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PLIOCENE MOLLUSCS FROM THE YORKTOWN AND CHOWAN RIVER FORMATIONS IN VIRGINIA

Lyle D. Campbell

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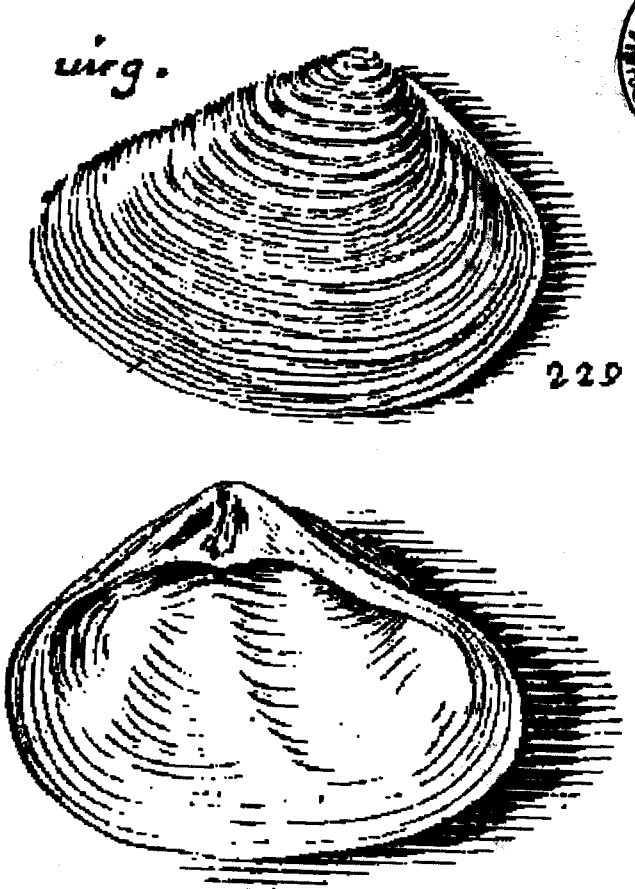

COMMONWEALTH OF VIRGINIA

DEPARTMENT OF MINES, MINERALS, AND ENERGY
DIVISION OF MINERAL RESOURCES
Stanley S. Johnson, State Geologist

CHARLOTTESVILLE, VIRGINIA
1993

FRONT COVER: *Eucrassatella virginica* (Gmelin, 1791), Figure 229 of Lister, 1685-92. This figure was named *Venus virginica* by Gmelin (1791). It illustrates the common Yorktown species later named *Crassatella undulata* by Thomas Say 1824, a named preoccupied by *Crassatella undulata* Lamarck, 1804. *Eucrassatella virginica* (Gmelin, 1791) appears to be the first invertebrate fossil species described from North America. Lister figured two other Yorktown species from colonial Virginia: *Mercenaria corrugata* (Lamark, 1818) is Lister's plate 499, 1688; and *Chesapecten jeffersonius* (Say, 1824) is Lister's plate 167, 1687.

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PLIOCENE MOLLUSCS FROM THE YORKTOWN AND CHOWAN RIVER FORMATIONS IN VIRGINIA

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ABSTRACT

Pliocene aged (4.5 to 2.5 million year bp) fossiliferous deposits underlie much of the Virginian Coastal Plain, and are frequently exposed in stream and river banks and in sand and gravel pits. Mollusk-dominated biotas characterize the three traditional biostratigraphic units present: lower, or Zone 1 Yorktown (105 molluscan species); upper, or Zone 2 Yorktown (507 molluscan species); and the Chowan River (108 molluscan species). Adjusting for overlap, a total of 572 molluscan species and subspecies are monographed, including 70 species and subspecies described as new. New supraspecific taxa proposed include a new genus, *Juliamitrella* (Columbellidae), and a new subgenus, *Odostomia (Chesapeakella)* (Pyramidellidae).

Systematic analysis of the Virginian Yorktown and Chowan River faunas has been hampered by a general lack of available literature, most of the significant literature being from the ninteenth century, and by the formidable number of species. Including valid names of documented taxa, their synonyms and misspellings, dubious records, and inadmissible names, over 2000 species level names can be found in the literature of the Virginia Pliocene.

Zone 1 faunules are often poorly preserved. The species are generally indicative of cold-temperate conditions. Zone 2 biotopes include brackish, sound, estuary, shallow sublittoral, open shelf, shell reef, shoal, and back-shoal habitats. Zone 2 deposits represent several transgressive-regressive sequences whose detailed stratigraphies are still being resolved. Taken collectively, the Zone 2 faunas reflect warm-temperate conditions not presently found in the western Atlantic. Preservation of Zone 2 faunas is good to exceptional. Chowan River faunules indicate shallow sublittoral, fresh water, and estuarine habitats, and the fossils commonly show physical and chemical deterioration.

A knowledge of the Yorktown and Chowan River species is essential for evolutionary and systematic studies of the Recent Western Atlantic fauna due to the considerable number of lineages that continue into the Recent, and because the holotypes of a surprising number of common Recent species were originally described from the Yorktown Formation.

FORWARD

This is the first thorough documentation of the molluscan fauna from the Yorktown and Chowan River formations in Virginia. Emphasis on illustration and brief descriptive text is designed to meet the needs of both the non-specialist and the professional. The work is modeled after the late Myra Keen's 1971 "Seashells of Tropical West America, (second edition)". An effort has been made to discuss all known species. It is hoped that the availability of a comprehensive guide will serve to standardize nomenclature and improve communication among stratigraphers, collectors, and systematists. It is also hoped that by documenting the full diversity of these exceptional beds, this guide will enable other workers to produce more accurate and thorough faunal surveys. Still, every field season brings new discoveries. Much work remains to be done, and to that ongoing effort I commit the present study.

INTRODUCTION

This work is an effort to correctly identify, accurately name, concisely describe, and adequately illustrate the 572 molluscan species and subspecies known from the Pliocene of Virginia. A minimum of technical terms are used, and most generic descriptions are taken with permission from Keen (1971), and Abbott (1974).

The need for this monograph can be illustrated by a brief review of the more pertinent literature. Although Yorktown fossils were known to the earliest English settlers (Ray, 1983), the first work to illustrate a specimen was by Lister (1687 and later editions). No further taxonomic work appeared until that of Lamarck, 1818, and of Say, 1824, who described the Virginian portion of the John Finch collection which had been erroneously cited as being from Maryland (Blackwelder and Ward, 1976). Conrad (1832) and Isaac Lea (1833) also described Finch material, and William and Henry Rogers published short works on the Yorktown fauna in 1835 and 1837. Timothy Abbott Conrad was the most prolific writer to study the fauna. His Yorktown works span the interval of 1832 to 1877.

H.C. Lea published a single work on the Petersburg, Virginia, faunules, but published that work four different times-as an abstract only (1843a), as a pamphlet with brief descriptions (1843b), as a preprint with illustrations and more complete descriptions (1845), and the same but with different pagination in the "Transactions of the American Philosophical Society" (1846). The reasons are now obscure, but the Leas probably were trying to insure priority over Conrad with whom they were feuding (Dall, 1893). Lea's Petersburg treatise listed or described about 180 species, which makes it the single most comprehensive published work to date dealing exclusively with Virginian Yorktown molluscs. H.C. Lea (1849) uncritically listed all Tertiary species proposed for the southeastern states, the first of several listings by various authors.

Possibly the most extensive mid-ninteenth century effort at systematizing all known fossil molluscs was d'Orbigny's (1850-1852) "Prodrome de Paleontologie". In

attempting to rectify the world literature, d'Orbigny created many new names for primary and secondary homonyms. Dall (1890-1903) cited approximately half of d'Orbigny's replacement names for North American species, and apparently all subsequent American Neogene works have referenced Dall rather than examined d'Orbigny's original. Many of d'Orbigny's replacement names are junior synonyms and therefore superfluous, but some are valid, and a number of previously overlooked names are here introduced into the American literature. Conrad's (1862) "Catalog of Miocene Fossils" included so few of the d'Orbigny names that it seems likely he learned of them through correspondence without seeing the work.

Meek's (1864) "Catalog of Miocene Invertebrates of the United States" was built on notes prepared by Conrad and included species from eastern and western North America. The influence of Conrad is obvious. Meek's list was the most thorough and scholarly North American check list to that date. Nevertheless, Meek's list introduced a variety of errors of locality, generic assignments, and varient spellings, some of which were probably typographical errors. Heilprin's (1884) synopsis of the Mio-Pliocene faunas of eastern North America was thorough, critical, and essentially North America was thorough, critical, and essentially accurate, but privately printed with a limited distribution, and has consequently been overlooked. Heilprin avoided many of the errors in the literature by basing his work on a re-analysis of the stratigraphic and type collections at the Academy of Natural Sciences in Philadelphia. Otto Meyer (1888) described a few new species from the bluffs at Yorktown, correctly noting that most of H.C. Lea's Petersburg, Virginia species could also be found there. Dall (1890-1903) in his monumental "Contributions to the Tertiary Faunas of Florida, with Especial Reference to the Miocene Silex-beds of Tampa and the Pliocene beds of the Caloosahatchee River", described or documented many Virginia Yorktown species. Dall's gastropod volumes (1890, 1893) stayed fairly close to the stated purpose of the title, but the subsequent volumes on bivalves ranged farther afield. Dall's mastery of the American Neogene faunas grew throughout the thirteen years of publication, producing a work of mixed quality. Dall's earliest published experience with Yorktown fossils is the list of species identified in perhaps 1886 or 1887, but published in Shaler (1890). Dall continues to be recognized as one of the two or three most eminent systematists and authorities on marine mollusks North America has ever produced, yet in the Shaler lists he missidentified 14 of the 26 species listed. Many of the errors were corrected without citation in Dall (1890-1903), but the list should stand as a warning to all who deal casually with the Yorktown faunas.

In 1904, the Maryland Geological Survey published its landmark "Miocene" volume, simultaneously the best single work ever published on the rich Maryland faunas and the most disastrous work for Yorktown studies. The problem lies not in the work itself, but in the extensive misapplication of Maryland Miocene names of Pliocene Virginian species. Faced with the bewildering array of Yorktown species and a dispersed literature, many student, stratigraphic, and paleontologic studies have succumbed to the "closest Maryland "Miocene" illustration" method of species identification. The work illustrates a few Yorktown specimens, substituting complete Virginia shells for fragmental Maryland material, but only about one in five species is shared between the Miocene Maryland and Pliocene Virginia faunas. Still, the largest single block of errors recorded in Appendix II, "Dubious and Rejected Species," are misidentifications based on the Miocene plates. A largely overlooked fact concerning the Maryland Miocene volumes is that the molluscan systematics sections were taken almost directly from doctoral dissertations by Martin or Glenn, and contain a number of errors typical of such works.

Clark and Miller (1906, 1912) formally defined the Yorktown Formation, and provided a faunal list of both Yorktown and pre-Yorktown species. Although helpful if used carefully, many species are incorrectly identified, and there is much scrambling of Yorktown and pre-Yorktown localities. For example, they followed Dall (1904)n rather than Meyer (1888) in placing the Petersburg localities in the Calvert middle Miocene, rather than in the Yorktown Formation.

Axel Olsson intended to monograph the Yorktown fauna (Moore, 1978), but other pursuits intervened. His intended dissertation on the Miocene of Virginia was never completed, and only two short papers (Olsson, 1914 and 1916) describing new species from the Yorktown and several other formations, reached publication. Perhaps the greatest contribution of these papers was the forceful restatement of equivalency between the Petersburg and York River faunules.

W.C. Mansfield described a few species from Yorktown localities (1928), but documented many more Yorktown records in his 1930 and 1932 works on the equivalent Jackson Bluff faunas of northwestern Florida. Also in the late twenties, J.K. Roberts at the University of Virginia began an extensive collecting survey around Yorktown in preparation for "The Lower York-James Peninsula" (1932). Only a few line drawings were included, but the Roberts collection became the basis for two unpublished masters theses, "Descriptions of the Majority of the Pelecypods of the Yorktown Formation of Virginia" (McGavock, 1935), and "Systematic descriptions of the Yorktown Gastropoda fauna" (Twardy, 1936). McGavock's work was essentially accurate and led to a brief publication (1944) of four new species. Twardy, however, borrowed uncritically from the Maryland "Miocene" volumes and his work is consequently less useful.

Julia Gardner's published involvement with the Yorktown fauna began with notes contained within her synopsis (Gardner and Aldrich, 1919) of a Duplin assemblage from Sumter County, South Carolina. New distributional records continued to appear in her work on the older Alum Bluff faunas of northwestern Florida (1926-1950), in which a few Yorktown species were illustrated as needed for comparison. Gardner's major contribution to the Yorktown faunas, however, was her U.S.G.S. Professional Paper 199, "Mollusca from the Miocene and Lower Pliocene of Virginia and North Carolina".

Horace Richards (1947) included Yorktown species in his "Invertebrate Fossils from Deep Wells along the Atlantic Coastal Plain," and Olsson and Harbison (1953) discussed and illustrated a number of Yorktown species for comparison with their Caloosahatchee fauna from St. Petersburg,

Florida. John Oleksyshyn (1960) added two species in "Some New Species of Miocene Mollusks from Maryland and Virginia." More recently there have been a number of shorter paleontologic and stratigraphic works that contribute faunal lists and some illustrations. References to these will be found in the systematic section or the appendices.

A major contribution to the understanding of the Yorktown strata and assemblages has been the Smithsonian Contributions to Paleobiology volumes edited by Ray (1983, 1987, and in preparation), which contain numerous articles including an important contribution by Ward and Blackwelder (1987) on the Upper Pliocene mollusks of Aurora, North Carolina.

Consequently, a proficiency in the Yorktown fauna requires a mastery of the literature of the entire western Atlantic Neogene from Massachusetts to the Caribbean, because the Virginia Yorktown fauna is of incidental importance to, and consequently is cited in most of the significant works. Another reason for searching the literature of more southern areas is that almost any contemporaneous western Atlantic species may show up in a Yorktown deposit. The most recent comprehensive survey of this literature (Campbell and others, 1975) cataloged 1553 species of Pliocene molluscs from Massachusetts to Florida. That work combined a literature search with documentation of many range extensions from my family's work in Virginia, the Carolinas, and Florida, and a systematic effort to document synonyms, homonyms, and current generic placement. The systematic revisions contained in that work have rarely been recognized or cited by subsequent authors, possibly because of the catalog format. The first goal of this monograph is to provide a thorough and critical synthesis of the Virginian Pliocene molluscan literature.

A second reason to monograph the Yorktown fauna is the abundance of new records from exceptionally diverse localities which have become available after 1960, including Rice's pit in Hampton, Zook's pit between Williamsburg and Yorktown, a stream cut exposed by construction on the campus of the College of William and Mary, and the westernmost cuts in the old Lone Star Cement Company pits in Chuckatuck, now Crane Lake, a park owned by the city of Suffolk. A large pit 2.5 km west of Deep Creek in the City of Chesapeake, sometimes also called the Yadkin pit, contains both Yorktown and the only consistently available Chowan River beds in Virginia. This pit is at present (1991) operated by Higgerson-Buchanan, Incorporated.

The need for a Yorktown monograph is obvious, but a monograph is a difficult undertaking.

> "Monographs, be they concerned with certain taxa, or with a given fauna, or both, present special problems and challenges. For the author, the main problem is to get the material published in this era of rising printing costs. There is a danger involved here, however; a danger which is directly related to the fact that no matter what, the monograph is bound to be part of the paleontological literature for a long time. This is for two reasons: descriptive work doesn't date to the same extent as more theoretical or analytic work will, as evidenced by the many 19th century descriptive works still cited regularly, and because whatever the author of a monograph has to say about a fauna or group is likely to remain the last word for a long time, given the relationship between the amount of material to describe, and the number of people available to do it. This danger can lead to complacency in that it is easy to be satisfied with merely describing the material, thus producing a work that everyone knows of but no one has read. The challenge is to transcend this possibility and to produce a work which will serve as both a reference for future workers and as a source of inspiration for others." (Lars Werdelin, 1989: 316).

Werdelin's observations underscore the necessity of careful and thorough work. Hasty, uncritical systematics perpetuate errors and produce more. There are any number of works, past and present, which contribute little of substance while externalizing to other workers the bother and tedium of putting sloppy work in order. On the other hand, the perfect monograph will never be written. In this work, an effort was made to examine all pertinent types available in the Smithsonian, the Academy of Natural Sciences, the American Museum of Natural History, and the Paleontological Research Institute. Homonyms and synonyms from 1758 to 1870 were determined through the listings of Sherborn (1892-1933) and Ruhoff (1980). Cited homonyms and synonyms were checked against types and original references. Also, an effort was made to review all literature pertaining to the Miocene-to-Recent systematics and distribution of the species discussed in this work. Weaknesses include a somewhat less thorough examination of the Caribbean literature, European literature, and of Paleogene works that include discussions of Atlantic Coastal Plain Pliocene taxa.

NOMENCLATURAL PHILOSOPHY

"Palaeontology is general suffers from too many species rather than too few." (Kermack, in Sylvester-Bradley, 1956, p. 101).

Nicol (1958) quotes from Newell (1956) as follows:

> "Morphologic forms artificially extracted from whole populations (e.g., polymorphs, ontogenetic stages, ecotypes, and individual variants) often are given formal Latin names as varieties or species. This action is defended on the grounds that all distinctive fossil forms are actually or potentially indices of stratigraphic horizon, hence deserving of separate recognition. As far as it goes there is some logic in this argument but the point of view on which it is based actually defeats one of the ultimate objectives in stratigraphy, which is the establishment of detailed, interregional fossil zones based on evolutionary development." (Newell, in Sylvester-Bradley, 1956, p. 66).
>
> "It hardly seems appropriate to burden international nomenclature with binominal or trinominal Latin names for categories which at

best have only local stratigraphic value and are devoid of evolutionary significance. Yet palaeontologists who favor the naming of artificial categories of scope less than whole populations unconsciously support the limited objectives of local and temporary advantage over the long term goal of world-wide stratigraphic zonation based on evolutionary succession. The individual variants might better be designated, if necessary, by non-Linnaean, vernacular names or numbers." (Newell, in Sylvester-Bradley, 1956, p. 73).

The nomenclatural philosophy used in the present work is a conservative one. I consider my systematic instincts to be of a biological and population focus, meaning that my concept of species allows room for much individual variation as demonstrated among any number of fossil and Recent molluscan species. Rather than seeking a balance between "splitter" and "lumper" taxonomy, I have sought to collect populations of each species from a number of localities and to determine the degree of morphological intergradation present within the population. I judge a morphospecies to be valid only when three or more form or sculpture components consistently differ across multiple populations. I also consider it legitimate to describe a fossil species from unique material if the species belongs to a genus not otherwise reported from the formation and if it shows multiple differences when compared with congeneric forms from other formations or Recent populations. Like most total fauna monographs, species evaluation in this work is mostly qualitative. It is hoped that the work will serve as the first rather than the last word on these many and varied taxa. Detailed quantitative morphometric statistical analyses such as that of *Anadara trilineata* Conrad (California Pliocene) by Alexander (1974) are needed for virtually every molluscan family present. New techniques of computer imaging and direct quantification of form provide great promise for future detailed systematic studies (D. Campbell, 1988). A significant problem for the few such studies published over the last twenty to thirty years has been failure to examine all proposed taxa within the family, genus, or tribe being studied. It is hoped that the present work will serve to alert present and future workers to the full diversity of taxa described in the existing literature.

Similarily, the nomenclatural concept of genus used in this work is conservative. I do not believe that a stratigraphic series or lineage of related species constitutes a separate biologic genus, but rather that a genus may contain many individual lineages. Provincial taxonomy is also avoided. I do not believe that geographic separation justifies the creation of multiple genera among morphologically similar taxa.

Variation through time is, itself, a subject worthy of detailed analysis. The literature contains much discussion of phyletic gradualism and punctuated equilibrium, the latter focused on homeostasis alternating with speciation events. However, homeostasis, the genetic tendency of individuals to cluster about a normative morphology, itself appears to vary episodically. In the early Pliocene, tightly clustered homeostasis appears to have broken down in certain groups, providing a somewhat bewildering array of morphologies among *Siphocypraea*, *Terebraspira*, *Calliostoma*, *Nassarius*, *Ilyanassa*, *Glycymeris*, *Astarte*, and *Macrocallista*, to mention a few. The sinistral *Busycon* and *Conus* appeared at this time and generated a number of bizarre but intergrading morphologies. No certain environmental or genetic trigger has as yet been documented, but the phenomenon was both extensive in that several dozen genera were nearly simultaneously affected, and selective in that many other genera retained a very conservative homeostasis. I suggest that the phenomenon of exceptional variation be called heterostasis. I concur with Nicol (1958) in arguing that it is biologically and paleontologically unsound to separately describe the various entites within these impermanent swarms of morphological variation. Eventually a more familiar, conservative homeostasis emerged in which the species either returned to its initial limited diversity of form as in *Glycymeris* and *Macrocallista*, or a small number of morphotypes emerged from the swarm to establish stabilized, apparently sympatric new species. I have perpetuated names for two such heterostatic swarms, the *Calliostoma mitchelli* species group and the *Illyanassa harpuloides* species group, on the rather poor argument that there are small, sometimes consistent, morphological differences and that these have been treated extensively in our literature for over a century as species level taxa. The individual morphotypes are here given subspecies rank, but biologically they are little more than varieties.

Subspecies level names in Neogene molluscan literature have a varied history of usage. Dall (1890-1903) largely used subspecific designations for segregatable varieties, a practice now generally rejected. Mansfield (1930, 1932) developed a regional taxonomy, frequently separating Jackson Bluff species from their Duplin equivalents by the creation of subspecific taxa. Ward (1992) has used subspecies to delineate stratigraphic variation within bivalve lineages from the Miocene of Virginia and Maryland. Current biologic usage resiricts subspecies to allopatric subpopulations. By this uage, two or more subspecies should not cooccur in a single locality or bed, and sympatric nominate subspecies must be reinterpreted as interspecific variation within a single species, or as multiple, subtle but discrete species.

I believe that the subspecies concept may have a morphologic validity in paleontological work, even when allopatric conditions cannot be demonstrated. As and operating procedure, I require at least three distinct, unique traits before naming a new morphospecies. The subspecies level may be appropriate when two taxa differ consistantly in one or two traits. *Scaphella solitaria solitaris* from the St. Marys Formation, Late Miocene of Maryland has a keeled and beaded shoulder, and *Scaphella solitaria ricei* (new, this work) has a sloping, noded shoulder. In all other respects, the shells are identical.

A second usage of subspecies in this work is to delineate taxa which appear discrete by the three trait rule, but which are either closely allied to one of the sympatric heterostatic complexes, or are members of a species whose varieties are conservative within a population, but show great variation in time and space. Of the four remaining subspecies described in this work, I judge *Terebra emmonsi hamptonensis* to be within a sympatric heterostatic swarm of variation.

Calliostoma mitchelli johnsoni and *Calliostoma virginicum jeffersonicum* are older, Zone 1 ancestors to much more variable Zone 2 heterostatic complexs. *Carolinapecten eboreus chesapeakensis* from the Chowan River Formation appears to be a discrete taxon, but the *Carolinapecten eboreus* stock is one of the best examples of conservative individual populations contrasting with rampant variation in time and space.

STRATIGRAPHY

The published lithostratigraphy of the Yorktown (Ward and Blackwelder, 1980) and Chowan River (Blackwelder, 1981a) Formations is summarized in Figure 1. Ward and Blackwelder (1980) named formal members as follows: the Sunken Meadow Member which is identical with the Zone 1 beds of Mansfield (1944), the Rushmere Member, Morgarts Beach Member, and the Moore House Member, the latter three being equivalent to the Zone 2 of Mansfield (1944). At its type section, the Rushmere Member consists of one to two meters of silty sands and common shell overlain by the Morgarts Beach Member. The type section contains a lower Zone 2 molluscan assemblage. The Morgarts Beach Member consists of silt and clay beds as much as 10 meters thick, containing fewer shells and occasional stringers of sand. The Moore House Member at its type locality consists of weakly to well cemented, fragmented shell calcarenite associated with large scale crossbeds. However, as applied by Ward and Blackwelder (1980) and subsequent authors, these units are treated as biostratigraphic and chronostratigraphic packages of mixed sediments often having little lithically in common with the type sections. The Moore House supposedly includes the beds at Rice's Pit and the Zone 2 beds at the Deep Creek Industries pit near Yadkin, even though both sites exhibit thick silt-clay beds. The Chuckatuck megacrossbeds were placed in the Rushmere even though they are lithically most similar to the Moore House.

The Chuckatuck beds merit special mention because of two dissimilar interpretations. Ward and Strickland (1985) have advanced the hypothesis that structural uplift pushed a horst of Rushmere sands into wave base, creating a large barrier. On the immediate back-flank, the mega-crossbeds were deposited while the Morgarts Beach silts and clays accumulated in the quiet water basin behind the barrier. Ward and Strickland (1958: 89) postulate a three step model:

"1. Sedimentation is essentially even-textured on a generally featureless, slightly seaward-dipping, shallow shelf.
"2. A structural failure, perhaps due to loading, creates a barrier.
"3. Later deposition across this feature creates a monocline, with thicker, finger-grained deposits accumulating on the backside while coarser sediments accumulate with increasing proximity to the apex. The beds dip rather steeply behind the structure, but seaward of the apex they dip very gently."

The structural hypothesis supports the prediction of a single barrier event. The strengths of this model are its compatibility with the structural model of Brown, Miller, and Swain (1972), and its ability to explain the reversal of dip occasionally encountered across the Virginia Coastal Plain. Its major limitation lies in step 1. Uchupi (1968) has documented hundreds of shoals and sand swells across the Recent Western Atlantic continental shelf between Nova Scotia and the Florida Keys. A "featureless" shallow shelf is therefore exceptional rather than normative, at least for the Recent.

I have advanced a sedimentary hypothesis (Campbell 1976, 1982) for the Chuckatuck barrier (Figure 2), arguing for the development of multiple shoal fields across the Yorktown continental shelf with the Chuckatuck barrier being simply one of the larger examples. Sand swells built during transgressive phases and high stands become shoals or even islands during recessive seas. Postulated sedimentation around the barrier is identical for both models. The sedimentary hypothesis argues for multiple episodes of surf-winnowed shell concentrates, mega-crossbedding, and silt-clay deposition, the episodes being repeated in both space and time. The strengths of this model are its capacity to explain reversed dip, its use of a common, pervasive, and well-documented Recent phenomenon (shoal fields), its dependence upon multiple transgressive-regressive episodes (at least five are documented for Zone 2 beds by Krantz (1991)) and its compatibility with the existance of numerous and varied shoal fields within the Zone 2 beds.

A complete cross section of the model cannot be demonstrated in outcrop, but the Chuckatuck complex at the Lone Star Cement Company pit (now Crane Lake) preserved lithofacies 1, 2, 3, and 5 (Figure 2). Other partial expressions include the James River section at Rushmere, which includes in ascending order: Zone 1 beds in the shallow subsurface, then a facies 1 silt (stratotype for Rushmere Member) capped by a thin bed of facies 5 sands with increased species diversity; a second facies 1 sequence (Morgarts Beach Member) capped by facies 3 horizontal, fragmental sands. To the east, near Mogarts Beach, facies 1 silt-clay beds (stratotype Morgarts Beach Member) are overlain by facies 5, open shelf sands with much increased species diversity. On the campus of William and Mary in Williamsburg, a stream cut preserved facies 4 shell sands overlain by facies 1 clay. Overlying the clay were sands containing brackish water faunules which became progressively more saline up section, clearly a transgressive phase, culminating in facies 5 sands. Rice's pit preserved a facies 1 basal silt overlain by facies 5 open marine sands. Less than two kilometers to the east, a well drilled for a heat pump encountered intensely fragmented, winnowed shell from either facies 2 or 3. The Deep Creek pit again preserves facies 1 silt-clays and sandy silts overlain by coarsely winnowed, crossbedded sands of facies 2, then open ocean sands of facies 5. These are then overlain by the Chowan River beds. The section at Yorktown exhibits the macro-crossbeds of facies 2 (Cornwallis' Cave) overlain by the horizontal, intensely fragmented facies 3 sediments of the stratotype Moore House. Southeast of Benn's Church, Virginia an extension of the Chuckatuck barrier is exposed in a sand pit exposing the silt-clay facies 1 beds overlain by facies 2 mega-crossbeds. Fragmental beds are found from the Piankitank River discontinuously south to Suffolk. Therefore, segments of the lithostratigraphic sequences predicted by the sedimentary model for the Chuckatuck barrier are

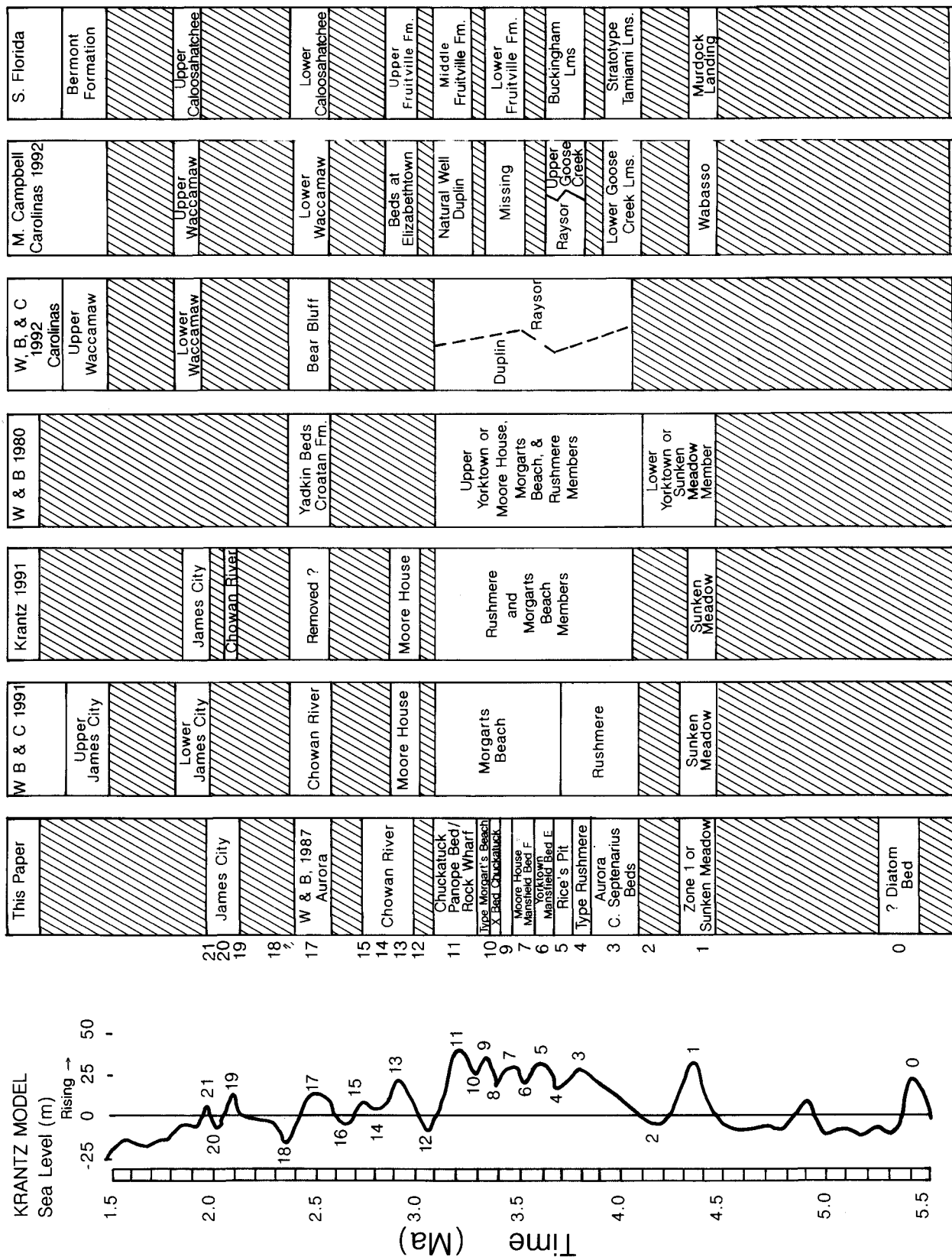

Figure 1. Correlation chart comparing the Krantz Oxygen Isotope model with Yorktown stratigraphy, previous stratigraphic proposals, and probable stratigraphic equivalents from South Carolina and South Florida.

repeated extensively throughout the Zone 2 Yorktown in Virginia, both on and away from the tectonic axes proposed by Brown, Miller, and Swain (1972).

Zullo and Harris (1990) have proposed a Sequence Stratigraphy model for the Pliocene of Virginia and northeastern North Carolina, and use it to interpret the stratigraphy of southern Florida. Their model assumes the accuracy of the Ward and Blackwelder (1980) sequence, and ,is therefore, subject to the same criticisms outlined below.

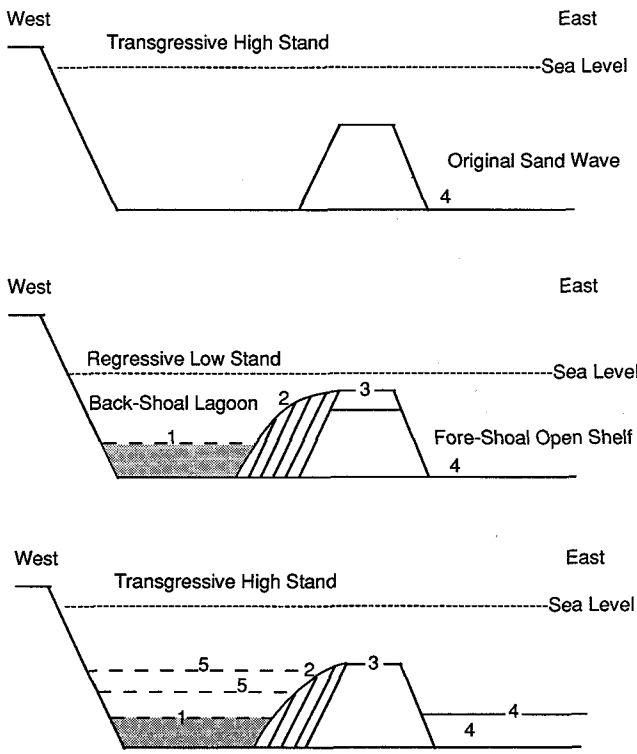

Figure 2. Sedimentary model for the Chuckatuck barrier. Lithofacies: 1. Silt-clay, often >90%: infaunal bivalves commonly paired, in life position. 2. Mega-crossbedded tempestite deposits; fragmented, winnowed shell carbonate, often >80%; bivalves rarely paired or in life position. 3. Horizontal, intensely fragmented shell sand; winnowed shell carbonate may exceed 95%; no undisturbed infauna. Surf planation phase. 4. Fore-shoal, bioturbated, relatively unsorted shell sands; common undisturbed infauna. 5. Open shelf, bioturbated, relatively unsorted sand.

BIOSTRATIGRAPHY

Mansfield (1944) was the first to propose an effective biozonation for the Yorktown Formation, recognizing a lower, or Zone 1, *Placopecten clintonius* zone, and an upper, or Zone 2, *Turritella alticostata* zone, the latter informally divided into beds which he believed to have a superposition order (Figure 3). Hazel (1971) proposed ostracode zones, recognizing a lower, or *Pterygocytheris inexpectata* zone, and upper *Orionina vaughani* zone essentialy equivalent to Mansfield's Zones 1 and 2. However, Bailey (1987) documents the *Pterygocytheris inexpectata* zone from basal Zone 2 beds. Hazel's *Puriana mesocostalis* zone corresponds with the Chowan River beds. Blackwelder (1981) has proposed interval zones and stages for the Yorktown and Chowan River Formations. His zones M6, M5, and M4 are equivalent with Mansfield's Zone 1 and overlying unconformity, Zone 2 and overlying unconformity, and Chowan River beds respectively. As proposed, Blackwelder's zones and stages include both depositional units and unconformities, and therefore are time rather than time-rock units.

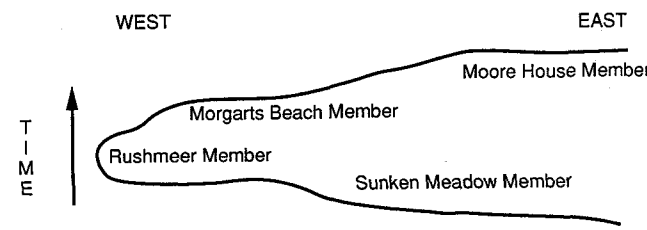

Figure 3. Single Pluse model for Yorktown deposition.

Zone 2 faunules have been slow to yield a coherent subzonation. Mansfield (1929; 1944:2) proposed an informal, threefold division of "Upper part (beds at Suffolk); Middle part (beds at Yorktown), and Lower part (including *Chama*-bearing bed)." He also believed that the "Biggs Farm" fauna from near Franklin, Virginia, was younger than the beds at Suffolk (Mansfield, 1944:8-9). However, Ward and Blackwelder (1980) cite a single faunal list for Morgarts Beach, Rushmere, and Moore House Members, and my own work initially seemed to document high diversity assemblages drawn from essentially a single species pool. New work by M. Campbell (1992, in preparation) in North and South Carolina indicates that there are significant biostratigraphic subdivisions in the Zone 2-equivalent interval in that area. His biostratigraphic analysis of South Carolina Pliocene molluscs is shown in Tables 1 and 2.

The direct transfer of total faunal comparisons between the Yorktown basin and the Pliocene Carolina basin is complicated by percentage data that best correlates all Yorktown basin faunas, including Zone 1, with the Natural Well fauna (Table 3). This bias is the result of commonality-components dominated by species widespread in space and time, and also by the enormous number of species recovered from Natural Well and its directly equivalent assemblages at Tearcoat Branch and Muldrow Place, Sumter County, South Carolina. This high species richness substantially increases the chances of any given species of a smaller assemblage also occurring in the Natural Well biota. The Dice Similarity Coefficient is a better measure of disparate diversity assemblages (Table 3); and produces an array of biostratigraphic correlations more consistent with those of the southern basin.

Index zonation developed for the Carolinas (M. Campbell, 1992, in preparation) is more directly transferrable to Virginia and provides an independent measure of biostratigraphic patterns, despite difficulties including problems of reworking, refugia, and variable extinction (Tables

Table 1. Percentage and Dice Similarity coefficients for Pliocene faunas of southern North Carolina and South Carolina (M. Campbell, 1972, in preparation).[1]

	R	UW	LW	D	RA	UGC	LGC	W	M	
R	-	48.2	38.6	21.0	21.2	20.8	22.7	-	-	R
UW		-	75.6	49.1	25.6	19.3	12.5	-	10.1	UW
LW			-	45.4	23.1	17.2	11.5	-	7.6	LW
D				-	39.1	30.5	20.1	-	12.5	D
RA		PERCENT IN			-	53.1	36.4	-	27.3	RA
UGC		COMMON				-	51.7	-	25.3	UGC
LGC		%					-	-	28.6	LGC
W								-	-	W
M									-	M

% calculations based on the N number of the younger of the two units compared.

	R	UW	LW	D	RA	UGC	LGC	W	M	
R	-	.540	.468	.268	.186	.167	.141	-	-	R
UW		-	.684	.418	.316	.253	.185	-	.212	UW
LW			-	.430	.305	.239	.179	-	.183	LW
D				-	.535	.437	.318	-	.267	D
RA	DICE SIMILARITY				-	.574	.463	-	.360	RA
UGC	COEFFICIENTS					-	.620	-	.315	UGC
LGC							-	-	.300	LGC
W								-	-	W
M									-	M

R = ALSO RECENT

1 Abbreviations used in Tables 1, 2, 3, 4, and 5.

UW = UPPER WACCAMAW N = 336 mollusc species. Index species include *Carolinapecten solaroides*, last *C. eboreus senescens* and *Argopecten vicenarius*

LW = LOWER WACCAMAW N = 407 Index species include *Pecten holmesii*, *Stralopecten ernestsmithii*, first appearance of *Carolinapecten eboreus senescens* and *Argopecten vicenarius*.

D = STRATOTYPE DUPLIN N = 453 Fauna contains many tropical species, but no unique calcitic species. *Scaphella trenholmii* is common.

RA = STRATOTYPE RAYSOR N = 209 This appears to be, at least in part, the near shore, sandy, clastic equivalent of the Upper Goose Creek Limestone.

UGS = UPPER GOOSE CREEK N = 178 *Nodipecten peedeensis*, *Ecphora bradleyae*, last occurrence of *Chesapecten septenarius* and *Encope macrophora*, fauna contains many tropical species. Calcite and mold preservation.

LGC = LOWER GOOSE CREEK N = 119 rare *Chesapecten jeffersonius*, common *C. septenarius*, *Nodipecten collierensis*, *Encope macrophora*. Calcite and mold preservation.

W = WABASSO N = 2 common *Chesapecten jeffersonius*. Calcite and mold preservation. N-18 Foraminifera present (Huddlestun, 1988). Number of mollusc species too small for meaningful comparison.

M = ALSO MIOCENE

Table 2. Range zones of twenty Pliocene mollusk species from the Carolinas (after M. Campbell, 1992, in preparation). Unit symbols as in Table 1.

	a	b	c	d	e	f	g	h	i	j	k	l	m	n	o	p	q	r	s	t
R																		o	o	
																			o	o
UW																o	o	o	o	
																	o	o	o	o
LW														o	o	o	o	o	o	
D										o	o	o								
											o	o								
RA					o	o	o	o	o	o	o	o								
					o	o	o	o	o	o	o	o								
UGC				o	o	o	o	o	o	o	o									
					o	o	o	o	o		o									
LGC		o	o	o	o	o	o	o	o		o									
		o							o											
W = Z1		o	o							o										
									o											
M									o											
	a	b	c	d	e	f	g	h	i	j	k	l	m	n	o	p	q	r	s	t

CAROLINA INDEX SPECIES

a. *Placopecten clintonius* (at Aurora, NC)
b. *Chesapecten jeffersonius*
c. *Placunanomia burnsii*
d. *Chesapecten madisonius* (10-14 rib average)
e. *Chlamys decemnarius*
f *Chesapecten septenarius*
g. *Encope macrophora*
h *Anadara propatula*
i. *Striarca centenaria*
j. *Glycymeris americana abberans*
k. *Hemimetis magnoliana*
l. *Plioptygma carolinensis*
m. *Coralliophila leonensis*
n. *Pecten holmesii*
o. *Stralopecten ernestsmithii*
p. *Scaphella precursor*
q. *Carolinapecten eboreus senescens*
r. *Argopecten vicenarius*
s. *Abra aequalis*
t. *Mulinia lateralis*

4 and 5). Species that became extinct in one basin may survive in another. For example, *Pecten hemicyclicus* Ravenel, restricted to the Goose Creek Limestone in South Carolina, occurs in Virginia as worn specimens of the upper valve in the apparently younger Chuckatuck crossbeds. Three arguments in support of the validity of the transfer of more southern index zonation into the Yorktown basin are: 1. the use of numerous species rather than a single index: 2. paleolatitude climatic gradients which would predict harsher rather than milder Virignia Pliocene marine climates during the glacio-eustatic regressions and therefore more severe extinction rather than refugia conditions; and 3. the consequent statistical ranking of total faunal statistics when ordered by index species (Table 4). Thus the extension of the Carolinian index zonation provides an independent measure of biostratigraphic patterns in the Yorktown basin.

In the following analysis, matricies of percentage and of Dice Similarity data are used rather than dendrogram cluster analysis. Dendrogram analysis has been used effectively by Hazel (1971) for Yorktown and Chowan River ostracodes.However, as a technique for zoogeographic and chronostratigraphic analysis, dendrograms strongly emphasize the primary or first order similarities to the neglect of second order relationships. For the analysis used herein, total assemblages are compared across nine different stratigraphic intervals ranging from Miocene to recent. This allows a more detailed analysis of biostratigraphic trends, especially when the differences are subtle.

THE KRANTZ (1991) MODEL FOR PLIOCENE SEA LEVEL FLUCTUATION

Krantz (1991) has synthesized the global literature of oxygen isotope records to create a predictive model of transgressions and regressions across the Atlantic Coastal Plain (Figure 1). Krantz cross correlated the model with the stratigraphy and chronostratigraphy proposed by Ward and Blackwelder (1980) and Blackwelder (1981a) (see also Cronin and others, 1984). The Krantz predictive Oxygen isotope model provides an extremely important tool in sorting out the Pliocene stratigraphy of the Atlantic Coastal Plain from Virginia to Florida, and for testing the compatibility of various stratigraphic schemes that have been

Table 3. Percentage and Dice Similarity (D) Coefficients for the biostratigraphic units of the Yorktown basin in comparison with those of South Carolina. R to M, see Table 1; JMC = type area James City Formation; CR = stratotype Chowan River; CKP = *Panopea* bed at Chuckatuck; CKX = fragmental, Chuckatuck crossbeds; MD = Morgarts Beach; RP = Rices Pit; RS = stratotype Rushmere; Z1 = all localities, zone 1

		R	UW	LW	D	RA	UGC	LGC	M
JMC	%	47.8	85.9	82.6	61.9	40.2	35.9	19.6	32.6
	D	.247	.369	305.	.209	.246	.244	.171	.300
CR	%	32.5	68.3	61.8	68.3	44.7	37.4	21.7	30.1
	D	.207	.366	.287	.292	.331	.306	.223	.320
CKP	%	18.9	37.4	39.8	72.9	40.5	31.7	19.3	20.1
	D	.187	.326	.309	.531	.449	.375	.265	.283
CKX	%	18.9	37.0	41.3	77.5	45.7	32.3	22.4	23.6
	D	.185	.319	.318	.557	.501	.380	.306	.331
MD	%	17.1	22.8	28.6	65.7	45.7	42.8	31.4	40.0
	D	.404	.43	.045	.094	.131	.141	.143	.196
RP	%	18.0	30.5	33.5	64.8	42.1	31.3	23.6	23.6
	D	.169	.250	.244	.440	.443	.355	.313	.323
RS	%	16.2	36.5	36.5	71.6	55.4	51.3	39.2	51.3
	D	.071	.132	.112	.201	.290	.302	.301	.418
Z1	%	14.3	30.5	27.6	60.0	45.7	42.8	30.5	39.0
	D	.081	.145	.113	.226	.306	.318	.286	.385

Table 4. Percentage and Dice Similarity Coefficient matricies for Pliocene faunas of Virginia and Northeastern North Carolina. Unit abbreviations as in Table 3.

PERCENTAGE

	N	R	JMC	CR	CKP	CKX	MB	RP	RS	Z1	M
R		-	47.8	32.5	18.9	18.9	17.1	18.0	16.2	14.3	-
JMC	92		-	57.8	39.1	46.8	14.3	36.1	17.4	20.7	32.6
CR	123			-	51.2	64.4	20.1	43.3	18.7	27.1	30.1
CKP	259				-	77.6	71.4	59.3	22.4	21.6	20.1
CKX	254					-	74.3	63.2	24.8	24.0	23.6
MB	35						-	80.6	62.9	40.0	40.0
RP	233							-	23.8	25.5	23.6
RS	74								-	52.7	51.3
Z1	105									-	39.0
M											-

% calculations based on the N number of the younger of the two units compared.

DICE	JMC	CR	CKP	CKX	MB	RP	RS	Z1
JMC	-	.495	.205	.249	.079	.203	.193	.193
CR		-	.330	.350	.089	.298	.234	.298
CKP			-	.784	.170	.622	.348	.308
CKX				-	.180	.657	.384	.340
MB					-	.207	.404	.200
RP						-	.365	.355
RS							-	.436
Z1								-
M								

Table 5. Range zones of twenty Pliocene mollusk species from Virginia and Northern North Carolina. * = also Carolinian. Unit abbreviations as in Table 3.

	a	b	c	d	e	f	g	h	i	j	k	l	m	n	o	p	q	r	s	t
R																			o	o
																			o	o
JMC																	o	o	o	o
																	o	o	o	o
CR														o	o	o	o	o	o	o
CKP											o	o	o							
											o	o								
MB									o	o	o	o								
									o	o	o	o								
RP/YD					o	o	o	o	o	o	o	o								
					o	o		o	o	o	o	o								
RM		o	o	o	o	o		o	o	o	o	o								
		o							o	o										
Z1	o	o							o	o										
									o	o										
M									o	o										
	a	b	c	d	e	f	g	h	i	j	k	l	m	n	o	p	q	r	s	t

YORKTOWN BASIN INDEX SPECIES

a. *Placopecten clintonius*
b. *Chesapecten jeffersoniux**
c. *Leptopecten leonensis**
d. *Chesapecten madisonium* (10-14 rib average*)
e. *Chlamys decemnarius**
f. *Chesapecten septenarius**
g. *Encope macrophora**
h. *Anadara propatula**
i. *Striarca centenaria**
j. *Clinocardium virginianum**
k. *Hemimetis magnoliana**
l. *Chesapecten madisonius* (16-18 rib average)
m. *Coralliophila leonensis**
n. *Carolinapecten eboreus* (large, flat ssp.)
o. *Eucrassatella kauffmani*
p. *Gari dalli*
q. *Noetia limula**
r. *Anadara aequicostata**
s. *Abra aequalis**
t. *Mulinia lateralis**

proposed. Evidence discussed below will challenge the concept or placement of particular Yorktown basin stratigraphic units as proposed by Ward and Blackwelder, and correlated by Krantz (1991) (Figure 1, columns 3 and 4), but the isotope curves are extremely well supported, and can be expected to withstand significant revision for the foreseeable future. For convenience of reference, the transgressions and regressions of the Krantz model are here assigned informal K-numbers, ranging from K-1 for the Yorktown zone 1 transgression to K-21 for the last James City-Waccamaw transgression.

CORRELATION AND DISTRIBUTION OF BIOSTRATIGRAPHIC FAUNAL UNITS IN VIRGINIA AND NORTH CAROLINA

K-O PRE-YORKTOWN PLIOCENE: The Krantz model indicates a major transgression at about 5.5-5.4 million years bp. William Abbott (1989, personal communication) found earliest Pliocene diatom beds in the vicinity of Petersburg, Virginia, which were subsequently placed in the top of the late Miocene Eastover Formation, based on recommendations during peer review. Therefore the existance of pre-Yorktown Pliocene in the study area is equivocal at present.

K-1 ZONE 1 YORKTOWN, SUNKEN MEADOW MEMBER, WILTONIAN STAGE, *Placopecten clintonius* zone, M-6.

Zone 1, all localities N = 105

	R	JMC	CR	CKP	CKX	RP	RS	Z1	M
%	14.3	18.1	32.3	53.4	58.1	57.3	37.2	100	39.0
Dice	.081	.193	.298	.308	.340	.355	.436	1.00	.385

Unit abbreviations as in Table 3.

Distinctive molluscan index species for zone 1 include *Placopecten clintonius*, *Turritella bipertita* (synonym: *I. pilsbryi*), and *Fusinus propeparilis*. *Chesapecten jeffersonius* is dominant only in Zone 1, but also occurs rarely in the immediately suprajacent beds. Zone 1 beds are found from the Piankitank River to the Aurora, North Carolina pits, but

are most extensively exposed along the York and James Rivers. Equivalent beds in the subsurface from South Carolina to Florida have been called the Wabasso beds by Huddlestun (1988). Apart from *Chesapecten jueffersonius* and *Ostrea sculpturata* recovered by SCUBA divers from the bottom of the Savannah River, nothing is known of the Wabasso macrofauna. Both Zone 1 beds and the Wabasso yield N-18 planktonic foraminifera (Ward and Blackwelder, 1980; Huddlestun, 1988) or lower N-19 (Chronin and others, 1984). The Krantz model predicts an age of 4.3 to 4.5 my.

Blackwelder (1981) assigns the Zone 1 Yorktown to his M-6, or *Chesapecten jeffersonius-Chesapecten madisonius* interval zone. He states that these beds contain about 5% living species of molluscs, but of the 105 species documented in the present work, 14.percent are extant.

ZONE 2 YORKTOWN, RUSHMERE, MORGARTS BEACH, AND MOORE HOUSE MEMBERS, BURWELLIAN STAGE, *Turritella alticostata* zone, M-5

As noted above, Zone 2 faunules have been slow to yield a coherent biostratigraphic subdivision. The work of M. Campbell (1992, in preparation), analyzing the distribution of 1127 Pliocene molluscan species from the Carolinas and Virginia has yielded a statistical biostratigraphy and index faunal zonation, which effectively divides the Zone 2-equivalent beds in South Carolina. To a reasonable degree, this more southern index zonation can be correlated into Virginia (Tables 1 to 3).

K-3 THE BASAL ZONE 2, OR AURORA, NC, BEDS

Gibson (1987, fig. 2) has described 9.43 meters of aragonite-leached section belonging to this interval in the Texasgulf Sulfur Aurora, North Carolina pits and has discussed the pectenid assemblage for these beds. Index species include an early race of *Chesapecten madisonius* having 10-14 ribs, *Leptopecten leonensis*, the first occurrences of *Chlamys decemnarius* and *Chesapecten septenarius*, and the last occurrence of *C. jeffersonius*. These beds are of very limited distribution in Virginia, being known only from the Piankitank River (Blackwelder, 1981, pl. 4, fig. 3), and from banks of a small stream between the York and Piankitank rivers. The unit is directly equivalent to the lower unit of the Goose Creek Limestone in South Carolina and with the Tamiami Limestone (original sense) in southern Florida. Bailey (1973) includes these beds with typical Zone 1 beds in his Unit II. In all known localities, this unit is a calcarenite leached of aragonite shells. Snyder and others (1983) give a Lower Pliocene age of PL-1 to PL-3, based on planktonic foraminifera from Aurora. This unit contains *Pterygocytheris inexpectata* ostracode zone species (Hazel, 1983). The Krantz model predicts an age of 3.9 to 4.1 my.

K-4 THE STRATOTYPE RUSHMERE, AND RICE'S PIT AND DEEP CREEK SILT BEDS

Rushmere stratotype N = 74

	R	JMC	CR	CKP	CKX	RP	RS	Z1	M
%	16.2	21.6	31.1	78.3	85.1	76.2	100.	52.7	51.3
Dice	.071	.193	.234	.348	.384	.365	1.00	.436	.418

Rice's pit silt N = 32

	R	JMC	CR	CKP	CKX	RP	RS	Z1	M
%	18.7	31.2	50.0	78.2	78.8	85.1	59.4	53.1	59.4
Dice	.041	.161	.206	.172	.175	.204	.358	.248	.271

Deep Creek pit silt N = 62

	R	JMC	CR	CKP	CKX	RP	RS	Z1	M
%	16.1	24.2	41.9	88.7	92.0	91.0	56.4	45.2	50.0
Dice	.061	.195	.281	.343	.361	.380	.515	.335	.365

Unit abbreviations as in Table 3.

The onset of regressive bar and sound deposition producing winnowed fragmental beds (facies 2 or 3), and silt and clay accumulation (facies 1) alternating with transgressive, open marine shell sand deposition (facies 4 and 5) begins in the Yorktown basin with the silty sands at the stratotype Rushmere, south bank of James River at Burwells Bay. The Rushmere stratotype section contains approximately 1.5 to 2 meters of silty sand with abundant shell. *Chesapecten madisonius* has evolved into the more advanced, 16-20 rib morphology. Common species include *Chesapecten septenarius*, *Chlamys decemnarius*, *Astarte roanoakensis*, and *Chama congregata*, the latter being commonly paired but not developed into bioherm reefs such as may be found higher in the section. The assignment to the K-4 regression of the Krantz model is based on silt-clay sediment type, high total faunal affinity for the Zone 1 and Miocene faunas, and superposition, the Rushmere Member in Burwells Bay immediately overlying typical Zone 1 beds.

Faunules of the Rice's Pit and the Deep Creek Pit silt and clay beds show a high Dice similarity to the fauna of the Rushmere stratotype. These silty beds also underlie sandier, more open ocean deposits with faunas indicative of the K-5 transgression. Very soft, silt-clay mud substrates are hostile environments and relatively few molluscan families can successfully exploit them. Those that are successful tend to be present in great numbers, and contain species having considerable stratigraphic longevity. All Yorktown silt and clay beds, regardless of their location in stratigraphic section, show reduced diversity and about 50% commonality with Miocene silt assemblages. Most pervasive are species of *Nucula*, *Nuculana*, *Yoldia*, and *Cadulus*. At Rice's pit, *Turritella alticostata* also dominates the assemblage, and at the Deep Creek pit, *Chesapecten madisonius* abounds in silty sand, providing a hard substrate for a variety of epibenthics including *Crepidula*, *Ostrea*, corals, barnacles, and annelids. Bones of a Pliocene Walrus have been recovered in the silty beds at Deep Creek.

The Krantz model predicts an age of 3.85 to 3.9 my.

K-5 *Chama* REEF, RICE'S PIT, AND THE DEEP CREEK PIT

Williamsburg Golden Horseshoe Golf Course *Chama* Reef N = 116

	R	JMC	CR	CKP	CKX	RP	RS	Z1	M
%	19.8	16.4	30.2	79.4	85.3	78.0	44.0	41.3	33.6
Dice	.121	.183	.293	.491	.535	.516	.537	.434	.348

Rice's pit, upper beds N = 233

	R	JMC	CR	CKP	CKX	RP	RS	Z1	M
%	18.0	14.0	22.5	65.4	68.4	100.	23.8	25.5	23.6
Dice	.169	.203	.298	.622	.657	1.00	.365	.355	.323

Deep Creek Pit, upper Zone 2 beds N = 229

	R	JMC	CR	CKP	CKX	RP	RS	Z1	M
%	19.2	14.0	21.8	70.3	76.4	65.7	24.0	23.1	20.5
Dice	.178	.199	.284	.660	.725	.649	.363	.317	.279

Unit abbreviations as in Table 3.

The upper beds at Rice's Pit contain a number of unique, subtropical range extensions such as *Triplofusus giganteus*. Several rare elements such as *Bullata oviformis*, *Conus adersarius*, and *Solariella ricei* are shared with the *Chama*-reef faunules, and numerous new taxa and range extensions are restricted to Rice's Pit and the Deep Creek pit. A number of species such as *Acteon novellus* which are extremely rare in other localities are relatively common at Rice's Pit. The three localities also contain a number of disparate elements, probably reflective of their varied lithologies, the *Chama* bed being a shell carbonate bioherm, the Deep Creek beds containing a coarse, well-sorted shell sand, and the Rice's Pit beds containing a less well sorted, slightly silty sand.

Placement in K-5 is based on the total faunal statistics showing a continued strong affinity for Rushmere and older deposits, on superposition, and on the last occurrence of a number of species including *Teredina fistula* (previously placed in *Kuphus*), *Chlamys decemnarius*, *Clinocardium* (*Planicardium*) *virginianum*, *Scaphella solitaria riceii*, *Panopea goldfussi*, *Striarca centenaria*, *Chesapecten septenarius*, *Anadara propatula*, and *Encope macrophora*. Most of these taxa extend into the more southern depositional basins of South Carolina and Florida, and there are restricted to pre-Natural Well (stratotype Duplin) and equivalent units. K-5 correlatives include the Raysor Marl and the upper unit of the Goose Creek Limestone in South Carolina and the "bed 10" at the APAC pit in Sarasota, Florida. These beds also appear to correlate with the Buckingham Limestone of south Florida as originally defined by Mansfield (1938), based on the common presence of a very large, warped subspecies or variant, *Carolinapecten eboreus walkerensis*, in the Carolinas and Florida.

Age of the K-5 beds has been given as N-19 (Akers, 1972) for beds at Rice's Pit, and 4.4 ± 0.2 my if the glauconite date published by Ward and Blackwelder (1980) from Grove Creek came from the *Chama* bed deposits which abound at Carter's Grove and Kings Mill. The Krantz model predicts an age of 3.7 to 3.85 my.

K-6 REGRESSION AND K-7 TRANSGRESSION

No beds are presently known which can be correlated to K-6 and K-7 with certainty. The faunules from the stream cut behind the football stadium at the College of William and Mary, may belong here, but they seem to better fit statistically with K-8 and K-9. It is also possible that Mansfield's (1944) "bed f" at Yorktown, the stratotype for the Moore House Member of Blackwelder and Ward (1980) may fit here (see discussion below). The Krantz model predicts an age of 3.5 to 3.7 my.

K-8 REGRESSION: STREAM CUT BEHIND FOOTBALL FIELD, THE COLLEGE OF WILLIAM AND MARY, WILLIAMSBURG, VIRGINIA, BASAL CLAY BED

William and Mary Clay bed, N = 24

	R	JMC	CR	CKP	CKX	RP	RS	Z1	M
%	25.0	50.0	50.0	83.1	91.5	75.0	62.4	45.9	54.2
Dice	.042	.207	.163	.141	.158	.140	.306	.171	.197

Unit abbreviations as in Table 3.

At this site a clay bed dominated by *Yoldia laevis* conformably underlies fresh and brackish water beds dominated by *Corbicula*, *Rangia*, and Ilyanassid gastropods. Upwards through section, these elements were progressively replaced by marine elements, culminating in an open shelf assmeblage which most highly correlates with the faunule in the Chuckatuck megacrossbeds. The clay bed at William and Mary is about 0.8 meter thick, and exceptionally cohesive. Based on superposition, biostratigraphic correlation, and paleoecology, it is here assigned to the regressive phase K-8. The Krantz model predicts an age of 3.45 to 3.5 my.

K-9 TRANSGRESSION: THE WILLIAM AND MARY UPPER, MARINE BED AND THE CHUCKATUCK CROSSBED ASSEMBLAGE

William and Mary, open marine bed, N = 171

	R	JMC	CR	CKP	CKX	RP	RS	Z1	M
%	21.0	19.3	32.7	79.0	86.5	69.9	33.3	29.2	25.7
Dice	.166	.251	.381	.628	.696	.589	.465	.362	.315

Chuckatuck Crossbeds, pre-reworking fauna, N = 254

	R	JMC	CR	CKP	CKX	RP	RS	Z1	M
%	18.9	17.0	25.9	79.2	100.	63.2	24.8	24.0	23.6
Dice	.185	.249	.350	.784	1.00	.657	.384	.340	.331

Unit abbreviations as in Table 3.

Faunules contained within the mega-crossbeds at Chuckatuck initially lived in open marine conditions during a transgressive event or a high stand, during which they lived, died, and were reworked by currents into a shoal field. Subsequent regression brought the shoal into wave base, creating the conditions necessary for back-shoal crossbed tempestite deposition. The assemblage is diverse and has a very high Dice correlation with the Natural Well Duplin-equivalent assemblage of the overlying Chuckatuck *Panopea* bed. Though diverse, the assemblage is lacking in distinctive, short lived, common index species.

The open marine bed at William and Mary shows a high correlation with the Chuckatuck crossbed fauna and is also assigned to K-9. The Krantz model predicts an age of 3.4 to 3.45 my.

K-10 REGRESSION: THE MORGARTS BEACH SILT-CLAY AND THE CHUCKATUCK MEGA-CROSSBEDS

Morgarts Beach, N = 35

	R	JMC	CR	CKP	CKX	RP	RS	Z1	M
%	17.1	14.3	20.1	71.4	74.3	80.6	62.9	40.0	
Dice	.040	.079	.089	.170	.180	.207	.404	.200	.196

Unit abbreviations as in Table 3.

The Morgarts Beach silts and clays fill an extensive basin or sound to the west of the topographic high provided by the Chuckatuck bar (Coch, 1968). Field relationships and superposition physically equate the Morgarts Beach and the Chuckatuck mega-crossbed facies. An older age, suggested by faunal statistics, is rather a result of long-term stability in the Mio-Pliocene silt-clay assemblages as discussed above. The mega-crossbeds are impressive. Beds dip as much as 35 degrees and are graded both vertically and laterally. As much as 6 meters of vertical relief was exposed above lake level, and based on the depth of characteristic sediment, may have had as much as 15 meters relief (Campbell, 1976). Proponents of the structural model suggest that the crossbeds have been tilted subsequently, but elsewhere the reversed dip remains less than 5 degrees, leaving a primary component of dip in excess of 30 degrees. Individual crossbeds were deposited episodically, probably as storm deposits or tempestites. A combination of dense sediment packing and the frequent addition of new beds limited successful invasions of the crossbed sediment by most infaunal species. The only pervasive infaunal element consists of callianassid decopod *Ophiomorpha* burrows. About midway along the north wall of Crane Lake (Chuckatuck pit), one crossbed contained a small population of fully adult *Panopea reflexa* and *Margaritaria abrupta*, two species of large, deep burrowing bivalve mollusks. Their success indicates a period of several years, or even decades, before deposition of the next crossbed. A smiliar invasion of the endolithic pholad, *Cyrtopleura arcuata*, was observed by Warren Blow (1980, personal communication) in an area subsequently mined out. Therefore, the time interval between deposition of individual crossbeds was normally sufficient to allow invasion by callinassid burrowers, but typically less than that necessary for colonoization by large, infaunal bivalves. Shoal epifauna included *Ostrea sculpturata* reefs and enormous colonies of *Crepidula fornicata*, some preserved in original stacks of 10 to 20 individuals. Typical crossbed faunules contain both contemporary shoal-crest epifauna and reworked K-9 elements eroded from the shoal.

The Morgarts Beach sound deposition varied from thick, apparently anoxic clays with no indigenous faunal content to silt and silty sand deposits typifyied by the stratotype beds at Mogarts Beach[1]. *Mulinia congesta* abounds at Days Point and elsewhere within the unit.
The Krantz model predicts an age of 3.35 to 3.4 my.

[1]. I find no published explanatio for the extra "r" in "Morgarts", but that usuage is consistent in Ward and Blackwelder (1980), and in all subsequent literature. Topographic maps give the locality as "Mogarts".

K-11: CHUCKATUCK UPPERMOST *Panopea* BED, ROCK WHARF NEAR SMITHFIELD, AND THE UPPERMOST BED AT RICE'S PIT

Chuckatuck Panopea bed, N = 259 taxa

	R	JMC	CR	CKP	CKX	RP	RS	Z1	M
%	18.9	13.9	24.3	100.	77.6	59.3	22.4	21.6	20.1
Dice	.187	.205	.330	1.00	.784	.622	.348	.308	.283

Rock Wharf near Smithfield, N = 199 taxa

	R	JMC	CR	CKP	CKX	RP	RS	Z1	M
%	18.6	16.1	28.1	81.3	83.4	66.6	27.6	27.1	27.6
Dice	.160	.220	.348	.707	.733	.611	.403	.355	.358

Uppermost bed, Rice's Pit, no assemblage data available.
Unit abbreviations as in Table 3.

This uppermost Yorktown transgression is characterized by an increased species richness, and by a considerable number of rare, tropical and subtropical elements restricted to, or more characteristic of the Natural Well, North Carolina, and the Tearcoat Branch, South Carolina faunules. These elements include *Extractrix hoerlei*, *Coralliophila leonensis*, *Aorotrema cistronium*, *Trigonostoma carolinensis*, *Tritonoharpa floridana*, and *Cyclostremiscus schmidti*. Although the Rock Wharf assemblage shows a slightly greater affinity for the K-9 Chuckatuck crossbed fauna, by superposition it overlies the crossbed-equivalent Morgarts Beach silt-clays and clearly reflects a return to open shelf sediments and faunas. The *Panopea* bed, uppermost fossiliferous unit, west wall of the Chuckatuck pit, is by superposition, the youngest Yorktown bed at Chuckatuck. Its diverse fauna and clastic sediments indicate a return to open shelf conditions, but the unit was to some degree protected by the now well-submerged crossbed unit. The contact with the crossbeds is conformable, dipping to the west. It is probable that the densely packed crossbed unit provided a hard ground for epibentic sponges, soft corals, ascidians, and other "live bottom" species which trophically supported the exceptional molluscan diversity. However, the crossbed contact is not extensively burrowed, as is typical of limestone and phosphatic hardgrounds in the Carolinas.

The uppermost bed at Rice's pit was less than a meter thick and was quickly mined out in the early 1960's (Druid Wilson, 1980, personal communication). Its fauna is poorly known, being represented in Smithsonian collections by a few unusual taxa such as *Corbicula densata* and *Anadara staminea*. By superposition and subtropical elements, it may represent a K-11 *Panopea* bed equivalent, or it may represent the last depositional episode of K-5, the more familiar upper Rice's pit beds. The Krantz model predicts a K-11 age of 3.2 to 3.4 my.

K-13 TO K-15: THE CHOWAN RIVER BEDS

Deep Creek Pit Chowan River beds, N = 133

	R	JMC	CR	CKP	CKX	RP	RS	Z1	M
%	21.0	30.1	38.3	47.6	55.6	43.0	21.1	21.8	28.5
Dice	.141	.356	.398	.327	.382	.311	.271	.244	.315

Chowan River stratotype beds, N = 123

	R	JMC	CR	CKP	CKX	RP	RS	Z1	M
%	32.5	43.1	100.	51.2	64.4	43.3	18.7	27.1	30.1
Dice	.207	.493	100.	.330	.350	.298	.234	.298	.320

Unit abbreviations as in Table 3.

The lower beds of the Chowan River Formation at the Deep Creek pit contain an odd combination of armored mudballs indicative of surf and marsh clay erosion in a littoral zone, a reworked Yorktown component including *Ecphora* fragments, an estuarine and fresh water component including elongate *Crassostrea virginica* and paired *Corbicula densata*, and a reworked Chowan River assemblage including concave down, densely packed valves of a large, flat subspecies of *Carolinapecten eboreus*. In this complex, the only paired, in-place element is the freshwater *Corbicula*. The taphonomy of the unit is complex, culminating in the admixture of several biotopes in a river bed deposit. Overlying the *Corbicula* complex in the northern part of the Deep Creek pit are Pleistocene sands containing a shallow water, Late Pleistocene marine assemblage (Spencer and Campbell, 1988). About 50 meters to the south, the *Corbicula* complex is overlain by a more diverse Chowan River fauna dominated by *Anadara aequicostata* and *Noetia limula*, but also containing many species not found in the earlier, reworked Chowan River component of the *Corbicula complex*.

The reworked marine Chowan River component is assigned to K-13, the littoral, estuarine, and fresh water components to the K-14 regression; and the *Anadara-Noetia* beds to the K-15 transgression. The Chowan River beds were placed at about 3 million years by Ward and Blackwelder (1980: 4), at about 2.5 million years by Blackwelder (1981: 2), at 2 - 2.5 million years by Cronin and others (1984: 40), and about 2.1 million years by Krantz (1991). Blackwelder (1981b) reports a uranium date of 1.9 my from corals collected from the Edenhouse Member of the Chowan River Formation. Cronin and others (1984) stress that the coral dates should be taken as minimum rather than as exact dating. Correlation to K-13-K-15 of the Krantz model predicts an age of 2.8 to 3.0 my.

The Chowan River is placed in K-13 to K-15 because of the molluscan extinction rates and the high affinity for the older, Yorktown faunas. The molluscan data set for the Virginian Chowan River is composite, and shows only 21% species extant and nearly equal Dice affinities for the Chuckatuck crossbed fauna and for the stratotype Chowan River beds. With the reworked Yorktown component, it may be argued that the extinction levels are biased. However, the Chowan River stratotype in North Carolina gives little evidence of reworking. Its published fauna of 123 molluscan species has only 32.5% extant species. These numbers contrast with the Lower Waccamaw K-17 faunas which have 38.6% extant species and the Upper Waccamaw K-19-21 faunas which have 48.2% extant species. The lower Waccamaw shares 45.4% species in common with the subjacent Natural Well Duplin; in contrast the Chowan River stratotype faunas share 64.4% with the upper Yorktown. Consequently, I conclude that the Virginia and stratotype Chowan River beds are older than the K-17 lower Waccamaw. In the Krantz model, K-13 and K-15 are the only transgressions compatible with superposition and faunal statistics for the Chowan River and Lower Waccamaw assemblages. Krantz (1991) had correlated the Moore House Yorktown with K-13 and K-15 on the basis of the Ward and Blackwelder model and ages reported in Cronin and others (1984: 40). That age assignment needs to be reassessed in light of the evidence provided here.

The beds above the black layer at the APAC pit in Sarasota, Florida contain characteristic molluscan species for both the Caloosahatchee Formation and for the older Fruitville (Pinecrest) Formation. This intermediate zone may be a Chowan River equivalent.

K-17: THE WARD AND BLACKWELDER (1987) UPPER PLIOCENE AT AURORA, NORTH CAROLINA

Aurora upper Pliocene, Bed B, N = 89

	R	JMC	CR	CKP	CKX	RP	RS	Z1	M
%	42.7	41.6	56.2	44.9	43.7	47.3	15.7	20.3	31.5
Dice	.215	.409	.472	.230	.227	.205	.172	.186	.284

Beds C, D, E, N = 138

	R	JMC	CR	CKP	CKX	RP	RS	Z1	M
%	39.8	36.2	64.0	36.2	33.4	27.7	10.1	14.5	21.0
Dice	.274	.435	.475	.252	.235	.205	.132	.165	.236

Unit abbreviations as in Table 3.

The upper Pliocene beds at Aurora, North Carolina, were monographed by Ward and Blackwelder (1987) who documented 89 species of molluscs from a lower bed (Bed B) which they assigned to the Chowan River Formation, and 138 species from Beds C-E which they assigned to the younger James City Formation. The statistical summaries of their Aurora faunules reveal little internal differences between beds B and C-E, a conclusion reached independently by Lyons (1991, p. 148). Beds B-E appear to be subpopulations of a single fauna. Additionally, the Aurora beds are not statistically compatible with either the James City or the Chowan River stratotypes. The James City Formation in the type area has 47.8% extant molluscs, a number closely compatible with the 48.2% for the upper Waccamaw (K-19-21). And as noted above, the stratotype Chowan River fauna has 32.5% Recent species. At 42.7% and 39.8%, the Aurora faunules fall in between, but are very compatible with the 38.6% extant species of the K-17 lower Waccamaw. I conclude that the Aurora upper Pliocene is biostratigraphically conformable with neither the Chowan River nor with the James City Formation, as defined by their stratotypes. Whether it should be included within an expanded concept of either formation, or be separately recognized is a subject for future study.

Blackwelder (1981b) reports uranium coral dates from the "Chowan River" a Aurora as 2.4 my. This is completely compatible with the Krantz model K-17 pulse which predicts 2.4 to 2.6 my.

K-19 TO K-21: THE JAMES CITY BEDS

James City Formation stratotype area beds, N = 92

	R	JMC	CR	CKP	CKX	RP	RS	Z1	M
%	47.8	100.	57.8	39.1	46.8	36.1	17.4	20.7	32.6
Dice	.247	1.00	.495	.205	.249	.203	.193	.193	.300

Unit abbreviations as in Table 3.

These youngest of Pliocene beds in the Yorktown depositional basin are known only from North Carolina. They were initially called the Croatan beds by Dall, 1892. Hazel (1983, p. 85) has called attention to the action by MacNeil (1938) designating a type ssection and formalizing the formation concept, making the Croatan Formation an earlier, valid usuage synonymous with the James City Formation of DuBar and others (1974). However, the James City has acquired prevailing usage and its use is here continued. The James City, upper Waccamaw, and upper Caloosahatchee faunas were contemporaneous, and subject to the same extinction event. This extinction event can now be dated in southern Florida as pre-1.5 million years (Lyons, 1991). Consequently, the younger published coral dates of 1.1 and 1.4 my for the James City (McCartan and others, 1982, p. 339) are either minimum dates or were based on younger, admixed Bermont-aged corals reworked with James City beds. Cronin and others (1984) report planktonic foraminiferal zone N-22 to N-23 species and NN-19 calcareous nannoplankton zones for their "lower James City". These equate with an age of 1.6 to 1.8 my. The Krantz model predicts K-17 ages of 1.9 to 2.1 my.

PREVIOUS STRATIGRAPHIC MODELS FOR THE YORKTOWN FORMATION

MANSFIELD MODEL

The larger zonation scheme of Mansfield (1929, 1944) of a lower, or zone 1, *Placopecten clintonius* zone, and an upper, or Zone 2, *Turritella alticostata* zone remains intact. However, Mansfield's subdivision of Zone 2 requires revision, Mansfield's model is as follows:

Biggs Farm with Duplin species
Upper typical Zone 2 Yorktown-beds at Suffolk
Middle Zone 2 Yorktown-all fragmental beds
Lower Zone 2 Yorktown-Chama beds.

Of these, the Biggs Farm faunula contains *Conus adversarius* which in Virginia is known only from K-5 Rice's Pit and equivalents. Mansfield states that the beds at Suffolk contain "*Pecten jeffersonius* Say (having 8 or 9 ribs)." Associated with Zone 2 components, this citation is most reasonably explained as a misidentification of *Chesapecten septenarius*, which apparently became extinct following the K-5 transgression. Mansfield's "beds at Yorktown" (1944: 8) include the fragmental bed, bed f or his figure 3, which is also the stratotype for the Moore House Member of Ward and Blackwelder, 1980. Support for a probable K-6 age is discussed in the next section. Manfield's *Chama* beds are indeed lower Zone 2, belonging to K-4 and K-5.

WARD AND BLACKWELDER MODEL

A single Yorktown transgressive-regressive cycle is a model which; although endorsed implicitly or explicitly by numerous authors (Mansfield, 1929, 1944; Hazel, 1971; Campbell and others, 1975; Ward and Blackwelder, 1980), is now untenable. This single cycle model is well stated by Ward and Blackwelder (1980: 31-32), and their proposed lithostratigraphic members were initially drawn from stages in the development of that cycle (Figure 3).

However, members must be lithostratigraphic subunits of a formation. Like formations, they may consist of a single rock type, or of a complex of lithologies bounded by recognizable scarps, terraces, disconformities, or other mappable contacts. The Zone 2 member stratotypes proposed by Ward and Blackwelder lend themselves to apparent lithologic definitions: Rushmere silty sands, Morgarts Beach clays, and Moore House fragmental beds. However, in practice, the three members have been treated as sedimentary packages of diverse lithologies representing areally or stratigraphically distinct deposition. For example, the "Moore House Member" was stated to be found exclusively east of the Surry Scarp (Ward and Blackwelder, 1980: 45).

Krantz (1991) has correlated these four members to his oxygen isotope model, assigning the Sunken Meadow to K-1, the Rushmere and Morgarts Beach to K-3 through K-11, and the Moore House to K-13. He also assigned the Chowan River beds to K-19, and the James City beds to K-21. Of these, K-1 equivalency with Zone 1 or the Sunken Meadow Member is clear. However, the Rushmere stratotype section narrowly defines the K-4 regression. Therefore, the lithostratigraphic concept of the Rushmere Member should be restricted to that part of the Yorktown section actually represented by the stratotype.

The Morgarts Beach is a valid, lithologic member when applied to K-10 silts and clays which accumulated west of the Chuckatuck topographic high. However, bar-and-sound deposition also occurred during at least three different Zone 2 regressions, and indiscriminiate lumping of laterally and biostratigraphically incoherent Yorktown Zone 2 silt-clay beds into a pervasive Morgarts Beach Member should be avoided. Ward, Bailey, and Carter (1991) now map the Chuckatuck bar crossbeds as part of the Morgarts Beach member, an action which further suggests time-rock rather than lithologic definitions.

The Moore House Member is conceptually muddled. Ward and Blackwelder (1980: 44-45) described a Moore House stratotype section containing one meter of fragmental sand and three meters of tan, clayey, highly calcareous sand. However, their figure 20, a photograph of the type section, assigns the three meter bed to the Morgarts Beach member. No taxa from the stratotype are identified to species. Fortunately, these beds are well described and figured by Mansfield (1944; p. 10, figure 3). The upper, fragmental sand is Mansfield's bed f, and the subjacent clayey sand is bed e. Mansfield's sketch shows beds a-d with reversed dip (backshoal or horst), a silt bed accumulating behind the topo-

graphic high, and a high energy fragmental bed capping the Pliocene sequence. Planation of the top of beds a-d can not be attributed with certainty to the bed f fragmenting surf event, although that scenario is compatible with field relations. Mansfield's beds a-f are all predictable facies of the sedimentary model (figure 2) discussed earlier. According to Mansfield's faunal lists, beds a and b contain *Oliva, Chlamys decemnarius, Clinocardium virginianum* and *Kuphus calamus* (= *Teredina fistula*), while bed c adds *Striarca centenaria*. These taxa are all compatible with upper Rice's Pit and correlative K-5 faunas (Table 5). If the bar (fragmental) and sound (clay) deposition (beds f and e) accumulated behind the topographic high refleted in beds a-d, then they are best assigned to the K-6 regression. Mansfield (1944) reported that beds younger than bed f were found 2 1/2 miles above (west) of Yorktown. He gives a list of 16 long-ranging species including no definitive index species. However, the list appears compatible with the fauna at the nearby Zook's Pit. The Zook's Pit species remain imperfectly documented. The faunula is somewhat similar to that in the K-9 Chuckatuck crossbeds, but Johnson (1972) reports a number of species from Zook's pit (Appendix 2, column E), including *Panopea goldfussi* and *"Chlamys jeffersonius"* which, as noted above, is a commonly used name for *Chesapecten septenarius* in zone 2 beds. Both of these taxa apparently became extinct at the end of K-5 to K-6 and are not part of the Morgarts Beach K-10 regression fauna. I conclude that the Moore House stratotype (bed f) most likely belongs to K-6 and its underlying clay bed does not belong to the Morgarts Beach member. Judging from Mansfield, the stratotype (bed f) should, be superposition, be older than, or equal tc the age of the beds at Zook's pit. Ward, Bailey, and Carter (1991) state that *Chesapecten septenarius* became extinct prior to Moore House time. *Chesapecten septenarius* definitely became extinct prior to the uppermost Yorktown, but the Moore House, defined by its stratotype, is not the uppermost Yorktown.

Consequently, the Rushmere, Morgarts Beach, and Moore House members are not pervasive, single-lithology units. nor do their stratotypes define broadly encompassing units of Yorktown time. Their characteristic sediment types recur frequently through the Yorktown section. Further, as presently applied to sediment packages, they are non-coherent when examined against the Krantz model and against detailed sedimentalogic and biostratigraphic statistical analyses. However, they may be potentially mappable if defined narrowly in terms of their stratotype sections. Such action leaves the K-3 beds at Aurora, North Carolina, and the K-9 to K-11 beds without formal member designation.

PREVIOUS BIOSTRATIGRAPHIC MODEL FOR THE COAST PLAIN

Blackwelder (1981) proposed two superstages, four stages, and four substages for the Pliocene and Pleistocene of the Atlantic Coastal Plain of Virginia and the Carolinas, based on the range zones of 102 molluscan species. Blackwelder recognized six molluscan, of "M-" zones which were defined as interval zones. The range zones were documented from "several hundred samples from the region" (Cronin and others, 1984: 30), and the data set was apparently based entirely upon the results of those samples. This approach has its merits, but while impressive of scope, it ignores the much larger body of data to be found in the literature. Of the 102 species in the survey, 27 had published ranges greater than or different from those cited by Blackwelder.

Another difficulty is the use of interval zones to span major unconformities. Stages and zones are Time-Rock, rather than Time units, and should properly be restricted to depositional events. Chronostratigraphic "zones" in coastal plain sequences are oxymorons. Specifically, M-6, the first-appearance-of-*Chesapecten jeffersonius*-to-first-appearance-of-*Chesapecten madisonius* zone (Mansfield Zone 1, or Krantz K-1 (Figure 1) is also said to be the range zone of *Chesapecten jeffersonius*. However, *Chesapecten jeffersonius* is now known to range into K-3 where it overlaps *Chesapecten madisonius*. M-5, the first-appearance-of *Chesapecten madisonius*-to-first-appearance-of-*Noetia limula* zone encompasses all of Mansfield's Zone 2, plus the unconformity up to the Chowan River Formation. M-5 may now be subdivided into at least four or five Yorktown index zones. M-4, the Gouldian stage, or the first-appearance-of-*Noetia limula*-to-last-appearance-of-*Glycymeris subovata* zone included the Chowan River Formation and the Bear Bluff Formation. Ward and Blackwelder (1987) changed their Gouldian *Glycymeris subovata* to *Glycymeris hummi*. However, the Bear Bluff Formation of DuBar and others (1974) is a composite of several disparate units ranging from K-5 to K-17. The stratotype Bear Bluff section is exclusively K-5, making it synonymous with the Goose Creek Limestone (M. Campbell, 1991). The K-17 beds included by DuBar (1987) in the upper Bear Bluff contain a Waccamaw-related fauna here considered to be Lower Waccamaw. M-3, the Windyan Stage, or last-appearance-of-*Glycymeris subovata* (*G. hummii*)-to-first-appearance-of-*Anadara ovalis* is anomalous in that the zone is said to be characterized by the absence of its two indicator species. However, the earlier published records of *Anadara ovalis* in the upper Waccamaw are confirmed by Charleston Museum collections. This necessitates the alteration of the name or the change of concept for M-3, M-2, and M-1, the *Anadara ovalis* range zone, the *Noetia limula-Anadara ovalis* interval zone, the *Glycymeris subovata-Anadara ovalis* interval zone, and the *Anadara ovalis-Anadara basiliana* interval zone.

Taken together, their numerous range and stratigraphic discrepancies lessen the utility of the M-zones. Given the continued stratigraphic and biostratigraphic refinements taking place in Atlantic Coastal Plain studies, proposing a new or modified stage system would presently be premature.

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SYSTEMATIC PALEONTOLOGY

INTRODUCTION

Generic descriptions are quoted with permission from Keen (1971) or Abbott (1974), supplemented by original definitions as needed. Authorship of genera is provided, but authorship of Family and higher systematic levels is omitted. The type species of the genus is provided only when the species was originally described from the Yorktown or Chowan River, or if it is based on a species occurring in these beds. New generic descriptions use normal prose rather than teleological style for consistency with Abbott (1974) and Keen (1971).

Information contained within the "Synonyms" category is based on a review of over 1500 books and articles covering the Eocene, Oligocene, Miocene, Pliocene, Pleistocene, and Recent molluscs found between Iceland and Texas. A complete stratigraphic synonymy for the Miocene to Pleistocene molluscs of the Atlantic and Gulf Coastal Plains is in progress, and is not provided here. "Synonyms" therefore make no attempt to document a complete synonymy for each species, but as here used, it includes synonyms proper, plus junior and senior homonyms, various misspellings, misidentifications, and some of the more obsure generic assignments. The terminology "non" is used for homonyms, and "not of" for misidentifications.

A brief description or comparison is provided for each species. For brevity, species description are given in teleological style. Focus is on the detail necessary to separate the species from others within the Yorktown or Chowan River faunas, but further comparisons may be made with closely related fossil and Recent species within the Western Atlantic realm as thought appropriate. Size data is provided in both comparative and specific fashion. For consistancy, the following comparative terminology is used: "minute" is <5 mm; "very small" is 5 to 10 mm; "small" is 11 to 25 mm; "moderate" is 26 to 50 mm; "large" is 50 to 100 mm; and "very large" is >100 mm. Comparative size data is based on the maximum dimension of an adult specimen. Specific size information is provided for the figured specimens. Measurements were variously made with a millimeter ruler, with calipers, or with a measuring microscope.

Locality data is generalized, being summarized from the literature or from unpublished collections. Sources for specific localities can mostly be found in Campbell and others (1975). Specific locality data for the figured specimens and for the original type of the species are given in plate descriptions and in Appendices IV and V. Discussion follows locality data when necessary.

PHYLUM MOLLUSCA
Class Bivalvia
Subclass Palaeotaxodonta
Order Nuculoida
Superfamily Nuculacea
Family Nuculidae

Genus *Nucula* Lamarck, 1799

"Beaks opisthogyrate; internal ligament in a resilifer; shell material nacreous" (Keen, 1971:26).
Subgenus *Nucula* s. s.
"Inner margin of shell crenulate, reflecting the presence of radial ribs in the middle or outer layers" (Keen, 1971:26).

1. *Nucula diaphana* H. C. Lea, 1843. Shell small and broadly oval in outline. Zone 2, Petersburg and Chuckatuck. Length 2.5 mm, height 2.1 mm.

2. *Nucula proxima* Say, 1822 (Synonym: *Nucula obliqua* Say, 1820, non Lamarck, 1819). Shell outline triangular, beaks forward of midline; hinge strong; ligamental pit large. Largest of the Yorktown *Nucula*. Zones 1 and 2, ubiquitous;

Chowan River deposits at Chesapeake. Length 7.27 mm, height 6.20 mm. *N. proxima* is most abundant in silt-clay sediments, but is present in all deposits. For a more complete discussion of this species see Ward and Blackwelder (1987).

3. *Nucula dolabella* H. C. Lea, 1843 (Synonym: *Nucula dallabella* (sic) H. C. Lea of Langdon, 1889). A small, teardrop-shaped shell; strongly inflated, resembling a smooth *Crenella*; hinge teeth minute. Zone 2, Petersburg, Hampton, Chuckatuck, and Chesapeake. Length 2.13 mm, height 2.88 mm.

4. *Nucula taphria* Dall, 1898 (Probable synonym: *Nucula tenuis* Montagu of Dall in Shaler, 1890, not of Montagu, 1808). Shell small, very solid; beak angle sharp; sculpture of strongly impressed concentric lines. Zone 2, Chuckatuck and Chesapeake. Length 3.67 mm, height 4.8 mm.

Superfamily Nuculanacea
Family Nuculanidae

Genus *Nuculana* Link, 1807

"Posterior end pointed, posterior or dorsal margin curved; pallial sinus small and rounded" (Keen, 1971:28).
Subgenus *Saccella* Woodring, 1925
"The shell, which is shaped like the classic grecian lamp, has strong regular concentric ribs throughout" (Keen, 1971:29).

5. *Nuculana acuta* (Conrad, 1832) (Synonyms: *Leda cuneata* Sowerby, 1832; *Nucula carinata* H. C. Lea, 1843, non M'Coy, 1844; *Leda jamaicensis* Orbigny, 1846; *Leda inornata* A. Adams, 1856; *Leda unca* Gould, 1862). A small, pointed shell with very even, fine concentric ribs. Zone 1, Middlesex County and Williamsburg ; Zone 2, Petersburg, Williamsburg, Yorktown, Hampton, and Chuckatuck. Length 9 mm, height 4.2 mm.

6. *Nuculana hypsoma* (Dall, 1898). Shell small, with rather wide, even, concentric ribs; rostrum short, gaping at the end. Chowan River Formation at Chesapeake. Length 4.27 mm, height 2.41 mm.

Genus *Yoldia* Moller, 1842

"With a posterior gape, ligament external in most, internal in a few" (Keen, 1971:35).

7. *Yoldia laevis* (Say, 1824) (Synonyms: *Nucula laevis* Say, 1824, non Sowerby, 1839, or Sandburger, 1842; *Nucula acutidens* H. C. Lea, 1843; *Nucula limatula* Say of Conrad, 1845, not of Say, 1831; *Leda pygmaea* Muenster of Meyer 1888, not of Muenster, 1835). Shell small to medium in size, elongate, thin, very smooth and shiny. Hinge line very long, taxodont, tightly interlocking (paired fossil valves not uncommon). Ligament internal. Zone 2, Greensville, York, Surry, and Isle of Wight counties; Williamsburg, Suffolk, Chuckatuck, and Chesapeake. Length 23 mm, height 11 mm. This is the only smooth nuculanid in the Yorktown fauna. The species varies greatly in maximum size attained at individual localities, the largest specimens coming from Rice's Pit. The holotype of *Nucula acutidens* was compared with the figured specimen. It was based on a small hinge fragment from a right valve. Otto Meyer's record of the European species, *Leda pygmaea*, appears from his figure to be a juvenile *Yoldia laevis*.

Subclass Pteriomorpha
Order Arcoida
Superfamily Arcacea
Family Arcidae
Subfamily Anadarinae

Genus *Anadara* Gray, 1847

"Radial sculpture regular; valves tightly closing; without a byssal gape" (Keen, 1971:42).

Subgenus *Anadara* s. s.

"Hinge teeth in a continuous series of uniform size; ligament amphidetic" (Keen, 1971:42).

8. *Anadara callicestosa* (Dall, 1898) (Synonym: *Anadara callicestosa wilsoni* Gardner, 1944). Shell thin, squarish in outline, and well inflated. Radial ribs numerous, ribs smooth or beaded. Zone 2, Chuckatuck. Length 25 mm, height 20 mm (dimensions are given for the adult holotype; 10 mm juveniles are more common at Chuckatuck.)

9. *Anadara carolinensis* (Dall, 1895). A large, squarish, heavy ark with about 30 ribs. A rare species, and specimens always seem eroded. Zone 2, Surry and York counties, and Chuckatuck. Length 56 mm, height 55 mm. Ward (1992:55-56) makes a plausible argument for the true *Arca carolinensis* "Wagner" of Dall, 1895 being from Virginia and pre-Yorktown, but his assignment of an Eastover type locality for his "neotype" presumes an equation which can not be made with certainty. If USNM 149020, the designated neotype, is accurately labled as comming from Wagner's type lot, then it was collected before Dall's birth, and the premise that Harris and Dall were collecting Eastover species at Bellefield above Yorktown around 1890 has no bearing on the provenance of the specimen. However, I prefer to give Wagner the benefit of the doubt, believing that his specimens came from the Yorktown Formation in North Carolina, as the name indicates, and that *A. carolinensis* may or may not be conspecific with the Eastover populations. This whole complex could benefit from a quantitative morphometric analysis. I do conceed that Wagner's localities for certain other species were without doubt badly scrambled as documented by Ward (1992), and the question could go either way. Specimens reasonably matching the figure in Dall (1898) do occur in the Yorktown of Virginia and North Carolina, and similar specimens from the Jackson Bluff Formation of West Florida were named *Anadara idonea alumensis* Mansfield, 1932 and *Anadara idonea harveyensis* Mansfield, 1932. A vigorous quantitative analysis will be necessary to resolve the question.

Ward (1992:54-55) erects a new genus, *Dallarca* (type *Arca idonea* Conrad, 1832), and includes *A. carolinensis* within that genus. The genus concept as used by Ward is frequently more narrow than that used in this study. In my opinion, such arcid morphologies belong in *Anadara*, but *Dallarca* might well prove to be a useful subgenus.

Subgenus *Granoarca* Conrad, 1862

A large, compressed ark with the hinge teeth becoming granular distally.

10. *Anadara propatula* (Conrad, 1844) (Synonym: *Arca hians* Tuomey and Holmes, 1856, non Braun, 1842, non Reeve, 1844). The strong ribs, posterior expansion, and lateral compression are distinctive. Zone 2, Petersburg, Hampton, Williamsburg, and Gloucester. Length 75 mm, height 38 mm. Most authors have placed *Anadara propatula* in *Barbatia*, but Bird (1965) argues convincingly for placement in *Anadara*. Dall (1898a) twice notes that *Arca hians* is preoccupied, but attributes authorship to "Brown, 1842" (p. 615) or to "Bronn, 1842" (p. 627). I appreciate R. E. Petit's tracking down the actual homonym. *Anadara propatula* appears to have become extinct prior to the end of Zone 2 and may be useful as an index to lower Zone 2 deposits.

Subgenus *Larkinia* Reinhart, 1935

"With the hinge teeth sloping differently at the end than in the center, converging at the ends" (Keen, 1971:48). Bird (1965) synonymized the following three *Larkinia* with the Recent *Anadara transversa* (Say, 1822). They are here treated as morphologically and stratigraphically distinct.

11. *Anadara improcera* (Conrad, 1845). Shell small, very rectangular, and laterally compressed. Zone 2, Williamsburg, Yorktown, Chuckatuck, Hampton, and Chesapeake. Length 23 mm, height 16 mm.

12. *Anadara improcera buccula* (Conrad, 1845). The subspecies differs by being smaller overall, less elongate, and more inflated. Intergrades exist. Zone 2, Hampton and Chuckatuck. Length 13 mm, height 10 mm.

13. *Anadara aequicostata* (Conrad, 1845) (Synonyms: *Arca plicatura*, *Arca brevidesma*, *Arca lineolata*, and *Arca subsinuata*, all Conrad, 1845; *Arca sublineolata* Orbigny, 1852 (substitute name for *Arca lineolata* Conrad, non Roemer, 1836)). This species is consistently larger and more inflated than any Recent *Anadara transversa*. In Virginia, *Anadara aequicostata* appears restricted to the Chowan River beds in Chesapeake. Length 43 mm, height 38 mm.

Subgenus *Sectiarca* Olsson, 1971

Shell valves equal in size, ribs grooved in both valves.

14. *Anadara lienosa* (Say, 1831) (Synonyms: *Arca protracta* Rogers and Rogers, 1837; *Scapharca triphera* Dall, 1898). Shell very large, strong, rectangular; with 26-30 strong, normally grooved, radial ribs beaded by fine concentric raised lines. Radial sculpture irregular over the posterior slope of the shell. Young shells (*A. triphera*) may have a central depression in the umbonal area and lack the grooving of the ribs. Zone 2, Prince George and James City counties; Yorktown, Chuckatuck, and Hampton. Length 78 mm, height 47 mm.

Anadara arata (Say, 1824) from the pre-Yorktown Eastover Formation superficially resembles *A. lienosa*, but the grooving is less distinct and the shell appears to be less elongate. Ward (1992, pl. 1, fig. 5) illustrates a specimen of *A. arata* and provides a good discussion of the species.

Subgenus *Cunearca* Dall, 1898

"Sculpture on one valve markedly different from that on the other" (Keen, 1971:44).

15. *Anadara staminea* (Say, 1831) (Synonyms: *Arca scalaris* Conrad, 1844; not *Arca staminea* Say of Glenn, 1904 (= *Anadara elevata* (Conrad, 1840), see Ward, 1992, for discussion)). Shell large, squarish, with 20 to 24 very heavy, beaded ribs. Beaks central and very high. Zone 2, Petersburg and Hampton. Length 38 mm, height 38 mm. This species is common in the mid-Pliocene beds of South Carolina and Florida, but is exceedingly rare in Virginia.

Subfamily Striacinae

Genus *Striarca* Conrad, 1863

Rectangular, well-inflated arcids with sculpture of fine radial striae.

16. *Striarca centenaria* (Say, 1824). Shell of medium size; beaks rounded, slightly anterior; sculpture of fine radial threads. Juvenile specimens laterally compressed; adults very inflated, resembling a small, broad-beamed ark. Zone 1, Surry and James City counties; Zone 2, Isle of Wight and James City counties, Petersburg, Williamsburg, Yorktown, and Hampton. Length 34 mm, height 23 mm. This common species is frequently referred to *Barbatia* in the older literature. *Striarca centenaria* is especially abundant in Zone 1 and lower Zone 2 assemblages, being a conspicuous member of the *Chama* reefs. It apparently became extinct prior to upper Zone 2 deposition.

Genus *Quadrilatera* Deshayes, 1860

__. *Quadrilatera adamsii* (Dall, 1886). See Appendix II.

Family Noetidae
Subfamily Noetiinae

Genus *Noetia* Gray, 1857

Beaks high, forward; ligamental area transversely striated; ribs frequently divided.

17. *Noetia incile* (Say, 1824) (Synonyms: *Eontia incile mansfieldi*, *Eontia incile suffolkensis*, and *Eontia incile yorkensis*, all MacNeil, 1938). Medium sized ark shells with a very characteristic "turkey wing" outline. Zone 2, Isle of Wight County, Petersburg, Williamsburg, Yorktown, Chuckatuck, Suffolk, Hampton, and Chesapeake. Length 26 mm, height 10 mm.

18. *Noetia limula* (Conrad, 1832) (Synonyms: *Arca limatula* Emmons, 1858; *Noetia carolinensis* Conrad, 1862.) Large, rectangular shell with strong radial ribs. Beaks high, pointed, near anterior of shell. Zone 2 ?, Hampton; Chowan River beds at Chesapeake. Length, 52 mm, height 34 mm.

18a. *Noetia trigintinaria* (Conrad, 1863) (Synonyms: *Noetia protexta* (Conrad, 1873); *Noetia filosa* (Conrad, 1873); *Noetia rigintinaria* (sic) of Owens, 1992). Shell of

medium size, resembling *Noetia incile* but much larger, proportionally less inflated, and more truncated posteriorly. This is a common species in mid-Pliocene beds of South Carolina and Florida, but I have not seen a Virginia specimen. Reported from Zone 2, Southampton County (MacNeil, 1937), and from well cuttings (Richards, 1947). Typical length 40-50 mm.

Superfamily Limopsacea
Family Glycymerididae

Genus *Glycymeris* Da Costa, 1778

"Shell sturdy, ...hinge plate arched, with part of the teeth somewhat chevron-shaped,.. symmetrical" (Keen, 1971:54).

19. *Glycymeris americana* (Defrance, 1826) (Synonyms: *Pectunculus pulvinatus* Lamarck of Conrad, 1832, not of Brongniart, 1823; *Pectunculus lentiformis* Conrad, 1837; *Pectunculus quinquerugatus* Conrad, 1841; *Pectunculus tricenarius* Conrad, 1843; *Pectunculus passus* Conrad, 1845; *Pectunculus elephantopus* H. C. Lea, 1845; *Pectunculus carolinensis* Holmes, 1858, not of Conrad, 1841; *Axinaea lentiformis* Conrad of Meek, 1864). Shell large, subcircular, variable in length-height ratio; ribs very low, formed of numerous fine radial lines. Zone 2, Petersburg, Williamsburg, Hampton, Chuckatuck, Suffolk, Yorktown, and Chesapeake. Length 72 mm, height 69 mm. *Glycymeris americana* form *quinquerugata* develops large, irregular wrinkles on the dorsal margin. Although this morphology is more common in the Duplin and Raysor Marl deposits to the south, Nicol (1953) reports a single specimen from Pampa, Virginia.

Subgenus *Tucetona* Iredale, 1931

"Radial ribs well developed, interspaces narrow to moderately wide, ribs sometimes dividing terminally; periostracum thin or wanting" (Keen, 1971:55).

__. *Glycymeris laevis* (Tuomey and Holmes, 1856). See discussion under *Glycymeris subovata* and Appendix II.

20. *Glycymeris pectinata* (Gmelin, 1791) (Synonyms: *Pectunculus aratus* Conrad, 1841; *Pectunculus pectiniformis* Orbigny, 1853, not of Lamarck, 1819; *Pectunculus charlestonensis* Holmes, 1858; *Glycymeris pectinata carinata* Dall, 1898) Shell smaller, heavier, more trigonal, and with stronger sculpture than *Glycymeris subovata*. Zone 2, Yorktown. Length 13 mm, height 13 mm.

21. *Glycymeris subovata* (Say, 1824) (Synonyms: *Axinaea bella* Conrad, 1871; *Glycymeris subovata plagia* Dall, 1898; *Glycymeris subovata tuomeyi* Dall, 1898; *Glycymeris hummii* Ward and Blackwelder, 1987; *Costoglycymeris subovata* (Say) Ward, 1992). Shell subcircular, ribs radial; variable in outline, width of interspaces, and strength of ribbing. Zones 1 and 2, ubiquitous; Chowan River beds at Chesapeake. Length 47 mm, height 44 mm. A population from South Carolina preserves a color pattern of red, squarish spots on a white shell, resembling the Recent *Glycymeris* (*Tucetona*) *pectinata* (Gmelin, 1791). Considerable morphologic variation exists in this species, producing a number of varieties, some of which have been named. Zone 1 specimens have the inter-rib spacing reduced to a narrowly incised line. Typical Zone 2 specimens agree with Say's 1824 figure in having wider and rounded interspaces. Dall (1898) described a flat-channeled form from the Duplin of South Carolina as *Glycymeris subovata tuomeyi*. Ward and Blackwelder (1980) have treated this taxon as a separate species and have reported it from the Yorktown. *Glycymeris subovata plagia* Dall, 1898, was proposed for small, obliquely developed specimens from the Yorktown of Edgecombe County, North Carolina. It also occurs in the Virginia Yorktown. Chowan River specimens of *Glycymeris subovata* have interspaces more narrow than typical Zone 2 material, but not so narrow as the Zone 1 populations. The Chowan River morphotype has recently been named *Glycymeris hummii* Ward and Blackwelder, 1987. Some Zone 2 specimens may develop bifurcating ribs: typically only two or three ribs are affected, but rarely this grooving may extend over the entire shell. *Axinaea bella* Conrad, 1871, described from Days Point, was such a specimen. Thomas (1975) provides the only quantitative statistical analysis of the *Glycymeris subovata* stock. I concur with him in considering the zone 1 through Chowan River populations as representing a single variable species.

Nicol and Jones (1984) proposed *Bellaxinaea*, a subgenus of *Tucetona* with distinctive ribbing, as follows: "..radial ribs raised and numerous, on umbonal region or in immature specimens simple, later dividing one or more times and with secondary radial ribs sometimes forming in the interspaces between the primary ribs: .."[They make no mention of *Axinaea bella*, i]s excusable since the taxon has been overlooked by all other authors as well. The "*bella*" morphology seems to bridge the gap between *Bellaxinaea* and *Tucetona*. Ward (1992) rejected *Tucetona* largely on geographical grounds and proposed *Costoglycymeris* (type: *Pectunculus subovatus* Say, 1824). I prefer use of *Glycymeris* at the generic level, and *Tucetona* as a subgenus. For those who prefer a more narrow generic concept, *Costoglycymeris* Ward is probably synonymous with *Bellaxinaea* Nicol and Jones.

Glycymeris laevis (Tuomey and Holmes, 1856) is a related species for which much confusion exists. Ward (1992:62-63) argues that *Glycymeris virginiae* "Wagner" (Dall, 1898) is a pre-Yorktown Eastover species from Virginia which is not conspecific with *Glycymeris laevis* from the Waccamaw beds of South Carolina. He states that the type of *Glycymeris virginiae* is missing and proposes a neotype from Claremont, Surry County, Virginia. However, in a review of types housed in the Wagner Free Institute collections, Spamer and Forster (1988) demonstrate that a single syntype series is the type lot for both *Glycymeris laevis* and *Glycymeris virginiae*. They illustrate the complete lot, showing the shells to be small, heavy, with weak sculpture of grooves which become obsolete over the lower half of the shell. The specimens are equidimensional to slightly higher than broad, and have a decidedly stunted look to them. The type lot originally came from "Waccamaw" which they speculate may indicate Lake Waccamaw, North Carolina. *Pectunculus laevis* may be a dwarf or abberent race of *Glycymeris subovata*, but is here kept separate pending further study of the problem.

Order Mytiloida
Superfamily Mytilacea
Family Mytilidae

Genus *Mytilus* Linnaeus, 1758

"Anterior retractor scar elongate; posterior retractors continuous; hinge with several small denticles; shell nearly smooth" (Keen, 1971:61).

22. *Mytilus edulis alaeformis* J. Sowerby, 1821. Shell relatively wider, with beak more hooked and more sharply-pointed than in any Pleistocene and Recent examples of *Mytilus edulis* Linnaeus, 1758 I have examined. Zone 2, Hampton, Suffolk, Chuckatuck, and Chesapeake; Chowan River beds at Chesapeake. Length (estimated) 46 mm, height 27 mm.

Genus *Brachiodontes* Swainson, 1840

"Small mytilids..... variable in form and sculpture" (Keen, 1971:61).

23. *Brachiodontes* sp. Mostly crushed fragments of a small, ribbed mussel are found in the Chowan River beds at Chesapeake, and similar material was reported by Gardner (1944) as *Brachiodontes recurvus* Rafinesque, 1819, from the bluffs at Yorktown. Length of figured juvenile, 2.11 mm.

Genus *Crenella* Brown, 1827

"Small, nearly orbicular, with radiating sculpture; sunken ligament; dorsal margin finely striate" (Keen, 1971: 65).

24. *Crenella aequilatera* (H. C. Lea, 1843) (Synonym: *Crenella duplinensis* Dall, 1898). Shell minute, oval, and inflated. External sculpture of numerous fine, divaricating radial ribs rippled by concentric growth lines. Zone 2, Petersburg, Hampton, Chuckatuck, and Chesapeake. Length 1.35 mm; height 1.66 mm. Dall's figure of *Crenella duplinensis* does not show external sculpture, but the outline, size, and written description agree with *Crenella aequilatera* as do Duplin specimens from North and South Carolina. Figure 24 is a Lea paratype from Petersburg. A smaller, more inflated variety (Figure 24a) is found at Chuckatuck and Chesapeake.

25. *Crenella* sp. cf. *C. decussata* (Montagu, 1808). Shell minute, oval, inflated; sculpture of relatively heavy, divaricating radial ribs and finer concentric lines. This form differs from *Crenella aequilatera* by having fewer and heavier ribs, separated by wider interspaces. Chowan River beds at Chesapeake. Length 1.25 mm, height 1.54 mm.

26. *Crenella precursor* Gardner, 1944. "Shell both large and heavy for the genus; evenly ovate, moderately inflated" (Gardner, 1944). Zone 2, Suffolk and Chesapeake, common only in the Chowan River beds at Chesapeake. Length 6.4 mm, height 7.6 mm.

Genus *Arcoperna* Conrad, 1865

Synonyms: *Rhomboidella* Monterosato, 1884; *Megacrenella* Habe, 1965

Shell resembling a thin shelled, gigantic *Crenella*; beaks anterior; hinge teeth lacking. Sculpture of finely incised radial lines. The type of the genus is *Arcoperna filosus* Conrad, 1865, from the Eocene.

27. *Arcoperna williamsi* Campbell, new species. Shell of medium size, thin and very fragile; beaks anterior, prosogyrate and prominent; quadrate in outline and inflated. Ventral margin slightly sinuate. Sculpture of even, distinct, fine radial grooves. Hinge without teeth, but with a low shelf along the posterior lateral area. Type locality is Zone 2, Rice's Pit, Hampton, Virginia. Length 22.3 mm, height 16.0 mm. *Arcoperna fragilis* (Verrill, 1885), found in water depths of 100 to 140 meters off Virginia and the Carolinas, is a closely related Recent species, but is more oval, with higher, more produced beaks.

Etymology: Named in honor of Walley Williams who discovered the unique holotype.

Genus *Musculus* Roding, 1798

Small mytilids with radial sculpture on the anterior and posterior ends, smooth across the middle of the valve. *Gregariella* principally differs from *Musculus* in having thick tufts of periostracal "hair" on the back of the shell, a feature invariably lost in fossil material. The following species are arbitrarily assigned to *Musculus*.

28. *Musculus ricei* Campbell, new species. Shell small, very narrow, well-inflated; beaks terminal. Twenty-five to thirty well-developed radial ribs over the posterior half of shell, and 9 weaker radial ribs over the anterior end; intervening area smooth. Weak concentric lines combine with the radial sculpture, producing a cancellate pattern. Interior margin strongly crenulate, reflecting the radial sculpture. Zone 2, Hampton. Length 4.58 mm, height 2.01 mm. Known from a single pair. Type locality is Rice's Pit, Hampton, Virginia, discovered by the late Dr. Walley Williams. The completely terminal beaks and its narrow and inflated shell separate *Musculus ricei* from the more common *Musculus virginicus*. *Musculus ricei* resembles *Gregariella coarctata* (Carpenter, 1857) as figured by Keen (1971), and may be congeneric with that Pacific species.

Etymology: Named for William Rice, late owner of Rice's Pit.

29. *Musculus virginicus* (Conrad, 1867) (Synonym: *Modiolaria petagnae* Sacchi Meyer, 1888, not of Sacchi, 1832; *Musculus carolinensis* (Dall, 1898)). Shell small, oval, inflated and strong for its size. Zone 2, Williamsburg, Chuckatuck, Hampton, and Chesapeake. Length 3.5 mm, height 2 mm.

Genus *Lithophaga* Roding, 1798

"These are cylindrical shells, tapering posteriorly, which bore into soft rock or other shells" (Keen, 1971:68).

30. *Lithophaga pectinicola* Olsson, 1916. Shell small, smooth, and relatively narrow for the genus. Zone 2, Yorktown. Length 12 mm, height 4 mm. This species is rare, and may represent a juvenile stage of the the following form.

39. *Lithophaga yorkensis* Olsson, 1914. Shell cylindrical,

rounded anteriorly, bluntly tapering posteriorly. Zone 2, Williamsburg, Hampton, and Chuckatuck. Length 13 mm, height 4.6 mm. A larger population of this species may prove to be conspecific with *Lithophaga bisulcata* (Orbigny, 1842), but insufficient material is presently in hand and Olsson's name is here provisionally maintained. See also species # 161.

Genus *Modiolus* Lamarck, 1799

Large, smooth, well-inflated mussel shells with subterminal beaks. Hinge without teeth. The shell is nacreous, and even small fragments of shell are easily identifiable to genus.

___. *Modiolus ducatelli* (Conrad, 1840). A common erroneous identification for Yorktown fragments. See Appendix II.

32. *Modiolus gigas* (Dall, 1898) (Synonyms: *Mytilus inflatus* Tuomey and Holmes, 1856, non Costa, 1846, Mueller, 1847, Moore, 1870, nor Whitfield, 1885 or 1895; *Modiolus gigantoides* (Olsson, 1914); not *Modiolus inflatus* (Tuomey and Holmes) of Richards, 1947 (= a *Gastrochaena*)). Shell large and fragile; posteriorly expanded. Exterior olive green to brown; interior nacreous. common as distinctive fragments but rarely found whole. Zone 1, Surry County and Williamsburg; Zone 2, Petersburg, Williamsburg, Hampton, Chuckatuck, Smithfield, and Chesapeake. Length 106 mm, height 60 mm.

Spamer and Forester (1988, pl. 5) illustrate the syntypes, WFIS 5354.

33. *Modiolus pulchellus* (Olsson, 1914) (Synonym: *Modiola phaseolina* Philippi of Meyer, 1888, not of Philippi, 1844). Shell small, fragile, very expanded. Zone 1, Williamsburg and Yorktown. Length 9 mm, height 6.5 mm.

Superfamily Pinnacea
Family Pinnidae

Genus *Atrina* Gray, 1847

"Shaped rather like a ham, these shells have no groove down the inside and the nacreous area is undivided" (Keen, 1971:75).

34. *Atrina harrisii* (Dall, 1898). Dall cited North Carolina Duplin and Maryland Choptank occurrences for this species, a stratigraphic separation making two species likely. The Yorktown specimens are conspecific with Duplin material, but are invariably broken and exfoliated. Complete specimens are known from the Pinecrest beds of south Florida. Zone 2, Chuckatuck and Chesapeake. Length (incomplete) 45 mm, width 25 mm.

Superfamily Pteriacea
Family Pteriidae

Genus *Pteria* Scopoli, 1777

Shell thin, highly nacreous within, having a wing-like triangular projection at each end of the straight hinge line.

35. *Pteria colymbus* (Roding, 1798) (Yorktown synonym: *Pteria multangula* (H. C. Lea, 1843); for Recent synonyms, see Dall (1898:670)). Shell of medium size, thin, fragile, with form typical of the genus. Zone 2, Petersburg, Chuckatuck, and Hampton. Length 33 mm, height 26 mm. Lea's name was proposed for an immature shell. Adult specimens appear identical with Recent *Pteria colymbus*. Rare Yorktown pearl specimens may or may not belong to this species.

Superfamily Pectinacea
Family Pectinidae

Genus *Pecten* Muller, 1776

"Right valve slightly to strongly arched, left valve flat to concave. Ears subequal in size and shape" (Keen, 1971:84).

36. *Pecten hemicyclicus* (Ravenel, 1834) (Synonyms: *Pecten ochlockoneensis* Mansfield, 1932; *Pecten ochlockoneensis leensis* Mansfield, 1939; *Pecten raveneli* (Dall) of Cooke, 1936, and of Campbell and others, 1975, not of Dall, 1898). Shell of medium size, with about 22 radial ribs; ribs wider and stronger centrally, smaller, weaker, and more closely spaced laterally. A smaller radial interrib is occasionally developed in the interspaces. Concentric sculpture of very fine, evenly raised lines. Byssal notch present. Zone 2, Chuckatuck crossbeds. Length 62 mm, height 54 mm. This species is very rare in the Yorktown, and only the left or flat valve has been recovered. *Pecten hemicyclicus* is proportionally wider than *Pecten raveneli* and has shallower interspaces. The two have frequently been confused in the literature.

37. *Pecten smithii* (Olsson, 1914). Shell medium to large, with 20 to 24 very low radial ribs. Ribs becoming proportionally stronger with mature growth. Left valve concave for 25 to 30 mm, but becoming slightly convex with subsequent growth. Byssal notch present. Ribs reflected internally by raised threads, as in *Amusium*. Zone 1, Surry County along the James River; Williamsburg, and Kings Mill. Length 100 mm, height 95 mm. This rare species is the oldest of a lineage including the Waccamaw species *Pecten holmesii* Dall, 1898 and the Recent *Pecten laurenti* Gmelin, 1791. Morphologically, they bridge the gap between *Pecten* and *Amusium*.

Genus *Amusium* Roding, 1798

Large to very large, compressed, very thin-shelled, nearly equivalve scallop shells. The shells are smooth without but with paired radial threads on the interior of the valves. Recent species commonly are colored red to red-brown on the upper valve, white on the lower.

38. *Amusium mortoni* (Ravenel, 1844). Shell very large, thin, and fragile. External surface smooth. Internal sculpture of paired radial lines. Zone 2, Southampton County, Hampton and Chesapeake. Mansfield (1932) noted that the Maryland Miocene records of this species were actually based on Virginia Yorktown material. Large specimens may exceed 200 mm, but the rare Yorktown material is normally much smaller. There are erroneous reports from the older literature of living *Amusium mortoni* in the Gulf of Mexico.

Genus *Leptopecten* Verrill, 1897

"Shell small, thin to medium in weight, valves subequal and only slightly convex; ribs narrow with wider interspaces; concentric sculpture, if present, microscopically fine" (Keen, 1971:91).

39. *Leptopecten leonensis* (Mansfield, 1932) (Synonym: *Pecten wendelli olgensis* Mansfield). Shell small, with 10 to 16 radial ribs that vary greatly in their relative strength. A common pattern has the stronger ribs separated by two weaker ones. Basal Zone 2, Gloucester County and the Piankitank River. Length 21 mm, height 20 mm. Ward and Blackwelder (1987) discuss various *Leptopecten* species, and erect a new species, *Leptopecten auroraensis*, which is named for Aurora, North Carolina, but they cite a type locality of Clewiston, Florida. They further state in an apparent lapse, that *Leptopecten wendelli* (Tucker, 1934) is a senior synonym of *Leptopecten leonensis* (Mansfield, 1932). *Leptopecten wendelli* occurs commonly in the Waccamaw deposits at Calabash, North Carolina and is not conspecific with the older *L. leonensis*. However, *L. wendelli olgensis* (Mansfield, 1939) appears identical with *L. leonensis*. Leptopecten *auroraensis* shares shell form, rib number, and rib pattern with *L. irremotis* Olsson and Harbison, 1953, and both of them may be junior synonyms of *Leptopecten harrisii* (Dall, 1898).

40. *Leptopecten wilsoni* Campbell, new species. The shell is small, compressed, with very large auricles. Nine radial ribs alternate in strength. Rib crests are smooth or weakly striate, but rib margins show delicate scaling. The interrib area is narrower than the ribs and is smooth or finely striate. Posterior auricle with seven radial threads, anterior auricle with five; auricle thread interspaces heavily scaled. Resilifer pit triangular, small. Inner surface of hinge with perpendicular striae. Zone 2, Wilson's Pit, Hampton, Virginia. Length 19 mm, height 18 mm. The unique type, a left valve, differs from *Leptopecten leonensis* in its proportionally larger auricles and its fewer and broader ribs.

Etymology: Named for its discoverer, Druid Wilson, formerly of the U. S. Geological Survey.

Genus *Argopecten* Monterosato, 1889

"Sturdy shells, ears nearly equal in size, valves convex and approximately equal; ribs numerous, concentric sculpture reduced to fine striae in interspaces" (Keen, 1971:87).

41. *Argopecten comparilis* (Tuomey and Holmes, 1855) (Synonyms from Waller (1969): *Pecten yorkensis* Conrad, 1867; *Pecten evergladensis* Mansfield, 1931; *Pecten comparilis jacksonensis* Mansfield, 1932; *Pecten caloosensis* Mansfield, 1939). Shell of medium size, obliquely circular, well-inflated, with ribs as high as wide. Zone 2, Southampton County, Petersburg, Chuckatuck, and Chesapeake; Chowan River beds at Chesapeake. Length 38 mm, height 40 mm.

Genus *Carolinapecten* Ward and Blackwelder, 1987

Large, thin-shelled, compressed to moderately inflated scallop shells with prominant, low, smooth ribs. Type is *Pecten eboreus* Conrad, 1833.

42. *Carolinapecten eboreus* (Conrad, 1833) (Synonyms: *Pecten micropleura* H. C. Lea, 1843; *Pecten holbrookii* Ravenel, 1844; *Pecten eboreus darlingtonensis* Dall, 1898; *Pecten eboreus bertiensis* Mansfield, 1936; *Pecten eboreus watsonensis* Mansfield, 1936). Shell medium to large, slightly inflated, with low, undulatory ribs. Zone 1, Middlesex and Surry counties; Zone 2, King and Queen, Isle of Wight, and Southampton counties, Petersburg, Chuckatuck, Suffolk, and Chesapeake. Length 67 mm, height 65 mm. This species is locally abundant, but patchily distributed. Some of the names synonymized above may eventually prove to be valid, at least subspecifically. *C. eboreus walkerensis* (Tucker, 1934) (synonym: *Pecten eboreus buckinghamensis* Mansfield, 1939) is an exceptionally large, stratigraphically important subspecies with a warped cross section. It is from the upper Goose Creek Limestone of South Carolina, and was erroneously synonymized with *Carolinapecten eboreus senescens* (Dall, 1898) by Mansfield, 1936. The latter is a small subspecies with obsolete sculpture which is restricted to the Waccamaw faunas.

42a. *Carolinapecten eboreus chesapeakensis* Campbell, new subspecies. Like *C. eboreus eboreus*, but larger, much less inflated, and attaining a greater maximum diameter. Ribs 25. Ribbing lower, and auricles proportionally smaller than in *C. eboreus eboreus*. Length 123 mm, height 107 mm. Type locality is the lower Chowan River level, Deep Creek pit, end of Cookes Mill Road, Chesapeake, Virginia. This subspecies appears to be stratigraphically distinct and restricted to the Chowan River Formation. It was apparently commensal with or coevolved with a very large, flat variety of *Crucibulum leanum* Campbell, new species (number 338 of this work), and is figured with that form.

Carolinapecten eboreus bertiensis (Mansfield) was described from the Chowan River, three-fourths of a mile below Mount Gould Landing, near Elizabethtown, North Carolina. It is more inflated than *C. e. chesapeakensis*, and has medially-grooved ribs for a portion of the disk.

Etymology: Named for the City of Chesapeake in which the Deep Creek Pit is located.

Genus *Chlamys* Roding, 1798

"With the valves equal in size, but the ears markedly unequal" (Keen, 1971:89).

43. *Chlamys decemnarius decemnarius* (Conrad, 1834) (Synonyms: *Pecten dispalatus* Conrad, 1845; typographical errors *Pecten decennarius* Conrad of Orbigny, 1852 and *Pecten decenmarius* Conrad of Ward and Blackwelder, 1980). Shell of medium size, exceedingly variable in sculpture (see Gardner, 1944, plate 5, and Gibson, 1987). 8 to 10 radial ribs typically obsolete during early growth, but becoming strong and bifurcate irregularly with continued growth. Zone 2, York and Southampton counties, Williamsburg, Yorktown, Rushmere, Poquoson, and Hampton. Length 42 mm, height 43 mm. This species is an index for lower Zone 2 assemblages.

44. *Chlamys decemnarius* variety *virginianus* (Conrad, 1840) (Synonyms: *Pecten tenuis* H. C. Lea, 1843, non Bosc, 1801; *Pecten subtenuis* Orbigny, 1852). Shell of medium

size, proportions and auricles as in *C. decemnarius*, but with the ribs reduced to fine threads. Lower Zone 2, Prince George, Isle of Wight, and Southampton counties, Petersburg, Williamsburg, and Camp Wallace. Completely intergrades with *C. decemnarius decemnarius* (see Gibson, 1987) and should be considered merely a variety of that taxon.

44a. *Chlamys* sp. Shell large, with seven low, more or less distinct ribs. Interspaces wide and very shallow. Surface covered with finely scaled radial threads, coarser and more closely spaced on the ribs, finer and more distantly placed in the interspaces. Concentric sculpture lacking. Resting stages distinct, marked by a slight vertical and lateral expansion of the ribs. Chowan River beds at Chesapeake. Length 61 mm, height 62 mm. A single left valve was discovered by William Hale at the Deep Creek pit in Chesapeake. A single, possibly related specimen with more exaggerated sculpture was collected by Dr. Thomas Gibson in the Zone 2 beds at Petersburg. Whether the two specimens represent related species or a single more variable taxon cannot be determined without additional material. Consequently, it seems best to defer species description until more definitive material is discovered.

44b. *Chlamys rogersii* (Conrad, 1834). Shell small to medium in size, well-inflated, with four low, broad, undulatory ribs and relatively narrow interspaces. Secondary sculpture of radial riblets which are finer in the interspaces. Concentric sculpture of fine growth lines and broad, low undulations. Zone 2, Isle of Wight and Southampton counties, Petersburg, Sycamore Bend and Chesapeake. Length 22 mm, height 25 mm. This is one of the rarest of Yorktown species. Dr. Tom Waller has examined the species and found it to belong to *Chlamys*. Ward (1992) notes that this species is restricted to lower Zone 2 beds.

Genus *Placopecten* Verrill, 1897

"Without ribs; with radial striae; right valve smoother; ears unequal; valves with a slight convexity" (Abbott, 1974:448).

45. *Placopecten clintonius* (Say, 1824). Shell large, circular, thin, compressed; with about 140 radial threads, coarser in the center of the disc. Zone 1, James City, Surry, Isle of Wight, and Southampton counties, and Williamsburg. Length 129 mm, height 124 mm. Mansfield (1936) described a subspecies, *Pecten clintonius rappahannockensis*, from pre-Yorktown beds near Urbanna. Ward (1992) has shown Mansfield's taxon to be a junior synonym of *Placopecten principoides* (Emmons, 1858), a species restricted to the Eastover Formation. Mansfield (1944) proposed the biostratigraphic zonation used in this work, designating the lower Yorktown as the "Zone 1 or *Pecten clintonius* zone". *Placopecten clintonius*, when carefully separated from *P. principoides*, remains one of the best index species for Zone 1.

Genus *Chesapecten* Ward and Blackwelder, 1976

Large to very large, circular, often heavy shells with prominent radial ribs; ribs and interrib area sculptured with radial threads and concentric, often scabarous, lamellae. Cardinal crua lacking.

46. *Chesapecten jeffersonius* (Say, 1824). Shell large, heavy, well-inflated, with 9 to 12 prominent radial ribs. Zone 1, ubiquitous. Length 142 mm, height 131 mm. This common species is an index species for Zone 1 strata in Virginia and North Carolina, but appears to have briefly survived into basal Zone 2 equivalents in South Carolina and Florida.

47. *Chesapecten madisonius* (Say, 1824) (Synonyms: *Pecten madisomus* (sic) Conrad of Orbigny, 1852; *Pecten edgecombensis* Conrad, 1862; *Chesapecten nephrens* Ward and Blackwelder of Jasper Burns, 1991, not of Ward and Blackwelder, 1976). Shell large, moderately inflated, typically with 15 to 16 radial ribs. Secondary sculpture of coarse radial threads much stronger in *C. madisonius* when compared with *C. septenarius* or *C. jeffersonius*. Zone 2, ubiquitous. Length 103 mm, height 101 mm. The name *Pecten madisonius* was misapplied to Maryland material for about 150 years (Ward and Blackwelder, 1976).

Several ecomorphs of this Zone 2 species can be found. Specimens from near shore and from high current or wave energy environments are more inflated, possess a thicker, more ponderous shell, and have lower and less distinct ribs. Specimens from quieter waters are thin shelled with less inflated valves, and have ribs with well-developed concentric scabrous scales.

In the basal Zone 2 strata, rare specimens of *Chesapecten madisonius* have 10 to 14 ribs. These are apparently an early stage in the evolution of the species. If these constitute a separate subspecies, the name, *Chesapecten madisonius carolinensis* (Conrad, 1873), may be used.

48. *Chesapecten septenarius* (Say, 1824) (Synonyms: *Pecten septemnarius* (sic) Say of Conrad, 1840; *Chesapecten jeffersonius septenarius* (Say) Gibson, 1987). Shell of medium to large size, strongly inflated, with 6 to 8, rarely 4 to 12, large broad, squarish to "T"-topped ribs. Zone 2, New Kent and Southampton counties, Petersburg, Poquoson, Hampton, Rushmere, Yorktown, and Suffolk. Length 51 mm, height 51 mm. Virginia specimens are rarer and seem to average smaller than North and South Carolina specimens. This is an index species for lower Zone 2 strata. It is the most variable of *Chesapecten* species.

Ward and Blackwelder (1976) figure the holotype, and Gibson (1987) provides revised descriptions and numerous illustrations of typical *Chesapecten septenarius*.

Genus *Nodipecten* Dall, 1898

Medium to large, well inflated scallop shells with strong ribs marked with large, hollow pustules.

50. *Nodipecten peedeensis* (Tuomey and Holmes, 1856) "James River, Virginia" Dall (1898). True *Nodipecten peedeensis* has not been discovered in Virginia. Dall's report was based on a complex of errors which can now be addressed. True *Nodipecten peedeensis* has until very recently been known from fewer than a dozen specimens. The type lot, consisting of the holotype pair and three single valves, was misplaced during the 1920's and 1930's when

Mansfield and Tucker were monographing the American Tertiary Pectenidae, so the species was known only from the type figure. Apparently, at some time between 1860 and 1890, a set of three *Nodipecten* valves were placed into the U. S. National Museum collections as lot USNM 9526, and were labled *Pecten peedeensis*. These are actually European specimens (J. Terry Smith, 1987, personal communication; and 1991). Two of lot 9526 were credited to the Pee Dee River in South Carolina (Mansfield, 1936), but the third had "James River, Virginia" inked onto it. This is the specimen herein illustrated, and is undoubtedly the basis for Dall's 1898 Virginia record. The "Virginia" specimen here illustrated was chosen by Tucker (1938) as "Lectotype", a multiply inaccurate designation now made superfluous by the rediscovery of the Tuomey and Holmes types. *Nodipecten peedeensis* is now known from over 200 South Carolina specimens. It typically shows seven narrow, noded ribs on the left valve, and eight broad, un-noded ribs on the left. In some populations the ribs may fuse to produce half the normal number. Specimens are typically 30 to 50 mm, but may exceed 160 mm.

Family Plicatulidae

Genus *Plicatula* Lamarck, 1801

"Right valve usually the more convex; the single adductor scar posterior to the center of the shell; sculpture coarsely radial" (Keen, 1971:94).

51. *Plicatula marginata* Say, 1824 (Synonym: *Plicatula rudis* H. C. Lea, 1843, non Eichwald, 1865). Shell small, very sturdy, with three to eight radial plicate ribs on free-growing specimens. Irregularity of substrate on the attached (right) valve reflected in the upper valve. Specimens from quiet water habitats frequently developing short, flat spines on the ribs. Hinge large, strong, tightly interlocking; articulated specimens common. Zone 1, Middlesex County, and Williamsburg; Zone 2, ubiquitous. Length 21 mm, height 24 mm.

Superfamily Anomicea
Family Anomiidae

Genus *Anomia* Linnaeus, 1758

"The valve without the hole has 1 large and 2 small muscle scars. The shell is attached to a rock or wood surface by means of a calcified byssus which passes through a large notch in the right valve" (Abbott, 1974:451).

52. *Anomia simplex* Orbigny, 1842 (Yorktown synonyms: *Anomia ruffini* Conrad of authors, not of Conrad, 1835, an Late Oligocene-Early Miocene species; *Anomya conradi* Orbigny, 1852; Recent synonyms: see Dall, 1898, p. 784. Shell small to medium in size, irregularly circular in outline; external surface smooth; muscle scars typical of the genus. Zone 1, Middlesex County; Zone 2, Hampton, Chuckatuck, and Chesapeake. Length 28 mm, height 20 mm. Ward (1992) has shown *Anomia ruffini* to be a Late-Oligocene to Early Miocene species, and Eocene records from the literature are erroneous.

Genus *Pododesmus* Philippi, 1837

53. *Pododesmus* sp. Shell small to medium in size, flat to inflated, with numerous rows of small scales or simply roughened. Zone 2, Hampton, Chuckatuck, and Chesapeake. Length of largest specimen 29 mm, height 29 mm. This species may be the source of Dall's report of Yorktown *Anomia aculeata* Muller, 1776 (see Appendix II).

Genus *Placunanomia* Broderip, 1832

"The presence of elevated ridges at the hinge margin of one valve, fitting into a socket in the other, separates this genus from the other two (anomids). Also the shell is strongly plicate in three or four places around the margin" (Keen, 1971:101).

54. *Placunanomia plicata* Tuomey and Holmes, 1855. Shell of medium size, roughly triangular, with heavy ridges at the hinge margin. Periphery with three or four low to deep radial folds or plicae. Zone 2, James City County and Hampton. Length 50 mm, height 56 mm. Two morphologies are present within this species, a thin shell with very deep plicae, and a heavier shell with low marginal folds. Only two Virginia Yorktown specimens of this species are known to me, and both are of the latter form.

Superfamily Limacea
Family Limidae

Genus *Lima* Bruguiere, 1797

Subgenus *Limaria* Link, 1807

Small to medium sized shells resembling scallops but with more dorso-ventrally elongate shells. The long axis intersects the hinge line at an oblique angle.

55. *Lima (Limaria) carolinensis* (Dall, 1898) Shell of medium size, relatively wide and inflated for the genus, with about 40 fine radial threads. Shell widest about two-thirds of the distance from the beak to the ventral margin. Zone 2, Hampton and Chesapeake. Length 29 mm, height 20 mm.

56. *Lima (Limaria) pellucida* C. B. Adams, 1846 (Synonyms: *Lima hians* (Gmelin) of authors, not of Gmelin, 1791; *Lima inflata* Lamarck, 1819, not of Gmelin, 1791 nor Petagna, 1819). Shell small, very fragile, relatively narrower than *Lima carolinensis*, with about 35 radial lines. The shell is widest at midpoint. Zone 2, Yorktown and Chuckatuck. Length 19 mm, height 14 mm.

Genus *Limatula* S. Wood, 1839

"Valves usually equilateral, closed. Ligamental pit small and centrally placed. animal without eyes" (Abbott, 1974:454).

57. *Limatula virginiana* Campbell, new species. Shell minute, narrow, and well-inflated; beaks central; hinge nearly perpendicular. Sculpture of 17 radiating riblets, stronger towards the midline of the shell; internally two central threads border a slight groove. Riblets sharp with wide, smooth interspaces. Concentric sculpture of faint

growth lines. Zone 2 Hampton (upper level at Rice's Pit is type locality), and Suffolk. Length 2.08 mm, height 3.13 mm. This species most closely resembles the Recent Caribbean *Limatula hendersoni* Olsson and McGinty, 1958, which differs in having narrower striate interspaces and a narrower resilifer pit.

Etymology: named for the state of Virginia.

Superfamily Ostreacea
Family Ostreiidae

Genus *Ostrea* Linnaeus, 1758

Shell medium to large, irregular in form and sculpture, with a single large adductor scar. The shell margin is denticulate. Prodissoconch hinge is long and valves are symmetrical. Species are commonly attached to another shell or hard substrate.

58. *Ostrea compressirostra* Say, 1824 (Synonyms: *Ostrea disparilis* Conrad, 1840; *Ostrea raveneliana* Tuomey and Holmes, 1855). Shell very large, attached only in the early juvenile stages or not at all; with an oval, deeply cupped lower valve and a nearly flat upper valve. Sculpture of the upper valve varies from smooth to coarse concentric growth lines. Lower valve wider and longer, with large, rough foliaceous concentric sculpture often produced into flanges adjacent to the hinge. In young shells the foliations crossed by low, narrow, curving radial riblets. Shell substance of both valves friable. Sculpture best developed in quiet water Zone 1 specimens, becoming obsolete in many Zone 2 populations. Zones 1 and 2, ubiquitous. Length 93 mm, height 122 mm. This species was particularly vulnerable to attack by *Cliona* sponge and other shell burrowing organisms. Say's 1824 figure of this species is in my estimation typical of Zone 1 faunas. However, the name has been applied to an entire lineage of related American oysters extending from the Paleocene to the upper Pliocene, a lineage which may also include *Ostrea bellovacina* Lamarck, 1806, from the Eocene of Europe (Heilprin, 1884).

Palmer and Brann (1965:238-239) provide an excellent discussion of the identification and provenance of Say's type specimen, and designate British Museum L13204 as the lectotype. They note past confusion between *Ostrea compressirostra* and *Ostrea sinuosa* Rogers and Rogers, 1837, the undoubted ancestral Eocene form. Ward (1992) has recently proposed two subspecies, *Ostrea compressirostra geraldjohnsoni* and *O. c. brucei* from the Eastover Formation.

59. *Ostrea sculpturata* Conrad, 1840 (Synonyms: *Ostrea virginiana* Conrad, 1832, not of Lamarck, 1818; *Ostrea subfalcata* Conrad, 1840; *Ostrea perlirata* Conrad, 1873). Shell of medium size, commonly trigonal; attached valve more deeply cupped; margin denticulate. Sculpture initially conforms to substrate; once free, the valves commonly develop large, V-shaped plications along the margins, plications irregular in strength and number. Zone 1, Williamsburg; Zone 2, ubiquitous. Length 53 mm, height 65 mm. This highly variable oyster is typically found solitary or in small clusters, but occasionally it formed small reefs. Ward and Blackwelder (1987) proposed a new genus, *Conradostrea*, to which they assign *Ostrea sculpturata*. I prefer to maintain the taxon in *Ostrea* (sensu lato), pending a more thorough study of oyster genera.

Genus *Crassostrea* Sacco, 1897

Shells large, frequently elongate (especially if intertidal); internal margin not denticulate; prodissoconch valves asymmetrical, prodissoconch hinge short.

60. *Crassostrea virginica* (Gmelin, 1791) (Synonyms: *Ostrea virginiana* Lister, 1687 (pre-Linnaean); *Ostrea virginiana* Lamarck, 1818; *Ostrea edulis* Akerly, 1818, not of Linnaeus, 1758; *Ostrea borealis* Lamarck, 1819; *Ostrea canadensis* Lamarck, 1819; *Ostrea semicylindrica* Say, 1822; *Ostrea triangularis* Holmes, 1856; *Ostrea fundata* Holmes, 1858; *Ostrea procyon* Holmes, 1858; *Crassostrea virginica auroraensis* Ward and Blackwelder, 1987). Shell large, elongate, with a few rough, radiating ridges on the lower valve. Upper valve commonly flat and smooth. Chowan River beds at Chesapeake. Length 43 mm, height 84 mm. The Chowan River specimens are typical of the very elongate, intertidal morphology. Mohr (1927) reports *Ostrea virginica* Gmelin from prehistoric midden deposits of Sumatra, Indonesia, an obviously suspect identification.

Crassostrea virginica first appears in the Pliocene at the base of the Chowan River and equivalent beds. A large *Crassostrea* informally referred to *C. virginica* in newspaper accounts, has recently been discovered in middle Miocene beds in Delaware. Delaware specimens in the Smithsonian show ponderous thickening of the valves, a trait rarely found in *C. virginica*, but characteristic of *C. westi* (Mincher, 1941) from the Pascagoula Miocene of Mississippi. In thin-shelled morphology, the Delaware material would be difficult to separate from *C. virginica*. Druid Wilson (1992, peersonnel communication) has found Miocene specimens near Tallahassee, Florida which more closely resemble *Crassostrea virginica*. Whether these are conspecific with *C. westi* or *C. virginica* is a problem for future study.

Subfamily Pycnodontinae

Genus *Pycnodonte* G. Fischer, 1835

"Small to large and massive. Shell material made up in part by spongy, cellular material" (Abbott, 1974:457).

61. *? Pycnodonte* sp. Blackwelder and Ward, 1976. This species was listed without description from Zone 1, but was later figured (Blackwelder, 1981). The illustration herein was provided by Blackwelder. It shows a small, trigonal oyster with *Cliona* sponge borings. The primary cellular shell structure is not apparent without a higher magnification than is available. Zone 1, James River, presumably Surry County; height about 50 mm.

Subclass Heterodonta
Order Veneroida
Superfamily Lucinacea
Family Lucinidae
Subfamily Lucininae

Genus *Parvilucina* Dall, 1901

Small, round, well inflated lucines with prominant concentric, or concentric and radial sculpture.

62. *Parvilucina crenulata* (Conrad, 1840) (Synonyms: *Lucina crenulata* Conrad, 1840, non Woods, 1840, nomen nudum; *Lucina lens* H. C. Lea, 1843, non Roemer, 1841 non Deshayes, 1843; *Lucina leana* Orbigny, 1852, replacement name for *Lucina lens* H. C. Lea). Shell small, circular, slightly inflated; beaks central, slightly elevated. Sculpture of concentric threads. Zones 1 and 2, ubiquitous. Length 6 mm, height 6 mm. This is the most common small lucine in the Yorktown Formation.

63. *Parvilucina multilineata* (Tuomey and Holmes, 1856) (Synonyms: *Phacoides* (*Parvilucina*) *crenella* Dall, 1901; *Phacoides mulrilineatus* (sic) Tuomey and Holmes of Cooke, 1937). Shell small, circular, well inflated; beaks central, slightly elevated. Sculpture consists of concentric threads crossed by radial threads of nearly equal strength. Very rare in Zone 2 beds near Suffolk. Length 4.79 mm, height 4.61 mm.

64. *Parvilucina postalveata* (Gardner, 1944). Shell very small, circular, slightly inflated; beaks central. Sculpture of broad, heavy, concentric ribs. The holotype remains unique. Zone 2, Yorktown. Length 3.4 mm, height 3.3 mm.

65. *Parvilucina trisulcata multistriata* (Conrad, 1843). Shell small, oval, with the beak posterior of center. Sculpture of heavy concentric threads and occasional deep, broadly incised concentric grooves; in the subspecies, fine radial lines present, especially in the interspaces of the concentric sculpture. Zone 2, Isle of Wight County. Length 6.4 mm, height 5.2 mm.

Genus *Ctena* Morch, 1861

Small, oval, compressed lucines sculptured with concentric and radial threads; beaks are placed a little posterior of center. Inner margin of the shell denticulate.

66. *Ctena speciosa* (Rogers and Rogers, 1837) (Synonyms: *Lucina speciosa* Rogers and Rogers, 1837, non Reeve, 1850; *Lucina squamosa* Lamarck of Conrad, 1844 and Tuomey and Holmes, 1856, not of Lamarck, 1806; *Ctena leonensis* (Mansfield, 1932); *Ctena magnoliana* (Dall, 1903)). Shell small, slightly inflated, oval; beaks posterior. Concentric sculpture of incised growth lines; radial sculpture of about 34 well-developed threads. Zone 2, Yorktown, Williamsburg, and Chuckatuck. Length 12 mm, height 10 mm.

Genus *Lucinisca* Dall, 1901

"Sculpture reticulate; posterior area less distinct than anterior; inner margin denticulate" (Keen, 1971:121).

67. *Lucinisca cribraria* (Say, 1824). Shell small, round, relatively compressed. Beaks central; sculpture of raised concentric and radial threads giving a cross-hatched and often scaly appearance to the shell. Zone 1, Surry County and Williamsburg; Zone 2, Isle of Wight and Southampton counties, Yorktown and Hampton. Length 16 mm, height 15 mm.

Genus *Lucinoma* Dall, 1901

"Lenticular, lacking dorsal area; lunule long, not sunken; hinge plate without lateral teeth; inner margin of shell smooth" (Keen, 1971:126).

68. *Lucinoma contracta* (Say, 1824) (Synonyms: *Lucina subplanata* Conrad, 1841; *Lucina radula* (Montagu) of Lyell, 1845, not of Montagu, 1803; *Lucina subplana* (sic) Conrad of Meek, 1864; *Lucina borealis* Linnaeus of Heilprin, 1884, not of Linnaeus, 1767; *Phacoides* (*Lucinoma*) *contracta murfreesboroensis* Mansfield, 1929). Shell large for the family, circular, but with a straight hinge line; sculpture of thin, well-developed concentic lamellae with wide, concentrically lined interspaces. Zone 1, Surry County; Zone 2, Isle of Wight county, Hampton, and Suffolk. Length 47 mm, height 41 mm. *Lucinoma contracta* is closely related to *Lucinoma filosa* (Stimpson, 1851), Recent offshore from Newfoundland to north Florida and the Gulf of Mexico, the two differing in the shape of the lunule and the curvature of the beaks. In South Carolina waters, *Lucinoma filosa* is restricted to water depths greater than 100 meters, a bathymetry in excess of that reasonably proposed for most Yorktown localities. Heilprin's synonymizing of *Lucinoma contracta* and *Lucinoma borealis*, of which *Lucinoma radula* is a junior synonym, helps explain Lyell's usage. Full resolution of this complex of species will require a review of fossil and Recent populations from both sides of the Atlantic.

Genus *Pseudomiltha* P. Fischer, 1885

"Large, circular, compressed, with small, erect beaks. Surface concentrically ribbed or smooth. Teeth obsolete or absent. Short stout nymph. Interior punctate. Shell margin smooth" (Abbott, 1974:462). Some authors use *Stewartia* for our eastern Tertiary species.

69. *Pseudomiltha anodonta* (Say, 1824) (Synonyms: *Lucina undula* Conrad, 1845; *Lucina americana* Conrad, 1863 of Glenn, 1904, not of Conrad, 1838, nor Defrance, 1823; *Stewartia anodonta intermixtus* Olsson and Harbison, 1953). Shell of medium size, circular, compressed, smooth or with roughened growth lines. Zone 1 Surry county and Williamsburg; Zone 2, Isle of Wight County; Petersburg, Williamsburg, Yorktown, Chuckatuck, Suffolk, and Hampton. Length 59 mm, height 59.5 mm.

Subfamily Divaricellinae

Genus *Divalinga* Chavan, 1951

"The shells are white, nearly orbicular, marked with obliquely radiating lines that meet to one side of the center of the disk. Lateral hinge teeth well developed; inner margin of shell denticulate" (Keen, 1971:125).

70. *Divalinga quadrisulcata* (Orbigny, 1842) (Synonyms: *Lucina divaricata* Lamarck of authors, not of Lamarck, 1806; *Lucina strigilla* Stimpson, 1851; *Lucina conradi* Orbigny, 1852; *Lucina americana* C. B. Adams, 1852, not of Defrance, 1823). Shell small, very circular, slightly inflated; sculpture of curving grooved chevrons. Zone 1, Williamsburg; Zone 2, Williamsburg, Hampton, and Chuckatuck. Length 11 mm, height 10 mm. No other Yorktown bivalve can be

confused with this distinct species.

Family Ungulinidae

Genus *Diplodonta* Bronn, 1831

"Shell thin, orbicular and strongly inflated. There are 2 cardinal teeth in each valve. The left anterior and right posterior ones are split or bifid. Laterals obscure or absent. Ligament external. Adductor scars subequal in size and connected by a broad, ribbon-like pallial line. No pallial sinus" (Abbott, 1974:464).

71. *Diplodonta acclinis* (Conrad, 1832) (Synonyms: *Lucina americana* Defrance of Conrad, 1838, not of Defrance, 1823, Forbes, 1846, or C. B. Adams, 1852; *Mysia acclinis* Conrad Meek, 1864; *Diplodonta acclina* Conrad of Bailey, 1977). Shell large for the genus, slightly inflated; beaks high, central, directed anteriorly. Anterior dorsal slope curves at a higher angle than the posterior. Hinge plate and teeth strong. Sculpture of closely spaced growth lines. Zone 2, Yorktown and Williamsburg. Length 33 mm, height 32 mm.

72. *Diplodonta conradi* McGavock, 1944 (Synonym: *Diplodonta soror* (Adams) of Gardner, 1944, not of C. B. Adams, 1853). Shell small, obliquely oval, with high anteriorly placed beaks. Sculpture of growth lines which may have irregular hollow pustules associated with them. Microscopic sculpture described by Gardner (1944) not developed on the Virginia specimens. Zone 2, Yorktown and Hampton. Length 16 mm, height 16 mm. Clench and Turner (1950) have illustrated the lectotype of *Diplodonta soror* (C. B. Adams). It is a circular, inflated shell with high, centrally placed beaks and concave dorsal slopes. No surface sculpture is visible. *Diplodonta conradi* is more obliquely oval with convex dorsal slopes. The Duplin specimen figured by Gardner is conspecific with *Diplodonta conradi*, but I have not examined her Waccamaw specimens.

73. *Diplodonta nucleiformis* (Wagner, 1838) (Synonyms: *Abra nucleiformis* Wagner, 1838; *Loripes elevata* Conrad, 1844; *Cytherea sphaerica* H. C. Lea, 1843; *Gemma sphaerica* (Lea) Meek, 1864; *Dione spherica* (Lea) Meek, 1864; *Mysia carolinensis* Conrad, 1873; *Diplodonta sphaeromorpha* Gardner, 1926). Shell small for the genus, perfectly circular and very inflated. Beaks central, perpendicular to the hinge line. Zone 2, Petersburg, Williamsburg, Yorktown, Hampton, Chuckatuck, and Chesapeake. Length 6 mm, height 5.5 mm, width (single valve) 2.1 mm.

74. *Diplodonta punctulata* (H. C. Lea, 1843) (Synonyms: *Psammocola lucinoides* H. C. Lea, 1843, not of Deshayes, 1824; *Diplodonta leana* Dall, 1900, replacement name for *P. lucinoides*; *Diplodonta yorkensis* Dall, 1900, in part, not the holotype; *Diplodonta ochlockoneensis* Mansfield, 1932; *Diplodonta berryi* McGavock, 1944). Shell small, typical of the genus, roughly circular, with low beaks; moderately inflated. Posterior dorsal slope higher and more angular than anterior. Zone 2, Petersburg, Williamsburg, Hampton, Chuckatuck, Suffolk, and Chesapeake. Lea's holotype (Figure 74a) length 8.29 mm, height 7.84 mm. McGavock's holotype (Figure 74b) length 13.59 mm, height 13.18 mm. The holotype of *Diplodonta punctulata* shows the "sugary" or frosted external microsculpture occasionally found in this genus, but this feature is mostly worn away in the type of *P. lucinoides*. The type of *Diplodonta berryi* has the microsculpture well-preserved. The type lot of *D. berryi* includes a thicker- shelled, more inflated pair with very sturdy dentition, and a thin-shelled, less inflated pair with a more delicate hinge. Both *Diplodonta punctulata* and *Psammocola lucinoides* are juveniles of the second form, but Dall's holotype of *Diplodonta leana* is the heavier morphotype. The two forms share the same outline and frosted microsculpture, and are here considered to represent a single species. Gardner (1944) correctly demonstrated that Dall's holotype of *D. yorkensis* was a *Cooperella*, conspecific with his *Cooperella carpenteri* (see species 184 of this work). However, the paratypes are specimens of a small, fragmented *Diplodonta*, apparently juvenile *D. punctulata*. *Lucina subobliqua* Say, 1824, judging from the description, may be the oldest name for this species, but without type or figure, the exact identity of Say's species remains uncertain.

Subgenus *Timothynus* Harris and Palmer, 1946

(Replacement name for *Sphaerella* Conrad)

Large, globose diplodontids with anteriorly directed beaks (see Ward, 1992).

75. *Diplodonta subvexa* (Conrad, 1833) (Synonyms: *Venerupis subvexa* Conrad, 1833; *Sphaerella subvexa* Conrad, 1838; *Erycina subconvexa* Orbigny, 1852; *Diplodonta subrexa* (sic) (Conrad) of Bailey, 1977). Shell of medium size, gigantic for the genus, thin, fragile, well inflated. Beaks large, central, well inflated. Surface smooth except for growth lines. Zone 2, Isle of Wight County, Chuckatuck, Williamsburg, Yorktown, Rushmere. Length 32 mm, height 29 mm, paired diameter 22 mm. *Diplodonta subvexa* is very closely related to the Recent *Diplodonta verrilli* Dall, 1900, differing only in averaging about a third larger in adult dimension. Juvenile *Diplodonta subvexa* are indistinguishable from South Carolina populations of *Diplodonta verrilli*.

Superfamily Chamacea

Family Chamidae

Genus *Chama* Linnaeus, 1758

(Synonym: *Pseudochama* Odhner, 1917)

Chamas are irregular in shape and sculpture and may be attached by either the left or right valves. The attached valve is deeper cupped and coiled, clockwise in left-attached forms, counterclockwise in right-attached forms. The unattached valve is flat or slightly convex (operculum-like). Most systemists regarded right-attached species as a separate genus, *Pseudochama*, but Younge (1967) has shown *Pseudochama* to be a form genus, lacking biological validity.

KEY TO YORKTOWN FORMATION *Chama* SPECIES

1. Attached valve coiling clockwise 2
   Attached valve coiling counterclockwise .*C. corticosa*
2. Unattached valve oval to circular in outline. *C. congregata*
   Unattached valve rectangular in outline . . . .*C. emmonsi*

76. *Chama congregata* Conrad, 1833 (Synonym: "*Crepidula* species" Jasper Burns, 1991). Shell small to medium in size; unattached right valve oval to circular in outline with low axial corrugations and, in some specimens, a few short flat spines. Fine crenulations on the inner margins of the valves. Attached left valve coiled clockwise. Zone 1. Williamsburg; Middlesex County; Zone 2. James City, Surry and Isle of Wight counties, Petersburg, Williamsburg, Yorktown, Hampton, Chuckatuck, Suffolk and Chesapeake Length 20 mm, height 23 mm.

77. *Chama corticosa* Conrad, 1833 (Synonym; *Chama agassizii* "Wagner" Dall, 1898). Shell large, massive, subcircular, attached by the counterclockwise coiled right valve. Juvenile and occasional adult specimens sculptured with thin, ruffled lamellae; typical adults rough, irregular in sculpture. Zone 2, Isle of Wight and James City counties, Petersburg, Williamsburg, Yorktown and Suffolk. A common host species for endolithic bivalves such as *Lithophaga* and *Gastrochaena*. Length 44 mm, height 52 mm. Spamer and Forster (1988, pl. 4) figure the syntypes of *Chama agassizii*, WFIS 5355.

78. *Chama emmonsii* Nicol, 1953 (September) (Synonyms: *Chama striata* Emmons, 1858, not of Smith, 1817; *Chama gardnerae* Olsson and Harbison, 1953 (November)). Shell small in size; attached by deep left valve and coiled clockwise. Adult form slightly smaller than other Yorktown species. Inflected ventral margin giving a distinctive squarish outline to the species. Zone 2, Isle of Wight County, Chuckatuck and Chesapeake. Length 11.5 mm, height 12.5 mm.

Nicol did not establish a lectotype, so the type of *C. emmonsi* must remain that figured by Emmons. Olsson and Harbison (1953) argued that Emmons' name should be restricted to his "unrecognizable" figure because his original type is lost. However in my judgment Emmons' figure is definitely a typical juvenile specimen of this species and *C. emmonsi* is considered to be the valid name. All three names are found in stratigraphic works and a consensus does not exist. This species is common in both Duplin and Waccamaw faunas of North Carolina (Gardner, 1944).

Superfamily Galeommatacea

"Small bivalves, mostly symbiotic with other invertebrates, these clams have adapted to life in the burrows of crabs, worms, etc., where they find a food source in the material the host winnows out of the water. They are not parasitic, for they do not feed directly on the tissues of the associate. They may, however, attach themselves by a byssus to some special crevice of the host, and the valves may be distorted by pressure--adding to problems of recognition for the systematist. The group has been relatively little studied" (Keen, 1971:131).

A number of Yorktown species have been described. Most are thin, smooth shells with few distinguishing features. The outline of the shell, extent of inflation, placement of beak, and number and arrangement of hinge teeth are diagnostic.

Family Lasaeidae

"Small, fragile, inflated, translucent" (Abbott, 1974:468) "Somewhat compressed shells, the hinge plate with cardinal and lateral teeth in both valves, a triangular but ill-defined socket indenting the center of the plate for the reception of the internal ligament" (Keen, 1971:135).

Genus *Erycina* Lamarck, 1805

"Shells 5 to 10 mm, white, ovate to oblong, thin. Resilium internal, lodged in a small, elongate resilifer behind the beak and under the shell margin. Teeth of 1 or 2 minute cardinals and 2 lateral laminae in each valve. Type: *lucida* Lamarck, 1805. The American species attributed to this genus are questionably placed" (Abbott, 1974:468).

79. *Erycina carolinensis* Dall, 1900. Shell small, smooth, rectangular and very compressed; beaks opisthogyrate, about 1/3 the distance from the posterior end. Length, 7.48 mm, height 5.23 mm. Zone 2, Williamsburg and Chuckatuck. This is one of the largest of the Yorktown galeommatid clams.

Family Kelliidae

"Hinge with two cardinal teeth and strong posterior laterals; ligament wholly internal, in a socket that forms a gap behind the cardinal teeth on the hinge plate" (Keen, 1971:137).

Genus *Bornia* Philippi, 1836

"Subtrigonal, white, smooth or with minute striae; hinge plate narrow, with strong lateral teeth and sockets; adductor muscle scars unequal, placed high in the shell; interior punctate in some" (Keen, 1971:137). "Shells 5 to 10 mm, with high umbones, subtrigonal to elliptical" (Abbott, 1974:469).

80. *Bornia lioica* Dall, 1900 (Synonyms: *Bornia virginiana* Olsson, 1914; *Bornia bladenensis* Gardner, 1944). Shell small, wider than high, oval in outline; well-inflated, beaks nearly central. Zone 2, James City and Isle of Wight counties; Chuckatuck. Length 6.08 mm, height 4.49 mm. Unique among Yorktown leptons, this species develops irregular undulating radial folds along the ventral half of the adult shell. However, there is considerable variation in the number of folds and the stage of ontogeny when the folds are initiated. A rare but widely distributed Pliocene species.

81. *Bornia rota* Dall, 1900 (Synonym: *Bornia triangula* Dall, 1900, in part, paratypes only). A very small, obliquely circular species, moderately inflated with beaks central. Zone 2, Petersburg and Chuckatuck. Length 3.0 mm, height 3.3 mm. Gardner's illustrations (1944, pl. 14, figs 3 and 10) of "*Bornia triangula*" paratypes belong rather to this smaller, rounder species. Great care must be exercised to distinguish this minute species from the early juvenile stages of larger bivalves, especially those of *Planicardium acutilaqueatum* (Conrad, 1838).

82. *Bornia triangula* Dall, 1900 (Synonym: *Kellia triangula* H. C. Lea, manuscript name). Shell small, very thin,

moderately inflated, with a distinctly triangular outline; beaks central. Zone 2, York and James City counties, Petersburg, Yorktown, Hampton, Suffolk, and Chuckatuck. Length 7.22 mm, height 5.83 mm. Gardner's (1944) statement that a continuous growth series exists between the smaller, rounded paratype (= *Bornia rota*, see species # 81) and the adult holotype of *Bornia triangula* is refuted by a careful examination of growth lines.

Genus *Aligena* H. C. Lea, 1846

83. *Aligena striata* H. C. Lea, 1843 (Synonyms: *Aligena aequata* (Conrad, 1844); *Erycina substriata* (Orbigny, 1852); *Aligena aequata nuda* Dall, 1900). Shell small, inflated, ovate-triangular, very thin and fragile. Sculpture of very thin, even, concentric lamellae, or rarely obsolete. Zone 2, Petersburg, Chuckatuck, and Smithfield. Length 8 mm, height 6.2 mm.

Family Leptonidae

"Compressed, beaks small; hinge plate little indented by ligament or resilium; pallial line irregular and well-removed from the ventral margin" (Keen, 1971:139).

Genus *Solecardia* Conrad, 1849

"Elongate-quadrate, with a fine surface pattern of minute punctuations. Hinge plate wide, hinge teeth well developed" (Keen, 1971:139)

84. *Solecardia cossmani* Dall, 1900. "Shell thin, nearly equilateral, rounded at both ends, the posterior end blunter, shorter, and higher than the anterior; surface with rather irregular obvious incremental lines, smoother near the beaks; base nearly straight, posterior dorsal slope arcuate, descending; anterior arcuate, beaks low, inconspicuous; right valve with the tooth narrow, slender, in a transverse vertical plane, the anterior dorsal margin expanded slightly just in front of it, the scar of the resilium strong, narrow, oblique; left valve with the tooth flattened in a horizontal plane, the anterior part longer; interior with faint, obsolete radiations; adductor scars rather large, ovate; margins entire" (Dall, 1900:1125). Zone 2, Petersburg (type locality). Length 8 mm, height 5.2 mm.

Family Montacutidae

"Shells slightly to moderately inequilateral, with a socket below the beak for the resilium; hinge with one somewhat hook-shaped tooth near the center (not a true cardinal tooth but the bent-up end of the anterior lateral) and one or more posterior lateral teeth" (Keen, 1971:140).

Genus *Montacuta* Turton, 1822

"Shell thin, obese, transversely ovate, no pallial sinus. Anterior part of the hinge in the right valve, with a narrow lamina having minute cardinal hook at the end; left valve with a similar, reduced lamina. Resilium strong, internal, posterior, seated on nymphs of which the right one is usually smaller" (Abbott, 1974:471).

85. *Montacuta chesapeakensis* Campbell, new species. Shell small, possibly immature; smooth save for weak lines of growth; very inflated; ovate-rectangular in outline. Beak central and relatively high; dorsal margin straight and higher than either of the previously described Yorktown species. Muscle scars oval-elongate, pallial line even and distinct. Type locality, Deep Creek pit, end of Cookes Mill Road, near Yadkin, Chesapeake, Virginia. The unique type was found in the upper, shell sand sediments and belongs to Zone 2. Length 1.99 mm, height 1.84 mm.

Etymology: named for Chesapeake, Virginia.

86. *Montacuta petropolitana* Dall, 1900. Shell small, thin, smooth, subtrigonal; moderately inflated; hinge with a strong anterior cardinal bent obliquely forward. Beak prominent and posteriorly placed. Zone 2, Petersburg. Length 5.75 mm, height 4.5 mm.

87. *Montacuta sagrinata* Dall, 1900. Shell small, oval, inflated; hinge with a forward projecting anterior cardinal tooth; beaks small and nearly central. Surface roughened by low concentric ridges. Zone 2, Yorktown and Chesapeake. Length 7.5 mm, height 6.0 mm.

Genus *Orobitella* Dall, 1900

"Resembling *Aligena* in the arrangement of the hinge, but with stronger teeth and a wider hinge plate; outline of shell tending to be more quadrate" (Keen, 1971:142).

88. *Orobitella laevis* (H. C. Lea, 1843) (Synonym: *Erycina sublaevis* Orbigny, 1852). Shell small, smooth, ovate-trigonal, with beaks slightly posterior. Posterior dorsal slope steeper than anterior; hinge with a strong, forward-directed cardinal. Zone 2, Petersburg. Length 5.6 mm, height 4.6 mm. Lea (1843) originally placed this species in *Aligena*, and Dall (1900) hesitantly referred it to *Fulcrella*. It is here referred to *Orobitella* because of the apparently internal ligament (see Gardner, 1944, for illustration) and the general similarity to the *Orobitella* species in Keen (1971).

Genus *Mysella* Angas, 1877

"Subquadrate to rounded-trigonal, with prominent umbones, anterior end longer; hinge plate stout, with a short central resilifer, bordered by two teeth in the right valve" (Keen, 1971:140).

89. *Mysella bladenensis* Gardner, 1944. Shell small, exceedingly thin and fragile; laterally compressed, rather rectangular in outline; with a small, pointed beak. Lateral teeth long, thin, and sharp. Zone 2, Chuckatuck. Length 5.1 mm, height 3.78 mm.

90. *Mysella spatula* Campbell, new species. Shell small, relatively heavy and strong, spatulate in outline. Beaks high, prominent, placed about two-thirds the distance from the anterior end. Cardinal area an open arch with small, sharp, tooth-like projections at the base; lateral area with short and rather stout lamellae. Muscle scars and pallial line typical of the genus. Exterior smooth save for faint lines of growth. Type locality, Zone 2 level, Deep Creek pit, end of Cookes Mill Road, City of Chesapeake. Length 3.33 mm, height 2.18 mm.

This species is more solid than *Mysella bladenensis* and

also differs in outline. *Mysella stantoni* is much more inflated and has more posteriorly placed beaks.
Etymology: named for the spatulate shape of the shell.

91. *Mysella stantoni* Dall, 1900. Shell small, inflated; beaks low and posteriorly placed. Zone 2, Southampton County, Chuckatuck, and Chesapeake. Length 5.35 mm, height 3.72 mm.

Superfamily Cyamiacea
Family Sportellidae
"Shells 5 - 10 mm, elongate, thin. Surface chalky, smooth, or pustulated" (Abbott, 1974:475). "Ligament external, on a small nymph or platform, in some with an additional small pit for the resilium on the hinge plate" (Keen, 1971:144).

Genus *Pythinella* Dall, 1899

"Inequilateral, trigonal, with prominent umbones, anterior end longer and produced, the ventral margin straight or somewhat indented. Hinge as in *Mysella*". (Keen, 1971:144).

92. *Pythinella filicaticola* (Olsson, 1914). "Shell small, elongated and with the anterior end much produced and one and a half times again as long as the posterior; anterior-dorsal margin straight with the extremity evenly rounded; posterior-dorsal margin curved behind the beak, becoming straight posteriorly and terminating in the well-rounded basal extremity; basal margin with a moderately deep insinuation pointing toward the beak" (Olsson, 1914:56). Zone 2, Isle of Wight County, and Chesapeake. Length, 3.0 mm, height 1.75 mm.

Olsson (1914) states that several pairs were found within a specimen of *Hesperisternia filicata* (Conrad). Abbott (1974) notes that the Recent genotype is symbiotic with sipunculid worms occupying gastropod shells. Hence, this species may provide indirect evidence for Yorktown sipunculid worms.

Genus *Sportella* Deshayes, 1858

"Outline ovate-quadrate, nearly equilateral, umbones medial or near anterior end; hinge with one or two large teeth; ligament mostly external, on a small nymph". (Keen, 1971:144).

93. *Sportella chesapeakensis* Campbell, new species (Synonym: *Sportella gibberosa* Gardner, of Campbell and others, 1975 (in part, Yorktown records only). Shell small, sturdy, compressed; anterior evenly rounded; posterior slope elongated, tapering; ventral margin straight. Resilifer pit oblique, rectangular, and deep, with tooth-like projections on either side. External sculpture smooth except for faint concentric encremental lines. Beaks central, prosogyrate; muscle scars weakly developed; pallial line entire. Zone 2, Chesapeake and Chuckatuck. Type locality, Deep Creek pit, end of Cookes Mill Road, City of Chesapeake. Length 2.91 mm, height 2.11 mm.

This species was at first confused with the Waccamaw species *Sportella gibberosa* Gardner, 1944, its probable descendant species. *S. gibberosa* is slightly larger, decidedly more inflated, and is not quite so produced posteriorly.

Etymology: named for the City of Chesapeake.

94. *Sportella constricta* (Conrad, 1841). Shell large for the genus, heavy, and very inflated; hinge teeth large and strong; beaks posteriorly placed. Fine incised concentric lines may or may not be present. Zone 2, Yorktown, Chowan River beds at Chesapeake. Length 15 mm, height 9 mm.

This is the type of the subgenus *Fabella* Conrad, 1863. Dall (1900) records the species from the bluffs at Yorktown. It occurs occasionally in equivalent strata in the Carolinas, but I know of no other Virginia Yorktown occurrence. The types from the Natural Well site near Magnolia, North Carolina, are lost, but Conrad apparently used different specimens for his two figures (Conrad, 1841, here reproduced as figure 94a, and Conrad, 1845, as figure 94b). Dall, 1900, illustrated a Caloosahatchee River specimen, a figure copied by Gardner (944), but Olsson and Harbison (1953) noted that the Caloosahatchee material is not conspecific and erected the name *Sportella* (*Fabella*) *dalli* for Dall's specimen. Natural Well specimens in the USNM Biological Collections include the variations shown by Conrad's drawings (figure 94c).

95. *Sportella pelex* Dall, 1900. Shell small, ovate-triangular; smooth. Posterior dorsal slope steep and blunt, marked on the exterior by a small radial ridge; beaks posterior. Zone 2, Petersburg and Hampton. Length 7.3 mm, height 5.5 mm. *Sportella pelex* differs from *Sportella chesapeakensis* by its larger size and much shorter posterior slope.

96. *Sportella petropolitana* Dall, 1900. Shell small, smooth, somewhat elongate; with beaks low and nearly central. Dorsal slope forms an even arc. Zone 2, Petersburg, Hampton, and Chuckatuck. Length 5.75 mm, height 3.75 mm. In size, outline, and external features, *Sportella petropolitana* resembles the semelid clam *Ervilia lata* Dall, 1898, but an examination of the hinge immediately separates the two.

97. *Sportella yorkensis* Dall, 1900. Shell small; ovate-rectangular; smooth, compressed. Zone 2, Yorktown, Hampton, and Chuckatuck. Length 7 mm, height 5 mm. *Sportella yorkensis* is smaller, more compressed, has a more sloping dorsal margin, and has more centrally placed beaks than *Sportella constricta*.

Genus *Ensitellops* Olsson and Harbison, 1953

Very small, fragile sportellid clams in which the posterior end is extremely elongated. Sculpture of microscopic beading.

98. *Ensitellops compressa* (H. C. Lea, 1843). "Shell very transverse, very inequilateral, subelliptical, compressed, posteriorly subtruncate, anteriorly rounded, thin, striate posteriorly and anteriorly; striae very small, concentric; basal margin straight; dorsal margin straight; beaks somewhat acute, prominent; teeth 2, small, divergent... The concentric lines of growth are very small. They are visible on the anterior and posterior portions of the shell. On the central part they are obsolete, leaving it smooth. The teeth are small and unusually divergent for a *Petricola*" (H. C. Lea, 1846:239). Zone 2, Petersburg and Chuckatuck. Length 6.3 mm, height 3.2 mm. This species is separated from

Ensitellops protexta by "a heavier shell, by an elongate and oval rather than a sublanceolate outline, and by the absence of punctae on the external surface" (Gardner, 1944:85).

99. *Ensitellops protexta* (Conrad, 1841) (Synonyms: *Hiatella lancea* H. C. Lea, 1843; *Ensitellops elongata* Olsson and Harbison, 1953). Shell small, exceedingly narrow and elongate; exterior surface with small, irregular pustules easily lost through abrasion. Zone 2, Isle of Wight County, Petersburg, Hampton, and Chuckatuck. Length 10.94 mm, height 3.76 mm.

Genus *Anisodonta* Deshayes, 1858

"Subquadrangular, narrowly transverse, anterior end short, attenuated. Posterior end long and broad. Hinge with irregular anterior laterals, partly fused to the anterior cardinals. Posterior laterals long. With a very narrow resilium and a short, flat, broad nymph. The type is *complanata* Deshayes, 1858" (Abbott, 1974:476).

100. *Anisodonta americana* Dall, 1900. Shell small, rectangular, with a bifurcating resilifer pit. Surface roughened, anterior end on non-abraded specimens is pustulose. Zone 2, Hampton and Chuckatuck. Length 11.95 mm, height 7.15 mm.

Genus *Paramya* Conrad, 1861

"Shell small, subquadrate, concentrically striate, beaks anterior to the middle line. No hinge teeth or external ligament. Hinge with a triangular, vertically directed pit for the resilium, the later borders of the pit sometimes carinated. Pallial line more or less broken up, and no sinus present" (Abbott, 1974:573). Note: this may be a synonym of *Anisodonta* (see discussion below).

101. *Paramya subovata* (Conrad, 1845). Shell small, slightly inflated, elongate, oval to rectangular in outline. External surface granular or pustulose, with concentric growth lines. A slight inflection runs posterior from the beak. Beaks low, prosogyrate, a little forward of center. Resilifer pit narrow, flanked by laterally projecting cardinal teeth. Muscle scars distinct, with a raised radial ridge bordering the inner margins. Zone 2, Hampton and Chesapeake. Length 12 mm, height 6.2 mm.

Dall (1900) clearly wavered between a leptonid and a corbulid assignment for this genus, but following his corbulid decision, no systemist has apparently challenged the placement of this species. The well preserved Yorktown specimens now in hand have the thin shell, hinge, and granular to pustulated surface of a sportellid. Additionally, the Recent mollusc traditionally assigned to this species (the type is fossil) lives commensally with an echiuroid worm, a typically sportellid habit otherwise unknown among corbulids. In my opinion, *Paramya* is very close to *Anisodonta*, and may be a junior synonym of it. Recent *Paramya subovata* from surf wash in South Carolina are thinner, smoother, and more regular in form, and may or may not prove to be conspecific. Shell microstructure of the Recent form, however, suggests myid affinities more compatible with corbulids (J. Carter, 1990, personal communication). Microstructure of the Yorktown material has not yet been examined.

Family Carditidae

Genus *Carditamera* Conrad, 1838

Moderate sized shells which are elongate, subrectangular, heavy,and with strong radial ribs. Beaks anteriorly placed.

102. *Carditamera arata* (Conrad, 1832) (Synonyms: *Cardita carinata* Conrad, 1832, non Bruguiere, 1791; *Cardita pseudocarinata* Orbigny, 1852; *Carditamera macropleura* Conrad, 1870; *Carditamera arata harveyensis* Mansfield, 1932; *Carditamera arata verdevilla* Gardner, 1944; *Cypricardia arata* (Conrad) Mongin, 1957). Shell heavy, elongate, rectangular, with about 15 broad radial ribs. Young shells with scaly flutings on the posterior ribs. Maximum size, extent of fluting, and strength of ribbing variable between localities. Zone 2, ubiquitous. Length 50 mm, height 21.5 mm.

Genus *Pleuromeris* Conrad, 1867

"Shell tiny, convex, triangular. Lunule small (elongate), restricted to the left valve; the escutcheon minute and poorly defined" (Abbott, 1974:477).

103. *Pleuromeris decemcostata* Conrad, 1867 (Synonyms: *Cardita tridentata* Say of Conrad, 1865, not of Say, 1826; *Cardita abbreviata* Emmons, 1858, not of Conrad, 1841). Shell small, very solid, with 10 to 13 radial ribs crossed by concentric beaded, threads; beaks central and relatively high. Chowan River beds, Chesapeake. Length 7 mm, height 6.2 mm. This species resembles *Pleuromeris tridentata* (Say, 1826), but has fewer and larger ribs and more distinct beading.

104. *Pleuromeris tridentata* (Say, 1826). Shell small, solid, trigonal, with 14 to 18 radial ribs. Ribs weakly beaded. Cardinal teeth heavy. Length 7 mm, height 7 mm. Zone 1, Middlesex County, Williamsburg; Zone 2, ubiquitous.

104a. *Pleuromeris auroraensis* Ward and Blackwelder, 1987. Shell very small, trigonal, solid. Anterior and posterior slopes nearly straight, ventral margin well rounded. Sculpture of 12 to 14 flat, very low radial ribs with very narrow interspaces. Concentric growth lines prominant, beading absent. Beaks high, narrow, centrally placed. Central cardinal triangular, massive. Ventral interior margin denticulate. Chowan River beds, Chesapeake. Length 4.68 mm. This species is proportionally higher than the other two species, has straighter sides, lower ribs, narrower interspaces, and lacks the beading characteristic of the other two. *Pleuromeris scituloides* (Olsson, 1914) from the Floridian Pliocene resembles *P. auroraensis*, but it is higher than wide, with fewer ribs and more deeply incised interspaces.

Genus *Pteromeris* Conrad, 1862

Very small, solid, compressed carditids with a concave anterior-dorsal slope. Sculpture of low, flat, radial ribs.

105. *Pteromeris abbreviata* (Conrad, 1841) (Synonyms:

Glans perplana (Conrad) of Richards, 1947, not of Conrad, 1841; ? *Astarte radians* Conrad, 1845). Shell very small, compressed, spatulate, with very high beaks. Sculpture of 18 to 20 flat radial ribs; hinge typical of the family. Zone 2, Isle of Wight County, Williamsburg, Yorktown, Hampton, Chuckatuck, and Chesapeake. Length 6 mm, height 6.5 mm. *Pteromeris perplana* (Conrad, 1841) is a larger, more compressed shell with fewer and wider ribs. It has frequently been confounded with *P. abbreviata* in literature, possibly because the latter might on casual examination be taken to be the juvenile of the former.

Genus *Cyclocardia* Conrad, 1867

"Short, compressed; ribs triangular, beaded; beaks low" (Keen, 1971:109).

106. *Cyclocardia granulata* (Say, 1824). Shell small to medium in size; heavy, circular to oval. Generally height greater than width. Ribs 19 to 25, averaging 22; ribs broader over the center of disk, beaded in the early stages of growth. Zones 1 and 2, ubiquitous. Length 24 mm, height 30 mm. *Cyclocardia borealis* (Conrad, 1831), a Pleistocene and Recent species, has been synonymized with *Cyclocardia granulata* by some authors, but Dall (1903) considered them to be distinct. The Pleistocene shells I have examined have been more circular, heavier shells, and the Recent Boreal to cold-temperate range is incompatible with the warm-temperate to subtropical range of *Cyclocardia granulata*.

Popenoe and Findlay (1933) report specimens of *Cyclocardia granulata* from the Waccamaw of the Cape Fear River, North Carolina, which have a transposed hinge, reversing the normal left and right valve tooth patterns. Such mutation has not been reported from the Yorktown, but given the abundance of this species in many of the deposits, such a study might prove of interest.

Family Condylocardiidae

Genus *Erycinella* Conrad, 1845

Very small, oval, solid shells with low, flat, radial ribs and heavy dentition.

107. *Erycinella ovalis* Conrad, 1845. Shell very small, solid, heavy, oval. Hinge large. Cardinal teeth heavy, two in each valve. About 20 low or rarely obsolete radial ribs. Interior margin crenulate. Zone 2, Yorktown, Hampton, Chuckatuck, Suffolk, and Chesapeake; Chowan River at Chesapeake. Length 2.6 mm, height 2.9 mm. Moore (1962:82) notes that the type lot of this species includes specimens from the English Crag. Heilprin (1884) compared *Erycinella ovalis* with *Goodallia pygmaea* S. Wood, 1840, from the Crag and concluded that the two were identical. Of the few subsequent references to this species, none follow Heilprin's synonymizing, but it seems likely that Heilprin left the comparative lot admixed with Conrad's material and they have remained there to the present time.

Genus *Astarte* Sowerby, 1816

"Shells compressed, heavy, subovate, 2 muscle scars joined by a pallial line, no pallial sinus. Hinge tridentate in each valve" (Abbott, 1974:480).

108. *Astarte arata* Conrad, 1840. "Shell ovate-trigonal, convex, with concentric scalariform sulci and fine intermediate striae; lunule very large, ovate, deeply concave; base very regularly arched; posterior extremity subtruncated; margin crenulated" (Conrad, 1840:42). Zone 2 ?, City Point (Hopewell, type locality), and Southampton County (Gardner, 1944). Length 26 mm, height 26 mm. This species has not been rediscovered in the present study nor can it be satisfactorily synonymized with any of the following species. It may be the species later named *Astrate roanokensis* Gardner, 1944, or possibly *Astarte berryi* Gardner, 1944.

109. *Astarte berryi* Gardner, 1944. Shell of moderate size, ovate-trigonal in outline, heavy and inflated. Beaks central, moderately high. Sculpture of somewhat regular concentric ribs with wide interspaces; concentric irregular striae also present. Zone 2, Suffolk and Southampton County. Length 25.0 mm, height 27.2 mm.

110. *Astarte coheni* Conrad, 1840 (Possible synonym: *Astarte thomasi* Conrad, 1855, fide Dall, 1903). Shell ovate, heavy, well-inflated; beaks central, pointing forward. Sculpture of low, concentric ribs with much wider interspaces; interspaces narrower and more deeply cut on the beaks. Zone ?, Lancaster County. Length of holotype 18 mm, height 17 mm. The type is illustrated. I have not collected in Lancaster County, and cannot document with certainty whether this species belongs to the Yorktown or to the Eastover Formation. Gardner (1944) and Dall (1903) record *Astarte coheni* from Yorktown localities, although Dall said it was the most common species along the York River, Gardner failed to record it there. They both describe the species as a small *Astarte* and Gardner emphasizes compressed valves. Apparently, neither author had true *Astarte coheni*, and their distributional data must therefore be rejected.

110a. *Astarte griftonensis* Gardner, 1944. This striking species was described from the North Carolina Yorktown. It has not yet been found in Virginia (see Appendix I.)

111. *Astarte* sp. cf. *A. exaltata* Conrad, 1841. Shell small, trigonal, inflated, heavy; ventral margin well-rounded. Dorsal margins concave, beaks very high. Sculpture of concentric ribs on the beaks, becoming undulatory over the disk. Lunule very large and deep. Zone 1, Surry and Isle of Wight counties, Yorktown, Williamsburg, and Hopewell. Length of holotype 17 mm, height 17 mm; length of a Zone 1 specimen (111a) 7.5 mm, height 8.0 mm. The type locality for *Astarte exaltata* is Calvert Cliffs, Maryland. The holotype (fig. 111) is higher and more trigonal than the Zone 1 taxon traditionally assigned to this species.

112. *Astarte concentrica* Conrad, 1834 (Synonyms: *Astarte lineolata* H. C. Lea, 1843, non Roemer, 1849; *Astarte bella* Conrad, 1863; *Astarte concentrica conradi* Gardner, 1944; not *Astarte concentrica* Goldfuss, 1837). Shell trigonal, compressed, of moderate size; ventral margin rounded; sculpture of fine, crowded concentric ribs; beaks forward of center. Relative height and sculpture quite variable. Zone 2, ubiquitous; Chowan River beds at Chesapeake. Length

23 mm, height 21 mm.

Mongin (1957) cites "*Astarte concentrica* Goldfuss, 1827", a date which would necessitate the abandonment of the familiar usage of Conrad. After much unsuccessful search for Goldfuss's 1827 usage, I submitted the problem to Mr. Richard Petit who has resolved the matter. Mongin cited the date of the first section of Goldfuss's work which spanned 1827 to 1844. His actual publication of *Astarte concentrica* dates from 1837, making his usage the junior homonym.

Popenoe and Findlay (1933) report Yorktown specimens of *Astarte concentrica* from Grove Wharf with transposed hinges, reversing the normal left and right valve dentition patterns.

113. *Astarte roanokensis* Gardner, 1944 (Synonyms: *Astarte hertfordensis* (fig. 113a) *Astarte hertfordensis meherrinensis*, *Astarte stephensoni* (fig. 113b), all Gardner, 1944). Shell of moderate size, large for the genus, trigonal, oblique. Beaks relatively high, anteriorly placed. Disk smooth or with low undulatory concentric ribs and irregularly spaced incised lines. Zone 2, Isle of Wight and Southampton counties, Hopewell, and Suffolk. Length 23.9 mm, height 24.4 mm. This species is variable in relative proportions, degree of inflation, and strength of sculpture. The more heavily sculptured forms were given the name *Astarte stephensoni*, and the relatively higher forms with their narrower beaks were called *Astarte roanokensis*. Gardner observed that the extremes of variation in her subspecies "approach *Astarte roanokensis* on the one hand and *Astarte stephensoni* on the other" (Gardner, 1944:54). IOf the various names available, *Astarte roanokensis* has page priority. This species resembles *Astarte castanea* Say, 1822, of the Recent fauna.

114. *Astarte symmetrica* Conrad, 1834 (Synonym: *Astarte orbicularior* Meyer, 1888). Shell small, very circular. Beaks moderately high, centrally located. Surface smooth or with widely spaced, incised growth lines. Zone 2, Petersburg, Hopewell, Williamsburg, Chuckatuck, Hampton, and Chesapeake; lower Chowan River beds at Chesapeake (worn single valves, probably reworked).

115. *Astarte undulata* Say, 1824 (Synonyms: *Astarte bipartita* Sowerby of Lyell, 1845, not of Sowerby, 1826; *Astarte undulata vaginulata* Dall, 1903; *Astarte undulata deltoidea* Gardner, 1944). Shell small, trigonal, compressed. Beaks anterior, acute; umbonal area flattened, at a slight angle to the remainder of the disk. Sculpture of concentric undulations, strongest on the flattened umbonal area. Interspaces wide, rounded, deeply excavated. Zones 1 and 2, ubiquitous. This is a variable species in outline and detail of sculpture. Typical *Astarte undulata undulata* (fig. 115) is found throughout Zone 2. It is a relatively thin shell with undulations passing over the entire disk. Both *Astarte undulata deltoidea* (fig. 115a, c, and d) and *Astarte undulata vaginulata* (fig. 115b) are heavier Zone 1 shells in which the concentric sculpture is stronger at the beaks, becoming obsolete with mature growth.

	Length	Height
Astarte undulata undulata	28.5 mm	25.0 mm
Astarte undulata vaginulata	21 mm	21 mm
Astarte undulata deltoidea	22.4 mm	27.5 mm

116. *Astarte vicina* Say, 1824. "Trigonal with a distant, somewhat regular, impressed line; lunule much excavated; apices acute. Apicies prominent: lunule dilated, deeply excavated. Subcordate, separated from the disk, particularly near the beaks, by a subacute angle; beaks prominent, approximate, acute, curved backwards; ligament margin concave; umbones convex. Length 9-10th of an inch, breadth 1 inch" (Say, 1824). This species (or subspecies) has not been satisfactorily identified since its initial description, with Conrad (1834), Dall (1903), and Gardner (1944) providing disparate interpretations. Say stated that he had numerous specimens, suggesting a rather common form. Say's original description quoted above provides no information about the sculpture of the shell, but the original figure (1824, Plate 9, figure 6, reproduced here as figure 116a) shows a shell with fine crowded concentric ribs, not unlike *Astarte concentrica*. On the other hand, Say's description stresses the large lunule and an umbonal area "separated from the disk, particularly near the beaks, by a subacute angle" (Say, 1824), which are features more typical of the *Astarte undulata* stock. Among the variations shown in Zone 2 *Astarte undulata* populations is a form (fig. 116) with sculpture so close set and regular that it converges with *Astarte concentrica*. Pending reexamination of the type, I argue that this particular race is more likely *Astarte vicina*. If the two prove to be conspecific, *Astarte undulata* has page priority and would remain the valid name.

117. *Astarte yadkinensis* Campbell, new species. Shell small, trigonal, higher than long; very compressed. Lunule narrow, lanceolate. Anterior end slightly expanded; ventral margin rounded. Sculpture of numerous broad, flattened concentric ribs with narrow interspaces. Length of holotype 6.90 mm, height 7.99 mm. Type locality, Deep Creek pit, end of Cooks Mill Road, Chesapeake, Virginia. Restricted to the upper beds of the Chowan River Formation. In outline this species resembles the carditid *Pteromeris perplana* (Conrad), but the concentric sculpture and tridentate hinge in each valve place it in *Astarte*. It belongs to the group containing *Astarte glenni* Dall, 1903, and the Recent *Astarte nana* Dall, 1886, but differs from both in details of sculpture and in being a proportionally higher shell.

Etymology: named for the community of Yadkin near which the pit is located.

Family Crassatellidae

Genus *Eucrassatella* Iredale, 1924

(Synonym: *Marvacrassatella* Ward and Blackwelder, 1987) "Inequilateral, medium-sized to large, thickened shells with a smooth inner margin, concentric ribs obsolete toward margin. Its shell has a crenulate inner margin. Prosogyrate beaks." (Keen, 1971:103-104).

Ward and Blackwelder (1987:151) erected a new genus, *Marvacrassatella*, for Atlantic Coastal Plain species traditionally assigned to *Eucrassatella* Iredale. The type of *Eucrassatella* is *Crassatella kingicola* Lamarck from Tasmania, and Ward and Blackwelder's arguments for a new genus are largely geographical. I have examined specimens of *Eucrassatella kingicola* in the U. S. National Museum collections, and it is my opinion that *E. kingicola* and the

various North American Neogene species are congeneric. In my opinion, geography and minor differences are not appropriate grounds for creating new genera. Were populations known only from Australia and from our Neogene deposits, converging but different genera could be argued, but *Eucrassatella* contains more than thirty Recent species scattered through all warm seas, and many more as fossils.

118. *Eucrassatella virginica* (Gmelin, 1791) (Synonyms: *Venus virginica* Gmelin, 1791:3294 (referencing Lister, 1683, fig. 229); *Crassatella undulata* Say, 1824, non Lamarck, 1805:408, non *Crassatella undulata* Sowerby, 1832; possibly *Eucrassatella undulata cycloptera* (Dall, 1903)). Shell large, heavy, relatively elongate, compressed; beaks high, anteriorly placed; anterior margin rounded, ventral margin straight, posterior end truncate. Hinge massive; sculpture of concentric undulations on the umbonal area becoming obsolete ventrally. Length-width proportions variable in ontogeny and among adults. Zones 1 and 2, ubiquitous. Length 69 mm, height 43 mm.

The familiar usage, *Eucrassatella undulata* (Say, 1824), is both a primary homonym and an junior synonym and therefore is doubly invalid. Both problems are somewhat obtuse in existing literature, necessitating a brief review. Sherborn (1931) lists *Crassatella undulata* Lamarck, 1805 as a nude name, but Abbott (1974) cites Lamarck's name as valid and senior to *Crassatella undulata* Sowerby, 1832, from western North America. Dick Petit (1989, personal communication) writes: "Sherborn erred in listing *Crassatella undulata* Lamarck as a *nomen nudum*. Lamarck explicitly referred to Martini (=Chemnitz) Conch. Cabinet volume 6, page 318, plate 30, figures 317 and 318. These figures had previously been named *Venus contraria* Gmelin, 1791". Consequently, *Crassatella undulata* Say, 1824 is validly preoccupied and the taxon needs a new name. I am unaware of any subsequent name being proposed for this species apart from the varietal name *E. undulata cycloptera* (Dall), but Dall (1903:1475) references a probable older name. Dall (1903) dismissed the Gmelin name as nondefinitive, probably in hope of thereby preserving the well-established name. In my opinion, Lister's figure 229 from "virg." (=Virginia) is well representative of this common species. Lister's sources of fossil shells from colonial Virginia have been ably discussed by Ray (1983, 1987). There is no other bivalve in the Tertiary or Recent faunas of Virginia that would have been available to Lister and which even remotely resembles the figure. The Lister collection is housed in the British Museum. Final confirmation must await examination of the specimen, but there is little doubt that Lister's figure applies to this species, and consequently that Gmelin's name is valid for the taxon. For those who find such detail of interest, it now appears that *Eucrassatella virginica* (Gmelin, 1791) may be the first North American invertebrate fossil to receive a binomial designation.

119. *Eucrassatella virginica cycloptera* (Dall, 1903) (Synonym: *Crassatella undulata* var. Tuomey and Holmes, 1856). Shell large, heavy, compressed. Like *Eucrassatella virginica* but proportionally higher and with the ventral margin well rounded. Zone 1, Middlesex, James City, and Surry counties, Zone 2, Chesapeake. Length 105 mm, height 72 mm.

Blackwelder (1981) lists *Crassatella cyclopterus* as being restricted to his M6 zone which equals Zone 1. However, while Dall cited material from Maryland, Virginia, and the Carolinas, including Zone 1 beds at Carter's Grove, he named the form based on the figure in Tuomey and Holmes. Tuomey and Holmes did not have access to M6 equivalent beds. They further state that their material was from the Sumter District, and they figure co-occuring typical *Eucrassatella virginica*. If Zone 1 specimens require a separate species-level name, then they are not *E. v. cycloptera*. I find Zone 1 populations to more consistently conform to the *cycloptera* morphology. Zone 2 populations are more variable, but contain reasonable *cycloptera* as one extreme of variation.

119a. *Eucrassatella kauffmani* (Ward and Blackwelder, 1987). Shell large, heavy, relatively elongate, compressed. Like *Eucrassatella virginica*, but more inflated, smoother, with the dorsal margin less concave in front of the beaks, dorsal margin more concave posteriorly. Posterior end more produced; ventral margin slightly but evenly curved, not sinuate as in *Eucrassatella virginica*. Chowan River beds, Chesapeake. Length 75 mm, height 48 mm

Subfamily Scambulinae

Genus *Crassinella* Guppy, 1874

"The Crassinellas contrast sharply with the Crassatellas in size, for few specimens even approach a diameter of 10 mm. They are triangular, concentrically sculptured with undulating ribs of varying strength. The genus is one of the few in which the beaks are opisthogyrate; that is, the tip of the shell points posteriorly. It is exclusively American" (Keen, 1971:104).

120. *Crassinella lunulata* (Conrad, 1834) (Synonym: *Crassinella lunulata harrisi* Gardner, 1944). Shell small, trigonal, very compressed; beaks prominent, sharp, centrally placed. Relative height variable, lower in juvenile stages. Concentric sculpture lacking (form *harrisi*) or of well developed, regularly spaced lamellae. Microsculpture of very fine "snakeskin" granulations covering both the lamellae and the interspaces. Lunule elongate, narrow. Zones 1 and 2, ubiquitous; Chowan River at Chesapeake. Length 7.15 mm, height 6.16 mm. Originally described from Yorktown strata along the James River, this species is common throughout the Neogene and the Recent.

121. *Crassinella johnsoni* Ward and Blackwelder, 1987. Shell very small, trigonal, somewhat inflated, very heavy and solid for its size. Anterior and posterior-dorsal margins straight; ventral margin broadly rounded. Beaks central, opisthogyrate. Sculpture of about 10 low, very regular, concentric, undulatory ribs. Inter-rib area smooth or with very fine concentric striae. Zone 2, Chuckatuck and Smithfield. Length 1.92 mm, height 1.88 mm. *Crassinella johnsoni* differs from *Crassinella lunulata* in having a much smaller, more inflated shell with more numerous (in shells of equal size) ribs which do not form lamellae. From *Crassinella dupliniana*, *Crassinella johnsoni* differs in its

trigonal outline with central beaks and in having the interspaces much wider than the ribs. The specimen figured by Ward and Blackwelder (Plate 17, figs. 1-2) is proportionally wider than the Yorktown and Duplin material, but agrees in all other respects.

122. *Crassinella dupliniana* (Dall, 1903) (Synonym: *Crassinella nansemondensis* Gardner, 1944). Shell very small, ovate-trigonal, slightly inflated. Beaks posteriorly placed. Concentric undulations regular, large and heavy, slightly wider than interspaces. Microsculpture of fine parallel plates crossed by exceedingly fine incised concentric lines. Zone 2, Suffolk and Chesapeake; Chowan River at Chesapeake. Length 1.12 mm, height 0.97 mm. Gardner's types of *Crassinella nansemondensis* are worn juveniles of *Crassinella dupliniana.*

Superfamily Cardiacea
Family Cardiidae

Genus *Papyridea* Swainson, 1840

"Elongate, ribs numerous, coarser on posterior slope; hinge relatively narrow, with teeth weaker than in *Trachycardium*; posterior end of shell gaping" (Keen, 1971:155).

123. *Papyridea turtoni* Dall, 1900 (Synonym: *Papyridea spinosa turtoni* Dall, 1900). Shell of moderate size, compressed, elongate; beaks low, rounded. Sculpture of about 45 flat, radial ribs which broaden on the posterior slope and become spinose laterally along the dorsal margins. Zone 2, rare at Hampton and Chesapeake. Length about 30 mm. This is the only Yorktown cockle in which length substantially exceeds height.

Subfamily Laevicardiinae

Genus *Laevicardium* Swainson, 1840

"Posterior slope smoother than remainder of shell; ribbing subdued throughout, showing mainly as crenulations within; hinge arched, moderately long" (Keen, 1971:158).

124. *Laevicardium sublineatum* (Conrad, 1841). Shell small to moderate in size, ovate-trigonal, somewhat compressed, smooth. Zone 2, Petersburg, Chuckatuck, and Chesapeake. Length 18 mm, height 16.5 mm. Conrad's type specimen was from the Waccaamaw. Yorktown specimens are smaller, more trigonal and less inflated than the younger Waccamaw material. These may be juvenile traits but insufficient material is in hand to properly evaluate the question.

Genus *Clinocardium* Keen, 1936

Subgenus *Planicardium* Olsson, 1967

(Synonym: *Chesacardium* Ward, 1992)
Large shells externally resembling *Dinocardium*, but with a hinge resembling *Cerastoderma*. All species of *Planicardium* possess a friable shell structure normally resulting in the exfoliation of the outer shell layer. Whole shells with surface detail are therefore something of a rarity. Olsson (1967) designated *Cardium virginianum* Conrad as type of *Planicardium*. The south Florida shell illustrated by Olsson may or may not be conspecific with *Cardium virginianum*, but the type designation stands on Conrad's species. Ward (1992:89) designated *Cardium laqueatum* Conrad, 1830, as type of the genus for *Chesacardium*. *Clinocardium* (*Planicardium*) *virginianum* and *C.* (*P.*) *laqueatum* are clearly congeneric. I follow Keen (1980) in treating *Planicardium* as a subgenus of *Clinocardium*.

125. *Clinocardium* (*Planicardium*) *acutilaqueatum* (Conrad, 1839) (Synonym: *Cardium laqueatum* Conrad of Richards, 1947, not of Conrad, 1831. Shell very large, quadrate, well inflated. Height greater than length. Adult sculpture of about 40 radial ribs which are flat-topped over the center of the disk. "V"-shaped laterally, and much finer on the anterior and posterior slopes. Juvenile shells (fig. 125b) rounded, relatively shorter, with more even ribs. Common as chalky, deteriorated fragments (fig. 125a). Zone 1, Williamsburg; Zone 2, Southampton County, Smithfield, Williamsburg, Yorktown, Chuckatuck, Suffolk, Hampton, and Chesapeake. Length 95 mm, height 105 mm.

126. *Planicardium taenopleura* (Dall, 1900). Shell fairly small, oval, slightly longer than high. Radial ribs "T"-shaped in cross section and crossed by raised concentric scales. Outer shell layer very spongy, surface usually abraded. Mansfield (1944) considered this a Zone 2 index fossil, but Blackwelder and Ward (1976) list it as a Zone 1 indicator. It is rare in Zone 2 and I have not recovered it from Zone 1 beds. Zone 2, Suffolk and Hampton. Most known specimens are from Rice's Pit. This is the smallest of the *Planicardium* species. Length 23 mm, height 22 mm.

127. *Planicardium virginianum* (Conrad, 1839) (Synonyms: *Cardium quadrans* Rogers and Rogers, 1839; *Cardium ingens* "Wagner" of Conrad, 1840, not of Wagner, in manuscript, or Dall, 1898). Shell large, quadrate, inflated, narrow. About 30 broad flat ribs. Shell surface very friable, easily worn away. Anterior and posterior margins oblique, nearly parallel. Zone 1, James City County and Williamsburg; Zone 2, Isle of Wight and Southampton counties, Yorktown, Williamsburg, Smithfield, and Hampton. Length 95 mm, height 116 mm. This is the type of *Planicardium* Olsson. It is most characteristic of Zone 1 and lower Zone 2 beds. Spamer and Forster (1988, p. 115, pl. 8) figure Conrad's syntypes, WFIS 4624, and discuss the confusion over *Cardium ingens* (1988:65-67).

Genus *Dinocardium* Dall, 1900

Shell large, well-inflated, thin but strong. Sculpture of strong radial ribbing. Hinge with a single projecting cardinal tooth, well-developed laterals, and a hinge plate with a dorsal projection which overlaps the umbo. Keen (1980) considers *Dinocardium* to be a subgenus of *Laevicardium*.

127a. *Dinocardium robustum* (Lightfoot, 1786) (Synonyms: *Cardium ventricosa* Bruguiere, 1789; *Cardium maculatum* Gmelin, 1791; *Cardium obliquum* Spengler, 1799; *Cardium carolinensis* Conrad, 1863; *Dinocardium robustum hazeli* Ward and Blackwelder, 1987). Shell large, well-inflated, with about 30 radial ribs which are triangular in cross section in early growth, flattened with more mature growth. Radial

sculpture visible in the shell interior. Chowan River beds, Chesapeake. Length 48 mm, height 45 mm.

Superfamily Mactracea
Family Mactridae

Genus *Mactra* Linnaeus, 1767

"The ligament is divided into two parts, the major part housed in the resilifer. Between the resilifer and the outer ligament there is a narrow shelly plate, a lamina. The shell itself is of a rather brittle porcellaneous texture, variously sculptured concentrically, but without radial sculpture. Shells are equivalve, thin, trigonal to ovate in shape, of medium to large size. The chondrophore is just back of the "V"-shaped cardinal teeth. Lateral teeth are also developed along the dorsal margin of the hinge. The pallial sinus is mostly deep and rounded" (Keen, 1971:201-202).

128. *Mactra fragilis* Gmelin, 1792 (Synonyms: *Mactra brasiliana* Lamarck, 1818; *Mactra oblonga* Say, 1822; *Mactra anserina* Guppy, 1875; *Mactra fragilis precursor* Gardner, 1944). Shell medium to large, very thin and fragile. Beaks central, hinge large, chondrophore with a raised thread. Posterior margin abrupt, somewhat rectangular. Surface smooth, with a prominent ridge on the posterior-dorsal slope. Zone 2, rare at Chesapeake. Length 47 mm, height 32 mm.

Genus *Spisula* Gray, 1837

"Small to large shells, mostly ovate-trigonal in shape. Hinge with the external ligament separated from the internal resilium by a flat space, not a ridge or plate as in *Mactra*. Lateral teeth tending to be striate" (Keen, 1971:209).

129. *Spisula confraga* (Conrad, 1833) (Synonyms: *Mactra confraga* Conrad, 1833; *Mactra fragosa* Conrad, 1833; *Mactra incrassata* Conrad, 1838; ? *Spisula duplinensis* Dall of Ward and Blackwelder, 1980, not of Dall, 1898). Shell large, ovate-trigonal, thin to fairly heavy. Beaks large, prominent, placed slightly forward of center. Lateral teeth and chondrophore large, heavy. External surface originally smooth, but almost always chalky and eroded, commonly producing a concentric "ribbed" pattern. Zones 1 and 2, ubiquitous. Length 75 mm, height 53 mm. This large, well-named shell is almost always found as fragments. Conrad's type from "St. Marys, Maryland" was another of the Finch collection specimens actually collected from Yorktown beds in Virginia. Zone 1 specimens (fig. 129a) are heavier and a little smaller then those typical of Zone 2. The specimen figured by Ward and Blackwelder (1980) appears to be the latter form.

130. *Spisula delumbis* (Conrad, 1832) (Synonym: *Mactra virginiana* Conrad, 1868). Shell large, thin, fairly fragile. Beaks slightly posterior of center, rotated forward. Hinge small, chondrophore narrow, triangular, directed obliquely posterior. Anterior dorsal margin concave; anterior end broadly rounded; posterior end somewhat pointed. Zone 2, Williamsburg, Yorktown, Smithfield, Suffolk, Hampton, and Chesapeake. Length may exceed 120 mm. *Spisula delumbis* was designated by Ward (1992:93-94) as type species for his new genus, *Leptomactra*. Also included in *Leptomactra* were *Spisula harrisii* and *Spisula marylandica* Dall, 1898. These 3 taxa are marked by a similar and somewhat odd outline, and in having very thin shells. However, among mactrids the latter is a highly variable trait. Beach specimens of *Mactra fragilis* are small, comparatively thickened, and sturdy shells, but conspecific material from offshore is large, thin, and very fragile. Zone 1 specimens of *Spisula confraga* are heavier than Zone 2 specimens. I prefer to retain *Spisula* as the genus for *Spisula delumbis* and related species, but *Leptomactra* probably deserves at least subgeneric standing.

131. *Spisula harrisi* Olsson, 1914. Shell large, very high, trigonal, fairly heavy. Posterior slope very steep, bordered by a prominent ridge. Zone 2, Hampton. Length exceeds 100 mm. This very rare species may prove to be an elevated variation of *Spisula delumbis*, but no connecting specimens are presently at hand.

132. *Spisula modicella* (Conrad, 1833) (Synonyms: *Mactra clathrodon* I. Lea, 1833 (in part, excluding New Jersey records); *Spisula capillaria* Conrad, 1866; *Mulinia parilis* Conrad, 1868; *Spisula modicella alta* Gardner, 1944; *Donax* sp. Coch, 1968). Shell small, solid, very heavy. Beaks turned slightly forward; hinge with short, sturdy laterals; chondrophore narrow, oval. External surface smooth. Zone 2, Yorktown, Smithfield, Chuckatuck, Suffolk, Hampton, and Chesapeake. Length 26 mm, height 19.5 mm. The type specimens of *Mactra clathrodon* (Plate 13, Figure 137a) were compared with juvenile *Spisula modicella* of the same size, and were found to be indistinguishable. However, Lea's reference to New Jersey specimens were Pleistocene *Mulinia lateralis* (Campbell and Campbell, 1986).

Genus *Mulinia* Gray, 1837

"Both parts of the ligament being sunken below the dorsal margin of the hinge, the two valves meet smoothly along their entire dorsal edges, with only a tiny hole or crevice just back of the beaks" (Keen, 1971:207).

133. *Mulinia congesta* (Conrad, 1833) (Synonyms: *Mactra crassidens* Conrad, 1841; *Mactra triquetra* Conrad, 1844; *Mulinia congesta magnoliana* (Dall, 1898); *Mactra millesii* Holmes of Dall, 1898, in part, not of Holmes, 1859). Shell small, variable, trigonal to oval, very heavy, well inflated; beaks high, centrally placed; hinge short, very heavy; chondrophore small, oval. Zone 2, Isle of Wight and Southampton counties. Yorktown, Petersburg, Smithfield, and Suffolk. Length 21.5 mm, height 16 mm.

Juvenile specimens are more thin and delicate, providing a basis for the occasional report of Zone 2 Yorktown *Mulinia lateralis* (Say, 1822). Specimens so labled in the U. S. Geological Survey stratigraphic collections are *Mulinia congesta* under 5 mm in length. True *Mulinia lateralis* appears to be restricted to the Chowan River, Pleistocene, and Recent faunas.

134. *Mulinia lateralis* (Say, 1822) (Synonyms: *Mactra clathrodon* I. Lea, 1833, in part, New Jersey records only; *Mulinia millesii* Holmes, 1859). Shell small, thin, trigonal,

well-inflated, smooth. Chowan River beds at Chesapeake. Length 9 mm. *Mulinia lateralis* resembles *Mulinia congesta* but is smaller, more trigonal, more angular, less variable, and remains thin-shelled in the adult. Lea's types were from the Yorktown (see *Spisula modicella*), but he also cited specimens from the Pleistocene of New Jersey (Campbell and Campbell, 1986).

Genus *Rangia* Desmoulins, 1832

"Shells 1 to 2 inches, very heavy, thick. Lateral teeth cross-striated. Pallial sinus small" (Abbott, 1974:491).

135. *Rangia clathrodonta* (Conrad, 1833) (Synonyms: *Gnathodon grayi* Conrad, 1838; *Gnathodon minor* Conrad, 1841). Shell fairly large, rough, heavy. Beaks high, forward of center. Posterior slope long, gently convex; posterior end pointed. Ligamental pit obliquely trapazoidal. Zone 2, Williamsburg, Yorktown, "James River"; Chowan River of Chesapeake. Length 58 mm, height 43 mm. All *Rangia* are brackish water species. Oxygen isotope ratios for *Rangia clathrodonta* are compatible with reduced salinities. *Rangia cuneata* (Gray, 1832), a Pleistocene and Recent species, is thicker and is more rounded posteriorly.

Genus *Raeta* Gray, 1853

"The outline is trigonal, the umbones narrow and fairly high; the surface is not simply concentrically sculptured, but the shell itself is thrown into low concentric ridges that tend to be weaker near the margin" (Keen, 1971:207).

136. *Raeta alta* Conrad, 1873 (Synonym: *Raeta erecta* Conrad, 1873). Shell fairly large, thin, fragile; ovate-trigonal, very inflated. Concentric ribs become obsolete ventrally. Zone 2, rare, Williamsburg, Yorktown, and Suffolk. Length 80 mm; height 69 mm. This is proportionally the highest of *Raeta* species. It is apparently quite rare. The genus is typically found living very near shore and Recent material is recovered almost entirely from beaches. The scarcity of this habitat among known Yorktown localities may explain the rarity of this and other typical littoral and shallow sublittoral genera.

Family Mesodesmatidae

Genus *Mesodesma* Deshayes, 1832

"Like a large *Donax* with a prominent chondrophore. Laterals with fine denticles" (Abbott, 1974:492).

137. *Mesodesma spatha* Gardner, 1944. "Shell small, compressed, ovate-oblong, strongly inequilateral. Umbones very low and flattened, located about two-thirds of the distance back. Anterior portion of shell slightly contracted, much produced, gently sloping dorsally, evenly rounded distally. Posterior dorsal margin slightly hunched. Lateral margin subtruncate. Base line nearly straight. surface smooth or marked with feeble incrementals. Hinge known from right valve only; hinge plate heavy. Lateral furrows narrow, deep, transversely grooved, the posterior decidedly shorter. Anterior arm of cardinal in line with the anterior ventral lamina but not confluent with it; posterior arm projecting almost horizontally over the chondrophore. Lateral sockets deep. Muscle impressions and pallial characters distinct. Anterior adductor scar pyriform; posterior semielliptical. Pallial line rather distant from the hinge margin. Sinus evenly rounded, projected forward as far as the umbones" (Gardner, 1944:115). Zone 2, Suffolk; Chowan River at Chesapeake. Length 10.3 mm, height 6.4 mm.

Subfamily Erviliinae

Genus *Ervilia* Turton, 1822

"Shell small, less than 10 mm, concentrically striate, and sometimes brightly hued. Ligament absent; resilium small and internal. Laterals small or absent. Left cardinal large and bifid or split. Right valve has a prominent cardinal just anterior to a large chondrophoral pit. Pallial sinus large" (Abbott, 1974:493). Recent anatomical studies demonstrate that *Ervilia* is a tellinoid clam and belongs near *Semele* (Morton and Scott, 1990). Consequently, they supress Erviliinae, and remove *Ervilia* from the Mesodesmatidae.

138. *Ervilia lata* Dall, 1898 (Synonym: *Ervilia lata radiata* Gardner, 1944). Shell small, elongate, elliptical, compressed. Beaks high, nearly central. Smooth or with numerous fine concentric lines. Zone 2, Chuckatuck, Suffolk, and Chesapeake. Length 5.66 mm, height 3.43 mm. Smooth specimens resemble certain of the lepton clams, but *Ervilia* can be separated immediately by the hinge.

Superfamily Solenacea

Family Solenidae

Genus *Ensis* Schumacher, 1817

The shells are medium to large, very elongate, compressed, with subparallel dorsal and ventral margins. The hinge is just back from the anterior end. Commonly called razor clams.

139. *Ensis directus* (Conrad, 1844) (Synonyms: *Solen magnodentata* H. C. Lea, 1843; *Solen ensis* Linnaeus of Lyell, 1845, not of Linnaeus, 1758; *Solen americanus* Gould, 1870; *Ensatella americana* (Gould) Verrill, 1872). Shell medium to large, very elongate, dorsal margin slightly curved, concave; ventral margin subparallel, slightly tapering anteriorly. Zone 1, Williamsburg; Zone 2, ubiquitous. Length 118 mm.

The type locality of the missing holotype of *Ensis directus* is the Cape Fear River in North Carolina. Pleistocene and Recent populations traditionally assigned to *Ensis directus* attain a larger size and are a little straighter than any of the Pliocene populations I have examined. The holotype of *Solen magnodentata* (fig. 139a) is a shell broken posteriorly and ventrally, the remaining fragment being 7 mm long by 4 mm high. It is a left valve with only the anterior cardinal tooth remaining. Despite its decrepit condition, Dall (1900) assigned it to the synonymy of *Ensis directus*. This was a "safe" action favoring the stability of the literature, but was based on the presumption that Conrad's name dated from 1843 and Lea's from 1845. Conrad's work was not published until 1844, however, and Lea's names are validated by the pre-print pamphlet of 1843. Hence, the well known *Ensis directus* becomes a junior synonym of *Solen magnodentata* if the two prove conspecific. Within the Yorktown fauna, there are two *Ensis* species, *Ensis directus* and *Ensis ensiformis*

(Conrad, 1844), which might be conspecific with Lea's species. After a careful comparison of Lea's type against both contenders, I conclude the type can not be assigned with confidence to either species to the exclusion of the other, and propose that *Solen magnodentata* be considered a *nomen dubium*, and the species concept be restricted to the unrecognizable type. This action will promote stability, but the species concept of *Ensis directus* will not become fully stabilized until the type is rediscovered or a lectotype is chosen. Such action is beyond the scope of the present work.

140. *Ensis ensiformis* (Conrad, 1844) (Synonym: *Solen ensiformis* Conrad, 1844, non Wood, 1840, a *nomen nudum*). Shell small to moderate in size, fragile, very elongate. Dorsal margin concave; dorsal and ventral margins subparallel, tapering posteriorly; ends well rounded. Zone 2, Chuckatuck, Hampton, and Chesapeake. Length 69 mm. The small size and degree of curvature separate this species. It most resembles *Ensis megistus* Pilsbry and McGinty, 1943 (= *Ensis minor* Dall, 1900, non Chenu, 1843), of the Recent fauna.

141. *Ensis hughesi* Campbell, new species. Shell very large (223 mm in the holotype), very elongate; dorsal and ventral margins straight, parallel; ends square; abrupt. Hinge typical of the genus. Holotype length 223 mm, height 29 mm. Fragments from Williamsburg have a height of up to 45 mm, which would project proportionally to about 345 mm, or about 14 inches maximum length.

From *Ensis directus*, *Ensis hughes* differs in its greater size, relatively greater height, and the abruptness of the terminations. The holotype is a complete valve from the Pinecrest beds of Lakeport, Florida, from the Hughes collection, U. S. National Museum. Paratypic material is from Zone 2 beds, stream bank near Yates Hall, the College of William and Mary, Williamsburg, Virginia.

Etymology: named for Thomas Hughes who collected the holotype.

142. *Ensis schmidti* Olsson, 1914. Shell of medium size, elongate, very stout for the genus; dorsal margin straight, save for a slight anterior rise. Anterior termination rounded, posterior termination abrupt. Zone 2, "Schmidt's Bluff, Nansemond River" (Olsson, 1914), Hampton, and Chesapeake. Length 86 mm. *Ensis schmidti* is the stoutest of the four Yorktown *Ensis*.

Genus *Tellina* Linnaeus, 1758

"Laterally compressed clams, usually having a slight twist at the posterior end. Smooth, polished surface. Hinge with 2 cardinals and 2 laterals in either valve" (Abbott, 1974:495).

Subgenus *Merisca* Dall, 1900

"Small, trigonal, with a strong posterior flexure and spaced concentric ribs" (Keen, 1971:219).

143. *Tellina aequistriata* Say, 1824 (Synonyms: *Tellina lintea* Conrad, 1837; not *Tellina aequistriata* Sowerby, 1868). Shell small, compressed, twisted posteriorly. Beaks small, high, pointed. Posterior slope steep, anterior end well rounded. Sculpture of numerous fine concentric lines. Zone 2, Yorktown, Suffolk, and Hampton, very common at Rice's Pit. Length 27 mm, height 19 mm.

Subgenus *Eurytellina* Fischer, 1887

Large tellins with elongate, compressed shells; smooth or with concentric sculpture.

144. *Tellina egena* Conrad, 1834 (Synonym: *Tellina gardnerae* McGavock, 1944). Shell fairly large for the genus, ovate-trigonal, compressed. Beaks low, a little posterior of center. Anterior end well rounded, posterior end somewhat pointed and truncate. Pallial sinus large, deep. Zone 2, Smithfield and Yorktown. Length 61 mm, height 38 mm.

This large species appears to be restricted to a silt-clay habitat. Conrad's original specimen came from the "James River", probably from east of Burrell's Bay, northwest of Smithfield, as the species has been rediscovered in clay beds there. Conrad's type lot also contains two fragmentary specimens of *Macoma* (*Psammacoma*) *arctata* (Conrad, 1843). McGavock's *Tellina gardnerae* was based on a smaller, proportionally lower, immature shell.

Subgenus *Angulus* Muhlfeld, 1811

Small, thin, compressed tellin clams with smooth or concentric sculpture. Frequently there are two internal rays descending from the beak.

145. *Tellina declivis* Conrad, 1834 (Synonym: non *Tellina declivis* Sowerby, 1868). Shell small, ovate-elongate, compressed. Beaks small, opisthogyrate. Anterior end well-rounded, posterior-dorsal margin humped, posterior end truncate. Sculpture of fine concentric incised lines. Zones 1 and 2, ubiquitous. Length 17 mm, height 9.5 mm. This is the most common small tellin in the Yorktown fauna.

146. *Tellina dupliniana* Dall, 1900 (Synonym: *Tellina propetenella* Dall, 1900). Shell small, ovate, elongate, compressed; beaks small. Anterior end well rounded, posterior slope steep, straight. Zone 2, Yorktown, Smithfield, Chuckatuck, and Suffolk. Length 8.86 mm, height 5.73 mm.

146a. *Tellina suberis* Dall, 1900. Shell small, thin, compressed, wedge-shaped. Ventral and anterior margins evenly rounded. Sculpture of very low, flat, concentric threads, becoming particularly strong and distinct on the posterior slope and the umbonal area. Chowan River at Chesapeake. Length 7.0 mm. This species is proportionally higher than either *Tellina declivis* or *Tellina dupliniana*.

Subfamily Macominae

Genus *Macoma* Leach, 1819

"Lateral teeth wanting; shell elongate-quadrate, thin" (Keen, 1971:227).

147. *Macoma cookei* Gardner, 1944. Shell of moderate size, oval, inflated anteriorly. Beaks low, central; anterior end well-rounded; posterior slope steeply inclined. Zone 2 Yorktown. Length 34.3 mm, height 28 mm. The type remains unique. This species is very close to the Pleistocene and Recent *Macoma balthica* (Linnaeus, 1758).

148. *Macoma virginiana* (Conrad, 1866) (Synonyms: *Tellina lusoria* Say of Meek, 1864, not of Say, 1822; *Macoma tenta* (Say) of Dall in Shaler, 1890, not of Say, 1834; *Macoma virginiana conradi* Dall, 1900; *Macoma carolinensis* Gardner and Aldrich, 1919). Shell fairly small, very thin, well inflated, inequivalve, flexed to the right posteriorly. Beaks small, posterior of center. Anterior end well rounded; posterior end more pointed; surface smooth. Zone 1, Williamsburg; Zone 2, ubiquitous. Length 24 mm, height 14 mm.

Relative proportions and degree of flexure is variable within and between populations, giving rise to the various synonyms. *Tellina lusoria* Say, 1822 has not been recognized with certainty by modern authors. Dall (1900) stated that after much study of the question, he could possibly equate *Tellina lusoria* with the Pleistocene and Recent *Macoma tenta*. *Macoma virginiana* is the only Yorktown *Macoma* resembling *Macoma tenta*, and is therefore the best candidate for both Meek's and Dall's (1890) references.

Subgenus *Psammacoma* Dall, 1900

"The valves are elongate, convex, and thin, the posterior end markedly shorter. The pallial sinus is not confluent with the pallial line and is rounded and relatively short" (Keen, 1971:227).

149. *Macoma arctata* (Conrad, 1843) (Synonyms: *Tellina* (*Eurytellina*) *scapha* Dall, 1900; *Macoma* (*Psammacoma* ?) *holmesii* Dall, 1900; *Macoma hosfordensis* Mansfield, 1932; not *Macoma holmesii* Dall of Ward and Blackwelder, 1987 (= *Macoma brevifrons* (Say, 1834))). Shell of moderate size, elongate, somewhat compressed. Anterior end produced, well rounded; posterior end truncate. Beaks low, small, a little back of center. Ventral margin straight. Surface smooth, save for occasional growth lines. Zone 2, Chuckatuck, Hampton, and Chesapeake. Length 36 mm, height 19 mm.

Conrad's type is missing. His description and published figure of *Macoma arctata* indicate a tellinid with size and outline identical with the Yorktown material. However, the species has remained enigmatic for most systematists because the figure depicts a sculptured rather than a smooth shell. I argue that the sculpture shown in the original illustration is taphonomic rather than primary, because occasional deteriorating specimens lose parallel, concentric strips of the outer shell layer, leaving an artificial pattern not unlike the original figure. Further, there is no other contemporary species with which the taxon might be confounded. Therefore, I believe the name, *Macoma arctata*, can be used with confidence for this species. *Macoma arctata* is larger, heavier, and less inflated than the younger Waccamaw, Caloosahatchee, and Recent *Macoma* (*Psammacoma*) *brevifrons* (Say, 1834), but they are very close in outline and can be easily confused.

Genus *Hemimetis* Thiele, 1934

Subgenus *Florimetis* Olsson and Harbison, 1953

"Lateral teeth wanting; posterior flexure strong, especially evident in the right valve; umbones inflated; shell inequilateral; ligament somewhat sunken but not completely internal" (Keen, 1971:225).

150. *Hemimetis magnoliana* (Dall, 1900) (Synonym: *Tellina biplicata* Conrad of Emmons, 1858, not of Conrad, 1834). Shell fairly large, rectangular, compressed. Beaks prominent, central; posterior slope perpendicular, concave, marked by a prominent diagonal ridge. Surface smooth save for incremental growth lines which may become raised over the posterior slope. Zone 2, Williamsburg, Chuckatuck, and Hampton. Length 59 mm, height 47 mm.

Family Donacidae

Genus *Donax* Linnaeus, 1758

"The internal margins of *Donax* are crenulate, reflecting the radial ribbing of the middle layer of the shell. Ribbing is well developed also on the surface of most forms. Living specimens of *Donax* are found on sandy beaches or in bays where they burrow shallowly so near the surface they may be washed out by heavy waves" (Keen, 1971:234).

151. *Donax chuckatuckensis* Gardner, 1944. Shell very small, compressed, wedge-shaped; beaks posterior; hinge complex, typical of the genus. Zone 2, Chuckatuck. Length 5.2 mm, height 3.6 mm.

Intensive collecting at Chuckatuck has yielded but a single additional specimen of this tiny *Donax*. From the two specimens now known, it is impossible to say whether they are juveniles, or the adult form of some very small species. *Donax* colonies inhabit the surf zone of sandy beaches, and are abundant fossils in the late Pleistocene of Virginia and the Carolinas. However, *Donax* is rare in the Pliocene, even in near shore beds.

151a. *Donax cuneola* Gardner and Aldrich, 1919. Shell small, solid, trigonal, distinctly wedge-shaped. Hinge large, heavy. Sculpture of crowded radiating lines. Ventral interior margin crenulate. Zone 2, Yorktown and Suffolk. Length 7.45 mm. This shell is proportionally higher than the other Yorktown and Chowan River *Donax* species.

152. *Donax emmonsi* Dall, 1892 (Synonym: *Donax* sp. Emmons, 1858). Shell large for the genus, elongate, heavy, compressed; posterior end pointed, rather produced. Surface with faint radial lines. Abraded specimens show a distinct radial pattern in the underlying shell layer. Zone 2, Yorktown and Suffolk; Chowan River at Chesapeake. Length 12.2 mm, height 6.5 mm.

___. *Donax parvulus* Philippi, 1849 (Synonym: *Donax fossor* Say of authors, 1822, not of Say, 1822). See Appendix II.

Family Psammobiidae

Genus *Gari* Schumacher, 1817

(Synonym: *Psammobia* of authors, not of Lamarck, 1818)

"Rectangular, smooth to weakly sculptured, posterior end wider than anterior and gaping more widely; ligament external, sturdy" (Keen, 1971:240).

153. *Gari dalli* (Olsson, 1916). Shell large, oval, elongate, thin, compressed. Beaks low, posterior of center; dorsal and

ventral margins straight, subparallel. Hinge small, with a distinctive vertical flange or nymph behind cardinal teeth. Anterior margin rounded, posterior end abruptly truncate. Surface smooth. Chowan River beds at Chesapeake. Length 64 mm, height 34 mm.

This large tellinoid shell is immediately separated by the prominent nymph. The Virginia specimens come from an 8 cm thick bed in the reworked or winnowed section of the lower Chowan River beds at Chesapeake. The shells are disarticulated, but probably represent a single episode of colonization.

Family Semelidae

Genus *Semele* Schumacher, 1817

(Synonym: *Amphidesma* Lamarck, 1818

Small to rather large, oval, compressed tellinoid clams with concentric or cancellate sculpture. Pallial sinus very wide and deep.

154. *Semele subovata* (Say, 1824) (Synonyms: *Syndosmya subobliqua* Conrad, 1854; *Abra ovalis* Conrad, 1862; *Semele subovata apressa* Dall, 1900; *Semele subovata duplinensis* Dall, 1900; *Semele subovata alta* Gardner, 1944). Shell small to moderate in size, oval, compressed. Ventral margin well-rounded; beaks small, pointed, a little posterior of center; pallial sinus large, distinct. Sculpture of numerous, fine, concentric laminae. Zone 1, York County and Williamsburg; Zone 2, ubiquitous. Length 30 mm, height 22 mm.

155. *Semele carinata* (Conrad, 1830) (Synonym: *Abra holmesii* Conrad, 1873). Zone 2, Yorktown (fide McGavock, 1936). The species has not been subsequently recovered in Yorktown beds and is not illustrated. Dall (1900) illustrates a specimen from the Duplin of North Carolina which he refers to *Semele carinata*. This shell appears to be smaller, more elongate, and more rectangular than *Semele subovata*. *Semele carinata* was originally described from St. Marys beds in Maryland. If the Duplin material is conspecific, *Semele carinata* is the most common *Semele* in the Duplin and Raysor formations of the Carolinas.

155a. *Semele alumensis* Dall, 1900. Shell very small, ovate-trigonal, solid, compressed. Beaks high, central. Sculpture of strong concentric threads. Hinge and pallial sinus typical of the genus. Zone 2, Hampton. Yorktown specimens known only from Rice's Pit. Length 4.82 mm, height 3.59 mm.

This very small *Semele* appears to be adult because of the weight of the shell and the large hinge structure. *Semele subovata* juveniles are much more fragile and have posteriorly placed rather than central beaks.

Genus *Semelina* Dall, 1900

"The small elliptical shell has the posterior end much the shorter; the hinge has strong lateral teeth in the right valve, none in the left. There is one bifid cardinal tooth in each valve, and the resilifer is internal. Sculpture of regular concentric riblets" (Keen, 1971:259).

156. *Semelina nuculoides* (Conrad, 1841) (Synonym: *Semele? virginiana* Meyer, 1888). Shell quite small, very oval, elongate, very compressed. Beaks low, opisthogyrate, posteriorly placed; dorsal and ventral margins subparallel. Sculpture of exceedingly fine and regular concentric grooves. Zone 2, Williamsburg, Yorktown, Chuckatuck, Suffolk, Hampton, and Chesapeake. Length 4.1 mm; height 2.97 mm. This small, not uncommon species is often overlooked.

Genus *Cumingia* Sowerby, 1833

"The Cumingias also are white shells but thicker and more irregular in shape... *Cumingia* has a pallial line that doubles back on itself so that it is confluent with the pallial sinus. The internal ligament is large; the cardinal teeth are small, the lateral teeth large in the right valve, weak or wanting in left. The anterior end is short and rounded, the posterior longer and angulate" (Keen, 1971:257).

157. *Cumingia subtellinoides* (Orbigny, 1852) (Synonyms: *Anatina tellinoides* H. C. Lea, 1843, not of Conrad, 1831; *Cumingia medialis* Conrad, 1866). Shell fairly small, thin, inflated anteriorly. Anterior end broadly rounded; posterior end flexed, pointed. Chondrophore round, prominent; sculpture of numerous concentric threads. This species is smaller than the Pleistocene and Recent *Cumingia tellinoides*, and has more crowded sculpture. Zone 2, Petersburg, Yorktown, Williamsburg, Smithfield, Chuckatuck, and Chesapeake. Length 23.5 mm, height 17 mm.

Subfamily Scrobiculariinae

Genus *Abra* Lamarck, 1818

"These are small, white, thin, nearly smooth shells. The ligament is partially external, with only a small portion in a little capsule back of the cardinal teeth" (Keen, 1971:257).

158. *Abra aequalis* (Say, 1822) (Synonyms: *Abra nucliformis* Conrad, 1867; *Abra aequalis deltoidea* Gardner, 1944). Shell small, oval to ovate-trigonal, thin, inflated. Beaks low, pointed, nearly central. Anterior margin rounded, posterior slope rapidly descending. Surface smooth. Zone 2 ?, Suffolk (fide Gardner, 1944); Chowan River at Chesapeake. Length 8.43 mm.

This small clam, when correctly identified, seems to be restricted to Chowan River and younger deposits. A search of the U. S. Geological Survey stratigraphic collections failed to locate Gardner's specimen. All Zone 2 records of this species are here considered dubious.

159. *Abra subreflexa* (Conrad, 1834) (Synonym: *Tellina modesta* Verrill of Dall in Shaler, 1890, not of Verrill, 1872). Shell fairly small, elongate, compressed. Beaks low, opisthogyrate. Posterior end produced, pointed. Surface smooth. This is the most elongate of the small tellinoid clams in the Yorktown fauna. Zone 2, Surry, Isle of Wight, and Southampton counties; Petersburg, Williamsburg, Yorktown, Hampton, Suffolk, Chuckatuck. Length 12.2 mm, height 6.0 mm.

Family Solecurtidae

Genus *Tagelus* Gray, 1847

"The jacknife clams are mud-flat dwellers, cylindrical like the Solens but with the hinge near the middle of the dorsal margin, both ends rounded and, or course, gaping. The hinge has two small cardinal teeth. The pallial sinus is deep" (Keen, 1971:246).

160. *Tagelus plebius* (Lightfoot, 1786) (Synonyms: *Solen gibbus* Spengler, 1794; *Solen adansonii* Bosc, 1802; *Solen guineensis* Chemnitz, 1795; *Solen cariboeus* Lamarck, 1818; *Solen declivis* Turton, 1819; *Siliquaria notata* Schumacher, 181'/; *Solecurtus centralis* Sowerby, 1874, non Say, 1822; *Solecurtus angulatus* Sowerby, 1874; *Siliquaria carolinensis* Conrad, 1863). Shell fairly large, elongate, rectangular, inflated. Beaks low, broadly rounded. Margins subparallel. Surface smooth save for occasional growth lines. Zone 2, James City County and Williamsburg. Length 77 mm, height 27 mm.

Family Trapeziidae

Genus *Coralliophaga* Blainville, 1824

Shell small, inflated, irregular in shape and proportions as is common with nestling species. Sculpture of radial lines.

161. "*Coralliophaga microreticulata*" Gardner, 1944. The type lot consists of burrows made by a *Lithophaga* mussel and thin fragments of shell with a reticulated microsculpture. True *Coralliophaga* frequently occupy *Lithophaga* burrows, but the shells are much heavier and more coarsely sculptured. I strongly suspect that this is a fragmented *Lithophaga yorkensis* Olsson (species 31 of this study) but maintain it provisionally pending the discovery of material with matching microsculpture.

Superfamily Glossacea
Family Glossidae

Genus *Glossus* Poli, 1791

(Synonym: *Isocardia* Lamarck, 1799)
Shells medium to large, thin to quite heavy, inflated to globose bivalves with very large, well inflated, incurved beaks.

162. *Glossus fraternus* (Say, 1824) (Synonyms: *Isocardia rustica* Conrad, 1838; *Isocardia conradi* Orbigny, 1852; *Isocardia carolina* Dall, 1900). Shell large, heavy (Zone 1 spcimens) to thin (Zone 2 specimens), inflated. Ovate-elongate to nearly circular. Beaks large, prominent, inflated, strongly incurved. Surface smooth except for rather coarse growth lines and resting stages. Zone 1, Surry County and Williamsburg; Zone 2, Hampton. Length exceeds 100 mm. This species is found from the late Miocene into lower Zone 2 faunules.
Superfamily Corbiculacea
Family Corbiculidae

Genus *Corbicula* Megerle von Muhlefeldt, 1811

"Shell unusually heavy, subtrigonal or cordate; not markedly inequilateral. Umbones subcentral, high, and prominent... External surface smooth or concentrically furrowed. Epidermis polished. Cardinals 3 in each valve, diverging fan-like beneath the umbones. Both anterior and posterior laterals developed, finely striate transversely. Pallial line little or not at all sinuated" (Gardner, 1944:64-65).

163. *Corbicula densata* (Conrad, 1844). Shell small to medium sized, thin, subcircular, well-inflated. Hinge with a prominent nymph. Surface smooth unless etched by fresh water around the umbones. Zone 2, Petersburg, Williamsburg, and Hampton; Chowan River at Chesapeake. Length 41 mm, height 35 mm.

Corbicula is a freshwater genus which became extinct in North America near the Plio-Pleistocene boundry. Introduced Asian species have successfully recolonized much of the continent in a matter of a few decades. However, *Corbicula densata* is almost always found surrounded by marine taxa, and Henderson (1935), Gardner (1944), and most recently Ward and Blackwelder (1987:124) expressed doubt over the fresh water requirements of the species. Campbell, Leventer, and Williams (1981) examined oxygen and carbon isotopes from several populations of *Corbicula densata*, and found only ratios consistent with fresh water. Consequently, *Corbicula densata* can be used as an indicator of fresh water, and, especially when paired, as an indicator of regressive unconformities in an otherwise marine sequence.

Superfamily Veneracea
Family Veneridae
Subfamily Chioninae

Genus *Mercenaria* Schumacher, 1817

Very large, circular to oval, heavy shells with low, cord-like or lamellar concentric sculpture. Cardinals large; posterior-laterals short, low, pitted.

164. *Mercenaria campechiensis campechiensis* (Gmelin, 1791). Shell very large, inflated, heavy, oval. Lunule heart-shaped; escutcheon lanceolate, raised, smoother than remaining sculpture. Ventral margin non-plicate, crenulate within. Chowan River of Chesapeake. Length 76 mm.

Mercenaria campechiensis campechiensis is more typical of Pleistocene and Recent faunas. It is more inflated than *M. c. corrugata* and has a straighter ventral margin.

164a. *Mercenaria campechiensis permagna* (Conrad, 1838) (Possible synonyms: *Venus mortoni* Conrad, 1838; *Venus submortoni* Orbigny, 1852; *Mercenaria carolinensis* Conrad, 1873). Shell large, heavy, strong, compressed, elongate-oval; beaks low; hinge large and heavy. Lunule elongate. Ventral margin straight, non-plicate. Sculpture of closely spaced, concentric lamellae. Zone 2, Chuckatuck, Hampton, and Chesapeake. Length exceeds 120 mm.

The outer shell layer of this and all Yorktown and Chowan River *Mercenaria* species is frequently lost due to abrasion or chemical dissolution. This subspecies may eventually prove to be a large, non-plicate form of the following taxon.

165. *Mercenaria (campechiensis ?) corrugata* (Lamarck, 1818) (Synonym: *Venus rileyi* Conrad, 1838). Shell large to

very large, oval, solid, well-inflated. Ventral margin undulated by irregular radial plications. Sculpture of crowded concentric lamellae which are commonly missing. Zone 2, Isle of Wight, Greensville, and James City counties; Petersburg, Williamsburg, Yorktown, and Suffolk. Length 80 mm. Wilson (1983) discusses the earlier Lamarckian name.

166. *Mercenaria mercenaria* (Linnaeus, 1758). Shell medium to large, circular to trigonal, strong. Beaks high, subcentral; sculpture of low, non-lamellar concentric cords becoming obsolete over the center of the disk. Zone 2 ?, Claremont Wharf (fide Gardner, 1944); Chowan River at Chesapeake. Length 75.5 mm.

167. *Mercenaria inflata* Dall, 1903 (Synonyms: *Mercenaria plena inflata* Dall, 1903; *Mercenaria plena nucea* Dall, 1903). Shell small for the genus, heavy, oval to subtrigonal, with prominent concentric lamellae and a massive hinge. Zone 2, Yorktown and Williamsburg. Length 60 mm, height 51 mm. Dall (1903) noted that the form *Mercenaria plena nucea* might be pathologic. The entire *Mercenaria inflata* stock could be produced by dwarfing the range of variation shown by *Mercenaria campechiensis* subspecies. However, at the same size, juvenile specimens of the other taxa are light, thin-shelled, and have more widely spaced sculpture. Ward (1992) has shown *Mercenaria plena* (Conrad) to be restricted to the Miocene.

168. *Mercenaria corrugata* variety "*tridacnoides*" (Lamarck, 1818) (Synonyms: *Venus deformis* Say, 1824; *Mercenaria percrassa* Conrad, 1867). Shell very large, inflated, heavy, thick, and massive. Ventral margin commonly plicate. Beaks rounded, massive, forward of center. Hinge massive; muscle scars and pallial line deeply impressed. Sculpture of closely spaced lamellae. Ventral margin even to coarsely and irregularly plicate. Zone 2, Isle of Wight and Southampton counties; Petersburg, Williamsburg, Suffolk, and Surry. Length exceeds 150 mm. Wilson (1983) has shown that *Mercenaria corrugata* is the oldest name available for this complex which includes both the tin-shelled (*mercenaria rileyi*) and thick-shelled (*Mercenaria tridacnoides*) morphologies. He suggests that *tridacnoides* be treated as a varietal form only.

This ponderous shell is one of the most impressive of the Yorktown fauna. One of the first North American species to be illustrated, it was figured by Lister (1683) (reproduced here as figure 168a). *Mercenaria tridacnoides* occasionally exceeds 30 mm in shell thickness, and normally has a plicate ventral margin. However, no single trait is constant: ponderously thick specimens may not be plicate, strongly plicate shells may be thin-shelled. Among the thin shelled forms, both well inflated and more compressed morphologies are present, the latter merging with *Mercenaria corrugata*. It is locally common in a variety of sediment types, yet not uniformily present in any given bio- or lithofacies. It is particularly common in some of the *Chama* reefs, but is very rare or absent from the upper Zone 2 beds. This distribution argues against a simple environmental control over valve thickness. A purely genetic explanation is weakened by the inconstancy of the morphologic traits. This variation is a good example of what was called heterostasis in the introduction of this work. It is also possible that the shell thickening and plication is a ponderous phenotypic response to some predator, parasite or pathogen. One large population of *Mercenaria tridacnoides* from the Raysor Formation of South Carolina shows heavy predation from *Ecphora quadricostata* and heavy infestation by *Gastrochaena* and *Lithophaga* endoliths. For the present, the nominate forms *Mercenaria corrugata*, *M. permagna*, *M. inflata*, and *M. tridacnoides* are retained as at least subspecifically valid taxa. All have been described on holotypic rather than on population concepts, and a comprehensive multivariant analysis of the group is overdue.

169. *Mercenaria* sp. Shell of moderate size, thin for the genus, oval, compressed. Sculpture unknown. Zone 1, ubiquitous. Length 78 mm. This form may be identical with *Mercenaria blakei* Ward, 1992, described from the Eastover Formation. Zone 1 specimens are typically very chalky and deterioriated.

Genus *Chione* Megerle von Muhlfeldt, 1811

"Concentric sculpture strong; lunule and escutcheon well-defined in most forms. The genus *Chione*, abundant in species, is almost entirely tropical American in distribution. The name is pronounced as three syllables -- ki-oh'nee" (Keen, 1971:183).

170. *Chione cortinaria* (Rogers and Rogers, 1837). Shell small to medium in size, ovate-trigonal, thin, inflated. Beaks a little forward of center. Sculpture of closely packed, ruffled concentric lamellae. Zone 1, Williamsburg and Carter's Grove. Length 26.5 mm, height 23.5 mm. *Chione cortinaria* has more closely spaced and more numerous lamellae than *Chione cribraria* (Conrad, 1843), its likely descendent species.

171. *Chione cribraria* (Conrad, 1843) (Synonyms: *Chione morsitans* Olsson and Harbison, 1953; possibly *Chione intapurpurea* (Conrad, 1849)). Shell small to medium-sized, oval, thin, inflated. Beaks low, a little forward of center. Sculpture of ruffled, concentric, upturned lamellae becoming stronger on the posterior dorsal slope; 28 to 35 lamellae per inch. Interspaces as wide or wider than lamellae. Zone 2, Hampton, Chuckatuck, and Chesapeake. Length about 25 mm.

Yorktown specimens are rare and typically smaller than Duplin and Waccamaw material. Conrad's types were Hodge collection material from Wilmington, North Carolina. They were from the Waccamaw Formation. *Chione cribraria* from the middle Pliocene Duplin and Yorktown faunas have their lamellae slightly more crowded than the Waccamaw and Caloosahatchee specimens. The Recent *Chione intapurpurea* matches the Yorktown pattern in the spacing of the lamellae, but the lamellae of the Recent shell are more subdued over the center of the disk. The Recent shell also has more and finer lamellae on the lunule. In all these traits, the differences are not great. Carol Jones (1986:personal communication) made an extensive study of Western Atlantic *Chione* and expressed the opinion that the fossil and Recent material belong to separate species.

Subgenus *Liophora* Conrad, 1863

"With wide or recurved concentric ribs, radial ribs weak or wanting. Pallial sinus short and angular" (Keen, 1971:190).

172. *Chione* (*Lirophora*) *latilirata* (Conrad, 1841). (Synonyms: *Venus varicosa* Sowerby, 1853; *Circumphalus athleta* Conrad, 1863). Shell small to medium size, trigonal, heavy, and solid. Beaks prominent, placed forward of center. Sculpture of heavy, rude, concentric ribs which may be rounded or fluted dorsally. Interspaces narrow to broad, deeply excavated. Zone 2, Williamsburg, Yorktown, and Chuckatuck. Length 25 mm, height 19 mm.

Ward (1992) considers *Chione latilirata* to be an index for the Calvert Formation Miocene. The Maryland shells do average smaller, and the sculpture is weaker than on the Pliocene to Recent shells. Additionally, no "*latilirata*" morphologies are found in the intervening faunas between the Calvert and Yorktown. On the other hand, both populations are highly variable and morphological intergradation occurs. There is at present a good argument but no consensus on the question of one or two species. If *Chione latilirata* is restricted to the Calvert, then the next available name for the Pliocene and Recent taxon is *Chione* (*Lirophora*) *varicosa* Sowerby.

Subgenus *Timoclea* Brown, 1827

"Small shells with sculpture predominantly radial, crossed by concentric lamellae of varying strength; escutcheon varying from weak (in the European type species, *Venus ovata* Pennant, 1777) to beveled and bounded by a scaly ridge; pallial sinus small and angular" (Keen, 1971:192).

173. *Chione grus* (Holmes, 1858) (Synonyms: ? *Venus antillarum* Orbigny, 1853; *Venus parva* G. B. Sowerby, 1854, not of J. Sowerby, 1829; *Chione parva* Romer, 1867; *Venus trapezoidalis* Kurtz, 1860). Shell very small, relatively solid, rectangular, compressed. Beaks low, anteriorly placed. Sculpture of flat radial ribs crossed by concentric lines. Zone 2, Suffolk, Chuckatuck, and Chesapeake. Length 6 mm. Yorktown specimens are rare and for the most part juvenile, but they appear conspecific with the Recent form.

Subfamily Metericinae

Genus *Transenella* Dall, 1883

"Small shells, mostly less than 35 mm in length, the inner margin with more or less well-developed oblique grooves. Confined to the Americas" (Keen, 1971:164).

174. *Transenella carolinensis* Dall, 1903 (Synonym: *Cytherea carolinensis* Conrad, 1841, nude name). Shell small, trigonal, inflated. Beaks low, subcentered. Surface smooth, polished, occasionally with irregular concentric lines laterally. Pallial sinus wide, short, rounded, horizontal. Zone 2, Williamsburg, Chuckatuck, Hampton, and Chesapeake; Chowan River at Chesapeake.
Length 8.0 mm.

Subfamily Circinae

Genus *Gouldia* C. B. Adams, 1847

"Small, sculpture fine; lunule long, escutcheon wanting; pallial sinus small" (Keen, 1971:162).

175. *Gouldia metastriata* (Conrad, 1838) (Synonym: *Circe metastria* (sic) Conrad of Meyer, 1888). Shell small, trigonal, sturdy, inflated. Beaks pointed, forward of center. Sculpture of crowded concentric cords crossed by radial threads; threads more prominent on the lateral slopes. Pallial sinus hardly more than a ripple in the pallial line. Zone 2, Petersburg, Williamsburg, Hampton, Yorktown, Smithfield, Chuckatuck, and Chesapeake. Length 11.02 mm.

Subfamily Pitarinae

Genus *Pitar* Romer, 1857

"Oval to subtrigonal, smooth or finely concentrically lamellate; lunule superficial, escutcheon not defined" (Keen, 1971:168).

176. *Pitar sayana* (Conrad, 1833) (Synonyms: *Cytherea convexa* Say, 1824, non Brongniart, 1811; *Cytherea elevata* H. C. Lea, 1843 (juvenile); *Pitar morrhuana* (Linsley) of authors (Yorktown records), not of Linsley, 1845; *Caryatis plionema* Conrad, 1869; *Chione albida* (Gmelin) of Dall in Shaler, 1890, not of Gmelin, 1791). Shell small to moderate in size, trigonal to oval, inflated, especially as juveniles. Surface smooth or with slightly raised growth lines. Beaks forward of center. Pallial sinus small, triangular. Zone 2, ubiquitous; Chowan River at Chesapeake. Length 48 mm, height 39 mm.

This species varies in shell weight, inflation, and outline, providing the raw material from which many useless varieties might be named. A very smooth, oval, inflated, thin-shelled form with maximum length of about 25 mm can be found in silt-rich beds at Rice's Pit in Hampton (Plate 19, Figure 176a), at the Deep Creek pit, and in the clay along the James River near Smithfield. A larger, heavier, oval form resembling Gardner's *Callocardia castoriana* can be found in *Corbicula*-dominated shell beds at Williamsburg (Plate 19, Figure 176b). Very large (> 95 mm), trigonal, and heavy specimens are common in coarse shell in the Chowan River deposits at Chesapeake. Juvenile shells (2-4 mm) are almost circular, with disproportionately large, inflated beaks. Both ecologic and ontogenetic variation is rampant.

___. *Pitar subnasuta* (Conrad, 1841) See Appendix II.

Genus *Macrocallista* Meek, 1876

"Scar of the pedal retractor muscle on the undersurface of the hinge plate and below the cardinal tooth is distinct and deep. Shell elliptical; surface smooth..., lunule narowly cordate, defined by an incised line. No escutcheon. 3 cardinal teeth in each valve. Anterior lateral in left valve. Ventral margins smooth" (Abbott, 1974:532).

177. *Macrocallista albraria albraria* (Say, 1832) (Synonyms: *Dione densata* Conrad, 1863; *Dione virginiana* Conrad, 1863). Shell of moderate size; elongate-oval; thickened and heavy; very compressed. Beaks well forward of center. Surface smooth, polished. Zone 2, Petersburg, Williamsburg, Yorktown. Length 68.5 mm.

Fourier harmonic analysis of shell outlines (D. Campbell,

in preparation) shows no difference between *M. a. albraria* and *M. a. reposta* (see #178 below). Adult *M. a. albraria* are typically smaller and thicker shells, differences that may be ecotypic.

178. *Macrocallista albraria reposta* (Conrad, 1834) (Synonyms: *Cytherea pandata* Conrad, 1834; not *Macrocallista reposta* Conrad of Conrad, 1838, Palmer, 1928-9, or Gardner, 1944 (= *Macrocallista greeni* Ward and Blackwelder, 1987)). Shell large, oval, elongate; thin and fairly fragile. Beaks forward of center. Surface smooth, polished. Juveniles proportionally more elongate. Zone 2, Petersburg, Williamsburg, Yorktown, Suffolk, Hampton, Chuckatuck, and Chesapeake. Length 90 mm, height 59 mm.

This form is higher, thinner, and more inflated than the previous taxon. The type is from Suffolk, Virginia. Under the name "*Cytherea reposta*" Conrad (1838) illustrated a North Carolina specimen of *Macrocallista greeni* Ward and Blackwelder, 1987, setting a precedent followed by almost all subsequent authors.

178a. *Macrocallista greeni* Ward and Blackwelder, 1987 (Synonym: *Macrocallista reposta* Conrad of authors, not of Conrad, 1834). Shell large, oval, elongate, thin and fragile; ventral margin often sinuous. *M. greeni* is rare in the Chowan River beds at Chesapeake. Length may exceed 80 mm. See Ward and Blackwelder (1987) for illustrations.

Fourier analysis (D. Campbell, in preparation) has shown that the outline of *M. greeni* is intermediate between the proportionally higher *M. albaria reposta* and the much more elongate Recent *Macrocallista nimbosa* (Lightfoot, 1786).

Genus *Dosinia* Scopoli, 1777

Venus clams with large, nearly circular, thin, compressed shells and strong concentric ribbing.

179. *Dosinia acetabula* (Conrad, 1832) (Synonyms: *Cytherea obovata* Conrad, 1834; *Dosinia elegans* (Conrad) of Dall in Shaler, 1890, not of Conrad, 1843; *Dosinia acetabulum obliqua* Dall, 1903; *Pandora obovata* Conrad of Sherborn, 1929; *Dosinia acetabulum blountana* Mansfield, 1932). Shell medium to large, circular; very compressed. Beaks high, central. Surface sculpture of flattened, smooth, concentric ribs, averaging 11 per centimeter. Pallial sinus narrow, fairly long and prominent. Ligament deeply excavated, just below the beak. Zone 1, Surry County; Zone 2, Isle of Wight, Greensville, and Southampton counties; Petersburg, Williamsburg, Yorktown, Hampton (abundant), Chuckatuck, Suffolk, and Chesapeake. Length 87 mm, height 84 mm.

Conrad used the trivial name "*obovata*" only once (Moore, 1962), so the only reasonable explanation for Sherborn's reference to "*Pandora obovata* Conrad" is as a lapse for *Cytherea obovata*, a junior synonym of *Dosinia acetabula*.

Subfamily Gemminae

Genus *Gemma* Deshayes, 1853

"Shell the size and shape of a split-pea; lunule large, faintly impressed; no escutcheon; 2 large teeth in the left valve with a large, median socket between the two. A very thin ridge which might be termed a tooth occurs posteriorly beneath the ligament. 3 teeth in right valve. Pallial sinus small and triangular. The shells of the brooded young may be found inside some females" (Abbott, 1974:534).

180. *Gemma magna* Dall, 1903 (Synonyms: *Gemma magna virginiana* Dall, 1903; *Gemma magna insulcata* Gardner, 1944; *Gemma magna majorina* Gardner, 1944; *Gemma magna floridana* Olsson and Harbison, 1953). Shell very small, trigonal to ovate-trigonal, heavy. Beaks central to a little forward. Surface with concentric undulations or fine concentric threads, rarely smooth. Hinge very large and heavy for size of the shell. Pallial sinus short, narrow, rounded. Zone 2, Williamsburg, Yorktown, Chuckatuck, Suffolk, and Chesapeake; Chowan River at Chesapeake. Length 2.79 mm.

Family Petricolidae

Genus *Petricola* Lamarck, 1801

"Ovate, mostly solid shells; sculpture, if present, mainly radial. Shells usually distorted by nestling habit in rock cavities" (Keen, 1971:197).

181. *Petricola pholadiformis* Lamarck, 1818 (Synonyms: *Petricola fornicata* Say, 1822; *Petricola carolinensis* Conrad, 1863; *Petricola rogersi* McGavock, 1944). Shell small to medium in size, cylindrical, thin, and fragile. Beaks anterior. Sculpture of anterior end consists of radial, scaled ribs which become obsolete over the posterior three fourths of the shell. Zone 2 at Yorktown in clay. Length (incomplete) 11.4 mm, height 4.8 mm.

Genus *Rupellaria* Fleuriau, 1802

"Shell inflated, strong, rounded in front, attenuated and more compressed behind; sculpture chiefly radial, stronger anteriorly. Considered a subgenus of *Petricola* by many workers" (Abbott, 1974:535).

182. *Rupellaria pectarosa* (Conrad, 1834) (Synonyms: *Rupellaria grinnelli* (Olsson, 1914); *Rupellaria pectrosa* (sic) (Conrad) of Campbell and others, 1975). Shell of moderate size, heavy, inflated, tapering posteriorly. Sculpture of rather rough, irregular radial cords. Relative height variable. Found burrowing into clay lumps, masses of annelid tubes, or bryozoans. Less often nestling in a depression in shell sand. Zone 2, Petersburg, Williamsburg, Yorktown, Smithfield, Day's Point, Suffolk, Chuckatuck, and Chesapeake. Length 20 mm, height 11 mm.

Genus *Pleiorytis* Conrad, 1862

"Shell of moderate dimensions, rather thin, slightly gaping; transversely elongate, moderately inflated. Umbones anterior, not conspicuously prominent, the tips proximate and prosogyrate. Lunule and escutcheon not developed. Posterior area flattened but not rostrate..." (Gardner, 1944:119).

183. *Pleiorytis centenaria* (Conrad, 1833) (Synonyms: *Psammocola regia* H. C. Lea, 1843; *Psammocola pleiocena*

Tuomey and Holmes, 1856; *Pleiorytis ovata* Conrad, 1862; *Petricola harrisi* Dall, 1900; *Asaphis centenaria* (Conrad) of authors). Shell of moderate size, ovate to rectangular, dorsally inflated. Hinge as in *Petricola*, but heavier. Sculpture of numerous, even, fine radial threads. Irregular outline reflects the nestling habit. Zone 1, York County and Williamsburg; Zone 2, Petersburg, Williamsburg, Yorktown, Chuckatuck, and Chesapeake. Length 55 mm, height 38 mm.

Family Cooperellidae

Genus *Cooperella* Carpenter, 1864

"These are thin, quadrate, rather small shells. The hinge of the right valve has two thin cardinal teeth, that of the left has three. The pallial sinus is large and wide" (Keen, 1971:199).

184. *Cooperella parilis* (Conrad, 1873) (Synonyms: *Cooperella carpenteri* Dall, 1900; *Diplodonta yorkensis* Dall, 1900). Shell small, smooth, thin, fragile, quadrate, well-inflated; length greater than height; resembling an elongate *Diplodonta* with a different hinge. The outline is distinctive. Zone 2, Surry, Isle of Wight, and Southampton counties; Petersburg, Yorktown, Chuckatuck, Suffolk, Hampton, and Chesapeake. Length 10.9 mm, height 8.7 mm. For discussion, see *Diplodonta punctulata*, species # 74,

Order Myoida
Superfamily Myacea
Family Myidae

Genus *Mya* Linnaeus, 1758

"The valves are slightly unequal in size and have a large posterior gape. Resilium internal, placed posterior to the beaks and attached in the left valve to a horizontally projecting chondrophore" (Abbott, 1974:536).

185. *Mya arenaria* Linnaeus, 1758 (Yorktown synonyms: *Mya corpulenta* Conrad, 1845; *Mya producta* Conrad of authors, not of Conrad, 1838; for additional synonyms see Dall, 1898, and MacNeil, 1964). Shell of moderate size, thin but strong, elongate-oval. Posterior end gaping. Zone 2, Yorktown and Petersburg. Length 63 mm, height 40.5 mm (size estimated from MacNeil figure).

Genus *Sphenia* Turton, 1822

"Small shells with the right valve edentulous and a small, shallow chondrophore in the left. The habit of nestling in cavities produces variations in shape. In general, Sphenias are white, with a broad, gaping posterior elongation and a shallow but wide pallial sinus" (Keen, 1971:263).

187. *Sphenia dubia* (H. C. Lea, 1843) (Synonyms: *Mya reflexa* H. C. Lea, 1843; *Tugoniopsis reflexa* (H. C. Lea) of Dall, 1903). Shell small to very small, elongate, inflated, very irregular in proportion and form. Left hinge with a narrow but prominent chondrophore. Surface smooth or with rough growth lines. Zone 2, Petersburg, Yorktown, Suffolk, and Chuckatuck. Length 2.3 mm. The type specimen of *Mya reflexa* (fig. 187a) is a slightly broken, relatively high specimen of *Sphenia dubia*. The more familiar name has page priority and can be retained. I have found living *Sphenia dubia* along the coast of South Carolina burrowing into decaying floating wood. This confirms Dall's (1898) report of living specimens. *Sphenia antillensis* Dall and Simpson, 1901 may be a Recent synonym.

Family Corbulidae

Genus *Varicorbula* Grant and Gale, 1931

"Left valve much smaller than right, umbones high and incurved, right valve inflated and with the posterior end somewhat set off by an angle" (Keen, 1971:270). Note: Stenzel, Krause, and Twining (1957:168-170) argue for the priority of *Notocorbula* Iredale, 1930, and discuss at length the vagrancies of the type concept for *Varicorbula*. However, *Varicorbula* is the prevailing usage in the literature at hand.

188. *Varicorbula chowanensis* Bailey, 1977. "Shell small, very strongly inequivalve; right valve convex and inflated with high, prosogyrate umbo, rounded anterior, truncate posterior, flat corselet separated from rest of valve by poorly defined posterior diagonal ridge and abrupt anterior turn of concentric ribs; left valve flatter and smaller than right; narrow, well defined umbo, rounded low posterior ridge defines irregular corselet, rounded anterior, subtruncate posterior."

"Sculpture of right valve consists of regularly spaced, rounded concentric ribs, becoming higher and wider near ventral margin..." (Bailey, 1977). Zone 2, Chuckatuck; Chowan River of North Carolina. Length 8.70 mm, height 6.82 mm.

Varicorbula chipolana carolina (Richards, 1947), reported from the "Yorktown" of a well at Bogue, North Carolina, at a depth of 130 feet, was associated with "*Melina maxillata* Lamarck" and other pre-Yorktown species. Richard's taxon is not conspecific with *Varicorbula chowanensis* and may be as old as the early Miocene (Richard Bailey, 1984, personal communication).

Genus *Corbula* Bruguiere, 1792

"The shells are sturdy and not only inequilateral but somewhat inequivalve, the left valve being the smaller, carrying the resilifer; there may be a blunt cardinal tooth in the right valve. Pallial sinus small to wanting" (Keen, 1971: 264).

A number of authors place most or all of the following corbulids in *Caryocorbula* Gardner, either as a subgenus, or as a genus.

189. *Corbula cuneata* Say, 1824 (Synonym: non *Corbula cuneata* Hinds, 1843). Shell small, inflated, rectangular, inequivalve, with a distinct posterior-dorsal ridge. Sculpture of fine concentric lines. Ventral margin nearly straight. Zones 1 and 2, ubiquitous. Length 11.17 mm, height 8.68 mm.

Say's figures were reversed for *Corbula cuneata* and *Corbula inaequalis*, leading to considerable confusion in the older literature (see Dall, 1898:854).

190. *Corbula retusa* Gardner, 1944 (Synonyms: *Corbula conradi conradi* Gardner, 1944, not of Dall, 1898; *Corbula*

conradi retusa Gardner, 1944; *Corbula swiftiana* Adams of Richards, 1947, not of C. B. Adams, 1852; *Caryocorbula auroraensis* Ward and Blackwelder, 1987; not *Corbula conradi* Dall of Lamay (1941)). Shell small, elongate-triangular, inflated. Posterior end truncate. Sculpture of numerous crowded concentric cords which turn upward abruptly at the posterior ridge. Microsculpture of fine radial lines. Ventral margin well-rounded. Zones 1 and 2, ubiquitous. Length 10.41 mm; height 5.86 mm.

Stenzel, Krause, and Twining (1957:167-168) provide a good discussion of the vagrancies of *Corbula conradi* Dall and of subsequent uses of the name. *Caryocorbula auroraensis* Ward and Blackwelder is an unnecessary replacement name for Gardner's preoccupied homonym.

191. *Corbula inaequalis* Say, 1824 (Synonym: *Corbula inaequalis mansfieldi* Richards, 1947). Shell small, trigonal, nearly equivalve; massively thickened in the adult form. Concentric sculpture of heavy, somewhat irregular riblets. Zones 1 and 2, ubiquitous. Length 11.71 mm, height 7.92 mm.

Genus *Gastrochaena* Spengler, 1783

"Burrowing forms, the shells lying free within a linear cavity; hinge edentulous; the valves broadly gaping... the anterior end is narrow, the posterior end flaring; some species have small shelly plates for the support of the muscles, extending into the shell cavity near the hinge" (Keen, 1971:270).

192. *Gastrochaena ligula* H. C. Lea, 1843 (Synonyms: *Modiolus inflatus* (Tuomey and Holmes) of Richards, 1947, not of Tuomey and Holmes, 1856; *Gastrochaena lingula* (sic) Lea of Campbell and others, 1975). Shell small, elongate, very thin, narrowly elliptical, inflated. Ventral margin gaping. Beaks low, anterior. Sculpture of fine concentric growth lines only. Burrow shaped like a long-necked vase. This is an endolithic species, commonly burrowing into a variety of bivalve and gastropod shells, especially thicker shells such as *Mercenaria* and *Chame*. If a *Gastrochaena* selects a thin shell, it can secrete a lumpy mass of carbonate around itself to accomodate its burrow. Zone 2, Petersburg, Williamsburg, Chuckatuck, and Smithfield. Length 12.41 mm, height 6.49 mm.

Superfamily Hiatellacea
Family Hiatellidae

Genus *Hiatella* Bosc, 1801

Shell small, rectangular to oval, normally compressed. Individual specimens highly variable due to their nestling habit.

193. *Hiatella arctica* (Linnaeus, 1767) (Yorktown synonyms: *Saxicava distorta* Say, 1822; *Saxicava bilineata* Conrad, 1838; *Saxicava arctica bicristata* Sandberger, 1863; *Saxicava insita* Conrad, 1869; *Saxicava incita* Conrad, 1869; *Saxicava protexta* Conrad, 1873). For additional synonyms see Dall, 1898:834. Shell small, elongate, rectangular, somewhat inflated, heavy, very irregular in form. Posterior slope with or without a pair of diagonal ridges which are spinose in very young specimens. Zones 1 and 2, ubiquitous. Length 21 mm.

This is a nestling species of irregular shape. It may be found paired and in place inside barnacles, in the sutural channel of the gastropods *Busycon incile* or *Ecphora quadricostata*, or simply in crevices of packed coarse shell. Recent material from off Charleston, South Carolina consists of larger, more robust and inflated shells with no trace of the posterior ridges. However, the general consensus is to recognize a single species widespread in space and time.

Genus *Panopea* Menard, 1807

"The valves are medium-sized to large, quadrate, gaping at both ends, the beaks subcentral. The ligament is large, on a nymph, and the pallial sinus is wide. In either valve there is one small cardinal tooth. Long siphons enable the animals to live some distance below the surface in muddy sand, a situation from which few enemies are able to dislodge them" (Keen, 1971:723).

194. *Panopea goldfussi* Wagner, 1838 (Synonym: *Panopea porrecta* Conrad, 1845). Shell large, thin, elongate, inflated, tapering posteriorly. Anterior end slightly gaping; posterior widely gaping. Beaks well anterior. Surface smooth save for rough lines of growth. Zone 2, Hampton and Suffolk. Length 102 mm, height 57 mm. This species seems restricted to lower Zone 2 beds.

195. *Panopea reflexa* (Say, 1824) (Synonyms: *Panopaea americana* Conrad of Lyell, 1845, not of Conrad, 1838; *Panopaea aldrovandi* Menard of Lyell, 1845, not of Menard, 1807; *Panopaea cymbula* Heilprin, 1886). Shell very large, thin, rectangular, elongate. Dorsal and ventral margins roughly parallel. Beaks slightly anterior. Surface smooth save for rough lines of growth. Zone 1, Williamsburg; Zone 2 ubiquitous. Length 135 mm, height 74 mm.

This form occurs rarely, or in dense colonies. It is almost always found paired and in the original growth position. Juvenile specimens are rarely found, suggesting low fecundity and high survival rates. Rough pearls may sometimes be present.

Panopea cymbula Heilprin (1886) was created for this, the most common Yorktown *Panopea*. Heilprin challenged the accepted origin and identity of *Panopea reflexa*, arguing that Say's 1824 figure is more typical of a Floridian species. However, he did not actually apply Say's name to any of the Floridian forms. Spamer and Forster (1988:78) note that the holotype of *Panopea cymbula*, ANSP 16377, has been relocated in Academy collections. In my opinion, Say's figured specimen is atypical but easily falls within the range of variation for Yorktown *Panopea reflexa*.

Superfamily Pholadacea
Family Pholadidae
Subfamily Pholadinae

Genus *Cyrtopleura* Tryon, 1862

"This genus, though resembling *Pholas*, does not have the reflected umbonal margin, and the supplementary plates are partially horny" (Keen, 1971:275).

196. *Cyrtopleura arcuata* (Conrad, 1841) (Synonyms:

Pholas costatus Linnaeus of Tuomey and Holmes, 1856, not of Linnaeus, 1758; *Pholas acuminata* Conrad, 1845). Shell fairly large, elongate, thin and fragile. Protoplax high, without vertical septa. Sculpture of 30 to 40 radial beaded ribs. Zone 2, Isle of Wight and Middlesex counties; Yorktown, Suffolk, Smithfield, and Chuckatuck. Length 93 mm, height 37 mm.

The figured specimen has a large blister pearl from polydorid worm infestation. *Cyrtopleura arcuata* differs from the Recent *Cyrtopleura costata* in being smaller, in having more numerous ribs, and in having a different umbonal margin.

Genus *Pholas* Linnaeus, 1758

"Shells narrowly pointed anteriorly, protoplax divided lengthwise in two parts" (Keen, 1971:275).

197. *Pholas memmingerii* Tuomey and Holmes, 1856. Shell of moderate size, elongate-rectangular, thin and fragile. Anterior and posterior margins rounded to truncate. Apophyses short, curved, spatulate. Protoplax with vertical septa beneath. Sculpture of serrated concentric lamellae especially prominent over the anterior half of the shell. Zone 2, Williamsburg (vertical pairs in stiff clay) and Chuckatuck. Length 53 mm, height 21 mm.

Genus *Zirfaea* Gray, 1842

"Shell oval in outline, beaked anteriorly, rounded posteriorly, widely gaping at both ends and having a sulcus extending from the umbo to the ventral margin. Only one dorsal acessory plate; a small, triangular, fragile, calcareous mesoplax. Apophyses solid, strongly curved, narrowly spoon-shaped" (Abbott, 1974:544).

198. *Zirfaea rhomboidea* (H. C. Lea, 1843). Shell very small (juvenile ?), elongate, thin. Umbonal-ventral sulcus well developed, with a secondary groove anterior and parallel to the umbonal groove. Anterior and posterior ends pointed. Ventral margin serrate. Apophyses short, curved, peg-like. Sculpture of concentric lines. Zone 2, Petersburg. Length 7.1 mm; height 4.57 mm. The type remains unique.

Subfamily Martesiinae

Genus *Martesia* Sowerby, 1824

"Shell thin, ovate-oblong, cuneiform, strengthened by 3 accessory plates; gaping posteriorly. At the completion of the burrow, valves closed in front with a calcareous septum or "callum". Surface deeply sculptured by a sulcus running diagonally backward from the umbones to the ventral margin. Concentric sculpture in front of the groove more raspy and more regular than behind it. Myophore long, slender, curved. Burrows flask-shaped" (Gardner, 1944:142-143).

199. *Martesia* sp. cf. *M. ovalis* (Say, 1820) (Synonym: *Martesia cuneata* (Say) of Gardner, 1944, not of Say, 1822). Shell small to moderate in size, obliquely oval, thin. Protoplax small, with a groove passing from the umbo to the ventral margin. Anterior margin gaping or nearly filled with callum. Sculpture of fine, rather even concentric lines. Apophyses narrow, curved, needle-like. Zone 2, Yorktown, Smithfield, Williamsburg, and Hampton. Length 25 mm.

The Yorktown specimens are nearly always found burrowed into coral. Recent *Martesia cuneiformis*, a more elongate shell with more widely spaced sculpture, is typically a wood borer. Glenn (1904, plate LXV) figures typical *Martesia ovalis* from the Choptank Formation of Maryland. The Yorktown material differs only in averaging larger.

Genus *Teredina* Lamarck, 1818

Shell as in *Martesia*, but in the adult phase extended into a *Teredo*-like chalky tube.

200. *Teredina fistula* (H. C. Lea, 1843) (Synonyms: *Teredo calamus* H. C. Lea of authors, not of H. C. Lea, 1843; *Kuphus calamus* Lea of Gardner, 1944). Shell very rarely preserved (or possibly unknown). Aragonitic burrows thick, heavy, often chalky, always broken. Zone 1, ubiquitous; Zone 2, Southampton County, Petersburg, Williamsburg, Yorktown, and Hampton. This species became extinct prior to the uppermost Yorktown. Length (incomplete) 39 mm, probably exceeding 250 mm.

Gardner (1944) argued that *Teredo fistula* was a junior synonym of *Teredo calamus*, based on page priority. However, Lauk Ward (1976, personal communication) pointed out that *Teredo calamus* consisted of narrow, calcitic tubes broken out of a mass of bryozoans, a typical annelid habit. More recently, Ward (1992:115) has placed *Teredo calamus* in *Teredo*, a genus otherwise known to only burrow in wood. I am convinced that *Teredo calamus* Lea is an annelid. Therefore Lea's two "*Teredo*" species are not conphyletic and cannot be synonyms.

Teredo calamus Tuomey, 1854, from the Cretaceous of Mississippi is almost certainly a lapse, because Tuomey was familiar with the Lea's and their work, being the source of the Petersburg material described by H. C. Lea. Tuomey and Holmes (1855-57) also cite Lea species names. Tuomey's usage is a primary homonym, but its exact identity is beyond the scope of this study. David Dockery (1992, personal communication) has sections of Cretaceous lignitic wood in the Mississippi Geological Survey collections which abound in large, Teredo-like burrows from which the carbonate burrow linings have been leached.

The shell of *Teredina fistula* is known from a single specimen, supposedly from the original Rogers and Rogers collection (Boston Society of Natural History specimen # 9562), now lost, but described and well illustrated by Johnson (1904). Johnson's short paper was not obscure, but only Ward (1992) has subsequently cited it. At least since Gardner (1944), this species has been placed in the genus *Kuphus* Guettard (1770). Its type, *Serpula polythalamia* Linnaeus, 1767, is a meter long, thin- tubed teredinid reaching 100 mm in diameter. Modern *Kuphus* initially burrow into mangrove roots, but continue tube development in mud when the animal outgrows its wood substrate (Ruth Turner, 1990, personal communication). *Kuphus incrassatus* Gabb, 1873, from the Miocene and Oligocene of Florida and the Caribbean appears to be a legitimate large, thin-shelled *Kuphus* (H. Vokes, 1972). However, such morphology is in sharp contrast with the thick, chalky, 15-20 mm diameter tubes of *Teredina fistula*. A possible second American Pliocene species of *Teredina* has been described from Ja-

maica as *Teredina bowdeniana* Dall, 1898. The specimen consists of the shell only, the presumed tube being broken away. Woodring (1925) dismissed the notion of a tube, however, and placed that species in *Martesia*.

Teredo species are wood-boring shipworms with a rudimentary shell inside the calcareous burrow lining or tube. The shell is almost always lost in fossil material. *Teredina* species are sand-burrowing pholads which initially produce a *Martesia*-like shell which developes typically up to a point in its ontogeny. The animal then abandons normal shell growth in favor of tube formation with the initial shell attached to the base of the tube. *Teredina* species apparently burrow in sand.

Here, I follow Johnson in placing *Teredo fistula* in *Teredina*, but it seems strange that a form known from thousands of tube segments should have only a single recovery of the shell. Further, many tube fragments in hand are smaller than the Johnson specimen without any trace of original shell. The *Teredina* assignment must therefore be considered provisional until someone rediscovers shell-preserved specimens. Should *Teredina* prove to be incorrect, *Teredo fistula* certainly is not a *Kuphus*, and may require a new genus. *Teredina* specimens from France show a constriction at the transition point from shell to tube, a feature not present in Johnson's (1904) illustration of *T. fistula*. Consequently, admixing of European and American specimens seems unlikely.

Subclass Anomalodesmata
Order Pholadomyoida
Superfamily Pholadomyacea
Family Margaritaridae

Genus *Margaritaria* Conrad, 1832

Elongate-rectangular, gaping shells with a friable nacreous shell structure. No hinge teeth. All known species have prominent, narrow, widely spaced radial threads.

201. *Margaritaria abrupta* (Conrad, 1832). Shell of moderate size, elongate, rectangular, rather brittle, nacreous. Beaks central, low. Surface rather rough, with three radial ridges passing from the beak to the ventral margin. Anterior and posterior ends gaping. Zone 2, Yorktown, Williamsburg, Chuckatuck, Hampton, Smithfield, and Chesapeake. Length 68 mm, height 38 mm. This was a deep burrowing species frequently found paired and in a vertical position. Juvenile specimens are very rare, indicating a species with low fecundity and high survival rates.

Superfamily Pandoracea
Family Lyonsiidae

Genus *Lyonsia* Turton, 1822

"Shells elongate, posterior side longer, gaping at the end; thin, nacreous, and with a thin yellowish periostracum. Middle section of the internal resilium is covered by a large, calcareous lithodesma" (Abbott, 1974:554).

202. *Lyonsia* species. Shell small, very thin, elongate, nacreous. Zone 2, Chesapeake. Length 15 mm. A single broken specimen and a single, minute juvenile (Plate 22, Figure 220a) belonging to this genus was recovered at the Deep Creek pit.

Family Pandoridae

Genus *Pandora* Bruguiere, 1797

"If odd shapes are any criterion, these are indeed Pandora's boxes. Some forms look like Turkish slippers done in pearl, others like hatchets, and still others like little fans. One wonders where the animal that formed the shells found space to live, for the right valve is flat, and the left valve only slightly arched. There is no hinge plate, but along the dorsal margin one to three radiating buttresses or laminae (called cardinal teeth, by courtesy, or more accurately, crura) serve to protect the ligament and act as a hinge" (Keen, 1971:287). Note: no separation into subgenera is here attempted.

203. *Pandora arenosa* Conrad, 1834 (Synonym: *Pandora carolinensis* Bush, 1885). Shell small, inequivalve, sturdy, irregularly elliptical. Left valve moderately inflated, right valve flat or concave. Posterior dorsal rostrum very short. Left valve smooth; right valve with faint radiating lines. Zone 2, Yorktown, Hampton, Suffolk, Chuckatuck, and Chesapeake. Length 17.5 mm.

204. *Pandora crassidens* Conrad, 1838 (Synonyms: *Pandora prodromos* Gardner and Aldrich, 1919; *Pandora conradi* Mansfield, 1929). Shell of moderate size, thin to fairly heavy, very compressed, inequivalve, nacreous. Surface smooth or with an occasional radial thread on the right valve. Crura massive. Relative proportions vary with growth from relatively narrow subadult shells (*Pandora conradi*) to broad, fully adult forms. Zone 2, Yorktown, Suffolk, Hampton, Chesapeake, Smithfield, and Chuckatuck. Length reaches 35 to 40 mm.

Pandora crassidens was thought by Mansfield and Gardner to be more typical of pre-Yorktown faunas, especially of Maryland as described and figured by Glenn (1904). However, the type locality is James River near Smithfield. It is the most common *Pandora* in Zone 2 faunules.

205. *Pandora crassidens majorina* Gardner, 1944. Shell very large for the genus, exceptionally broad, very heavy, rectangular. Dorsal and ventral margins subparallel. Crura very massive. Right valve concave, with radially incised grooves. Zone 2, Southampton County and Hampton. Length exceeds 50 mm. This is a very rare taxon. Larger populations will probably establish it as a fully distinct species.

206. *Pandora undulata* Campbell, new species. Shell of moderate size, nacreous, rather brittle. Full outline unknown. Left valve well inflated; right valve unknown. Sculpture of left valve vigorous, of concentric undulations over the entire disk. beaks anteriorly placed. Anterior crura ventrally directed. Type locality: Tutter's Neck Pond spillway, just east of Williamsburg, Virginia. Zone 1, Williamsburg and Carter's Grove. Length (incomplete) 22 mm, height 23 mm.

Etymology: No other Yorktown or Recent *Pandora* shows such vigorous undulatory structure. The species is

named for this most distinctive trait.

207. *Pandora* species Shell small, compressed, thin, nacreous under a thin, flaking, porcellaneous outer shell layer. Like *Pandora crassidens* but less produced posteriorly in shells of the same size, and with more delicate crura with a different curvature. Chowan River at Chesapeake. Length 19 mm, height 12 mm.

208. *Pandora tuomeyi* Gardner and Aldrich, 1919 (Synonym: *Pandora trilineata* Say of Tuomey and Holmes, 1856, not of Say, 1822). Shell fairly small, very elongate, thin and compressed, tapering posteriorly, wing-like in outline. Surface smooth. Zone 2, Williamsburg, Yorktown, and Suffolk. Length 17 mm, height 9 mm.

Pandora tuomeyi is close to the Pleistocene and Recent *Pandora trilineata* Say, differing in attaining a larger size and in having the crura set at a different angle.

Family Thraciidae

Genus *Thracia* Sowerby, 1823

"Smooth, not nacreous-textured, inequivalve, the right valve larger; surface granular in most forms, hinge edentulous, resilium in an obliquely directed chondrophore; posterior end broadly truncate and set off by a low ridge; pallial line with a sinus" (Keen, 1971:295).

209. *Thracia magna* Campbell, new species (Synonym: *Thracia conradi* Couthouy of authors, in part, Yorktown and Jackson Bluff records only, not of Couthouy, 1839). Shell very large, dorsally inflated, thin and very brittle. Beaks low, rounded; umbo often perforated. Posterior end somewhat produced. Type locality: Rice's Pit at Hampton, Virginia. Zone 2, Hampton, Suffolk, and Days Point. Length exceeds 120 mm.

Thracia conradi is a smaller and more rounded shell which is confined to the Pleistocene and Recent of Boreal and Cold-temperate provinces. *Thracia stimpsoni* Dall, 1886, found from Cape Hatteras to Texas, is larger than *Thracia conradi*, smaller than *Thracia magna*, and more produced posteriorly than either of those species. Dall (1900) proposed *Thracia conradi harrisi* for a Maryland Miocene shell which represents yet another species.

Etymology: named for its size, the largest *Thracia* of which I can find reference.

210. *Thracia transversa* H. C. Lea, 1843. Shell very small, thin, very compressed. Beaks high, pointed. Posterior-dorsal slope concave, posterior end truncate. Anterior and ventral margins rounded. Surface smooth. Zone 2, Petersburg, Yorktown, Hampton, Suffolk, and Chuckatuck. Length 3.2 mm.

210a. *Thracia maddelysensis* Gardner, 1944. Shell very small, thin, oval, inflated. Sculpture of flat, concentric threads. Umbo high, inflated. Posterior bluntly truncate, not produced. Zone 2, Maddely's Bluff, Meherrin River in Southampton County.
Length 5.0 mm.

Genus *Cyathodonta* Conrad, 1849

"Shell with undulating sculpture or oblique rows of granules; ligament internal, on a chondrophore" (Keen, 1971:297).

211. *Cyathodonta dalli* (Mansfield, 1929). Shell fairly small, thin, very fragile and usually broken. Outline ovate-rectangular. Beaks low, opisthogyrate. Sculpture forward of the posterior ridge consists of obliquely concentric wrinkles visible on both the internal and external surfaces. Fine sculpture of radial rows of granular beads especially prominent on the posterior slope. Zone 2, Isle of Wight County, Chuckatuck, Benns Church, Chesapeake, and Smithfield. Length 34 mm, height 25 mm. No other Yorktown species can be confused with this rare, elegantly sculptured bivalve.
Family Periplomatidae

Genus *Periploma* Schumacher, 1817

"Thin, right valve more convex than left and overlapping it. Surface granular, beaks opisthogyrate; resilium in a spoon-shaped chondrophore in each valve, anterior muscle scar long and narrow, posterior small and crescentic; pallial sinus short, rounded" (Keen, 1971:292).

212. *Periploma* sp. cf. *P. peralta* Conrad, 1867 (Synonym: *Periploma alta* Conrad, 1863, not of C. B. Adams, 1852). Shell small to moderate in size, circular to slightly oval-elongate, very thin and fragile. Chondrophore prominent, supported by a subumbonal rib, ventrally and posteriorly directed. Right valve well inflated, left valve compressed. Surface nearly smooth. Length exceeds 34 mm.

Periploma peralta is based on crushed material from Maryland. Very similar crushed material can be found in the Mogarts Beach clays along the James River north of Smithfield, but perfect material has been found at Rice's Pit in Hampton. Whether the Yorktown species is identical with the older Maryland material is uncertain, but the name is here provisionally used, pending discovery of better comparative Maryland material.

Genus *Cochlodesma* Couthouy, 1838

"The prominent clavicular rib supporting the chondrophore is absent, and in front of the chondrophores there is a cartilaginous dark-brown mass uniting the valves and taking the place of the lithodesma" (Abbott, 1974:561).

213. *Cochlodesma antiqua* (Conrad, 1834) (Synonyms: *Cochlodesma leanafloridana* Mansfield, 1937; *Cochlodesma emmonsii* Ward and Balckwelder, 1987; not *Cochlodesma antiquatum* (sic) Conrad of Verrill, 1873). Shell of moderate size, ovate-elongate to rectangular, thin and very fragile. Chondrophore prominent, ventrally directed. Left valve very compressed, right valve a little less so. Surface smooth and polished. Zone 2, Yorktown, Chuckatuck, Benns Church, and Chesapeake. Length 47 mm, height 33 mm.

The recent *Cochlodesma leana* Conrad is a smaller, thinner, more compressed shell with a more posteriorly directed chondrophore.

Order Septibranchoidea
Superfamily Poromyacea
Family Verticordiidae

Genus *Verticordia* Sowerby, 1844

"Small, lustrous, with strong, curved, radial ribs; ligament internal, in a large lithodesma" (Keen, 1971:302).

214. *Verticordia rogersii* Gardner, 1944. Shell very small, compressed, nacreous within. Beaks high, prominent, directed forward. Sculpture of nine or ten heavy radial ribs with a very wide posterior-central inter-rib area. Microsculpture of very densely packed granular beads. Zone 2, Isle of Wight County, Smithfield, Williamsburg, Suffolk, Chuckatuck, and Chesapeake.
Length 3.0 mm.

215. *Verticordia* species. Shell very small, somewhat compressed, ovate. Beaks prominent, rolled forward. Sculpture of ten fairly heavy radial ribs. Chowan River at Chesapeake. Length 5.0 mm.

This rare shell resembles *Verticordia rogersii*, but differs in being nearly twice as large, proportionally more elongate, and in having narrower ribs and more prominent beaks. It might be taken for an exceptionally large *V. rogersii*, but a population of over 50 specimens of the latter demonstrates an adult maximum size well short of the Chowan River specimen.

Class Scaphopoda
Family Dentaliidae
"Shells with the greatest diameter at the oral aperture; surface smooth or sculptured; radula with central tooth twice as wide as high; foot of animal conical, not terminating in an expandable disk" (Keen, 1971:883).

Genus *Dentalium* Linnaeus, 1758

216. *Dentalium attenuatum* Say, 1824 (Synonyms: *D. costatum* Sowerby of Lyell, 1845, not of Sowerby, 1814; *D. dentalis* Conrad Lyell, 1845, not Lamarck, 1818). Shell a narrow tapering curved cylinder with 12 to 16 longitudinal ribs extending the length of the shell. Interrib groove narrower than ribs. Zone 1, ubiquitous; Zone 2, Petersburg, Wiliamsburg, Yorktown, Hampton and Chuckatuck. Length 34 mm.

217. *Dentalium carolinense* Conrad, 1862. Shell a curved tapering cylinder with 8 to 11 broader ribs becoming obsolete with mature growth. Zone 2, Chuckatuck, Hampton and Chesapeake. Length 39 mm.

This species needs to be validated by a comparison of populations. Supposed differences of less curvature, wider interspaces and obsolete sculpture on the anterior end may reflect ontogeny rather than species-level traits.

Genus *Cadulus* Philippi, 1844

"Mostly small, somewhat arched; greatest diameter between the middle of the shell and the apertural end; aperture contracted; tube surface smooth; foot of animal with a median disk lacking a central projection" (Keen, 1971:890).

218. *Cadulus thallus* (Conrad, 1834) (Synonyms: *Dentalium thallum* Conrad, 1834; *Ditrupa gadus* Montagu of Lyell, 1845, not of Montagu, 1803; *Cadulus carolinensis* Bush of Dall in Shaler, 1890 not of Bush, 1885). Shell small, smooth, cylindrical, slightly curved, slightly swollen above the base. Zone 1, Middlesex County and Williamsburg; Zone 2, ubiquitous. Length 8.96 mm. Some Yorktown specimens are smaller, more slender and more evenly tapered. These are interpreted as juvenile specimens of *C. thallus*. Some freshly excavated specimens show an apparent color pattern of dark brown, slightly oblique bands.

Class Polyplacophora
Order Neoloricata
Family Ischnochitonida

Genus *Ischnochiton* Gray, 1847

Small to very small chitons, commonly with pitted sculpture.

219. *Ischnochiton* species. Shell very small to minute, acutely arched; central plates transversely very narrow. Tail valve with a central knob or mucro. Sculpture of spiraling rows of large pits forming a "snakeskin" pattern. Zone 2, Chuckatuck and Chesapeake. Length of center plate 0.71 mm, width 2.01 mm. Length of figured tail plate 1.51 mm, width 2.37 mm. This species was first compared with *I. papillosus* of the Recent fauna, but the fossil species lacks beading and the well-defined central ridge (jugum), and central plates are narrower, longitudinally. Bill Lyons (1992, personal communication) states that the fossil is conspecific with a living species from Florida. The nomenclature of the Recent species is confused in the literature, and he has a revision in progress.

Family Chaetopleuridae

Genus *Chaetopleura* Shuttleworth, 1853

"The girdle spiculose, interspersed with scattered hairs or spines. Valve sculpture of pustules, generally arranged in rows. Serrate sinus plane present, and outer surfaces of insertion teeth grooved" (Keen, 1971: 877).

220. *Chaetopleura apiculata* (Say, 1830) (Synonym: *Chiton transenna* H. C. Lea, 1843). Shell small, well arched, with a central ridge or jugum. Sculpture of parallel rows of beads on the head and tail plates. Invariably found as disarticulated plates in the shell sands. Zone 2, Petersburg, Williamsburg, Smithfield, Chuckatuck and Chesapeake. Length of center plate, 1.7 mm; width 7.0 mm. Length of head plate, 3.5 mm; width 9.5 mm.

Class Gastropoda
Subcless Prosobranchia
Order Archaeogastropoda
Superfamily Fissureliacea
Family Fissurellidae

Genus *Diodora* Gray, 1821

"Sculpture cancellate; callus inside apex squared posteriorly; muscle scars with hooked ends" (Keen, 1971:313).

___. *Diodora carolinensis* (Conrad, 1875). Shell fairly small, oval, slightly tapering; keyhole constricted. Sculpture of 38 rather large radial ribs crossed by fine concentric

threads. See Appendix I.

___. *Diodora alticosta* (Conrad, 1834). Restricted to the St. Marys Formation. See Appendix II.

221. *Diodora catilliformis* Rogers and Rogers, 1837 (Synonym: *Fissuridea catilliformis alumensis* Mansfield, 1930). Shell small, oval, fairly low; keyhole oval, posteriorly placed. Radial sculpture of numerous flattened ribs; interspaces very narrow; concentric sculpture of growth lines only.

If this is a valid taxon, it is apparently a rare form not recognized in recent collections. Gardner (1948) records it from Zone 2 without a specific locality. Length originally given as 1/2". Pilsbry and Johnson (1892:105) concluded that *F. catilliformis* was likely a synonym of *F. redimicula* Say.

222. *Diodora oblonga* (H. C. Lea, 1843) (Synonyms: *Fissurella alticosta* Conrad of Pilsbry and Johnson (1892), not of Conrad 1834; *Diodora redimicula virgilina* Gardner, 1948). Shell of medium size, oval, moderately elevated. Apical foramen oval and slightly posterior. Radial sculpture of numerous uneven ribs typically alternating through a pattern of very strong, then weak, moderately strong, then weak, etc. Fine concentric threads bead the radial ribs. Juvenile stages may show a spiral protoconch which is later absorbed by the expanding apical foramen. Zone 2, ubiquitous. Length 39 mm; height (elevation) 20 mm.

Lea's type specimen was a 1 mm juvenile which he erroneously placed in *Cemoria*, thus avoiding homonymy with *Fissurella oblonga* Menke, 1843 from Australia. This Australian taxon is not a *Diodora* (*fida* Petit, 1981, personal communication), therefore Lea's designation remains valid. A full ontogenetic series connects Lea's juvenile with adult forms (up to 55 mm in length) later named *D. redimicula virgilina* by Gardner (1948). Pilsbry and Johnson (1892) assigned the large, strongly sculptured Yorktown *Diodora* to *D. alticosta* (Conrad, 1834). As figured by Glenn (1904: pl. LXIII), *D. alticosta* shares details of sculpture pattern with *D. oblonga*, but its shell is proportionally higher from base to "keyhole". I have not examined populations of the Maryland taxon. If conspecific, *D. alticosta* has priority.

223. *Diodora redimicula* (Say, 1824) (Synonym: *Fissurella redimicola* (sic) Say Sherborn, 1930). Shell of moderate size, elevated, apical foramen oval and a little posterior. Sculpture of numerous crowded, uniformly-sized radial ribs beaded by fine concentric lines. Say's 1824 figure and description are less than definitive but resemble a *Diodora* with uniformly elevated radial sculpture, a pattern found especially in Zone 1 specimens. Zone 1, ubiquitous.

Superfamily Trochacea
Family Trochidae

Genus *Solariella* Wood, 1842

"Deeply umbilicate shells in which the umbilicus is usually bordered by a beaded cord. The radula is diagnostic, with lateral teeth two to four in number, cusped only on the outer side. All species occur offshore, some in relatively deep water" (Keen, 1971:331).

224. *Solariella olssoni* Campbell, new species (Synonym: *S. gemma* (Tuomey and Holmes) of Olsson, 1914, not of Tuomey and Holmes, 1856). Shell of moderate size, turbinate; two nuclear and four postnuclear whorls. Umbilicus wide, deep, with two faintly impressed spiral lines. External sculpture of three strong, granulated keels on body whorl and three smooth spiral cords on the base, with a stronger, granulated rib at the umbilical margin. Radial sculpture of oblique threads which granulate the keels. Aperture round, nacreous within. Zone 1, James City County at Grove Wharf and Williamsburg. Type locality: Williamsburg,at the spillway for Tutters Neck pond. Height 7.5 mm; diameter 8.27 mm.

Etymology: named for Axel Olsson who first figured the species.

225. *Solariella ricei* Campbell, new species. (Synonym: *S. cancellata* (Conrad) Campbell, 1976, not of Conrad, 1833). Shell large for the genus, turbinate; two smooth nuclear and five tabulate postnuclear whorls. Suture narrowly impressed. Umbilicas wide, deep, with four spiral ribs. External sculpture of numerous finely granular ribs, 9 or 10 on the body whorl; shoulder and central ribs are stronger, forming a carina. Base and umbilicus with 8 or 9 granulated spirals strongest at umbilical border. Shoulder whorl and base covered with fine, closely spaced, uniformly oblique radial threads, giving the surface a granular or cancellate appearance. Aperture circular, nacreous within. Zone 2, Williamsburg and Hampton. Type locality: *Ensis* shell bed at Rice's Pit, Hampton, Virginia. Height 11.56 mm; diameter 12.55 mm.

Conrad (1833) provided a brief, but compatible, description of *Solarium cancellatum* from "Suffolk, Va" which I (Campbell and others, 1975) applied to the Zone 2 Yorktown *Solariella* commonly found in Hampton. However later reversing himself, Conrad (1835) stated that his specimen came from Claibourne, Alabama (Eocene), thus predating Isaac Lea's *S. cancellatum* (1833) from those beds by a few days. Whether Conrad started with a Suffolk shell and later switched the type or just confused his localities remains buried in his feud with the Leas, but the existing type was examined and found to be Eocene.

Etymology: named for William Rice.

226. *Solariella shacklefordensis* Olsson, 1914 "Shell of medium size, pearly; whorls about 6 in number; nucleus very small; earlier whorls with two carinated ribs, one at the angle, the other about the middle; upper surface of whorl smooth and with oblique wave-like undulations which cause the granulation of the revolving ribs; suture of the later whorls gradually advancing down so that additional revolving ribs and lines are brought into view; on the body whorl a smaller faint revolving line is introduced between the two carinated; in addition there are two plain ribs below the carinated ones, the lowermost being the largest; base of shell with about five revolving, plain ribs; umbilicus deep and bordered by a strongly carinated rib; interior of umbilicus smooth with a single revolving line and crossed by transverse ribs. Height of type 10, diameter 10 mm" (Olsson, 1914:47-48). Zone 1, Shackleford, Va.

S. shacklefordensis has four ribs on the body whorl

rather than the three ribs of the new species, *S. olssoni*.
Subfamily Calliostomatinae

Genus *Calliostoma* Swainson, 1840

"The shells are either flat-sided or with rounded whorls, mostly with fine beading and color markings. The base may have a slight umbilical depression; rarely is it deep. The aperture is round, with no folds or teeth on the columella" (Keen, 1971:332).

The Yorktown fauna of Virginia and North Carolina is unusually rich in *Callistoma*, with 30 nominate taxa from which I recognize 19 species and subspecies. Contributing to this diversity are two exceedingly variable stocks, the *Calliostoma mitchelli* (*philanthropus*) species group and the *C. virginicum* species group, which contain over 66% of the taxa. Various subgenera have been proposed within *Calliostoma*, principally based upon radular and soft tissue characteristics, hence the fossils are not subdivided.

___. *Calliostoma armillus* H. C. Lea, 1843. From the figure, this appears to be a member of the *C. mitchelli* group, but the type is lost and exact identity is uncertain. Hence this becomes a *nomen dubium*. See Appendix II.

227. *Calliostoma bellum* (Conrad, 1834) (Synonym: *Trochus aratus* H. C. Lea, 1843). Shell of moderate size, conic, apical angle 65 degrees; six whorls, each slightly constricted below the suture; no umbilicus. Spiral sculpture of 7 to 9 beaded threads on the whorls and another 7 to 9 on the base. The uniformly prickly beading is diagnostic for this species. Zone 2, Petersburg, Williamsburg, Smithfield and Suffolk. Height of largest cotype (here illustrated) 11.38 mm; diameter 11.27 mm.

228. *Calliostoma sarae* Campbell, new species. Shell of moderate size; conic, apical angle 67 degrees. Spiral sculpture as in *C. bellum*, but finer, with wider interspaces. Beading also finer, more abundant, and oval-rounded rather than prickly. Interspaces on slopes and base crowded with oblique axial threads connecting beads. Zone 1, Williamsburg. Type locality: Tutters Neck pond, James City County just east of Williamsburg, Virginia. Height 8.77 mm; diameter 8.55 mm.

Etymology: Named "princess" for its delicate sculpture and in recognition of my wife, Sarah Lu Campbell for long and patient support in the field, at the keyboard, and as an editor.

___. *Calliostoma cheopsi* Gardner, 1948. Shell of moderate size, conic, six whorls. Spiral sculpture of four heavily beaded cords in the early whorls and a heavy, smooth cord just above the suture on the body whorl. Base with seven heavy spiral cords. Zone 2, Pitt County, North Carolina, not yet found in Virginia. Height 11.1 mm; diameter 10.0 mm. See Appendix I.

229. *Calliostoma labrosum* (Conrad, 1834) (Synonyms: *Trochus lens* H. C. Lea, 1843; *Delphinula trochiformis* H. C. Lea, 1843). Shell small, biconic, low; apical angle 98 degrees; deeply umbilicate; 5 to 6 whorls, nuclear whorls smooth. Spiral sculpture of numerous fine grooves and one strong groove above the suture to form a prominent keel or carina. Basal sculpture of fine spiral threads and two strong cords at the umbilicus. Zone 2, ubiquitous. Height 7.3 mm; diameter 9.3 mm.

A very common small species easily recognized by the low, biconic form and peripheral keel. Martin (1904) incorrectly synonymized *T. lens* with the St. Marys species *C. humilis* (Conrad, 1830).

230. *Calliostoma lapidosum* (Conrad, 1834) (Synonyms: *Trochus conus* H. C. Lea, 1843, non Gmelin, 1789; *Trochus subconus* Orbigny, 1852; *Zizyphinus punctatus* Conrad, 1868, non Reiner, 1814, or Sowerby, 1818; *Calliostoma suffolkense* Olsson, 1916; *Calliostoma conradi* Gardner, 1948). Shell fairly small, rounded; umbilicus narrow, deep; apical angle 87 degrees. Sculpture of 15 to 20 fine spiral lines on the slopes and 20 or more on the base, coarsening at the suture and umbilicus. Five to six convex whorls; suture slightly impressed. Zone 2, Isle of Wight and Southampton counties, Petersburg, Williamsburg, Yorktown, Hampton, and Chuckatuck. Height 9.8 mm, diameter 11.9 mm.

This is one of the Yorktown species everyone likes to name. Martin (1904) incorrectly synonomized *Zizyphinus punctatus* with the St. Marys species, *Calliostoma distans* (Conrad, 1862). Figure 230a is H. C. Lea's type specimen of *Trochus conus*. *Zizyphinus arenosus* Conrad, 1863, based on Emmons' (1858) Figure 168, may be this species, but it also resembles a young *Tegula exoluta*.

The *Calliostoma mitchelli* species group

Generally constant characteristics include the relatively large size, lack of umbilicus, apical angle of 70 degrees or less, three beaded lines on early whorls, with partial to complete beading of the spiral sculpture on the entire slope, no beading on the base, and an overhanging suture. Variable traits include the number and strength of spiral threads on the base and slopes; extent of beading; and absolute size attained. *Calliostoma mitchelli* has page priority over *Calliostoma philanthropus*, the best known (and most misidentified) member of the group. The numerous, seemingly distinct typological species contained within this group are here treated as subspecies, but may be only local phenotypes. Only one subspecies is typically found at any given locality. Outside the study area, two additional forms have been described: *Calliostoma mitchelli eliminatum* Dall, 1892, a low-spired form from the Duplin of North Carolina; and *Calliostoma mitchelli pontoni* Mansfield, 1930, a flat-sided form with weak sculpture from the Jackson Bluff Formation of northwest Florida.

KEY TO THE YORKTOWN *Calliostoma mitchelli* SPECIES GROUP

1 a apical angle less than 60 degrees..... *C. m. johnsoni*
  b apical angle greater than 60 degrees..... 2
2 a maximum height exceeding 30 mm ..... *C. m. conradianum*
  b height less than 30 mm 3
3 a both peripheral cords beaded ..... *C. m. mitchelli*
  b peripheral beading on one cord or lacking .. 4
4 a weak basal sculpture ..... *C. m. philanthropus*
  b strong basal sculpture ..... *C. m. basicum*

231. *Calliostoma mitchelli mitchelli* (Conrad, 1834). Shell of moderate size, conic; apical angle 70 degrees. All major spiral cords on whorl slope strongly beaded; base with seven or eight strong, smooth spiral cords. Both peripheral carinae beaded. Zone 2, Isle of Wight County and Chuckatuck. Height 23 mm, diameter 23 mm.

232. *Calliostoma mitchelli basicum* Dall, 1892 (Possible synonyms:*Trochus torquatus* H. C. Lea, 1843 *nomen dubium*; *T. ruffinii* H. C. Lea, 1843 *nomen dubium*). Shell of moderate size, conic; apical angle 69 degrees. Spiral sculpture with finer and more numerous beads on the primary cords than in *C. m. mitchelli*; secondary spirals weakly beaded or smooth. Upper peripheral carina beaded, lower carina smooth. Base with weak to strong cords. Zone 2, Isle of Wight County, Petersburg, Yorktown, Williamsburg, Hampton, Chesapeake and Chuckatuck. Height 15.4 mm; diameter 14.5 mm.

Torchus torquatus H. C. Lea is a juvenile shell with characteristic basal sculpture, but the dorsal surface is heavily abraded and nondiagnostic. *T. ruffinii* H. C. Lea, a fragment of a larger shell, lacks the apex and body whorls. The supposed alternate beaded and smooth spirals are more apparent in Gardner's retouched photograph (1948: pl. 26, fig. 18) than in the type. Although probably an earlier designation for this subspecies, *T. ruffinii* should be considered a dubious name because the type lacks basal sculpture and other diagnostic features.

233. *Calliostoma mitchelli conradianum* Dall, 1892. Shell very large for genus, conic, thin; apical angle 70 degrees. Sculpture as in *C. m. philanthropus*. This taxon differs from other members of the group in its gigantic size. In his original description Dall postulated this form to be a deep water ecomorph, paralleling a size trend shown by certain Recent species. If this size explanation is correct, Dall's presumed Petersburg (nearshore) locality is unlikely. Zone 2, Hampton at Rice's Pit, and Chesapeake. Height 43 mm, diameter 44 mm.

234. *Calliostoma mitchelli johnsoni* Campbell, new subspecies. Shell of moderate size, conic; apical angle 56 degrees. No umbilicus. Two smooth nuclear whorls; five postnuclear whorls, slopes with three heavily beaded spiral cords per whorl. Body whorl with two additional beaded secondary spiral threads, one just below the subsutural cord and one below the major peripheral cord. Major peripheral cord faintly grooved. Base with six strong, narrow, smooth cords and wide interspaces. Zone 1, Williamsburg. Type locality: Tutters Neck Pond spillway, just east of Williamsburg, James City County, Virginia. Height 12 mm, diameter 11.4 mm.

C. m. johnsoni differs from other members of this group in its more acute apical angle, reduced number of basal cords, and coarse beading.

Etymology: named in recognition of Gerald H. Johnson's contribution to Virginia Coastal Plain studies.

235. *Calliostoma mitchelli philanthropus* (Conrad, 1834). Shell of moderate size, conic; apical angle 74 degrees. Slope sculpture of finely beaded, thin spiral threads, 8 on body whorl, with wide interspaces. Subsutural thread coarser and more strongly beaded. Basal sculpture of 12 to 14 very low spiral lines and threads. Zone 2, Williamsburg, Smithfield, Chuckatuck, Yorktown and Hampton. Height 19 mm, diameter 19 mm.

236. *Calliostoma nottowayense* Gardner, 1948. Shell medium to small; conic, apical angle 82 degrees. Suture constricted, well-impressed; 6 rounded whorls. Sculpture of about 12 strong, flattened, unbeaded cords on slopes and numerous finer basal threads. Zone 2, Southampton County and Chesapeake. Height 9.3 mm, diameter 11.1 mm. Gardner (1948:186) compared this species with *C. harrisii* Dall, 1892 which has much finer sculpture and lacks the constricted suture.

237. *Calliostoma shacklefordensis* Olsson, 1916 (Synonym: *C. (Eutrochus) shackelfordensis* Olsson, 1916 [typographical error]). "Shell of moderate size, depressed, with flat upper whorls, a conic spire and flattened base; periphery with 2 prominent carinae, grooved between; umbilicus small; whorls about 5, the 1st probably smooth, the 2nd and 3rd with 3, 4 or 5 raised, subequal spirals; on the later whorls, the spirals become low and irregular, and assume the appearance of impressed lines; on the 4th whorl, these spiral lines are crowded close to the surture (sic) and to the periphery, and with a smooth area between; on the last whorl, the whole space is covered with fine, even spirals; suture deep, excavated, the whorls coiling on the lower carina; the suture is bordered in front by a raised line which is either smooth or beaded; on the last whorl, this sutural line is made up of 3 spirals, similar to those covering the rest of the surface of the whorls; base flattened with impressed spirals, small and regular on the area bordering the periphery, few, coarse and groove-like around the umbilicus; mouth subovate. Greater diameter 9, height 7 mm.

"This species may be compared with *C. cyclus* Dall, which it resembles in shape and general characters, but it differs from that species in its manner of coiling. In *C. cyclus*, the sutures are closely appressed, the coiling being along the lower carina, thereby producing a deep, excavated suture. Miocene: Shackleford, Virginia" (Olsson, 1916: 140-141).

This species has not been reported by subsequent workers. The old marl pit, probably the source of Olsson's material, has Zone 1 spoil including *Chesapecten jeffersonius* (Say, 1824). However, pre-Yorktown strata are also found nearby. Zone 1, Shackleford.

Calliostoma virginicum SPECIES GROUP

A number of morphotypes appear more or less related to *C. virginicum*. These rare shells invite typological rather than population analysis. Constant traits are hard to find, but apical angles of 80 to 85 degrees and small size (maximum diameter 10 to 12 mm) are characteristic. Typically the periphery is grooved between two lines or carinae and the sculpture is beaded, but exceptions exist. Mansfield (1930) compared the west Florida Pliocene *C. aluminum* Dall, 1892, with this group, but I have reservations about such placement. Parodiz (1977:101) erected a new subgenus, *Tropidotrocus*, with *C. virginicum* as the type.

KEY TO THE YORKTOWN *C. virginicum* SPECIES GROUP

1 a Periphery ungrooved, spiral sculpture very fine . . . . . *C.v. harrisii*
  b Periphery grooved 2
2 a Some spiral threads beaded 5
  b No spiral threads beaded 3
3 a Peripheral carinae weak . . . . . *C. v. gizehi*
  b Peripheral carinae strong 4
4 a Spirals below subsutural cord fine to very fine . . . . . *C. v. virginicum*
  b 2 strong spiral cords below subsutural cord . . . . . *C. v. carolinensis*
  c 3 strong spiral cords below subsutural cord . . . . . *C. v. harrisianum*
5 a Only one subsutural cord beaded . *C. v. jeffersonius*
  b 2 or more subsutural cords beaded .*C. v. hertfordensis*

238. *Calliostoma virginicum virginicum* (Conrad, 1873) (Synonym: *Calliostoma* (*Tropidotrochus*) *jayae* Parodiz, 1977). Shell small, conic; apical angle 80 degrees. Whorls flat between carinae. Slope sculpture of fine to coarse spiral lines with a subsutural carina. At periphery, a prominent double carinae is separated by deep channel. Basal sculpture of strong, commonly paired, spiral cords; no umbilicus. Dall's 1892 figured Yorktown specimen had an unusually acute angle (72 degrees), or was misdrawn. Zone 2, Chuckatuck, Williamsburg and Hampton. Height 13 mm; diameter 13.5 mm.

Parodiz (1977) erected a new subgenus *Tropidotrochus*, for *C. virginicum*. and added a species, *C. jayae*. However this Rice's pit specimen appears to be only a coarsely sculptured variation.

238b. *Calliostoma virginicum carolinensis* Gardner, 1948. Shell size small, conic; apical angle 85 degrees. Peripheral carinae separated by prominent channel. Slope sculptured by a strong subsutural cord above 2 equally strong, equispaced spiral cords with smooth interspaces. 7 to 8 flat, heavy spiral cords on base. No umbilicus. Zone 2, Martin County, NC. Height 9.8 mm; diameter 11.2 mm. See Appendix I.

239. *Calliostoma virginicum gizehi* Gardner, 1948. Shell of moderate size, conic; apical angle 83 degrees. Dorsal sculpture of 10 to 12 fine to obsolete spiral lines slightly stronger just below suture and at periphery. Very shallow peripheral channel. Numerous spiral basal threads, coarser near umbilical depression. Zone 2, Yorktown and Chesapeake. Height 9.2 mm, diameter 10.5 mm.

240. *Calliostoma virginicum harrisianum* Olsson 1916. "Shell of usual size, conic, with straight-sided whorls, and a narrow grooved periphery; base flattened or only slightly convex; whorls 5, separated by deep, excavated sutures; upper surface of whorls with 2 heavy, raised spirals, one bordering the suture, the other at the periphery; the space between these 2 primary spirals may be granulated or smooth, and the peripheral carina is frequently double; base flattened, imperforate, and strongly sculptured with 6 or 7 smoothish spirals which are wider than their interspaces; mouth subovate, oblique. Greater diameter 7.5 mm; height 6.5 mm.

"A well-marked species known at present only from Kingmills (sic). Related to *C. virginicum*. Yorktown formation; Kingmills (sic), Virginia" (Olsson, 1916:139).

This form has not been recovered by subsequent workers. The shell differs from *C. v. carolinensis* in having 3 rather than 2 strong cords between the subsutural and peripheral carinae. Zone 1, Kingsmill, James City County.

241. *Calliostoma virginicum harrisii* Dall, 1892. Shell of moderate size, conic; apical angle 82 degrees; no umbilicus. Periphery ungrooved, angular. Dorsal sculpture of very fine, spiral lines; base with very fine spiral lines coarsening near umbilical pit. Zone 1, Bellefield, York County. Height 10.4 mm, diameter 11.6 mm.

241c. *Calliostoma virginicum hertfordense* Gardner, 1948. Shell fairly small, conic; apical angle 85 degrees. Peripheral carinae smooth; very shallow peripheral groove; dorsal sculpture of 5 spiral threads, outermost being more prominent and beaded. 8 basal spiral cords. Not yet reported from Virginia. Zone 1?, Murfreesboro, Hertford County, NC. Height 7.3 mm, diameter 8.8 mm.

242. *Calliostoma virginicum jeffersonium* Campbell, new subspecies. Shell small, conic; apical angle 84 degrees. non-umbilicate. Dorsal sculpture variable; subsutural spiral thread prominent, with weak beading; remaining spiral sculpture smooth. Twin peripheral carinae moderate to very prominent, separated by a deep, narrow to broad groove or channel. 6 to 10 secondary spiral lines and threads between subsutural thread and upper carina. Base flattened, with a deep groove marking limit of lower peripheral carinae; strong spiral subperipheral cord formed by 1 to 3 coalesced threads; 2 additional cords mark umbilical area; intervening basal sculpture of fine, commonly paired, spiral lines.

Etymology: the subspecific name alludes to the association of this form with *Chesapecten jeffersonius* (Say), a common index species to Zone 1 faunas. Zone 1, Williamsburg. Type locality: spillway of Tutters Neck pond, just east of Williamsburg, James City County, Virginia. Height (incomplete) 7 mm, diameter 9 mm.

Genus *Tegula* Lesson, 1835

"Shells medium-sized, variously colored, globose to conic in form, and smooth to strongly ribbed, always with a tooth at the base of the columella" (Keen, 1971:335).

Subgenus *Agathistoma* Olsson and Harbison, 1953

"Small to medium-sized shells, with spiral sculpture, open umbilicus, base of columella with one to three denticles, the largest at the termination of a strong spiral cord bordering or passing into the umbilical cavity" (Keen, 1971: 337).

243. *Tegula exoluta* (Conrad, 1843) (Synonyms: *Trochus exolutus* Conrad, 1843; possibly *Monodonta kiawahensis* Tuomey and Holmes, 1856; *Trochus* sp. Emmons, 1858; *Monilia exoluta* Conrad, 1863; ? *Turbo heliciformis* Heilprin, 1886; *Chlorostoma* (*Omphalius*) *exoletum* Dall, 1892 (unnecessary emmendation);? *Chlorostoma* (*Omphalius*) *exoletum limatulum* Dall, 1892; *Chlorostoma* (*Omphalius*)

exolutum (Conrad) Gardner, 1947). Shell of medium size, trochoid, domed; whorls well-rounded. Umbilicus narrow, very deep. Sculpture of numerous low spiral lines with wider interspaces. Aperture round, with a strong denticle at the base of the inner lip. Zone 2, *Chama* bed at Williamsburg. Height 12 mm, diameter 13.5 mm.

Some Pinecrest *Tegula exoluta* from south Florida preserve a color pattern with numerous spiral lines of dark brown dashes superimposed on a light brown shell with narrow, white, radiating flammules.

Tegula heliciformis and *T. exoletum limatulum* Dall, 1892 are both late Oligocene to early Miocene taxa synonymized with *T. exoluta* by Dall, 1892. Comparisons with type material have not been made, but the time gap between the older taxa and the Pliocene *T. exoluta* make the synonymies somewhat doubtful.

Subfamily Gibbulinae

Genus *Gibbula* Risso, 1826

Small, often brightly colored, turbinate shells with variable sculpture; aperture nacreous within.

244. *Gibbula rustica* (H. C. Lea, 1843) (Synonyms: ?*Turbo caperatus* Conrad, 1834; *Gibbula americana* Dall, 1892; *Gibbula americana yorktownensis* Gardner, 1948). Shell very small, turbinate, nacreous; suture finely channeled. Whorls rounded, 4 to 6. Umbilicus narrow, deep, unsculptured. Body whorl with dorsal and basal sculpture of 15 to 20 strong spiral cords with 1 to 3 narrower spiral threads in each interspace. Radial sculpture of very fine, oblique lines which may become obsolete on coarser spirals. Zone 2, Petersburg, Yorktown, Hampton, Chuckatuck and Smithfield. Height 4.5 mm; diameter 4.7 mm.

Family Skeneidae

Genus *Skenea* Fleming, 1825

Minute planorbid to naticoid shells with a smooth dorsal surface. Base smooth or sculptured. Umbilicus narrow, very deep.

245. *Skenea harrisi* (Olsson, 1916) (Synonym: *Cithna pilsbry* Richards, 1947). Shell minute, naticoid; 2 to 3 well-rounded whorls; suture distinct, impressed. Dorsal suface smooth, or with faint growth lines. Base with spiral grooves, strong at umbilicus, becoming obsolete towards periphery; basal spiral sculpture crossed by 15 to 20 radially incised lines. Aperture round, with internal opercular shield. Zone 2, Williamsburg, Smithfield, Hampton, Chuckatuck and Chesapeake; probably ubiquitous. Height 1.0 mm, diameter 1.0 mm.

246. *Skenea smithfieldensis* (Olsson, 1916). Shell minute, naticoid; 2 to 3 well-rounded whorls; suture distinct, impressed. Dorsal surface smooth, or with faint growth lines. Base with spiral grooves becoming obsolete towards periphery. Radial sculpture lacking. Aperture round, with internal shelf. Zone 2, Williamsburg, Smithfield, Hampton, Chuckatuck and Chesapeake; probably ubiquitous. Height 0.75 mm, diameter 1.00 mm. This species is proportionally lower than, and lacks the basal radial sculpture of *S. harrisi*.

247. *Skenea yorktownensis* Campbell, new species. Shell minute, though large for genus; naticoid; umbilicus narrow and very deep. Suture finely impressed. Three well-rounded, smooth whorls. Surface with fine frosting visible under high magnification. Outer shell layer rather friable, especially around umbilicus. Dorsal and basal sculpture of rather rough growth lines only. Aperture round, with internal opercular shelf. Zone 2, Williamsburg, Chuckatuck, and Chesapeake. Type locality: Deep Creek Pit, end of Cookes Mill Road, 2 miles west of Deep Creek, Chesapeake, Virginia. Height 1.62 mm, diameter 1.64 mm.

Etymology: named for the Yorktown Formation.

Genus *Leptogyra* Bush, 1897

"Minute, deepsea, planorboid shells with rounded whorls, round aperture and deep rounded umbilicus. Operculum horny" (Abbott, 1974:57).

247a. *Leptogyra davidi* Campbell, new species. Shell minute, naticoid, exceedingly thin and fragile. Spire depressed. Sculpture of exceedingly fine spiral striations. Aperture large, circular, entire. Umbilicus narrow, very deep. Zone 2, Chesapeake. Type locality: Deep Creek Pit, end of Cookes Mill Road, 2 miles west of Deep Creek, Chesapeake, Virginia. Diameter 1.34 mm.

Etymology: named for my son, David Campbell, a frequent and skilled field companion.

Family Pelycidiidae

Genus *Pelycidion* Fisher, 1873

(Synonym: *Nannoteretispira* Habe, 1961).
Minute, high spired, cylindrical shells with circular, projecting apertures.

247b *Pelycidion matthewi* Campbell, new species. Shell minute, elongate-pupoid, cylindrical, smooth. Whorls 5; protoconch large, well-rounded. Suture well indented on initial whorls, becoming progressively less so with continued growth. Aperture circular, entire. Final half whorl detached. Zone 2, Chesapeake. Type locality: Deep Creek Pit, end of Cookes Mill Road, 2 miles west of Deep Creek, Chesapeake, Virginia. Length 1.50 mm.

P. megalomastomus (Olsson and McGinty, 1958), the only described Recent Western Atlantic species is equally small, but has a faint subsutural line, distinctly more rounded whorls, and a less detached body whorl. *Pelycidion matthewi* has also been found in middle Pliocene deposits at the Berkeley Quarry, Cross, SC.

Etymology: named in honor of Matthew Campbell, my son and skilled field companion.

Another as yet undescribed species from the South Carolina Duplin fauna shows faint spiral sculpture.

Family Liotiidae

Genus *Arene* H. and A. Adams, 1856

"Small to minute, with variegated color patterns; spiral cords beaded or fluted into short spines, umbilicus deep, the umbilical wall with one or more spiral cords; suture descend-

ing in the last whorl, lip usually thickened. Inner surface of the operculum with a glossy corneous layer, outer surface concave, studded with beads in a radiating pattern, scanty bristles at the outer edge" (Keen, 1971:345).

248. *Arene* sp. Shell minute, turbinate, deply umbilicate. Whorls tabulate. Sculpture of three spiral cords and crowded axial threads, obsolete in juvenile shells. Zone 2, Chuckatuck and Chesapeake. Diameter 1.71 mm. This small form recalls the Recent *A. tricarinata* (Stearns, 1872), but the single Yorktown specimen is subadult, hence not assigned to species.

248a. *Arene tuomeyi* Campbell, new species. Shell small, trochoid, thin but solid. Spire depressed. Whorls 4 1/2, suture vertically impressed. Periphery with three narrow keels crossed by numerous coarse axial riblets. Diameter 9.21 mm. Zone 2, Chesapeake. Type locality: Deep Creek Pit, end of Cookes Mill Road, 2 miles west of Deep Creek, Chesapeake, Virginia.

This species was at first confused with *Trochus gemma* Tuomey and Holmes, 1856 (Synonym: *Liotia (Arene) major* Gardner and Aldrich, 1919). *Trochus gemma* is a *Solariella* with sculpture convergent with *Arene tuomeyi*. However, the former is higher spired, height and width being approximately equal. *A. tuomeyi* is more depressed. *A. tuomeyi* is also found in the Waccamaw beds at Calabash, NC.

Etymology: named for Michael Tuomey who supplied Yorktown material to H. C. Lea.

Superfamily Littorinacea
Family Littorinidae

Genus *Littorina* Ferussac, 1822

Shells medium-sized, solid, naticoid to elongate, smooth or with spiral cords. Intertidal snails that are rarely encountered in Yorktown faunules.

249. *Littorina irrorata* (Say, 1822) (Synonyms: *Littorina carolinensis* Conrad, 1862 [1863], *L. lineata* Emmons, 1858). Shell of medium size, heavy, conic; spire acute. Nonumbilicate. Aperture circular. Sculpture of deeply incised, even spiral lines.

Gardner (1948: 192) recorded this common Recent species from the Yorktown bluffs. This species has not been subsequently found in Yorktown strata, but it is a common Pleistocene fossil in the area. Zone 2, Yorktown. Recent specimens reach a height of 22 mm.

Superfamily Rissoacea
Family Rissoidae
Subfamily Rissoinae

Genus *Alvania* Monterosato, 1884

Minute, trochoid rissoids with cancellate sculpture.

250.*Alvania lipeus* (Dall, 1892). Shell minute, broad, conic. Protoconch of two to three large, smooth whorls. Postnuclear whorls sculptured with four strong spiral cords crossed by finer, widely spaced axial threads. Microsculpture of uniformly fine spiral lines in interspaces. Base with three to four spiral threads. Umbilicus a narrow, comma-shaped chink. Aperture oval. Zone 2, Chuckatuck, Hampton and Chesapeake. Height 0.89 mm, diameter 0.69 mm.

Dall (1892: 339) recorded this species as also living in the Bahamas, but I can find no other Recent reference, nor does this species appear conspecific with any other Recent species.

Genus *Cingula* Fleming, 1828

"Extremely small shells, conic-ovate; aperture round, peristome complete; whorls moderately rounded. Smooth or with weak spiral sulpture. Nuclear whorls smooth. Umbilicus slitlike" (Abbott, 1974: 74).

251. *Cingula geraea* (Dall, 1892) (Synonym: *C. g. minor* (Dall, 1892)). Shell fairly small, elongate; aperture oval, narrowing posteriorly. Five to six rounded whorls; suture impressed. Umbilicus a narrow chink. Sculpture of spiral cords which coarsen on the base. Zone 2, Chuckatuck. Height 2.94 mm, diameter 1.54 mm.

252. *Cingula* sp. Shell minute, fragile, (immature?) Three gently rounded whorls. Surface smooth; base with fine spiral lines, very narrow interspaces. Umbilicus a very narrow chink. Aperture chipped, oval; outer lip thin. Zone 2, Chuckatuck. Height 1.40 mm.

This unique specimen does not appear to be a juvenile of *C. geraea*, but more material must be found before formal description is feasible.

Genus *Rissoina* Orbigny, 1840

Slender, very small shells with weak to prominent axial sculpture and, in some species, weak spiral sculpture. Aperture large, oblique, spatulate; outer lip commonly flaring.

253. *Rissoina* sp., cf. *R. striatocostata* Orbigny, 1842. Shell very small, elongate, nonumbilicate. Three smooth nuclear and five postnuclear rounded whorls. Suture impressed. Axial sculpture of subequal narrow ribs with wide interspaces; ribs form at suture and rise a little above it. Spiral sculpture of fine lines which cross axial ribs, becoming stronger on base. Aperture oval, narrowing posteriorly to a constricted posterior notch. Outer lip flaring, with prominent varix. Zone 2 Chuckatuck. Height 3.03 mm, diameter 1.09 mm.

Family Vitrinellidae
Subfamily Vitrinellinae

Genus *Vitrinella* C. B. Adams, 1852

Minute, flattened, discoidal shells; widely umbilicate; surface smooth or with weak spiral sculpture; aperture oblique.

254. *Vitrinella lipara* (H. C. Lea, 1843) (Synonym: not *Vitrinella lipara* Lea of Martin, 1904). Shell minute, flattened, discoidal, polished, smooth. Three to five whorls tightly coiled; well-rounded periphery. Umbilicus wide, exposing penultimate coiling. Zone 2, Petersburg, Williamsburg, Yorktown, Hampton, Chuckatuck and Chesapeake; Chowan River, Chesapeake. Diameter about 2 mm. Resembles *Cochliolipis virginica* Pilsbry, 1953, a larger, snail with a more open coil and a wider umbilicus. The shell

figured by Martin (1904) from the Maryland Miocene is apparently an undescribed species.

Genus *Aorotrema* Schwengel and McGinty, 1942
"With two strong keels; sculpture pitted; umbilicus present" (Keen, 1971:379).

255. *Aorotrema cistronium* (Dall, 1889) (Synonym: *Adeorbis* sp. Emmons, 1858). Shell very small, nearly as high as broad, tabulate, with very striking form. Whorls three, high, rapidly descending, with two very prominent spiral keels. Apex covered with coarser, crowded spiral threads. Umbilicus wide, deep, funnel-shaped. This species can be mistaken for no other. Zone 2, Chuckatuck, very rare. Height 1.3 mm, diameter 2.5 mm.

Genus Circulus Jeffreys, 1865
"Shell small, thin, circular, depressed, with a wide and deep umbilicus. Nucleus transparent, smooth, 2 whorls. Outer lip not stepped forward at the top. Upper edge of outer lip serrate. Sculpture of strong spiral threads" (Abbott, 1974:83-84). Radial sculpture obsolete or absent.

256. *Circulus costulatus* (H. C. Lea, 1843). Shell small, flattened, discoidal. Three to four whorls; well-rounded periphery. Umbilicus wide, deep, showing the coiling of two earlier whorls. Sculpture of 20 to 25 even spiral threads uniformly distributed over spire, periphery, base and umbilical wall. Aperture an even circle. Zone 2, Petersburg, WIlliamsburg, Yorktown, Hampton, Chuckatuck and Chesapeake. Chowan River, Chesapeake. Height 1.63 mm, diameter 3.36 mm.

C. costulatus is probably ancestral to *C. liratus* (Verrill, 1882), a Pleistocene and Recent form with fewer, coarser spiral threads on the spire, and a large smooth area on the base.

Genus *Cyclostremiscus* Pilsbry and Olsson, 1945
"Lenticular, with several spiral keels and weaker axial ribs" (Keen, 1971:379).

257. *Cyclostremiscus obliquestriatus* (H. C. Lea, 1843). Shell minute, discoidal, flattened. Four whorls. Prominent ventral peripheral keel. Umbilicus wide, exposing penultimate whorl. Nuclear whorls smooth; postnuclear whorls with strong radial undulations (18 on penultimate whorl) on spire, periphery and base, becoming obsolete on last half of body whorl. Dorsal and ventral peripheral area with strong oblique spiral threads which converge on keel. Zone 1, Middlesex County and Williamsburg; Zone 2, Petersburg, Williamsburg, Hampton and Chuckatuck. Height 1.20 mm, diameter 2.52 mm.

Related forms include *C. greensboroense* (Martin, 1904) with finer sculpture from the Maryland Miocene, and *C. undula* (Dall, 1896) in which the radial undulations are fewer and stronger. The latter is found in the Virginian Chowan River fauna where some specimens seem to merge back towards its ancestral *C. obliquestriatus* form.

258. *Cyclostremiscus pseudaeorbis* (Dall, 1892). "Shell small, solid, with four rounded whorls, a rather depressed spire and generally *Adeorbis*-like form; whorls slightly impressed in front of distinct suture, rounded at the periphery; sculpture of numerous fine, sharp grooves with wider rounded interspaces, tending to be feeble on the periphery and more distant on the base near the umbilicus, but otherwise rather uniform over the shell; these are crossed by fine, incremental striae, giving a somewhat punctate aspect to the grooves; base flattish, moderately rounded, the umbilical margin smooth, and evenly rounded over, umbilicus narrow, deep, somewhat scalar; aperture wider than high, oblique, the pillar-lip not differentiated, but thickened; the body with a moderate callus connecting the lips" (Dall, 1892:417). Zone 2, very rare, Yorktown and Williamsburg. Height 2.5 mm, diameter 5.0 mm.

259. *Cyclostremiscus schmidti* (Olsson, 1916) (Synonym: *Circulus gunteri* Mansfield, 1930). Shell minute, very depressed, discoidal, thin. Nuclear whorls elevated, pointed; postnuclear whorls flattened above and below. Umbilicus wide. Sculpture of crowded, fine spiral lines; periphery marked by strong keels at base and shoulder. Some specimens may show a varix above the outer lip, or at a resting stage. Zone 2, very rare, Chuckatuck and Smithfield. Height 0.75 mm, diameter 1.75 mm.

260. *Cyclostremiscus undula* Dall 1896. Shell minute, like *C. obliquestriatus* (H. C. Lea, 1843), but with coarser sculpture, especially the radial undulations. This form appears descended from, and may be only a subspecies of *C. obliquestriatus*. Chowan River, Chesapeake. Height 0.91 mm, diameter 1.78 mm.

Genus *Parviturboides* Pilsbry and McGinty, 1950
Minute, naticoid shells with numerous spiral lines or threads. Axial sculpture weak or wanting.

261. *Parviturboides* sp. Shell minute, broadly turbinate, thin, 3 1/2 rather loosely coiled whorls. Umbilicus a very narrow chink. Sculpture of spiral threads over entire shell, coarsening on base. Zone 2, Williamsburg, Chuckatuck and Chesapeake. Height 0.66 mm, diameter 0.83 mm.

Genus *Didianema* Woodring, 1928
Minute shell with a heavy ridge bordering umbilicus; opercular shelf inside aperture.

262. *Didianema carolinae* Gardner, 1948. Shell minute, solid, naticoid. Three smooth whorls. Aperture circular. with internal opercular shelf. Umbilicus narrow, deep; bordered by a heavy umbilical rige. Base with short radial ribs along outer edge of ridge. Chowan River, Chesapeake. Height 1.03 mm, diameter 1.15 mm. *Didianema* species from the underlying Yorktown beds has a larger shell with a narrower umbilicus and without radial basal sculpture.

263. *Didianema* sp. Shell minute, solid, polished, smooth; naticoid. Umbilicus narrow, bordered by a sturdy spiral ridge. Three well-rounded whorls; suture vertically impressed. Zone 2, Williamsburg. Height 1.43 mm, diameter 1.58 mm. This species is closest to *D. carolinae* Gardner, 1948, but that species is fifty percent smaller and has radial

crinkling on the base.

Genus *Solariorbis* Conrad, 1865

"Depressed, spirally striate to smooth, umbilicus with a spiral ridge ending in a lobe on inner lip" (Keen, 1971:382).

264. *Solariorbis variabilis* (Olsson, 1914). "Shell small, solid, rather depressed, but with a slightly pointed spire; umbilicated; whorls 4, enlarging uniformly; periphery of last whorl slightly angulated; suture impressed; sculpture variable, consisting of simple riblets, crossed by oblique, spiral striae, persistent; in some cases the riblets may also continue over a larger portion of the later whorls than usual; base of shell strongly sculptured, the riblets being here persistent; in old shells a gerontic stage is introduced, coming after a resting stage, and this is characterized by an entire lack of sculpture; aperture rounded or slightly oblique, and with the edge bordering the umbilicus thickened; umbilicus deep, not bordered by a ridge or carina. Greater diameter 2; height 1 mm.

"This species is characterized by its variability. From *Teinostoma undula* Dall and *T. greensboroense*, both now *Cyclostremiscus*, the species may be distinguished by its lack of the carina which occurs on the periphery of those shells. It is probable that H. C. Lea's *Delphinula obliquestriata* belongs to this genus. This last mentioned species has the radiating ribs divided into 2 or 3 branches near the periphery, with the umbilicus bordered by a slight, carinated line. Yorktown formation: Yorktown, Virginia" (Olsson, 1914: 48-49). Zone 2, Yorktown and Petersburg.

265. *Solariorbis yadkinensis* Campbell, new species. Shell minute, depressed. discoidal, solid. Two smooth nuclear whorls and one and one-quarter sculptured postnuclear whorls. Spire slightly domed; suture distinct, somewhat impressed, bordered by a spiral ridge and subsutural groove. Dorsal sculpture complex; about 35 strong radial ribs per whorl arise at the suture and cross the inner one-third of the upper whorl area before abruptly ending; interspaces narrow with faint spiral grooves. Dorsal central portion of whorl smooth with traces of exceedingly faint spiral lines. Basal sculpture similarly patterned; periphery with incised spiral lines. Umbilicus narrow, deep; with crowded radial ribs extending over inner third of base. No other closely comparable species is known. Rare in the Chowan River beds at Chesapeake. Type locality: Deep Creek Pit, end of Cookes Mill Road, 2 miles west of Deep Creek, Chesapeake, Virginia, in the upper, or *Anadara* biofaces. Height 0.68 mm, diameter 1.29 mm.

Subfamily Teinostomatinae

Genus *Teinostoma* A. Adams, 1851

Shell minute, solid, smooth, polished; discoidal, domed, or rarely naticoid in form. Body whorl may partially or completely overlap spire. Keel present in some species. Umbilicus present in juvenile stages, filled with callus in adult forms. Weak spiral and peripheral axial sculpture rarely present.

266. *Teinostoma alexanderi* (Olsson, 1914). "Shell small, solid, porcellaneous; spire low and rounded; whorls 3, the 1st turn small. the others much larger; suture distinct between later whorls, indistinct between the earlier, generally with an impressed area in front; surface smooth, polished with fine incremental growth lines; mouth round, with a heavy calloused columella, behind which is a small umbilical chink; the umbilicus is faintly outlined by a small spiral line. Greater diameter 2.25, height 1.50 mm.

"This species is related to the recent shells, placed by Dall in the genus *Ethalia*, namely *reclusa*, *suppressa* and *solida*, all of Dall, and in order to associate the Miocene species with those shells, I am referring it to the genus *Ethalia* rather than to *Teinostoma*. These two genera have long been incorrectly used judging from their respective types.

"Named for C. P. Alexander of the 2nd Ecphora trip.

"Duplin formation; Natural Well, N.C. Yorktown formation; James River, north of Smithfield, Virginia" (Olsson, 1914:142-3).

Gardner's figure (1948:pl. 25, figs. 12-4) of *T. alexanderi* from Waccamaw strata differs in form from Olsson's Duplin type, partly due to different inclinations of the illustrated specimens. Olsson's taxon has a tabulate spire, but Gardner's shell is domed. The Waccamaw form is also found in the Chowan River beds in Chesapeake. This younger form may be a separate species, but more specimens are needed for comparison. Zone 2, Smithfield and Chesapeake; Chowan River, Chesapeake.

267. *Teinostoma bushi* (Olsson, 1916) (Synonym: *T. smikron* Gardner, 1948; ?*T. vortex* Dall, 1892). Shell minute, extremely compressed discoidal, polished. 3 1/2 whorls; distinct suture vertically impressed. Umbilical callus thin, often showing a central pit. Sides and base with numerous (50-60) oblique, low, radial ribs.

The unique type of *T. vortex*, which Dall described as crushed before it could be figured, cannot now be identified with certainty and should be considered a *nomen dubium*. Olsson's figure is inadequate, but his description well matches that of Gardner's *T. smikron*. Zone 2, Williamsburg and Chuckatuck. Diameter 1.72 mm.

268. *Teinostoma goniogyrus* Pilsbry and McGinty, 1945 (Synonym: *Rotella carinata* H. C. Lea, 1843 non *R. carinata* Orbigny, 1842). Shell very small, solid, smooth, polished. Spire domed. Suture forming an open spiral, subsutural line very close to suture. Prominent peripheral keel. Base low, with heavy umbilical callus. Zone 2, Petersburg, Williamsburg, Chuckatuck, Hampton, Chesapeake, Smithfield and Suffolk. Height 0.68 mm, diameter 1.55 mm.

269. *Teinostoma beaufortensis* Ward and Blackwelder, 1987. Shell small, smooth, polished, solid. 3 1/2 whorls; earlier whorls flattened, body whorl rapidly descending, with a distinct angle at the change of slope. Suture distinct, not impressed. Periphery well-rounded. Aperture round, oblique. Base with heavy umbilical callus. This form may be identical with the Recent *Teinostoma megastoma* (C. B. Adams, 1850). Zone 2, Chuckatuck. Height 1.8 mm, diameter 2.4 mm.

270. *Teinostoma lenticlare* (H. C. Lea, 1843). Shell very

small, solid, polished. Spire domed. Suture forms an open spiral. Peripheral keel very low. Zone 2, ubiquitous. Height 1.1 mm, diameter 1.8 mm.

T. lenticlare has more tightly coiled whorls, proportionally higher shell, and weaker keel than *T.goniogyrus*.

271. *Teinostoma nana* (I. Lea, 1833) (Synonym: *Rotella umbilicata* H. C. Lea of Martin 1904, not of H. C. Lea, 1843). Shell minute, smooth, solid, polished. 3 to 3 1/2 whorls well-rounded dorsally. Spire tabulate; suture is an open spiral; subsutural line faint or lacking. Periphery rounded, no keel. Base with small umbilical plug. Zone 1, Middlesex County; Zone 2, Chuckatuck, Smithfield and Chesapeake. Height 0.54 mm, diameter 0.90 mm.

This smallest of Yorktown Teinostomas can be recognized by its lack of a keel and by its faintly tabulate spire.

272. *Teinostoma subconica* (H. C. Lea, 1843). Shell very small, naticoid; smooth, polished. Spire elevated; suture slightly impressed. 3 whorls. Umbilicus covered by flaring inner lip; umbilical ridge lacking. The covered umbilicus separates this form from *Skenea* and *Didianema* species. Zone 2, Petersburg, Chuckatuck and Chesapeake. Height 1.19 mm, diameter 1.17 mm.

273. *Teinostoma umbilicata* (H. C. Lea, 1843) (Synonym: *T. cryptospira* Verrill, 1884). Shell very small, smooth, discoidal, polished. Spire low, domed; body whorl nearly or completely overlapping spire so that suture is reduced to an exceedingly tight spiral or to a single curved line. Periphery well-rounded. Base with large umbilical callus. Zone 2, Petersburg, Williamsburg, Hampton, Chuckatuck, Smithfield and Chesapeake. Height 1.31 mm, diameter 2.21 mm.

Pilsbry (1953:416) noted that the Yorktown and Recent species probably represented a single taxon.

274. *Teinostoma virginica* Campbell, new species. Shell very small, smooth, polished. 3 1/2 whorls. Spire very depressed, nearly flat; body whorl rapidly enlarging, partially overlapping earlier whorls. Suture a tight spiral; subsutural area concave, depressed. Periphery rounded. Base smooth, flattened; umbilical plug depresed. Aperture oblique, circular. This species is unusualy large and depressed for the genus. Zone 2, Williamsburg. Type locality: stream cut behind Carey Field, William and Mary campus. Height 0.78 mm, diameter 2.12 mm.

Etymology: named for the state of Virginia.

Genus *Macromphalina* Cossman, 1888

"Small, apex smooth, pointed, set at an angle to later whorls, usually brown in color; body whorl rapidly enlarging" (Keen, 1971:454).

275. *Macromphalina aperta* (H. C. Lea, 1843) (Synonym: *Macromphalina* sp. Gardner, 1948). Shell minute, thin, fragile. Three whorls rapidly increasing in size. Spire tabulate; suture impressed. Aperture very large, oblique. Umbilicus wide, deep, funnel-shaped. Sculpture of even, finely incised spiral lines over entire shell; rather coarse radial growth lines on base. Zone 2, Petersburg, Chuckatuck and Smithfield. Height 1.28 mm, diameter 1.57 mm.

276. *Macromphalina chuckatuckensis* Campbell, new species. Shell very small, thin, smooth, fragile. Two and a half very rapidly expanding whorls; nuclear whorl elevated, forming a pointed apex; postnuclear whorls low, domed; suture slightly impressed. Umbilicus large, deep, funnel-shaped. Aperture very large, oblique, fractured in the only specimen. Sculpture of radial growth lines only. No other Neogene *Macromphalina* combines such large size with a lack of sculpture. Zone 2, Chuckatuck. Type locality: upper bed, west wall of former Lone Star Industries pit, Chuckatuck, Virginia. Height 2.12 mm, diameter 4.20 mm.

Etymology: named for the village of Chuckatuck.

Genus *Cochliolepis* Stimpson, 1858

Shell small to minute, very depressed, discoidal. Whorls radidly expanding; body whorl partially or completely covering spire. Aperture oblique, large. Widely umbilicate. Surface smooth and polished, or with axial growth lines or spiral lines and threads.

277. *Cochliolepis concava* (H. C. Lea, 1843) (Synonyms: *Delphianla arenosa* Conrad, 1846; *Trochus delphinuloides* d'Orbigny, 1852). Shell small, thin, exceedingly depressed. Four to 4 1/2 rapidly expanding whorls. Periphery rounded. Umbilicus very wide. Sculpture of growth lines and traces of very fine spiral lines. Zone 2, Petersburg, Williamsburg, Hampton and Chuckatuck. Height 2 mm, diameter 5 mm.

278. *Cochliolepis striata* Dall, 1889. Shell small, thin, exceedingly depressed. Four to 4 1/2 whorls; body whorl rapidly expanding, overlapping much of spire. Sculpture of numerous spiral threads which coarsen near suture. Chowan River, Chesapeake. Height 2.8 mm, diameter (fragment) 3.6 mm. Known in Virginia from this single broken specimen.

279. *Cochliolepis virginica* Pilsbry, 1953. Shell small, thin, exceedingly depressed. Smooth, polished; 3 1/2 whorls. Periphery round; umbilicus wide. Aperture large, very oblique. Zone 2, Petersburg and Chuckatuck. Height 2 mm, diameter 4.5 mm.

C. virginica has a more strongly oblique aperture and is larger overall than *Vitrinella lipara*, It is smaller, smoother and more tightly coiled than *C. concava*.

Superfamily Turritellacea
Family Caecidae

Genus *Caecum* Fleming, 1813

Minute shells. Spiral nuclear whorls planorboid, shed with growth as the shell uncoils to form a curved cylinder. Posterior end plugged with an apical plug which may be evenly rounded or with a small peg-like projection, the mucro. Ontogeny in this group of common meiofaunal gastropods is unusual. The coiled, planorboid protoconch is very commonly encountered while sorting foraminifera and ostracodes. Postnuclear stages are uncoiled, forming a gently curved tube. Four morphologic growth stages may be recognized:

1 coiled, planorboid protoconch, about 0.2 mm in diameter;

2 very narrow tube, occasionally with protoconch

attached; adult sculpture poorly developed;

3 subadult; tube often strongly curved or tapering; protoconch and early postnuclear tube broken off remaining tube; septum sometimes with a projection (mucro); adult sculpture and proportion becoming recognizable;

4 fully adult; tube diameter expanded, nearly uniform; sculpture characteristic; aperture may or may not be modified by thickening, constriction, or change in sculpture, depending upon the species.

Stages 1 and 2 are nearly impossible to identify specifically, and some caution must be used with stage 3. Only the adult stage can be identified with any confidence.

KEY TO VIRGINIA YORKTOWN *Caecum*

1a. Shell smooth 2
b. Shell sculptured 4
2a. Septum rounded, mucro absent or very weak . *C. johnsoni*
b. Septum depressed, mucro easily visible 3
3a. Shell small (3.5 mm long), mucro small . . *C. flemingi*
b. Shell large (5.7 mm long), mucro large . . *C. virginianum*
4a. Sculpture of annulations only 5
b. Sculpture of strong longitudinal ribs 6
5a. Annulations narrow, with slightly wider, rather deep interspaces; aperture constricted . . *C. pulchellum*
b. Annulations broad, with very shallow, narrow interspaces; aperture not constricted . . . *C. chuckatuckensis*
6a. Longitudinal sculpture obliquely spiraling around tube . . . . . *C. tortile*
b. Longitudinal sculpture parallels shell outline . 7
7a. 12 to 15 strong even ribs, wide interspaces. *C. cooperi*
b. 30 to 40 ribs alternating in strength; narrow interspaces . . . . . *C. stevensoni*

Subgenus *Caecum* s. s.

(Synonym: *Micranellum* Bartsch, 1920)
Small, well-curved cylinder with moderate to well-developed annulations.

280. *Caecum chuckatuckensis* Campbell, new species. (Possible synonym: *Caecum* sp. aff. *C. regulare* Carpenter of Mitchell-Tapping, 1978). Shell small, cylindrical, gently curved. Aperture not constricted or marked by change in sculpture. Septum rounded, with small, blunt macro. Sculpture of broad, even axial rings with very shallow, narrow interpaces. No longitudinal sculpture present. Zone 2, *Panopea* bed, Chuckatuck. Type locality: upper bed, west wall, former Lone Star Industries pit, Chuckatuck, Virginia. Length 3.95 mm, diameter 0.86 mm.

C. heladum Olsson and Harbison, 1953, most resembles this new species, but that taxon has adult apertural thickening, weak longitudinal striations, and a smaller mucro.

281. *Caecum pulchellum* Stimpson, 1851 (Synonyms: *C. annulatum* (Emmons, 1858); *C. conjunctum* Folin, 1867; *C. curtatum* Folin, 1867; *C. dux* Folin, 1871; *C. capitanum* Folin, 1874). Shell very small, cylindrical, gently curved. Aperture constricted. Septum low with small mucro. Sculpture of narrow, even axial rings; interspaces deep, as wide as rings; longitudinal sculpture lacking. Chowan River beds, Chesapeake. Length 2.16 mm, diameter 0.74 mm.

Subgenus *Elephantulum* Carpenter, 1857

(Synonym: *Elephantanellum* Bartsch, 1920; not *Elephantulus* Thomas and Schwann, 1906, Mammalia, Macroscelidea, African elephant shrews). Comparatively large caecids with dominant longitudinal sculpture of raised ribs. Juvenile shells commonly with cancellate sculpture.

282. *Caecum cooperi* S. Smith, 1862. Shell small, cylindrical, gently curved. Aperture not constricted. Septum nearly flat, with strongly projecting macro. Dominant longitudinal sculpture of 12 to 15 widely spaced ribs, and exceedingly fine striae in interspaces. Axial sculpture of incised lines which may be stronger at aperture. Juvenile sculpture evenly cancellate. Zone 2, ubiquitous. Length 3.91 mm, diameter 0.79 mm.

283. *Caecum stevensoni* Meyer, 1888. Shell small, cylindrical, gently curved. Aperture not constricted; marked by 2 or 3 incised axial lines. Remaining axial sculpture of growth lines only. Longitudinal sculpture of 30 to 40 ribs which alternate in strength; interspaces narrow. Septum flat, with short, pointed mucro. Zone 2, Yorktown and Suffolk; Chowan River, Chesapeake. Length 4.30 mm, diameter 0.90 mm.

284. *Caecum tortile* Dall, 1892. Shell small, cylindrical, gently curved. Aperture not constricted or marked by change in sculpture. Septum flat, with short, pointed macro. Longitudinal ribs flat, obliquely spiraling. Axial sculpture of growth lines only. Zone 2, Chuckatuck. Length 3.34 mm, diameter 0.86 mm.

Subgenus *Brochina* Gray, 1857

Small, smooth or very weakly sculptured shells. *Fartulum* Carpenter, 1857, differs in having a heavy periostracum, a feature lost during fossilization. Hence this assignment is arbitrary.

285. *Caecum flemingi* Gardner and Aldrich, 1919 (Synonym: *C. virginianum* Meyer of Gardner, 1948, not of Meyer, 1888). Shell very small, cylindrical, gently curved, smooth. Aperture slightly constricted in adult. Septum low, flat, with small, pointed mucro. Zone 2, Williamsburg, Hampton, Chuckatuck and Chesapeake; Chowan River, Chesapeake. Length 2.48 mm, diameter 0.58 mm.

286. *Caecum johnsoni* Winkley, 1901 (Synonyms: *C. putnamensis* Mansfield, 1924; ?*C. glabrum* Montagu of Meyer, 1888, and of Gardner, 1948, not of Montagu, 1808). Shell very small, cylindrical, gently curved, smooth. Aperture not constricted. Septum round, with no mucro. Zone 1, Middlesex County; Zone 2, ubiquitous; Chowan River, Chesapeake. Length 1.81 mm, diameter 0.48 mm.

The differences between *C. johnsoni* and *C. glabrum* are based on non-preservable soft tissues (Donald Moore, 1976, personal communication) so fossil designation is arbitrary. *C. beaufortensis* Ward and Blackwelder, 1987, may be a synonym, but at 3.3 mm in length, it is significantly larger.

287. *Caecum virginianum* Meyer, 1888. Shell large for genus, cylindrical, gently curved. Aperture not constricted. Shell smooth save for axial growth lines and irregularities. Septum flat, with very large, pointed mucro. Zone 2, Yorktown, Chuckatuck and Chesapeake. This largest of Yorktown caecums is rather rare. Length 5.65 mm, diameter 1.21 mm.

Family Turritellidae

Genus *Turritella* Lamarck, 1799

"Tightly coiled shells...among the most slender-spired of the gastropods. The shells are somewhat variable--even within the course of growth of one individual--in the expression of spiral ribs. Axial sculpture is weak. The aperture is round and is closed by a remarkable operculum...so flexible it may be withdrawn well within the shell...these are gregarious mollusks, tending to form large colonies" (Keen, 1971:391). True *Turritella* (*Turritella*) is a very large shell with very rounded whorls, deep sutures, and uniform spiral sculpture.

Subgenus *Torcula* Gray, 1847

Straight-sided Turitellas with uneven spiral sculpture.

288. *Turritella alticostata* Conrad, 1834 (Synonyms: *T. alticostata* Conrad, 1834, in part; *T. quadrastriata* Rogers and Rogers, 1837; *T. terebriformis* Dall, 1892, in part pl. LVII fig. 2 only; *T. alticostata* Conrad of Mansfield, 1944; *T. alticosta* Conrad of Richards, 1947; *T. alticostata* Conrad Gardner, 1948, pl. 27, fig. 17). Shell of medium size, elongate, tapered. Sculpture somewhat variable, of spiral threads and cords--the two largest cords, found immediately above and below the suture, are equal or subequal (if subequal the lower cord is stronger). Intervening sculpture of threads of various strength. Adult whorls may also add a thread or low cord just above suture. Suture broadly indented; unequal, lower above suture. Nuclear whorls somewhat constricted and nuclear sutures moderately constricted; protoconch small, with a thread between keel and basal suture; adult sculpture incipient on fourth whorl. Variable but rather narrow spire angle for first 10 to 15 mm of growth. Subsequent whorls expand more rapidly, so that juvenile shell has distinctly narrower outline than adult. Adult with brooded young reported from Rices Pit (Antil, 1974). Zone 2, ubiquitous. Length 50 mm.

Neogene *Turitella* are a very diverse group, showing both a wide range of morphologic variability and high stratigraphic and geographic endemism. More than one author, faced with this bewildering array of forms, has applied "*T. variabilis* Conrad, 1830" indiscriminately. Fortunately, Conrad's all encompassing taxon is preoccupied by *T. variablis* Defrance, 1828, and must be purged from our Pliocene literature.

T. alticostata was initially founded on three species. Conrad cited localities of James River, Virginia and Choptank River, Maryland, but labeled the syntypes "Virginia' thus eliminating the distinct Choptank form (figured by Martin, 1904). However all but one of the syntypes belong to a Yorktown Zone 1 indicator species subsequently named *T. terstriata* Rogers and Rogers, 1837. The remaining type (fig. 288) is a worn specimen compatible with the form Mansfield referred to *T. alticostata* and designated as indicative of the upper or Zone 2 Yorktown beds (his *T. alticostata* Zone). If the syntypes were coexistent, at least one species exceeded its supposed index zone, but abrasion of all syntypes suggests that Conrad collected reworked, river beach-strand material and the primary sources could have been stratigraphically distinct. For stability of the literature the syntype figured herein (288) should represent *T. alticostata* and is hereby designated as the lectotype. See further comparisons under *T. virginica* and *T. beaufortensis*.

289. *Turritella beaufortensis* Ward and Blackwelder, 1987. Shell of medium size, elongate, evenly tapered. Sculpture of spiral threads and cords; two cords incipient in juvenile whorls, becoming very strong on adult whorls; a third spiral cord develops just below suture. Intervening sculpture of low, subequal threads. Nuclear whorls somewhat inflated; nuclear sutures narrow, shallow; protoconch large, smooth; second and third whorls keeled; adult sculpture pattern incipient on fourth whorl. This species is apparently the Chowan River descent of *T. alticostata*, differing in nuclear character, in fine details of sculpture, in absolute size attained, and in less sutural constriction of adult whorls. Chowan River, Chesapeake. Length 80+ mm.

290. *Turritella virginica* Campbell, new species (Synonym: *Turritella variabilis* Conrad of authors (Virginia records), not of Conrad, 1830). Shell of medium size, elongate, evenly tapered. Sculpture of rather regular, even spiral cords, lower cord somewhat stronger on each whorl. Suture broadly indented, forming a very low, even "v"-shaped notch. Nuclear whorls rounded, inflated, pupoid, smooth; nuclear suture very narrow and shallow; keel absent; adult sculpture incipient on fourth whorl. Zone 2, ubiquitous; lower Chowan River, Chesapeake (reworked?). Length 25 mm. Type locality: Crane Lake, formerly the Lone Star Cement Company pit, Chuckatuck, City of Suffolk, Virginia.

This smallest of Yorktown turritellas has the largest spire angle and the only completely sculptureless nuclear whorls. Exceptional specimens preserve color pattern of rectangular dots arranged in axial rows. *T. virginica* from Chuckatuck consistently showed this same pattern under ultraviolet light, but *T. alticostata* from those same beds showed no fluorescent pattern.

Etymology: named for the state of Virginia.

291. *Turritella fluxionalis* Rogers and Rogers, 1837 (Synonyms: ?*T. carolinensis* Conrad, 1873; *T. duplinensis* Gardner and Aldrich, 1919). Shell of medium size, elongate, evenly tapered. Sculpture very regular, with 4 or 5 unequally spaced spiral threads. Interspaces with crowded, even, very finely raised spiral lines. Suture narrow, even. Nuclear whorls constricted; suture wide, very deep; protoconch small, smooth; second and third whorls prominently keeled. Zone 2, Williamsburg and Chuckatuck. Length 32 mm. This rare species is unfigured by Rogers and Rogers, but the distinctive and unique sculpture is exactingly described.

292. *Turritella bipertita* Conrad, 1844 (Synonyms: *T. pilsbryi* Gardner, 1918; *T. alumensis* Mansfield, 1930, Yorktown records only). Shell large, narrowly tapered,

heavy. Juvenile sculpture of three symmetrically placed spiral cords; adult sculpture generally of four spiral cords on lower(anterior) half of whorl. Finer sculpture of spiral threads. Nuclear whorls keeled as in *T. alticostata*. This largest of Yorktown turritellas is a useful index fossil. Zone 1, ubiquitous. Length > 110 mm.

Gardner (1948) stated that *T. pilsbryi* closely resembled *T. alumensis* Mansfield, but differs in having three rather than two major cords on the early whorls. Mansfield's (1930) reference to Yorktown specimens close to *T. alumensis* are likely *T. bipertita*. The juvenile stages of *T. bipertita* also resemble adult *T. etiwanensis* Tuomey and Holmes, 1856, from the Carolina Duplin faunas. However the Duplin shell never attains the size of *T. bipertita* and differs in adult patterns of ribbing.

293. *Turritella terstriata* Rogers and Rogers, 1837 (Synonym: *T. alticostata* Conrad, 1834, in part, see above; not *Turritella terstriata* Rogers and Rogers of Petuch, 1988). Shell of medium size, elongate, narrowly tapered. Sculpture of spiral cords and threads; center of whorl with deeply sulcate constriction. Nuclear whorls unknown. Zone 1, King and Queen County, Williamsburg, and "James River".

Gardner(1948:198) stated that the type of *T. terstriata* was housed in the Boston Society of Natural History collection. This suite was subsequently moved to the Museum of Comparative Zoology at Harvard University. Dr. Ruth Turner kindly had a search made for this and other Rogers and Rogers types, but no Yorktown material could be located (1980).

___. *Turritella terebriformis* Dall, 1892. See Appendix II.

___. *Turritella variabilis* Conrad, 1830 (Synonym: not *T. variabilis* Defrance, 1828). No specimens of this Miocene species, properly restricted, have been found in the Yorktown Formation, but many past and current authors have applied this name indiscriminately to any of the several valid Yorktown species, especially to *T. alticostata* or *T. virginica*. See Appendix II.

___. *Turritella plebia carinata* Gardner, 1948 (Synonym: not *T. carinata* I. Lea, 1833). Shell small, elongate, fairly fragile. Whorls 10+, very round; sutures strongly constricted.

Gardner questioned the single Yorktown Zone 2 report of this pre-Yorktown species. I concur that the "Suffolk" label is an error if Yorktown age beds are intended. See Appendix II.

Superfamily Architectonicacea
Family Architectonicidae

Genus *Architectonica* Roding, 1798

"Generally low-spired shells, trochoid in outline, sculptured with spiral ribs that may be evenly beaded...umbilicus bounded by a beaded ridge; operculum flat and few-whorled"(Keen, 1971:388).

295. *Architectonica nobilis* Roding, 1798 (Synonym: *Solarium granulatum* Lamarck, 1816). Shell of moderate size, trochiform, solid; spire low; periphery sharply keeled. Sculpture of flat spiral cords regularly intersected by radial grooves on base and spire. Umbilicus deep, broad, bordered by a row of coarse denticles. Zone 2, Williamsburg and Chuckatuck. Diameter 10 mm.

This species is known from two Yorktown localities where it is present in some numbers, but these specimens are consistently smaller than specimens from Duplin and Recent populations.

Genus *Pseudotorinia* Sacco, 1892

Small, flat spired, nearly planorbid architectonids with circular aperatures. Spiral sculpture dominating.

296. *Pseudotorinia nupera* (Conrad, 1834). Shell small, nearly planspiral, solid; spire flat or low-domed; periphery well-rounded. Suture narrow, vertically impressed. Sculpture of spiral threads and cords regularly cut by radial grooves; largest and most coarsely denticulate spirals just below suture and bordering umbilicus. Umbilicus wide, deep, with earlier whorls plainly visible. Zone 1, Middlesex County; Zone 2, Southampton County, Williamsburg, Yorktown, Hampton, Chuckatuck, Smithfield and Chesapeake. Diameter 12 mm.

Family Vermetidae

Genus *Petaloconchus* H. C. Lea, 1843

"The worm gastropods are among the most puzzling of shells. It is a moderately large shell, attached only in the early stages, the coiling being rather regular, in the form of a hollow cylinder ending in one long and nearly straight turn. Inside, in the medial whorls, there is a complex structure called a spiral lamina--two or more spiral calcareous plates that diverge from the columella or hang down from the upper margin of the tube" (Keen, 1971:400-3).

297. *Petaloconchus sculpturatus* H. C. Lea, 1843 (Synonyms: *Serpula anguina* H. C. Lea, 1843; *P. domingensis* Sowerby, 1849; *Vermetus pulcher* Bose, 1906). This genotypic species is well-described by Keen's quotation. Coiling regular for 30 to 40 mm, unless individuals are crowded into intertwining colonies. However, older growth often departs from the coiling pattern and grows randomly. This free-growing tube is often broken off, leaving an illusion of regular coiling not true of the living adult. The nuclear whorls are smooth, turritelliform, and apparently free-crawling. Early postnuclear stages require attachment to a solid substrate, but mature stages were again free-growing or at least free standing. It was apparently susceptible to silting, as it is rarely found in fine-grained sediments. Zone 2, Petersburg, Wiliamsburg, Yorktown, Chuckatuck, Smithfield and Chesapeake. Length 38 mm.

Olsson (1922) suggested conspecificity with the Caribbean Neogene species. H. C. Lea's *Serpula anguina* shows the turritelliform protoconch and early growth typical of *Petaloconchus*.

Genus *Serpulorbis* Sassi, 1827

Large, loosely coiling worm-snails with scaley or granular sculpture.

298. *Serpulorbis granifera* (Say, 1824) (Synonyms: *Serpula granifera* Say, 1824, non Konig, 1825; *Serpula convoluta* H. C. Lea, 1843; *Vermetus virginica* Conrad of Roberts, 1932, not Conrad, 1839; *Anguinella virginiana* (Conrad) of Whitfield, 1894, not of Conrad, 1845). Shell moderate to large, irregularly and loosely coiled. Sculpture of coarse granulations. Whorls thin, circular in cross-section; attached throughout their entire length. Zone 2, Hampton, Smithfield, Suffolk, Chuckatuck; Southampton and Isle of Wight counties. Maximum diameter 47 mm.

Tubes are ocasionally found broken with nestling bivalves growing inside. The species was silt tolerant and is most commonly found attached to larger shells or corals in silty-sand sediments. H. C. Lea's *Serpula convoluta* is a juvenile specimen.

Superfamily Cerithiacea
Family Cerithiidae

Genus *Bittium* Gray, 1847

"Sturdy small shells with nodose sculpture; aperture with only a slight anterior notch, not a canal"(Keen, 1971:413).

299. *Bittium curtum* (H. C. Lea, 1843) (Synonym: *Cerithium curtum* H. C. Lea, 1843, non Sowerby, 1855). Shell very small, elongate, narrow, evenly tapered. Aperture round; columella without folds. Sculpture of prominent spiral threads and cords, and highly variable axial ribs or riblets. Nuclear whorls smooth, small, dextral. Zone 2, Petersburg, Willioamsburg, Chuckatuck and Chesapeake. Length 3.415 mm.

This small species is abundant at Petersburg and Williamsburg associated with estuarine taxa and may be used as a near-shore indicator. It is rarely encountered in offshore faunas. The axial sculpture may be completely lacking, may weakly ripple the spirals, or may predominate over the spirals. The latter morphotype resembles certain odostomias, however true odostomias have columellar folds and a sinistral nuclear whorl.

Genus *Cerithiopsis* Forbes and Hanley, 1851

Elongate, very small, high spired shells resembling minature Terebras, but with more coarse axial and spiral sculpture.

300. *Cerithiopsis smithfieldensis* Olsson, 1916 Shell very small, narrow, elongate, pupoid; 3 to 4 smooth nuclear whorls. Sculpture of 3 spiral beaded cords, 14 beads per cord on body whorl. Body whorl constricted. Aperture small, rectangular; canal very short, straight. Zone 2, Williamsburg, Hampton, Chuckatuck, Smithfield and Chesapeake. Length 2.29 mm.

This species may be ancestral to the Recent *C. greeni* (C. B. Adams, 1839). The Yorktown form is consistently smaller and more slender.

Subgenus *Laskeya* Iredale, 1918

(Synonym: *Eumeta* Morch, 1868, not *Eumeta* Walker, 1855) "*Laskeya* differs from *Cerithiopsis* in the shorter, more obtuse nucleus, the more tesselate sculpture and, usually, in the more elevated and slender outline" (Gardner, 1948:204).

301. *Cerithiopsis bicolor* (C. B. Adams, 1845) (Synonyms: *Cerithiopsis emersoni* of authors, fossil and southern records, not of C. B. Adams, 1838; *Cerithium bicostatum* Emmons, 1858, not of Piette, 1855; *Cerithiopsis emersoni persubulata* Gardner, 1948; *C. subulata* Montagu of authors, not of Montagu, 1808). Shell small, narrow, elongate, evenly tapered. Sculpture of beaded spiral cords above and below suture, with a weaker-beaded spiral in between. Aperture rectangular; canal short, obliquely recurved. Zone 2, Yorktown, Hampton, Chuckatuck and Chesapeake. Length 6.92 mm.

Gardner (1948) erected the subspecies *persubulata* to distinguish a slightly narrower southern race. Lyons (1989) also notes that the more southern shell is a separate species, but argues that the oldest name is *C. bicolor*. The Yorktown fossils are indistinguishable from Recent Carolinian shells.

Subgenus *Metaxia* Monterosato, 1884

"Slender, columnar, sculpture nodose, whorls inflated, suture indented" (Keen, 1971:415).

302. *Cerithiopsis* sp. Shell small, very narrow, elongate; sides subparallel. Suture wide, distinctly constricted. Sculpture of three spiral, coarsely beaded threads. Aperture round; canal short, straight. Zone 2, Chesapeake. Length 3.47 mm.

Recent Western Atlantic *Metaxia* include *C. metaxae* Della Chiaje, 1829, *C. m. taeniolata* Dall, 1889, *C. abruptum* Watson, 1880, *C. exile* (C. B. Adams, 1850) and *C. rugulosum* (C. B. Adams, 1850). The Yorktown fossil is distinct from the latter three, but I lack comparative material and illustrations of the genotype and its subspecies.

Genus *Seila* A. Adams, 1861

Small, slender, high spired shells with very strong, keel-like spiral ribs and weaker axial lines best developed in the interspaces.

303. *Seila adamsii* (H. C. Lea, 1845) (Synonyms: *Cerithium terebralis* C. B. Adams, 1840, non Lamarck, 1804; *C. clavulum* H. C. Lea, 1843, non Eudes-Deslongchamps, 1842; *C. adamsii H. C. Lea, 1845;* C. terebellum C. B. Adams, 1850, non Gmelin, 1790; *C. annulatum* Emmons, 1858, non Zekel, 1852; *Terebra clavula* (H. C. Lea of Meek, 1864; *C. subclavulus* Orbigny, 1852). Shell usually small, narrow, elongate, evenly tapered. Sculpture of three even spiral ridges, four on body whorl; interspaces wide, deep, with very fine axial lines. Aperture rectangular; canal short, straight. Zone 1, Williamsburg; Zone 2, ubiquitous. Height 16 mm.

Family Triphoridae
Subfamily Triphorinae

Genus *Triphora* Blainville, 1828

Small to very small, sinistral cerithids resembling *Cerithiopsis*.

304. *Triphora bartschi* (Olsson, 1916). Shell small, sinistral, narrow, elongate, tapered. Two smooth nuclear whorls. Postnuclear sculpture of three subequal spiral rows of rounded

beads. Aperture circular; canal slightly recurved. Zone 2, Smithfield, Chuckatuck, Williamsburg, Hampton and Chesapeake. Length 4.06 mm.

305. *Triphora submonilifera* (Orbigny, 1852) (Synonyms: *Cerithium moniliferum* H. C. Lea, 1843, non Deshayes, 1833; *Triforia melanura* Adams of Dall, 1892 and of Clark and MIller, 1912, not of C. B. Adams, 1850: *T. dupliniana* (Olsson, 1916). Shell small, sinistral, narrow, elongate, tapered. Five nuclear whorls, with fine reticulate sculpture. Postnuclear sculpture initially of two spiral rows of beads; with continued growth a central thread is added, becoming beaded with further growth. Aperture rectangular; outer lip spatulate, broadly rounded, with a narrow, deep anal notch at suture. Three smooth basal costae. Zone 2, Williamsburg, Smithfield, Chuckatuck and Chesapeake. Length 5.905 mm.

Dall (1892:264) synonymized *T. submonilifera* with the Recent *T. melanura*. Comparing fossil and recent specimens, I find that the protoconchs are very similar, but the recent *Triphora* has finer sculpture, its third spiral rib is incipient on the third postnuclear whorl rather than on the sixth as in the fossil form, and it is proportionally more slender with straighter sides.

Superfamily Epitoniacea
Family Epitoniidae

Genus *Opalia* H. and A. Adams, 1853

"Axial sculpture of strong ribs, but not of regular and laminar costae;; spiral sculpture various. Outer lip thickened by the last rib" (Keen, 1971:38).

306. *Opalia textuvestitum* (Maury, 1917). Shell small, high-spired, solid. Whorls 6+, early whorls missing. Shell surface friable. Axial sculpture of about 16 low. oblique, undulatory, sinuous ribs. Entire surface overlain with a cancellate network of coarse axial and spiral lines of equal strength. Interspaces pitted. Aperture oval. Zone 2, Hampton. Height 11+ mm (incomplete). Illustrated specimen from the Rob Dillon collection.

Genus *Epitonium* Roding, 1798

"Spiral stair-case shells have a classic beauty of form...the shells are mostly slender and conical, of numerous whorls, with a round aperture and regular axial ribs or costae...interspaces smooth or only weakly sculptured" (Keen, 1971:421,423).

The Western Atlantic wentletraps have proliferated into a bewildering array of species, a trend already established by Yorktown time. It is not surprising that similar morphologies are found among the 12 Yorktown and 40+ Recent Carolinian and Caribbean species. Some, like *Epitonium fractum* Dall, 1927, are morphotypically indistinguishable, yet Recent populations of this species are restricted to water depths far greater than any reasonably postulated for Pliocene bathymetry.

Subgenus *Epitonium* Roding, 1798

Spiral sculpture lacking.

307. *Epitonium bolteni* Gardner, 1948. Shell small, slender, elevated, smooth. Whorls convex, well-rounded. Costae low, narrow, simple (without spinose projections), eight on body whorl. Zone 2, Williamsburg and Chuckatuck. Height of holotype 8.5 mm.

Gardner (1948) compared this species with the recent *E. sayana* (Dall, 1889) (synonym of *E. humphreysi* (Kiener, 1838)), a larger, stouter form with heavier costae. However, the fossil form is much closer to *E. tollini* Bartsch, 1938, from West Florida, differing primarily in having lower, less prominent costae. *E. bolteni* is probably the species most responsible for the occasional report of *E. sayana* from Neogeme faunas.

308. *Epitonium cornigerum* (H. C. Lea, 1843) (Synonym: *E. robesonense* Gardner, 1948). Shell small, fairly slender, elevated. Whorls 10+, rounded, loosely coiled; suture very deep. Costae thin, prominent, 9-10 per whorl, with a triangular projection at the shoulder. Juvenile shells, such as Lea's holotype, are more spiny than mature specimens. This is one of the most elegant of the Yorktown molluscs. Zone 2, Petersburg, Williamsburg, Chuckatuck and Hampton. Height 10 mm.

309. *Epitonium edgecombense* Gardner, 1948. Shell small, fairly slender, elevated. Whorls 8+, rounded; suture fairly deep. Costae thin, prominent, 14-16 per whorl, slightly tabulated at shoulder. Zone 2, Chuckatuck. Height 6.19 mm.

310. *Epitonium fractum* Dall, 1927. Shell fairly small, slender, elongate. Whorls 10+, well-rounded, somewhat compressed. Costae prominent, very thin, 16-18 per whorl; costae reflected posteriorly with a small, posteriorly reflected triangular spine at shoulder. Zone 2, Hampton. Height 10-12 mm.

Recent *E. fractum* are deep water shells with slightly more open coiling than the fossils, but the morphologies are very close. This shell is also similar to *E. smithfieldensis* Mansfield, 1929 but that species is larger and has less regular, more distantly spaced costae.

311. *Epitonium sheldoni* (Olsson, 1916). Shell fairly small, slender. Whorls 6+, sutire impressed. Costae 10 to 12 per whorl, rather thick, with narrower interspaces. Costae composed of many thin, used lamellae. *E. sheldoni* is smaller and has distinctly thicker costae than the Zone 2 *E. smithfieldensis* Mansfield, its probable descendent. Height 8-10 mm.

312. *Epitonium smithfieldensis* Mansfield, 1929 (Synonym: *Epitonium suffolkensis* (sic) Mansfield of Campbell and others, 1975, a lapse). Shell fairly small, slender, thin. Whorls 10+, rounded; suture impressed. Costae 12-14 per whorl, thin, prominent, composed of many very thin, weakly fused, irregular lamellae, giving the costae a ragged appearance. Zone 2, Suffolk, Chuckatuck and Smithfield. Height 15-18 mm.

313. *Epitonium druidi* Campbell, new species. Shell very small, narrow, elongate. Nuclear whorls smooth; six or

seven postnuclear whorls; 18-20 very low, narrow costae per whorl. Interspaces wide, smooth; aperture broken. This specimen was first compared with *E. unifasciatum* (Sowery, 1844) but that species is larger, relatively broader, with fewer and stronger varices. Zone 2, Chuckatuck and Chesapeake. Height 4.25 mm.

Etymology: named for Druid Wilson in recognition of the aid and support he has provided this project.

314. *Epitonium* various species. Fragments of various worn *Epitonium* have been found in the Chowan River beds in Chesapeake, but none are specifically identifiable.

Subgenus *Gyroscala* deBoury, 1887

With a distinct basal cord or ridge.

315. *Epitonium aciculum* (H. C. Lea, 1843) (Synonyms: *Scala lineata* Say, of Clark and Miller, 1912, not Say, 1822; *E. pratti* Gardner, 1948). Shell large for genus, relatively broad, elongate. 12+ well-rounded, inflated whorls; suture narrowly impressed. Costae narrow, low, lamellar, of variable strength and number, 16-25 per whorl. Spiral sculpture of weakly impressed incised lines and a single basal thread or cord. Aperture obliquely oval. Zone 1, Williamsburg; Zone 2, Petersburg, Williamsburg, Yorktown, Hampton, Smithfield, Chuckatuck, Suffolk and Chesapeake. Height 15 mm.

This species resembles *Epitonium rupicolum* (Kurtz, 1860), but is larger and has more regular costae.

316. *Epitonium microstomum* (H. C. Lea, 1843). Shell very small, relatively stout, elongate. Whorls 7+; suture impressed. Thin costae prominent, evenly rounded, 10 per whorl. Basal rib strong, crossed by axial costae. Zone 2, Petersburg, Chuckatuck and Hampton. Height 6 mm (holotype).

Subgenus *Asperiscala* deBoury, 1909

"With spiral sculpture between axial costae"(Keen, 1971:424).

317. *Epitonium chuckatuckensis* Campbell, new species. Shell minute, slender, elevated. Whorls well-rounded, four smooth nuclear and four postnuclear; suture deeply impressed. Axial costae thin, prominent, 14-16 per whorl. Spiral threads strong, 14-16 per whorl; secondary sculpture absent. Zone 2, Chuckatuck. Type locality: *Panopea* bed at Crane Lake, Chuckatuck, Virginia. Height 2.08 mm.

This minute species recalls the Recent *E. candeanum* (Orbigny, 1842) but the fossil shell is smaller, narrower, has fewer and lower costae and has more spiral threads per whorl.

Etymology: named for the type locality.

318. *Epitonium duplinianum* (Olsson, 1916) (Synonyms: *Scalaria clathrus* Linnaeus of Emmons, 1858, not of Linnaeus, 1758; *Epitonium delandensis* Mansfield, 1918; *Epitonium antillarum* (deBoury) [a synonym of *Epitonium candeanum* (Orbigny, 1842)] of Gardner, 1948 and Olsson and Harbison, 1953, not of DeBoury, 1909; *Epitonium sohli* Ward and Blackwelder, 1987; *Epitonium greenlandicum* (Perry) Paschall, 1988, not of Perry, 1811, [North Carolina specimen only-Georgia specimen is an Eocene taxon]). Shell of moderate size, slender, elongate. Suture impressed; 8+ well-rounded whorls. Costae low, heavy, lamellar, 10-13 per whorl, with small posteriorly projecting hook just below suture. Primary spiral sculpture of numerous strong threads, becoming obsolete just below suture. Secondary sculpture of exceedingly fine axial and spiral lines which reticulate the surface. Zone 1, Williamsburg; Zone 2, Williamsburg and Chuckatuck. Length 12 mm.

Many Neogene systemists have assigned this distinct species to one or another of the synonyms of the Recent *E. candeanum* (see Gardner, 1948:207), but that shell is half the size, has more numerous costae, and more crowded primary spirals. *E. duplinianum* more closely resembles *E. novangeliae* (Couthouy, 1838) and *E. championii* Clench and Turner, 1953. *E. novangeliae* is larger, with more prominent costae, and with a hook or spine at the shoulder rather than just below the suture; and *E. championii* has heavier primary sculpture and lacks the secondary reticulation.

319. *Epitonium micropleurum* (H. C. Lea, 1843) (Possible synonym: *E. turriculum* Sowerby, 1847, non Cantraine, 1842 of Mansfield, 1930). Shell very small to minute, very slender, elongate. Smooth nuclear and postnuclear whorls well-rounded; suture shallowly impressed. Axial costae narrow, low, evenly rounded, 26-28 per whorl. Spiral threads even, subequal, producing a cancellate pattern. Zone 2, Petersburg, Chuckatuck and Chesapeake. Height 4.48 mm.

This small, elegant species was at first referred to *E. junceum* Gardner, 1948, which it resembles in size, shape, and in the prominence and crowding of the costae. However Gardner's species lacks the spiral sculpture and the axial costae are even more crowded than on *E, micropleurum.*

320. *Epitonium novangeliae* (Couthouy, 1838) (Synonym: *E. uncinaticosta* (Orbigny, 1842)). Shell fairly large for genus, loosely coiled, fairly slender, elevated. Axial costae thin, prominent, 9-16 per whorl; with a posteriorly reflected triangular spine at shoulder. Spiral threads between costae strong over lower half of whorl, becoming obsolete above. Secondary sculpture of fine axial and spiral lines which reticulate the surface. Zone 2, Hampton. Height about 30 mm.

320a. *Epitonium alumensis* Mansfield, 1930. Shell small, high-spired, thin, rather fragile. Whorls 8+, periphery sharply angular in earlier whorls, becoming more rounded with subsequent growth. Axial sculpture of 20 very low, undulatory ribs per whorl. Costae on last half of body whorl stronger, more widely spaced. Spiral sculpture of microscopic striae and a strong basal cord. Aperture large, obliquely oval, with a strong varix on outer lip. Zone 2, Hampton. Height 10 mm. *E. alumensis* was based on an imperfect juvenile from West Florida. Dr. Robert Dillon's discovery of a Yorktown specimen at Rice's Pit allows the adult morphology to be described and figured for the first time.

Suborder Gymnoglossa
Family Melanellidae

Genus *Melanella* Bowdich, 1822

(Synonyms: *Balcis* Gray, 1847; *Eulima* Risso, 1826) Shell small, smooth, "ovate-conic, aperture ovate, not markedly pointed...inner lip smoothly appressed to body whorl" (Keen, 1971:443,445).

321. *Melanella arcuata* C. B. Adams, 1850. Shell minute, smooth, polished. Body whorl evenly rounded. Vertical axis distinctly curved. Zone 2, Chuckatuck. Height 1.84 mm.

322. *Melanella chesapeakensis* Campbell, new species. Shell small, smooth, heavy, relatively broad, tapered, elongate. Flat whorls slightly constricted below suture, overhung by preceeding whorl to give a "Christmas tree" outline. Suture distinct, faintly impressed; aperture oblique. Inner lip joined to columella by a heavy parietal callus. Outer lip sinuate, broadly spatulate. Chowan River beds at Chesapeake. Type locality: Deep Creek pit, end of Cookes MIll Road, 2 miles west of Deep Creek, Chesapeake, Virginia. Height 6.10 mm.

No other Western Atlantic Neogene melanellid species is as stocky and solid as this small species. I am not completely satisfied with the generic or even familial placement. It may belong near *Rissoina*, especially near *Zebina*.

Etymology: named for the City of Chesapeake.

323. *Melanella angulata* (H. C. Lea, 1843) (Synonyms: *Actaeon angulatus* H. C. Lea, 1843; ?*Melanella conoidea* Kurtz and Stimpson, 1851; ?*Eulima alba* Calkins, 1878). Shell small, elongate, polished, smooth. Whorls flat, suture indistinct; sides straight or slightly concave. Body whorl with a distinct angulation at periphery. Zone 2, Wiliamsburg, Hampton, Suffolk, Smithfield and Chesapeake. Height 3.32 mm.

William Lyons (1984, 1991, personal communication) notes that the Recent *Melanella conoidea* is the male morphology of a protandous hemaphrodite, the adult, female shell morphology being commonly but incorrectly assigned to *Melanella intermedia* (Cantraine), a European species. The Yorktown *M. angulata* and the Recent *M. conoidea* are morphologically indistinguishable. However, if *M. angulata* was the male form of the adult female *M. laevigata*, the latter averages more slender than the "*M. intermedia*" females. Detailed morphometric studies are needed to settle these problems.

324. *Melanella laevigata* (H. C. Lea, 1843) (Synonyms: *M. eborea* (Conrad, 1846); *M. bartschi* Gardner and Aldrich, 1919; not *Eulima laevigata* Morris and Lycett, 1854). Shell fairly small, elongate, tapering, polished, smooth. Suture indistinct; 12-14 nearly flat whorls very slightly sinuate; nuclear whorls relatively constricted. Body whorl evenly rounded with no angulation. Aperture relatively narrow,oblique. Outer lip smooth, weakly spatulate. Zone 2, ubiquitous. Height 10.5 mm.

Lea's type is missing the body whorl, but I have compared his type specimen with typical *M. eborea* and there is little doubt concerning its identity. Gardner (1948) retained her *M. bartschi* by applying "*M. eborea*" to a stouter form here assigned to *M. nisoformis* Olsson and Harbison, 1953.

Conrad's 1846 figure and the type of *M. laevigata* are both of the more slender morphotype. *M. laevigata* is the largest and most common *Melanella* in the Yorktown faunules. It is possibly the female equivalent of *M. angulatus* (see above).

325. *Melanella nisoformis* (Olsson and Harbison, 1953) (Synonym: *Strombiformis eborea* Conrad, of Gardner, 1948, not of Conrad, 1846). Shell fairly small, relatively broad, evenly tapered, smooth, polished. 8+ nearly flat whorls increasing rapidly in diameter; suture distinct, weakly impressed; sides straight, even. Body whorl with weak angulation at periphery. Aperture wide, somewhat rectangular. Zone 2, Chuckatuck. Height 9 mm.

Genus *Strombiformis* da Costa, 1778

"Shell very slender, the aperture long and pointed above. Because these are small shells and sculpture must be studied under a microscope, detailed treatment will not be given here" (Keen, 1971:443).

326. *Strombiformis conchits* Olsson and Harbison, 1953. Shell minute, slender; whorls 7-8, slightly rounded. Zone 2, Chuckatuck, Smithfield, and Chesapeake. Height 3.1 mm. Juveniles of the larger melanellid species have fewer whorls at 3 mm. The slightly rounded whorls are diagnostic.

327. *Strombiformis migrans* (Conrad, 1846) (Synonyms: *Eulima subulata* Emmons, 1858, non Brocci, 1814 or Chaije, 1830; *S. dalli* Gardner and Aldrich, 1919, in part, Carolina records; *S. leonensis* Mansfield, 1930; *S. l. harveyensis* Mansfield, 1930). Shell small, exceedingly slender, evenly tapered, smooth, polished. Whorls 10+, nearly flat; suture indistinct; sides straight, even. Body whorl very elongate, evenly rounded. Zone 2, Williamsburg, Hampton, Chuckatuck, Suffolk, Smithfield and Chesapeake. Height 8.5 mm.

Gardner fixed the type of *S. dalli* on a Caloosahatchee (Pliocene) specimen while recognizing Duplin and Yorktown populations. These latter populations belong to *S. migrans*, but the Florida type has a slightly different aspect and I hesitate to synonymize it.

Genus *Niso* Risso, 1826

"Slender, base widely and deeply umbilicate; color markings in spiral bands present on most species...whorls flat, smoothly tapering" (Keen, 1971:448).

328. *Niso aeglees* Bush, 1885 (Synonyms: *N. gunteri* Mansfield, 1930; *N. dalli* Gardner, 1948; *N. lineata* (Conrad) of Heilprin, 1884, not of Conrad, 1841). Small and proportionally slender, especially at apex. Chestnut-brown peripheral band bordered by lighter areas; suture channeled. Body whorl angled at periphery; umbilicus broad, funnel-shaped. Zone 2, Chuckatuck (single minute juvenile recovered). Height (typical) 21 mm, diameter 9 mm.

Longchaeus suturalis (H. C. Lea, 1843), a common Yorktown pyramidellid, is similar in size, general outline, and in having an umbilicus. It can be confused with *Niso*

species. However Nisoes have a circular aperture and lack the collumellar plications found in *Longchaeus*.

Family Stiliferidae

Genus *Mucronalia* A. Adams, 1862

"Shells small, white, smooth, globose last whorl, attenuated apex. Aperture oval-elongate" (Abbott, 1974:130).

329. *Mucronalia* sp. Shell small, smooth, polished, elongate. Whorls 8, rounded, nuclear whorls rapidly expanding, becoming less convex. Body whorl more than half of total length, evenly rounded; aperture oblique, oval, constricted above. Zone 2, Chesapeake. Height 3.39 mm.

Superfamily Atlantacea
Family Atlantacea

Genus *Atlanta* Lesueur, 1817

"Shell small, fragile, discoidal, transparent-white, compressed. Protoconch dextral" (Abbott, 1974:133).

330. *Atlanta cordiformis* Gabb, 1873. Shell minute, planorboid, very compressed, smooth, exceedingly fragile. Periphery with single prominent keel. Aperture with deep slit at periphery of outer lip. Zone 2, Hampton and Chesapeake. Diameter 2.05 mm.

This fossil resembles a minature *A. peronii* Lesueur, 1817, from the Recent faunas.

Superfamily Hipponicacea ? (now Pyramidellacea)
Family Amathinidae Ponder, 1987

Genus *Carinorbis* Conrad, 1862

Small to moderately sized, paucispiral shells with strong spiral ribs or keels, weak axial sculpture, and rapidly expanding whorls. Type is *Delphinula lyra* Conrad, 1834. A synomyn is *Clathrella*, Recluz, 1864.

331. *Carinorbis lyra* (Conrad, 1834) (Synonyms: *Delphinula globulus* H. C. Lea, 1843; *Fossarus lyra* (Conrad) of Dall, 1892). Shell fairly small, naticoid. Whorls 3-4, tabulated, very rapidly expanding. Spiral sculpture of 5 coarse ribs which form projections on outer lip; interspaces with 8-10 very fine spiral lines, and with 40-50 coarser axial threads on body whorl. Aperture very large, oval. Base narrowly umbilicate. Zone 1, Williamsburg; Zone 2, Petersburg, Williamsburg, Hampton, Chesapeake, Chuckatuck and Smithfield. Diameter 10* mm.

Allometric growth and the very rapid lateral expansion of the whorls produce a rather peculiar growth series in this species. Juveniles of 1 to 1 1/2 whorls and adults are strikingly wider than high, but at 2 to 2 1/2 whorls the shells are higher than wide. Juveniles of 1 to 2 whorls are common at many Zone 2 localities, but adults are very uncommon.

Some juveniles have a high, erect protoconch, while others have the protoconch low and partially involute. However, all adult specimens I have examined have the low protoconch, raising the possibility of sexual dimorphism or multiple species. None of the several hundred juveniles examined consistently differ in other traits, and only a single Yorktown species is here recognized.

James McLean of the Los Angeles County has examined specimens and recommends that this species not be assigned to *Fossarus*. Because it is the type of the genus *Carinorbis* Conrad, 1862, that name is used here, pending a review of the *Fossarus*-like genera. A second species of *Carinorbis*, *C. quadricostata* (Emmons, 1858) (Synonym: *Aorotrema gardnerae* Olsson and Harbison, 1953) is known only from Natural Well near Magnolia, North Carolina. It has 4 spiral keels and the axial sculpture, of very low riblets, is more subdued and more numerous.

Genus *Iselica* Dall, 1918

"Spirally coiled, few-whorled, with a wide umbilicus" (Keen, 1971:453). Abbott (1974:136) has maintained the traditional systematic placement of *Iselica* following *Fossarus*, while noting that Keen (1971) placed the genus in the Pyramidellidae. Abbott (1974) stated that the soft parts are unknown, but Gardner (1947:572) reported that J.P.E. Morrison (personal communication) had examined the soft anatomy of a Californian species and found it typical of a pyramidellid. As no consensus exists, *Iselica* is provisionally retained here.

332. *Iselica globosa* H. C. Lea, 1843) (Synonyms: *Actaeon globosus* H. C. Lea, 1843; non *Acteon globosus* (Bronn, 1931) of Bronn, 1948; *Iselica anomala* (C.B. Adams, 1850); *Dolium octocostatum* Emmons, 1858; *Isapis caloosaensis* Dall, 1890; *I. anomala floridana* Mansfield, 1930; *Fossarus florius* Gardner of Forti, 1969, not of Gardner, 1947). Shell very small, solid, turbinate. Protoconch involute; 3 1/2 rounded whorls tightly coiled. Spiral sculpture of 8-9 ribs with slightly wider interspaces. Axial sculpture of threads which cross the spiral ribs, but are more prominent in the interspaces. Aperture small, oval; outer lip scalloped by spiral ribs. Base evenly rounded, with deep, narrow umbilicus. Zone 2, Williamsburg and Chuckatuck. Height 3.08 mm.

Lea's 2 mm type is now broken, but retains the distinctive spire and sculpture of the shell later named *I. anomala*. I have compared Lea's type (figure 332) with the complete specimen (figure 332a) and with a juvenile *Carinorbis lyra* of the same size. The latter, at 3 mm (figure 331a) has fewer and coarser ribs, and it is a very different shell.

Family Crepidulidae

Genus *Calyptraea* Lamarck, 1799

"The shell is conical, its apex central and spiral, the aperture basal, having a spiral diaphram that is twisted at the margin to form a false umbilicus" (Keen, 1971:455).

333. *Calyptraea centralis* (Conrad, 1841) (Synonym: *Infundibulum concentricum* H.C. Lea, 1843). Shell small, circular, broadly conic, smooth, apex central; relative height variable. Internal septum obliquely spiral, smooth and polished. Zone 2, ubiquitous; Chowan River, Chesapeake. Diameter 19 mm.

Two ecomorphs are found in Yorktown beds. The common form is typically 5 to 7 mm in diameter, about as high as wide, with convex whorls. The larger form, 15 to 20 mm in diameter, is rarer, with low, concave whorls. A third form, common in Duplin beds of South Carolina and much larger

than either Yorktown form (reaching 25 to 30 mm in diameter and height) and having markedly straight, steep sides, is possibly a separate species.

Genus *Crucibulum* Schumacher, 1817

"The internal shelf or septum is concave and principally attached near the apex of the shell, standing more or less free in later stages of growth--hence the popular name `cup-and-saucer limpet.' Because of the sessile habits of these snails, the shells may be distorted by growth in cramped quarters or on irregular sufaces; sculpture and shape may be variable" (Keen, 1971:461).

Subgenus *Crucibulum*, s.s.

"Septum attached along a narrow part of the right side, the edge or margin mostly free" (Keen, 1971:461).

334. *Crucibulum scutellatum* (Wood, 1828) (Synonyms: *Calyptraea imbricata* Sowerby, 1824, non Fischer, 1807; *Crucibulum ramosum* Conrad, 1845; *Calyptraea rugosa* Lesson, 1830, non Borson, 1825, non Anton, 1839); *C. maculata* Broderip, 1834; *Crucibulum corrugatum* Gould and Carpenter, 1857; *C. imbricatum broderipii* Carpenter, 1857). Shell large, patelliform, round to oval; height variable. Sculpture of 15 to 20 heavy radial ribs with deep interspaces; ribs and interspaces covered with irregular, divaricating scabrous cords. Apex hooked. Internal cup attached by a narrow line. Zone 2, Williamsburg, Chuckatuck, Smithfield and Chesapeake. Diameter 40.5 mm.

Recent *C. scutellatum* from the intertidal zone of Mazatlan, West Mexico, are more irregularly formed, heavier shells with proportionally wider ribs having a trapizoidal cross-section. Their interspaces are narrow to wide, with strong concentric cords. In contrast, the Yorktown specimens are more uniformly circular, lighter in weight, and have narrower ribs with subparallel sides and weak to obsolete concentric cords. Whether these differences are of species value or functions of habitat is a question beyond the scope of this study. Should they eventually prove distinct, the oldest name for the Yorktown populations is *C. ramosum* Conrad, 1845.

Subgenus *Dispotaea* Say, 1824

With 1/4 to 1/2 of internal septum attached to wall of shell. Type by original designation, *Calyptraea (Dispotaea) grandis* Say, 1824.

335. *Crucibulum grandis* (Say, 1824). Shell large, oval, smooth or with growth lines; occasionally with rippled pattern ghosting the substrate. Internal cup large, expansive, circular; attached to wall by a narrow band. Apex subcentral, height roughly half of maximum diameter. Zone 1 shells are much heavier. Zone 1, ubiquitous; Zone 2, Chuckatuck, Hampton and Chesapeake. Diameter 6 mm.

Say(1824) described this species as a *Calyptraea* and then made it the type of his new genus, *Dispotaea*, as indicated by Newton (1902).

Crucibulum constrictum Conrad, 1842, from the Calvert and Choptank formations of Maryland, has a smaller, thinner shell but may possibly be conspecific with *C. grandis*. *C. constrictum* Conrad, of Gardner (1947, pl. 56, figs. 21, 22, not of Conrad, 1842) is the Yorktown Zone 2 form of *C. grandis*.

336. *Crucibulum multilineatum* (Conrad, 1841). Shell small to moderate in size, patelliform, circular to oval, low. Sculpture of crowded, low, rounded ribs with very narrow interspaces; ribs may bear short, hollow spines. Apex coiled, hooked, centrally placed. Internal cup low, fragile, triangular; attached along 1/3 of circumference. Chowan River, Chesapeake. Diameter 11.2 mm.

337. *Crucibulum leanum* Campbell, new species (Synonyms: *Calyptraea costata* Say, 1824, not of Say, 1820 or Gray, 1825; *Calyptraea pileolus* H. C. Lea, 1843, non Orbigny, 1841; *Crucibulum constrictum* (Conrad) of Mansfield, 1930 (in part) and Gardner, 1947 (in part), not of Conrad, 1842; not *Crucibulum (Dispotaea) costatum pileolum* (Lea) of Martin, 1904). Shell size small to moderate; patelliform, circular; height variable. Sculpture of 10 to 30 coarse radial ribs with low, rounded interspaces and prominent growth lines; secondary sculpture lacking. Shell may ghost substrate. Apex hooked; early growth smooth or costate. Internal cup attached along 1/3 of circumference. These shells are highly variable in height and ribbing. The cup attachment and the lack of secondary sculpture separate this species from *C. scutellatum*. Zone 2, ubiquitous
Type locality: Deep Creek pit, end of Cookes Mill Road, 2 miles west of Deep Creek, Chesapeake, Virginia. Diameter 40 mm.

Etymology: named in recognition of the pioneering work of H.C. Lea.

338. *Crucibulum leanum* Campbell, new species, new ecomorph. Shell large, patelliform, very low, circular. Initial sculpture typical of *C. leanum* but becoming obsolete over outer half of disk. Internal cup small, flattened. Chowan River, Chesapeake. Diameter 47 mm.

This variety, occuring only in the Chowan River beds in Chesapeake, commonly ghosts the rib pattern of the large, flattened race of *Carolinapecten eboreus* which is unique to these beds. Consequently, this taxon is better treated as an ecomorph rather than a subspecies.

Genus *Crepidula* Lamarck, 1799

"The shells of the slipper limpets are low, oval, with the apex at or near the margin. Very young shells are spiral, but these spiral whorls are soon lost and the shell becomes flat, with a deck or shelf across about one-half of the aperture. Although individuals can move about, they customarily remain attached to whatever spot the young shell settles on, and great variations in shape may result. Those that live inside the apertures of dead gastropod shells may be smooth and curved backward to fit the contour of the shell, whereas specimens from the same brood lodging in the outside of the shell may become rough and distorted. In some species the individuals cluster together, perhaps even stacked one upon the back of another" (Keen, 1971: 458).

The species and synonymies used here are from Hoagland, 1977, with notes on any differences of interpretation following the species descriptions.

Subgenus *Crepidula* s.s.
Sculptureless, small to large, arched *Crepidula* typically with large, incurved apices.

339. *Crepidula adunca* Sowerby, 1825 Hoagland, 1977 (Synonyms: *C. cornucopiae* H.C. Lea, 1843; *C. rostrata* Conrad, 1870; *C. aesop* Dall, 1903). Shell fairly small, thin, cap-shaped. Beak small, high, incurved. Aperture subcircular. Zone 2, ubiquitous. Length 10.7 mm.

Crepidula adunca is a well-established, legitimate Eastern Pacific species ranging at least from the Miocene to recent. A seaway between the Atlantic and Pacific was functional throughout the Miocene and several species, including a calyptraeid (*Crucibulum scutellatum*), are found in faunas of both coasts. So *Crepidula adunca* could theoretically be in the Yorktown fauna. However, these particular "*adunca*" morphologies were found in place as part of *C. fornicata* stacks at Chuckatuck. Normally the suprajacent individual will settle and grow over the beak of the next lower animal, and take on typical *C. fornicata* form. When a second shell grows on the flank of a shell whose beak is already occupied, the "*C. adunca*" form results. Hence the Yorktown shells are probably better assigned to *C. fornicata*.

340. *Crepidula convexa* Say, 1822 (Synonyms: *C. glauca* Say, 1822; *C. acuta* H. C. Lea, 1842; ?*C. navicula* Morch, 1877). Shell small, usually thin, highly arched. Beaks high, curved to the right. Shelf margin straight, shelf covers about 1/3 of aperture. Zone 2, Williamsburg ("Yorktown Zone 1 and 2" (Hoagland, 1977)). Length 22 mm.

Recent shells have a dark coloring which easily separates them from *C. fornicata*, but the *C. convexa* fosssils converge with the "*C. cornucopiae*" form of *C. fornicata* and are difficult to determine.

341. *Crepidula cymbaeformis* (Conrad, 1844) (Synonyms: *C. recurvirostra* Conrad, 1871; *C. phalanea* Weisbord, 1962; *C. avirostra* Weisbord, 1962; *C. corcovada* Weisbord, 1962). Shell fairly large, heavy, elongate. Beak small, produced, extending well beyond the aperture. Shelf edge sinuate, shelf covering about 1/2 of aperture. Aperture oval, elongate. Zone 2, Petersburg, Williamsburg, Suffolk, Smithfield; Chowan River, Chesapeake. Length 45 mm.

Hoagland separates this from *C. fornicata* by its larger size, elongate shell shape, and style of beak coiling. *C. cymbaeformis* from Tearcoat Branch, South Carolina have the unique tendency to absorb hematite into the shell structure just under and beyond the inner shelf, giving the shell a discrete rusty stain.

342. *Crepidula fornicata* (Linnaeus, 1758) (Synonyms: *Crepidula riisei* Dunker, 1852; *C. virginica* Conrad, 1871; *C. densata* Conrad, 1871; *Crypta nautarum* Morch, 1877; *Crepidula roseae* Petuch, 1991; see also *C. adunca* and *C. cymbaeformis*). Shell of moderate size. Typically a smooth, oval, highly arched shell with strongly recurved beaks, but exceedingly variable because individuals conform to substrate. Shelf margin sinuate, shelf covering about 1/2 of aperture. Zone 1, Williamsburg; Zone 2, ubiquitous. Length of stacked individuals, 20 to 30 mm; apparently solitary individuals may attain 50 mm or more.

Ribbed shells are rare, but do occur when ghosting a ribbed substrate. The stacking habit was perfected before Yorktown time, and stacks of 15 to 20 individuals were found in the Chuckatuck pit. Stacked individuals accomodate the apex of the underlying shell by developing a rippled buldge in the shell margin. Petuch (1991) has described such a shell as *Crepidula roseae*. At Chuckatuck, in situ stacks preserve a symbiotic pea crab.

Subgenus *Bostrycapulus* Olsson and Harbison, 1953
Slipper shells with prominent ribs and spines.

343. *Crepidula aculeata aculeata* (Gmelin, 1791) (Synonyms: *Calyptraea echinus* and *hystrix* Broderip, 1834; see also Hoagland, 1977:364). "The spiny slipper has the apex spirally curved to one side and the surface of the shell covered with spiral rows of spines, with much variation in coarseness or fineness...The septum or deck is white, slightly notched at the sides and in the center" (Keen, 1971:458). Zones 1 and 2, ubiquitous. Length 15 mm.

343a. *Crepidula aculeata ponderosa* H. C. Lea, 1843 (Synonym: *C. spinosa* Conrad, 1844). See discussion below. Length 36 mm.

343b. *Crepidula aculeata costata* Morton, 1829 (Synonyms: non *C. costata* Sowerby, 1824; non Deshayes, 1830). Length 28 mm.

Three very distinct morphologies can be separated out of this complex. Small shells usually have fine, long, regular spines and are indistinguishable from Recent *C. aculeata*. Yorktown adults typically grow a fairly large, heavy, irregularly thorny shell with massive, strongly recurved beaks. This is *C. spinosa* Conrad and *C. ponderosa* H.C. Lea. Stacks of 6 to 10 individuals can occasionally be found; when stacked, the animals modified their substrate, apparently by chemical dissolution. Not only are the spines removed, but the shell margin is frequently imprinted on the subajacent shell. Specimens attached to *Chesapecten* and *Ostrea* similarily modified their substrate.

A third morphology is typically spineless but has crowded, low, radial ribs. This is Morton's *C. costata*. I have not observed stacking in this form. Although rather scarce in the Yorktown, shells of the "*costata*" morphology dominate Duplin populations at Tearcoat Branch (Sumter County, South Carolina). Some southern specimens exhibit spines on the dorsum and ribs on the flanks. Therefore these three morphologies appear to represent a single species.
However, of the three, only the small, fragile, delicately-spined morph seems to have escaped extinction.

Subgenus *Ianacus* Morch, 1852
White slipper shells with flattened, concave shells.

344. *Crepidula plana* Say, 1822 (Synonyms: *C. depressa* Say, 1822; *C. lamina* H. C. Lea, 1843; *C. rhyssema* Olsson and Harbison, 1953). Shell small to moderate in size; often concave, very flattened, smooth; oval to trigonal in outline. Beak inconspicuous. Shelf edge curved inward, shelf extending 1/3 to 1/2 of aperture. Zone 2, ubiquitous. Length 38 mm.

Recent *C. plana* are most commonly found in the interior of gastropod shells, usually commensal with hermit crabs. Yorktown *C. plana* are likewise found inside snail shells and probably had a symbiotic relationship with hermit crabs.

Hoagland (1977) observed that *C. plana* may be synonymous with *C. unguiformis* Lamarck, 1822, of the Eastern Atlantic faunas.

Family Lamellaridae

Genus *Lamellaria* Montagu, 1815

Small, exceedingly thin and fragile shells typically imbedded in the mantle of a considerably larger animal. Aperture large, shell resembling a minature *Sinum*.

345. *Lamellaria perspicua* (Linnaeus, 1758). Shell very small, exceedingly thin and delicate; rare. Externally resembling a juvenile *Crepidula fornicata*. Zone 2, Chuckatuck and Chesapeake, a single specimen from each site. Length 6.0 mm.

Family Eratoidea

Genus *Erato* Risso, 1826

"The generic name is derived from a Greek word meaning 'pleasing,' which is appropriate for these smooth and rather shiny little shells. They resemble the Marginellas, and early authors tended to confuse the two, failing to notice that the *Eratos* lack any strong columellar folds. There may be a line of weak denticles, however, along the border of the inner lip" (Keen, 1971:488). Lyons(1989) stated that eratoids feed on colonial tunicates.

346. *Erato maugeriae* Gray, 1832. Shell small, smooth, solid, polished, pear-shaped, covered with a very thin glaze. Spire low, conic. Outer lip arched at shoulder, with about 15 denticles on inner margin. Zone 2, Williamsburg, Chuchatuck, Smithfield and Chesapeake. Height 4.3 mm.

Superfamily Cypraeacea
Family Cypraeidae

Genus *Cypraea* Linnaeus, 1758

"Glossy, colorful, ovate shells with a long narrow aperture bounded on both sides by inrolled, toothed lips" (Abbott, 1974:149). "Spire concealed in adult by the glaze that covers the body whorl" (Keen, 1971:492).

___. *Cypraea annulifera* Conrad, 1866 (type locality: Yorktown, Virginia) was a Recent Indo-Pacific *C. annulus* (Linnaeus, 1758) dropped by an Indian or trader (Dall, 1890). See Appendix II.

Subgenus *Siphocypraea* Heilprin, 1887

Pear-shaped to cylindrical shells with a strong, deep, posterior groove.

347. *Cypraea* (*Siphocypraea*) *carolinensis* Conrad, 1841 (Synonyms: *C. globosus* Dujardin of Heilprin, 1884, not Dujardin, 1837, non Gray, 1832; *C. pilsbryi* Ingram, 1939; possibly *C. carolinensis floridensis* Mansfield, 1931; possibly *Siphocypraea hertweckorum* Petuch, 1991). Shell large, oval, rather heavy; with a deep, curved posterior groove. Base flattened. Relative width variable, possibly due to sexual dimorphism. Outer lip incurved, thickened, with about 20 small teeth on inner edge. Zone 2, very rare, Williamsburg. Length 51 mm.

When preserved, a color pattern of scattered round spots on the dorsum is diagnostic. In Virginia this striking species has been recovered with certainty from but a single Williamsburg locality. Most of the Yorktown "cowries" prove to be the large, rare marginella, *Microspira oviformis* (Conrad, 1868), in which the spire apex remains visible as a small point.

Superfamily Naticacea
Family Naticidae

The naticids are active, burrowing carniverous snails feeding primarily on other molluscs. They drill a round, countersunk hole through the shell of their intended victim. These characteristic holes are frequent in bivalves, gastropods, and scaphopods in most Yorktown assemblages.

Genus *Polinices* Montfort, 1810

"The horny operculum that distinguishes the group from *Natica* is paucispiral, thin, and ovate, with the nucleus at the larger end. In another contrast to *Natica*, the umbilicus does not have a true funicle, for the major part of the callus is at the upper edge of the inner lip" (Keen, 1971:477).

Late Note: Kabat (1991: 433) recognizes *Neverita* Risso, 1826 as distinct from *Polinices*. By this usage, the following species becomes *Neverita duplicata* (Say).

348. *Polinices duplicatus* (Say, 1822) (Synonyms: *Neverita percallosa* Conrad, 1868; *Neverita densata* Conrad, 1868; *Neverita emmonsii* Conrad, 1868; *Neverita* (*Glossaulax*) *asheri* Petuch, 1988; *Neverita* (*Glossaulax*) *discula* Petuch, 1988). Shell of medium size, naticoid, very solid, smooth. Typically low, domed or flat-spired, twice as broad as high, but variable, rarely as high as wide. Whorls well-rounded, 6 to 8, tightly coiling in the smaller males, coiling more open in females. Umbilicus wide, deep, filled or partially filled with a thick callus. Zone 2, Williamsburg, Petersburg, Hampton, Chuckatuck, and Chesapeake. Diameter 35 mm.

348a. *Polinices* sp. Shell small, naticoid, very solid. Spire high, pointed.. Umbilicus filled or nearly filled by a callus. Zone 2, Hampton. Height 10.5 mm. This small species shares the size, shell outline, and spire form of *Lunatia perspectivia*, and the umbilical callus form of the smaller *Tectonatica pusila*. Apparently rare, this species has probably been confounded with those more common taxa.

Genus *Lunatia* Gray, 1847

Thin, globose, naticoid shells with a corneous operculum and a narrow, deep umbilicus. *Lunatia* specis have an outer shell layer which weathers easily and flakes away. Such deteriorated shells must be identified with caution. The three Yorktown *Lunatia* species discussed below have had

rather varied taxonomic treatment. Martin, 1904, believed that all were varieties of a single form identical with the Recent and late Pleistocene *L. heros* (Say, 1822). Dall, 1892, recognized three species, two smaller, extinct forms and a larger, thin shelled species which he assigned to *L. heros*. However, Johnson's Waccamaw lists in Dall, 1892, record *Lunatia heroica*, a nude name that can only apply to the large, thin shelled species. This work rejects *L. heros* as a Yorktown species.

Late Note: Kabat (1991: 431) has shown *Lunatia* to be a junior synonym of *Euspira* Agassiz, 1837.

349. *Lunatia interna* (Say, 1824) (Synonyms: *Natica crassilabrum* H. C. Lea, 1843; *Lunatia hemocrypta* (sic) Gabb of Conrad, 1863, not *L. hemicrypta* Gabb, 1860 (New Jersey Miocene); *L. tuomeyi* Whitfield of Petuch, 1988). Shell fairly small, very solid, naticoid, smooth. Whorls 5 to 6, rounded, tabulated at shoulder; suture rather distinct, slightly grooved. Umbilicus large, deep with a heavy spiral ridge at border. Inner lip with small incipient callus covering upper edge of umbilicus. The small size and umbilical ridge are diagnostic for this species. However this latter feature is lost in weathered specimens. Zone 1, Williamsburg; Zone 2, Petersburg, Williamsburg, Hampton and Smithfield. Height 18 mm.

350. *Lunatia perspectivia* (Rogers and Rogers, 1837). Shell fairly small, thin but solid, naticoid, smooth and polished. Rounded whorls, 5 to 6, body whorl constitutes most of shell. Suture rather indistinct. Spire elevated, tapering conic. Umbilicus narrow, very deep; lacks a bordering ridge. Small size and high, conic spire are diagnostic for this species. Exceptional specimens preserve the original colors, a rich chestnut brown with a white aperture. Zone 2, Williamsburg, Chuckatuck, Hampton, Suffolk and Chesapeake. Height 20.5 mm.

351. *Lunatia sayana* Campbell, new species (Synonyms: *Lunatia heros* (Say) of authors, not of Say, 1822; *Natica catenoides* Wood of Conrad, 1862, not of Wood, 1842; *L. heroica* Johnson in Dall, 1892, *nomen nudum*). Shell moderate to large, thin, somewhat fragile, smooth. Six to eight well-rounded, inflated, globose whorls. Suture distinct, excavated in weathered specimens. Spire fairly low, tabulate. Umbilicus fairly narrow, very deep. Zone 2, ubiquitous. Type locality: upper Zone 2 level, Deep Creek pit, end of Cookes Mill Road, 2 miles west of Deep Creek, Chesapeake, Virginia. Height 45 mm.

This species is relatively broader than the other Yorktown *Lunatia* species. It is also thinner shelled and attains a much larger size. The fossils have traditionally been assigned to *L. heros* (Say, 1822), a common Pleistocene and Recent shell. A cold water species, *L. heros* does not live in shallow sublittoral seas south of New England. Adult *L. heros* are 70 to 120 mm in height, with heavy shells typically higher than wide. *L. sayana* had warm water affinities, being common in the subtropical Duplin and Waccamaw faunas as well as in the Yorktown; adults reached 40 to 60 mm in height, had thin shells, and were typically wider than high. Young *L. heros* are thin-shelled and at that stage may closely resemble the Yorktown form.

Etymology: named for Thomas Say.

Genus *Bulbus* Brown, 1839

Small, thin, high-spired naticids with a narrow, deep umbilicus. Typical of boreal and temperate faunas.

352. *Bulbus chesapeakensis* Campbell, new species. Shell small to very small, thin but solid, elongate-naticoid, smooth. Three to five whorls evenly rounded, slightly tabulated at suture. Suture with very narrow, shallow channel. Spire elevated, turreted. Aperture oval, elongate; outer lip thin, well-rounded. Umbilicus very narrow, deep. Zone 2, Chesapeake. Type locality: upper Zone 2 level, Deep Creek Pit, end of Cookes Mill Road, 2 miles west of Deep Creek, Chesapeake, Virginia. Height 4.91 mm.

Known from three specimens, *B. chesapeakensis* resembles *B. islandica* (Gmelin, 1791), but the new species is slimmer, much smaller (possibly a juvenile trait), and has a much weaker sutural channel.

Etymology: named for the type locality.

Genus *Sinum* Roding, 1798

(Synonym: *Sigaretus* Lamarck, 1799)

"A periostracum may or may not be present on the low, ear-shaped shell. The sculpture is of fine spiral grooves, and the color varies from brown to white" (Keen, 1971:482).

353. *Sinum chesapeakensis* Campbell, new species (Synonyms: *Natica fragilis* Conrad, 1830, non Leach, 1819, non Loven, 1846; *Natica aperta* H. C. Lea, 1843, non *Sigaretus apertus* Anton, 1839). Shell of moderate size, inflated, thin and fragile. Three to five rapidly expanding whorls, well-rounded. Spire high, conic. Protoconch smooth. Sculptured with 80 to 100 fine spiral threads of irregular strength. Aperture very large; columella twisted. Umbilicus deep, exceedingly narrow. Zone 2, Petersburg, Williamsburg, Yorktown, Hampton, Suffolk, Smithfield and Chesapeake. Type locality: upper Zone 2 level, Deep Creek pit, end of Cookes Mill Road 2 miles west of Deep Creek Chesapeake, Virginia. Length 27 mm.

No high spired *Sinum* are found in the Recent Western Atlantic faunas, but this fossil closely resembles *S. scopulosum* (Conrad, 1849) of the Eastern Pacific.

Etymology: the two names previously proposed for this species are primary and secondary homonyms, respectively, so that a new name is required. The species is named for the Chesapeake group of Virginia, North Carolina, and Maryland, to which the species is largely confined.

Pitt and Pitt (1993) have illustrated *Sinum lacondamini* Olsson, 1964, a similar species from the Pliocene of Ecuador. They have provided comparative specimens which show the detail necessary for separating the two species. *Sinum chesapeakensis* is considerably larger than *S. lacondamini*, shows 67 spiral threads on the body whorl in contrast with 53 for the Ecuadorian species, has flatter threads, and the spiral of the suture opens more rapidly in *S. chesapeakensis*.

354. *Sinum perspectivum* (Say, 1831). Shell of moderate size, compressed, thin and fragile. Three to four rounded whorls, very rapidly expanding. Spire very low, flat. Sculp-

ture of numerous fine spiral threads. Aperture very large; columella an open spiral. Zone 2, Hampton. Diameter 28 mm.

Genus *Natica* Scopoli, 1777

"The shells of the Naticas are sturdy, porcelaneous, mostly smooth or polished, with bold color patterns...The funicle in the umbilicus is a distinguishing feature--a riblike structure that is built up from the little bulge of callus on the outer side of the inner lip just below the middle of the lip" (Keen, 1971:473).

355. *Natica plicatella* Conrad, 1863. Shell of moderate size, thin but solid, smooth. Five to eight well-rounded whorls. Sculpture of short radial grooves which radiate from suture. Aperture large. Umbilicus large, wide, with a central spiral ridge. Zone 2, Chuckatuck. Height of unique juvenile 4.9 mm.

This shell is more common in the Duplin, Waccamaw and more southern Pliocene faunas. Olsson and Harbison (1953) noted that the shell is identical with the modern *Natica canrena* (Linnaeus, 1858) but the calacreous operculum is distinct.

Genus *Tectonatica* Sacco, 1890

Small to very small naticids with a calcareous operculum, and a callus which seals or very nearly seals the umbilicus.

356. *Tectonatica pusilla* (Say, 1822) (Synonym: *Natica sphaerulus* H. C. Lea, 1843). Shell very small, solid, naticoid, smooth. Three to five well-rounded whorls; with slight dcpression just below suture. Umbilicus filled with small callus. Zone 2, ubiquitous. Height 3.075 mm.

Abundant but frequently overlooked. This small shell is more solid than any of the coexistent juvenile naticids of similar size, and is the only naticid of its size with a complete umbilical callus.

Family Cassidae

Genus *Sconsia* Gray, 1847

Medium to large, thin shells with incised spiral lines and one or more former varicies. This genus lacks the parietal shield typical of many cassid genera.

357. *Sconsia* sp. cf. *S. hodgeii* (Conrad, 1841). Shell large, thin, elongate. Five to six convex whorls; suture channeled. Sculpture of crowded, fine spiral lines, coarsening anteriorly. Siphonal canal short, straight, with a deep notch. Outer lip forms a varix, interior of outer lip has denticles posteriorly and low ridges anteriorly. Exceptional specimens preserve a color pattern of small squares in spiral rows. Zone 2, Chuckatuck, Days Point, and Hampton. Length 55 mm.

The Yorktown specimens are morphologically close to *Sconsia hodgeii* from the Duplin of South Carolina. However, Druid Wilson (personal communication, 1980, 1991) stated that there are two Pliocene *Sconsia* species in south Florida, *S. hodgeii*, and an as yet unnamed species which appears to be identical with the species at Rice's Pit in Hampton. Exact species placement must await clarification of these Floridian taxa.

Family Ficidae

Genus *Ficus* Roding, 1798

(Synonym: *Pyrula* Lamarck, 1799)

"The fig shells are thin, elegantly curved, about the size and shape of a large fig. Finely sculptured with spiral and concentric riblets" (Keen, 1971:503).

358. *Ficus holmesii* Conrad, 1867 (Synonym: *F. duplinensis* (Smith, 1907)). Shell moderate to large, pear-shaped, thin and fragile. Five plus whorls, highly inflated. Spiral sculpture of about 20 strong, flat cords; interspaces with a strong central thread flanked by two fine lines. Axial sculpture of numerous fine, flat-topped threads. Intersections of spiral and axial sculpture raised, forming a square bead. Siphonal canal narrow, tapering, elongate. Two nuclear whorls are small, smooth, not inflated. Zone 2, Hampton. Height exceeds 70 mm.

Ficus communis Roding, 1798, from the Waccamaw, Caloosahatchee and Recent faunas is very similar, but it has a large, bulbus protoconch consisting of a single whorl.

Family Muricidae

Genus *Chicoreus* Montfort, 1810

"Shells varying in size from small to very large, characterized by having 3 more or less foliaceous varices. Spire moderately high. Body whorl may be capacious to moderate in size with an aperture that may range from small to large...canal ranges from short to quite long...axial sculpture generally consists of 3 varices and one or more axial ridges in each intervarical space" (Radwin and D'Attilio, 1976:32).

359. *Chicoreus floridanus* E.H. Vokes, 1965

(Synonyms: *C. sallaenus* (A. Adams) of authors, not of Adams, 1854; *Murex sexcostata* Emmons, 1858, non *M. sexcostata* Lamarck, 1822; see Vokes, 1965 or 1990, for further synonyms). "Shell large to moderate in size, whorls greatly inflated. With postnuclear whorls in the adult...On the third postnuclear whorl every third rib becomes strengthened to form a small varix, gradually increasing in size with each successive varix; three varices to one complete whorl...The shoulder spine is somewhat wider than the others, but is not noticeably longer...The siphonal canal is broad, recurved at the distal end, and almost covered over, however it remains open by a narrow slit" (Vokes, 1965: 189-190). Zone 2, Hampton. Height about 30 mm.

This species is represented in the Virginian Yorktown by a single specimen in the Rice's Pit Museum at Hampton. Mr. Rice permitted the specimen to be photographed in its case and stated that it came from the lower (*Turritella*) bed of the pit. This illustration is sketched from that photograph.

Genus *Murexiella* Clench and Perez Farfante, 1945

"Varices are (with a few exceptions) 4 to 5 in number, composed of a row of spines intricately netted or webbed together by fine layers of frills; anterior canal moderately broad; operculum with a subapical nucleus" (Keen, 1971:517-519). "Aperture almost circular; no anal notch" (Abbott, 1974:174).

360. *Murexiella shilohensis* (Heilprin, 1888). Shell small, fusiform, elongate, rather fragile. Two smooth nuclear and five postnuclear whorls. Axial sculpture of eight lamellar, tabulated ribs with a sharply reflected tubular spine at the shoulder. Spiral sculpture of five to six scaly cords of unequal strength. Suture constricted. Siphonal canal straight, somewhat elongate. Zone 2, Williamsburg. Height 12 mm.

Genus *Scalaspira* Conrad, 1862

Small shells with a turreted spire and a long, constricted siphonal canal; surface nonscabrous and devoid of spines.

361. *Scalaspira strumosa* (Conrad, 1830). Shell small, solid, fusiform, turreted. Seven tabulated whorls. Axial sculpture of 15-16 ribs per whorl; rib flanks slope gently into interspaces, beoming obsolete at base of siphonal canal. Fine axial growth lines also present. Spiral sculpture of low, undulatory cords on body whorl and narrower, stronger and more widely spaced cords on siphonal canal; canal long, constricted at base of body whorl. Zone 2, Smithfield, Chuckatuck, Hampton and Chesapeake. Height 21 mm.

Specimens from the St. Marys Formation assigned in literature to this species are not conspecific. The Miocene shell was recently named *Scalaspira harasewychi* Petuch, 1988.

Genus *Urosalpinx* Stimpson, 1865

Small to moderate-sized muricids with solid, sturdy shells. Low, generally rounded whorls with axial and spiral sculpture and frequently, in good material, with a scabrous surface. Siphonal canal typically open, short and somewhat constricted.

Most Yorktown *Urosalpinx* species have a distinct, translucent brown calcitic layer, much the same color as *Ecphora* This brown layer weathers differently from the underlying aragonitic layers.*Trossulosalpinx* Petuch, 1986 and*Vokesinotus* Petuch, 1988b are synonyms of *Urosalpinx*.

362. *Urosalpinx barbitoides* (Gardner, 1948). Shell small to moderate in size, fusiform, solid. Whorls 7+. Axial sculpture of 9-11 heavy, lamellar, recurved ridges which turn abruptly to the left at the suture. Spiral sculpture of 8-10 low undulatory cords on body whorl and canal. Siphonal canal fairly short and somewhat constricted. Surface smooth, not scabrous. Zone 2, Yorktown and Smithfield. Height 24 mm.

Gardner's type remained unique until the 1980 field season, when a second, larger specimen was obtained along the James River. Vokes (1991:118) assigned this species to *Pterorytis* and suggested a possible synonymy with *Pterorytis umbrifer* (Conrad). Given the broken and repaired nature of the holotype and the less than definitive original illustration, these assignments are understandable.

363. *Urosalpinx lepidota* (Dall, 1890) (Synonyms: ?*Fusus cannabinus* Conrad, 1844; *F. lamellosus* Emmons, 1858, non Borson, 1821, Philippi, 1836 or Gray, 1839; *Neptunea lamellosus* Emmons Meek, 1864;*Coralliophila lepidota* Dall, 1890; *Urosalpinx phrikna* Gardner and Aldrich, 1919; *U. suffolkensis* Gardner, 1948; *Trophon lepidota* (Dall) Olsson and Harbison, 1953; *Vokesinotus lepidota* (Dall) Petuch, 1988). Shell small to moderate in size, solid, fusiform. Nuclear whorls smooth, flat-sided, inturned, typically muricid. Five to seven postnuclear whorls, convex to very convex, rounded to inflated. Axial sculpture highly variable. The basic form has 10 to 16 low, rounded ribs crossed and undulated by spiral threads. Basic spiral sculpture of 15 to 20 strong threads on the body whorl. Interspaces narrower than threads, with an occasional secondary thread. In the fimbriate specimens, axial ribs become lamellar, with a single lamella or several fused lamellae standing erect or curving backwards; spiral threads heavily scaled, with more prominent and numerous secondary threads; these secondary threads likewise scaled; scaling of threads and interspaces axially aligned in fluted rows. Intermediate shells may show lamellae only between suture and shoulder. Siphonal canal fairly short, straight, open; degree of basal constriction variable, narrow in "*U. suffolkensis*" forms, less so in "*U. phrikna*" forms. Zone 2, Williamsburg, Hampton, Suffolk, Chuckatuck, Smithfield and Chesapeake. Height 27 mm.

The type of *C. lepidota* is from the Caloosahatchee Formation of south Florida. In the Caloosahatchee and Waccamaw populations the frilled morphotype is more common and the shells tend to be heavier and more angulated at the shoulder. These tendencies merge back into the general type. The non-frilled morphologies are probably responsible for the records of Waccamaw *Urosalpinx perrugata* (Conrad, 1846). Because these tendencies merge back into the general type, I believe the younger Waccamaw-Caloosahatchie populations and the older Yorktown-Duplin populations are best served by a single species. Emily Vokes (1992, personal communication) argues that *C. lepidota* and the Yorktown form are not conspecific. Resolution of the problem must await a more detailed study.

Fusus cannabinis Conrad, 1844 was not illustrated but was provided with a better than average description which best fits *Urosalpinx lepidota*. However, Conrad (1862) later synonymized *F. cannabinis* with *Hesperisternia filicata* (Conrad, 1843) which superficially resembles the unfrilled *U. lepidota*. The holotype of *Fusus cannibinis* being lost, it seems best to let Conrad's judgement stand. Petuch (1988b) has erected the genus *Vokesinotus* for *U. lepidota*, but the supposed generic characters are inconstant at the species level. *Vokesinotus* appears to be a synonym of *Urosalpinx*.

364. *Urosalpinx gardnerae* Campbell, new name (Synonyms: *Urosalpinx stimpsoni* Gardner, 1948, not of Dall, 1927; ? *U. gardnerae* DuBar, *nomen nudum*, in DuBar and others, 1980). Shell of moderate size, fusiform, solid. Whorls 7+, tabulated, convex. Axial sculpture of ten to twelve somewhat irregular, low, rounded ribs. Spiral sculpture of eighteen to twenty coarse threads on body whorl and siphon, with finer threads between suture and shoulder and in interspaces. Zone 2, Williamsburg; Chowan River, Chesapeake. Height 34 mm.

This species may be a giant ecological varient within the *U. lepidota* stock, paralleling the giant races of *U. cinereus*, the Recent genotype. Although *U. gardnerae* parallels *U. lepidota* in space and time, it remains rare, and a full interconnection cannot be demonstrated with the material at hand.

Gardner's (1948) name for this species was preoccupied

and must be replaced. DuBar, DuBar, Ward, Blackwelder, Abbott, and Huddlestun (1980: 217) probably had this species in mind when listing "*Urosalpinx gardnerae*", but without description, figure, or reference, their name becomes a *nomen nudum*. Ward and Blackwelder (1987) subsequently documented the species as *U. stimpsoni* Gardner.

365. *Urosalpinx trossula* (Conrad, 1832) (Probable synonyms: *Trossulasalpinx hertwecki* Petuch, 1991; *T. schmidti* Petuch, 1991; *T. maryae* Petuch, 1991; *T. lindae* Petuch, 1991 (type is injured and repaired); "*T. trossulus* (Conrad, 1832) Petuch, n. sp." lapse in Petuch, 1991). Shell small, solid, fusiform. Whorls 7+, evenly rounded, convex. Axial sculpture of 18-20 very low, undulating ribs; ribs more prominent and coarsely beaded in early whorls. Spiral sculpture of 16-20 strong cords; wider interspaces typically with narrow thread and variable number of fine lines; cords, threads and lines finely scaled by growth lines; scaling commonly worn off. Siphonal canal short, straight, open. Outer lip heavily denticulate within. Zone 2, ubiquitous. Height 32 mm.

Within Yorktown Formation populations, this species is constant in its characters; the spiral scuplture dominates over the axial, and the whorls are evenly rounded. The heavy beading of the whorls is likewise characteristic. Some limited variation may be found, especially in its relative proportions. The Floridian populations are more variable, but I believe they still represents but a single taxon conspecific with *Urosalpinx trossula*.

Petuch (1986) has proposed a new genus, *Trossulasalpinx*, with *Urosalpinx trossula* as type and *Urosalpinx curtus* Dall, 1890 and *Urosalpinx subsidus* Dall, 1890 as congeneric taxa. I consider *Trossulasalpinx* to be, at best, only subgenerically valid, or, more likely, to be a synonym of *Urosalpinx*.

366. *Urosalpinx rappahannockensis* (Gardner, 1948) Synonym: *Fusinus rappahannockensis* Gardner, 1948. Shell small, elongate, fusiform. Whorls 5+, rounded; nuclear whorls unknown. Axial sculpture of ten to twelve low, undulatory ribs. Spiral sculpture of twelve to fourteen weakly scabrous cords. Outer lip thickened, seven denticles within. Aperture oval; siphonal canal long, straight, open. Zone 1, Williamsburg. Height 24 mm.

Genus *Eupleura* H. and A. Adams, 1853

"Two varices on opposite sides of the whorls...strong denticles occur inside the outer lip" (Keen, 1971: 530).

___. *Eupleura caudata* (Say, 1822). See Appendix II.

Genus *Pterorytis* Conrad, 1862

Medium to large shells with prominent axial ridges or blade-like varicies, and a sharp spine projecting from the base of the outer lip.

367. *Pterorytis umbrifer* (Conrad, 1832) (Possible synonyms: *Purpura marshalli* Mansfield, 1930; *Pterorytis seminola* Olsson and Petit, 1964). Shell moderate to large, fusiform, thin but strong, or heavy. Whorls 7+, angulated, with a strong carina at shoulder. Axial sculpture variable, of four to ten varices. Varix morphology of three distinct, probably environmentally controlled patterns: 1-varices low, thick and massive (*P. seminola* Olsson and Petit, 1964), apparently reflective of high energy conditions; 2-thin, erect blades with fluting at intersection of spiral cords, and frilled lamellae on apertural side of varix, the "normal" form; or 3-very thin, erect, recurved blades with strongly recurved open spines at intersection of spiral cords, a form apparently from sheltered habitats. Spiral sculpture of two to five raised cords or carinae, strongest at shoulder. Aperture oval; siphonal canal short, nearly straight, slightly upturned at tip; siphonal fasciole generally well-developed; siphonal canal closed by a very thin lamina which is often broken. Zone 2, Petersburg, Williamsburg, Yorktown, Hampton, Smithfield, Chuckatuck and Chesapeake. Height 27 mm.

P. umbrifer is rare but persistent in Zone 2 faunas. Ornamentation varies with both ecologic and geographic factors, the most ornate forms coming from fine-grained sediments judged to reflect quiet water habitats. This species is highly prized by collectors.

The first known live taken specimen of *Pterorytis hamatus* (Hinds, 1844), the very rare Recent species from the eastern Pacific, was well illustrated and described by Emerson, 1985. Radular characteristics place the genus in the subfamily Ocenebrinae. As illustrated, it is very close to the *P. umbrifer* morphology. Forms morphologically intermediate between *P. umbrifer* and *P. conradi* Dall, 1890 occur at Tearcoat Branch, Sumter County, South Carolina. They may represent a new species (E. Vokes, 1988, personal communication).

Genus *Trophonopsis* Bucquoy, Dautzenberg and Dollfus, 1882

Very small, solid, fusiform shells with lamellar axial sculpture and a proportionally large, muricid protoconch. Many of the species in the Recent literature referred to *Trophonopsis* belong elsewhere (Emily Vokes, 1989, personal communication).

368. *Trophonopsis petiti* Campbell, new species. Shell very small, fusiform, elongate, solid. Nuclear whorls smooth, convex, inflated, of one and one half turns. Four and one half postnuclear whorls. Axial sculpture of thirteen lamellar, fluted ridges on body whorl. Spiral sculpture of six or seven cords on body whorl which flute the axial ridges, and three or four cords on siphonal canal. Siphonal canal short, open, straight. Aperture oval. Outer lip thickened, with crowded, thin lamellae on outer margin and six coarse denticles on interior. Columella smooth. Zone 2, Williamsburg. Type locality, *Chama* bed facies at Golden Horseshoe golf course equipment building, Williamsburg, Virginia; two specimens. Height 6.95 mm.

Named in recognition of Richard Petit, who has been a valued friend and resource throughout this study. Dr. Emily Vokes kindly examined the figured holotype, and determined that it belonged to *Trophonopsis*, a genus common in the boreal faunas of the Pliocene British Crag. This is the first record of the genus in the Pliocene of eastern North America, and adds another member to the small but growing list of Yorktown age molluscs with boreal affinities.

Genus *Boreotrophon Fischer, 1884*

"Moderate sized, fusiform, whitish shells with a long, slender siphonal canal. Varices usually lamellate, rarely spinosse" (Abbott, 1974: 189).

369. *Boreotrophon tetricus* (Conrad, 1832) (Synonyms: *Fusus tetricus* Conrad, 1832; *Trophon tetricus* (Conrad) Martin, 1904; *Eupleura candata* (Say) of Gardner, 1948: pl. 29, figs. 12-13, not of Say, 1822). Shell small, fusiform, turreted, thin-shelled and fragile. 8 rather straight-sided whorls; shoulder tabulated or sloping. Axial sculpture of 10-12 lamellar varices with a small spine at the shoulder. Spiral sculpture of 4-6 strong spiral threads which cross varices. Aperture rectangular; outer lip thin, not denticulate. Siphonal canal long, straight or somewhat curved, open, narrowly constricted at base of body whorl. Zone 1, Williamsburg; Zone 2, Williamsburg, Hampton, Chuckatuck, Smithfield and Chesapeake. Height 35 mm.

Martin (1904) erected a variety, *B. tetricus laevis*, for St. Marys (Maryland) Formation specimens in which the spiral sculpture is obsolete or nearly so. A similar form occurs at Rice's Pit, Hampton (369a); the Hampton form is also larger, and the spines are more prominent than in the typical Yorktown form (369) from other Zone 2 localities. Another morphotype is known from small, fragmented Zone 1 specimens with narrow, recurved, blade-like spines at the shoulder. Petuch (1988b:72) recently erected the name *Boreotrophon lindae*, for the St. Marys Formation specimens. If the Miocene and Pliocene populations prove to be distinct, *B. laevis* has priority over *B. lindae*.

Emily Vokes (1992, personnel communication) suggests that *Fusus tetricus* may be the most primitive *Eupleura*.

Family Coralliophilidae

Genus *Coralliophila* H. & A. Adams, 1853

"Aperture with a well-defined anterior canal. Spire evident, aperture shorter than shell length. Axial sculpture weak or very irregular" (Keen, 1971:543).

370. *Coralliophila leonensis* Mansfield, 1937. Shell small, fusiform, thin. Whorls 6+, with a prominent carina at shoulder. Axial sculpture of 8-10 well-rounded ribs. Spiral sculpture of numerous scabrous threads, 45-50 on body whorl; spirals very fine above shoulder, fine on body and fairly coarse on siphonal canal. Siphonal canal straight, with prominent fasciole. Zone 2, Chuckatuck. Height 18 mm. *Babelomurex lindae* Petuch, 1991, may be a synonym.

Family Columbellidae

Genus *Anachis* H. & A. Adams, 1853

"Distinguished by strong axial ribs on the spire that tend to fade toward the base of the body whorl; spiral sculpture various. The outer lip has teeth within in most forms, the inner lip smooth, or nearly so. The notch at the anterior end of the aperture is deep, but the anterior canal is short to absent" (Keen, 1971:576-7).

Subgenus *Costoanachis* Sacco, 1890

"Spire more tapering than in *Anachis*, *s. s.*, suture less indented, whorls tending to be flat, not tabulate; a short anterior canal in some species; columellar edge smooth or finely denticulate" (Keen, 1971:577).

371. *Anachis parvula* (H. C. Lea, 1843) (Synonyms: *Buccinum interruptum* Conrad, 1841, non Schroeter, 1805, non Brocchi, 1814; *Fasciolaria parvula* H. C. Lea, 1843; *Anachis reticulata* (Conrad, 1862); *A. harrisii* Dall, 1892; *A. milleri* Gardner, 1948; *A. avara similis* (Ravenel) of Gardner, 1948, not of Ravenel, 1861). Shell small, solid, tapering. 3 small, convex, smooth nuclear whorls and 6-7 postnuclear whorls. Axial sculpture variable, of 12-26 narrow ribs becoming obsolete on body whorl. Spiral sculpture of 4-8 cords on spire whorls, 16-30 cords on body whorl. Spiral cords much more crowded on base and on short siphonal canal. Outer lip with small posterior notch, 4 to 8 denticles within. Zone 1, Williamsburg; Zone 2, ubiquitous. Height 16 mm.

Dall, 1892, and Gardner, 1948, both overlooked Conrad's and Lea's older names for this species. Gardner's *A. milleri* from the Waccamaw beds falls within the range of variation shown by Virginia Yorktown populations. There may, however, be a trend in younger beds toward finer and more numerous ribs and spiral cords. Lea's holotype is a recognizable juvenile of this species.

372. *Anachis styliola* Dall, 1892 (Synonym: *A. s. obsoleta* Gardner & Aldrich, 1919). Shell slender, tapered, high-spired, small. Whorls 10. Axial sculpture of 16 to 18 narrow ribs with wider interspaces. Spiral sculpture fine on upper portion of whorl, coarsening over base. Suture narrowly channeled. Zone 2, Chesapeake. Height 13+ mm.

373. *Anachis virgilina* Gardner, 1948 (Synonym: *Anachis clappii* Mansfield of Richards, 1947, not of Mansfield, 1930). Shell small, solid, turreted, elongate. Whorls 8+. Axial sculpture of 24 low, narrow ribs with equal interspaces; ribs becoming obsolete on lower part of whorl. Spiral sculpture of threads which become more prominent on posterior half of body whorl. Suture marked by a wide, shallow channel. Spire outline sinuate. Zone 2, Hampton. Height 19 mm.

This may be a stout, coarsely sculptured varient of *A. styliola* Dall, but insufficient material is available to settle this question.

Genus *Parvanachis* Radwin, 1968

"Small, stout, with body whorl inflated, anterior canal short or wanting, outer lip thickened" (Keen, 1971:584). Squat, ribbed, *Anachis*-like forms with ventricose apertural lips, typified by *P. obesa* (C. B. Adams).

374. *Parvanachis obesa* (C. B. Adams, 1845). Shell very, small, stout, solid. Whorls 6-8, inflated. Axial sculpture of 20-30 narrow, straight ribs. Spiral sculpture of crowded, low threads. Outer lip thickened, flaring, denticulate within. Zone 2, Suffolk. Gardner, 1948, recorded this small species from Suffolk. It has not been subsequently recovered in the Virginia Pliocene.

Genus *Mitrella* Risso, 1826

"Small to very small, smooth, fusiform shells. Sculpture, if present, of incised spiral lines. Spiral sculpture is generally restricted to the anterior end near the base; axial sculpture is, with few exceptions, entirely absent. The outer lip is dentate in adult specimens" (Keen, 1971:590).

375. *Mitrella communis* (Conrad, 1862) (Synonym: *M. c. carolinensis* (Gardner & Aldrich, 1919). Shell small, broad, solid, smooth, evenly tapered. Whorls 8; body whorl broadly angulate; sharply angulate in juvenile shells. Sculpture of incised spiral lines on lower third of body whorl. Outer lip thickened, denticulate in adult. Exceptionally preserved specimens retain color patterns of axial flammules or numerous small round spots on a darker background. Zone 2, ubiquitous. Height 12.5 mm.

376. *Mitrella lunata* (Say, 1826) fide Gardner, 1948. Shell very small, solid, fusiform, biconic. 6 rounded whorls, smooth save for incised lines on lower 1/4 of body whorl. Zone 2, ? Suffolk.

Gardner's 1948 report of this species from Suffolk remains unconfirmed. She compared *M. lunata* to a "dwarf" *M. communis*, and the Yorktown record may in fact be the latter species. *Mitrella matsoni* Mansfield, 1924, from the equivalent Duplin beds of South Carolina, resembles *Mitrella lunata*, and could also be the basis for Gardner's record.

376a. *Mitrella harbisonae* Campbell, new name (Synonym: *Anachis* (*Alia*) cf. *fenestrata* (C. B. Adams, 1850) of Olsson and Harbison, 1953, p. 237, pl. 38, figs. 2, 2a). Shell very small, solid, elongate. Whorls 7-8. Spire elevated, flat sided, smooth. Periphery of body whorl rounded or with a slight angulation. Lower half of body whorl constricted, with strong spiral cords. Aperture narrow, denticulate on columella and outer lip. Chowan River beds at Chesapeake. Length, 8.5 mm. The designated holotype is ANSP 18530, Plate 38, figure 2 of Olsson and Harbison; type locality, St. Petersburg, Florida, Caloosahatchee Formation. The single Virginia specimen is recognizable but decrepit, and unsuitable for type designation. *M. fenestrata*, a Recent Caribbean shell, is more slender, with a less abrupt basal constriction and much weaker spiral sculpture.

Etymology: named for Miss Ann Harbison.

Subgenus *Astyris* H. & A. Adams, 1853

Very small, smooth, narrow shells with a thin, non-denticulate outer lip.

377. *Mitrella* (*Astyris*) *edenensis* Richards and Harbison, 1947 (Possible synonyms: *Fusus anomalous*, *Fusus pygmaeus*, *Buccinum frumentum*, and *Buccinum pusillum*, all H. C. Lea, 1843; *Mitrell waccomawensis* of Ward and Blackwelder, 1987, non Gardner, 1948. Shell very small, solid, smooth, elongate, pupoid. Whorls 5-6, well-rounded, slightly inflated. Surface smooth, devoid of sculpture. Outer lip thin, smooth, evenly curved; inner lip sinuate. Siphonal canal very short, straight. Zone 2, ubiquitous. Height 3.38 mm.

This shell resembles its probable descendant, *M.* (*A.*) *waccamawensis*, Gardner, 1948, but is consistently shorter, proportionally broader, with more inflated whorls and a larger protoconch. Some of H. C. Lea's four names may be intended for this common species, but the holotypes are very poorly preserved, fragmented shell which can not now be identified to genus with any confidence, and are here considered *nomina dubia*.

Dall (1890) described two small Neogene forms of *Mitrella* as *Astyris profundi minor* and *Astyris profundi permagna*.(*nomen nudum*). *Mitella* (*Astyris*) *profundi* is a common, rather stubby, abyssal species morphologically close to both *Mitrella edenensis* and to the following species. The unfigured type of *A. p. minor* is a smooth, small relatively broad shell specifically distinct from any mitrellid in the study area.

378. *Mitrella waccamawensis* Gardner, 1948. Shell very small, solid, smooth, elongate. Whorls 7, gently rounded. No sculpture present in Virginia population. Suture fine, narrow, but easily eroded. Aperture small. Outer lip thin, non-denticulate. Chowan River, Chesapeake. Height 4.90 mm.

Genus *Nassarina* Dall, 1889

"Small shells with both axial and spiral sculpture; whorls more rounded and sutures more deeply indented than in *Anachis*; spiral cords narrower than their interspaces" (Keen, 1971:593).

379. *Nassarina glypta* (Bush, 1885) (Synonym: *N. dalli* Olsson and Harbison, 1953). Shell very small, solid, elongate, turrid-like. Nuclear whorls 3, inflated; postnuclear whorls 5, gently rounded; suture narrow, incised. Axial sculpture of 12 narrow, beaded ribs with wider interspaces. Spiral sculpture of 3 fine threads between suture and shoulder, and 2 stronger cords at periphery. Body whorl and siphonal canal with 8-10 additional spiral threads below peripheral cords. Outer lip thin, denticulate within, with a posterior anal notch just below suture. Siphonal canal straight, constricted, rather long for the family. Zone 2, Chuckatuck and Chesapeake. Height 5.27 mm.

Gardner and Aldrich (1919) first reported *N. glypta* in the fossil record from the Duplin of South Carolina. Olsson and Harbison (1953) erected *N. dalli* on differences judged by Radwin (1977) to be trivial. The Yorktown specimens have 12 axial ribs while Recent shells off South Carolina have 10. Consequently, the axial ribs of Yorktown specimens are narrower, and are beaded rather than strapped by the spiral sculpture. Also, the two spiral cords are carried higher on the whorl, and the threads are narrower in Yorktown specimens. The significance of these differences can not be determined without larger populations than are now available.

Genus *Aesopus* Gould, 1860

Narrow, high spired, cylindrical shells with prominent spiral ribs and punctate interspaces. "The short aperture and small size are distinguishing features" (Keen, 1971:576).

380. *Aesopus stearnsii* (Tryon, 1883). Shell very small, narrow, cylindrical, bullet-shaped. Nuclear whorl large, blunt; postnuclear whorls 5-6, flat to gently rounded; suture a very narrow line. Spiral sculpture only, of numerous, low, crowded, irregular flat ribs; interspaces with vertically aligned, incised, narrow punctae. Zone 2, Chuckatuck and

Chesapeake. Height 4.04 mm.

Genus *Juliamitrella* Campbell, new genus
(type: *Aesopus gardnerae* Ward and Blackwelder, 1987). Very small, fusiform shells with a smooth protoconch of one to one and one-half whorls, and generally five to six postnuclear whorls. Whorls somewhat inflated, well-rounded. Spiral sculpture dominant, of crowded or widely-spaced threads. Axial sculpture absent or very subdued. Outer lip thin, nondenticulate. Named for Julia Gardner who first described and figured the type species of these small shells.

This genus has the general form of *Nassarina*, but lacks the prominent axial sculpture of that genus. Gardner (1948) figured three *Juliamitrella* species under *Aesopus*, but *Aesopus*, from the type of the genus, should include only small, solid, cylindrical shells with spiral sculpture and punctate interspaces.

Zemitrella Finlay, 1927 (as figured by Wenz, 1938) is very similar, but is an endemic New Zealand genus with denticles in the outer lip. Because no mitrellids with similar morphology are known in intervening waters, the similarity between the Western Atlantic Pliocene and the Tertiary and Recent New Zealand genus is better ascribed to convergence than to a common generic heritage. Gardner (1948) hesitated to name her specimens because of their juvenile appearance, but study of large populations demonstrates them to be adult shells.

381. *Juliamitrella chesapeakensis* Campbell, new species. Shell very small, fusiform, thin, fragile. Nuclear whorls 1 1/2, smooth, large, inflated. Post-nuclear whorls 3, gently rounded, moderately inflated. Spiral sculpture only, of 26-30 even, narrow, low threads with very narrow interspaces. Aperture oval. Columella with a low ridge that defines the siphonal canal. Pillar smooth save for growth lines. Siphon short, open, straight. Zone 2, Chesapeake. Type locality: Deep Creek pit, end of Cookes Mill Road, Chesapeake, Virginia. Height 2.88 mm.

Etymology: named for the type locality.

382. *Juliamitrella gardenerae* (Ward and Blackwelder, 1987) (Synonym: *Aesopus* sp. Gardner, 1948, pl. 28, fig. 33). Shell very small, fusiform, elongate. Spiral sculpture of 14-16 prominent, raised, narrow cords on body whorl and siphonal canal; cords strongest on periphery of whorl. Interspaces very wide on whorl but narrow on siphon. Axial sculpture of very low, broad, undulatory ripples which gently scallop the spiral cords, and of exceedingly fine raised lines which cross the spiral cords, but which are more prominent in interspaces. Zone 2, Williamsburg, Suffolk, Hampton, Smithfield and Chesapeake. Height 3.4 mm.

383. *Juliamitrella smithfieldensis* (Mansfield, 1929). Shell very small, fusiform, rather fragile. Nuclear whorls 1-1/3 large, smooth, inflated. Postnuclear whorls 3-4. Spiral sculpture only, of 11 broad, grooved ribs on body whorl with narrow, deep interspaces. Zone 2, Suffolk and Smithfield. Height 3.37 mm.

384. *Juliamitrella virginica* Campbell, new species. Shell very small, fusiform, elongate, solid. Nuclear whorls 1 1/2, smooth, rounded; postnuclear whorls 4-5, well-rounded; suture narrow. Spiral sculpture only, of 13-15 cords on body whorl with somewhat narrower interspaces. Spiral cords strongest at periphery. Aperture oval. Outer lip thin, nondenticulate. Columella with low ridge marking the beginning of the siphonal canal. Chowan River beds, Chesapeake. Type locality is Deep Creek pit, end of Cookes Mill Road, Chesapeake, Virginia. Height 5.59 mm.

This shell is nearly twice the size of the other *Juliamitrella* species described above.

Etymology: named for the state of Virginia.

Family Buccinidae

Genus *Buccinum* Linne, 1758
Large, thin, inflated shells with a large, flaring aperture and very short canal. Spiral and axial sculpture usually present.

385. *Buccinum* sp. Shell moderate to large, thin, easily weathered. Whorls 5+, rounded to well-rounded. Spiral sculpture of 14-16 wide, flat cords with equally wide interspaces. Axial sculpture of 10-12 rounded, oblique ribs. Spire of variable proportions. Zone 2, Chuckatuck; Chowan River, Chesapeake, and Chowan River, North Carolina. Height 27 mm (incomplete).

This genus is represented in the Yorktown by very rare and imperfect material from Chuckatuck (VA) and single Chowan River specimens from the Chowan River (NC) and at Chesapeake. These fossils fall within the range of variation shown by *Buccinum undatum* Linne, 1758, Recent in cold water of both the Eastern and Western Atlantic, and Pliocene in the British Crag, but it is thought best not to unite them until better fossil material is available. A second Yorktown species of *Buccinum* is in a private collection unavailable to this study.

Genus *Tortifusus* Conrad, 1867
(Synonym: *Meganema* Conrad, 1868)
"Fusiform; ribs revolving; columella with a slight oblique groove as in *Sycotypus* (i.e..*Busycon*); beak long, twisted, lip entire within. This shell differs from *Lirosoma* in being without longitudinal ribs or varices, and without a prominent fold on the columella, which is very similar to that of *Sycotypus* with its oblique, slight groove. It differs from the species of the latter genus in its prominent, equal revolving ribs, and want of lines on the interior of the labrum" (Conrad, 1867:187). (type: *Lirosoma curvirostra* Conrad, 1864).

Meganema Conrad, 1868, shares the same unique genotype with *Tortifusus* Conrad, 1867. Wenz, 1940, synonymized *Tortifusus* with *Lirosoma* Conrad, 1862, but the two have little in common. Conrad stressed the columellar form like *Busycon* (*Sycotypus*) and Gardner (1948) described a fragment as *Busycon chowanense* because of this similarity. *Tortifusus* appears, from Conrad's illustration of the lost type and the rare, very fragmentary remains at hand, to be a buccinid related to *Colus* Roding, 1798.

The supposed *Busycon* affinities of *Tortifusus* may have influenced Wenz to place *Lirosoma* next to the *Busycon* in the Melongenids. The Pleistocene shell, *Neptunea stonei* Pilsbry, 1893, very likely is a *Tortifusus*, and Dall's 1894 report of *N. stonei* as an internal mold from the Pliocene of

Martha's Vineyard may be a reference to *T. curvirostra*.

386. *Tortifusus curvirostra* (Conrad, 1864) (Synonym: *Busycon chowanense* Gardner, 1948). Shell large, fusiform, thin. Whorls 5+, with tabulated shoulders and strong, spiral cords. Siphon long, bent to the left. Axial sculpture lacking. Zone 2, Chesapeake, Yorktown. Height 70 mm.

Petuch (1988, p. 75, pl. 11, fig. 7) has illustrated a strongly grooved *Busycon* as *B. chowanense*. It is a true *Busycon*, and not conspecific with Gardner's taxon.

Genus *Ptychosalpinx* Gill, 1867

Moderately sized, solid, ovate shells with variable, strong sculpture, larger apertures, and short, oblique siphonal canals.

This genus is common in many Yorktown localities, and present at most. The shells show an unusually high incidence of predatory naticid borings. The genus *Ptychosalpinx* is first encountered in the Middle Miocene Calvert fauna of Maryland, represented by *P. lienosa* (Conrad, 1841) (including *P. multirugata* Conrad of Martin, 1904, not of Conrad, 1841), and again in the St. Marys Miocene, represented by *P. altile* Conrad. Within the Yorktown fauna, Zone 1 beds have yielded rare specimens of *P. altile*, but it is in the Zone 2 fauna that the genus reaches its zenith. These species are apparently of cold water affinities since the only living representatives of this and the closely related *Liomesus* Stimpson, 1865, are all characteristic of Arctic, Boreal or deep water faunas. The fossil distribution supports this affinity, as *Ptychosalpinx* spp. are rare components of the Duplin (Carolina) fauna and in Florida are reported only from the *Ecphora* Zone of Mansfield, 1930 and from very rare Pinecrest material (Petuch, 1991). As a component of the shallow shelf community they apparently became extinct at the end of Yorktown-Duplin time. The unusually high incidence of predation has already been mentioned (133 bored specimens, 1 attempted boring, and 28 unbored specimens in one lot). The very large protoconch and the rarity of juvenile specimens suggest a very low rate of fecundity, which would be greatly disadvantageous under conditions of selective predation. Speciation in the upper Yorktown beds is very difficult to interpret. Six names have been proposed for Yorktown *Ptychosalpinx*, and Gardner, 1948, has illustrated many of the types. Of these, I recognize four holotypic species and describe a fifth as new. However, a through biometric study may prove at least three of these five to be end members of a single variable species.

KEY TO THE YORKTOWN *Ptychosalpinx*

1a. Adult shell greater than 50 mm in maximum length 2
1b. Adult shell less than 50 mm in length 3
2a. Whorls tabulated, suture channeled ..... *P. tuomeyi*
2b. Whorls rounded, suture not channeled ..... *P. multirugata*
3a. Spire elevated, shell relatively slender ..... *P. laqueata*
3b. Spire short 4
4a. Shell with strong, coarse spiral threads and wide, channeled interspaces ..... *P. chesapeakensis*
4b. Shell with fine, rippled spiral threads with narrow, incised interspaces ..... *P. altile*

387. *Ptychosalpinx altile* (Conrad, 1832) (Synonyms: *P. altilis* Conrad, of Gill, 1867, unnecessary emendation; *P. bilix* (Conrad, 1843)). Shell solid, thin to rather thick, small to moderate in size. Whorls 6, gently rounded. Axial sculpture of coarse growth lines and, in some races, of 14-16 strong rounded ribs which become obsolete towards the siphon. Spiral sculpture incipient on third whorl but of equal strength with the growth lines on the fourth whorl, producing a cancellate pattern; spiral sculpture becoming dominant, of irregular, alternating flat threads, lines and fine lines. Spirals coarser at base, and at shoulder of whorls. Zone 1, Middlesex County; Zone 2, Williamsburg, Yorktown, Hampton, Smithfield, Chuckatuck, Chesapeake. Height 36 mm.

Gardner's 1948 illustration of the broken type of *P. bilix* includes a portion of the characteristic cancellate whorl. A perfect specimen of the *bilix* form (387a), recovered from the James River cliffs near Smithfield, is clearly conspecific with *P. altile* differing only in the absence of axial ribs.

388. *Ptychosalpinx chesapeakensis* Campbell, new species. Shell of moderate size, solid, thick, relatively broad. Nuclear whorls 2, smooth, well-inflated. Post-nuclear whorls 4-5, slightly tabulated, well-rounded. Axial sculpture of many very low, rude, narrow sinuous riblets best observed by looking down on the spire: growth lines coarse; outer lip may be flaring, former resting stages marked by a thin lamella at irregular intervals. Spiral sculpture of 17 to 22 coarse ungrooved cords, triangular in cross-section. Shell width variable. Aperture oval, oblique; outer lip thin, crenulate, occasionally weakly flaring. Inner lip with a thick, polished parietal shield. Siphonal fasciole with crowded lamellae. Zone 2, Chesapeake. Type Locality: Deep Creek pit, end of Cooke's Mill Road, Chesapeake, Virginia. Height 41 mm.; width 26 mm.

Etymology: named for the City of Chesapeake.

389. *Ptychosalpinx laqueata* (Conrad, 1832) (Probable synonym: *Ptychosalpinx perprotractus* Petuch, 1991). Shell solid, thick, of moderate size. Whorls 7, gently rounded. Spire elvated but variable. Axial sculpture of 15-16 low, rounded ribs, becoming obsolete anteriorly. Spiral sculpture irregular, of generally alternating threads and fine lines coarsening near suture and siphon; interspaces narrow. Outer lip crenulated by sculpture. Inner lip with two folds on columella reflecting the expansion of the lip over the raised edges of siphon and siphonal fasciole. Zone 2, Petersburg, Yorktown, Hampton, Chesapeake, Williamsburg, Chuckatuck, Suffolk, Smithfield. Height 45.5 mm.; width 26 mm.

Spire height is variable, and some specimens are difficult to assign to *P. laqueata* or *P. altile*. If the two species prove conspecific, *P. laqueata* has page priority.

390. *Ptychosalpinx multirugata* (Conrad, 1841). Shell of moderate size, solid, high spired. Spire tapering, not tabulate. Axial sculpture wanting. Spiral sculpture of narrow threads which coarsen at suture and base of shell. Zone 2, Smithfield, Suffolk, Chesapeake. Height, 49 mm.

This form may in turn prove to be an exceptionally large *P. altile*. Conrad cited a two inch length for his unique specimen, but the "holotype" is only half of that measurement. Hence, it appears the presumed type may not be

Conrad's original, or that the published dimensions are erroneous.

391. *Ptychosalpinx tuomeyi* (H. C. Lea, 1843) (Synonym: *P. fossulata* (Conrad, 1843 [1844]). Shell large, thin, inflated; of 5-7 whorls. Axial sculptu of growth lines only. Spiral sculpture of 70-90 fine threac and lines, coarsening on the base and siphon. Suture channeled, whorls tabulate at the shoulder suture. Nuclear whorls may be broadly domed (form *P. fossulata*) or narrow and rapidly descending. Zone 2, Petersburg, Yorktown, Smithfield, Chuckatuck, Sycamore, Hampton, Chesapeake. Height 54 mm, width 33 mm.

Conrad's name was not published until 1844, giving Lea's priority. As with all *Ptychosalpinx*, *P. tuomeyi* varies considerably in relative proportions. However, the large size, tabulated shoulder, and fine sculpture distinguish it.

Formerly Family Colubrariidae, now Cancellaridae

Genus *Tritonoharpa* Dall, 1908

"Sculpture mainly axial, not regularly concellate; aperture more than one-half the shell length" (Keen, 1971:511).

392. *Tritonoharpa aclinica* (Tucker and Wilson, 1933) (Synonym: *Colubraria aclinica* Tucker and Wilson, 1933). Shell small to medium size, high spired, elongate, fragile. Nuclear whorls 2 1/2, smooth; initial whorl involute; 6-8 postnuclear whorls. Axial sculpture of about 36 thin, low threads with equal interspaces; a varix is formed just behind the outer lip, and former varices occur at 2/3 whorl intervals. Spiral sculpture of 45-50 threads on body whorl and siphon; spiral threads irregular and alternating in strength, becoming obsolete on siphon; every fourth spiral may be stronger. Aperture elongate, nearly 1/2 the length of shell. Zone 2, rare at Chuckatuck Height 18 mm.

Beu and Maxwell (1987) which document two very different groups, one a true buccinid line, the other cancellarid, lumped under the traditional genus *Colubraria*. All Pliocene species of the southeastern United States appear to be congeneric with *Tritonoharpa lanceolata*.

Any long term monographic study will reach a point of committment to a particular order. Neither *Tritonoharpa* nor the *Ecphora* which follows are buccinids, but the best literature available at the beginning of this work so placed them. They are retained here for compatibility with plates and appendicies, but should be placed in their proper systematic order in subsequent works.

Genus *Cantharus* Roding, 1798

(*Pisania*, *Pollia*, *Pseudoneptunea*, *Tritonides* of authors)

"The type species, *C. tranquebaricus* (Gmelin, 1791), is from the Indian Ocean, a solid, short shell with a rapidly tapering spire, impressed sutures, low axial folds, and numerous irregular spiral ribs. The siphonal fasciole is large and the aperture ovate, with a short canal" (Keen, 1971:558).

393. *Cantharus (Celatoconus) nux* (Dall, 1892). Shell small, fusiform, thin, solid. Two smooth, rounded nuclear whorls; five post-nuclear whorls. Spiral sculpture of 20-24 primary threads beaded or granulated by axial sculpture; secondary sculpture of spiral lines alternating with threads may be present. Axial sculpture finer than spiral, of 80-100 subequal threads on body whorl. Body whorl narrow to inflated. Aperture 2/3 the length of shell; outer lip thin, crenulate to finely denticulate within. Zone 1, Williamsburg; Zone 2, Yorktown, Hampton, Suffolk and Chuckatuck, Height, 16 mm.

Formerly Family Buccinidae, now Family Thaididae

Genus *Ecphora* Conrad, 1843

Large, broad, calcitic shells with loosely coiled adult whorls and a flaring umbilicus. Aperture oval to round. Interior of shell lined with a white, often chalky, aragonitic layer.

I initially followed Dall (1916:7) who placed *Ecphora* between *Searlesia* and *Stenomphalus* in the Buccinidae. More recently, Wilson (1987) and Kool (1988, personal communication) have argued convincingly for a thaid placement.

394. *Ecphora quadricostata* (Say, 1824) (Synonyms: *Fusus 4- costata* Say, 1824; *Fusus umbilicatus* Wagner, 1837, in manuscript; *Colus quadricostatus* Say Tuomey and Holmes, 1856; *Fusus umbilicatus* Wagner Dall, 1898, non Smith, 1839, non Philippi, 1851; *Ecphora parvicostatus* Pilsbry, 1911; *Ecphora striatula* Petuch, 1986; *Ecphora quadricostata* (Say) Wilson, 1987; *Ecphora quadricostata* (Say) Ward and Gilinsky, 1988; *Ecphora hertweckorum* Petuch, 1987; *Ecphora violetae* Petuch, 1988a; *Ecphora floridana* Petuch, 1988b; *Ecphora quadricostata rachelae* Petuch, 1988b; *Ecphora mansfieldi* Petuch, 1988b; *Ecphora quadricostata leecreekensis* Petuch, 1988b; *Ecphora pachycostata* Petuch, 1988b; *Ecphora hopei* Petuch, 1991; *Ecphora roxaneae* Petuch, 1991). Shell large to very large, calcitic, widely and openly coiling in the adult. Nuclear whorls 2 1/2, rounded, smooth; 6-8 postnuclear whorls. Axial juvenile sculpture of lamellar threads which become obsolete with continued growth. Spiral sculpture of four strong rectangular or "T" shaped ribs which may have a shallow central groove. Aperture oval to round. Siphonal canal straight and shallow in young shells; becoming deep and obliquely twisted in subadult and adult growth. Umbilicus absent in young shells, becoming deep and flaring as a consequence of the twisted siphon and loose coiling of adult. Zones 1 and 2, ubiquitous; Chowan River beds at Chesapeake (reworked, worn fragments only). Height 68 mm.

Large specimens typically 80 to 100 mm, but rarely exceeding 150 mm. The "T" form ribs are more frequently developed in Zone 1 faunas.

Petuch's (1986-1991) myriad species are here considered to represent minor variations. Large populations from the Pliocene of Virginia and South Carolina justify recognition of only two species-level taxa, *Ecphora quadricostata* and *Ecphora bradleyae* Petuch, 1986, the latter restricted to southern North Carolina, northeastern South Carolina, and Florida.

Family Melongenidae

Genus *Busycon* Roding, 1798

Subgenus *Busycon* Roding

Large heavy pyriform shells commonly keeled or noded at shoulder.

395. *Busycon maximum maximum* (Conrad, 1839) (Synonyms: *Pyrula carica* Gmelin of Say, 1824, Lyell, 1845 and H. C. Lea, 1845, not of Gmelin, 1791; *Fulgur maximus* Conrad, 1839; *Pyrula nansemondi* "Wagner" Dall, 1898). Shell very large, pyriform, heavy, solid. Spire conic, frequently with spiral grooves above shoulder. Shoulder rounded, smooth or with nodes per whorl. Siphonal canal long, wide, open, not constricted at the base. Zone 2, ubiquitous. Height (incomplete) 238 mm.

Variation in *B. maximum* parallels that in the Pleistocene and Recent *B. carica*, its probable descendant species, in having both smooth and knobbed shouldered varieties. A third parallel set of morphotypes has stronger sculpture, shoulder spines, and a broad swollen ridge at the base of the canal. They have been called *B. carica eliecens* Montford, 1810, and *B. maximum filosum* Conrad, 1862.

396. *Busycon maximum filosum* Conrad, 1862 (Synonyms: *Busycon tritonis* Conrad, 1863; *Fulgur fusiforme* Conrad of Twardy 1936, not of Conrad, 1841). Shell large, as in *B. maximum*, but with spines at shoulder, with a swollen ridge at base of canal, and frequently with outer lip flared, producing low, fluted costae at the resting stages. Zone 2, Wiliamsburg, Yorktown, Hampton. Height 125 mm.

The type lot of *B. filosum* contains three specimens. The first is an 85 mm specimen with crowded spiral threads, nodes at the shoulder, and widely spaced lines inside the aperture; the base of the siphonal canal is marked by the characteristic spiral buldge. Acompanying labels identify it as the specimen figured by Conrad (1867, pl. 21, fig. 7) from North Carolina (ANSP 14307). No matrix is visible in the aperture. The shell surface is slightly chalky and colored a brownish gray. The second specimen, 44 mm in length, is like the first but less well preserved. The acompanying label states "Mioc. N. car., Va." (ANSP 14310). The third specimen (also ANSP 14310) is 125 mm long, with spiral cords becoming obsolete at mid-whorl, and with low spire nodes coarsening on the body whorl. The base of the siphonal canal is swollen, with low, rough, axial lamellae. Matrix in the aperture is a fragmental shell sand. The shell is here figured as figure 396. Conrad (1862:286) states that *B. filosum* had a long canal and was found only at "Yorktown, Virginia," where it was "rather common." This is the same type locality as his *B. tritonis*, described the following year. Of the three specimens, only the third and largest has an unbroken and therefore "long" canal, and only the third shows color, shell condition, and matrix typical of Yorktown cliff specimens. I therefore conclude that the two smaller specimens constitute the "North Carolina" part of the type lot, and that they were added between 1863 and 1867. ANSP 14307 is Conrad's 1867 figured hypotype.

Subgenus *Busycotypus* Wenz, 1943

Large *Busycon* with thin shells, an inflated body whorl, a keel at the shoulder, and a channeled suture.

397. *Busycon canaliferum* Conrad, 1862 [1863] (Synonyms: *B. carolinensis* Emmons, 1858, not of Holmes, 1857). Shell large, pyriform, rather thin. Whorls 6-7, gently rounded. Shoulder and suture keeled; shoulder keel with low nodes becoming obsolete on later whorls. Suture narrowly channeled. Sculpture of fine spiral lines becoming obsolete on middle of body whorl. Siphonal canal twisted to left. Zone 2, Suffolk, Chesapeake. Height 88 mm.

B. canaliferum resembles both *B. incile* Conrad, and the Pleistocene and Recent *B. canaliculata* (Linnaeus, 1758). From the former, *B. canaliferum* can be separated by its greater space between shoulder and suture keels, the narrow sutural channel, finer sculpture, and the lack of a swollen body whorl in the adult. From the Recent shell, *B. canaliferum* differs in having a lower spire, broader shoulder, heavier shell, and more twisted siphon.

398. *Busycon incile* (Conrad, 1833) (Synonyms: *Fulgur canaliculatus* Linnaeus of Say, 1824, not of Linnaeus, 1758; *Busycon conradii* (Tuomey & Holmes, 1856); ? *Busycon alveatum* Conrad, 1863; *B. aepynotum* (Dall, 1890); *B. pyrum propeincile* Mansfield, 1930). Shell large to very large, thin to moderately heavy. Whorls 7-9, flat-sided in juvenile shells, but very rounded and swollen in adult stage. Shoulder and suture keeled; shoulder keel noded only in earliest whorls. Sculpture of coarse, irregular spiral threads, very prominent on juvenile shells, but lower and becoming obsolete at mid-whorl in adults. Sutural channel wide. Siphonal canal constricted at base. Zone 1, Williamsburg; Zone 2, ubiquitous. Height (incomplete) 186 mm, may exceed 250 mm.

Juvenile (398a) and adult shell form are very different in this species, but adolescent intermediate morphotypes easily connect the two. The size of the adult morphology is also variable, ranging from less than 60 mm to over 300 mm. The holotype of *Busycon alveatum* Conrad, 1863 (figure 398b) appears to be a fragmented and river-worn specimen of Yorktown dwarf adult *B. incile*. Conrad (1863) stated that he was unsure whether his specimen came from Maryland or Virginia. The type is labeled "St. Marys River, Md.", and Petuch, 1988, has figured St. Marys material which may be conspecific with the holotype. Resolution of the problem is beyond the scope of this study.

Subgenus *Sinistrofulgur* Hollister, 1958

As in typical *Busycon*, but left coiling.

399. *Busycon contrarium* (Conrad, 1840) (Synonyms: *Busycon perversum* Linnaeus of Tuomey and Holmes, 1856, not of Linnaeus, 1758; *Busycon adversarium* Conrad, 1862; *Fulgur obrapum* Grabau, 1903; *Fulgur obfilosum* Grabau, 1903; *Busycon perversum robesonense* Gardner, 1948; *Busycon sinistrum* Hollister, 1958; *Sinistrofulgur roseae* Petuch, 1991). Shell large to very large, pyriform, sinistral, slender for the genus. Whorls 6-8, gently rounded. Spire low to rather elevated, gently concave. Periphery of shoulder may be rounded, keeled by a strong cord, noded, or spinose. Sculpture of coarse, irregular spiral threads. Zone 2, ? Yorktown; Chowan River, Chesapeake. Height of spire fragment 5 mm.

B. contrarium is a common, large and conspicuous member of the Duplin and Waccamaw faunas of the Carolinas, but is exceedingly rare in Virginia. Clark and Miller (1912) recorded it from Yorktown. A single fragment found in the course of this study establishes it as part of the Virginia Chowan River also.

Genus *Lyrasoma* Conrad, 1862

Small shells with a short, tabulate spire, inflated body whorl, and long, narrow siphon.

A low ridge, hardly more than a thickening of the columella, marks the point of apertural constriction. It is apparenly this feature that led Dall (1890) and Wenz (1940) to place *Lyrasoma* next to *Busycon*; I am not satisfield with this placement. The size, general shell form, and especially the protoconch closely resemble *Scalaspira* Conrad, 1862 (type: *Fusus strumosus* Conrad, 1830) which most authors place in the Muricidae. *Lyrasoma* is here provisionally retained in its traditional position until this question is more extensively studied.

400. *Lyrasoma sulcosa* (Conrad, 1830). Shell small to medium size, fusiform, rather strong. Whorls 6, inflated, tabulated at shoulder. Axial sculpture of 25-26 riblets which bead the dominant spiral sculpture and become obsolete on siphon. Spiral sculpture of 7-8 flat threads on body whorl and finer, more numerous, threads on siphon. Zone 2, Hampton, Smithfield, Chuckatuck, Chesapeake. Height 29 mm.

The illustrated specimen hosted the barnacle *Concavus finchii* Lea, 1833, and the flat slipper snail *Crepidula plana* (Say, 1822), the latter indicating a period of hermit crab occupancy.

401. *Lyrasoma sulcosa multicostata* Olsson, 1914. Shell as in *L. sulcosa*, but with 10-12 spirals on body whorl, and 34-35 axial riblets. Zone 1, ubiquitous. Height 23+ mm.

Family Nassariidae

Genus *Nassarius* Dumeril, 1806

"The distinctive shell feature of the genus is the fossa, a deep groove on the base of the shell around the siphonal fasciole and the slotlike recurved canal. Sculpture is apt to be cancellate, the spire tapering, the aperture rounded and lirate within. The operculum is ovate and small for the size of the aperture, has an apical nucleus, and is notched along the edges in some species" (Keen, 1971:604).

While an exhaustive treatment of *Nassarius* is not possible here, a short summary of Atlantic Coastal Plain usage may be helpfull. Most of the early work referred the various species to *Buccinum* Linnaeus, but *Nassa*, *Trita*, *Ptychosalpinx*, *Paranassa*, *Alectrion*, *Uzita* and other genera were also used. I recognize two genera, *Nassarius* and *Ilyanassa*, within our American East Coast Neogene. Cernohorsky (1975) cautioned against the use of multiple genera and subgenera until the tangled synonymies, genotypes and supposed genotypes are unraveled.

Cernohorsky (1984) published world-wide species lists which include the most thorough listing of Western Atlantic fossil and Recent species anywhere in print. In that work he continued to use the genus *Nassarius* for all species found in the study area.

402. *Nassarius consenoides* (Olsson, 1916) (Synonyms: *Nassarius albus* Say of Campbell and others, 1975, not of Say, 1826; not *Uzita consenoides* (Olsson) Gardner, 1948, pl. 30, figs. 8 & 14). "Shell small, with a proportionally large, rounded body-whorl and a pointed spire; rather numerous, low, straight ribs, which are crossed by unequal spiral bands; nucleus of 3 pointed whorls, smooth at first, but with a few ribs on the later portion; post-nuclear whorls 5; the body whorl with 15 straight, low ribs; spiral sculpture of irregular bands; ...the body-whorl with about 21 spirals, strongest on the middle of the whorl" (Olsson, 1916: 13). Zone 2, Chuckatuck. Height 11+ mm.

This is the largest, and proportionally the broadest, of the Yorktown *Nassarius* species.

Earlier (Campbell and others, 1975), I followed Gardner's (1948) error in confounding the small, squat varieties of *N. quadrulatus* (see below) with *N. consenoides*. True *N. consenoides* from Chuckatuck were then referred to *N. floridensis* Olsson and Harbison, 1953, which Abbott (1974) synonymized with the Recent *N. albus* (Say, 1826). *N. albus* has frequently been cited as the senior synonym of *Nassarius consensa* (Ravenel, 1861), but Cernohorsky (1984:40) states that *N. albus* is a composite of two distinct species and *N. consensa* is valid and distinct from both. Olsson (1916) named his species as ancestral to *N. consensa*. *N. consenoides* is here considered to be a valid Middle Pliocene species, ancestral through the Upper Pliocene *N. floridensis* to *N. albus* of the Recent fauna. Whether *N. floridensis*, should be considered a subspecies of *N. consenoides* or *N.albus*, or valid in its own right, is beyond the scope of this study.

403. *Nassarius quadrulatus* (H. C. Lea, 1843) (Synonyms: *Nassa impressa* H. C. Lea, 1843; *Buccinum (Tritia) praerupta* Conrad, 1844; *Uzita suffolkensis* Gardner, 1948; *Uzita consenoides* (Olsson) of Gardner, 1948, pl. 30, figs. 8 & 14, not of Olsson, 1916; *Uzita neogenensis* (Gardner and Aldrich) of Gardner, 1948 (Yorktown records), not of Gardner and Aldrich, 1919; *Uzita smithiana* (Olsson) of Gardner, 1948 (Yorktown records), not of Olsson, 1916; *Uzita chowanensis* Gardner, 1948; *Nassa bidentata* (Emmons) of Clark and Miller, 1912, not of Emmons, 1858). Shell very small, thin, high spired; outline typical of genus. Two smooth, rounded nuclear whorls and 5-7 postnuclear sculptured whorls. Axial sculpture of 10-14 narrow ribs with wider interspaces, and microscopic growth lines. Spiral sculpture of 8-11 threads; threads and interspaces of variable width; when viewed in profile the shoulder thread appears doubled; threads finer at suture. Aperture oval; outer lip round, with 8 denticles inside, coarsening towards siphon. Siphonal canal short, twisted. Zone 2, ubiquitous. Height 10.4 mm. (Type of *U. suffolkensis* is here illustrated).

After careful study of several large populations, I am convinced that there is but a single, variable species of small *Nassarius* in Zone 2 Yorktown faunules. *N. consenoides* (Olsson, 1916), very rare in the Virginia Yorktown, is a much larger and stouter species. Compared to *N. quadrulatus*, *N. moniliformis* (Emmons, 1858) (synonym: *N. neogenensis* (Gardner and Aldrich, 1919)), a Waccamaw species, is larger, more elongate, with the spiral sculpture becoming obsolete in the inter-rib area. *N. smithianus* (Olsson, 1916), a Duplin species, is likewise larger, with stronger, higher axial ribs and coarse, spiral cords which are prominent in the inter-rib area, and which expand as they cross the axial ribs. *N. smithianus* may prove to be a subspecies of *N. moniliformis*, and both may eventually prove to be local varients of *N. quadrulatus*. *N. quadrulatus* also varies in the number and

size of spiral threads on the body whorl. The 10 to 12 spiral grooves may be very narrowly incised lines (*Uzita suffolkensis*), wide channels (*U. chowanensis*), or of intermediate width. The widths of spiral threads and grooves are inversely proportional.

Lea's *Buccinum quadrulatum* was immature and had not developed the characteristic nassoid outer lip, but it has single page priority over *Nassa impressa* of the same author.

404. *Nassarius shacklefordensis* (Olsson, 1916). Shell very small, solid. Whorls 6 1/2, turreted. Axial sculpture of 15 narrow, low ribs with wide interspaces. Spiral sculpture finer than axial, of 7 or 8 narrow cords on body whorl with wider interspaces; cords strongest at shoulder, progressively declining in strength anteriorly. Aperture oval; outer lip broken; siphonal canal short, twisted to left. Zone 1, Shackleford. Height 6.35 mm.

Compared with the above species, this form is smaller, with more numerous and very narrow ribs. It is probably ancestral to the Zone 2 *N. quadrulatus*.

Genus *Ilyanassa* Stimpson, 1865

Small, rough, somewhat inflated nassoid shells. The genotype, *I. obsoleta* (Say, 1822), is the only living representative, but this genus was well diversified in Yorktown time. *I. obsoleta* is characteristic of mud flats, intertidal and shallow subtidal protected inshore habitats where it feeds on diatom ooze.

Gardner, 1948, provides the most extended discussion, and her Yorktown generic assignments are followed here. She translates "*Ilyanassa*" as "queen of the mud," a most apt name for the Recent shell.

405. *Ilyanassa granifera* (Conrad, 1868) (Synonym: *Ptychosalpinx* (*Paranassa*) *granifera* Conrad, 1868; non *Nassarius granifer* (Kiener, 1834), non DuJardin, 1837). Shell small, solid, ovate, conical. Whorls 7-8. Axial sculpture of 25 narrow, rather sharp ribs beaded or granulated by spirals. Spiral sculpture of 14 coarse threads on body whorl; spiral and axial sculpture of equal strength. Aperture oval, with 6 denticles inside the outer lip. Zone 2, Yorktown, Petersburg, and Williamsburg. Height 18 mm.

Cernohorsky (1984:43) further notes that *Buccinum graniferum* Kiener, 1834 belongs in *Nassarius*. Therefore, *Ilyanassa granifera* is a secondary homonym of *Nassarius granifer* (Kiener, 1834) if *Ilyanassa* is a synonym of *Nassarius* or if it merits only subgeneric status.

Conrad described this species as *Ptychosalpinx granifera*, thereby avoiding primary homonymy with *Nassa granifera* Dujardin, 1837. The name should remain valid so long as the generic asignment of *Ilyanassa* is maintained. *I. granifera* is likely ancestral to *I. irrorata* (Conrad, 1863), a higher spired, larger species from the Waccamaw faunas. For further discussion, see *I. sexdentata* (Conrad, 1844) (below).

406. *Ilyanassa harpuloides harpuloides* (Conrad, 1844). Shell small to medium in size, solid, with a high, tabulated spire. Whorls 7-8; body whorl large. Axial sculpture of 13-18 strong, sinuous ribs with wider, irregularly spaced interspaces. Spiral sculpture of 10-12 strong threads, and of fine, crowded lines covering threads and interspaces alike: fine lines arise oblique to the suture. Zone 2, Petersburg, Yorktown, Williamsburg, and Chuckatuck; Chowan River at Chesapeake. Length 29 mm.

___. *Ilyanassa harpuloides gastrophila* (Olsson, 1916). (See Appendix I.) This form has the coarse sculpture reduced in number and strength. Its validity as a distinct taxon is questionable.

407. *Ilyanassa harpuloides johnsoni* Dall, 1892. Shell small, squat, rather solid; spire short, conical, concave of slope, rapidly tapering. Whorls 6+, well rounded. Axial sculpture of 18-20 narrow, slightly oblique riblets. Spiral sculpture of 26 fine, fairly even threads. Aperture large, with a large parietal shield extending well beyond the inner lip. Siphonal canal deep, very short. Zone 2, Williamsburg, Suffolk. Height 18 mm.

I. h. johnsoni differs from the typical *I. h. harpuloides* in having a short, stubby spire, and finer and more numerous axial ribs.

408. *Ilyanassa harpuloides scalaspira* (Conrad, 1868). Shell like *I. h. harpuloides* but shorter, having a proportionately lower spire, more tabulated shoulders, and a tendency for the stronger spiral sculpture to become obsolete. Zone 2, Petersburg, Williamsburg, Yorktown; Chowan River at Chesapeake. Height, 23 mm.

Most systemists have treated *I. harpuloides*, *I. johnsoni*, and *I. scalaspira* as distinct species, and the shells illustrated herein are certainly distinctive. However, larger populations show intergradation of every trait. The three names are well entrenched in the literature, but I believe them to be morphotypes with dubious biological validity, even at the subspecies level.

___. *Ilyanassa isogramma* Dall, 1892. Yorktown records of this species cited in the original description are here rejected (see Appendix II).

___. *Ilyanassa obsoleta* (Say, 1822). Gardner (1948) states that she doubted the authenticity of this species in the collections from Suffolk. No other pre-Pleistocene records exist to my knowledge, and I therefore concur with Miss Gardner.

409. *Ilyanassa porcina* (Say, 1824) (Synonyms: *Buccinum aratum* Say, 1824; *Tritia idonea* Conrad, manuscript name; *Tritia ovata* Meek, 1864). Shell of medium size, stout, solid, rather inflated. Spire conic. Whorls 7-9. Spiral sculpture only, of 20-24 flat, narrow threads becoming obsolete with adult growth. Zone 2, Petersburg, Williamsburg; Chowan River at Chesapeake. Height 24 mm.

Gardner (1948) correctly noted that *I aratum* is the more strongly sculptured juvenile phase of *I. porcina*. The name, *porcina* has page priority, and should therefore be retained. This is the type species of *Paranassa* Conrad, 1868, which I consider to be a junior synonym of *Ilyanassa*. A single juvenile specimen from Williamsburg has an unusually elevated spire (see figure 409a), recalling the variety or subspecies *I. p. schizopyga* (Dall, 1892) from the Duplin and Waccamaw faunas.

410. *Ilyanassa sexdentata* (Conrad, 1844) (Synonym: *I. isogramma* (Dall, 1892) in part, Yorktown records). Shell small, ovate-conic, solid. Whorls 6-9. Axial sculpture of 25-35 narrow, sinuous, low riblets. Spiral sculpture of 18-20 fine lines on the body whorl. Spirals of irregular strength, with wider interspaces. Spiral sculpture crosses axial, and may or may not form beads at the point of intersection. Outer lip with six denticles. Zone 2, Williamsburg; Chowan River at Chesapeake. Height 13 mm.

Conrad (1843) described this species in the company of Yorktown species from the James River, but he did not specify a locality or figure the species. The type is lost, and the original description is sufficiently vague to allow some differences of interpretation. Dall (1892) discussed the form as *I. granifera* var. *sexdentata*, and justified the placement of the older name as subspecies on the contention that *sexdentata* represented a rare variant of the more common and therefore more typical *granifera*. Priority, rather than appropriateness, determines such order, and should Dall's interpretation stand, the name order must be reversed. Gardner (1948) compared *sexdentata* with *I. irrorata*, rather than *I. granifera* and referred to *sexdentata* a Duplin shell which is larger and has fewer and coarser riblets and spirals than the Virginia shells described here. In a separate discussion she attributes coarse sculpture to "*sexdentata*", but in context this is an obvious lapse of the pen for "*granifera*", and consequently, has no bearing on the question of identity of *I. sexdentata*. The position here taken is that the Virginia material more closely conforms with Conrad's description, and that the species is distinct from the *I. granifera* complex. However, the identity of *I. sexdentata* will not be known with full certainty until the type is rediscovered, or a lectotype designated. True *I. isogramma* (Dall, 1892) is here illustrated as Figure 410a.

Family Fasciolariidae

Genus *Fasciolaria* Lamarck, 1799

Large, elongate, rather smooth shells with rounded whorls and a long siphonal canal. Color pattern typically dominated by dark spiral lines, color lines commonly preserved in the fossils also.

411. *Fasciolaria rhomboidea* Rogers & Rogers, 1834. Shell large, fusiform, elongate, thin, smooth. Whorls 8, gently rounded; initial postnuclear whorls cancellate; spiral grooves persistent for about 4 whorls; adult whorls smooth. Four or five narrow, dark color lines persistent on body whorl of many fossils. Siphonal canal straight, open, fairly long. Zone 2, Petersburg, Williamsburg, Yorktown, Hampton, Smithfield and Chesapeake. Height 59 mm.

Genus *Triplofusus* Olsson & Harbison, 1953

(*Pleuroploca* P. Fischer, 1884, of authors)

Exceedingly large, fusiform shells, with 2 or 3 columella plaits and a long, open siphon. Large nodes at the shoulder in some specimens, nodes lacking in others.

412. *Triplofusus gigantea* (Kiener, 1840). (Synonyms: *Fasciolaria nodulosa* Emmons, 1858, non Defrance, 1820; *Fasciolaria gigantea harveyensis* Mansfield, 1930; *Fasciolaria papillosa acmensis* B. Smith, 1940; *F. p. duplinensis* B. Smith, 1940). Shell very large, heavy, fusiform; whorls 8-12, noded at the shoulder or evenly rounded. Spiral sculpture of coarse threads which are finer at suture. Columella with 3 strong plaits. Zone 2, Hampton, rare at Rice's pit. Height exceeds 350 mm.

Genus *Terebraspira* Conrad, 1862

Large, fusiform shells with strong spiral sculpture; columella with 3 plaits. *Terebraspira* differs from *Triplofusus* in the strength and form of the spiral sculpture, and *Terebraspira* species are smaller overall. Type: *Fasciolaria elegans* Emmons, 1858.

413. *Terebraspira acuta* (Emmons, 1858) (Synonym: *Fasciolaria sparrowi* (Emmons) of Mansfield, 1932 and Gardner, 1948, not of Emmons, 1858). Shell large, fusiform, thin. Whorls 7-8, rounded. Axial sculpture of shoulder nodes which often become obsolete in later whorls, and of very fine lamellar growth lines. Spiral sculpture of 25-30 strong, narrow, irregularly spaced cords which are sharp-edged rather than flattened. Columella with 3 plaits. Zone 2, Williamsburg, Smithfield, Chesapeake, Isle of Wight County. Height (incomplete) 75 mm.

Genus *Fusinus* Rafinesque, 1815

(*Fusus* of authors, not of Helbling, 1779)

"The spindle shells have spire and canal almost equally long. Ribbing is both spiral and axial....columella without folds" (Keen, 1971:616).

414. *Fusinus exilis exilis* (Conrad, 1832). (Synonyms: *Fusus exilis* Conrad, 1832, in part, not of Philippi, 1841, nor of Menke, 1843, *F. dalli* Mansfield, 1930). Shell large, narrow, elongate, thin. Whorls 9-10. Axial sculpture of 10 strong nodulose ribs per whorl which become obsolete over the lower body whorl and siphonal canal. Spiral sculpture of crowded, sharp-crested threads which alternate in strength. Aperture oval, with the spiral sculpture visible as lirations on both the inner and outer lip. Body whorl constricted at base of the siphonal canal. Zone 2, Williamsburg, Rushmere, Smithfield, Chuckatuck, and Chesapeake. Height: 70 mm.

Specimens from Rushmere are smaller, have a proportionally shorter siphon, and less even sculpture. There may be two species of *Fusinus* among the populations here assigned to *F. exilis exilis*, but more material must be obtained before the question can be settled.

415. *Fusinus exilis burnsii* Dall, 1890 (Synonyms: *Fusus exilis* Conrad, 1832, in part; *F. fragilis* "Wagner" Dall, 1898, non Risso, 1826, non Bonelli, 1841). This subspecies differs from typical *F. e. exilis* in that the axial ribs of *F. e. burnsii* become obsolete on the penultimate whorl, the sutures are less constricted, and the spiral threads are coarser on the canal. Dall (1890) and others have argued that *F. burnsii* should be considered a separate species, but there is some intergradation in the population from the Deep Creek pit, and I can justify no more than subspecific rank for the taxon.

Zone 2, Petersburg Yorktown, Chuckatuck, Suffolk, Hampton, Chesapeake, Smithfield; Isle of Wight and Southampton counties. Height 84 mm.

416. *Fusinus propeparilis* Mansfield, 1929. Shell large, fusiform, thin and very fragile. Whorls 8+, constricted at the suture. Axial sculpture of 11-12 strong, rounded ribs. Spiral sculpture of 3 or 4 strong, sharp primary threads on the upper whorls, and 18-20 on the body whorl and canal: secondary spiral sculpture of 3 to 5 fine lines in each interspace.

Zone 1, Bellefield, Williamsburg, and James City County. Height of holotype; 83 mm (incomplete). *F. propeparilis* is an index fossil for Zone 1 faunas.

Genus *Hesperisternia* Gardner, 1944

Medium sized shells with prominent axial and spiral sculpture. Columella with one or two plaits low in the aperture. Siphonal canal short, twisted to the left.

Lyons (1991:133) rejects the traditional familial placement among the Fasciolaridae, stating that these forms belong to the Buccinidae.

417. *Hesperisternia filicata* (Conrad, 1843) (Synonym: *Fusus cannabinus* Conrad, 1844). Shell of medium size, high spired, solid and strong. Whorls 8. Axial sculpture of 10 to 12 strong ribs with deep interspaces. Spiral sculpture of some 15 primary, undulating threads which cross and expand over the axial ribbing; secondary spiral sculpture of very fine lines. Aperture oval; outer lip thin, with 10 to 12 raised lines within. Columella with a single grooved plait at the base of the canal. Zone 2, ubiquitous. Height 31.7 mm.

This common species is easily confounded with *Urosalpinx lepidota* (Dall, 1890) which has a longer siphon, coarser secondary sculpture, and even, less undulatory primary spirals.

Superfamily Volutacea
Family Olividae

Genus *Oliva* Bruguiere, 1789

"Brilliantly polished shell because two wide lobes of the foot and mantle fold back over the shell when the animal is moving about... The cylindrical shells have a long aperture and a channeled suture on the low spire. The inner lip is wrinkled but does not have a wide callus area" (Keen, 1971:622).

418. *Oliva canaliculata* H. C. Lea, 1843 (Synonyms: *Oliva litterata* Lamarck Clark and Miller, 1912, not of Lamarck, 1810; *Oliva webbi*, anonymous manuscript name; non *Oliva canaliculata* Gabb, 1873). Shell of moderate size, cylindrical, smooth, glossy, solid. Spire low to rather high, turreted. Suture deeply channeled vertically, with a thickened spiral ridge just above the channel. Body whorl with oblique line near siphonal notch. Zone 2, Petersburg and Hampton (common); rare at Williamsburg, Chuckatuck, and Chesapeake. Height 43 mm.

Rarely the spire of this species is elongated into a high turret (418b). This is an abnormality with no separate status as a species. The name *O. webbi* has come into common usage for Rice's Pit specimens (418a). This local population has a more elevated spire than the Petersburg shells, but otherwise appear identical. According to Richards (1968:110) the type locality according to the label for the holotype of *O. canaliculata* is "St. Leonard's Creek, Maryland", a St. Marys Formation locality. Lea (1845) stated that an unnamed specimen of his new species was in the Academy collections. Lea's description could possibly apply to the Maryland species (figured by Martin, 1904: pl. 44, figs. 1a-b) or the Petersburg species. Lea's figure, however, is plainly identical with Petersburg, Virginia specimens. Consequently, the purported type, ANSP 31412, is not from Maryland, or is not the specimen figured by Lea. The type must be reexamined before the question can be settled with certainty.

Oliva canaliculata Gabb, 1873, Pliocene of Santo Domingo, is not identical with Lea's species. No replacement name is required, however, because Gabb's species is generally recognized as a junior synonym of *Oliva muticoides* Gabb, 1873 (fide Pilsbry, 1921).

Genus *Olivella* Swainson, 1840

"The olivellas are dainty little shells, more slender and with a higher spire than the olives. The operculum is a thin horny scale not large enough to close the aperture" (Keen, 1971: 626).

The definitive work on fossil and Recent Western Atlantic olivellas is Olsson (1956).

419. *Olivella ancillariaeformis* (H. C. Lea, 1843). Shell very small, elongate, thin, fragile, smooth. Spire gently convex. Suture narrow, vertically cut, very deep. Aperture narrow, elongate. Parietal callus thin, narrow. Inner lip lacks plaits or thickened ridges. Siphonal notch fairly deep.

Zone 2, Petersburg, Williamsburg, Smithfield, Chuckatuck, Hampton, and Chesapeake. Height 8.24 mm.

420. *Olivella carolinae* Gardner, 1948 (Synonym: *Olivella nitidula* (Dillwyn) of Dall, 1890 and Mansfield, 1944, not of Dillwyn, 1817). Shell small, stout, heavy, sturdy, smooth. Spire straight sided. Suture incised, rather shallow. Aperture less than half the length of shell. Parietal callus thickened, expansive, nearly reaching to suture of body whorl. Inner lip thickened, with a heavy ridge at the base of the columella. Zone 2, Chuckatuck, Chesapeake, and Southampton County. Height 19 mm.

O. nitidula Dillwyn is cited by Burch and Burch (1960) as a synonym of *Olivella minuta* (Link, 1807). Neither *O. minuta* or the similar *O. mutica* (Say, 1822) grow as large or are as high spired as *O. carolinae*.

421. *Olivella mutica* (Say, 1822) (Synonyms: *Olivella mutica coensis* Mansfield, 1930; *Oliva duplicata* Conrad, 1843; *Oliva muticoides* Gabb, 1873; *Oliva rufifasciata* Reeve, 1850; *Oliva fimbriata* Reeve, 1850). Shell very small, rather stout, sturdy, smooth. Spire flanks straight. Suture incised, shallow. Parietal callus very thick, reaching nearly to suture. Inner lip thickened, with numerous oblique plaits. Zone 2, Williamsburg and Chuckatuck. Height 9.5 mm.

O. mutica is smaller than *O. carolinae*, with a different callus and with plaits prominent on the inner lip. The

Virginia fossils are more high spired than the Recent shells I have examined, but are otherwise indistinguishable. Olsson (1956) recognized *Olivella mutica* only from the Pleistocene and Recent, but gave no clear indication as to where the Virginia Yorktown species should be placed.

422. *Olivella* sp. Shell very small, somewhat elongate, thin. Spire blunt, bullet shaped. Suture incised. Parietal callus narrow, somewhat thickened, with microscopic vertical striations. Inner lip thickened, with rather granular striations; plaits lacking.

Known from a single specimen from Chuckatuck. Naming the form should await a larger population. Zone 2, Chuckatuck. Height, 6.005 mm.

Family Vexillidae

Genus *Vexillum* Roding, 1798

Small, high spired shells with axial ribbing stronger than spiral. Columellar folds prominent.

423. *Vexillum elaboratum* (H. C. Lea, 1843) (Synonyms: *Pyramidella elaboratum* H. C. Lea, 1843; *Mitra* sp. Dall, 1890; *Mitra holmesii* Dall, 1890; *Mitra dalli* Gardner and Aldrich, 1919; *Mitra wandoensis* Holmes of Mansfield, 1930, not of Holmes, 1859; *Mitra hosfordensis* Mansfield, 1930; *Mitra hosfordensis libertiensis* Mansfield, 1930; *Vexillum* (*Uromitra*) *healeyi* Fargo, 1948). Shell very small, slender, solid. Whorls 7-8. Axial sculpture of 14-18 narrow, straight or sinuous ribs with wider interspaces. Spiral sculpture of 6 to 9 narrow threads on spire whorls, 14 to 18 on the body whorl; spiral sculpture restricted to axial interspaces. A strong spiral groove divides the body whorl into an upper, more finely-sculptured, and a lower, more strongly sculptured portion. Columella with three plaits. Zone 2, Petersburg, Williamsburg, Chuckatuck, and Smithfield. Height, 7.96 mm.

V. elaboratum is rare in the Virginia Yorktown, but the small population at hand is exceedingly variable, easily justifying the synonymy listed above. Remarkably, Gardner and Aldrich, Mansfield, and Fargo all claimed "*Mitra* sp. Dall, 1890" as the first reference to their species. I agree.

424. *Vexillum reticulatum* (Emmons, 1858) (Synonyms: *V. mauryi* (Olsson, 1916); *V. wandoensis* (Holmes) Gardner, 1937, not of Holmes, 1859). Shell very small, cylindrical, solid. Whorls 6, constricted just below the suture. Axial sculpture of 32-36 narrow, closely spaced riblets. Spiral sculpture of slightly finer threads, 16-18 on the body whorl, which are confined to the axial interspaces. Zone 2, Smithfield, Chuckatuck; Chowan River at Chesapeake. Height, 4.61 mm.

Dall (1890) and Mansfield (1930) state that *Pyramidella reticulata* Emmons, 1858, is preoccupied, but do not indicate by what name, date, or author. I can find no earlier usage in *Pyramidella* or *Vexillum*. Both Dall and Mansfield placed all vexillids in "*Mitra*" and here there is an earlier usage, *Mitra reticulata* (Roemer, 1841) Orbigny, 1850. Until Roemer's taxon is shown to belong to *Vexillum*, Emmons' name should remain valid.

The Pleistocene and Recent *V. wandoensis* (Holmes, 1859) is a similar and probably descendant species. It has fewer (26-30) axial riblets, and is less constricted below the suture. Holmes' illustration is totally inadequate, but Dall (1890) provides a definitive discussion of the type, and Abbott (1974) provides a figure of a typical Recent specimen.

Family Volutidae

Genus *Scaphella* Swainson, 1832

(Synonyms: *Maculopeplem* Dall, 1907; *Scaphellopsis* Petuch, 1988)

Medium to large shells with an inflated body whorl and three or four columellar folds. Usually spotted and highly polished.

426. *Scaphella solitaria ricei* Campbell, new subspecies. Shell of moderate size, thin, fragile. Whorls 6-7; shoulder sloping from the suture, not tabulate. Shoulder periphery unkeeled, with low, nodulose undulations. Zone 1, Williamsburg and Carter's Grove; Zone 2, Hampton. and Chesapeake. Type locality: Rice's Pit, Hampton, Virginia. Height, 29 mm. The new subspecies is very rare, a little more frequent at Rice's Pit.

A Zone 1 specimen in the Robert Dillon collection from Carter's Grove is a little heavier, but otherwise typical. *S. solitaria solitaria* (Conrad, 1830) from the St. Marys Formation in Maryland has a tabulate shoulder and a granulated keel at the periphery, a morphology which extends back into the Calvert fauna (Martin, 1904). The likely descendant of the lineage is the recent *S. florida* (Clench and Aguayo, 1940), found in deep water off Florida.

Supposing that true *Scaphella solitaria* came from the Yorktown Formation, Petuch (1988:76) has named the Calvert Formation population *Scaphella coronaspira* and the St. Marys Formation population *Scaphella sanctaemariae*. However, the type of *Scaphella solitaria* came from the St. Marys Formation (Conrad, 1830), leaving the Yorktown form in need of a name.

Etymology: named for William Rice.

Genus *Aurinia* H. & A. Adams, 1853

(Synonyms: *Volutifusus* Conrad, 1863; *Bathyaurinia* Clench and Aguayo, 1940).

Narrow, thin, fusiform shells with long, narrow apertures. Color pattern of reddish brown, squarish or rectangular spots arranged in spiral rows. Color often preserved in the fossils. The tendency to glaze the exterior of the shell is inconstant at the species level in *A. mutabilis*, and therefore has no generic status. A number of Recent systematists prefer to synonymize *Aurinia* with *Scaphella*.

427. *Aurinia mutabilis* (Conrad, 1834) (Synonyms: *Voluta lamberti* Sowerby of Morton, 1830, not of Sowerby, 1816; *Aurinia dubia* (Broderip) of Dall, 1890, 1903, in part, Pliocene records, not of Broderip, 1827; ? *Aurinia striata* (Gabb, 1873); *Aurinia mutabilie* (sic) Conrad of Berry, 1932; *Volutifusus acus* Petuch, 1988; *Volutifusus asheri* Petuch, 1988; *Volutifusus marylandicus* Petuch, 1988; and *Volutifusus meganuculus* Petuch, 1988; *Volutifusus spengleri* Petuch, 1991). Shell large to very large, narrow, fusiform,

thin, but strong. Whorls 6-10. Nuclear whorls bulbus, constricted below the protoconch. Axial nodes and angular shoulder sometimes present in sub-adult whorls. Adult shoulder rounded, smooth. Spiral sculpture of very fine, crowded striations. Color pattern commonly preserved, of 8-10 rows of rectangular, red-brown dots, about 10 dots per spiral row on the body whorl. Both color pattern and striations masked in glazed specimens. Columella with two narrow, oblique folds which become obsolete at the aperture. Columella and siphon may be straight or twisted to the left. Zone 2, rare but ubiquitous. Height exceeds 150 mm.

Dall (1890) made a distinction between left-twisted columellas which he assigned to *A. mutabilis*, and straight columellas which he assigned to *A. dubia* (Broderip, 1827), the Recent genotype. I restrict *A. dubia* to the Recent, but recognize that variation in *A. mutabilis* parallels that of the *A. dubia* complex. If such recent forms as *A. kieneri* Clench, 1946 and *A. georgiana* Clench, 1946, are validly synonymized with *A. dubia*, as some modern systematists have done (see Abbott, 1974), then the range of Recent variation exceeds and encompasses that of *A. mutabilis* and *A. obtusa* morphologies, leaving no basis for segregating the fossil and recent species. In my opinion, multiple species do exist in the Recent, and they are not conspecific with the fossil taxa. The synonymizing of *A. striata* (Gabb, 1873) is tentative, pending comparison of adult specimens. Pilsbry's (1921) figure of *A. striata* could easily pass for a broken juvenile of *A. mutabilis*.

A. mutabilis was a frequent prey of crabs, leaving a characteristic "band-schnitt" breakage pattern around the middle of the body whorl.

Petuch (1988a) has recently split the Maryland populations, proposing four new species-level taxa. *Aurinia* species are typically both rare and variable in the fossil deposits, inviting holotypic splitting. Yorktown populations from Chuckatuck and Chesapeake show most of the morphologies segregated by Petuch along with complete intergradation.

428. *Aurinia obtusa* (Emmons, 1858) (Synonyms: *Volutifusus typus* Conrad, 1866; *A. virginiana* "Conrad manuscript" Dall, 1890; not *Aurinia typus* (Conrad) of Martin, 1904, pl. 44, fig. 10; not *A. obtusa* (Emmons) of Gardner, 1948, pl. 36, fig. 10; *Scaphella conradiana* Martin, 1904). Shell large, fusiform, inflated, smooth and glossy, thin. Whorls 6-8, completely covered by a thin glaze of shell. Axial nodes at shoulder of earlier whorls, becoming obsolete after 2-3 post-nuclear whorls. Outer lip thin, curved forward in an even, rounded arc. Columellar plaits 2; color pattern of 14 to 16 narrow rectangles per spiral row, the pattern and fine spiral striations usually masked under the veneer of glaze. Zone 2, Williamsburg, Yorktown, Hampton, Chuckatuck, Suffolk, and Chesapeake; Chowan River of Chesapeake. Height, 87 mm.

The presence of glaze, which is occasional in *A. mutabilis*, is characterisitic of most *A. obtusa*. *A. obtusa* is consistently more inflated, with more color spots per whorl, and with smaller and more numerous axial nodes on the early whorls. The nuclear whorls of *A. obtusa* are greatly inflated, the feature responsible for the name.

I have collected probable *A. obtusa* in the Calvert Miocene of Plum Point, Maryland, but the shell figured by Martin, 1904, as *A. obtusa* is a separate and distinct species found also in the Eastover Formation at Bowler's Wharf on the Rappahannock River. The latter is a broader shell, with a smaller protoconch, coarser axial nodes, more prominent columellar folds, and a different shell outline. Ward (1992) argues that the Maryland species with "*obtusa*' morphology is a different species, and that the name *Scaphella virginiana* Dall, 1890, should be applied to the Calvert and Choptank taxon.

Sexual dimorphism is occasionally expressed in the shells of gastropods. *A. obtusa* might be interpreted as the more inflated, female equivalent of the male *A. mutabilis*. However, significant differences in geologic and geographic ranges preclude this interpretation.

Gardner (1948:261, pl. 36, fig. 10) refers to *A. obtusa* with three columellar folds. These three fold specimens are now known from enough material to recognize them as a separate species (see below).

429. *Aurinia sinuosa* (Gabb, 1862) (Synonyms: ?*Turbonilla demissa* Conrad, 1834, type locality-Choptank River, MD; *Voluta sinuosa* Gabb, 1862, type locality-museum drawer; *Megaptygma sinuosa* (Gabb, 1862) Conrad, 1863; *Megaptygma sinuosa* (Gabb) Meek, 1864; *Aurinia triplicata* (Dall, 1890); *Aurinia obtusa* (Emmons) of Gardner, 1948, not of Emmons, 1858). Shell rare, gigantic, reaching 350 mm, fusiform, thin, rather fragile and mostly found as fragments. Whorls 8-10, initially very slender, but becoming inflated with adult growth. Nuclear whorls bulbus. Axial sculpture of about 20 slender nodes on the shoulder of early whorls, becoming obsolete with continued growth. Spiral sculpture of exceedingly fine crowded lines. Spiral sculpture and color pattern not covered by glaze. Color pattern of 20 small, very narrow red-brown axial flamules per row, number of rows on the body whorl indeterminable with the material at hand. Columellar plaits three, narrow, prominant, the anterior plait distinctly larger. Zone 1, Camp Wallace; Zone 2, Hampton, Chuckatuck, Chesapeake, and Southampton County. Height of larger, incomplete figured hypotype > 90 mm. This species is the type of the genus *Megaptygma* Conrad, 1863

Few species of Pliocene molluscs have been more elusive or spectacular than *A. sinuosa* (Gabb). The only large, perfect specimens I am aware of were in the Rice's Pit Museum in Hampton, Virginia. These specimens demonstrated a maximum length of greater than 14 inches. Rumor of other complete adults have circulated, but I have not been able to confirm them. The illustrated hypotypes are fragmentary, and the description above is of necessity based on several partial specimens.

Turbonilla demissa Conrad, about 2 inches long, disappeared from the Academy collections, apparently about the same time Gabb (1862) found his unlabled, 2 inch long fragment in an Academy museum drawer. Gabb described this species in a work otherwise dealing with fossils from Texas. Conrad's (1834) description implies but does not require a complete specimen. No species matching Conrad's description has subsequently been recovered from the Choptank River. Conrad also had a penchant for occasionally mixing up localities.

Dall's (1890) *Aurinia triplicata* was described as a

triplicate variety of the normally biplicate *Aurinia mutabilis* collected by Joseph Wilcox and held in the Wagner Free Institute of Science collection in Philadelphia, Pennsylvania. Gardner (1948) apparently illustrates the same Wilcox specimen, noting "It bears the name, "*Aurinia obtusa*" but is doubtfully referable to that species" (Gardner, 1948:261, pl. 36, fig. 10). This Natural Well specimen is now missing (Spamer, 1989, written communication).

Gabb's holotype was initially decrepit and has now deteriorated to a few small fragments of body whorl and a perfectly recognizable section of the large, triplicate columella. From the size of the columella, I estimate that the original shell was at least 200 mm in total length. The state of preservation was very puzzling, because the scant material subsequently discovered was fragile but not deteriorated. However, Mr. Warren Blow of the Smithsonian Institution has located a Zone 1 specimen from Camp Wallace, Virginia, which shares the poor shell condition shown by the holotype. I suggest that Gabb's specimen probably came from Virginia Zone 1 deposits, and that Conrad's *Turbonilla demissa* references the same triplicate specimen. As the latter cannot be established beyond reasonable doubt, I suggest that *T. demissa* be treated as a *nomen dubium*.

Slender, juvenile specimens with the bulbus protoconch are remarkably close to the recently described *Scaphella macginnorum* Garcia and Emerson, 1987, a Recent, triplicate *Aurinia*-form volute from deep water off Cabo Catoche, Yucatan Channel, Mexico. This taxon further shares the color pattern and microscopic sculpture patterns of *A. sinuosa*. They are extremely close, but satisfactory adult material of both species must be discovered before any synonymizing is considered.

Family Cancellariidae

Genus *Cancellaria* Lamarck, 1799

Moderate sized, inflated, cancellate shells with prominent, thin columellar folds.

430. *Cancellaria depressa* Tuomey and Holmes, 1856 (Synonyms: *C. scalarina* Conrad, 1866, non Lamarck, 1822; *C. tabulata* Gardner and Aldrich, 1919; *C. reticulata* Emmons, 1858, not of Montfort, 1810). Shell small to moderate size, solid, cancellate. Whorls 7-8; spire tabulate, shoulder moderately to strongly angulate. Outer lip with 10-12 spiral lines within; inner lip with two strong, thin plaits. Larger shells have more rounded shoulders. Zone 2, Williamsburg, Hampton, Smithfield, and Chuckatuck. Height 29.6 mm.

431. *Cancellaria plagiostoma* Conrad, 1834. Shell as in *C. depressa*, but smaller, broader, with coarser sculpture and beading at the intersection of the spiral and lateral threads. Known only from the type lot, this may be only a variety of the more common *C. depressa*, in which case, *C. plagiostoma* would have priority. Zone 2, "James River, Va." Height of holotype, 6 mm.

432. *Cancellaria rotunda* Dall, 1892. Shell of moderate size, heavy, solid. Whorls 7-8. Spire high, evenly tapered. Sculpture cancellate, spiral threads predominating. Aperture with three heavy folds on the columella. Zone 2, Hampton (Rice's Pit). Height, 16.5 mm.

Subgenus *Massyla* H. and A. Adams, 1854

"Ovate, low-spired, sculpture of low, spiral threads; aperture contracted anteriorly, with a truncated columella." (Keen, 1971: 653).

433. *Cancellaria* (*Massyla*) *rapella* Johnson, 1904 (Synonym: *C. propevenusta* Mansfield, 1930). Shell small to moderate in size, thin, fragile. Whorls 6-7, strongly inflated posteriorly; body whorl with about 25 spiral cords. Aperture with two strong plaits. Siphonal canal narrow, constricted in young specimens; becoming broader and stubbier with adult growth. Zone 2, Chuckatuck. Height 13 mm.

Cancellaria rapella Johnson, 1904, was well figured in the Nautilus (vol. 17, p. 143), but has been generally overlooked. The holotype, Wagner Free Institute of Science 11597 was from Magnolia, Duplin County, North Carolina. The species is rare at Tearcoat Branch, Sumter County, South Carolina, but there is enough material in hand to establish the conspecificity with *Cancellaria propevenusta* Mansfield, 1930. Only a single Virginia specimen has been recovered.

Genus *Agatrix* Petit, 1967

High spired cancellarids with deeply indented sutures.

434. *Agatrix williamsii* Petit, 1978. Shell small, fragile, high spired, loosely coiled, narrow. Whorls 6-7. Axial sculpture of about 10 slightly oblique ribs per whorl. Body whorl with 12 strong spiral threads and wider interspaces; interspaces may show an occasional secondary thread. Columella with two oblique plaits. Zone 2, Hampton. Height 17.4 mm.

Genus *Trigonostoma* Blainville, 1827

Moderate sized cancellarids with low spires and loose coiling.

Subgenus *Ventrilia* Jousseaume, 1887

(Synonym: *Emmonsella* Olsson and Petit, 1964)

Moderate sized, with a triangular aperture, and a deep, funnel-shaped umbilicus. Whorls flat or concave above the shoulders.

435. *Trigonostoma* (*Ventrilia*) *perspectiva* (Conrad, 1834). Shell small, thin, fragile, loosely coiled. Whorls 5-7, triangular in cross section, with a wide, deep channel at the suture. Axial sculpture of 16-18 prominent ribs with wider interspaces. Spiral sculpture of crowded, alternating coarse and fine threads. Aperture triangular, with 3 plaits on the columella. Umbilicus narrow, deep, with coarse spiral threads. Zone 2, Williamsburg, Hampton, Chesapeake, and Smithfield. Height 16 mm.

436. *Trigonostoma* (*Ventrilia*) *tenerum carolinensis* (Emmons, 1858) (Synonym: *T. antiqua* (Dall, 1898)). Shell of moderate size, thin, fragile, loosely coiled. Whorls 6-7, triangular in cross section. Sculpture of 6-7 noded spiral cords and uniform spiral lines on the shoulder, body, and

umbilicus. Umbilicus wide, very deep. Aperture with 2 plaits on the columella.
Zone 2, Chesapeake. Height (incomplete) 20 mm.

T. t. carolinensis differs from the Recent *T. tenerum* only in attaining a larger size and heavier shell. Subadult *T. t. carolinensis* have been compared with a Recent shell from off Charleston, South Carolina and were found to be virtually identical. Dall (1898) simply validated the unpublished names of Wagner from the 1840's.

437. *Trigonostoma* (*Ventrilia*) *smithfieldensis* Oleksyshyn, 1960. Shell small to moderate in size, thin, fragile, loosely coiled. Whorls 6-7, triangular in cross section. Axial and spiral sculpture as in *T. perspectiva*. Suture narrowly channeled.

In comparison with *T. perspectiva*, *T. smithfieldensis* is supposedly larger, with greater relative height and narrower suture channels. These differences may be factors of ontogeny or population variation, but there are not enough specimens available at present to settle the question.
Zone 2, Smithfield (type locality). Height, 19 mm.

Subgenus *Extractrix* Korobkov, 1955

Trigonostomas with open coiling in subadult and adult whorls.

438. *Trigonostoma* (*Extractrix*) *hoerlei* Olsson, 1967. Shell small to moderate in size, thin, fragile, open-coiled. Whorls 5-6, becoming detached after the first 3-4; whorls triangular in cross section. Axial sculpture of 12-14 riblets which project beyond both the shoulder and umbilical margins as nodes or low spines. Spiral sculpture of fine threads on the spire and umbilicus, becoming coarser on the sides of the whorl. Zone 2, Chuckatuck. Height of illustrated specimen, 6 mm, width 8 mm.

Family Marginellidae

Genus *Bullata* Jousseaume, 1875

Moderate sized, elongate shells with a thickened outer lip, involute spire, and prominent columellar plaits.

439. *Bullata antiqua* (Redfield, 1852). Shell of moderate size, narrow, parallel-sided, dorsoventrally compressed, smooth. Spire concealed. Aperture long, narrow, with four strong, oblique plaits on the inner lip. Outer lip thickened and denticulate. Zone 2, Petersburg and Greenville, Pitt County. Height of holotype 28 mm, width, 14 mm.

Redfield's Petersburg type locality, and Greenville, Pitt County (Gardner, 1948) are the only Virginia Yorktown records of this common Duplin species. Mr. Bill Hale has shared specimens from the Yorktown of Tarboro, North Carolina. *Bullata taylori* (Olsson, 1916) differs only in being about a third larger, and is likely a synonym.

B. popenoei (Mansfield, 1930) was synonymized with *B. taylori* by Olsson (1967). It is an even larger shell with a flattened spot on the spire, a wider aperture, and a more inflated outline. It would be considered distinct if the Recent type of the genus, *Bullata bullata* (Born) did not show the same range of morphologies and size variation.

Subgenus *Microspira* Conrad, 1868

As in *Bullata*, but with a low point of spire projecting, and typically more inflated.

440. *Bullata* (*Microspira*) *oviformis* (Conrad, 1868). Shell of moderate size, elongate-ovate, smooth, thin, and fragile. Spire low, polished, with a very small, conic apex. Aperture fairly wide, sinuate. Outer lip thickened, finely denticulate. Inner lip with four oblique plaits. Zone 2, rare at Williamsburg and Yorktown, more common at Rice's Pit in Hampton. Height 34.8 mm.

This species is apparently restricted to lower Zone 2 sediments.

Genus *Dentimargo* Cossman, 1899

"Small, biconic, generally with a strong denticle on the posterior part of the outer lip and a series of smaller ones anteriorly" (Keen, 1971:633).

441. *Dentimargo aureocincta* (Stearns, 1872) (Synonyms: *Marginella auricincta* (sic) Stearns of Mansfield, 1935; *Dentimargo polyspira* (Olsson and Harbison) of Ward and Blackwelder, 1987, not of Olsson and Harbison, 1953). Shell minute, slender, high spired, polished, smooth. Whorls 4 1/2; suture indistinct, with or without a slight constriction. Outer lip very slightly thickened, smooth within, or with a low, posterior denticle. Inner lip with four oblique plaits.

The fossil and recent populations extensively overlap in their range of variation, and I can find no constant trait by which they can be distinguished. Zone 2, ubiquitous. Height 3.31 mm.

442. *Dentimargo chesapeakensis* Campbell, new species. Shell very small, fairly slender, high spired, smooth, polished. Whorls 5; suture strongly constricted, shoulders prominent. Outer lip slightly thickened, smooth within. Inner lip with four slightly oblique plaits. Upper beds, Chowan River Formation at the Deep Creek pit, end of Cookes Mill Road, City of Chesapeake (type and only known locality, not uncommon). Height 5.27 mm.

D. chesapeakensis was at first referred to *D. schmidti* (Olsson, 1916), but an examination of Olsson's type (figure 442a) proved that *D. schmidti* is a much larger, Duplin shell identical with *D. macronuclea* (Gardner, 1948). *D. chesapeakensis* resembles *D. aureocincta*, but has a broader shell, a much more tabulate spire, and is about a third larger.

Etymology: named for the type locality.

443. *Dentimargo eburneola* (Conrad, 1834) (Synonyms: *Marginella denticulata* Conrad, 1830, not of Link, 1807; *Marginella elevata* Emmons, 1858; *Marginella denticulata clarksvillensis* Mansfield, 1930). Shell very small, high spired, polished, smooth. Whorls 4 1/2-5; spire weakly turreted, suture constricted, shoulder gently rounded. Outer lip thickened, denticulate within, posterior denticle largest. Inner lip with four strong, oblique plaits. Zone 1, Williamsburg. Zone 2, Williamsburg, Chuckatuck, Yorktown, Smithfield. Height 9 mm.

Genus *Prunum* Hermannsen, 1852

Small to medium sized, cylindrical to inflated marginellas

with a low, conic spire. The type, *P. prunum* (Gmelin, 1791), is a thinner, larger, more cylindrical shell, quite unlike the squat, solid, biconically tapered "*Prunum*" found so commonly in the fossil and Recent faunas of the southeastern United States. Convention is followed here, although I am not completely satisfied it is best usage.

444. *Prunum bellum* (Conrad, 1868) (Synonym: *P. rushmerensis* Oleksyshyn, 1960). Shell small, solid, cylindrical, biconically tapering, smooth and polished. Whorls 4 1/2; spire high, conic. Outer lip thickened, with a strong inward flexure. Columella with four strong, oblique folds. Zone 2, Petersburg, Williamsburg, Chuckatuck, and Smithfield. Height 13 mm.

P. bellum stands intermediate between a skinny *Prunum* and a stout *Volvarina*, and its generic placement is somewhat arbitrary. It has a simple, elegant outline which has been repeated many times in the evolution of the Marginellidae. Dall (1890) described two supposed subspecies, *Marginella bella bellula*, and *M. b. inepta*, from the lower Miocene Tampa silex beds. They are distinct from *P. bellum*, properly restricted. More subspecies were erected by Mansfield (1930), as *M. b. tersa* and *M. b. hosfordensis*. Both are distinct. *M. tersa* is, however, a part of the Yorktown fauna (see # 451). *P. bellum*, properly restricted, has an adult size range of 10 to 14 mm compared with *Volvarina tersa* at 7 to 9 mm.

The name, *Prunum bellum*, has been applied to a much smaller, 6 to 7 mm, Recent shell (Abbott, 1974:250, species 2728a, fig. 2726a). A specimen of this form from off Charleston, South Carolina, possesses much the same outline as typical *P. bellum*, but is adult at 6 mm., is proportionally more slender, and lacks the pronounced flexure of the outer lip. It is a distinct and aparently unnamed species. Other Recent records of *P. bellum* are likely based on *Volvarina succinea* (Conrad, 1846). Olsson and Harbison (1953, pl. 30, fig. 5) illustrate the type of *V. succinea*, a shell as large as, and of the form of, *P. bellum*, but with smaller folds placed much lower on the columella.

P. rushmerensis is identical with *P. bellum* except for the color band which is an artifact of preservation. *Marginella exilis* H. C. Lea, 1843, not of Gmelin, 1791, was based on a very early juvenile stage of either *P. bellum* or *V. tersa*, and at that stage cannot be assigned to either with certainty. It is therefore a *nomen dubium*.

445. *Prunum limatulum* (Conrad, 1834) (Synonyms: *Marginella* (*Egouena*) *apicina* (Menke) of Gardner, 1947, not of Menke, 1828; *Prunum limulum* (sic) Conrad of DuBar and others, 1980.) Shell small, solid, smooth, polished. Whorls 4-5, spire very short, conic. Outer lip thickened, with a slight central flexure; lip denticulate within. Inner lip with four columellar folds, and a parietal wash thickening posteriorly. Color pattern of large round spots preserved in some specimens. Zone 2, ubiquitous. Height 13 mm.

Although somewhat similar in form, *P. apicinum* of the Recent faunas never show the spotted pattern characteristic of *P. limatulum*. *P. limatulum* has also been confused with or synonymized with the next species.

446. *Prunum roscidum* (Redfield, 1860). Shell as in *P. limatulum*, but larger, with a proportionally higher, larger, more tabulate spire. Living material shows a color pattern of smaller and less regular spotting. Chowan River at Chesapeake. Height 15 mm.

P. roscidum has variously been considered a recent, junior synonym of *P. limatulum*, and as a species in its own right, the latter opinion being the present consensus. However, the adult size range necessitated by considering the 8.5 mm *P. beali* McGinty, 1940, to be a synonym of *P. roscidum* makes the distinction between *P. limatulum* and *P. roscidum* less certain. All three are here considered to be separate species.

447. *Prunum virginianum* Conrad, 1868 (Synonym: *Marginella contracta* Conrad of Campbell, 1976, not of Conrad, 1870; not *P. virginianum* Conrad of Gardner, 1937). Shell small to very small, smooth, cylindrical, tapering, polished. Whorls 4; spire very low, broadly conic. Outer lip thickened, very gently inflexed, smooth within. Inner lip with four oblique folds. Parietal wash thin. Zone 2, Williamsburg, Yorktown, Hampton, Chuckatuck, Smithfield and Chesapeake. Height 9.5 mm.

P. virginianum differs from *P. limatulum* in being smaller, more cylindrical, relatively more narrow, and in having a non-denticulate outer lip.

P. contracta (Conrad, 1870) (new name for *Marginella constricta* of Emmons, 1858, not of Conrad, 1835) is the upper Pliocene, Waccamaw descendant. The Waccamaw shells are usually smaller than *P. virginianum*, have subparallel sides, and have greater constriction at the mid point of the body whorl. The Recent shell often incorrectly called *Prunum virginianum* completes this lineage. The Recent shell is shorter, as in *Prunum contractum*, but returns to the rounder outline of *P. virginianum*. The Recent shell typically shows a weak, narrow color band below the suture and another below mid-whorl. No trace of color pattern has been found on the fossils.

Genus *Gibberula* Swainson, 1840

Shells minute, solid, low spired; with spiral lines deep within the outer lip.

448. *Gibberula lavalleeana* (Orbigny, 1842) (Synonyms: *Marginella minuta* Pfeiffer, 1840, non Gray, 1826; *M. conulus* H. C. Lea, 1843). Shell minute, solid, cylindrical, smooth and polished. Spire very short, but visible. Outer lip with spiral lines internally, best seen in broken specimens. Zone 2, Petersburg, Williamsburg, Smithfield, Chuckatuck, Chesapeake. Height 2.77 mm.

I have compared fossil and Recent populations of this species and find no significant differences in size or form. Martin (1904) has referred a specimen from the Maryland Miocene to this species also, but his figure (plate XLIV, fig. 4) does not appear conspecific.

Genus *Granula* Jousseaume, 1875

Very small, solid shells with a low, unconcealed spire and a notch at the base of the aperture.

449. *Granula* sp. Shell minute, smooth, very solid, moderately inflated. Spire very low, not concealed. Inner lip with

four columellar folds. Outer lip slightly thickened, smooth within. Anterior siphonal notch very shallow. Chowan River beds, Chesapeake. Height 3.489 mm.

Of the other Virginia species, this species most resembles *Gibberula lavalleeana* (Orbigny) but it is nearly twice the length, is relatively more broad, and lacks spiral lines within the aperture. *Granula ocellus* (Dall, 1927), the only Recent Western Atlantic *Granula* cited by Abbott (1974), is even larger, and is only known from 294 fathoms off north Florida.

Genus *Persicula* Schumacher, 1817

Shells small, solid, inflated; spire low, frequently concealed. Columellar folds numerous; outer lip thickened, commonly denticulate within.

450. *Persicula ovula* Conrad, 1870 (Synonyms: *M. ovata* Emmons, 1858, non Lea, 1833; *P. gravida* (Dall, 1890); not *Marginella ovulum* Sowerby, 1846). Shell small, very solid, inflated, smooth. Spire concealed. Inner lip with 5 to 8 columellar folds, decreasing in size posteriorly; outer lip thickened, denticulate within. Zone 2, Williamsburg, Smithfield and Chuckatuck. Height 8.89 mm. Olsson and Harbison (1953:159) discuss the confused nomenclature on this species.

Genus *Volvarina* Hinds, 1844

"Shell cylindrical to conic, without an anterior notch. The spire may be low to slightly elevated" (Coan and Roth in Keen, 1971:635).

451. *Volvarina tersa* (Mansfield, 1930) (Synonyms: ? *Marginella americana* Conrad, 1838; *Volvarina avenacea* Deshayes of Campbell and others, 1975, not of Deshayes, 1844). Shell small, cylindrical, very elongate, smooth. Spire elevated. Outer lip slightly thickened, smooth within, not medially flexed. Zone 2, Williamsburg, Chuckatuck, Smithfield and Chesapeake. Height 7.53 mm.

V. tersa is more highly spired and posteriorly tapered than the Recent *V. avenacea*. *Prunum bellum* Conrad is larger, more swollen at the shoulder, more tapered, and the outer lip is inflexed.

Conrad (1838) figured his *Marginella americana* without description or locality, and later (1861) stated that the specimen was lost. Dall (1890) assigned the species to *Marginella columba* (I. Lea, 1833), but Conrad was careful to screen Eocene material out of his "Fossils of the Medial Tertiary". Of all Neogene species in hand, Conrad's figure most resembles *Volvarina tersa*. However, the figure is too broad in comparison with *Volvarina tersa*, and *Marginella americana* must be considered a *nomen dubium*.

Genus *Granulina* Jousseaume, 1888

Shells minute, solid, inflated. Spire concealed, aperture running the full length of shell. *Granulina* species most resemble minute cowries. Most systemists have recognized a single, Recent western Atlantic and Caribbean species, *G. ovuliformis* (Orbigny, 1841) from continental shelf deposits. However, after examining several offshore populations from South Carolina, I am convinced that Dall (1889) was correct in recognizing at least three species in these waters. Sorting out the Recent distributions confounded under the single species concept are beyond the scope of this paper.

Gary Coovert of the Cleveland Museum in Dayton Ohio has shared a manuscript survey of the Recent Western Atlantic *Granulina* which defines the true *G. ovuliformis* (Orbigny) and restricts its distribution to the Caribbean. The common shallow shelf species of the southeastern coast is *G. hadria*. Coovert (1988, personal communication) suggests that the Virginia Yorktown specimens are probably conspecific with *G. hadria*.

Granulina species have a geologic range in the western Atlantic back to the Middle Miocene (*G. pyrenoides* (Gardner, 1937)) and are a common, although often overlooked, component of the Mediterranean, western Atlantic and eastern Pacific faunas. In the Australian region, a host of species of this morphology are usually assigned to *Microginella* Laseron, 1957.

452. *Granulina mansfieldi* Campbell, new species (Synonyms: *Granulina dacria* (Dall) of Mansfield, 1930, not of Dall, 1892; *Granulina ovuliformis* (Orbigny) of Ward and Blackwelder, 1987, not of Orbigny, 1842). Shell very small, but gigantic for the genus; oval, solid, outer shell layer worn in all specimens. Spire involute, completely covered; outer lip thickened; inner lip with four large, oblique plaits.

Type locality is the upper bed, Chowan River Formation, Deep Creek pit at the end of Cookes Mill Road, Chesapeake, Virginia. Height 4.1 mm.

This species resembles *G. hadria* (Dall) but is twice as large. True *G. dacria* (Dall) from the Waccamaw is even larger, is relatively more produced posteriorly (teardrop in shape), is narrower, more dorsoventrally flattened, and is more heavily calloused around the aperture. *Granulina mansfieldi* is rare in the Duplin, Jackson Bluff, and Chowan River faunas.

Etymology: named in recognition of the work of Mansfield who first figured this species.

453. *Granulina virginiana* Campbell, n. sp. (Synonyms: *Granulina amiantula* (Dall) of Campbell and Campbell, 1977, not of Dall, 1890; *G. ovuliformis* (Orbigny) of authors, not of Orbigny, 1841). Shell minute, oviform, polished. Whorls completely enveloped, resembling a minute *Cypraea*. Surface smooth, or with microscopic striations. Aperture curved, extending the full length of shell. Small denticles line the complete length of the outer lip. Inner lip with four plaits low on the columella. Zone 1, Williamsburg. Zone 2, ubiquitous. Chowan River, Chesapeake. Height 2.45 mm. This is a larger, heavier, and less inflated shell than the Recent *G. ovuliformis* (Orbigny, 1841).

Late Note: This species is listed in the appendices as *G. hadria* (Dall, 1889). Gary Coovert (1992, personal communication) has examined the Virginia fossils and has determined that the species is close to, but distinct from, *G. hadria*.

Superfamily Conacea
Family Conidae

Genus *Conus* Linnaeus, 1758

Small to very large, conic or biconic shells with a long,

narrow aperture and thin outer lip. The living snails are active predators and are often poisonious.

454. *Conus adversarius* Conrad, 1840 (Probable synonyms: *C. tryoni* Heilprin, 1886; *Contraconus lindajoyceae* Petuch, 1991; *Contraconus osceolai* Petuch, 1991; *Contraconus schmidti* Petuch, 1991). Shell large, thin, conical, sinistral. Whorls 7-9. Spire typically low but highly variable, especially in the Pinecrest beds. Body whorl with spiral threads on anterior third. Zone 2, Williamsburg, Hampton and Southampton County. Height reaches 100 mm. This complex requires a thorough quantitative biometric survey, and I consider it premature to name any typological species within it until such work is done.

455. *Conus marylandicus* Green, 1830 (Synonyms: *Conus diluvianus* Green of Emmons, 1858, not of Green, 1830; not *C. marylandicus* Green of Olsson and Harbison, 1953; *Conus stearnsi* Conrad Parodiz, 1977, not of Conrad, 1869). Shell small to moderate in size, thin, rather strong, dextral, conical. Whorls 8-10. Sides of spire concave. Nuclear whorls high spired. Sculptured with about 12 spiral grooves on anterior half of body whorl. Color pattern of about 20 spiral rows of small, square dots. Zone 1, Williamsburg, and Middlesex County; Zone 2, Williamsburg, Hampton, Chuckatuck, Smithfield, and Chesapeake. Height 32 mm.

Family Terebridae

Genus *Terebra* Bruguiere, 1789

The auger shells are elongate, exceedingly high spired shells with a pronounced columella and an anterior siphonal notch. The genus superficially resembles *Turritella*.

456. *Terebra* sp. cf. *T. blakei* Mansfield, 1937. Shell of medium size, thin, fragile. Spire high, whorls 8+, spire angle 8.5 degrees. Axial sculpture of 24 narrow, sinuous ribs per whorl. Spiral sculpture of a single strong subsutural groove and fine, crowded lines, becoming somewhat stronger at the base of the whorl.

Mansfield's type specimen is smaller, has fewer and stronger axial ribs (20 instead of 24), and has the spiral groove at mid-whorl. Because of these differences, the identity of the Yorktown specimens must be considered tentative until larger populations become available. Zone 2, Hampton. Height (incomplete) 36 mm. Rare at Rice's Pit.

___. *Terebra carolinensis* (Conrad, 1841). Reported by Gardner, 1948, from Suffolk. This is probably an error for 461 (see below).

457. *Terebra* sp. cf. *T. concava* (Say, 1826) (Synonym: *Turritella concava* Say 1826, non Sowerby, 1827). Shell small to moderate size, thin, rather sturdy. Spire high, whorls 11, gently constricted medially; spire angle 13.5'. Axial sculpture of 26 to 30 nodes per whorl immediately above and below the suture. Spiral sculpture of coarse threads, strongest at mid-whorl between the nodes; spirals often developing a medial groove on the body whorl.

Compared with Recent *T. concava*, the Yorktown fossils are larger, have less concave whorls, and have coarser spiral sculpture and weaker nodes. Zone 2, Chuckatuck, Chesapeake. Height 26 mm.

458. *Terebra emmonsii emmonsii* Dall, 1896 (Synonyms: *T. neglecta* Emmons, 1858, non Michelotti, 1847; *T. robesonensis* Gardner, 1948). Shell of moderate size, inflated, thin, rather variable. Whorls 10-12, spire angle 22°. Axial sculpture of 12-15 ribs, becoming obsolete in the later whorls of some specimens. Spiral sculpture of a subsutural groove, and shallow, incised lines between the axial ribs. Spiral sculpture weak or obsolete in some specimens. Zone 2, Hampton, and Chesapeake. Height 29 mm.

This species is common only at Rice's Pit where the population is rampantly variable. Juvenile shells are relatively more inflated and have coarser sculpture, duplicating the small Duplin form named *T. robesonensis* Gardner, 1948. *T. emmonsii grayi* Gardner, 1948, (below) has weak axial sculpture and spirals completely obsolete. *T. emmonsii hamptonensis* Campbell, new subspecies, is larger, and lacks both axial and spiral sculpture. It may warrant status as a separate species. Virtually all authors, including Dall himself (1896) have overlooked Dall's replacement name for Emmons' homonym.

459. *Terebra emmonsii grayi* Gardner, 1948. Shell as in *T. e. emmonsii* Dall, but with the spiral sculpture completely obsolete.

Zone 2, Yorktown, Hampton. Height 31 mm.

460. *Terebra emmonsii hamptonensis* Campbell, new subspecies. Shell moderate to large, thin, smooth. Whorls 10 to 12, slightly convex; spire angle 20 degrees. Axial sculpture of growth lines occasionally coarsening into a low riblet on the early whorls. Spiral sculpture of a subsutural groove only. Outer lip thin, broken. Zone 2, Hampton. (type locality, Rice's Pit). Height 50 mm.

Etymology: named for Hampton, Virginia.

461. *Terebra indenta* Conrad, 1863 (Synonyms: *T. dislocata* Conrad, 1841, not of Say, 1822; ?*T. kissimmeensis* Mansfield, 1924). Shell small to moderate in size, thin. Whorls 11-12, spire angle 16.5 degrees. Axial sculpture of 18 to 20 narrow ribs. Spiral sculpture of a subsutural groove and coarse, undulating threads in the axial interspaces; 10 to 12 spiral threads in the upper whorls; 22 on the body whorl. Zone 2, Wiliamsburg, Chesapeake, Suffolk, Hampton, and Chesapeake. Height 30 mm.

Terebra indenta, the Recent and Pleistocene *T. dislocata* (Say, 1822), and *Strioterebrum petiti* Olsson, non *Terebra petiti* Kiener, 1843 (= *T.dislocata olssoni* DuBar, 1980, nomen nudum, in DuBar and others, 1980, p. 217) are very similar morphologically, and a careful, quantitative study of populations will probably demonstrate them to be subspecies or varieties of a single species. *T. indenta* is here provisionally retained.

462. *Terebra* sp., near *T. indenta* Conrad, 1863 (Synonym: *T. carolinensis* Conrad Campbell, 1976, not of Conrad, 1841). Shell as in *T. indenta* Conrad, but with exceedingly fine, wavy spiral lines rather than the coarse sculpture of typical *T. indenta*. Zone 2, Suffolk, Hampton, and Chesa-

peake, Height 26 mm. Shells in the *T. dislocata* complex are notoriously variable, but among the 30 or so specimens at hand, no intermediate morphologies between the coarse and fine spiral forms are present. The two are therefore considered separately.

T. carolinensis Conrad, 1841, is a larger shell with still finer axial and spiral sculpture. Gardner (1948) has figured the type. A specimen from Tearcoat Branch, South Carolina shows a microscopic pattern of wavy axial lines completely covering the shell, giving the surface a silky texture. No Yorktown terebras so far examined show this trait.

463. *Terebra* sp. A single badly worn and broken *Terebra* has been recovered from the Chowan River beds at Chesapeake. The spire angle of 24' is greater than any of the Yorktown species. The axial ribs are more narrow than *T. emmonsii emmonsii*, and the whorls are not so inflated.

Chowan River at Chesapeake. Height (incomplete) 14 mm.

Family Turridae

The turrids are a complex of small to fairly large fusiform shells with a multitude of similar looking genera and species. Powell (1966) established the modern basis for turrid systematics with a review of 549 valid genera and subgenera. McLean (in Keen, 1971: 686-766) has revised the family as found in the tropical Eastern Pacific, erecting several new sub-families based on radular characteristics. His organization of genera is considerably different from that of Abbott (1974: 262-290), whose analysis was assisted by the late Virginia Maes, a turrid authority at the Academy of Natural Sciences in Philadelphia. This work follows Abbott. Mrs. Maes has kindly examined the Yorktown turrids, suggesting generic affinities and comparing questionable forms with Conrad's types. Her support has been invaluable, and is gratefully acknowledged. However species descriptions, nomenclature, and synonymies are the responsibility and work of the author, and credit for any errors is mine alone.

The most distinctive turrid family attribute is the anal sinus or turrid notch, an indentation of the outer lip at, or just below, the suture. The track of the sinus on preceeding whorls typically leaves a channel just below the suture. Most Yorktown genera of turrids can be separated by the form of the turrid notch, the form and sculpture of the nuclear whorls, the presence or absence of a stromboid notch low on the outer lip, the length and twisting of the siphonal canal, and general patterns of sculpture. Turrid species are separated on the basis of adult size, relative proportions, and details of sculpture.

Subfamily Turriculinae

Genus *Leucosyrinx* Dall, 1889

"Shells 1 to 3 inches, fusiform, with a tall spire. Protoconch small, globular, 2 smooth whorls. Adult whorls with axial nodes on the periphery and with spiral cords below. Sinue fairly deep, broadly concave. Outer lip arching forward" (Abbott, 1974: 263).

___. *Leucosyrinx nodulifera* (Conrad, 1862) (see Appendix II). This Maryland Miocene turrid was originally described from "Virginia" but has not subsequently been recovered from Yorktown beds (see figure 465a). This species was referred to *Surcula* in the older literature. See Gibson, 1962.

___. *Leucosyrinx engonata* (Conrad, 1862). (See Appendix II). This is also a "Virginia" error for a St. Marys species.

Genus *Cochlespira* Conrad, 1865

"Shell white, up to 2 inches, fusiform, with a strong spiny carina on the upper part of the whorl. Siphonal canal narrow and long" (Abbott, 1974: 265).

464. *Cochlespira* sp. Shell of moderate size, exceedingly thin and fragile. Whorl number unknown. Suture deeply constricted. Spiral sculpture of a prominent, thickened keel ornamented with 20 sharp, upturned spines per whorl. There is an additional spiral thread just above the keel, and fairly strong oblique spirals on the elongated siphonal canal.

Known from a single, very fragmentary specimen. This may have evolved from the smaller and more vigorously sculptured *C.* (*Tahusyrinx*) *rotifera* (Conrad, 1830) (see Gibson, 1962a). The Recent *C. radiata* (Dall, 1889) is a smaller, more delicate shell with more closely set spines on the keel. Zone 1, Chippoaks Plantation near Surry, South bank of the James River. Height (incomplete) greater than 30 mm.

Genus *Pyrgospira* McLean, 1971

"Shell of medium size, high-spired, with tabulate whorls, shoulder concave, periphery with vertical nodes; sculpture across the body whorl coarsely clathrate, anterior canal short, stromboid notch deep" (Keen, 1971:713).

465. *Pyrgospira tricatenaria* (Conrad, 1834). Shell of moderate size, high spired, sturdy. Whorls 9+, tabulate below the sutural groove. Spiral sculpture of two strong subsutural cords, a prominent, concave turrid groove, followed by very coarse spiral ribs which diminish towards the siphonal canal. Axial sculpture of 13 to 14 coarse ribs per whorl; ribs initiate below the turrid groove. The dominant sculpture pattern is overlain by a microscopic pattern of axial and spiral raised lines, the fine spirals strongest in the turrid groove. Outer lip with a very broad, open, U-shaped turrid notch.

Zone 2, Williamsburg, Hampton, Chuckaluck, Smithfield, and Chesapeake. Height 24 mm.

This species differs from all other Yorktown turrids by its combination of relatively large size and strong sculpture.

Subfamily Mitrolumnainae

Genus *Mitrolumna* Bocquoy, Dautzenberg, and Dollfus, 1883

Small, biconic, spindle-shaped shells with strong spiral threads. No turrid notch present. The small southeastern Neogene turrids previously assigned to *Mitromorpha* by various authors rather appear to be *Mitrolumna*.

466. *Mitrolumna smithfieldensis* (Olsson, 1916). Shell

minute, biconic, fragile. Whorls rounded, 5 1/2 including 2 smooth, rounded nuclear whorls. Spiral sculpture of 8 strong chords on the body whorl. Axial sculpture of 7 to 8 low, widespaced, undulatory ribs and very fine lines of growth. Aperture narrow. Turrid notch absent.

Zone 2, Williamsburg, Chuckatuck, Smithfield, and Hampton. Height 4.26 mm.

467. *Mitrolumna yadkinensis* Campbell, new species. Shell very small, biconic, fairly solid. Whorls gently rounded, 5 1/2, including 2 small, smooth nuclear whorls. Spiral sculpture of 12 evenly spaced threads on the body whorl; interspaces wider than threads. Axial sculpture of exceedingly low to obsolete, undulatory ribs, and microscopic, crowded, raised lines of growth. Columella with three oblique folds. The type specimen was victimized by a naticid snail. Type locality, Deep Creek pit, end of Cookes Mill road, near Yadkin, City of Chesapeake. Upper Chowan River beds. Height 4.49 mm.
Etymology: named for the community of Yadkin, Virginia.

Subfamily Clavinae

Genus *Drillia* Gray, 1838

"Shells fusiform, ..., with strong axial ribs. Spiral sculpture of weak threads. Anterior canal short and straight. Sinus spoutlike. 2 1/2 nuclear whorls, smooth and small" (Abbott, 1974: 270).

468. *Drillia (Drillia) chuckatuckensis* Campbell, new species. Shell small, slender, high spired. Whorls 12, including 1 1/2 nuclear whorls. Nuclear whorls large, rounded, smooth. Axial sculpture of 9 knobby, oblique, evenly rounded ribs which arise below the turrid groove. Spiral sculpture of fine, crowded, incised lines most prominent in the subsutural turrid groove. Outer lip flaring, with open, U-shaped turrid notch arising at the suture. Zone 2, Chuckatuck. Height 17.5 mm. Type locality, former Lone Star Cement Company pit, now Crane Lake, Chuckatuck, City of Suffolk; upper bed, west wall.

Etymology: named for the village of Chuckatuck.

Subgenus *Clathrodrillia* Dall, 1918

"Fusiform, with a heavy, rounded varix at about 1/3 whorl back from the aperture. Protoconch of 2 smooth whorls" (Abbott, 1974:270).

___. *Drillia (Clathrodrillia) conradiana* Olsson, 1914. (Synonym: *Drillia distans* Conrad, 1862, not of Conrad, 1860). *D. distans* Conrad, 1860 was from the Cretaceous. *D. distans* Conrad, 1862, type locality "Virginia", has not been subsequently reported from the Yorktown or any other Virginia formations. Gibson (1962a), however, reported *D. distans* Conrad, 1862, as common in the St. Marys faunas of Maryland, where it is a junior synonym of *Clathrodrillia gracilis* (Conrad, 1830). The "Virginia" type locality is therefore considered dubious. (Appendix II).

___. *Drillia (Clathrodrillia) emmonsii* Olsson, 1914. Synonym: *Pleurotoma tuberculata* Emmons, 1858, non Pusch, 1838). Olsson simply erected a replacement name. Gardner (1948: 266) reported a specimen from Yorktown beds at Suffolk, but her figure of a Duplin *C. emmonsii* does not satisfactorily conform with Emmons' original figure, and her Virginia report must therefore be considered equally doubtful.

469. *Drillia (Clathrodrillia) impressa* (Conrad, 1862) Shell small, high spired. Whorls 8. Nuclear whorls 2, rounded, smooth; first nuclear whorl inflated, of diameter nearly equal to the second. Axial sculpture of 12 low, oblique, narrow ribs. Spiral sculpture of fine, impressed lines in the turrid groove; lines becoming more prominent over the ribs and body whorl. Outer lip flaring, with an open, U-shaped turrid notch arising at the suture. A small stromboid notch is present. Zone 2, Smithfield. Height 13 mm.

Genus *Imaclava* Bartsch, 1944

"Relatively large, with a strong noded periphery. ...the nuclear tip is lateral and the second nuclear whorl is carinate. The anterior canal is elongate and at an angle to the outer lip, as in *Kylix*, but the back of the last whorl has a massive thickened rib one-third of a whorl from the lip. No subsutural beading on the last whorl" (McLean in Keen, 1971: 699).

470. *Imaclava halei* Campbell, new species. Shell small, solid, smooth and polished. Whorls 9 to 10. First nuclear whorl smooth, rounded; the second with a strong keel. Axial sculpture of 9 to 10 oblique ribs which arise and are strongest just below the subsutural turrid groove, becoming obsolete over the lower 2/3 of the body whorl. Spiral sculpture of very fine, microscopic, incised lines which are broken into a pattern of connected and disconnected dashes. Outer lip flaring, with a small but deep stromboid notch. Turrid notch separated slightly from the suture, slightly constricted at the aperture. Zone 2, upper bed, west wall, Chuckatuck, Virginia (type locality) and Hampton. Height 23.5 mm.

This species has previously escaped notice, possibly because of its superficial resemblance to a dwarf *Cymatosyrinx lunata* (H. C. Lea). This is the first report of the genus *Imaclava* in our southeastern Neogene.

Etymology: named in recognition of the aid given by Mr. William Hale, Portsmouth, Virginia, and his dedication to the discovery of Yorktown fossils.

Genus *Cerodrillia* Bartsch and Rehder, 1939

"Shell small, axial ribs running from suture to suture, angulate at the periphery, spiral sculpture of fine cords on the base; anterior end truncate, columella twisted toward the right; nucleus of two or three smooth whorls; shell brownish or flesh colored with lighter axial ribs" (McLean, in Keen, 1971:704).

471. *Cerodrillia simpsoni cingulata* Gardner, 1848 (Synonyms: *Cerodrillia simpsoni lipara* Fargo, 1953; *Cymatosyrinx lunata* (Lea) Ward and Blackwelder, 1987, plate 45, fig. 5, not of Lea, 1843). Shell very small, smooth, solid. Whorls 7. Nuclear whorls 2, smooth and rounded; no keel. Sprial sculpture lacking. Axial sculpture of 12 slightly oblique, sinuous, low and well-rounded ribs. Outer lip with a very shallow turrid notch. Zone 2, Chuckatuck and Smithfield. Height 7.7 mm.

Genus *Crassispira* Swainson, 1840

"Relatively large and slender; periostracum thick, dark brown; aperture elongate, axial and spiral sculpture subdued across the base; sinus moderately deep; parietal wall with a callus tubercle; posterior part of the aperture narrowed above the sinus into a vertical slot" (McLean, in Keen, 1971: 715).

472. *Crassispira pyrenoides* (Conrad, 1834). Shell small, solid, high-spired. Whorls 10. First nuclear whorl smooth; second with numerous spiral grooves. Typical axial sculpture initiated with the third whorl; consisting of 10 oblique, sharp-edged ribs which arise and are most prominent just below the turrid groove; becoming obsolete at the siphonal canal. Aperture with a vertical notch above the U-shaped turrid notch. Stromboid notch lacking. Zone 2, Hampton, Chuckatuck, Smithfield (Gibson, 1962), and Chesapeake. Height 18 mm.

Subgenus *Crassispirella* Bartsch and Rehder, 1939.

"Sinus deep, laterally directed, parietal callus directed downward. Shoulder with subsutural thread. Axially ribbed and spirally threaded" (Abbott, 1974:273).

473. *Crassispira* (*Crassispirella*) *virginiana* (Conrad, 1834) (Synonyms: ?*Pleurotoma multisecta* Conrad, 1843 (1844); *P. elegans* Emmons, 1858, non Defrance, 1826, Wood, 1828, Blainville, 1829, Sacchi, 1835, or Melleville, 1843; *Drillia cornelliana* Olsson, 1916; Clavatula cornelliana (Olsson) Gardner, 1948; not *Mangelia virginiana* Conrad, a *Bellaspira*). Shell small, very solid, high spired. Whorls 11 to 12. Axial sculpture of 18 to 20 narrow, oblique, sharp ribs with wider interspaces. Spiral sculpture of a subsutural carina and even spiral threads, 36 threads on the body whorl. Spiral threads in interspaces only, not crossing the axial ribs. Aperture with a heavy callus above the turrid notch. Turrid notch open, U-shaped.

Zone 2, Williamsburg, Suffolk, Chuckatuck, and Smithfield. Height 17 mm. The unique sculpture of this attractive species makes it immediately recognizable. No other Yorktown species can be confused with it, which is no small claim. This species was unfigured by Conrad and overlooked by subsequent authors, but the holotype, figured here for the first time (Figure 473) is clearly conspecific with the shells later described by Emmons and Olsson. Conrad's description of *P. multisecta* is generally compatible with this species, but the type is missing, and being unfigured, its exact identity must remain uncertain.

Genus *Sedilia* Fargo, 1953

"Shell of moderate size, 11-20 mm; stoutly built, clariform, with a very tall, more or less turreted spire, but a truncated anterior end. Protoconch blunt, of 2-2 1/2 whorls, the first whorl or less dome-shaped, smooth, after which stout axial riblets commence, crossed by spiral threads. Adult sculpture of long, rounded axial folds, weak or absent over the shoulder sulcus, and overridden by numerous spiral cords. A weak to moderate, smooth cord submargins the suture. Aperture ovate-quadrate, terminated in a very short, broadly and weakly notched anterior canal. Outer lip thin at its outer edge, with a moderately deep, broadly U-shaped sinus, occupyiing most of the shoulder slope, and without a stromboid notch below. Inner-lip callus with a free raised edge and thickened above into a moderate entering callus pad" (Powell, 1966: 92).

475. *Sedilia bella* (Conrad, 1862). Shell small, high-spired, solid. Whorls 9, well-rounded. Nuclear whorls 2 1/2; first 1/2 whorl rounded and smooth, the next whorl with fine axial riblets and one or two basal spirals; final nuclear whorl cancellate with axial and spiral riblets of equal strength. Post-nuclear axial sculpture of 9-10 rounded ribs per whorl, overlain by exceedingly fine and crowded raised growth lines. Spiral sculpture of coarse threads just below the suture and in the turrid groove; spiral threads alternating with stronger spiral cords below the groove. Spiral sculpture undiminished over the axial ribs. Outer lip flaring; turrid notch deep, constricted at the aperture. Stromboid notch a slight inflection of the lip. Zone 2, Smithfield. Height 11 mm.

"*Bella*" is an appropriate name for this attractive species. The sculpture is more elegant than that of the two following species.

476. *Sedilia belloides* (Olsson, 1916). Shell small, high-spired, solid. Whorls 9. Nuclear whorls 2, the first smooth and rounded, the second cancellate. Axial sculpture of 9 low, oblique, rather sharp ribs. Spiral lines in the subsutural turrid groove; below the groove, coarse spiral threads irregularly alternate with spiral lines of unequal strength. Turrid notch as in *S. bella* but deeper and more constricted. Zone 2, Smithfield. Height 14 mm.

S. belloides recalls *S. bella* but is larger, with relatively finer and much less regular sculpture.

477. *Sedilia rushmerensis* (Mansfield, 1929). Shell small, solid, high-spired. Whorls 7. Nuclear whorls 2; the first smooth and round, the second with numerous spiral threads and very weak axial riblets. Adult axial sculpture incipient with the third whorl, of 11 to 12 low, rounded, rather short, oblique ribs. Spiral sculpture of even threads in the relatively broad turrid groove, coarsening to cords as the spirals cross the axial ribs. Spiral cords alternate with threads on the lower half of the body whorl. Outer lip flaring; turrid notch deep, slightly constricted; stromboid notch only a slight inflection. Zone 2, Rushmere and Smithfield. Height 8 mm (figured) to 11 mm (type).

Genus *Carinodrillia* Dall, 1919

"Shell of moderate size, shoulder concave, subsutural cord wanting; axial ribs on the early whorls relatively few, tending to be continuous from whorl to whorl; spiral sculpture weak or obsolete; periphery rounded; anterior canal of moderate length or relatively short; sinus deep, the slot walls directed apically, the parietal callus well developed but not tending to constrict the sinus entrance; first two nuclear whorls smooth, third whorl slightly subcarinate" (McLean, in Keen, 1971:728).

478. *Carinodrillia smithfieldensis* (Olsson, 1916). Shell small, elongate, slender. Whorls 10-11. Nuclear whorls 2; the first smooth, the second with four spiral threads. Post-nuclear sculpture of 11 to 12 short axial ribs on mid-whorl

only and low spiral threads in the interspaces. Aperture small. Body whorl short. Zone 2, Chuckatuck and Smithfield. Height 10.71 mm.

Genus *Splendrillia* Hedley, 1922

"Small, glossy-surfaced shells with a smooth, concave shoulder area, axial sculpture of strong, projecting peripheral nodes, which may be obsolete on the final whorl, spiral sculpture lacking or of fine striae; sinus narrow, with a heavy deposit of parietal callus; protoconch two-whorled, smooth; shells colored, frequently banded" (McLean, in Keen, 1971:705).

479. ?*Splendrillia arata* (Conrad, 1862). "Turriculate, whorls 9; spire elevated, acute; subscalariform, the contracted portion of the whorls flattened and with perpendicular sides, below this space costate, ribs somewhat oblique and crossed by minute, which on the body whorl reach the base, obsolete above, distinct inferiorly. Locality. Virginia" (Conrad, 1862:285).

This is most likely a Yorktown species, but it's exact province remains unknown.

Genus *Cymatosyrinx* Dall, 1889

"Shell polished, 1 to 1 1/2 inches, tall spired, truncated body whorl, terminated in a short, twisted, very deeply notched anterior canal. Whorls with a strong subsutural cord or fold which is usually nodulated. Axial ribs oblique. Outer lip with a distinct stromboid notch. Sinus deep, U-shaped, bounded by a thick parietal pad. Second nuclear whorl with a peripheral carina" (Abbott, 1974:275).

480. *Cymatosyrinx lunata* (H. C. Lea, 1843). Shell of moderate size, smooth, thin, high-spired. Whorls 10. Nuclear whorls 2 1/2, large, smooth, with a prominent keel. Spiral sculpture completely lacking, save for a single low, subsutural ridge which is noded at the conjunction with the axial ribs. Axial sculpture of 12 long, narrow, oblique, sharp-edged ribs per whorl. Siphonal notch oblique, deep, with a prominent siphonal fasciole. Outer lip flaring, with a deep turrid notch constricted by a thick callus pad at the suture. Stromboid notch well developed. Zone 2, Petersburg, Williamsburg, Hampton, Chuckatuck, and Smithfield; nearly ubiquitous. Height 38 mm. This is the largest of the Yorktown turrids, and type species of the genus.

481. ?*Cymatosyrinx ricei* Campbell, new species. Shell small, high-spired. Whorls 8 to 9. Nuclear whorls 2, smooth, inflated, rounded, with a very weak basal keel. Axial sculpture of 9 short, oblique, rounded ribs per whorl; ribs lined up whorl to whorl. Suture separated from turrid groove by a low, spiral ridge. Spiral sculpture of very fine, crowded lines on the ridge and groove, becoming a little coarser over the axial ribs, and very coarse below the ribs on the anterior half of the body whorl. Outer lip broken in all known specimens; turrid sinus inferred from growth lines to be U-shaped.

Zone 2, Hampton. Height 13 mm. Type locality, Rice's Pit. Without the outer lip, generic placement of this species must be considered tentative.

Etymology: named for William Rice.

Genus *Bellaspira* Conrad, 1868

"Small to medium-sized shells with axial ribs that are best developed at the periphery; anterior and sharply truncate, anal sinus narrow, closely constricted, its slot walls directed apically; nucleus of two smooth whorls. Confused with the Mangeliinae by authors because of an error in figuring the type species which is a Miocene form from Virginia" (McLean in Keen, 1971, 706-707).

482. *Bellaspira virginiana* (Conrad, 1862) (Synonyms: "*Drillia polygonalis* "Dall" Gardner, 1948; not "*Bellaspira virginiana*" of Rehder, Gardner, or Powell, a mangellid). Shell small, solid, biconic. Whorls 9. Nuclear whorls 1 1/2 - 2, smooth. Axial sculpture of 9 thin, low, sharp ribs with much wider, concave interspaces. Spiral sculpture of microscopic crowded lines which are very even and regular on the upper whorls and posterior half of the body whorl; spirals of the body whorl progressively coarsen from mid-whorl to siphonal canal. Outer lip flaring; turrid notch no more than a slight inflection. Stromboid notch lacking. Zone 2, Williamsburg, Chuckatuck, Smithfield, Hampton, Yorktown, and Chesapeake. Height 23 mm.

Genus *Compsodrillia* Woodring, 1928

"Shell about 1/2 inch, elongate-fusiform, tall spire, inflated body whorl, constricted siphonal canal, angular whorls. Short siphonal canal. Protoconch 2 whorls smooth, followed by axial riblets. Postnuclear whorls with heavy, rounded axial ribs crossed by spiral cords and threads. Sinus subsutural, deep and U-shaped. Outer lip sharp, with a varix behind" (Abbott, 1974: 270).

483. ?*Compsodrillia* sp. (Synonym: "*Drillia*" *arctata* Conrad Gardner, 1948). From Gardner's figure of the "type", this is a small shell with 9-10 short, oblique, well-rounded axial ribs per whorl. Spiral sculpture of fine grooves which are strongest at mid-whorl. Nuclear whorls missing; early post-nuclear whorls abraded. Outer lip broken. Gardner states that it is a little over 8 mm in length.

Gardner (1948) figured without description a decrepit turrid bearing the unpublished label name of *Drillia arctata* Conrad. Moore (1962) and Richards (1968) incorrectly list it as validated by subsequent description, but the description here is the first to be published. Richards refers this specimen to the "Virginia Miocene". Until the species is rediscovered, its diagnostic morphology and exact province must be considered uncertain.

___. ?*Compsodrillia chowanensis* Gardner, 1948. A North Carolina Chowan River species (Appendix I), not yet found in Virginia faunas. The species may belong to a different genus.

484. *Compsodrillia eburnea* (Conrad, 1862). (Synonym: *Drillia eburnea* Conrad, 1862, non Carpenter, 1865) "Turrited; upper part of whorl without ribs and with an impressed revolving line; lower part ribbed, ribs oblique, rounded: surface striated with close impressed revolving lines, finer and obsolete on the upper part of the whorls" (Conrad, 1862, 285).

Conrad did not cite an original locality, but Gardner

reported it from Zone 2 localities near Yorktown and Suffolk. She also noted that Dall's (1890) Caloosahatchee records of this species are in error.

Subfamily Mangeliinae

Genus *Mangelia* Risso, 1826

"Operculum absent. Shells 1/2 inch or less, narrowly fusiform, spire tall, whorls convex, sculpture variable (ribbed or reticulated), usually finely spirally striate. Sinus usually deep and fluted. Inner and outer lip may have denticulations" (Abbott, 1974: 278).

485. ?*Mangelia andrewi* Campbell, new species. Shell very small, biconic, solid. Whorls 7. Nuclear whorls 3; the first two smooth, small, and well-rounded, the third cancellate with perpendicular axial riblets stronger than spirals. Remaining whorls tabulate below the turrid groove. Axial sculpture of 12 low, oblique, well-rounded ribs per whorl, interspaces narrower than ribs. Spiral sculpture weak, of evenly spaced, indistinct grooves. Aperture narrow, parallel sided, oblique. Outer lip not flaring. Turrid notch shallow, very broad. No stromboid notch. Height 6.52 mm. Zone 2, Williamsburg. Type locality, stream bank behind Cary Field, the College of William and Mary, Williamsburg, Virginia.

Etymology: named for my son, Andrew Campbell, in recognition of his assistance over many field seasons.

___. *Mangelia emissaria* Olsson, 1916. (Appendix I).

Genus *Cryoturris* Woodring, 1928

"Small, biconic, angulate whorls, axial ribs crossed by spiral threads, giving a frosty surface. Canal short. Sinus weak" (Abbott, 1974:280).

486. *Cryoturris maesi* Campbell, new species. (Possible synonym: *Kurtziella eritima* (Bush) of Gardner, 1948, in part, Yorktown records, not of Bush, 1885). Shell very small, elongate, fragile. Whorls 7, rounded, with a prominent keel. Nuclear whorls 3, the first two small, smooth, rounded; the third with 5 or 6 spiral threads, the central thread forming a keel; third nuclear whorl spirals crossed by crowded axial riblets. Post-nuclear axial sculpture of 16 to 18 narrow, sharp, low ribs forming low nodes at the intersection with the keel. Keel high on the body whorl; a little above mid-whorl on the upper whorls. Spiral sculpture of delicately beaded lines, 24 to 26 lines on the upper whorls, about 60 on the body whorl. Aperture short. Outer lip thin, partially broken: turrid notch shallow, U-shaped, broadly open. Zone 2, Chuckatuck. Type locality, former Lone Star Cement Company pit, now Crane Lake, upper bed, west wall, Chuckatuck, City of Suffolk. Height 7.28 mm.

This species resembles *C. cerinella* (Dall, 1889) of the Recent fauna but is proportionally a little shorter and has twice the number of axial ribs.

Etymology: named in appreciation of Mrs. Virginia Orr Maes of the Philadelphia Academy of Natural Science, whose assistance with the turrids was invaluable, and is here gratefully acknowledged.

This or the following species is likely responsible for Gardner's report of the prominently beaded, recent *Glyphoturris eritima* (Bush) (junior synonym of *G. quadrata* (Reeve, 1845) from Suffolk and the North Carolina Yorktown. Her illustration is of a recent specimen, and I have not as yet located any conspecific "Yorktown" specimens.

487. *Cryoturris magnoliana* Olsson, 1916. Shell very small, fragile. Whorls 7, angular, with a central keel. Nuclear whorls 2 to 3, rather worn in the material at hand. Axial sculpture of 9 low, rounded ribs. Spiral sculpture of microscopic, crowded, beaded lines, giving the shell a granular appearance. Outer lip with a shallow, U-shaped turrid notch. Zone 2, Williamsburg, Smithfield, Chuckatuck, and Hampton. Height 7.40 mm.

Genus *Kurtziella* Dall, 1918

"Aperture elongate, sculpture of low axial ribs with wider interspaces, periphery angulate; spiral sculpture of dense lirae; lip varix no thicker than a regular axial rib, sinus a slight inflection of the outer lip on the shoulder slope. Most species are sand dwellers" (McLean in Keen, 1971:747).

488. *Kurtziella smithfieldensis* (Olsson, 1916). (Synonym: *Brachycythara galae* Fargo of Campbell, and others, 1975, Yorktown records only, not of Fargo, 1953). Shell small to very small, thin. Whorls 8 1/2, periphery angular with a prominent central keel. Nuclear whorls 2 1/2 to 3; initial whorl minute, smooth, rounded; the following 2 whorls smooth, rounded, faintly rippled, rapidly expanding. Axial sculpture of post-nuclear whorls of 16 narrow, sinuous ribs with wider interspaces; ribs strongly recurved above the keel. Spiral sculpture of crowded lines above the keel, coarser, paired threads below. Spiral lines above the keel draped, concave up, like popcorn chains on a Christmas tree: threads below the keel straight, not curving. Turrid notch shallow, broad.

The figured specimen has an annelid boring on the columella, a feature common in hermit crab occupied shells. Zone 2, Suffolk, Smithfield, and Hampton. Height 11 mm.

Genus *Glyphostoma* Gabb, 1872

"Shells 3/4 inch, fusiform, biconic, solid, whorls bulging. Aperture long and narrow. Outer lip strongly variced. Both outer and inner lips heavily sculptured with denticles and ridges. Sinus wide, deep, strongly rimate. Fasciole with strong growth wrinkles. Sculpture of strong axial threads. Protoconch of 3 whorls, the second one having a strong keel" (Abbott, 1974:282).

489. *Glyphostoma zoster* Gardner, 1948. Shell very small, thin, keeled. Whorls 6; upper post-nuclear whorls with an angular periphery; body whorl rounded, concave in outline below mid-whorl. Nuclear whorls 1 1/2, small, smooth, not expansive; axial sculpture of 12-13 low, short, sharp ribs with an overlay of fine, crowded, oblique, granular, microscopic lines, giving the surface a frosted texture. Spiral sculpture of fine spiral lines in the turrid groove, coarse threads crossing the axial ribs, and finer threads over the lower half of the body whorl. Outer lip flaring; turrid notch deep, constricted at the aperture.

Zone 2, Chuckatuck and Smithfield. Height mm.

Genus *Pyrgocythara* Woodring, 1928

"Shells 1/3 inch, slender, spire tall, axially ribbed. Numerous spiral threads. Sinus deep, with a denticle below its lower edge" (Abbott, 1974: 283).

Subgenus *Vitricythara* Fargo, 1953

Very small, slender shells with strong, cancellate sculpture.

490. *Pyrgocythara* (*Vitricythara*) *micromeris* (Dall, 1903). Shell minute, slender, cancellate. Whorls 6 1/2. Nuclear whorls 2, smooth, conic. Next two whorls well rounded; remaining whorls straight sided, angular at the shoulder. Axial sculpture incipient on the first post-nuclear whorl, of about 20 straight, narrow riblets per whorl. Spiral sculpture incipient on the second post-nuclear whorl; of 6 subequal threads on the spire; body whorl with 11-12 strong spiral threads with wider interspaces: interspaces of body whorl may have a central weaker thread. Aperture narrow; outer lip thin, not flaring.

Fargo (1953) considered this to be a subspecies of *P.* (*V.*) *metria* (Dall, 1903), but it appears to have a different range and is here treated as a distinct taxon.

Zone 2, Williamsburg, Suffolk, and Chesapeake. Height 3.41mm.

490a. *Pyrgocythara (Vitricythara) metria* (Dall, 1903). Shell outline and cancellate sculpture as in *P. (V.) micromeris*, but twice as large, proportionally a little wider, and with a less delicate shell. Zone 2 Chuckatuck. Height 5.76 mm.

Genus *Oenopota* Morch, 1852

"Resembles *Propebela* in shape and sculpture, but lacks shouldered whorls and the sculpturing is weaker on the shoulders. Protoconch narrowly pupillate of about 2 to 2 1/2 whorls, initially smooth, then developing 3 spiral cords crossed by spaced axials" (Abbott, 1974:286).

491. *Oenopota pumilus* (I. Lea, 1833). (Synonym: *Fusus pumilus* I. Lea, 1833, left of three syntypes). Shell minute. Whorls 5, slightly shouldered, evenly rounded. Axial sculpture of about 16 low, narrow nodes at the shoulder. Spiral sculpture of weak lines. Aperture large; outer lip and siphon broken. Height about 3 mm.

Like the Yorktown species, *Conus marylandicus* Green, this is one of the Finch collection species with erroneous "St. Marys, Maryland" locality data. This is Zone 2 material, but its exact Yorktown provenance can never be known.

Campbell and Campbell (1986) have discussed the I. Lea (1833) species from the Finch collection. None of the three cotypes glued to a card were conspecific. They fixed the species concept of *O. pumilis* by designating the left specimen as lectotype.

Subclass Euthyneura
Order Pyramidelloida
Superfamily Pyramidellacea
Family Pyramidellidae

Members of this family are typically small, dextral, high spired shells with a sinistral protoconch. The transition from sinistral to dextral growth is accomplished by tortion of the shell which commonly results in a twisted or completely involute apex. Most, if not all, are parasitic upon various other mollusks or annelid worms, and many are species-host-specific. The number of niches is therefore enormous, and the consequent specialization provides opportunity for a very large number of species. Pyramidellids are the insects of the molluscan world. The genera *Odostomia* and *Turbonilla* are particularly renowned (and cursed) for their propensity to generate legions of species. The Yorktown total of 14 *Turbonilla* falls considerably short of the 200 plus species listed by Keen (1971) for the tropical Eastern Pacific, but the number is still sufficient to be confusing.

The only works to seriously treat the Neogene pyramidellids of the southeastern United States are H. C. Lea (1843, 1845, 1846) and Bartsch (1955). The work of Bartsch, in turn, has so hopelessly oversplit the Caloosahatchee pyramidellids as to discourage subsequent study of the group.

An additional pitfall of the family is the habit of juvenile and adult shells of the same species to be sculptured differently. The initial post-nuclear whorls of *Triptychus* resemble the morphology of *Odostomia* (*Miralda*) species, necessitating the study of pyramidellid populations in all stages of growth before drawing any conclusions.

Generic and subgeneric determinations among pyramidellids are sufficiently straightforward, but anyone seeking to determine the proper specific identity for the various *Odostomia* and *Turbonilla* is at an immediate disadvantage. Serious work with the fossils must include comparison with the dozens of Recent Western Atlantic species and a study of three major treatises on the fossils.

H. C. Lea's (1843, 1845, 1846) pioneering work on the Yorktown (Pliocene) smaller and micromollusks referenced none of the few Recent species then described. Pilsbry (1922) described several *Odostomia* and *Turbonilla* in his revision of Gabb's Pliocene fossils of Santo Domingo. Pilsbry attempted comparisons with other described Carribbean fossil forms, but lamented the incomplete knowledge of Caribbean recent faunas. Bartsch (1955) added the pyramidellid chapter to Olsson and Harbison's (1953) treatise on the St. Petersburg, Florida Caloosahatchee fossils, splitting the group into more than 120 "species". Hence, in the Recent, the Yorktown, the Caloosahatchee, and the Santo Domingo pyramidellid faunas we have four unique and essentially uncompared traditions of nomenclature. Rather than attempt to sort through this maze, most Neogene workers have sought alternative strategies when faced with pyramidellids. The more common may be summarized as follows:

1. Selective blindness-ignore them and maybe they will go away. After all, they are microscopic. Despite their being among the most common of species in most well preserved molluscan faunas, pyramidellids are typically missing from faunal lists.
2. Procrastination-let someone else do it. Woodring (1926) and Gardner (1944) consigned their Jamaica and Alum Bluff pyramidellids to Bartsch, who never got around to them. Olsson and Harbison (1953) as noted above, consigned their St. Petersburg specimens to Bartsch, who did get to them in a work which accentuated the stratigrapher's urge to stomp them on sight. After Bartsch's death in 1960, no replacement

"other guy" has emerged, but stocks of pyramidellid species continued to be hoarded in anticipation of his appearing.
3. The Any-common-recent-name-will-do school: if its a fossil *Turbonilla*, call it *T. interrupta* (Totten)
4. The Letterman school- these workers give a letter to each perceived variety. "*Odostomia* sp. A" dodges the systematic and nomenclatural morasse, while allowing one to catalog the number of species discovered. Unfortunately, species "A" of one paper may be species "Z" of the next, and without good illustrations (another major difficulty) the letter system lacks continuity.

Even after wrestling with the literature, many as yet unnamed species remain, but uniquely naming a new species is no small challenge, given the opportunities for homonymy. The index of Bartsch (1955) reads like a who's who of malacology, coupled with a listing of the significant members of the Greek, Norse, and Hindu pantheons. And with over 500 described world wide Recent *Odostomia* and over 600 *Turbonilla* species, obvious descriptive terms like "*impressa*", "*striata*", or "*cancellata*" have been used to exhaustion. It is almost impossible to revise a fauna of these species without discovering previously undetected synonyms and homonyms. For example, *Odostomia* (*Evalea*) *diaphana* (H. C. Lea, 1843) of the Yorktown Pliocene is the senior homonym of *O.* (*E.*) *diaphana* (Jefferys, 1848), Recent of Great Britain to the Mediterranean.

The nomenclatural strategy adopted herein is a modified "letterman". The Greek alphabet, Alpha to Omega, are complete words and have both standing as valid, nondeclinable Latin adjectives and nomenclatural precedent. However, to the extent I can determine, they have not been used within the pyramidellids and are thus available.

Genus *Longchaeus* Morch, 1875

"Shell elongate-conic, not umbilicate, having 3 columellar folds, a basal fasciole, and a peripheral sulcus. Entire surface with fine growth lines and microscopic spiral striations" (Abbot, 1974:290)

492. *Longchaeus suturalis* (H. C. Lea, 1843) (Synonyms: *Pyramidella arenosa* Conrad, 1843; *Pyramidella crenulata* Holmes, 1859; *Longchaeus marionae* Bartsch, 1955). Shell small, thin, fairly sturdy. Whorls 12, tapering, flat sided. Protoconch sinistral, twisted, partly immersed in and filling the apex: protoconch and early whorls commonly broken off larger specimens. Surface smooth save for rough lines of growth. Suture marked by a square cut groove. Microscopic axial lines may be present within the groove above and below the suture. Columella with a single strong blade-like fold perpendicular to the shell axis, and two smaller, oblique folds below. Outer lip smooth, thin, with or without three large denticles inside the aperture. Zone 1, Middlesex County; Zone 2, ubiquitous. Height >12 mm.

493. ? *Longchaeus simplex* (H. C. Lea, 1843). Shell minute, thin, fragile. Whorls 5, very slightly rounded. Protoconch very small, immersed in but not completely filling the dorsal concavity of the subsequent whorl. Sutural channel narrow, not sculptured. Major columellar fold above mid-point of aperture; lower folds obsolete. Zone 2, Petersburg, Smithfield, Suffolk. Height 2.10 mm.

L. suturalis at the 5 whorl stage are minature adults of that species, and are quite different from the present species. Generic assignment of ? *L. simplex* is uncertain. The species may belong to *Odostomia* subgenus *Eulimastoma*.

Genus *Odostomia* Fleming, 1813

"Small, elongate-conic shells, white, some smooth, some cancellate; all with a small fold on the upper part of the columella" (Abbott, 1974:291.
Subgenus *Odostomia* Fleming, 1813
"Axial and spiral sculpture absent, usually. Columellar fold present" (Abbott, 1974:291).

494. *Odostomisa* (*Odostomia*) *alpha* Campbell, new species. Shell small, originally smooth, although the unique type is somewhat abraded; fragile, high-spired. Whorls, incomplete. Columella with a single, very prominent fold. Outer lip inflexed at the center. Height 4.35 mm.

This is the only Zone 1 Odostome I have recovered. Its large size and inflexed lip separate it from all Zone 2 species.

Zone 1, Type locality is Tutter's Neck Pond, Williamsburg, Virginia.

Etymology: named for the Greek letter.

495. *Odostomia* (*Odostomia*) *beta* Campbell, new species. Shell small, thin, smooth, fragile. Whorls 3+ (incomplete); spire rapidly tapering. Suture vertically impressed. Columellar fold small, oblique, low in the aperture. Umbilicus narrow, slit-like. Aperture large oblique. Height 3.60 mm. Zone 2, type locality is Rice's Pit, Hampton, Virginia.

Etymology: named for the Greek letter.

496. *Odostomia* (*Odostomia*) *gamma* Campbell, new species. Shell minute, smooth, fairly solid. Whorls 4 1/2, rounded. Suture impressed. Protoconch large, involute. A juvenile specimen shows basal spiral incised lines which are absent in the adult. Columellar fold present, indistinct. Umbilicus narrow, slit-like. Height 2.46 mm.

Zone 2, Chesapeake. Type locality is the upper Zone 2 level at the Deep Creek pit, end of Cookes Mill Road, Chesapeake, Virginia.

Etymology: named for the Greek letter.

497. *Odostomia* (*Odostomia*) *epsilon* Campbell, new species. Shell minute, smooth, solid. Whorls 5 1/2, narrow; periphery very gently rounded. Spire high; suture impressed. Umbilicus narrow, slit-like. Protoconch large, involute. Columellar fold obsolete. Height 2.11 mm.

The high spire and obsolete columellar fold will separate this form from other Yorktown *O.* (*Odostomia*) species. All of Bartsch's (1955) *O.* (*Odostomia*) species show stronger columellar folds and rounder whorls.

Zone 2, Chesapeake. Type locality is the upper Zone 2 level at the Deep Creek pit, end of Cookes Mill Road, Chesapeake, Virginia.

Etymology: named for the Greek letter.

498. *Odostomia* (*Odostomia*) *mu* Campbell, new species. Shell very small, smooth, slender, elongate, thin, fragile. Whorls 6; periphery well rounded. Suture well impressed. Columellar fold very low, nearly obsolete. Umbilicus no

more than a small pit. Aperture oval. Height 2.43 mm.

This species resembles *O.* (*Evalea*) *xi* in shell outline, but lacks the distinctive spiral sculpture, is 1/3 smaller, and has a more circular aperture. Zone 2, Chesapeake. Type locality is the upper Zone 2 level at the Deep Creek pit, end of Cookes Mill Road, Chesapeake, Virginia.

Etymology: named for the Greek letter.

Subgenus *Chrysallida* Carpenter, 1857

"Odostomias having strong axial ribs crossed by equally strong spiral keels between the sutures, thus forming small nodes. Base with strong spiral cords or threads, but weak axial sculpture" (Abbott, 1974:292).

____ *Odostomia* (*Chrysallida*) *seminuda* (C. B. Adams, 1837). Appendix II.

499. *Odostomia* (*Chrysallida*) *granulata* (H. C. lea, 1843). Shell very small, solid, high spired. Whorls 6 to 7, gently rounded. Protoconch small, involute. Sculpture coarse. Axial sculpture of 16 to 18 ribs per whorl. Spiral ribs strong, 14 to 16 on the body whorl. Axials cross the upper four spirals to produce a coarsely granular pattern. Spirals diminish in size towards the base. Sculpture pattern commonly worn off, leaving smooth but unbroken specimens (Figure 499a). Columellar fold central, weaky developed. No umbilicus. Zone 2, ubiquitous. Height 3.36 mm.

O. granulata is normally the most common gastropod in coarse, sandy Yorktown shell deposits.

500. *Odostomia* (*Chrysallida*) sp., cf. *O.* (*C*). *archeri* Bartsch, 1955. Shell minute, solid, stocky. Whorls 4 1/2, straight sided. Protoconch large, involute. Spiral sculpture of two subsutural, closely spaced, granular ribs followed by a third, more distantly spaced granular rib and a fourth, smooth spiral placed just above the suture. Interspace between the second and third spirals formed by a series of circular pits. Basal spiral sculpture of body whorl weak. Axial sculpture of about 20 riblets which coarsen to form granular beads on the upper three spirals, but are very narrow in the interspaces. Columellar fold hidden by sediment lodged in the aperture.

Chowan River beds at Chesapeake. Height 3.11 mm.

501. *Odostomia* (*Chrysallida*) *eta* Campbell, new species. Shell very small, relatively broad, evenly tapering, solid. Whorls 5 1/2, gently rounded. Protoconch large, involute. Axial sculpture of 28 to 30 narrow, oblique riblets per whorl, crossing and granulating the upper 5 spirals. Axials persisting as narrow, raised lines in the interspaces and to the base of the shell. Spiral sculpture of 5 granulated spirals on the upper whorl, 15 on the body whorl; spirals dimenishing in strength to the base. Sutural channel wide, defined above by a strong, spiral groove. Columellar fold prominent, high in the aperture. Height 3.83 mm.

This species is an exceptionally large, broad odostome which appears cancellate rather than granular.

Type locality is Zone 2, Chuckatuck, now part of the City of Suffolk, Crane Lake (formerly Lone Star Cement Company pit), *Panopea* bed, west wall.

Etymology: named for the Greek letter.

502. *Odostomia (Chrysallida) theta* Campbell, new species. Shell very small, solid, high-spired. Whorls 6 1/2 to 7, periphery gently rounded. Protoconch small, involute. Axial sculpture of 28 narrow riblets which cross and granulate the first 4 or 5 spiral ribs, continuing as narrower, raised lines in the interspaces between spirals of the body whorl. Spiral sculpture on the upper whorls of 4 or 5 noded, granular ribs: the second subsutural spiral entire or divided into two threads. Body whorl with 11 or 12 spirals diminishing towards the base. Umbilicus no more than a small pit. Columellar fold strong, high in the aperture. Height 4.55 mm.

Type locality is the upper Zone 2 level at the Deep Creek pit, end of Cookes Mill Road, Chesapeake, Virginia.

Etymology: named for the Greek letter.

503. *Odostomia (Chrysallida) zeta* Campbell, new species. Shell very small, solid, high spired. Whorls 7 1/2, periphery flat. Protochonch small, involute. Axial sculpture of 30 flat riblets per whorl, appearing at the posterior suture and terminating above the sutural channel. Spiral sculpture of 5 flat, relatively weaker riblets crossing axial sculpture on upper whorls; depressed spiral channel just above anterior suture; channel containing a low, flat, spiral rib. Body whorl with a large, flat, spiral rib below the sutural channel, and 10 progressively smaller spiral ribs anteriorly; axial sculpture on body whorl of riblets above the sutural channel, and of numerousfine threads in the anterior interspaces. Columellar fold prominant, medially placed. No umbilicus. Height 5.42mm.

This species is a large, slender odotome with axial sculpture dominating above the suture and spiral dominating below.

Type locality is Zone 2, Chucktuck, now part of the City of Suffolk, Crane Lake (formerly Lone Star Cement Company pit), *Panopea* bed, west wall.

Etymology: named for the Greek letter.

503a. *Odostomia* (*Chrysallida*) *omicron* Campbell, new species. Shell minute, thin, slender, graceful. Whorls 3 1/2, periphery gently rounded. Protoconch large, involute. Axial and spiral sculpture narrow, equal, with wider interspaces, producing a striking cancellate pattern. A small node forms at the intersection of the axial and spiral riblets. About 30 axial and 16 spiral threads on the body whorl. Aperture oval. Umbilicus small, narrow. Columellar fold very low. Height 1.25 mm.

Zone 2, Chuckatuck and Chesapeake. Type locality is the upper Zone 2 level at the Deep Creek pit, end of Cookes Mill Road, Chesapeake, Virginia.

Etymology: named for the Greek letter.

Subgenus *Menestho* Moller, 1842

"Odostomias lacking strong axial riblets and having few to many spiral cords" (Abbott, 1974:294)

504. *Odostomia* (*Menestho*) *iota* Campbell, new species. Shell very small, solid, high spired. Whorls 5 1/2, periphery gently rounded. Protoconch small, involute. Axial sculpture lacking. Spiral sculpture of widely spaced, microscopically pitted incised lines, 3 or 4 on the upper whorls, 11 to 112 on

the body whorl. Columellar fold strong no umbilicus. Height 3.84 mm.

Zone 2, Williamsburg. Type locality is stream bank behind Cary Field, the College of William and Mary, Williamsburg, Virginia.

Etymology: named for the Greek letter.

505. *Odostomia* (*Menestho*) *milium* (H. C. Lea, 1843) (Synonym: *O.* (*M.*) *promilium* (Meyer, 1888)). Shell minute, slender, high spired. Axial sculpture of microscopic raised lines in the interspaces. Spiral sculpture dominant, variable. Body whorl with 12 (form *O. promilium*) to 22 spiral cords with complete intergradation, ranging from a few broad cords to grooved cords to numerous distinct threads. Also highly variable as to adult size and relative width. Zone 2, ubiquitous. Height 1.60 mm.

Subgenus *Evalea* A. Adams, 1860

"Odostomias smoothish, except for numerous, microscopic, spiral incised lines" (Abbott, 1974:295).

506. *Odostomia* (*Evalea*) *diaphana* (H. C. Lea, 1843) (Synonyms: *Pasithea turbinopsis* H. C. Lea, 1845; non *O.* (*E.*) *diaphana* (Jefferys, 1848)). Shell small, high spired, very thin and fragile. Whorls 6 to 7, periphery well rounded; protoconch small, involute. Sutures well indented. Axial sculpture of fine growth lines only, sometimes strong enough to crinkle the spiral lines. Spiral sculpture of even to variable microscopic lines, 20 to 24 lines on the upper whorls, about 40 on the body whorl. Shell outline variable, slender to fairly stout, adult height many vary from 4 1/2 to 7 mm. Columellar fold centrally placed. Umbilibus a narrow to fairly wide slit. Height 3.91 mm. Zone 2, Petersburg, Suffolk, Hampton, and Chesapeake.

507. *Odostomia* (*Evalea*) *ovula* (H. C. Lea, 1843) (Synonym: *Acteon glans* H. C. Lea, 1843). Shell minute, smooth, glistening, thin, fragile, Whorls 3 1/2, periphery very gently rounded, rapidly inflating. Protoconch very large, involute. Axial sculpture lacking. Spiral incised lines microscopic, very shallow, strongest just below the suture. Columellar fold oblique, very low, best seen in broken specimens. Umbilical slit very narrow. Aperture exceptionally large, half the length of the shell.

This species is remarkable for its swollen, overlapping whorls. Juveniles change body outline with growth. Height 3.40 mm. Zone 2, Petersburg, Hampton, and Chesapeake.

508. *Odostomia* (*Evalea*) *lambda* Campbell, new species. Shell minute, thin transparent, fragile. Whorls 4 to 5, periphery gently rounded. Protoconch large, planorbid, apex perforate. Suture impressed. Axial sculpture lacking. Spiral sculpture of even, incised lines, 14 to 15 on the upper whorls, about 30 on the body. Columellar fold low, central, oblique. Umbilicus a wide, rounded slit. Height 3.09 mm.

This small species has fewer spirals than *O.* (*E.*) *diaphana*.

Zone 2, Chesapeake. Type locality is the upper Zone 2 level at the Deep Creek pit, end of Cookes Mill Road, Chesapeake, Virginia.

Etymology: named for the Greek letter.

509. *Odostomia* (*Evalea*) *nu* Campbell, new species. Shell small, squat, solid. Whorls 5, periphery very gently rounded. Protoconch large, involute. Suture vertically channeled. Axial sculpture lacking. Spiral sculpture worn, of fairly wide-spaced (for *Evalea*), shallow, incised lines. Columellar fold low, central. Umbilicus pit-like, expanded by breakage. Height 3.44 mm. No other Yorktown *Evalea* shows such a stout and solid shell.

Zone 2, Chesapeake. Type locality is the upper, Zone 2 level at the Deep Creek pit, end of Cookes Mill Road, Chesapeake, Virginia.

Etymology: named for the Greek letter.

510. *Odostomia* (*Evalea*) *xi* Campbell, new species. Shell very small, slender, elongate, thin, fragile. Whorls 6, gently rounded. Spire straight sided, not broadly concave as in *O.* (*E.*) *diaphana*. Periphery shouldered. Protoconch large, nearly planorbid. Axial sculpture lacking. Spiral sculpture of very fine lines. Columellar fold very low, oblique. Umbilicus slit-like, expanded by breakage. Aperture elongate-oval.

No other Yorktown *Evalea* shows the shoulder tabulation. Height 4.09 mm.

Zone 2, Chesapeake. Type locality is the upper Zone 2 level at the Deep Creek pit, end of Cookes Mill Road, Chesapeake, Virginia.

Etymology: named for the Greek letter.

Subgenus *Evalina* Dall and Bartsch, 1904

"Odostomias having feebly developed axial ribs only near the top of the whorls. Spiral sculpture of numerous fine lirations" (Abbott, 1974:298).

511. *Odostomia* (?*Evalina*) *sculpturata* (H. C. Lea, 1843) (Synonyms: *Pasithea sculpturata* H. C. Lea, 1843; *Pasithea sculpta* H. C. Lea, 1845). Shell minute, solid, evenly tapering. Whorls 4 1/2, periphery rounded. Protoconch fairly small, involute. Sutures moderately indented. Axial sculpture of 28 to 30 oblique riblets per whorl, with slightly wider interspaces. Riblets diminish below mid-body whorl, persisting as lines to the base. Spiral sculpture equal with axial, diminishing in strength towards the base so that the shell appears cancellate. Columellar fold strong, centrally placed. No umbilicus.

The axial riblets of *O.* (?*E.*) *sculpta* persist somewhat lower than typical *Evalina*, making the subgeneric assignment therefore tentative.

Zone 2, Petersburg, Chuckatuck, and Chesapeake. Height 2.10 mm.

Subgenus *Eulimastoma* Bartsch, 1916

".2 to 5 mm., high spired, with a single columellar plication. Base of whorl with angulation or keel. 2 nuclear whorls almost planorbid, partially immersed, without axial sculpture. With or without a small umbilicus" (Abbott, 1974:299).

512. *Odostomia* (*Eulimastoma*) *rho* Campbell, new species. Shell small, conic, smooth, straight sided. Whorls 5 1/2, periphery flat. Protoconch broken and repaired. Axial sculpture lacking. Spiral sculpture of a single carina at the angulation of the body whorl. Columellar fold high in the

aperture.

Zone 2, Smithfield, type locality at Rock Wharf, south bank of James River. Height 2.15 mm.

Etymology: named for the Greek letter.

Subgenus *Chesapeakella* Campbell, new subgenus

Minute, exceedingly elongate Odostomias with a large, rounded, involute protoconch and few, rapidly descending whorls. Aperture oval, tapering posteriorly. The unusually narrow and minute shell suggests adaptation to a specialized niche, possible living within the tube of a small, annelid host. Type species: *Odostomia* (*Chesapeakella*) *sigma* Campbell, new species.

Etymology: named for the City of Chesapeake.

513. *Odostomia* (*Chesapeakella*) *sigma* Campbell, new species. Shell minute, exceedingly elongate, translucent, thin, fragile. Whorls 4, periphery gently rounded; whorls elongated and rapidly descending. Protoconch involute. Axial and spiral sculpture lacking. Shell surface with a frosted appearance under very high magnification. No umbilicus. Aperture oval, tapering posteriorly. Height 1.52 mm, width, 0.45 mm.

This remarkable species is known at present only from the Zone 2 beds at the Chesapeake Development Company pit, Yadkin area, City of Chesapeake. It is placed in *Odostomia* rather than among the rissoids or acilids because of the few whorls, relatively large, involute protoconch, and the frosted microstructure of the shell surface which perfectly matches certain of the Yorktown *Odostomia* (*Odostomia*) species. At the same magnification the minute mesogastropods have a smoother and more porcellaneous shell surface.

Etymology: named for the Greek letter.

Genus *Odostomia* Fleming, 1813, *sensu lato*.

No subgeneric placement attempted.

514. ?*Odostomia limnia* Conrad, 1846. "Subfusiform, polished, whorls 4; convex; suture impressed; aperture oblong-ovate, half the length of the shell; columella slightly folded. Locality. Yorktown, Virginia" (Conrad, 1846:20).

The type is listed as missing (Moore, 1962; Richards, 1968). Conrad cited an illustration (Plate 1, Figure 4), but a careful examination of his text and plate indicates that two plates were initially prepared, then condensed into a single published plate. In the process, the figures of *O. limnia* and *O. protexta* were inadvertantly deleted. Without a more specific description, the names cannot be applied to any of the known taxa with any certainty. The species must therefore be considered dubious until the type is rediscovered.

515. *Odostomia nitens* (H. C. Lea, 1843). "Shell ovate-acuminate, thick, perforate, smooth, polished; spire subulate, mammillate; sutures impressed, deep; whorls five, convex; last whorl rounded; base smooth; perforation small; mouth ovate, elongated, effuse; fold on the columella obtuse, thick" (H. C. Lea, 1846).

516. ?*Odostomia protexta* Conrad, 1846. "Subulate, minutely cancellated, with five volutions, those of the spire being subangulated near the base; labrum sub-angulated above the middle; columella with a prominent fold in the middle. Locality. Yorktown, Virginia" (Conrad, 1846: 20). Note: see discussion under 514 above.

517. ?*Odostomia turbinatus* (H. C. Lea, 1843). Shell ovately conical, thick, smooth, subperforate; spire rather short, conical, obtuse; sutures small, linear; whorls five, flattened; last whorl somewhat angular; base smooth; perforation very small; mouth ovate, sub-effuse; fold on the columella large, acute. Length .12 (inch)" (H. C. Lea, 1846).

Genus *Triptychus* Morch, 1875

"Sculpture nodose, fairly strong; base with two to three cords that enter the aperture and one or more columellar folds; outer lip lirate within" (Keen, 1971:780).

518. *Tryptychus biseriatus* (Gabb, 1873). Shell very small, solid, strongly sculptured. Whorls 5. Periphery with strong keels, two on the upper whorls, three on the body. Upper keel coarsely noded with about 15 nodes per whorl. Zone 2, Chuckatuck. Height 2.71 mm.

Genus *Turbonilla* Risso, 1826

Small, very elongate, multiwhorled shells with a sinistral, twisted apex; no columellar folds. Axial sculpture is dominant.

Subgenus *Turbonilla* Risso, 1826

Turbonillas with axial sculpture only, ribs extending from suture to base of the shell. No *Turbonilla* (*Turbonilla*) species have yet been discovered in Yorktown faunas.

Subgenus *Chemnitzia* Orbigny, 1839

Turbonillas with axial sculpture only; ribs not crossing base of shell, base of shell smooth.

519. *Turbonilla* (*Chemnitzia*) *alpha* Campbell, new species. Shell small, very slender, solid. Whorls 12. Protoconch small, smooth, sinistral, partly immersed. Spiral sculpture lacking. Axial sculpture of 20 strong, obliquely sinuous ribs with equal interspaces. Interspaces shallow, smooth, rounded anteriorly. Ribs terminate just below mid-line of the body whorl. Aperture oval. Height 5.85 mm.

This species shows some variation in relative width and length of the adult shell. Zone 2, Smithfield. Type locality is Zone 2, Smithfield, Virginia, at Rock Wharf, shell bed above clay, south bank of the James River.

Etymology: named for the Greek letter.

520. *Turbonilla* (*Chemnitzia*) *beta* Campbell, new species. Shell minute, exceedingly slender, solid. Whorls 8 to 10. Protoconch smooth, relatively large, coiled to the side. Spiral sculpture absent. Axial sculpture of 16 to 18 nearly straight, vertical ribs; interspaces half as wide as ribs. Ribs terminate just below midline of the body whorl. Aperture squarish.

This species resembles *T.* (*C.*) *alpha*, but is relatively more slender, half as long, with fewer ribs and relatively narrower interspaces.

Zone 2, Chesapeake. Type locality is the upper Zone 2 level at the Cookes Mill Road pit, Chesapeake, Virginia. Height 2.63 mm.

Etymology: named for the Greek letter.

Subgenus *Strioturbonilla* Sacco, 1892.

Turbonillas with strong axial ribs and finer spiral sculpture.

521. *Turbonilla* (*Strioturbonilla*) *exarata* (H. C. Lea, 1843). Shell small but gigantic for the genus, elongate, solid. Whorls 16 or more. Axial sculpture of 26 narrow, nearly straight ribs; ribs becoming obsolete or absent below midline of body whorl. Interspaces as wide as axial ribs. Spiral sculpture of microscopic, incised lines, most conspicuous in the axial interspaces. Major sculpture overprinted by a network of exceedingly fine microscopic lines, giving the shell surface a frosted appearance. Aperture oval. Height 11.30 mm.

Zone 2, Petersburg, City of Suffolk (at Chuckatuck), Hampton, and Chesapeake.

522. *Turbonilla* (*Strioturbonilla*) *subula* (H. C. Lea, 1843). Shell very small, slender, high spired. Whorls 9. Protoconch small, rounded, coiled perpendicular to the long axis. Axial sculpture of about 35 narrow, straight riblets extending to the base. Interspaces wider than riblets. Spiral sculpture of crowded, subequal threads, 23 on the upper whorls, 40 to 45 on the body whorl. Spiral pattern interrupted by a pair of prominent spiral grooves, one 1/4 whorl below the upper suture, the second just above the lower suture. An additional pair of grooves occur very low on the base of the body whorl. Aperture oval. Height 4.76 mm.

Zone 2, Petersburg, Hampton, Chuckatuck, and Smithfield.

523. *Turbonilla* (*Strioturbinella*) *delta* Campbell, new species. Shell small, solid, elongate. Whorls 11 to 12, periphery flat. Axial sculpture of 20 to 22 broad, very low ribs, ribs becoming obsolete near the lower suture and about mid-whorl on the body. Spiral striae microscopic, irregular. Outer lip sinuate. Aperture oval. Height 4.95 mm.

Zone 2, Chesapeake. Type locality is the upper Zone 2 level at the Deep Creek pit, end of Cookes Mill Road, Chesapeake, Virginia.

Etymology: named for the Greek letter.

524. *Turbonilla* (*Strioturbonilla*) *eburnea* (H. C. Lea, 1843). Shell small, slender, very high spired. Whorls 12, periphery well rounded. Protoconch smooth, rounded, partially immersed. Axial sculpture of 28 to 30 narrow, slightly oblique to the left, sinuous ribs. Interspaces of equal width. Spiral sculpture of fine, deeply incised lines, 16 to 18 on the upper whorls; Spiral lines interrupted by broad spiral grooves, one 1/3 whorl below the upper suture. Body whorl with coarse spirals between the grooves, spirals becoming finer on the base; no basal grooves as in *T.* (*S.*) *subula*. Aperture subrectangular. Periphery of body whorl subangulate. Height 6.72 mm.

This species superficially resembles the Recent *T.* (*Pyrgiscus*) *interrupta* (Totten) and may be responsible for Pliocene reports of that species. *Turbonilla interrupta* has coarser sculpture, 20 to 22 wider ribs, and only 7 or 8 very even spirals with no grooving; the axial ribs are oblique to the right, and the body whorl periphery is more evenly rounded.

Zone 2, Petersburg, Chuckatuck, and Smithfield.

Subgenus *Pyrgiscus* Philippi, 1841

Turbonillas with strong axial ribs and strong spiral sculpture.

525. *Turbonilla* (*Pyrgiscus*) *kappa* Campbell, new species. Shell minute, exceedingly slender, fragile. Whorls 7 to 8; periphery well rounded, sutures indented. Axial sculpture of about 16 narrow, oblique, sinuous riblets per whorl. Spiral sculpture of 8 to 10 rather coarse threads on the upper whorls, 14 to 16 on the body.

T. (P.) *kappa* was at first confounded with *T.* (*P.*) *protracta* Dall, 1892, which shares the minute size and slender outline. Dall's species has 30 to 32 axial riblets and much weaker spiral sculpture. It has been recovered from the Duplin Pliocene, Pleistocene, and Recent faunas.

Zone 2, Chesapeake. Type locality is the upper level, Zone 2 beds at the Deep Creek pit, end of Cookes Mill Road, Chesapeake, Virginia. Height 0.86 mm.

Etymology: named for the Greek letter.

526. *Turbonilla* (*Pyrgiscus*) *digamma* Campbell, new species (Synonym: *T. reticulata* Emmons, 1858, non *T. reticulata* (C. B. Adams, 1850)). Shell small, solid, high spired. Whorls 9 to 10, slightly tabulated at the shoulder. Protoconch small, oblique, rounded, smooth. Axial sculpture of narrow, strong, well elevated sinuous oblique ribs, 16 to 18 per whorl; on body whorl, ribs terminate anteriorly on a strong, spiral, basal cord. Axial interspaces twice as wide as ribs. Spiral sculpture of 4 or 5 strong, narrow threads confined to the axial interspaces, not crossing the ribs. Body whorl with 4 or 5 weaker spirals below the basal cord. This species resembles the Recent *T.* (*P.*) *reticulata*, but the fossil is stouter and has more vigorous sculpture. Height 4.48 mm. Zone 2, Smithfield. Type locality: Rock Wharf, shell sand above clay, south bank of the James River, just west of Smithfield, Virginia.

Given the generalized locality "Miocene of Lenoir" and the uncertainty of location of Emmons' type, stability is better served by recognizing a new species rather than erecting a replacement name.

Etymology: named for the Greek letter.

527. *Turbonilla* (*Pyrgiscus*) *zeta* Campbell, new species. Shell small, solid, elongate. Whorls 5+ (incomplete), weakly rounded. Sculpture cancellate. Axial ribs low, narrow, 28 to 30; ending on a strong basal cord as in *T.* (*P.*) *digamma*, but cord is higher on the whorl. Spiral threads subequal to axials, relatively broader than in *T.* (*P.*) *digamma*. Aperture oval. Base well rounded. Height (incomplete), 2.90 mm.

Chowan River beds, Chesapeake. Type locality: Deep Creek pit, end of Cookes Mill Road, Chesapeake, Virginia.

Etymology: named for the Greek letter.

528. *Turbonilla* (*Pyrgiscus*) *eta* Campbell, new species. Shell small (large for the genus), solid, high spired. Whorls 9+, protoconch missing. Whorls constricted below the

suture. Axial ribs broad, low, 16 per whorl; obsolete above but becoming stronger across the whorl; axials obsolete on the body whorl. Spiral sculpture of 6 broad, low, strap-like ribs crossing axial ribs and interspaces alike. Spirals finer on base of body whorl. Aperture oval. Height 8.84 mm.

Zone 2, Williamsburg. Type locality is Zone 2, Williamsburg, Virginia, at the shell bank by the maintenance shed, Golden Horseshoe Golf Course.

Etymology: named for the Greek letter.

529. *Turbonilla* (*Pyrgiscus*) *daedaleum* (H. C. Lea, 1843). "Shell subulate, thin, imperforate, costate, striate; spire attenuate, subovate, mammilate, smooth and polished near the apex; sutures small, linear; whorls seven, flattened; striae transverse, numerous, deep; costae longitudinal, numerous, smooth, flattened; last whorl rounded; base striate, polished, mouth narrow, subquadrate; angulate above, effuse below; outer lip acute" (H. C. Lea, 1846:269). Zone 2, Petersburg.

The type of *T. daedaleum* has 22 strong axial ribs with 5 spiral threads in the upper whorls. Spirals restricted to the axial interspaces.

_____. *Turbonilla* (*Pyrgiscus*) *interrupta* (Totten, 1835). Erroneously reported from Yorktown and Chowan River beds. (Appendix II).

Subgenus *Bartschella* Iredale, 1917.

"Turbonillas with well-rounded whorls, marked with strong axial ribs and strong spiral cords, the junctions of which are usually subnodulous" Abbott, 1974: 308).

530. *Turbonilla* (*Bartschella*) *iota* Campbell, new species. Shell small, thin, strong, high spired. Whorls 6 1/2+, incomplete. Sculpture cancellate; spirals slightly stronger than axials. Axial ribs 24 per whorl, narrow, with equal interspaces; ribs slightly oblique to the right. Spirals coarse, 4 per whorl, 8 on body whorl; spiral interspaces of equal width. Height 4.71 mm.

Typical of the subgenus, this species looks like a too tall *Odostomia* (*Chrysallida*) species.

Zone 2, Chesapeake. Type locality: upper level, Zone 2, Deep Creek pit, end of Cookes Mill Road, Chesapeake, Virginia.

Etymology: named for the Greek letter.

Subfamily *Cyclostremellinae* Moore, 1966

Genus *Cyclostremella* Bush, 1897

Minute, planorbid shells with an involute, large protoconch and wide umbilicus in which the protoconch is plainly visible.

532. *Cyclostremella magnoliana* Olsson, 1916. Shell minute, planorbid. Whorls 2 1/2. Protoconch immersed, visible in floor of umbilicus. Suture broadly "V"-shaped, deeply excavated, bordered above by a low spiral cord. Periphery and outer edge of base with spiral incised lines; sculpture strongest on base. Aperture squarish. Zone 2, Chuckatuck, Chesapeake, and Hampton. Maximum diameter 1.59 mm.

Considerable variation in sculpture is shown in the material at hand.

Order Cephalaspidea P. Fischer, 1883

Superfamily Acteonacea Orbigny, 1842

Family Acteonidae Orbigny

Genus *Acteon* Montfort, 1810

Small, inflated, thin shells with low to moderately high spires. Sculpture lacking or of punctate spiral groves.

533. *Acteon novellus* Conrad, 1834 (Synonym: *A. n. nansmondensis* Gardner, 1948). Shell very small, thin, inflated. Whorls 4 to 5, tabulated at the shoulder. Spire elevated. Sculpture of evenly spaced, spiral cords with very narrow interspaces; cords may or may not be divided by a medial line. Aperture oval, oblique. Height 5.30 mm.

Zone 2, Williamsburg, Smithfield, Chuckatuck, Chesapeake, and especially common at Rice's pit in Hampton.

534. *Acteon vaughani* Mansfield, 1930. Shell as in *A. novellus*, but smaller, with the posterior 1/3 of the whorl devoid of spiral sculpture. Zone 2, Hampton.

A single specimen of this more typically southern species was in the Rice's pit collection of the late Dr. Walley Williams. The specimen is not avalilable for illustration (see Mansfield, 1930 for an illustration).

Family Ringiculidae

Genus *Ringicula* Deshayes, 1838

Very small, helment-shaped shells with high spires, spiral sculpture, a thickened outer lip, and 2 or 3 prominant columellar folds.

535. *Ringicula guppyi* Dall, 1889. Shell minute, solid, stocky. Whorls 3 1/2 to 4, tabulated at the shoulder; suture impressed. Spire elevated. Sculpture of 10 to 12 irregular, incised spiral lines on the body whorl. Outer lip flaring, very thick. Inner lip with a thickened callus; two oblique columellar folds. Height 2.76 mm. Chowan River beds at Yadkin.

536. *Ringicula* sp. A single specimen of a small, relatively short spired *Ringicula*, was found by Dr. Williams at Rice's pit, and donated to the Smithsonian. It cannot at present be located. The short spire separates it from previously described species. Zone 2, Hampton.

Family Acteocinidae

Genus *Acteocina* Gray, 1847

Cylindrical, very small to minute shells with an elongate, spatulate aperture. Spire low to moderately high. Protoconch involute but typically not totally immersed. Recent divisions of this complex family are increasingly based on the soft anatomy. Mikkelsen and Mikkelsen (1984, 1987) clarify many of the species.

537. *Acteocina candei* (Orbigny, 1842) (Possible synonyms: *Acteocina canaliculata* of authors, not of Say, 1826; *Acteon wetherilli* Lea, 1833 of authors, not of Lea; ?*Tornatina cylindrica* Emmons, 1858, *Cylichna virginica* Conrad, 1868, *Acteocina cederstromi* Richards, 1947; *Retusa canaliculata*

vaughani Gardner, 1948). Shell very small, thin but strong, cylindrical, smooth. Spire truncated; apex small, projecting, involute, spire lacks an inter-sutural carinae. Height 5.39 mm. Zone 2, ubiquitous.

538. *Acteocina myrmecoon* (Dall, 1895). Shell small (large for the genus); thin, fragile, smooth. Spire truncated, protoconch protruding. Suture deep, vertically impressed. Columella with a single, very oblique fold. Height 6.30 mm. Zone 1, Williamsburg; Zone 2, Hampton.

This species can be separated from other Yorktown *Acteocina* by its large size and rounded rather than cylindrical outline.

539. *Acteocina lepta* Woodring, 1928. Shell very small, slender, thin, cylindrical, smooth. Like A. candei, but with a spiral carina on the spire between the sutures. Height 3.39 mm. Zone 2, Chesapeake, Virginia.

Mikkelsen and Mikkelsen (1987) provide an excellent discussion and illustrations of this species.

Family Cylichnidae

Genus *Cylichna* Loven, 1846

"Small, cylindrical shells with the lower end truncate and with the spire involute, leaving a small apical concavity. Columella with 1 oblique fold" (Abbott, 1974:314).

540. *Cylichna johnsoni* Campbell, new species. Shell small, thin, perfectly smooth, cylindrical. Aperture narrow, spatulate, longer than body whorl. Spire broadly funnel-shaped, with a small, very deep, central perforation. Columella with a single, oblique fold. Height 11.58 mm.

C. duplinensis (Dall) is smaller and possesses spiral sculpture. *C. johnsoni* most resembles the Recent *C. verrillii* Dall, 1899 (see Abbott, 1974:315, for figure), but *C. johnsoni* is proportionally more narrow. It may possibly be ancestral to the Recent species.

Type locality is Zone 1 beds at the spillway of Tutter's Neck Pond, Williamsburg, Virginia.

Etymology: named in recognition of the support given by Dr. Gerald H. Johnson of the College of William and Mary.

Genus *Cylichnella* Gabb, 1873

Shells as in *Cylichna*, but usually smaller and with two columellar folds low in the aperture.

541. *Cylichnella* species. Shell very small, thin, fragile, inflated. Spire involute, perforated. Surface smooth. Columella broken, appears to have two folds. Height 2.39 mm. Zone 2, Chesapeake.

The four known specimens of this species are all fragmentary. It has the general form of *C. eburnea* Verrill, 1885, of the Recent fauna. Naming the species must await the discovery of better material.

Family Philinidae

Genus *Philine* Ascanius, 1772

Very small, very thin shells with large, flaring apertures. Sculpture of spiral rows of oval punctae.

542. *Philine williamsi* Campbell, new species. Shell very small, thin, fragile. Spire bulbus, involute. Aperture very large, flaring. Sculpture of numerous, fine, deeply punctate spiral grooves. Outer lip thin, crenulated by the sculpture. Height 2.75 mm.

P. williamsi is broader than the Recent *P. sagra* Orbigny, 1841, smaller and more quadrate than *P. quadrata* (S. Wood, 1839). This is the first Neogene record of the genus from Eastern North America.

Zone 2, Hampton and Chesapeake. Type locality is the upper Zone 2 level at the Deep Creek Pit, end of Cookes Mill Road, Chesapeake, Virginia.

Etymology: named in honor of Dr. Wally Williams who has unselfishly assisted this project and who discovered the first known specimen at Rice's Pit.

Family Haminoeidae

Genus *Atys* Montfort, 1810

Ovate to inflated, involute shells with a narrow aperture extending well above the apex. Sculpture of spiral threads becoming obsolete at mid-whorl.

____. *Atys ornata* Gardner, 1948. North Carolina Yorktown species not recovered in this study (Appendix I).

Genus *Haminoea* Turton and Kingston, 1830

Cylindrical to very inflated, globose, paper-thin smooth shells with large, flaring apertures. Spire involute.

543. *Haminoea* sp. Two specimens of an undescribed species preserving a pair of narrow spiral color bands were present in the collection of the late Dr. Walley Williams.

Zone 2, Hampton (at Rice's Pit). Height about 10 mm.

Family Retusidae

Genus *Retusa* Brown, 1827

Very small, cylindrical shells with very narrow apertures. Apex truncated, nuclear whorls immersed.

Subgenus *Cylichnina* Monterosato, 1884

Minute, slender, cylindrical shells with a perforate apex. Often sculptured with axial grooves on the crown of the apex or extending the length of the shell. Synonyms found in our Tertiary literature include *Sulcularia* Dall, 1921 and *Sulcoretusa* Smith and Gordon, 1949.

544. *Retusa* (*Cylichnina*) *microtrema* Dall, 1896. Shell minute, thin, fragile, cylindrical, smooth. Spire involute, perforated. Aperture very narrow, extending the length of the shell. Surface smooth except for very fine lines of growth. Height 2.54 mm.

Zone 2, Williamsburg, Hampton, Suffolk (at Chuckatuck).

545. *Retusa chesapeakensis* Campbell, new species. Shell minute, thin, fragile, stocky, cylindrical. Spire involute, deeply perforated. Aperture very narrow, extending the length of the shell. Outer lip inflexed. Shell smooth, except for fine growth lines and a crown of very fine, axial grooves on the spire. Height 2.51 mm. Zone 2, Hampton and

Chesapeake. Type locality: the upper Zone 2 level at the Deep Creek pit, end of Cookes Mill Road, Chesapeake, Virginia.

R. chesapeakensis is smaller and proportionally broader than *R. microtrema*, and shows microscopic sculpture on the crown.

Etymology: named for the City of Chesapeake.

Genus *Volvulella* Newton, 1891

Small, slender, spindle-shaped shells with the apex imperforate, commonly drawn out into a point.

546. *Volvulella cylindra* (H. C. Lea, 1843). Shell small, elongate, bluntly tapering at both ends. Spire involute, imperforate, lacking a sharp, pointed apex. Inner lip with a prominent columellar fold. Sculpture of spiral incised lines on the lower 1/3 of the shell. Height 5.53 mm. Zone 1, Williamsburg, Zone 2, Petersburg, Hampton, Suffolk, and Chesapeake.

Juveniles of this species are proportionally slimmer.

Order Thecosomata
Suborder Euthecosomata
Family Limacinidae

Genus Limacina Bosc, 1817

Small to minute, very thin shelled, transparent to translucent, sinistral shells with a low, planorbid to rather high spire.

547. *Limacina chesapeakensis* Campbell, new species. Shell minute, very thin and fragile, translucent, sinistral, smooth. Early juveniles high spired; subsequent growth progressively envelopes the spire; adult shells planorbid, involute, with a perforate spire and narrow, deep umbilicus. Outer lip very thin, without a projecting spur. Diameter 1.20 mm.

L. chesapeakensis adult forms resemble a minute freshwater *Planorbis*. From the modern, planorbid pteropod, *L. inflata* (Orbigny, 1836), the new species differs in being multiwhorled and in lacking the prominent spur on the outer lip. *Limacina chesapeakensis* more closely resembles *Limacina atlanta* (Morch, 1874) as illustrated by Janssen (1989).

Zone 2, Hampton and Chesapeake. Type locality is the upper Zone 2 level at the Deep Creek pit, end of Cookes Mill Road, Chesapeake, Virginia.

Etymology: named for the type locality.

Family Cuvieridae
Subfamily Clionae

Genus *Creseis* Rang, 1828

Small, tapered, very elongate cones; nearly circular in cross section. Commonly called "needle pteropods"

548. *Creseis acicula* (Rang, 1828). Shell small to very small, fragile, cylindrical, tapering, exceedingly narrow, needle-like.

Recent populations I have examined show a greater range of variation in relative proportion than do the Yorktown specimens. Length 5.9 mm. Zone 2, Yorktown, Hampton, Chuckatuck; commonly at Chesapeake.

Creseis acicula is common in recent, mid-shelf deposits but is typically absent from near shore deposits from the Carolinas. However, Lyons (1989) documents very large inshore concentrations of the species at Hutchinson Island, Florida, and it can be found in beach drift at Pensacola Beach, Florida.

Genus *Hyalocylis* Fol, 1875

Shell very small, shaped like a narrow cone or funnel; sculpture of conspicuouc annulations.

549. *Hyalocylis striata* (Rang, 1828). Shell small, exceedingly thin and fragile; conic. Sculpture of rather broad, concentric annulations. Zone 2, Chesapeake.

No significant difference is apparent between the fossil and Recent shells. This and the following species were found packed with other shells in the cavity of a large *Busycon*.

This, and the following two species were sent to and identified by the late Dr. Allen Be. Unfortunately, the unique material was not returned before his death, and the staff at Lamont were unable to discover the package. Because no subsequent material has been discovered, figures of conspecific material are here borrowed with permission from Abbott, 1974.

Subfamily Cavoliniinae

Genus *Cavolinia* Abildgaard, 1791

Small, thin, inflated, bilaterally symetrical shells with a dorsal, hooded aperture. Shell body bulbus, tapering ventrally to a blunt to sharp point. Ventral margin usually with spurs or flanges at the outer corners.

550. *Cavolinia uncinata* (Rang, 1829). "6 to 11 mm. in length. Brownish. Dorsal lip with a thin margin. Ventral lip not more developed than the dorsal one. Shell with distinct lateral points. Upper lip flattened posteriorly. Generally a warm-water species. *C. uncinatiformis* Pfeiffer, 1880, and *roperi* and *pulsa* van der Spoel, 1967, are synonyms" (Abbott, 1974:327). Zone 2, Chesapeake.

551. *Cavolinia* cf. *C. ventricosa* (Guppy, 1882). "Almost globular, rounded and much inflated in front; lower valve swollen; upper value spoon-shaped, inflated, adorned by three keels or ribs radiating from the umbo to the extremely reflected and recurved lip; the central keel more pronounced and distinct; the lateral ones broader and more rounded; lateral mucrones simply angular, not pointed, terminal mucro short and pointed; mouth narrow, hidden by the protusion of the sharp thin lip. Length 4 1/2 mill., breadth 4 mill" (Collins, 1934: 184). Zone 2, Hampton.

Two fragments of a small *Cavolinia* found by Dr. Williams at Rice's pit, Hampton, appear best referred to this species.

Order Basommatophora
Superfamily Melampidacea
Family Melampidae

Genus *Melampus* Montfort, 1810

Shell small, thin, subcylindrical, inflated. Columella with 2 or 3 folds. Salt marsh air breathing snails.

____. *Melampus longidens* Conrad, 1863. "Acutely oval; spire conical, mucronate at the top; whorls 7; suture profound; aperture very narrow; labrum dento-striate within; base of columella with an elongated, slightly curved plate, directed obliquely upwards in the line of the aperture"

No additional Yorktown records or specimens of this species have been discovered. Conrad's specimen was probably a Pleistocene or recent *Melampus bidentatus* Say, 1822

FRESH WATER AND TERRESTRIAL TAXA

Genus *Viviparus* Montfort, 1810

552. *Viviparus glaber* (H. C. Lea, 1843). "Shell ovately turbinate, elevated, thin, umbilicate, smooth, polished; spire elevated, rounded; sutures small, linear: whorls _____, very convex; last whorl rounded; base smooth, umbilicus small; mouth ovate, angular above, rounded below; outer lip acute" (H. C. Lea, 1846: 267).

Lea noted the similarity between this and "*Paludina vivipara*" in his comments, but dismissed the idea because the species was presumably marine. Dall, quoted in Henderson (1935), stated that the type was in the collections of the National Museum and was definitely a *Viviparus*.

Lea stated that his specimen lacked the spire, but his figure shows that feature. Artist's license aside, Lea's Figure 87 is easily recognizable as a specimen of the common *Lunatia perspectiva* (Rogers and Rogers), species number 350 in the present work. Especially telling are the size and form of the umbilicus and the wash of callus on the inner lip, as figured. Consequently, I conclude that Lea's species has not been figured, and that the figure of "*Turbo glaber*" should not used in the species concept.

Until the type can be reexamined, its relationship to the following can not be ascertained.

Zone 2, Petersburg.

553. *Viviparus* sp. cf. *V. emmonsi* Henderson, 1935 (Synonym: *Paludina subglobosa* Say Emmons, 1858, not of Say, 1825). Shell small, roughened by erosion, rounded, thin, inflated. Aperture oval. Spire fairly high, shouldered. Zone 2, Williamsburg, campus of College of William and Mary. Height 22 mm.

This species was found with abundant *Corbicula*, a fresh water clam discussed earlier in the text.

554. *Viviparus* sp. A single specimen was found with the proceeding, and is now in the collections of the Geology Department, College of William and Mary. The form was smaller, and had a distinct angulation, forming a low keel on the whorls. This feature may place it into the genus *Lioplax*. Height about 10 to 12 mm.

555. *Viviparus* sp. Shell small, globose, thin. Umbilicus very small, nearly blocked by callus. Body whorl with two very low keels. Upper whorls slightly tabulated, angular, with a low keel at the periphery. Chowan River beds, Chesapeake. Height 12.73 mm.

Family Helicidae

Genus *Pleurodonte* Fischer

___. *Pleurodonte strangulata* (C. B. Adams). Conrad tentatively reported this Jamaican land snail from Yorktown (Conrad, 1876), but all subsequent authors (see Henderson, 1935: 142) have been of the opinion that an Academy specimen fell into Conrad's box of Yorktown fossils after he opened it in Philadelphia. The species has no validity as a Yorktown fossil.

Family unknown

556. *Incerta sedis*. Here figured is the broken protoconch and early whorls of a gastropod which has eluded all efforts to determine it, even to family. It occurred with the *Viviparus* in the lower Chowan River beds and has much the same staining and preservational appearance. The specimen has a small, very worn protoconch, and an irregular, noded keel.

Chowan River beds, Chesapeake. Height (incomplete) 13 mm.

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APPENDIX I

NORTH CAROLINA MOLLUSCS FROM THE YORKTOWN AND CHOWAN RIVER FORMATIONS NOT YET REPORTED IN VIRGINIA.

The following species are taken from the literature and are here enumerated in order to more completely document the Yorktown and Chowan River faunas. The North Carolina Pliocene also includes molluscan assemblages from the Yorktown basin which appear to be younger than the Chowan River. These include the assemblage described by Ward and Blackwelder (1987) from Aurora (Appendix III, column 39), and the assemblage from the James City Formation (Appendix III, column 38).

NORTH CAROLINA YORKTOWN SPECIES

BIVALVES

Placopecten sp. cf. *P. magellanicus* (Gmelin)
Mysella velaini Gardner, 1944
Sportella calpix Gardner, 1944
Astarte griftonensis Gardner, 1944
Eucrassatella speciosa (A. Adams, 1852)
Tellina verdevilla Gardner, 1944
Pitar castoriana (Gardner, 1944)
Gemma cravenense Gardner, 1944
Gemma verdevilla Gardner, 1944

GASTROPODS

Diodora carolinensis (Conrad, 1873)
Calliostoma virginicum hertfordense Gardner, 1948
Ilyanassa gastrophila (Olsson, 1916)
Terebra unilineata (Conrad, 1841)
Mangelia emissaria Olsson, 1916
Atys ornata Gardner, 1948

NORTH CAROLINA CHOWAN RIVER SPECIES

(Taken primarily from Bailey, 1977, Gardner, 1944, Gardner, 1947, Mansfield, 1928, and Mansfield, 1936).

BIVALVES

Anadara sp., aff. *A. compyla* (Dall, 1898)
Noetia carolinensis Conrad, 1862
Pecten sp. cf. *P. sentis* Reeve, 1853
Anomia aculeata Gmelin, 1792
Bellucina waccamawensis delandensis (Mansfield, 1918)
Cavilinga trisulcata (Conrad, 1841)
Cavilinga trisulcata albermarlensis (Richards, 1947)
Diplodonta sp., cf. *D. caloosaensis* Dall, 1900
Echinochama arcinella (Linnaeus, 1758)
Aligena chowanensis Gardner, 1944
Fabella calpix Gardner, 1944
Eucrassatella speciosa (A. Adams, 1852)
Trachycardium isocardia (Linnaeus, 1758)
Spisula subparilis (Conrad, 1841)
Tellina propetenella Dall (error for *T. propetenera* Dall, 1900)
Tellina texana Dall, 1900
Chione cancellata (Linnaeus, 1767)
Gemma trigona Dall, 1903
Parastarte sp. cf. *P. triquetra* (Conrad, 1846)
Caryocorbula contracta (Say, 1822)
Pandora trilineata Say, 1822
Anisothyris sp.

SCAPHOPOD

Cadulus quadridentatus (Dall, 1881)

GASTROPODS

Diodora cayenensis (Lamarck, 1822)
Caecum regulare Carpenter, 1858 (= *C. pulchellum* Stimpson, 1851)
Epitonium sayanum Dall, 1889 (= *E. humphreysi* (Kiener, 1838))
Anachis avara translirata (Ravenel, 1861) (= *A. lafresnayi)*
Busycotypus canaliculatum (Linnaeus, 1758)
Drillia sp. aff. *D. sumterensis* Gardner and Aldrich, 1919
Compsodrillia chowanensis Gardner, 1948
Mangelia eritima Bush, 1885
Odostomia sp. cf. *O. conoidea* (Brocchi, 1814)
Chrysallida seminuda (C. B. Adams, 1837)
Turbonilla nivea (Stimpson, 1851)
Turbonilla interrupta (Totten, 1835)
Acteocina canaliculata (Say, 1822)

APPENDIX II

UNCERTAIN OR DOUBTFUL YORKTOWN RECORDS

This appendix documentes missidentifications, nude names, doubtful names, manuscript names, and other invalid Yorktown records. Additionally, 18th and 19th century literature often cites only "Virginia" as locality data, and occasionally taxa were proposed without locality. Where possible, these species are assigned to their proper age and formation. Meek (1864) compiled a listing of the North American Miocene fossils, using among other resources, manuscript lists provided by Conrad. These include a number of nude names which reflect either Conrad's well known faulty memory or specimen lable names which Conrad intended to publish. I have consulted Conrad's original papers and the compilations by Moore (1960) and Richards (1968) in an effort determine the status of these names. Occasionally, the literature will list a unique Virginia record of a well known, easily identified species which remains unverified after extensive search of stratigraphic collections and outcrops. Such records are here treated as possible but problematical.

Arca carolinensis Conrad Meek, 1864. This is *Noetia carolinensis* Conrad, 1862, which has been reported from the Chowan River beds of North Carolina, but has not as yet been recovered in Virginia.

Arca idonea Say H. C. Lea, 1845. The actual authorship is Conrad, 1832. There remains some question of the exact provenance of the type and therefore some question of application of the name. Two closely related species are involved, the common late Miocene St. Marys and Eastover form traditionally called *Anadara idonea*, and the very rare Pliocene form found from Virginia to Florida called *Anadara carolinensis* (Dall, 1898). Richards (1968:56) records the type of *Arca idonea* Conrad as coming from the St. Marys.

Anadara clisea (Dall, 1898) Sheldon, 1917. Properly restricted, this is a pre-Yorktown species.

Anadara transversa (Say, 1822) (Synonyms: *Scapharca ransversa* (Say) Conrad Meek, 1864; not *Arca transversa* Portlock, 1843, or *Arca transversa* Morris & Lycett, 1843)

Arcopsis adamsii (Dall, 1886). Gardner, 1926, p. 28, records this species but a search of both the biologic and stratigraphic collections at the National Museum failed to discover a Yorktown specimen, and no subsequent record is known. Ward and Blackwelder (1987) assigned this species to the genus *Quadrilatera*.

Glycymeris laevis (Tuomey and Holmes, 1856) (Synonyms: *Pectunculus laevis* Tuomey and Holmes, 1856; *Pectunculus virginiae* "Wagner" Dall, 1898. Tuomey and Holmes indicate that their species was also found in Virginia, probably referencing *Glycymeris tumulus* (see below.) The syntypes from Lake Waccamaw, North Carolina, have recently been discussed and illustrated by Spamer and Forster (1988, p. 67-68, plate 6).

Glycymeris parilis (Conrad, 1843) (Synonym: *Pectunculus parilis* Conrad, 1843). Properly restricted, this is a pre-Yorktown, middle Miocene species.

Glycymeris reflexa Olsson, 1916. This nude name occurs in the middle of a stratigraphic discussion, and there is no indication that Olsson was intending to erect a new taxon. The best explanation is that Olsson was referring to *Panopea reflexa* Say. Early on, "*Glycymeris*" was proposed for glycymerids and for panopeas by different authors. The glycymerids had priority, but Olsson's reference may well be a lapse based on the other usage.

Glycymeris tumulus (Conrad, 1845) (Synonyms: *Axinaea tumulus* Conrad Meek, 1864; *Pectunculus tumulus* Conrad, 1845). This is a pre-Yorktown, Eastover Formation species.

Melina maxillata Lamarck Lyell, 1845. The species is also European. Much disagreement remains over the generic placement, but by whatever genus, the species became extinct in the Western Atlantic at the end of the Eastover, and is therefore pre-Yorktown. There are authors who have incorporated the Eastover into their Yorktown Formation concept and who therefore cite this as a valid Yorktown species.

Ischadium recurvum (Rafinesque, 1820) (Synonym: *Mytilus hamatus* Say 1822). Clark and Miller (1912) and Gardner (1944) have reported this species from the Yorktown beds, but all available material is fragmented and not accurately identifiable even to genus.

Perna conradianus Orbigny, 1852 (Synonyms: *Mytilus incrassatus* Conrad, 1841, not of Deshayes, 1830; *Mytiloconcha incrassata* Conrad Meek, 1864; *Mytilus conradinus* Orbigny, 1852). Apart from a suggestive but non-definitive fragment from Petersburg, there is no Virginia material in hand to document this common Duplin to Southern Florida species.

Crenella glandula Totten (Synonym: *Modiola glandula* Totten Lyell, 1845). Properly restricted, *C. glandula* is a Pleistocene and recent species. It is uncertain which of the various Yorktown mussels Lyell intended.

Modiolus ducatelli (Conrad, 1840). Properly restricted, this is a middle Miocene species known from Maryland and Florida. It is laterally rather than dorsoventrally inflated. All specimens labled *M. ducatelli* in the National Museum stratigraphic collections are fragments. All complete large *Modiolus* I have seen from the Yorktown belong to *M. inflatus*.

Modiola spinigera H. C. Lea, 1843 (Synonym: *Volsella* ? *spinigera* (H. C. Lea, 1843) Meek, 1864). The type appears to be missing from the Academy of Natural Sciences collections, and both Lea's description and figure are insufficient for accurate identification. Dall (1898) suggested that the form might be a *Crenella*, but the figure and original

generic assignment also suggest *Musculus virginicus* (Conrad, 1867).

Pecten biformis Conrad, 1843. Properly restricted, this is an Oligocene species.

Pecten dispalatus Conrad, 1845. Properly restricted, this is an Oligocene species.

Pecten marylandicus Wagner Clark and Miller, 1912. Properly restricted, this is a middle Miocene species.

Pecten principoides Emmons, 1858. Properly restricted, this is a pre-Yorktown, Eastover Foramtion species.

Pecten tricenarius Conrad, 1843 (Meek, 1864). Properly restricted, this is an Oligocene species.

Aequipecten muscosus (Wood, 1828) Dall (in Shaler, 1890). Shaler's report on the Great Dismal Swamp included fossil shells from spoil of apparently mixed Yorktown and Chowan River deposits. True *Aequipecten muscosus* is a well inflated, prickly scallop quite unlike any Virginia Pliocene species. Exactly which species was intended can not now be determined.

Argopecten gibbus (Linnaeus) Tucker-Rowland, 1938. Waller (1969) could not document any Yorktown records for this typically Pleistocene and recent species.

Argopecten vicenarius (Conrad) (Synonyms: *Pecten vicenarius* Conrad, 1843 of Meek, 1864; *A. vicenarius* (Conrad) Ward and Blackwelder, 1980). Both Meek (1864) and Ward and Blackwelder (1980) cite this species from Virginia, the latter as a Yorktown species. On the other hand, Waller (1969) has demonstrated the species to be characteristic of the younger, Waccamaw beds. Virginia records of this species are here considered to be problematical.

Chesapecten middlesexensis (Mansfield, 1936) Sabol, 1960. Properly restricted, this is an Eastover Formation species.

Pseudamussium sp. Bird, 1965. True *Pseudamussium* are very small, fragile scallops typical of the deeper waters of the outer shelf. This Zone 1 record is probably based on a juvenile *Amusium* or, more likely, *Placopecten*.

Lima papyria Conrad of Meyer, 1888. Properly restricted, this is a middle Miocene species. Meyer probably had a specimen of *Limaria pellucida* (C. B. Adams, 1846).

Anomia delumbis Conrad Meek, 1864. This appears to be a *nomen nudum*.

Anomia squamula Linnaeus, 1758 (Synonym: *Anomia aculeata* (Muller, 1776). Dall (1898:785) states "Upper Miocene of York River, Virginia, Harris; ... The presence of this species in the Virginia Miocene is established by some beautifully preserved small valves with characteristic sculpture obtained by Mr. Harris." Similar valves from Chuckatuck were at first assigned to *A. aculeata*, but adult forms proved to be a species of *Pododesmus*.

Anomia ruffini Conrad, 1844 Meek, 1864. Properly restricted, this is an Oligocene species (Ward, 1992).

Ostrea verpertina Conrad Meek, 1864. Listed in Meek without locality, Richards (1968) states that this belongs to the California Pliocene.

Lucina americana Defrance of Meek, 1864. This appears to be a synonym of one of the common recent Western Atlantic lucinid clams, but the name is not discussed by Dall (1903) or Abbott (1974). Meek's 1864 listing of a Virginia record cannot be applied with certainty to any of the various Yorktown species.

Lucina edentula Say H. C. Lea, 1845. This is a confusing list entry. The only Say usage I can find is *Cyclas edentula* Say, 1829. Lea may have had in mind *Venus edentula* (Linnaeus, 1758), a European species which is the type of *Anodontia* in the Lucinidae. If so, this may reference *Pseudomiltha anodonta* (Say, 1824), but there is no way of settling the question.

Lucina (Cyclas) Conradi Orbigny Meek, 1864 (Synonym: *Lucina divaricata* Linnaeus of Conrad, not of Linnaeus). Orbigny (1852) proposed a replacement name which is a synonym of his *Divalinga quadrisulcata* (Orbigny, 1842).

Diplodonta deltoidea Conrad, 1860 (Synonym: *Misia deltoidea* Conrad, 1865). Properly restricted, this is a synonym of the Eocene species, *Diplodonta ungulina* (Conrad).

Bornia mactroides (Conrad, 1834) Meyer, 1888a. Properly restricted, this is a Choptank Formation, Maryland Miocene species.

Aligena sharpei Meyer, 1888b. An odd species from an odd and apparently completely overlooked paper. The new species was among about a dozen species discovered inside a barnacle two inches in diameter found on "the west shore of the Chesapeake Bay." This locality suggests the cliffs in Maryland, but a Virginia locality can not be ruled out. The identification of the accompanying listed fauna is stated to be preliminary, and contains species unique to Maryland as well as uniquely Yorktown taxa. The only detailed descriptions contained in the short paper are that of the new species and, rather surprisingly, the barnacle. Victor Zullo (1991, personnal communication) suggests that the barnacle best matches with certain Choptank Formation specimens. A complete analysis of the Meyer paper will be published later.

Pteromeris perplana (Conrad, 1841) (Synonym: *Cardita perplana* Conrad, 1841). Adult *P. perplana* are distinctive bivalves which do not occur in any of the Yorktown collections I have examined. However, juveniles may be

confused with *P. abbreviata* (Conrad, 1841), a common Yorktown species which has been synonymized with *P. perplana* by some authors. Here, the two are considered to be distinct, and the Virginia records of *P. perplana* are considered suspect.

Astarte lirata Conrad Lyell, 1845. No such Conrad species seems to exist. Neither Moore (1962) or Richards (1968) document the taxon.

Astarte obruta Conrad, 1840. Conrad (1840) cited an original locality of "Maryland and Virginia". Properly restricted, this is a Maryland Miocene species.

Astarte virginica Conrad, 1863. The type is missing and both description and orginial locality data are inadequate. This may be an older name for *Astarte rappahannockensis* Gardner, 1944, a pre-Yorktown Eastover Formation species, but the name is best considered a *nomen dubium.*

Crassatella melina Conrad H. C. Lea, 1845. Properly restricted, this is a middle Miocene species.

Cardium carolinensis Conrad. Conrad, 1862, proposed *C. carolinensis* as a replacement for *Cardium magnum* Born of Tuomey and Holmes, 1856; Conrad, 1867, proposed *C. carolinensis* as a new name for *Cardium muricatum* Linnaeus of Tuomey and Holmes, 1856, not of Linnaeus, 1758 (= *Trachycardium oedalium* (Dall, 1900). Conrad, 1873, proposed *C. carolinensis* for a Cretaceous species from North Carolina. If the South Carolina Pliocene *Laevicardium* (*Dinocardium*) species is distinct from the recent *L.* (*D.*) *obustum* (= *Cardium magnum* Born), as Ward and Blackwelder (1987) have proposed, then *Cardium carolinensis* Conrad, 1862, is the oldest name available. In my opinion, the fossil and recent populations represent variation within a single species. The two later uses are homonyms and therefore invalid. By any of the three species concepts, the Virginia record can be ignored.

Cardium islandicum Bruguiere, 1789 Dall (in Shaler, 1890). Which of the various cockle species Dall intended can not now be determined.

Cardium robustum Solander Clark and Miller, 1912. *Laevicardium* (*Dinocardium*) *robustum* (Lightfoot) has not been subsequently recovered from any Yorktown locality, although it does occur in the overlying Chowan River beds.

Americardia media (Linnaeus, 1758). Specimens which I earlier identified from Williamsburg as worn, broken *A. media* are actually *Clinocardium* (*Planicardium*) *acutilaqueatum* (Conrad)

Spisula duplinensis (Dall). Ward and Blackwelder (1980) illustrate a broken valve as this species. The record is here treated as problematical, pending discovery of a complete, unequivocal specimen.

Spisula subparilis (Conrad, 1841). This species was originally described from the Waccamaw beds of Wilmington, North Carolina. Reports of this species in the Virginia Yorktown are probably based on *Spisula modicella.*

Mulinia lateralis (Say, 1822). Dall (1898) was the first to record this species as Yorktown, but the only Yorktown specimens so labled in the United States Geological Survey stratigraphic collections are indeterminate juvenile *Mulinia* which might be equally well assigned to *M. congesta.* Typical adult *Mulinia lateralis* first appear in the overlying Chowan River beds.

Tellina producta Conrad, 1840 of Clark and Miller, 1912. Properly restricted, this is a middle Miocene species.

Semele scintillata Dall Richards, 1947. Properly restricted, this is a Chipola Miocene species. Richards record is apparently either missidentification or a pre-Yorktown specimen.

Euloxa latisulcata Conrad Meek, 1864. This is a pre-Yorktown, Eastover Formation species.

Venus ascia H. C. Lea, 1843. This is a *nomen dubium.* The type is lost and the figure and description too indefinite for certain assignment.

Mercenaria berryi Gardner, 1948 Blackwelder and Ward, 1976. This species appears to be restricted to the Eastover Formation.

Mercenaria violacea Schumacher? of Meek, 1864. This color morph of *Mercenaria mercenaria* can not be distinguished in any of the fossil material I have examined.

Chione alveata (Conrad, 1831) (Synonym: *Venus alveatus* Conrad, 1831). Properly restricted, this is a late Miocene species found in the St. Marys and Eastover formations.

Pitar morrhuana (Linsley, 1845). Properly restricted, this is a late Pleistocene and recent species easily confounded with *P. sayana* (Conrad), its probable ancestor.

Pitar subnasuta (Conrad, 1841) of Dall, 1903. This species was described from Maryland. Palmer (1928) synonymized it with *P. sayana.*

Macrocallista emmonsi Gardner, 1944. Druid Wilson (1978, personal communication) has shown that this species was based upon a European specimen which was accidently admixed with the Emmons collection.

Dione spherica (H. C. Lea) Meek, 1864. This is a junior synonym for *Diplodonta nucleiformis* (Wagner).

Mya producta Conrad, 1838. Conrad reported this species from Yorktown, Virginia, but it has subsequently been found only in the Choptank Formation of Maryland.

Panopea americana Conrad 1838 Lyell, 1845. Properly restricted, this is a Maryland Miocene species.

Periploma applicata Conrad, 1834. Richards (1968) recorded this Vicksburg Oligocene species from a Yorktown locality. The record is plainly a lapse or missprint.

Pholadomya abrapta Conrad of Clark and Miller, 1912. This is a misspelling of *Margaritaria abrupta* Conrad.

Dentalium dentale Clark and Miller, 1912. This is a misspelling of *D. entale* Linnaeus which is known only from the recent and Pleistocene.

Cadulus carolinensis Bush, 1885 Dall (in Shaler, 1890). This species has not subsequently been recovered from Pliocene deposits in Virginia.

Fissuridea marylandica Conrad, 1841 Clark and Miller, 1912. Properly restricted, this is a pre-Yorktown, Maryland Miocene species.

Fissuridea nassula Conrad Twardy, 1936. Properly restricted, this is a pre-Yorktown, Maryland Miocene species.

Diodora alticostata (Conrad, 1834). Properly restricted, this species is restricted to St. Marys faunas. It somewhat resembles *D. oblonga* (H. C. Lea), the common Yorktown zone 2 species.

Calliostoma armillus (H. C. Lea, 1843). The holotype is missing and the original description and figure are equivocal. It is best treated as a *nomen dubium.*

Calliostoma aphelium Dall Twardy, 1936. Properly restricted, this is a pre-Yorktown, Maryland Miocene species.

Trochus cinctus "Wagner" Dall, 1898. This *Calliostoma* from unknown locality does not resemble any of the Yorktown species.

Calliostoma distans Conrad Clark and Miller, 1912, and Twardy, 1936. Properly restricted, this is a pre-Yorktown, Maryland Miocene species.

Calliostoma humilis Conrad Clark and Miller, 1912; Richards, 1947 Properly restricted, this is a pre-Yorktown, Maryland Miocene species.

Solariella cancellata (Conrad, 1833). The original reference states that the specimen came from "Suffolk, Virginia", but Conrad (1836) corrected this to Claiborne, Alabama. The holotype is the Eocene species.

Delphinula naticoides H. C. Lea, 1843. *Nomen dubium.* The type is lost and both description and illustration are insufficient for certain identification.

Turritella indenta Emmons of Heilprin, 1884. Properly restricted, this is a more southern species common in the Duplin beds of North and South Carolina.

Turritella interrupta Totten Meek, 1864. This is either a lapse for *Turbonilla interrupta*, or a nude name.

Turritella linnaea Dujardin Lyell, 1845. The authorship is actually Deshayes. According to Heilprin (1884), this European species resembles *Turritella plebia* Say.

Turritella plebia Conrad Richards, 1947 (Synonyms: *Turritella plebia* Say, 1824; *Turritella plebia carinata* Gardner, 1948, not *T. carinata* Lea, 1833, or Muenster, 1841). The authorship is actually Say. *T. plebia* is a common pre-Yorktown species common in the late Miocene St. Marys and Eastover formations. Gardner's subspecies name is twice preoccupied and is puzzling because she was certainly familiar with the Lea usage.

Turritella variabilis Conrad, 1830 (Replacement name: *T. subvariabilis* Orbigny, 1852; not *T. variabilis* Defrance, 1828). This pre-Yorktown species has been used as a catch-all name for any and all Atlantic Coastal Plain Turritellas. Being preoccupied, it is an invalid name.

Anguinella virginiana (Conrad) Heilprin, 1884. Properly restricted, this is a pre-Yorktown, Maryland Miocene and Eastover species.

Scala arctata Conrad, of Meek, 1864. This is a *nomen nudum* or manuscript name because it does not seem to have been cited by Conrad. There is a specimen so labled, ANSP 17138.

Scala clathra Lamarck (Conrad) Meek, 1864. Properly restricted, this European recent *Epitonium* has no valid status in Atlantic Coastal Plain faunas. It is a common 19th century missidentification.

Scala distans Conrad, 1862. This is a *nomen nudum.*

Scalaria pachypleura Conrad, Meek, 1864. Properly restricted, this is a pre-Yorktown, Maryland Miocene species.

Scala procera Conrad, 1844. The type is lost, the species unfigured, and the description inadequate. The cited size is too large for any of the numerous Yorktown *Epitonium* documented in this work.

Calyptraea aperta (Solander) Richards, 1947. This spiny *Calyptraea* has been reported from the Eocene of Europe and of the Atlantic Coastal Plain, and occurs in the Maryland Miocene. It is not a part of the Yorktown fauna.

Calyptraea sinensis Linnaeus Lyell, 1845. This is an Eastern Atlantic species.

Crepidula lirata Conrad Twardy, 1936. Properly restricted, this is an Eocene species.

Cypraea annulifera Conrad, 1863. (Senior synonym: *Cypraea annulus* (Linnaeus, 1758). Dall notes that Conrad described a recent, Indo-Pacific shell, possibly dumped on the beach by an Indian trader.

Pyrula jamesii Olsson, 1914. *Pyrula* is a junior synonym of

Ficus, the fig shells. No subsequent specimen resembling Olsson's rather poor figure has been discovered and the type is lost. Pending rediscovery, the species is here considered uncertain.

Urosalpinx cinereus (Say, 1822) (Synonyms: *Fusus cinereus* Say H. C. Lea, 1845; *Fusus cinereus* Linnaeus Lyell, 1845). This Pleistocene and recent species was commonly missidentified with one or more of the Yorktown species.

Urosalpinx gardnerae Twardy, 1936. A manuscript name proposed in thesis.

Urosalpinx rusticus (Conrad, 1832) (Synonymns: *Fusus rusticus* Conrad, 1832, not of Sowerby, 1831; *Fusus subrusticus* Orbigny, 1852 replacement name; not *Urosalpinx rusticus* Conrad Johnson, 1972). Properly restricted, this is a Maryland Miocene species.

Muricidea veronicae Twardy, 1936. A manuscript name proposed in thesis

Eupleura caudata (Say, 1822). A common late Pliocene, Pleistocene and recent species which first makes its appearance in the Waccamaw faunas.

Purpura lapillus Linnaeus Lyell, 1845. This boreal, Pleistocene and recent species bears some resemblance to certain of the *Ptychosalpinx* species.

Ecphora tricostata Martin Richards, 1947. Properly restricted, this is a pre-Yorktown, Maryland Miocene species.

Anachis obesa (C. B. Adams, 1845) Gardner, 1948. True *A. obesa* first appears in the Waccamaw faunas and is most common in the Pleistocene and recent. Exactly which Yorktown columbellid Gardner had can not now be determined.

Mitrella lunata (Say) Gardner, 1948. True *M. lunata* is a post-Yorktown species.

Liomesus stimpsonii Dall Dall (in Shaler, 1890). The recent genus, *Liomesus*, is closely related to *Ptychosalpinx*.. Which of the several Yorktown *Ptychosalpinx* species Dall intended can not now be determined.

Busycon carinatum Conrad Meek, 1864. Described without certain locality, this species is now known from the Little Cove Point beds of Maryland (Ward, 1980, personnal communication).

Fulgur coronatum Conrad (Clark and Miller, 1912). Properly restricted, this is a pre-Yorktown, Maryland Miocene species.

Fulgur spiniger Conrad Clark and Miller, 1912. Properly restricted, this is a pre-Yorktown, Maryland Miocene species.

Nassarius scalaris (Conrad, 1862) Meek, 1864. This species was briefly described without illustration or specific locality and the type is lost. Consequently, *nomen dubium.*

Tritia trivitata (Say) Conrad Meek, 1864, and Wollman, 1898. This common Pleistocene and recent *Nassarius* species has not been confirmed in the Yorktown fauna.

Ilyanassa isogramma Dall, 1892. Dall originally recorded this species from both the Yorktown and from Waccamaw beds. The Yorktown record appears to be in error.

Ilyanassa obsoleta (Say, 1822) Wollman, 1898. This is a Pleistocene and recent species.

Fusus rostratus Dujardin Lyell, 1845. This is a European species.

Oliva carolinensis (Conrad) Meek, 1864. No subsequent records exist for Virginia. The species is typical of Duplin and Waccamaw faunas.

Dactylus eboreus Conrad, 1862. This is a pre-Yorktown, Eastover Formation species of *Oliva.*

Dactylus idoneus Conrad, 1868. This is a pre-Yorktown, Eastover Formation species of *Oliva.*

Oliva zonalis Conrad Orbigny, 1852. I find no record of Conrad ever naming such a species. Orbigny reports the form from Virginia.

Oliva littoralis Orbigny, 1852. Cited by Orbigny without author, *Oliva litterata* Lamarck may be intended. As published, the name is a *nomen nudum.* Orbigny reports the form from Virginia.

Marginella americana Conrad, 1861. Conrad named and figured the specimen, but lost it before it could be described. A named figure constitutes a valid proposal, but the figure is poor and can not be matched with any Yorktown species. Consequently, this is a *nomen dubium.*

Marginella distans Conrad Meek, 1864. This is a *nomen nudum.*

Marginella nana Conrad Orbigny, 1852. I can find no record of Conrad ever using this name. *Nomen nudum.*

Marginella prepusilla Conrad H. C. Lea, 1845. Again, there is no record of Conrad using this name. *Nomen nudum.*

Terebra curvilineata calvertensis Martin Twardy, 1936. Properly restricted, this is a pre-Yorktown, Maryland Miocene species.

Terebra sublirata Conrad Meek, 1864. This is a *nomen nudum.*

Leucosyrinx engonata (Conrad, 1862). Although originally described from "Virginia" this is a pre-Yorktown, Maryland Miocene species.

Leucosyrinx nodulifera (Conrad, 1862). Although originally described from "Virginia" this is a pre-Yorktown, Maryland Miocene species.

Pleurotoma flexuosa Emmons, 1858, not of Muenster, 1835. Originally described from North Carolina, this species has not been subsequently recognized with certainty, is preoccupied, and is therefore invalid.

Clathrodrillia gracilis (Conrad, 1830) (Synonyms: *Drillia distans* Conrad, 1862, not of Conrad, 1860; *Drillia incilifera* Conrad Twardy, 1936; *Drillia incilifera distans* Conrad Twardy, 1936). Properly restricted, this is a Maryland Miocene species.

Bela daedalia Heilprin, 1884. Listed without authorship, this name can not be applied with certainty to any Yorktown turrid.

Compsodrillia chowanensis Gardner Johnson, 1972. Gardner's type came from the Chowan River. Apart from the one listed by Johnson, no Yorktown records have been reported. That record is here considered problematical.

Drillia dissimilis Conrad Meek, 1864. Properly restricted, this is a pre-Yorktown synonym of Splendrilia limatula (Conrad, 1830).

Drillia limatula (Conrad) Richards, 1947. Properly restricted, this is a pre-Yorktown Maryland Miocene species.

Drillia pseudeburnea Whitfield Twardy, 1936. Properly restricted, this is a pre-Yorktown Maryland Miocene species.

Clathrodrillia emmonsii (Olsson) Gardner, 1948 (Synonym: *Drillia emmonsii* Olsson, 1914; *Pleurotoma tuberculata* Emmons, 1858, not of Pusch, 1838, Anton, 1839, or Gray, 1839). Gardner records Yorktown records for this species, but her illustration of the species does not match that of Emmons, 1858, and the Virginia records must therefore be considered doubtfull.

Drillia whitfieldi Martin Twardy, 1936. Properly restricted, this is a pre-Yorktown Maryland Miocene species.

Pasithea ornata H. C. Lea, 1843 (Synonym: *Auriculina ornata* (H. C. Lea, 1843) Meek, 1864). The type is missing and both figure and description are insufficient for certain identification. This becomes a *nomen dubium*.

Odostomia (*Chrysallida*) *seminuda* (C. B. Adams, 1839) (Synonym: *Jaminia seminuda* C. B. Adams, 1839). Properly restricted, this is a post-Yorktown, Pleistocene and recent species.

Turbonilla interrupta (Totten, 1835). This Pleistocene and recent species, properly restricted, does not occur in the Yorktown fauna.

Turbonilla paucistriata Jeffreys, 1884 Meyer, 1888. It is impossible to determine which of the several Yorktown species was intended.

Turbonilla sp. near *T. nivia* Stimpson Twardy, 1936. It isimpossible to determine which of the several Yorktown species was intended.

Bulla biplicata H. C. Lea, 1844 of Dall, 1898. Dall seems to have confounded Lea (1843, 1845, 1846) dealing with the Yorktown faunas near Petersburg, Virginia, with Lea, 1844, dealing with recent shells. *Bulla biplicata*, supposedly from a Cape May, New Jersey beach, can not be assigned with certainty to any recent species. Abbott (1974:315) states of *Cylichnella bidentata* (Orbigny, 1841) "This is *C. biplicata* of authors, not A. Adams." A. Adams usage dates from 1850. Whether H. C. Lea's earlier usage was included by Abbott was not specified, but *C. bidentata* has a published range of Cape Hatteras to Brazil, and, if conspecific with *Bulla biplicata* Lea, seems out of place in New Jersey. Gardner (1937) reports *C. biplicata* Lea as both recent and as present in the Chipola, Oak Grove, and Shoal River formations. However, from her discussion, she appears to be comparing her fossil taxon with Lea's illustration rather than from any certain recent specimens. I doubt that the Gardner and Lea taxa are conspecific.

Bulla subspissa Conrad Meyer, 1888. This Maryland Miocene species was listed by Meyer without figure or description. properly restricted, it is pre-Yorktown.

Melampus bidentatus Say, 1822 (Synonym: *Melampus longidens* Conrad, 1863). Conrad's species is suspect because the recent species lives along the York River. No authentic Yorktown specimens have subsequently been recovered.

Pleurodonte strangulata (C. B. Adams, 1849) (Synonym: *Helix strangulata* C. B. Adams, 1849, non Hombron and Jacquinot, 1841). This recent Jamaican land snail was reported from the Yorktown by Conrad (1876), but apparently was simply a museum specimen which fell into Conrad's box (Henderson, 1935:142).

APPENDIX III
DISTRIBUTION OF WESTERN ATLANTIC PLIOCENE MOLLUSCS FROM VIRGINIA TO FLORIDA
(VIRGINIA YORKTOWN AND CHOWAN RIVER RECORDS ARE IN BOLDFACE)

1 Common Count

RECENT DISTRIBUTION OF GENUS

2 ARCTIC 3 BOREAL 4 VIRGINIAN 5 CAROLINIAN (ON SHORE)
6 CAROLINIAN (OFF SHORE) 7 CARIBBEAN

PLIOCENE GEOGRAPHIC DISTRIBUTION OF SPECIES

8 WEST FLORIDA 9 SOUTH FLORIDA 1 0 NORTH & SOUTH CAROLINA 11 NORTHERN NORTH CAROLINA
12 VIRGINIA

PLIOCENE CHRONOSTRATIGRAPHIC DISTRIBUTION OF SPECIES
(DATA BASE COMBINES INDIVIDUAL LOCALITY RECORDS AND "WITHIN-RANGE" DATA)

13 UPPER WACCAMAW EQUIVALENTS 14 LOWER WACCAMAW EQUIVALENTS
15 CHOWAN RIVER EQUIVALENTS 16 DUPLIN FORMATION EQUIVALENTS
17 RAYSOR FORMATION EQUIVALENTS 18 UPPER GOOSE CREEK EQUIVALENTS
19 LOWER GOOSE CREEK EQUIVALENTS 20 BASAL PLIOCENE

EXTRA-PLIOCENE DISTRIBUTION OF SPECIES

21 MIOCENE 22 BERMONT (DuBAR) 23 BERMONT (HOERLE) 24 CANEPATCH
25 UPPER PLEISTOCENE 26 RECENT

PLIOCENE ASSEMBLAGES BY INDIVIDUAL UNIT

27 VA ZONE 2 CRANE LAKE BEDS: PANOPEA BED AND ROCK WHARF
28 VA ZONE 2 YORKTOWN CHUCKATUCK CROSSBEDS
29 VA ZONE 2 YORKTOWN MORGARTS BEACH
30 VA ZONE 2 YORKTOWN CHAMA BEDS
31 VA ZONE 2 YORKTOWN RUSHMERE MEMBER

32 VA CHOWAN RIVER FORMATION UPPER BED
33 VA CHOWAN RIVER FORMATION LOWER BED
34 VA ZONE 2 YORKTOWN RICE'S PIT, CHAMA BEDS, DEEP CREEK PIT, AND EQUIVALENTS
35 VA ALL ZONE 2
36 VA ZONE 2 YORKTOWN AURORA CALCARENITE-EQUIVALENT BED
37 VA ZONE 1 YORKTOWN

38 NC JAMES CITY FORMATION 39 WARD AND BLACKWELDER, AURORA
40 NC CHOWAN RIVER FORMATION 41 NC ZONE 2 YORKTOWN UPPER BEDS
42 NC ZONE 2 YORKTOWN ? MEMBER 43 NC ZONE 2 YORKTOWN, AURORA CALCARENITE
43 NC ZONE 1 YORKTOWN

45 UPPER WACCAMAW 46 LOWER WACCAMAW 47 ELIZABETHTOWN BEDS
48 DUPLIN FORMATION 49 RAYSOR FORMATION 50 UPPER GOOSE CREEK LIMESTONE
51 LOWER GOOSE CREEK LIMESTONE 52 WABASSO BEDS

53 JACKSON BLUFF CANCELLARIA ZONE 54 JACKSON BLUFF ECPHORA ZONE
55 JACKSON BLUFF LOWER LIMESTONE 56 JACKSON BLUFF (N-18)

57 NASHUA BEDS

58 UPPER CALOOSAHATCHEE 59 LOWER CALOOSAHATCHEE
60 UPPER PINECREST BEDS 61 LOWER PINECREST BEDS
62 BUCKINGHAM LIMESTONE 63 TAMIAMI LIMESTONE

64 MURDOCK LANDING 65 SARASOTA UPPER BED

CLASS BIVALVIA

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            111 11111112 222222 22233 333333 3344444 44444555 5555 5 55666666
1 234567 89012 34567890 123456 78901 234567 8901234 56789012 3456 7 89012345
x xxxxxx ----x ---x---- ------ xx--- ---x-- ------- -------- ---- - -------- Nucula diaphana H. C. Lea
x xxxxxx x---x ---xx--- ------ xx-x- --xx-- ------- -------- -x-- - -------- Nucula dolabella H. C. Lea
x xxxxxx ----- -x------ ------ ----- ------ -x----- -------- ---- - -------- Nucula pilkeyi Ward and Blackwelder
x xxxxxx xxxxx xxxxxxxx xxxxxx xxxxx xxxx-x xxx-x-x xxxxxxx- xx-- x xxx----- Nucula proxima Say
x xxxxxx xxxxx -xxxxxxx x----- xx--- --xx-- -xx---- -xxxx--- xx-- - --x----- Nucula taphria Dall
x xxxxxx xxxxx xxxxxxxx xxxxxx xx-x- --xx-x xxx---- xxxxxx-- xx-- x xxx--x--- Nuculana acuta (Conrad)
x xxxxxx xxxxx -xxxx--- ------ ----- x----- ------- ---x---- ---- - --x----- Nuculana hypsoma (Dall)
x xxxxxx xxx-- ---xx--- ------ ----- ------ ------- ---xx--- xx-- - --x----- Nuculana trochilia (Dall)
x xxxxxx -x--- ---xxxxx x----- ----- ------ ------- ------- ---- - --x----- Nuculana sp. cf. N. proteracuta Gardner
x xxx--- x-xxx xxxxxxxx x----- xxxxx x-xxxx -xx-x-x xxxx---- -x-- - -------- Yoldia laevis (Say)
x xxx--- x---- ----x--- ------ ----- ------ ------- ------- -x-- - -------- Yoldia tarpaeia Dall
x -----x xx--- ---x---- ------ ----- ------ ------- ------- x--- - --x----- Adrana kurtzi (Mansfield)
x ---xxx -x--- xxxx---- ------ ----- ------ ------- ------- ---- - x-x----- Arca aquila Heilprin
x ---xxx xx--- xxxxxxxx x---xx ----- ------ ------- ------- x--- - xx---x-- Arca occidentalis Philippi
x ---xxx -xx-- xxxxxxxx x--xxx ----- ------ ------- xx----- ---- - xx--x--- Arca umbonata Lamarck
x ---xxx -xx-- xxxx---- ------ ----- ------ ------- -x----- ---- - xxx----- Arca wagneriana Dall
x ---xxx -x--- ---x---- ------ ----- ------ ------- ------- ---- - --x----- Arca williamsi Olsson
x ---xxx -x--- ---x---- ------ ----- ------ ------- ------- ---- - --x----- Barbatia aclinensis Tucker & Wilson
x ---xxx xx--- ---x---- ------ ----- ------ ------- ------- x--- - --x----- Barbatia candida floridana Mansfield
x ---xxx -x--- xxxx---- ------ ----- ------ ------- ------- ---- - xxx----- Barbatia caloosahatchiensis (Sheldon)
x ---xxx -xx-- xxxxxxxx x-x-xx ----- ------ ------- x------ ---- - x-x----- Barbatia domingensis (Lamarck)
x ---xxx xxx-- ---xxx-- ------ ----- ------ ------- ----xx-- xx-- - --x----- Barbatia (Calloarca) leonensis Mansfield
x ---xxx -xx-- x------- ------ ----- ------ ------- x------ ---- - x------- Barbatia taeniata Dall
x ---xxx -x--- x------- ------ ----- ------ ------- ------- ---- - x------- Barbatia (Fugleria) millifila (Dall)
x --xxxx -x--- ---x---- ------ ----- ------ ------- ------- ---- - --x----- Anadara acompsa intermediata (Tucker & Wilson)
x --xxxx -x--- xxxx---- --x--- ----- ------ ------- ------- ---- - x-x----- Anadara aequalitas (Tucker & Wilson)
x --xxxx -xxxx xxx----- ------ ----- xx---- xxx---- xxx----- ---- x xx------ Anadara aequicostata (Conrad)
x --xxxx -x--- xxxx---- ------ ----- ------ ------- ------- ---- x x-x----- Anadara alcima (Dall)
x --xxxx x---- ----x--- ------ ----- ------ ------- ------- -x-- - -------- Anadara aresta (Dall)
x --xxxx xxxxx ---xx--- ------ xx--- ---x-- ----x-- ---x---- -x-- - --xx---- Anadara callicestosa (Dall)
x --xxxx xx--- ---xx--- ------ ----- ------ ------- ------- xx-- - --x----- Anadara campsa (Dall)
x --xxxx -x--- xxxx---- ------ ----- ------ ------- ------- ---- x x-x----- Anadara campyla (Dall)
x --xxxx -x--- ---x---- ------ ----- ------ ------- ------- ---- - --x----- Anadara cardioides Gardner
x --xxxx x-xxx ---x---- ------ -x--- --xx-- ----x-- ---x---- x--- - -------- Anadara carolinensis Dall
x --xxxx -x--- -x------ --x--- ----- ------ ------- ------- ---- - x------- Anadara (Caloosarca) catasarca (Dall)
x --xxxx -x--- ---x---- ------ ----- ------ ------- ------- ---- - --x----- Anadara chiriquiensis (Gabb)
x --xxxx -x--- x------- ------ ----- ------ ------- ------- ---- - x------- Anadara (Caloosarca) crassicosta (Heilprin)
x --xxxx -x--- x------- ------ ----- ------ ------- ------- ---- x -------- Anadara delandensis (Mansfield)
x --xxxx -x--- ---x---- ------ ----- ------ ------- ------- ---- - --x----- Anadara (Caloosarca) hoerleae H. E. Vokes
x --xxxx xxxxx xxxxxxx- ------ xx-x- --xx-- ------- xxxxxxx- xx-- - xxx--x-- Anadara improcera (Conrad)
x --xxxx -xxxx ---xxx-- ------ xx--- --xx-- ------- ---xxx-- ---- - --x----- Anadara improcera buccula (Conrad)
x --xxxx ----- xxxxxxx- -xx--- -x--- --xx-- ------- xx-xxxx- xx-- - xxxxxx-- Anadara lienosa (Say)
x --xxxx -x--- xx------ -x---- ----- ------ ------- ------- ---- - xx------ Anadara megerata Olsson & Harbison
x --xxxx -x--- ---x---- ------ ----- ------ ------- ------- ---- - --x----- Anadara (Caloosarca) notoflorida H. E. Vokes
x --xxxx --x-- x------- ---xxx ----- ------ ------- x------ ---- - -------- Anadara ovalis (Bruguiere)
x --xxxx -x--- xxxx---- ------ ----- ------ ------- ------- ---- - -xxx---- Anadara petersburgensis Olsson & Harbison
x --xxxx xxxxx ---xxxx- ------ x--x- --xx-- ------- ----x-x- xx-- - ---xx--- Anadara (Granoarca) propatula (Conrad)
x --xxxx x---- ---xxxxx x----- ----- ------ ------- ------- x--- - -------- Anadara propearesta (Mansfield)
x --xxxx -xx-- xx------ ------ ----- ------ ------- xx----- ---- - -------- Anadara rustica (Tuomey & Holmes)
x --xxxx xx--- xxxx---- ------ ----- ------ ------- xx----- ---- x xxx----- Anadara scalarina (Heilprin)
x --xxxx xx--- ---x---- ------ ----- ------ ------- ------- x--- - --x----- Anadara sellardsi Mansfield
x --xxxx xxxxx ---xxxx- ------ ----- --xx-- ------- ---x-x-- xx-- - --xxx--- Anadara staminea (Say)
x --xxxx -xxx- xx------ --xxxx ----- ------ --x---- xx----- ---- x x------- Anadara transversa (Say)
x --xxxx -x--- ----x--- ------ ----- ------ ------- ------- ---- - ---x---- Anadara (Caloosarca) n. sp. Vokes
x --xx-x -x--- x------- ------ ----- ------ ------- ------- ---- - x------- Noetia caloosana (MacNeil)
x --xx-x ---x- -x------ ------ ----- ------ --x---- --x---- ---- - -------- Noetia carolinensis Conrad
x --xx-x x-xxx ---xxxxx ------ xxxxx --xx-x ----x-- ---xx-x- -x-- - -------- Noetia incile (Say)
x --xx-x -xxxx xxx----- ------ ----- xx---- xxx---- xxx----- ---- x x------- Noetia limula (Conrad)
x --xx-x -x--- x------- --x-x- ----- ------ ------- ------- ---- x x------- Noetia platyura (Dall)
x --xx-x -x--- -------- ---xxx ----- ------ ------- ------- ---- - -------- Noetia ponderosa (Say)
x --xx-x -x--- xxxx---- ------ ----- ------ ------- ------- ---- - xxx----- Noetia ponderosa locklini Olsson & Harbison
x --xx-x xxxxx ---xxxx- ------ ----- ---x-- ----x-- ---xxxx- x--- - --x----- Noetia trigintinaria (Conrad)
x ------ x-xxx ----xxxx x----- ---xx --xx-x ----x-x ------x- -xx- - -------- Striarca centenaria (Say)
x ---xxx xxxx- xxxxxxxx xxxxxx ----- ------ xxx---- xxxxxx-- xx-- - xxx----- Quadrilatera adamsi (Dall)
x ---xxx -xx-- ----xx-- ------ ----- ------ ------- ----xx-- ---- - ---x---- Glycymeris abberans Nicol
x ---xxx xxxxx xxxxxxx- -x-xxx xx-x- xxxx-- xxx-x-- xxxxxxx- xx-- x xxxx---- Glycymeris americana (Defrance)
x ---xxx -xxxx ---xxxx- ------ ----- ---x-- ------- ---xxxx- ---- - -----x-- Glycymeris americana quinquerugata (Conrad)
x ---xxx -xxx- xx------ -xx--- ----- ------ xx----- ------- ---- - xx------ Glycymeris aratus (Conrad)
x ---xxx -xx-- xxxx---- -----x ----- ------ ------- xx-x--- ---- - xx------ Glycymeris decussata (Linnaeus)
x ---xxx --x-- ---xxx-- ------ ----- ------ ------- ---xxx-- ---- - -------- Glycymeris duplinensis Dall
x ---xxx --xxx xx------ ------ ----- xx---- -xx---- xxx----- ---- - -------- Glycymeris subovata var. hummi Ward & Blackwelder
x ---xxx --x-- -x------ ------ ----- ------ ------- -?------ ---- - -------- Glycymeris laevis (Tuomey & Holmes)
x ---xxx -xxxx xxxxxxxx x-xxxx ----- --x--- xx----- xx-x--- ---- - x----x-- Glycymeris pectinata (Gmelin)
x ---xxx --xx- xx------ ------ ----- ------ xxx---- xx------ ---- - -------- Glycymeris sloani Ward & Blackwelder
x ---xxx xxxxx ---xxxxx x----- xxxxx -xxx-x ------- --xxxxx- -x-- - --x--x-- Glycymeris subovata (Say)
x ---xxx -x--- x------- -----x ----- ------ ------- x------- ---- - x------- Glycymeris undatus (Linnaeus)
x -----x xx--- xxxx---- ------ ----- ------ ------- -------- x--- - x-x----- Nucinella woodii (Dall)
x xxxx-- ----x -xxx---- ------ xx--- x-xx-- ------- -------- ---- - -------- Mytilus edulis alaeformis (J. Sowerby)
x xxxx-- ---x- --x----- ------ ----- ------ --x---- -------- ---- - -------- Mytilus sp.
x ------ xxx-- xxxxx--- x----- ----- ------ ------- -------- x--- - x-xx---- Perna conradina (Orbigny)
x ------ -x--- ---xx--- x----- ----- ------ ------- -------- ---- - --xx---- Perna incurva (Conrad)
x ---x-x -x--- xxxx---- -xx-xx ----- ------ ------- -------- ---- x xxx----- Branchidontes exustus (Linnaeus)
x ---x-x -x--- x------- ------ ----- ------ ------- -------- ---- - x------- Brachidontes venustus Olsson & Harbison
x ---x-x -xxxx ---xxxx- ----x- ----- -x---- x------ -x-xx-x- ---- - --x----- Brachidontes sp.
x ---x-x -x--- ---x---- ------ ----- ------ ------- -------- ---- - --x----- Septifera sp.
x -xxx-x -xx-- xx------ ----xx ----- ------ x-x---- -x------ ---- - x------- Ischadium recurvum (Rafinesque)
x xxxxxx -xxxx xxxxx--- -xx-xx xx--- --xx-- ------- -x-xx--- ---- - xxx----- Crenella aequilatera (H. C. Lea)
x xxxxxx ---xx xx------ ------ ----- x----- -x----- -------- ---- - -------- Crenella cf. decussata (Montagu)
x xxxxxx ---xx --xx---- ------ x---- x----- ----x-- -------- ---- - -------- Crenella precursor Gardner
x --x-x- ----x ---x---- ------ ----- --xx-- ------- -------- ---- - -------- Arcoperna williamsi Campbell
x xxxxxx -xxx- xx------ --x-xx ----- ------ -x----- -x------ ---- - x------- Musculus lateralis (Say)
x xxxxxx ----x ---x---- ------ ----- --xx-- ------- -------- ---- - -------- Musculus ricei Campbell
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             111 11111112 222222 22233 333333 3344444 44444555 5555 5 55666666
1 234567 89012 34567890 123456 78901 234567 8901234 56789012 3456 7 89012345
x xxxxxx --xxx ---xx--- ------ xx-x- --xx-- ------- ---xx--- ---- - -------- Musculus virginicus (Conrad)
x ---xxx -x--- xxxx---- -----x ----- ------ ------- -------- ---- - --x----- Lithophaga bisulcata (Orbigny)
x ---xxx -xx-- ----xxx- ------ ----- ------ ------- ----xxx- ---- - -------- Lithophaga antillarum (Orbigny)
x ---xxx ----x ---x---- x----x ----- ---x-- ------- -------- ---- - -------- Lithophaga pectinicola Olsson
x ---xxx ----x --xxx--- ------ xx--- --xx-- ------- -------- ---- - -------- Lithophaga yorkensis Olsson
x xxxxxx xxxxx -xxxxxx- ------ xx-xx -xxx-- --x---- ---xxxx- -x-- - -----x-- Modiolus gigas (Dall)
x xxxxxx ---x- xx------ ----xx ----- ------ -x----- -------- ---- - -------- M.cf. M. modiolus (Lin.) Ward & Blackwelder
x xxxxxx ----x -------x ------ ----- -----x ------- -------- ---- - -------- Modiolus pulchellus Olsson
x ------ ----- -------- ------ ----- ------ ------- -------- ---- - -------- Volsella (?) spinigera (H. C. Lea) Meek
x xxxx-- -xxx- x------- ----xx ----- ------ ------- x------- ---- - x------- Geukensia demissa (Dillwyn)
x ----xx -x--- xxxxxxxx x----x ----- ------ ------- -------- ---- - x------- Botula cinnamomeus Lamarck
x -----x -xx-- xxxx---- ------ ----- ------ ------- -x------ ---- - x-x----x Pinna callosaensis Dall
x -----x --x-- x------- ----xx ----- ------ ------- x------- ---- - -------- Pinna carnea Gmelin
x -----x -x--- -x-xxx-- ------ ----- ------ ------- -------- ---- - x----x-- Pinna sp.
x ---xxx xxxxx -xxxxx-- ------ xx--- ---x-- ------- -x-xxx-- xx-- - --x----- Atrina harrisii Dall
x -----x -x--- xx------ -----x ----- ------ ------- -------- ---- - xx------ Isognomon alata bicolor (C.B. Adams)
x -----x -x--- ---x---- ------ ----- ------ ------- -------- ---- - --x----- Isognomon kecia (Tucker & Wilson)
x --xxxx xxxxx xxxxxxx- --x-xx x---- --xx-- ------- -x--xxx- -x-- - xxx----- Pteria colymbus (Roding)
x ---x-x --x-- -----x-- ------ ----- ------ ------- -----x-- ---- - -------- Pecten broweri Tucker
x ---x-x xxxxx ---xxxx- ------ -x--- ---x-- ------- ----xxx- xxx- - --xxxx-- Pecten hemicyclicus Ravenel
x ---x-x --x-- -x------ ------ ----- ------ ------- -x------ ---- - -------- Pecten (Euvola) holmesii Dall
x ---x-x -x--- ---xxxxx x----- ----- ------ ------- -------- ---- - --x----- Pecten improcera Conrad Gardner
x ---x-x x---- ----xxxx x----- ----- ------ ------- -------- -?-- - -------- Pecten macdonaldi Olsson
x ---x-x -xx-- xxxx---- --x--? ----- ------ ------- x------- ---- - x-x----- Pecten raveneli Dall
x ---x-x ----x -------x x----- ----- -----x ------- -------- ---- - -------- Pecten (Euvola) smithii Olsson
x ---x-x -x--- ----x--- ------ ----- ------ ------- -------- ---- - ---x-x-- Pecten violae Tucker
x ---x-x -x--- ?------- -----x ----- ------ ------- -------- ---- - ?------- Pecten ziczac Linnaeus
x -----x -xxx- xx------ ------ ----- ------ ------- -x------ ---- - x------- Leptopecten auroraensis Ward & Blackwelder
x -----x -xx-- x------- ------ ----- ------ ------- -x------ ---- - x------- Leptopecten harrisii (Dall)
x -----x -x--- ------x- ------ ----- ------ ------- -------- ---- - -----x-- Leptopecten irremotis (Olsson & Harbison)
x -----x xxxxx ----xxx- ------ ----- ---xx- ------- -----xx- -x-- - -----x-- Leptopecten leonensis (Mansfield)
x -----x -xx-- xx------ ------ ----- ------ ------- -x------ ---- - x--?-?-- Leptopecten wendelli (Tucker)
x -----x ----x ---x---- ------ ----- --xx-- ------- -------- ---- - -------- Leptopecten wilsoni Campbell
x -----x xxxxx xxxxxx-- ------ ----- --xx-- ------- xx--xxx- xxx- - x-xx-x-- Amusium mortoni (Ravenel)
x ----xx -x--- xxxxxxx- --xx-x ----- ------ ------- -------- ---- - xxx--x-- Aequipecten muscosus (Wood)
x ------ xxxxx ------xx ------ ----- -----x ------x ------xx --x- - -----xx- Chesapecten jeffersonius (Say)
x ------ -xxxx ---xxxx- ------ xxxxx --xx-- ----x-- -----x-- ---- - --xx---- Chesapecten madisonius (Say)
x ------ -xxxx -----xx- ------ ----- ---xx- ------- ---xxx-- ---- - -----x-- Chesapecten m. carolinensis (Conrad)
x ------ xxxxx ----xxx- ------ ----x --xx-- ----xx- ----xxx- -x-- - -----x-- Chesapecten septenarius (Say)
x ------ ---x- ----xxx- ------ ----- ------ ----x-- ------x- ---- - -------- Chesapecten septenarius palmyrensis (Mansfield)
x ------ xxxxx xxxxxxxx ------ xx--- -xxx-x xxx-x-x xxxxxx-- xx-- - x-xx-x-- Carolinapecten eboreus (Conrad)
x ------ --x-- -x------ ------ ----- ------ ------- -x------ ---- - -------- Carolinapecten e. senescens (Dall)
x ------ -xxx- xx------ -x-x-- ----- ------ x------ x------- ---- x xx------ Carolinapecten e. solarioides (Heilprin)
x ------ -xx-- -----x-- ------ ----- ------ ------- ----x--- ---- - ----x--- Carolinapecten e. walkerensis (Tucker)
x ------ ----x --x----- ------ ----- -x---- ------- -------- ---- - -------- Carolinapecten e. chesapeakensis Campbell
x -xxxxx -xx-- xxxxx-- ------ ----- ------ ------- x----x-- ---- - xxx----x Argopecten anteamplicostatus (Mansfield)
x -xxxxx xxxxx xxxxxxx- ------ x---- xx-x-- x---x-- xx--xxx- xxx- - x-xxxx-- Argopecten comparilis (Tuomey & Holmes)
x -xxxxx -x--- xxxx---- --xxxx ----- ------ ------- -------- ---- x x-x----- Argopecten gibbus (Linnaeus)
x -xxxxx -x--- -----x-- ------ ----- ------ ------- -------- ---- - -----x-- Argopecten evergladensis (Mansfield)
x -xxxxx -x--- -----xx- ------ ----- ------ ------- -------- ---- - ----xx-- Argopecten interlineatus (Gabb)
x -xxxxx -x--- xxxx---- ----xx ----- ------ ------- -------- ---- - --x----- Argopecten irradians (Lamarck)
x -xxxxx -xxx- xx------ ------ ----- ------ x------ xx------ ---- - x------- Argopecten vicenarius vicenarius (Conrad)
x -xxxxx -x--- x------- ------ ----- ------ ------- -------- ---- - x------- Argopecten vicenarius charlottensis (Mansfield)
x -xxxxx -x--- ------x- ------ ----- ------ ------- -------- ---- - -----x-- Argopecten species a Waller
x -xxxxx -xx-- xx-x---- ------ ----- ------ ------- -x------ ---- - x-x----- Strahlopecten caloosaensis (Dall)
x -xxxxx -xx-- xx------ ------ ----- ------ ------- -x------ ---- - x------- Strahlopecten ernestsmithi (Tucker)
x ----xx -x--- -------- --x--x ----- ------ ------- -------- ---- - --x-x--- Nodipecten nodosus (Linnaeus)
x ----xx -x--- x------- ------ ----- ------ ------- -------- ---- - x------- Nodipecten pernodosus (Heilprin)
x ----xx --x-- -----x-- ------ ----- ------ ------- -----x-- ---- - -------- Nodipecten peedeensis (Tuomey & Holmes)
x ----xx -xx-- ------x- ------ ----- ------ ------- ------x- ---- - -----x-- Nodipecten collierensis Dall
x xxx--- ---xx -------x ------ ----- -----x ------x -------- ---- - -------- Placopecten clintonius (Say)
x xxx--- ---x- ------x- ----xx ----- ------ ----x-- -------- ---- - -------- P. sp. cf. P. magellanicus (Gmelin) Gibson
x xxxxxx --xxx ----xx-- ------ ----- ---x-- ----xx- -----x-- ---- - -------- Chlamys decemnarius (Conrad)
x xxxxxx ---xx ----xx-- ------ ---xx ---x-- ----xx- -------- ---- - -------- Chlamys decemnarius virginiana (Conrad)
x xxxxxx ----x ---x---- ------ x---- --xx-- ------- -------- ---- - -------- Chlamys rogersii (Conrad)
x xxxxxx ----- -------- ------ ----- ------ ------- -------- ---- - -------- Chlamys sentis Reeve
x xxxxxx ----x --x----- ------ ----- -x---- ------- -------- ---- - -------- Chlamys sp.
x ---xxx -xx-- x------- --x-xx ----- ------ ------- x------- ---- - x------- Pilcatula gibbosa Lamarck
x ---xxx -x--- ---x---- ------ ----- ------ ------- -------- ---- - --x----- Plicatula hunterae Shaak and Nicol
x ---xxx xxxxx xxxxxxxx x--x-- xx-xx xxxx-x xxxxx-- xxxxxxx- xxx- x xxxx-x-- Plicatula marginata Say
x ---xxx -xx-- xxxxxx-- ------ ----- ------ ------- -----x-- ---- - xxx----- Spondylus rotundatus Heilprin
x ---xxx xxx-- ---xxxx- ------ ----- ------ ------- ----xxx- -x-- - --xx-x-- Spondylus n. sp.
x -xxxxx xxxxx xxxxxxxx xxxxxx xx--- xxxx-x xxx-x-- xx-xxxx- xx-- x xxx-xx-- Anomia simplex Orbigny
x -xxxxx ---x- xxxxxxxx x---xx ----- ------ ----x-x -x------ ---- - -------- Anomia squamula Linnaeus
x ----xx --xx- xx------ ------ ----- ------ -x----- xx------ ---- - -------- Pododesmus fragosus Conrad
x ------ -xx-- ------x- ------ ----- ------ ------- ------x- ---- - -----x-- Placuanomia burnsi (Mansfield)
x ------ xxxxx ---xxx-- ------ x---- --xx-- ------- ---xxx-- xx-- - --xx-x-- Placunanomia plicata Tuomey & Holmes typical
x ------ -xx-- ----xx-- ------ ----- --xx-- ------- --x----- ---- - -------- Placunanomia plicata Tuomey & Holmes thick
x -----x -x--- x------- --x-xx ----- ------ ------- -------- ---- - x------- Lima lima Linnaeus
x ---xxx -x--- x------- ------ ----- ------ ------- -------- ---- - x------- Ctenoides floridana (Olsson & Harbison)
x ---xxx -x--- xx------ ?xx-xx ----- ------ ------- -------- ---- - xx------ Ctenoides scabra (Born)
x ---xxx -xx-- xxxx---- ------ ----- ------ ------- x------ ---- - x-x----- Limaria caloosana (Dall)
x ---xxx xxxxx ---xxxx- ------ ----- --xx-- ------- ---xxxx- x--- - --x-x--- Limaria carolinensis (Dall)
x ---xxx -x--- xxxx---- ------ ----- ------ ------- -------- ---- - x-x----- Limaria florpacifica (Olsson & Petit)
x ---xxx -xxxx xxxxxx- --x--x xx--- ---x-- ------- -x-x-xx- ---- - x------- Limaria pellucida C. B. Adams
x xxxxxx ----x ----x--- ------ ----- --xx-- ------- -------- ---- - -------- Limatula virginiana Campbell
x xxxxxx -x--- -------- --x--x ----- ------ ------- -------- ---- - -------- Limatula subauriculata (Montagu)
x xxxxxx --x-- -------- ------ ----- ------ ------- x------ ---- - -------- Limatula sp.
x --xxxx xxxxx xxxxxxxx x----- xx-xx -xxx-x ----x-x xxxxxxx- xx-- - xxxxxx-- Ostrea compressirostra Say
x --xxxx -x--- ------x- ------ ----- ------ ------- -------- ---- - -----x-- Ostrea coxi Gardner
x --xxxx --x-- x------- -----x ----- ------ ------- x------- ---- - -------- Ostrea permolis Sowerby
x --xxxx -xxx- xx------ ------ ----- ------ xxx---- xx------ ---- - x------- Ostrea lawrencei (Ward & Blackwelder)
x --xxxx -xx-- ------x- ------ ----- ------ ------- ------x- ---- - -----x-- Ostrea locklini Gardner
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                111 11111112 222222 22233 333333 3344444 44444555 5555 5 55666666
1 234567 89012 34567890 123456 78901 234567 8901234 56789012 3456 7 89012345
x --xxxx xxxxx xxxxxxxx -xxx-- xxxx- xxxx-x x-x-x-x xxxxxxx- xx-- x xxxx-x--  Ostrea sculpturata Conrad
x --xxxx -x--- -----x-- ------ ----- ------ ------- -------- ---- - -----x--  Ostrea subdigitalina Olsson & Harbison
x -xxx-x -xxxx xxxx---- -xxxxx ----- -x---- xxx---- xxx----- ---- x x-x----x  Crassostrea virginica (Gmelin)
x -----x ----x -------x ------ ----- -----x ------- -------- ---- - --------  Pycnodonte sp. Blackwelder
x -----x -x--- -----x-- ------ ----- ------ ------- -------- ---- - ?----x--  Pycnodonte (Gigantostrea) sp.
x -----x -xx-- ---xxxxx x----- ----- ------ ------- -----x-- ---- - ?-xxxx--  Hyotissa haitensis (Sowerby)
x ----xx xxx-- xxxxxxxx xxx-xx ----- ------ ------- ---xx-x- -x-- - xxxx----  Lucina pensylvanica (Linnaeus)
x ---xxx -x--- xxxx---- -----x ----- ------ ------- -------- ---- - x-x-----  Linga (Pleurolucina) leucocyma (Dall)
x ---xxx xxx-- ---xxxx- ------ ----- ------ ------- ---xxxx- xx-- - --x-----  Parvilucina (Radiolucina) tuomeyi (Dall)
x ---xxx -xxx- xx------ ---x-- ----- ------ -x----- xx------ ---- x xx------  Parvilucina (Radiolucina) waccamawensis (Dall)
x ---xxx xxxxx xxxxxx-- -xxxxx ----- -x-x-- -xx---- xxxxxxx- xx-- x xxx-----  Parvilucina multilineata (Tuomey & Holmes)
x ---xxx -x--- ----xxxx x----- ----- ------ ------- -------- ---- - --x-----  Parvilucina sp. cf. P. vaughani (Gardner )
x ---xxx -xxx- xxxxxxxx x---xx ----- ------ -xx-x-- xxxxx--- ---- x xxx-----  Parvilucina (Cavilinga) trisulcata (Conrad)
x ---xxx xxxxx xxxxx--- ------ ----- ---x-- ------- xx-xx--- x--- x --x-----  Parvilucina (C.) trisulcata multistriata (Conrad)
x ---xxx xxxxx xxxxxxxx x----- xx-xx x-xx-x --x-x-- xxxxxx-- xx-- - --x-----  Parvilucina crenulata (Conrad)
x ---xxx ----x ----x--- ------ ----- ---x-- ------- -------- ---- - --------  Parvilucina postalveata (Gardner)
x ---xxx -x--- ---xxxxx x----- ----- ------ ------- -------- ---- - --x-----  Parvilucina sphaeriolus (Dall)
x ---xxx -x--- x------- -x--xx ----- ------ ------- -------- ---- - x-------  Codakia costata (Orbigny)
x ---xxx -x--- xxxx---- --x-xx ----- ------ ------- -------- ---- - x-x-----  Codakia orbicularis (Linnaeus)
x ---xxx xx--- xxxx---- ------ ----- ------ ------- -------- x--- - xxx-----  Codakia (Ctena) orbiculata (Montagu)
x ---xxx --x-- ---x---- ------ ----- ------ ------- ---x---- ---- - --------  Codakia (Ctena) microimbricata Gardner
x ---xxx -xxxx xxxxxxxx ----xx xx--- --xx-x -----x- x--xxxx- xx-- - x-x-----  Codakia (Ctena) speciosa (Rogers & Rogers)
x ---xxx -x--- -xxxxxxx x----- ----- ------ ------- -------- ---- - -x------  Lucina (Lucina) pectinata (Gmelin)
x ---xxx xxxxx xxxxxxxx x----- ----x --xx-x ----xx- -x-xxxx- xx-- - x-x-----  Lucina (Lucinisca) cribraria (Say)
x ---xxx -x--- xx------ --xx-x ----- ------ ------- -------- ---- - xx------  Lucina (Lucinisca) nassula Conrad
x ---xxx -x--- xx------ ------ ----- ------ ------- -------- ---- - xx------  "Lucina" amabilis (Dall)
x ---xxx xxxx- xxxxxxxx xxxx-x ----- ------ ----x-x xx--xx-- -x-- x xxx-----  Lucina (Callucina) keenae Chavan
x -----x --xxx ---xxxxx x----- ----- --xx-x --x---- -----x-- ---- - --------  Lucinoma contracta (Say)
x -----x -x--- xxxx---- ------ ----- ------ ------- -------- ---- - xxx-----  Miltha caloosaensis (Dall)
x -----x -x--- x------- -----x ----- ------ ------- -------- ---- - xxx-----  Miltha disciformis (Heilprin)
x -----x -x--- x------- ------ ----- ------ ------- -------- ---- - x-------  Miltha pectinata (Gmelin )
x -----x -xxxx xxxxxxxx x----- xx--- -xxx-x x-x---- -xxxxxx- ---- - xxxx----  Pseudomiltha anodonta (Say)
x -----x xx--- xxxx---- ?xx-xx ----- ------ ------- -------- x--- - --x-----  Pseudomiltha floridana (Conrad)
x ---x-x -x--- xxxxx--- -----x ----- ------ ------- -------- x--- - x-x-----  Anodontia alba Link
x ---x-x -xx-- xxxxxxx- ------ ----- ------ ------- -x----x- ---- - x-xxx---  Anodontia philippiana (Reeve)
x --xx-x -x--- xx------ x----- ----- ------ ------- -x------ ---- - xx------  Divaricella compsa Dall
x --xx-x -x--- ---x---- x----- ----- ------ ------- xx------ ---- - --x-----  Divaricella sp., cf D. chipolana Dall
x --xx-x --x-- xx------ ------ ----- ------ ------- xx------ ---- - --------  Divaricella dentata (Wood)
x --xx-x xxxxx xxxxxxxx ---xxx xx--- x-xx-x x-x-x-- xxxxxxx- -x-- x xxx-----  Divaricella quadrisulcata (Orbigny)
x xxxxxx -x--- x------- --x--x ----- ------ ------- -------- ---- - x-------  Thyasira trisinuata Orbigny
x ---xxx xxxxx xxxxxxx- x---x- ---x- xx-x-- -xx-x-- xxxx--x- x--- x x-x-----  Diplodonta acclinis (Conrad)
x ---xxx -xx-- xx------ ------ ----- ------ ------- xx------ ---- - x-------  Diplodonta caloosaensis Dall
x ---xxx --xxx xxxx---- ------ x---- --xx-- ------- xx-x---- ---- - --------  Diplodonta conradi McGavock
x ---xxx ---x- x------- ------ ----- ------ -x----- -------- ---- - --------  Diplodonta heronensis Ward and Blackwelder
x ---xxx -xxxx xxxxxxxx x-x--x xx--- --xx-x ------- -x-xx--- ---- - -x------  Diplodonta nucleiformis (Wagner)
x ---xxx ----- -------- --x-xx ----- ------ ------- -------- ---- - --------  Diplodonta punctata (Say)
x ---xxx xxxxx ---xxxxx ---x-- xx-x- x-xx-- ---xxx- -----xx- -x-- - --x-----  Diplodonta punctulata (H. C. Lea)
x ---xxx -x--- x------- ------ ----- ------ ------- -------- ---- - x-------  Diplodonta sp.cf. D. radiata Dall
x ---xxx -x--- x------- --x-xx ----- ------ ------- -------- ---- - x-------  Diplodonta semiaspera (Philippi)
x ---xxx --x-- x------- -----x ----- ------ ------- x------- ---- - --------  Diplodonta subglobosa (C. B. Adams)
x ---xxx ----- -------- ------ ----- ------ ------- -------- ---- - --------  Diplodonta subobliqua (Say)
x ---xxx xxxxx ---xxxxx x----- xx--x ---x-x --x---- -----x-- x--- - ----xxx-  Diplodonta subvexa (Conrad)
x ---xxx -x--- x------- ------ ----- ------ ------- -------- ---- - x-------  Cyrenoida caloosaensis Dall
x ---xxx -xx-- xxxx---- ------ ----- ------ ------- -x------ ---- - x-x-----  Chama caloosana Dall
x ---xxx xxxxx xxxxxxxx ?-x-xx xx-xx --xx-x ----x-- xx-xxx-- xx-- x --xx-x--  Chama congregata Conrad
x ---xxx --xxx ---xxxx- ------ xx-x- ---x-- ----x-- ---xxxx- ---- - -----x--  Chama (Pseudochama) corticosa Conrad
x ---xxx xxxxx xxxxxx-- ---x-- xx--- xxxx-- -x----- xx-xxx-- xx-- x x-x-----  Chama emmonsi Nicol
x ---xxx -x--- xxxx---- ------ ----- ------ ------- -------- ---- - x-x-----  Chama heilprini Nicol
x ---xxx --x-- x------- ------ ----- ------ ------- x------- ---- - --------  Chama macerophylla Gmelin
x ---xxx -x--- xxxx---- ------ ----- ------ ------- -------- ---- - x-x-----  Chama wilcoxii Dall
x ---xxx xxx-- xxxxxxxx x-xxxx ----- ------ ------- xx-xxxx- xx-- x x-x-----  Arcinella cornuta Conrad
x ---xxx --xxx ---xx--- ------ xx--- x--x-- --x-x-- ---xx--- ---- - --------  Erycina carolinensis Dall
x ---xxx -xx-- xx------ ---x-- ----- ------ --x---- xx------ ---- - x-------  Erycina carolinensis elongata Gardner
x ---xxx -xx-- x------- ------ ----- ------ ------- x------- ---- - x-------  Erycina kurtzii (Dall)
x ---xxx -x--- -x------ ------ ----- ------ ------- -------- ---- - -x------  Erycina phaseola Olsson & Harbison
x ---xxx -xx-- x------- ------ ----- ------ ------- x------- ---- - x-------  Erycina protracta Dall
x ---xxx --x-- ---x---- ------ ----- ------ ------- ---?---- ---- - --------  Erycina regifica Olsson
x ---x-- -xxxx xxxxx--- --x--- x---- --xx-- ------- -------- ---- - xx------  Bornia lioica Dall
x ---x-- -x--- x------- --x--- ----- ------ ------- -------- ---- - x-------  Bornia mazyckii Dall
x ---x-- -xxxx xxxxx--- ------ xx--- --xx-- ------- ---xx--- ---- - x-------  Bornia rota Dall
x ---x-- -xxxx xxxxx--- x---x- xx--- x--x-- xxx-x-- xxxx---- ---- - xx------  Bornia triangula Dall
x --xx-- ---x- -x------ ------ ----- ------ --x---- -------- ---- - --------  Aligena chowanensis Gardner
x --xx-- --x-- ---x---- ------ ----- ------ ------- ---x---- ---- - --------  Aligena minor Dall
x --xx-- --x-- ---x---- ------ ----- ------ ------- ---x---- ---- - --------  Aligena rhomboidea Gardner
x --xx-- xxxxx xxxxxx-- ------ xx--- x--x-- x-x---- xx-xxx-- -x-- - x-------  Aligena striata H. C. Lea
x --xx-- -x--- ---x---- ------ ----- ------ ------- -------- ---- - --x-----  Aligena sp.  Gardner
x ------ ----x ---x---- x----- x---- ---x-- ------- -------- ---- - --------  Solecardia cossmani Dall
x xxxxxx ----x ---x---- ------ x---- --xx-- ------- -------- ---- - --------  Montacuta chesapeakensis Campbell
x xxxxxx -x--- x------- ------ ----- ------ ------- -------- ---- - x-------  Montacuta floridana Dall
x xxxxxx -x--- -x------ ------ ----- ------ ------- -------- ---- - -x------  Montacuta floridana inflata Olsson & Harbison
x xxxxxx -xxxx xxxx---- ------ x---- ---x-- ------- -------- ---- - x-------  Montacuta petropolitana Dall
x xxxxxx ----x ---x---- ------ x---- ---x-- ------- -------- ---- - --------  Montacuta sagrinata Dall
x -----x ----x ---x---- ------ x---- ---x-- ------- -------- ---- - --------  Orobitella laevis (H. C. Lea)
x -xxxxx ---x- x------- ------ ----- ------ -x----- -------- ---- - --------  Mysella beaufortensis Ward & Blackwelder
x -xxxxx --xxx xxxx---- ------ x---- --xx-- --x---- x------- ---- - --------  Mysella bladenensis Gardner
x -xxxxx --x-- -x------ ------ ----- ------ ------- -x------ ---- - --------  Mysella majorina Gardner
x -xxxxx ----x ---x---- ------ xx--- --xx-- ------- -------- ---- - --------  Mysella spatula Campbell
x -xxxxx --xxx -xxxx--- ------ -x--- ---x-- ------- -x-xx--- ---- - --------  Mysella stantoni (Dall)
x -xxxxx --x-- xx------ ---x-- ----- ------ ------- xx------ ---- - --------  Mysella velaini Gardner
x --xxxx ----x ---x---- ------ x---- --xx-- ------- -------- ---- - --------  Pithionella filicaticola (Olsson)
x -xxxxx -xx-- xx------ ----xx ----- ------ ------- -x------ ---- x x-------  Rochefortia planulata (Stimpson)
x -xxxxx --x-- ---x---- ------ ----- ------ ------- ---x---- ---- - --------  Rochefortia stimpsoni Dall
x ------ -x--- xx------ --x--- ----- ------ ------- -------- ---- - -x------  Fabella dalli Olsson & Harbison
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x ------ ----- -------- ------ ----- ------ ------- -------- ---- - -x------  Fabella navicula Olsson & Harbison
x ---xxx -xxxx xxxx---- ------ x---- --x--- ------- -------- ---- - xx------  Anisodonta americana Dall
x ---xxx --xx- xxxxx--- ------ ----- ------ x-x---- ---xx--- ---- - --------  Anisodonta carolina Dall
x --xxxx -xxxx xxxxxxxx x---xx x---- --x--- x-x---- x--x---- ---- - x-------  Paramya subovata (Conrad)
x ------ -x--- xx------ ------ ----- ------ ------- -------- ---- - xx------  Basterotia floridana (Dall)
x ---xxx --xx- xxxx---- ------ ----- ------ --x-x-- x------- ---- - --------  Sportella calpix Gardner
x ---xxx ----x ---x---- ------ xx--- --xx-- ------- -------- ---- - --------  Sportella chesapeakensis Campbell
x ---xxx -xxxx xxxx---- ----x- ----- x----- x-x-x-- x--x---- x--- - x-------  Sportella constricta (Conrad)
x ---xxx --x-- xx------ ------ ----- ------ ------- xx------ ---- - --------  Sportella gibberosa Gardner
x ---xxx ----x ---x---- ------ xx--- ---x-- ------- -------- ---- - --------  Sportella pelex Dall
x ---xxx ----x ---xxxxx x----- x---- --xx-- ------- -------- ---- - --------  Sportella petropolitana Dall
x ---xxx --x-- xx------ ------ ----- ------ ------- xx------ ---- - --------  Sportella waccamawensis Gardner
x ---xxx ----x ---xx--- ------ xx-x- --xx-- ------- -------- ---- - --------  Sportella yorkensis Dall
x ----xx -xxxx xxxx---- ------ x---- ---x-- ------- xx-x---- ---- - x-------  Ensitellops compressa (H. C. Lea)
x ----xx -x--- -x------ ------ ----- ------ ------- -------- ---- - -x------  Ensitellops elliptica Olsson & Harbison
x ----xx xxxxx xxxxx--- ----xx x-x-- ---x-- xx--x-- xx-x---- x--- - xxx-----  Ensitellops protexta (Conrad)
x ----xx -x--- xx------ --x--- ----- ------ ------- -------- ---- - -x------  Ensitellops tabula Olsson & Harbison
x ----xx --x-- ---x---- ------ ----- ------ ------- ---x---- ---- - --------  Hindsiella acuta Dall
x ----xx x-x-- ---x---- ------ ----- ------ ------- ---x---- x--- - --------  Hindsiella carolinensis Dall
x -----x -x--- xxxx---- ------ ----- ------ ------- -------- ---- - x-x-----  Taxocardia floridana Olsson & Harbison
x -----x -x--- ---x---- ------ ----- ------ ------- -------- ---- - --x-----  Carditamera aclinica (Tucker & Wilson)
x -----x xxxxx xxxxxxxx xx-x-- xx--x xxxx-x xxx---- xxxxx--- xx-- x xxxx-x-x  Carditamera arata (Conrad)
x -----x --x-- -x------ ------ ----- ------ ------- -x------ ---- - --------  Carditamera arata columbiana Gardner
x -----x -x--- xx------ ------ ----- ------ ------- -------- ---- - xx------  Carditamera catharia (Dall)
x -----x -x--- ---x---- ------ ----- ------ ------- -------- ---- - --x-----  Carditamera dasytes Olsson
x -----x -x--- x------- --x-xx ----- ------ ------- -------- ---- - x-------  Carditamera floridana Conrad
x -----x -x--- ---x---- ------ ----- ------ ------- -------- ---- - --x-----  Carditamera osceolaensis Mansfield
x -----x -x--- ---x---- ------ ----- ------ ------- -------- ---- - --x-----  Carditamera seminolensis (Olsson)
x -----x -x--- ----xx-- ------ ----- ------ ------- -------- ---- - ---x-x--  Carditamera tamiamiensis (Mansfield)
x -----x xx--- ---xx--- ------ ----- ------ ------- -------- x--- - ---x-x--  Carditamera vaughani (Dall)
x -----x -x--- ---x---- ------ ----- ------ ------- -------- ---- - --x-----  Glyptoactis olga (Mansfield)
x ---xxx --xxx -xxx---- ------ xx--- xxx--- -x----- ---x---- ---- - --------  Pleuromeris auroraensis Ward & Blackwelder
x ---xxx xxxxx xxxx---- -----x ----- -x---- x---x-- xx-x---- xx-- - --x-----  Pleuromeris decemcostata Conrad
x ---xxx x---- ----x--- ------ ----- ------ ------- -------- -x-- - -----x--  Pleuromeris scituloides (Olsson)
x ---xxx xxxxx xxxxxxx- -xxxxx xx--- -xxx-- --x-x-- xx-xx-x- xx-- x xxx-----  Pleuromeris tridentata (Say)
x ---x-x xxxx- xxxx---- --x--x ----- ------ -xx---- -x------ x--- x x-x-----  Pteromeris perplana (Conrad)
x ---x-x xxxxx xxxxx--- ------ xx-x- xxxx-- x---x-- xx-xxx-- xx-- - xxx-----  Pteromeris abbreviata (Conrad)
x ---x-x -xx-- ----x--- ------ ----- ------ ------- ----x--- ---- - ---x----  Pteromeris abbreviata gladeensis (Mansfield)
x xxx--- xxxxx xxxxxxxx x--x-- xx-xx -xxx-x x-x-x-x xx-xxx-- xx-- - x-xx----  Cyclocardia granulata (Say)
x -----x -x--- x------- -----x ----- ------ ------- -------- ---- - x-------  Condylocardia floridensis Pilsbry & Olsson
x ------ ---xx -xxx---- ------ xx--- -xxx-- -x---x- -------- ---- - --------  Erycinella ovalis Conrad
x xxxxx- ---xx ----??-? ------ ----- ---x-- ----x-- -------- ---- - --------  Astarte arata Conrad
x xxxxx- ---xx -xx----- ------ ----- x----- -x---?- -------- ---- - --------  Astarte berryi Gardner
x xxxxx- ----x -------x ------ ----- -----? ------- -------- ---- - --------  Astarte coheni Conrad
x xxxxx- -xxxx xxxxxxxx x----- xx-xx xxxx-- xxx-x-- xx-xxxx- ---- - x-x-----  Astarte concentrica Conrad
x xxxxx- ----x -------x x----- ----- -----x ------x -------- ---- - --------  Astarte exaltata Conrad
x xxxxx- -xx-- xx------ ------ ----- ------ ------- -------- xx-- - xx------  Astarte floridana Dall
x xxxxx- xxx-- ---xxx-- ------ ----- ------ ------- xx------ -x-- - --------  Astarte glenni Dall
x xxxxx- ---x- ----x--- ------ ----- ------ ----x-- -------- ---- - --------  Astarte griftonensis Gardner
x xxxxx- -x--- ---xx--- ------ ----- ------ ------- -------- ---- - --xx----  Astarte perplana Conrad
x xxxxx- ---xx ----x--- ------ ----x ---x-- ----x-- -------- ---- - --------  Astarte roanokensis Gardner
x xxxxx- xxxxx -xxxx--- ------ -x-x- -x-x-- ------? ----x--- ---- - --x-----  Astarte symmetrica Conrad
x xxxxx- ----- ---xxxx- x----- xx-x- -xxx-x -----x- ---xxxx- x--- - x-x-----  Astarte undulata Say
x xxxxx- xx--- ---xxxx- x----- ----- ------ ------- ---xxxx- -x-- - --x-----  Astarte vaughani Mansfield
x xxxxx- ----x ---??--- ------ x---- ---x-- ------- -------- ---- - --------  Astarte vicina Say
x xxxxx- ----x --x---- ------ ----- x----- ------- -------- ---- - --------  Astarte yadkinensis Campbell
x xxxxx- -x--- ---x---- ------ ----- ------ ------- -------- ---- - --x-----  Astarte sp.
x xxxxx- -x--- ----x--- ------ ----- ------ ------- -------- ---- - ---x----  Astarte sp.
x xxxxx- --x-- ----x--- ------ ----- ------ ------- ----x--- ---- - --------  Astarte sp.
x ----xx x---- -------- ------ ----- ------ ------- -------- -x-- - --------  Eucrassatella alaquaensis (Mansfield)
x ----xx ---xx -xx----- ------ ----- xx---- -xx---- -------- ---- - --------  Eucrassatella kauffmani (Ward and Blackwelder)
x ----xx xx--- ---xx--- ------ ----- ------ ------- -------- -x-- - --xx----  Eucrassatella meridionalis (Dall)
x ----xx xxxx- xxxxxx-- -xxx-x ----- ------ --x---- xx-xxxx- xx-- x xxx--x--  Eucrassatella speciosa (A. Adams)
x ----xx --xxx ---xxxxx ------ xxxxx --xx-x ----x-x ---xxxx- ---- - --------  Eucrassatella virginica (Gmelin)
x ----xx --xxx ----xxxx ------ ----- -----x ------- ----x--- ---- - --------  Eucrassatella virginica cycloptera (Dall)
x --xxxx xx--- xxxx---- -x---- ----- ------ ------- -------- x--- - xxx-----  Crassinella acuta (Dall)
x --xxxx xxxxx xxxx---- -x-x-x x---- -xx--- -x-x--- xx-x---- x--- x x-x-----  Crassinella dupliniana (Dall)
x --xxxx --xxx xxxx---- ------ xx--- x--x-- -x----- -x-x---- ---- - --------  Crassinella johnsoni Ward and Blackwelder
x --xxxx xxxxx xxxxxxxx xxxxxx xx-xx -xxx-x x-x-x-x xx-xx--- xx-- x xxx-----  Crassinella lunulata (Conrad)
x --xxxx -x--- ---x---- ------ ----- ------ ------- -------- ---- - --x-----  Acanthocardium (Agnocardia) spinosifrons H. Vokes
x ---x-x -x--- ---x---- ------ ----- ------ ------- -------- ---- - --x-----  Trachycardium aclinensis (Tucker & Wilson)
x ---x-x -x--- x------- ------ ----- ------ ------- -------- ---- - x-------  Trachycardium arestum (Dall)
x ---x-x -xx-- x------- -----x ----- ------ ------- x------- ---- - x-------  Trachycardium egmontianum (Shuttleworth)
x ---x-x -xx-- xxxx---- --x--- ----- ------ ------- xx------ ---- - xxx-----  Trachycardium emmonsi (Conrad)
x ---x-x -x--- ---x---- ------ ----- ------ ------- -------- ---- - --x-----  Trachycardium evergladeensis (Mansfield)
x ---x-x -xxx- xxxxxx-- ----xx ----- ------ x------ xx------ ---- x x----x--  Trachycardium isocardia (Linnaeus)
x ---x-x -x--- ---x---- ------ ----- ------ ------- -------- ---- - --x-----  Trachycardium sp. cf. T. malacum Dall  Gardner
x ---x-x -xx-- xxxx---- -xx-xx ----- ------ ------- xx------ ---- - xxx-----  Trachycardium muricatum (Linnaeus)
x ---x-x xxx-- xxxx---- ------ ----- ------ ------- x--x---- xx-- x x-x-----  Trachycardium oedalium (Dall)
x ---x-x xx--- ---x---- ------ ----- ------ ------- -------- x--- - x-------  Trachycardium striatum leonense (Mansfield)
x ---x-x -x--- -xxxxx-- ------ ----- ------ ------- -------- ---- - -xx--x--  Acrosterigma (Acrosterigma) dalli (Heilprin)
x ----xx -x--- xx------ --x-xx ----- ------ ------- -x------ ---- - xx------  Papyridea semisulcata Gray
x ----xx -xxxx xxxxxxx- --x--x x---- --xx-- ------- -x---xx- ---- - x-x-----  Papyridea soleniformis (Bruguiere) turtoni Dall
x -----x xx--- ---x---- x----- ----- ------ ------- -------- x--- - --x-----  Trigoniocardia deadenense Mansfield
x -----x -x--- xxxx---- -x--x- ----- ------ ------- -------- ---- - xxx-----  Trigoniocardia willcoxi (Dall)
x ---xxx xxx-- xxxx---- -xx-xx ----- ------ ------- -x-x---- x--- - xxx-----  Trigoniocardia (Americardium) media (Linnaeus)
x ---xxx xx--- ---x---- ------ ----- ------ ------- -------- x--- - --x-----  Protocardia jacksonense Mansfield
x --xxxx xxx-- xxxx---- --x-xx ----- ------ ------- -x------ x--- - x-x-----  Laevicardium laevigatum (Linnaeus)
x --xxxx -x--- xx------ ---xxx ----- ------ ------- -------- ---- - xx------  Laevicardium mortoni (Conrad)
x --xxxx xxxxx xxxxxxx- ------ xx--- xxxx-- x-x-x-- xx-xxxx- xx-- - --------  Laevicardium sublineatum (Conrad)
x --xxxx -x--- xxxx---- -----x ----- ------ ------- -------- ---- - x-x-----  Laevicardium vitellinum (Reeve)
x --xxxx -xxxx xxxxxxx- -xxxxx ----- -x---- xx----- xx-xxxx- ---- x xxx----x  Laevicardium (Dinocardium) robustum (Lightfoot)
x ------ xxxxx ---xxxx- ------ xx-xx --xx-- ----x-- ---xxxx- x--- - ---x----  C. (Planicardium) acutilaqueatum (Conrad)
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                111 11111112 222222 22233 333333 3344444 44444555 5555 5 55666666
1 234567 89012 34567890 123456 78901 234567 8901234 56789012 3456 7 89012345
x ------ ----x ---x---- ------ x---- --x--- ------- -------- ---- - -------- Clinocardium (Planicardium) taenopleura (Dall)
x ------ -xxxx ---xxxxx ------ x--x- --xx-x ------- -----x-- -x-- - --x----- Clinocardium (Planicardium) virginianum (Conrad)
x ------ -x--- ---x---- ------ ----- ------ ------- -------- ---- - --x----- Clinocardium (P.) sp. near C. taprium Gardner
x ---xxx -xxxx xxxx---- --x-xx x---- --x--- ------- xx------ ---- - x-x----- Mactra fragilis Gmelin
x ---xxx xxx-- xxxx---- ------ ----- ------ ------- ---x---- x--- - xxx----- Mactra undula Dall
x ---xxx -x--- x------- ------ ----- ------ ------- -------- ---- - x------- Mactra willcoxi Dall
x -xxxx- -xxxx ---xxxxx x----- xx-xx --xx-x ------- ---x---- ---- - --x----- Spisula confraga (Conrad)
x -xxxx- --x-- ---x---- ------ ----- ------ ------- ---x---- ---- - -------- Spisula curtidens Dall
x -xxxx- xxxxx ---xxxxx x----- x-x-- -xxx-- ------- ---x---- x--- - -------- Spisula delumbis (Conrad)
x -xxxx- --xxx ---x---- ------ x---- ---x-- ------- ---x---- ---- - -------- Spisula duplinensis Dall
x -xxxx- --xxx ---x---- ------ ----- --xx-- ------- ---x---- ---- - -------- Spisula harrisi Olsson
x -xxxx- ---xx ---xxxxx x----- xx--- --xx-- ----x-- -------- ---- - -------- Spisula modicella (Conrad)
x -xxxx- xxxx- xxxxxxx- ---xxx ----- ------ -xx---- xx--x-x- -x-- - -------- Spisula similis (Say)
x -xxxx- --x-- x------- ---xxx ----- ------ ------- x------- ---- - -------- Spisula solidissima (Dillwyn)
x -xxxx- -x--- ---x---- ------ ----- ------ ------- -------- ---- - --x----- Spisula solidissima peninsulae M. Smith
x -xxxx- xxx-- ---xxxxx x----- ----- ------ ------- ---x---- x--- - --x----- Spisula subparilis (Conrad)
x -xxx-x -x--- xx------ ------ ----- ------ ------- -------- ---- - xx------ Mulinia caloosaensis Dall
x -xxx-x xxxxx xxxxxxxx x----- -xx-x ---x-- x---x-- xx-xxxx- xx-- x -xxx-x-- Mulinia congesta (Conrad)
x -xxx-x -xxxx xx-?---- -x-xxx ----- -x---- -xx---- xxx----- ---- x xxx----- Mulinia lateralis (Say)
x -xxx-x -x--- xxxx---- ------ ----- ------ ------- -------- ---- - xxx----x Mulinia sapotilla Dall
x --xx-- --xxx xxxx---- ------ ----- -x-x-- -xx-x-- x-x----- ---- - -------- Rangia clathrodonta (Conrad)
x --xx-- -xx-- x------- --xxxx ----- ------ ------- x------- ---- - x------- Rangia cuneata (Sowerby)
x --xx-- -x--- xxxx---- ------ ----- ------ ------- -------- ---- - xxx----- Rangia nasuta (Dall)
x --xx-- ----- ------- ------ ----- ------ ------- -------- ---- x -------- Rangia sp. cf. R. cyrenoides Desmonlins
x ---x-x -xx-- xxxx---- --x-xx ----- ------ ------- ---x---- ---- - xx------ Anatina anatina (Spengler)
x ---x-x ----x ---xxx-- ------ x---- ------ ------- ----x--- ---- - -------- Raeta alta Conrad
x ---x-x -xxx- xx------ --xxxx ----- ------ -x----- xxx----- ---- - xx-----x Raeta plicatella (Lamarck)
x ---x-x -x--- ---x---- ------ ----- ------ ------- -------- ---- - --x----- Raeta undulata (Gould)
x xxx--- ----x --xx---- ------ ----- x--x-- ------- -------- ---- - -------- Mesodesma spatha Gardner
x ---xxx -x--- xx------ --xxxx ----- ------ ------- -------- ---- - -x------ Ervilia concentrica (Holmes)
x ---xxx -xxxx xxxx---- ------ xx--- --xx-- ------- xx-x---- x--- - -x------ Ervilia lata Dall
x ---xxx -x--- xx------ ----x- ----- ------ ------- -------- ---- - xxx----- Ervilia polita Dall
x -xxx-x xxxxx xxxxxxxx x--xxx xx-xx -xxx-x xxx-x-- xxxxxxx- -x-- - x-x----- Ensis directus (Conrad)
x -xxx-x --xxx ---xxxxx x----- xx--- --xx-x ------- ---x---- -x-- - -------- Ensis ensiformis (Conrad)
x -xxx-x -xxxx ---x---- ------ -x--- ---x-- ------- -------- ---- - --x----- Ensis hughesi Campbell n. sp.
x -xxx-x -xx-- xx------ --x-xx ----- ------ ------- xx------ ---- - -------x Ensis megistus Pilsbry & McGinty
x -xxx-x ----x ----x--- ------ ----- --xx-- ------- -------- ---- - -------- Ensis schmidti Olsson
x --xx-x --xx- x------- ----xx ----- ---?-- ------- x------- ---- - -------- Solen viridis Say
x -xxxxx xxxxx xxxxxxxx x-x-xx ----- --xx-- --x---- x--xxx-- xx-- - x------- Tellina aequistriata Say
x -xxxxx -xxx- xx------ -x--xx ----- ------ -xx---- -------- ---- - x------- Tellina agilis Stimpson
x -xxxxx xxx-- xxxx---- -xxxxx ----- ------ ------- -x------ xx-- x xxx----- Tellina alternata Say
x -xxxxx -x--- ---x---- ------ ----- ------ ------- -------- ---- - --x----- Tellina cala M. Smith
x -xxxxx -x--- x------- ------ ----- ------ ------- -------- ---- - x------- Tellina calliglypta Dall
x -xxxxx -x--- x------- ------ ----- ------ ------- -------- ---- - x------- Tellina caloosana Dall
x -xxxxx ---x- ---x---- ------ ----- ------ ----x-- -------- ---- - -------- Tellina calpix Gardner
x -xxxxx -x--- x------- ------ ----- ------ ------- -------- ---- - x------- Tellina candeana Orbigny
x -xxxxx -xxxx xxxxxxxx x----- xx-xx xxxx-x --x-x-- -x-xx--- ---- x x-x----- Tellina declivis Conrad
x -xxxxx -x--- xxxx---- ------ ----- ------ ------- -------- ---- - x-x----- Tellina dinomera Dall
x -xxxxx -xxxx xxxxxxxx x----- xx--- x--x-- x---x-- xx-xx--- ---- - x-x----- Tellina dupliniana Dall
x -xxxxx ----x ---xx--- ------ --x-x --xx-- ------- -------- ---- - -------- Tellina egena Conrad
x -xxxxx -x--- -------- --x--x ----- ------ ------- -------- ---- - -------- Tellina gouldii Hanley
x -xxxxx -x--- -------- --x--x ----- ------ ------- -------- ---- - -------- Tellina lineata Turton
x -xxxxx xxxx- xxxx---- --x--x ----- ------ ----x-- -------- x--- - xxx----- Tellina listeri Roding
x -xxxxx x-xx- ---xx--- ------ ----- ------ ----x-- -x-xx--- x--- - -------- Tellina macilenta Dall
x -xxxxx -xx-- xxxx---- --x-xx ----- ------ ------- ----x--- ---- - --x----- Tellina magna Spengler
x -xxxxx -x--- x------- --x--x ----- ------ ------- -------- ---- - x------- Tellina mera Say
x -xxxxx -x--- -------- --x--x ----- ------ ------- -------- ---- - -------- Tellina nitens C. B. Adams
x -xxxxx -x--- x------- ------ ----- ------ ------- -------- ---- - x------- Tellina propetenera Dall
x -xxxxx -x--- xx------ --x--x ----- ------ ------- -x------ ---- - xx------ Tellina similis Sowerby
x -xxxxx -x--- -xxx---- ------ ----- ------ ------- -------- ---- - -xx----- Tellina strictolineata Olsson & Harbison
x -xxxxx -xxxx xxx----- ------ ----- x----- ------- -x------ ---- - xx------ Tellina suberis Dall
x -xxxxx -x--- xx------ --x-xx ----- ------ ------- -------- ---- - xx------ Tellina sybaritica Dall
x -xxxxx -x--- x------- ----xx ----- ------ ------- -------- ---- - x------- Tellina tampaensis Conrad
x -xxxxx -xx-- x------- -----x ----- ------ ------- x------- ---- - x------- Tellina tenella Verrill
x -xxxxx -xxx- xxxxx--- x--xxx ----- ------ x------ xx-xx--- ---- - x-x----- Tellina texana Dall
x -xxxxx -xxxx xxxxx--- x----- ----- -x---- ------- x--xx--- ---- - x------- Tellina umbra Dall
x -xxxxx ---x- ----x--- ------ ----- ------ ----x-- -------- ---- - -------- Tellina verdevilla Gardner
x -xxxxx -x--- xx------ --x--x ----- ------ ------- -------- ---- - -x------ Tellina versicolor Dekay
x ---x-x -x--- xxxx---- -xxxxx ----- ------ ------- -------- ---- x xxx----- Tellidora cristata (Recluz)
x ---x-x -x--- xxxx---- --x-xx ----- ------ ------- -------- ---- - x-x----- Arcopagia (Johnsonnella) fausta (Pulteney)
x ---x-x xxx-- xxxx---- --x-xx ----- ------ ------- -xxx---- x--- - xx------ Strigilla mirabilis (Philippi)
x ---x-x x---- ---xxxxx x----- ----- ------ ------- -------- x--- - -------- Strigilla paraflexuosa Gardner
x ---x-x x---- ----x--- ------ ----- ------ ------- -------- -x-- - -------- Macoma alumensis Dall
x x--x-x -x--- xxxx---- --x-xx ----- ------ ------- -------- ---- - x-x----- Macoma constricta (Bruguiere)
x x--x-x ----x ---x---- ------ -x--- --x--- ------- -------- ---- - -------- Macoma cookei Gardner
x x--x-x xxx-- ---xx--- ------ ----- ------ ------- -------- -x-- - --x----- Macoma gardnerae Mansfield
x x--x-x xx--- ---x---- ------ ----- ------ ------- -------- x--- - --x----- Macoma hosfordensis Mansfield
x x--x-x -x--- x------- ------ ----- ------ ------- -------- ---- - x------- Macoma laxa Dall
x x--x-x -x--- x------- --x-xx ----- ------ ------- -------- ---- - x------- Macoma tenta (Say)
x ---x-x xxxxx xxxxxxxx x----- xx-x- --xx-x ------- x--xxxx- xx-- - x------- Macoma virginiana (Conrad)
x ---x-x -xxx- xx------ --x--x ----- ------ -x----- xx------ ---- - x------- Macoma (Psammacoma) brevifrons (Say)
x ---x-x xxxxx ---xx--- ------ xx--- --xx-- ------- ---xxx-- xx-- - --x----- Macoma (Psammacoma) arctata (Conrad)
x ---x-x -x--- ---x---- ------ ----- ------ ------- -------- ---- - --x----- Macoma sp. Gardner
x -----x -x--- xxxx---- ------ ----- ------ ------- -------- ---- - x-x----- Cymatoica marcottae Olsson & Petit
x -----x xxx-x -------- ------ x--x- --xx-- ------- ---xxxx- xx-- - xxxxxx-- Hemimetis (Florimetis) magnoliana (Dall)
x -----x -x--- x------- --x-xx ----- ------ ------- -------- ---- - x------- Hemimetis (Florimetis) intastriata (Say)
x -----x -x-xx xxx----- ------ ----- -x---- --x---- -------- ---- - x-x----- Gari dalli (Olsson)
x ---x-x -xx-- xxxxxx-- ------ ----- ------ ------- xx---x-- ---- - x-x----- Gari wagneri (Dall)
x --xx-x --x-- x------- ------ ----- ------ ------- x------- ---- - -------- Donax aequilirata Dall
x --xx-x ----x ---x---- ------ -x--- ---x-- ------- -------- ---- - -------- Donax chuckatuckensis Gardner
x --xx-x --xxx -xxx---- ------ ----- --xx-- ----x-- -xxx---- x--- - -------- Donax cuneola Gardner & Aldrich
x --xx-x --xxx -xxx---- ------ ----- -x---- ----x-- -x-x---- ---- - -------- Donax emmonsi Dall
x --xx-x -xxx- xx------ ---xxx ----- ------ -xx---- xx------ ---- - xx------ Donax fossor Say
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            111 11111112 222222 22233 333333 3344444 44444555 5555 5 55666666
1 234567 89012 34567890 123456 78901 234567 8901234 56789012 3456 7 89012345
x --xx-x ----- -------- ---xxx ----- ------ ------- -------- ---- - -------- Donax roemeri protracta Conrad
x ---xxx xxx-x ---xx--- ------ ----- --x--- -----x- ----x--- xx-- - ---x---- Semele alumensis Dall
x ---xxx xxxx- xxxx---- --x-xx ----- ------ -x----- xx-x---- -x-- - xxx----- Semele bellastriata (Conrad)
x ---xxx xxxxx xxxxxxxx x----- -x--- --x--- ----x-- x-xxxxx- xx-- - x------- Semele carinata (Conrad)
x ---xxx xx--- ---x---- ------ ----- ------ ------- -------- ---- - --x----- Semele coensis Mansfield
x ---xxx xx--- ---x---- ------ ----- ------ ------- -------- x--- - --x----- Semele harveyensis Mansfield
x ---xxx --x-- ---x---- ------ ----- ------ ------- ---x---- ---- - -------- Semele nelliana Olsson
x ---xxx -x--- xxxx---- -xx--- ----- ------ ------- -------- ---- - xxx----- Semele perlamellosa Heilprin
x ---xxx xxx-- xxxx---- --xxxx ----- ------ ------- x------- x--- - x-x----- Semele proficua (Pultney)
x ---xxx xx--- xxxxx--- --xxxx ----- ------ ------- -------- -x-- - xx------ Semele purpurascens (Gmelin)
x ---xxx -xx-- xxxx---- -----x ----- ------ ------- xx------ ---- - x-x----- Semele rosea (Sowerby)
x ---xxx xxxxx ---xxxxx x----- xx-xx -xxx-- ----x-- ---xx--- xx-- - --x----- Semele subovata (Say)
x ---xxx x---- ---x---- ------ ----- ------ ------- -------- x--- - -------- Semelina clappi Mansfield
x ---xxx xxxxx xxxxx--- -xx--- xx--- --xx-- ------- xx------ ---- - xx------ Semelina nuculoides (Conrad)
x -xxx-x -x--- xx------ -----x ----- ------ ------- -------- ---- - x------- Cumingia amydra Olsson & Harbison
x -xxx-x -x--- xx------ -----x ----- ------ ------- -------- ---- - xx------ Cumingia coarctata Sowerby
x -xxx-x --x-- x------- --xxxx xx--- --xx-- --x-x-- xxxxx--- ---- - xxx----- Cumingia subtellinoides Orbigny
x -xxx-x --x-- -x------ --xxxx ----- ------ -xx---- -x------ ---- - -------- Cumingia tellinoides (Conrad)
x -x---- -xxxx xxx----- ------ xx-x- -x---- -xx---- xxx----- ---- - xx?----- Abra aequalis (Say)
x -----x -xx-- xxxxxx-- -xx--x xx--- x-xx-- --x---- -x-x-x-- ---- - --x----- Abra subreflexa (Conrad)
x ----xx -xx-- xxxxxx-- ------ ----- ------ ------- xx--xx-- xx-- x xxx----- Solecurtus cumingianus (Dunker)
x --xx-x -xx-- xxxxxx-- ----xx ----- ------ ------- xx-xxx-- ---- - xxx----x Tagelus divisus (Splengler)
x --xx-x -xxxx xx------ ----xx ----- ------ ------- xxxx---- ---- - x-x----x Tagelus plebeius (Lightfoot)
x --xx-x ----- -------- ------ ----- ------ ------- -------- ---- - xx------ Mytilopsis lamellata Dall
x -xx--- --xxx ----xxxx x----- ----- --xx-x ----x-- ----x--- ---- - -------- Glossus fraternus (Say)
x ------ --x-- ---x---- ------ -x--- -xxx-- xxx---- xx--x--- ---- - x------- Corbicula densata (Conrad)
x ------ -xx-- xxxx---- ------ ----- ------ ------- -------- ---- - x------- Pseudocyrena dupliniana (Dall)
x -----x -xx-- ---xxx-- ------ ----- ------ ------- -----x-- ---- - --xx-x-- Periglypta tamiamensis Olsson & Petit
x -----x x---- ----x--- ------ ----- ------ ------- -------- -x-- - -------- Periglypta clarksvillensis (Mansfield)
x -----x -x-- xxxx---- ------ ----- ------ ------- -x------ ---- - xxx----- Periglypta rugatina (Heilprin)
x -----x -x--- x------- ------ ----- ------ ------- -------- ---- - x------- Periglypta willcoxi (Dall)
x -xxx-x -xxxx xxxx---- -xxxxx ----- xx---- ------- xxx----- ---- - x-x----x Mercenaria campechiensis campechiensis (Gmelin)
x -xxx-x xxxxx ----xxx- ------ ----xx ---x-- --x-x-- ---xxxx- -x-- x x--x---- Mercenaria (campechiensis?) corrugata (Lamarck)
x ---xxx xxx-- ---xx--- ------ ----- ------ ------- ---xx--- x--- - -------- Mercenarias c. ochlockoneensis
x -xxx-x --xxx xxxx---- ------ xxx-- xxx--- --x---- xx-x---- ---- - -------- Mercenaria campechiensis permagna (Conrad)
x -xxx-x -xxxx xx------ x---xx ----- -x-x-- x------ xx------ ---- - xx------ Mercenaria mercenaria (Linnaeus)
x -xxx-x --xxx ---xxxxx x----- x---- ---x-- ------- ---x---- ---- - -------- Mercenaria inflata Dall
x -xxx-x xxxxx ---xxx-- ------ ----- ------ ------- ----xx-- -x-- - ---x---- Mercenaria tridacnoides (Lamarck)
x -xxx-x ----x -------x ------ ----- -----x ------- -------- ---- - -------- Mercenaria sp.
x -----x -x--- x------- ------ ----- ------ ------- -------- ---- - x------- Protothaca marcottae (Olsson & Petit)
x ---xxx -xxx- xxxxx--- -xxxxx ----- ------ x------ x------- ---- x xxxx---x Chione cancellata (Linnaeus)
x ---xxx -?--x -------x ------ ----- -----x ------- -------- ---- - -----?-- Chione cortinaria (Rogers & Rogers)
x ---xxx xxxxx xxxxxx-- -x-x-- xx--- -xxx-- x----x- xx-xxx-- -x-- - x-x--x-- Chione cribraria (Conrad)
x ---xxx xxx-- ---xxx-- ------ ----- ------ ------- ----x-x- -x-- - --xx-x-- Chione (cancellata subsp. ?) erosa Dall
x ---xxx xxxxx xxxx---- -xx-xx -x--- x-xx-- -xx-x-- xx-xx--- -x-- - xxx----- Chione grus (Holmes)
x ---xxx xxxxx xxxxxxxx xxxx-x -x-x- -xxx-- x-x-x-- xx-xxxx- xx-- x x-xxxx-- Chione latilirata (Conrad)
x ---xxx -x--- ---x---- ------ ----- ------ ------- -------- x--- - --x----- Chione procancellata Mansfield
x ---xxx xx--- ---xxx-- ------ ----- ------ ------- -------- xx-- - --xxxx-- Chione ulocyma Harris
x ---xxx x---- ----x--- ------ ----- ------ ------- -------- -x-- - -------- Chione xesta Dall
x -----x -x--- x------- --x-xx ----- ------ ------- -------- ---- - x------- Anomalocardia brasiliana (Gmelin)
x -----x -x--- xxxx---- -x--x- ----- ------ ------- -------- ---- - xxx----- Anomalocardia caloosana (Dall)
x -----x -x--- x------- ------ ----- ------ ------- -------- ---- - x------x Anomalocardia callosa Olsson & Harbison
x -----x -x--- x------- --x--- ----- ------ ------- -------- ---- - x------- Anomalocardia concinna Olsson & Harbison
x -----x --x-- ---x---- ------ ----- ------ ------- ---x---- ---- - -------- Anomalocardia dupliniana Dall
x -----x -x--- x------- ------ ----- ------ ------- -------- ---- - x------- Anomalocardia hendriana Mansfield
x ---x-x xx--- xxxx---- --x--x ----- ------ ------- -------- x--- - x-x----- Cyclinella tenuis (Recluz)
x ---xxx -x--- x------- ------ ----- ------ ------- -------- ---- - x------- Transenella caloosana Dall
x ---xxx xxxxx xxxxx--- ---x-- xx--- x-xx-- x------ xx-xx--- -x-- - --x----- Transenella carolinensis Dall
x ---xxx -x--- xx------ -xx-xx ----- ------ ------- -------- ---- - xx------ Transenella conradiana (Dall)
x ---xxx -x--- -------- --x--x ----- ------ ------- -------- ---- - -------- Transenella cubaniana (Orbigny)
x ---xxx -xxx- xxxx---- ----xx ----- ------ x-x---- -x------ ---- - x-x----- Transenella stimpsoni Dall
x ---xxx -x--- x------- -xx-xx ----- ------ ------- -------- ---- - x------- Gouldia cerina (C. B. Adams)
x ---xxx -x--- xx------ ------ ----- ------ ------- -------- ---- - xx------ Gouldia floridana Olsson & Harbison
x ---xxx xxxxx xxxxxx-- ---x-- xx-x- -xxx-- -xx-x-- xx-xxx-- xx-- x x-x----- Gouldia metastriata (Conrad)
x -xxxxx ---x- ----x--- ------ ----- ------ ----x-- -------- ---- - -------- Pitar castoriana (Gardner)
x -xxxxx --x-- x------- ------ ----- ------ -x----- x------- ---- - -------- Pitar chioneformis (Gardner)
x -xxxxx ----- -------- --x--x ----- ------ ------- -------- ---- - -------- Pitar cordata (Schwengel)
x -xxxxx --x-- ---x---- ------ ----- ------ ------- ---x---- ---- - -------- Pitar filosina (Dall)
x -xxxxx -x--- x------- ------ ----- ------ ------- -------- ---- - x------- Pitar opisthogrammata (Dall)
x -xxxxx xxxxx xxxxxxxx xxx--- xx-xx xxxx-- x-x-x-- xx-xxxx- xx-- x xxx----- Pitar sayana (Conrad)
x ---xxx xxxxx ---xx--- ------ x---- --xx-- ----x-- ---xxx-- xx-- - --xx---- Macrocallista albaria albaria (Say)
x ---xxx -xxxx ---xxxxx x----- xx--- --xx-- ---x---- ---xxxx- ---- - --xx---- Macrocallista albaria reposta (Conrad)
x ---xxx -xxxx xxxx---- ------ ----- -x---- -xx---- xxxx---- ---- - x------- Macrocallista greeni Ward & Blackwelder
x ---xxx -xx-- xxxxxxxx xxx-xx ----- ------ ------- -x------ ---- - xxx----- Macrocallista maculata (Linnaeus)
x ---xxx -x--- xxxx---- -x-xxx ----- ------ ------- -------- ---- x xxx----x Macrocallista nimbosa (Lightfoot)
x --xx-x xxxxx ---xxxxx x----- xx--- --xx-- ----x-x ----xxx- xx-- - --xx-x-- Dosinia acetabula (Conrad)
x --xx-x -x--- xxxx---- ----xx ----- ------ ------- -------- ---- x x-x----- Dosinia discus (Reeve)
x --xx-x -xx-- xxxx---- -xxxxx ----- ------ ------- xxxx---- ---- x xxx-x--- Dosinia elegans (Conrad)
x --xx-x ---x- x------- ------ ----- ------ x------ -------- ---- - -------- Dosinia sp.
x -xxx-x ---x- ----x--- ------ ----- ------ ----x-- -------- ---- - -------- Gemma cravenense Gardner
x -xxx-x xxxxx xxxx---- ---x-- xx--- x--x-- xxx-x-- xxxx---- -x-- x xxx----- Gemma magna Dall
x -xxx-x x---- ---x---- ------ ----- ------ ------- -------- x--- - -------- Gemma ovata Mansfield
x -xxx-x --x-- -------- ----xx ----- ------ ------- -x------ ---- - -------- Gemma purpurea (Lea)
x -xxx-x -xxxx xxxx---- ------ ----- ------ x------ x--x---- ---- x x-x----- Gemma trigona Dall
x -xxx-x ---x- ----x--- ------ ----- ------ ------- ----x--- ---- - -------- Gemma verdevilla Gardner
x -----x -x--- ---x---- ------ ----- ------ ------- -------- ---- - --x----- Parastarte martensi Mansfield
x -----x -xxx- xxxx---- -x--xx ----- ------ x------ ---x---- x--- - x-x----- Parastarte triquetra (Conrad)
x -xxx-x --xxx xxxx---- ---xxx ----- -xx--- ----x-- -x------ ---- - -------x Petricola pholadiformis Lamarck
x -xxx-x -x--- xx------ -----x ----- ------ ------- -------- ---- - xx------ Petricola lapicida (Gmelin)
x ---x-x -xxxx xxxx---- ------ xx--- x--x-- -x--x-- -------- ---- - --x----- Rupellaria pectarosa (Conrad)
x ---x-x -xx-- x------- --x-xx ----- ------ ------- x------- ---- - x------- Rupellaria typica (Jonas)
x ------ xxxxx ---xxxxx x----- xx-xx --xx-x ----x-- ---xxx-- x--- - --x--x-- Pleiorytis centenaria (Conrad)
x -----x --xxx ---xx--- ------ -x--- --xx-- ----x-- ---xx--- ---- - -------- Cooperella parilis (Conrad)
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            111 11111112 222222 22233 333333 3344444 44444555 5555 5 55666666
1 234567 89012 34567890 123456 78901 234567 8901234 56789012 3456 7 89012345
x xxx--- --xxx xxxx---- ----xx x---- --x--- ----x-- xx-x---- ---- - --------  Mya arenaria Linnaeus
x ---x-x -x--- xx------ ------ ----- ------ ------- -------- ---- - xx------  Sphenia attenuata Dall
x ---x-x --xxx xxxxx--- x----x -x--- x-xx-- xx----- --xxx--- ---- - --------  Sphenia dubia (H. C. Lea)
x ----xx -xx-- xxxxx--- -xx-x- ----- ------ ------- xx-xx--- ---- x xxx--x--  Varicorbula caloosae (Dall)
x ----xx ---xx -xxxxx-- ------ -x--- x--x-- --x---- -------- ---- - --------  Varicorbula chowanensis Bailey
x --xxxx xxx-- xxxxx--- -x-xxx ----- ------ ------- xx-x---- xx-- x --------  Corbula barrattiana C. B. Adams
x --xxxx ----- -------- --x--x ----- ------ ------- -------- ---- - --------  Corbula caribaea Orbigny
x --xxxx -xxx- xxx----- ---xxx ----- ------ xxx---- xx------ ---- - x-------  Corbula contracta Say
x --xxxx xxxxx xxxxxxxx x----- xx-xx -xxx-- ------- -x-xx--- -x-- - x-x-----  Corbula cuneata Say
x --xxxx xxxxx xxxxxxxx x----- xx-xx x-xx-x x-x-x-x xx-xxx-- -x-- x --x-----  Corbula inaequalis Say
x --xxxx xx--- xxxx---- -x---- ----- ------ ------- -------- x--- - xxx-----  Corbula leonensis (Mansfield)
x --xxxx xxx-- xxxxxxxx x----- ----- ------ ------- ---xx--- xx-- - x-x-----  Corbula nucleata Dall
x --xxxx xxxxx xxxxx--- ------ x---- x-xx-x -xx-x-- -x-xx--- xx-- - --x-----  Corbula retusa Gardner
x --xxxx -xx-- xx ----- -xx--- ----- ------ ------- xx------ ---- - xx------  Corbula (Juliacorbula) scutata (Gardner)
x --xxxx -x--- -------- --x--- ----- ------ ------- -------- ---- - --------  Corbula swiftiana C. B. Adams
x --xxxx -x--- xx------ ------ ----- ------ ------- -------- ---- - xx------  Corbula wilcoxii
x ---xxx -xxx- xx------ ----xx ----- ------ x------ -------- ---- x xx------  Gastrochaena cuneiformis Spengler
x ---xxx xxxxx xxxxxxx- ------ xx-x- --xx-- --x---- ---xxxx- x--- - x-x-----  Gastrochaena ligula H. C. Lea
x ---xxx -xxx- xxxx---- --x--x ----- ------ x------ -------- ---- - xxx-----  Gastrochaena hians (Gmelin)
x ---xxx -x--- ---xxx-- ------ ----- ------ ------- -------- ---- - --x--x--  Gastrochaena sp.
x xxxxxx -xxxx xxxxxxxx x---xx xx-xx x-xx-x ------- ---xxxx- ---- - xx------  Hiatella arctica (Linnaeus)
x ---xxx --x-- -x------ ------ ----- ------ ------- -x------ ---- - --------  Panopea dockensis Olsson & Petit
x ---xxx xxxx- xxxxxx-- --x--x ----- ------ x------ xx------ x--- - xxx-----  Panopea floridana (Heilprin)
x ---xxx xxxxx ----xxxx x----- x---- --xx-- -----x- -----x-- -x-- - ---x----  Panopea goldfussi Wagner
x ---xxx xxxxx ---xxxx- ------ xx-xx -?xx-x ------- ---xxxx- xx-- - ---x-x--  Panopea reflexa (Say)
x ---xxx ----x ---xx--- ----xx --xx- --xx-- ------- -------- ---- - --------  Martesia cuneiformis (Say)
x ---xxx --x-- -x------ ------ ----- ------ ------- -x------ ---- - --------  Martesia sp.
x --xx-x --xxx xxxx---- ------ xx--- -xxx-- ----x-- xx-x---- ---- - --------  Cyrtopleura arcuata (Conrad)
x --xx-x -xx-- xxxx---- ---xxx ----- ------ ------- xx------ ---- - xxx----x  Cyrtopleura costata (Linnaeus)
x ---x-x -xxxx -xxx---- ------ x-x-- ---x-- ------- xx-x---- ---- - --x-----  Pholas memmingerii Tuomey & Holmes
x ---x-x --x-- ----x--- ------ ----- ------ ------- ----x--- ---- - --------  Pholas producta Conrad
x xxx--- ----x ---x---- ------ x---- ---x-- ------- -------- ---- - --------  Zifraea rhomboidea (H. C. Lea)
x ------ --xxx ----xxxx x----- ----- --xx-x ----x-x ---xx-x- ---- - --------  Teredina fistula (H. C. Lea)
x xxx--- -xxxx -xxxxxx- ?----- xxxx- --xx-- ------- -x--xxx- ---- - --x--x--  Margaritaria abrupta (Conrad)
x xxxx-- -x--- x------- ------ ----- ------ ------- -------- ---- - x-------  Lyonsia acuta Dall
x xxxx-- --x-- -x------ ------ x---- ---x-- ------- -x------ ---- - --------  Lyonsia sp
x xxxx-- -x--- ---x---- ------ ----- ------ ------- -------- ---- - --x-----  Lyonsia sp.
x xxxxxx xxxxx xxxxx--- ----xx xx-x- --xx-- ----x-- ---xx--- xx-- - x-x-----  Pandora arenosa Conrad
x xxxxxx xxxxx ----xx-- -x---- xx--x --xx-- ----x-- ---xx--- x--- - -x------  Pandora crassidens Conrad
x xxxxxx --xxx ---x---- ------ --x-- --xx-- ----x-- -------- ---- - --------  Pandora crassidens majorina Gardner
x xxxxxx --x-- x------- ------ ----- ------ ------- x------- ---- - --------  Pandora naviculoides Gardner
x xxxxxx --xx- xx------ --x-xx ----- ------ x------ xx------ ---- - --------  Pandora trilineata Say
x xxxxxx -xxxx xxxx---- --x--- -xx-- ---x-- -xx-x-- -x-xxx-- ---- - --x-----  Pandora tuomeyi Gardner & Aldrich
x xxxxxx ----x -------x ------ ----- -----x ------- -------- ---- - --------  Pandora undulata Campbell n. sp.
x xxxxxx ----x -x------ ------ ----- -x---- ------- -------- ---- - --------  Pandora sp.
x -xxxxx ---x- -x------ ------ ----- ------ -x----- -------- ---- - --------  Thracia brioni Ward & Blackwelder
x -xxxxx x-x-x ---xxx-- ------ --x-- --xx-- ----x-- ------x- -x-- - --------  Thracia magna Campbell n. sp.
x -xxxxx ---xx ---x---- ------ x---- ---x-- ----x-- -------- ---- - --------  Thracia maddelysensis Gardner
x -xxxxx --xxx -xxxx--- ------ xx--- x-xx-- --xx--- -x--x--- xx-- - --------  Thracia transversa H. C. Lea
x ----xx -xxxx ---xxxx- ------ xx--- --xx-- ------- ---xxxx- ---- - ----xx--  Cyathodonta dalli (Mansfield)
x ----xx -xx-- xx------ --x--x ----- ------ ------- -x------ ---- - x-------  Cyathodonta semirugosa (Reeve)
x -xxxxx xxxxx -xxxx--- ------ -x--- --xx-- -x--x-- -x-x---- -x-- - --------  Periploma antiqua (Conrad)
x ----xx ----- -------- ---x-x ----- ------ ------- -------- ---- - --------  Periploma inequale C. B. Adams
x -xxxxx ----x ---x---- x----- --x-- --xx-- ------- -------- ---- - --------  Periploma peralta Conrad
x -xxxxx -x--- ---x---- ------ ----- ------ ------- -------- ---- - --x-----  Periploma sp.
x -xxxxx ---x- -x------ ------ ----- -x---- --x---- -------- ---- - --------  Verticordia chowanensis Gardner
x -xxxxx xxxx- xxxxxx-- ------ ----- ------ --x-x-- ---xxx-- x--- - xx------  Verticordia emmonsii Conrad
x -xxxxx --xx- xx------ ------ ----- ------ -x----- -x------ ---- - --------  Verticordia lockei Ward & Blackwelder
x -xxxxx ----- -------- --x--x ----- --xx-- ------- -------- ---- - --------  Verticordia ornata (Orbigny)
x -xxxxx ----x ---x---- ------ xx--- --x--- ------- -------- ---- - --------  Verticordia rogersii Gardner
x -xxxxx ----x -x------ ------ ----- x----- ------- -------- ---- - --------  Verticordia sp.
x xxxxxx -x--- -x------ ------ ----- ------ ------- -------- ---- - -x------  Poromya floridana Olsson & Harbison
x xxxxxx --x-- -x------ ------ ----- ------ ------- -x------ ---- - --------  Poromya sp.
x xxx-xx -xx-- ----x--- --x--x ----- ------ ------- ----x--- ---- - ---x----  Cuspidaria granulata (Dall)
x xxx-xx -x--- x------- ------ ----- ------ ------- -------- ---- - x-------  Cuspidaria orbignyi Olsson & Harbison
x xxx-xx -x--- x------- ------ ----- ------ ------- -------- ---- - x-------  Cuspidaria scabrata Olsson & Harbison
x xxx-xx -x--- -------- --x--x ----- ------ ------- -------- ---- - --------  Cardiomya costellata (Deshayes)
x ----xx -x--- xxxx---- ------ ----- ------ ------- xx---x-- ---- - xxx-----  Cuspidaria (Cardiomya) vaughani Mansfield
x ----xx x-x-- -xxxx--- ------ ----- ------ ------- -x-xx--- x--- - --------  Cardiomya mansfieldi Olsson and Harbison
SCAPHOPODS AND POLYPLACOPHORANS
x -xxxxx --x-- x------- --x--x ----- ------ ------- xx------ ---- - --------  Dentalium antillarum Orbigny
x -xxxxx xxxxx ---xxxxx x----- xx-xx -xxx-x --xx--- ---xxxx- xx-- ? --x-----  Dentalium attenuatum Say
x -xxxxx -x--- x------- -----x ----- ------ ------- -------- ---- - x-------  Dentalium calamus Dall
x -xxxxx -x--- x------- -----x ----- ------ ------- -------- ---- - x-------  Dentalium callipeplum Dall
x -xxxxx -x--- xx------ ------ ----- ------ ------- -------- ---- - xx------  Dentalium caloosaense Dall
x -xxxxx xx--- xxxxx--- ------ xx--- --xx-- ------- -------- xx-- x x-------  Dentalium carolinense Conrad
x -xxxxx -x--- xx------ -x--xx ----- ------ ------- -------- ---- - xx------  Dentalium ceratum Dall
x -xxxxx xxx-- xxxx---- -----x ----- ------ ------- ---x---- x--- - x-------  Dentalium disparile Orbigny
x -xxxxx --x-- -------- ------ ----- ------ ------- -------- ---- - --------  Dentalium duodecenaria Emmons
x -xxxxx xxx-- xxxxx--- --x--x ----- ------ ------- xx-xx--- -x-- - xx------  Dentalium eboreum Conrad
x -xxxxx -x--- x------- ------ ----- ------ ------- -------- ---- - x-------  Dentalium oleacinum Dall
x -xxxxx -x--- x------- ------ ----- ------ ------- -------- ---- - x-------  Dentalium prisma Dall
x -xxxxx -x--- -------- --x--x ----- ------ ------- -------- ---- - --------  Dentalium sowerbyi Guilding
x -xxxxx --x-- xx------ ------ ----- ------ ------- xx------ ---- - --------  Dentalium waccamawense Gardner
x -xxxxx x---- ----x--- ------ ----- ------ ------- -------- x-- - --------  Cadulus blountense Mansfield
x -xxxxx -x--- -------- --x--x ----- ------ ------- -------- ---- - --------  Cadulus carolinensis Bush
x -xxxxx x-x-- -------- ------ ----- ------ ------- ---xx--- -x-- - --------  Cadulus floridanus Dall
x -xxxxx xxxx- xxxx---- -xx--x ----- ------ -x----- xx------ x--- - xxx-----  Cadulus tetraschistus (Watson)
x -xxxxx -x-xx --xxxxxx ------ xxxxx -xxx-x ----x-- -------- ---- - --x-----  Cadulus thallus (Conrad)
x -xxxxx -x--- -------- --x--- ----- ------ ------- -------- ---- - --------  Cadulus tetrodon Pilsbry & Sharp
x -----x -x--- x------- ------ ----- ------ ------- -------- ---- - x-------  Chiton burnsii Dall
x xxxxxx -xx-- xx------ -----x ----- ------ ------- xx------ ---- - x-------  Ischnochiton papillosus (C. B. Adams)
x xxxxxx -x--- x------- -----x ----- ------ ------- -------- ---- - x-------  Ischnochiton striolatus (Gray)
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             111 11111112 222222 22233 333333 3344444 44444555 5555 5 55666666
1 234567 89012 34567890 123456 78901 234567 8901234 56789012 3456 7 89012345
x xxxxxx --xxx -------- ------ xx--- ---x-- ------- ---xx--- ---- - -------- Ischnochiton sp.
x xxxxxx ----- -------- ------ ----- ------ ------- -------- ---- - -------- Ischnochiton tampaensis Dall
x -----x -x--- x------- -----x ----- ------ ------- -------- ---- - x------- Acanthochiton pygmaeus (Pilsbry)
x -----x --x-- x------- -----x ----- ------ ------- x------- ---- - -------- Acanthochiton spiculosa (Reeve)
x --xxxx --xxx xxxxxxxx x---xx xx-x- --xx-x ------- xx-xx--- ---- - -------- Chaetopleura apiculata (Say)
GASTROPODS
x ----xx -xx-- xx------ ------ ----- ------ ------- xx------ ---- - x------- Rimula carolinensis (Dall)
x -----x -x--- xx x---- ------ ----- ------ ------- -------- ---- - xxx----- Hemitoma retiporosa (Dall)
x ----xx -x--- x------- --x--- ----- ------ ------- -------- ---- - x------- Emarginula pilsbryi Dall
x ----xx -x--- -- x---- ------ ----- ------ ------- -------- ---- - --x----- Emarginula sp.
x --xxxx --xx- -xxx---- ------ ----- ------ -x----- ---xxx-- ---- - -------- Diodora auroraensis Ward & BLackwelder
x --xxxx -xx-- xxxx---- -x---- ----- ------ ------- -x-x---- ---- - xxx----- Diodora caloosaensis (Dall)
x --xxxx -xxx- xxxxxx-- --x--- ----- ------ x------ xx------ ---- - xxx----- Diodora carditella (Dall)
x --xxxx -xxx- ---x---- ------ ----- ------ ----x-- ---x---- ---- - --x----- Diodora carolinensis (Conrad)
x --xxxx -xxx- xxxx---- -xx-xx ----- ------ x------ xx------ ---- - xxx----- Diodora cayenensis (Lamarck)
x --xxxx -x--- x------- ------ ----- ------ ------- -------- ---- - x------- Diodora floridana Gardner
x --xxxx xxxx- xxxxx--- ------ ----- ------ -x----- -x-xx--- xx-- - xxx----- Diodora nucula (Dall)
x --xxxx ---x- x------- ------ ----- ------ -x----- -------- ---- - -------- Diodora pamlicoensis Ward & Blackwelder
x --xxxx x-xxx ---xxxxx ------ ----- -----x --x-x-- ---xxx-- x--- - -------- Diodora redimicula (Say)
x --xxxx --xxx ---xx--- ------ xx-xx --xx-- --x-x-x ---x---- ---- - -------- Diodora oblonga (H. C. Lea)
x ----xx -xx-- xx------ --x--x ----- ------ ------- xx------ ---- - xx-----x Lucapinella limatula (Reeve)
x ----xx -x--- xx x---- --x--x ----- ------ ------- -------- ---- - xxx----- Lucapina suffusa (Reeve)
x ----xx -x--- x------- ------ ----- ------ ------- -------- ---- - x------- Acmea punctulata Gmelin
x xxxxxx x-x-- ?--xxx-- ------ ----- ------ ------- -- xxx - -x-- - x------- Solariella gemma (Tuomey & Holmes)
x xxxxxx ----x ---xx--- ------ xx-x- --xx-- ------- -------- ---- - -------- Solariella ricei Campbell n. sp.
x xxxxxx ----x -------x ------ ----- -----x ------- -------- ---- - -------- Solariella shacklefordensis Olsson
x xxxxxx ----x -------x ------ ----- -----x ------- -------- ---- - -------- Solariella olssoni Campbell n. sp.
x xxxxxx x-x-- ---xx--- ------ ----- ------ ------- ---x---- -x-- - -------- Calliostoma aluminum Dall
x -xxxxx --x-x ---xx--- ------ xx-x- --xx-- ------- ---x---- ---- - -------- Calliostoma bellum (Conrad)
x -xxxxx --x-- ----?--- ------ ----- ------ ----x-- -------- ---- - -------- Calliostoma cheopsi Gardner
x -xxxxx --x-- ---x---- ------ ----- ------ ------- ---x---- ---- - -------- Calliostoma cyclus Dall
x -xxxxx --xx- x------- ------ ----- ------ x------ x------- ---- - -------- Calliostoma erosum Dall
x -xxxxx -x--- x------- ------ ----- ------ ------- -------- ---- - x------- Calliostoma euconulum Olsson & Harbison
x -xxxxx -xx-- x------- --x--x ----- ------ ------- x------- ---- - x------- Calliostoma jujubinum (Gmelin)
x -xxxxx -xx-- xx------ ------ ----- ------ ------- -x------ ---- - x------- Calliostoma jujuconulum Olsson & Harbison
x -xxxxx --xxx -xxxxx-- ------ xx-xx --xx-- ------- ---xxx-- ---- - -------- Calliostoma labrosum (Conrad)
x -xxxxx ---xx ---xx--- ------ xx-x- --xx-- ----x-- -------- ---- - -------- Calliostoma lapidosum (Conrad)
x -xxxxx -x--- x------- ------ ----- ------ ------- -------- ---- - x------- Calliostoma limulum Dall
x -xxxxx --xxx ---x---- ------ xx--- --xx-- ----x-- ---x---- ---- - -------- Calliostoma mitchelli mitchelli (Conrad)
x -xxxxx ---xx ---xx--- ------ -x-xx --xx-- ----x-- -------- ---- - -------- Calliostoma mitchelli basicum Dall
x -xxxxx ---xx ----x--- ------ x---- --xx-- ------- -------- ---- - -------- Calliostoma mitchelli conradianum Dall
x -xxxxx --x-- ---x---- ------ ----- ------ ------- ---x---- ---- - -------- Calliostoma mitchelli eliminatum Dall
x -xxxxx ----x -------x ------ ----- -----x ------- -------- ---- - -------- Calliostoma mitchelli johnsoni Campbell n. ssp.
x -xxxxx xx--x ---xx--- ------ xx-xx --xx-- ------- -------- x--- - --x----- Calliostoma mitchelli philanthropus (Conrad)
x -xxxxx x-xxx ---xxx-- ------ ----- ------ ------- ---xxx-- xx-- - -------- Calliostoma mitchelli pontoni Mansfield
x -xxxxx ----x ----x--- ------ --x-- --xx-- ------- -------- ---- - -------- Calliostoma nottowayense Gardner
x -xxxxx -x--- ---x---- ------ ----- ------ ------- -------- ---- - --x----- Calliostoma pauli Olsson
x -xxxxx -x--- xx------ ------ ----- ------ ------- -x------ ---- - xx------ Calliostoma permagnum Dall
x -xxxxx -x--- x------- ------ ----- ------ ------- -------- ---- - x------- Calliostoma seminolum Olsson & Harbison
x -xxxxx ----x -------x ------ ----- -----x ------- -------- ---- - -------- Calliostoma shackelfordensis Olsson
x -xxxxx -x--- -x------ ------ ----- ------ ------- -------- ---- - -x------ Calliostoma sincerum Olsson & Harbison
x -xxxxx ----x -------x ------ ----- -----x ------- -------- ---- - -------- Calliostoma sarae Campbell n. sp.
x -xxxxx --x-- ---xx--- ------ ----- ------ ------- ---xx--- ---- - -------- Calliostoma tuomeyi Olsson
x -xxxxx --xxx ---xx--- ------ xxx-x --xx-- ------- ---x---- ---- - -------- Calliostoma virginicum virginicum (Conrad)
x -xxxxx ---x- ---x---- ------ ----- ------ ---x--- -------- ---- - -------- Calliostoma virginicum carolinensis Gardner
x -xxxxx ----x ---x---- ------ --x-- ---x-- ------- -------- ---- - -------- Calliostoma virginicum gizehi Gardner
x -xxxxx ----x -------x ------ ----- -----x ------- -------- ---- - -------- Calliostoma virginicum harrisianum Olsson
x -xxxxx ----x ---x---- ------ ----- ---x-- ------- -------- ---- - -------- Calliostoma virginicum harrisii Dall
x -xxxxx ---x- ----?--- ------ ----- ------ ----x-- -------- ---- - -------- Calliostoma virginicum hertfordense Gardner
x -xxxxx ----x -------x ------ ----- -----x ------- -------- ---- - -------- Calliostoma v. jeffersonium Campbell n. ssp.
x -xxxxx -xx-- xxxx---- ------ ----- ------ ------- xx------ ---- - xxx----- Calliostoma willcoxiana Dall
x -----x xxx-x ---xx--- x----- ---x- --xx-- ------- ---xx-x- x--- - --x----- Tegula exoluta (Conrad)
x -----x ----- -------- --x--x ----- ------ ------- -x------ ---- - xxx------ Tegula fasciatum (Born)
x ------ ---xx ---xx--- ------ xx--- --xx-- ----x-- ---x---- ---- - -------- Gibbula rustica (H. C. Lea)
x ---xxx -xxxx ---xx--- ------ xx-x- --xx-- ----x-- ---x---- ---- - --x----- Skenea smithfieldensis (Olsson)
x ---xxx ----x ---x---- ------ ----- ---x-- ------- -------- ---- - -------- Skenea yorktownensis Campbell n. sp.
x ---xxx --xxx ---xxx-- ------ xxxxx --xx-- ----x-- -xxxx--- ---- - -------- Skenea harrisii (Olsson)
x ---xxx --x-- -x------ ------ ----- ------ ------- -x------ ---- - -------- Skenea sp.
x ------ xxx-- xxxx---- ------ ----- ------ ------- -x-x---- -x-- - xx------ Gelasinostoma elegantula (Dall)
x ------ ----x ---x---- ------ x---- --xx-- ------- -------- ---- - -------- Leptogyra davidi Campbell n. sp.
x ----xx --x-x ---xx--- ------ x---- --xx-- ------- ----x--- ---- - -------- Pelycidion matthewi Campbell n. sp.
x ----xx --x-- ---x---- ------ ----- ------ ------- ---x---- ---- - -------- Pelycidion sp.
x ----xx --x-- -x------ ------ ----- ------ ------- -x------ ---- - -------- Pelycidion sp.
x ----xx -x--- x------- ------ ----- ------ ------- -------- ---- - x------- Arene perarmata (Dall)
x ----xx --xx- xxxxxxx- ------ ----- ------ --x-x-- xx--x--- ---- - -------- Arene pergemma (Gardner)
x ----xx -xxx- xxxxxxx- --x--x ----- ------ -xx---- xx-x---- ---- - xxx----- Arene tricatenaria (Stearns)
x ----xx -x--- xx------ ------ ----- ------ ------- -------- ---- - xx------ Parviturbo milium (Dall)
x -----x -x--- x------- -----x ----- ------ ------- -------- ---- - x------- Astraea deplanatum Link
x -----x -x--- xx------ -----x ----- ------ ------- -------- ---- - xx------ Astraea longispina (Lamarck)
x -----x -x--- xx------ ------ ----- ------ ------- -------- ---- - xx------ Astraea precursor(Dall)
x -----x -x--- -xxx---- ------ ----- ------ ------- -------- ---- - -xx----- Astraea scolopax Olsson & Harbison
x -----x -x--- ---x---- ------ ----- ------ ------- -------- ---- - --x----- Astraea tectariaformis Petuch
x -----x -x--- ?------- ------ ----- ------ ------- -------- ---- - -------x Astraea sp. aff. A. americanum (Gmelin) Lyons
x -----x -x--- ---x---- ------ ----- ------ ------- -------- ---- - --x----- Astrea sp. Gardner
x ---xxx -xx-- xxxx---- --x-xx ----- ------ ------- xx------ ---- - xxx----- Turbo castaneus Gmelin
x ---xxx -x--- ---x---- ------ ----- ------ ------- -------- x--- x --x----- Turbo castaneus ayersi Olsson
x ---xxx -x--- ---x---- ------ ----- ------ ------- -------- ---- - --x----- Turbo castaneus tiara M. Smith
x ---xxx -x--- xxxx---- ------ ----- ------ ------- -------- ---- - x-x----- Turbo crenulatoides Maury Tucker & Wilson
x ---xxx -x--- x------- ------ ----- ------ ------- -------- ---- - x------- Turbo dominicensis Gabb
x ---xxx -x--- xx------ ------ ----- ------ ------- -------- ---- - xx------ Turbo floridensis Olsson & Harbison
x ---xxx -x--- xxxx---- ------ ----- ------ ------- -------- ---- - xxx----x Turbo rectogrammicus Dall
x ---xxx -x--- x------- ------ ----- ------ ------- -------- ---- - x------- Turbo wellsi Tucker & Wilson
x ----xx -xx-- x------- -----x ----- ------ ------- x------- ---- - x------- Tricolia bella (M. Smith)
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            111 11111112 222222 22233 333333 3344444 44444555 5555 5 55666666
1 234567 89012 34567890 123456 78901 234567 8901234 56789012 3456 7 89012345
x ----xx -x--- xx------ --x--x ----- ------ ------- -------- ---- - xx------ Tricolia thalassicola Robertson
x -----x -x--- x------- ------ ----- ------ ------- -------- ---- - x------- Neritina edentula Dall
x -----x -x--- xxxx---- ------ ----- ------ ------- -------- ---- - xxx----- Neritina sphaerica Olsson & Harbison
x -----x -x--- xx------ --x--- ----- ------ ------- -------- ---- - xx------ Smaragdia viridis merida (Dall)
x -xxx-x -x--- xxxx---- ------ ----- ------ -x----- xxx----- ---- - --x----- Littorina irrorata carolinensis Conrad
x -xxx-x -xx?- xx--?--- ----xx ----- ------ ----x-- xx------ ---- x -x------ Littorina irrorata (Say)
x -xxx-x -x--- ---x---- ------ ----- ------ ------- -------- ---- - --x----- Littorina sheaferi Olsson
x -xxxxx -x--- x------- ------ ----- ------ ------- -------- ---- - x------- Cingula athymorhyssa (Dall)
x -xxxxx -x--- x------- ------ ----- ------ ------- -------- ---- - x------- Cingula callistrophia (Dall)
x -xxxxx xxx-x xxxx---- ------ x---- ---x-- -x----- xx------ xx-- - x------- Cingula geraea (Dall)
x -xxxxx -x--- x------- ------ ----- ------ ------- -------- ---- - x------- Cingula microcharia (Dall)
x -xxxxx ----x ---x---- ------ x---- ---x-- ------- -------- ---- - -------- Cingula sp. Campbell
x ----xx -x--- x------- ------ ----- ------ ------- -------- ---- - x------- Hydrobia amnicoloides Pilsbry
x --x-xx xxx-x xxxx---- -----x xx--- --xx-- ------- -x-xx--- x--- - x------- Alvania lipeus (Dall)
x --x-xx -x--- ---x---- ------ ----- ------ ------- -------- ---- - --x----- Alvania sp.
x --x-xx --x-- -x------ ------ ----- ------ ------- -x------ ---- - -------- Alvania sp.
x --x-xx --x-- -x------ ------ ----- ------ ------- -x------ ---- - -------- Alvania sp.
x --xx-x x---- ---x---- ------ ----- ------ ------- -------- x--- - -------- Amnicola sp. aff. A. floridana convexa Pilsbry
x --xx-x -x--- x------- ------ ----- ------ ------- -------- ---- - x------- Assiminea affinis Orbigny
x --xx-x -x--- x------- ------ ----- ------ ------- -------- ---- - x------- Assiminea auberiana Orbigny
x ---xxx -x--- xx------ --x--x ----- ------ ------- -x------ ---- - xx------ Zebina browniana (Orbigny)
x ---xxx -x--- xx------ ------ ----- ------ ------- -x------ ---- - xx------ Rissoina bulimina Olsson & Harbison
x ---xxx -x--- x------- --x--x ----- ------ ------- -------- ---- - x------- Rissoina cancellata Philippi
x ---xxx -x--- x------- -----x ----- ------ ------- -------- ---- - x------- Rissoina catesbyana Orbigny
x ---xxx x---- ----x--- ------ ----- ------ ------- -------- -x-- - -------- Rissoina clarksvillensis Mansfield
x ---xxx -x--- x------- ------ ----- ------ ------- -------- ---- - x------- Rissoina fargoi Olsson & Harbison
x ---xxx -xx-- xx------ ------ ----- ------ ------- -x------ ---- - xx------ Rissoina harpa Gardner
x ---xxx xxx-- xxxxx--- ------ ----- ------ ------- ---x---- xx-- - -x------ Rissoina johnsoni Dall
x ---xxx -x--- x------- -x---- ----- ------ ------- -------- ---- - x------- Rissoina liriope Olsson & Harbison
x ---xxx -x--- x------- ------ ----- ------ ------- -------- ---- - x------- Rissoina parkeri Olsson & Harbison
x ---xxx -x--- xx------ ------ ----- ------ ------- -------- ---- - xx------ Rissoina planata Dall
x ---xxx -x--x xxxx---- -----x x---- ---x-- ------- -x------ ---- - xx------ Rissoina striatocostata Orbigny
x ---xxx --x-x --xxx--- ------ xx-x- x-xx-- ------- -x-x---- ---- - -------- Vitrinella lipara (H. C. Lea)
x ---xxx --x-x --xxx--- ------ xx--- -xxx-- ------- ---x---- ---- - -------- Circulus costulatus (H. C. Lea)
x ---xxx --x-- xx------ ----xx ----- ------ ------- xx------ ---- - -------- Circulus liratus (Verrill)
x ---xxx xxx-- xxxx---- ------ ----- ------ ------- ---xx--- x--- - xxx----- Cyclostremiscus bartschi (Mansfield)
x ---xxx -x--- xxxx---- --x--x ----- ------ ------- -------- ---- - xxx----- Cyclostremiscus beaui (Fischer)
x ---xxx -x--- xx------ ------ ----- ------ ------- -------- ---- - xx------ Cyclostremiscus fargoi Pilsbry
x ---xxx --xxx ---xxxxx ------ xx-x- x-xx-x -x--x-- --xx---- ---- - -------- Cyclostremiscus obliquestriatus (H. C. Lea)
x ---xxx -xx-- xx------ ------ ----- ------ ------- -x------ ---- - x------- Cyclostremiscus olssoni Pilsbry
x ---xxx ----x ---x---- ------ -x--- ---x-- ------- -------- ---- - -------- Cyclostremiscus pseudadeorbis (Dall)
x ---xxx xxx-- xxxx---- ------ x---- ---x-- ------- ---x---- x--- - xxx----- Cyclostremiscus schmidti (Olsson)
x ---xxx -xx-- xxxx---- ------ x---- --x--- ------- ---x---- ---- - x------- Cyclostremiscus strigillatus (Dall)
x ---xxx -x--- xxxx---- --x-xx ----- ------ ------- -------- ---- - x-x----- Cyclostremiscus trilix (Bush)
x ---xxx --xxx xx------ ------ ----- x----- xxx---- xx------ ---- - -------- Cyclostremiscus undula (Dall)
x ---xxx --x-- ---x---- ------ ----- ------ ------- ---x---- ---- - -------- Cyclostremiscus sp. A
x ---xxx --x-- -x------ ------ ----- ------ ------- -x------ ---- - -------- Cyclostremiscus sp. B
x -----x -x--- xx------ ------ ----- ------ ------- -------- ---- - xx------ Anticlimax annae Pilsbry & Olsson
x -----x -x--- xx------ -x---- ----- ------ ------- -------- ---- - xx------ Anticlimax calliglyptum (Dall)
x -----x -x--- xx------ ------ ----- ------ ------- -------- ---- - xx------ Anticlimax locklini Pilsbry & Olsson
x -----x -x--- x------- ------ ----- ------ ------- -------- ---- - x------- Anticlimax radiata (Dall)
x -----x -x--- x------- ------ ----- ------ ------- -------- ---- - x------- Anticlimax symmetrica Pilsbry & Olsson
x -----x -x--- ---x---- ------ ----- ------ ------- -------- ---- - --x----- Anticlimax tholus prodromus Pilsbry & Olsson
x ----xx -xx-x xxxx---- -----x x---- ---x-- ------- -x-x---- ---- - xxx----- Aorotrema cistronium (Dall)
x ----xx -xx-- xxxx---- --x-xx ----- ------ ------- xx-x---- ---- - xx------ Episcynia multicarinata (Dall)
x ----xx -x--- xx------ --x--- ----- ------ ------- -x------ ---- - xx------ Parviturboides avitus Pilsbry
x ----xx --x-- xx------ -----x ----- ------ ------- -x------ ---- - -------- Parviturboides interruptus (C. B. Adams)
x ----xx --x-- ---x---- ------ xx--- ---x-- ------- ---x---- ---- - -------- Parviturboides sp.
x ----xx --x-x xx------ ------ ----- -x---- ------- xx------ ---- - -------- Didianema carolinae Gardner
x ----xx xxx-x xxxx---- ------ ----- -x---- -x----- -x-x---- x--- - xxx----- Didianema duplinensis (Dall)
x ----xx -x--- -x------ ------ ----- ------ ------- -------- ---- - -x------ Didianema orthorhytis Pilsbry
x ----xx ----x ---x---- ------ x---- --x--- ------- -------- ---- - -------- Didianema sp. Campbell
x ---xxx -x--- xx------ --x--- ----- ------ ------- -------- ---- - -x------ Solariorbis basilissus Pilsbry
x ---xxx --x-- ---x---- ------ ----- ------ ------- ---xx--- ---- - -------- Solariorbis duplinense (Dall)
x ---xxx -x--- -x------ ------ ----- ------ ------- -------- ---- - -x------ Solariorbis eugenes Pilsbr
x ---xxx -x--- xx------ ------ ----- ------ ------- -x------ ---- - xx------ Solariorbis floridanum (Dall)
x ---xxx xx--- xxxx---- --x--- ----- ------ ------- -------- ---- - xxx----- Solariorbis funiculus (Dall)
x ---xxx -xx-- xxxx---- --x-xx ----- ------ ------- -------- x--- - --x----- Solariorbis infracarinata (Gabb)
x ---xxx -x--- xxxx---- ------ ----- ------ ------- -------- ---- - xxx----- Solariorbis opistelotus (Dall)
x ---xxx ----x --xx---- ------ ----- ---x-- ------- -------- ---- - -------- Solariorbis variabilis Olsson
x ---xxx ----x --x----- ------ ----- x----- ------- -------- ---- - -------- Solariorbis yadkinensis Campbell n. sp.
x --xxxx -x--- -xxx---- ------ ----- ------ ------- -x------ ---- - -xx----- Teinostoma alatum Pilsbry
x --xxxx --xxx xxxxx--- ------ x---- x--x-- -x-x--- x--xx--- ---- - -------- Teinostoma alexanderi (Olsson)
x --xxxx -x--- -xxx---- ------ ----- ------ ------- -------- ---- - -xx----- Teinostoma avunculus Pilsbry
x --xxxx --x-x xxxxx--- ------ xx--- ---x-- ------- xx-xx--- ---- - -------- Teinostoma bushi (Olsson)
x --xxxx -x--- xx------ ------ ----- ------ ------- -------- ---- - xx------ Teinostoma caloosaense Dall
x --xxxx -x--- xx------ --x--x ----- ------ ------- -------- ---- - xx------ Teinostoma carinicallus Pilsbry & McGinty
x --xxxx --x-- x------- ------ ----- ------ ------- -------- ---- - x------- T. sp. cf. T. cocolitoris Pilsbry and McGinty
x --xxxx --x-- ---x---- ------ ----- ------ ------- ---x---- ---- - -------- Teinostoma collinus (Dall)
x --xxxx xxxxx xxxxx--- --x--x xx-x- -xxx-- -xx-x-- xx-x---- x--- - xx------ Teinostoma goniogyrus Pilsbry & McGinty
x --xxxx x---- ---x---- ------ ----- ------ ------- -------- x--- - -------- Teinostoma harveyensis Mansfield
x --xxxx ----x ---x---- ------ x---- ---x-- ------- -------- ---- - -------- Teinostoma leana Campbell n. sp.
x --xxxx --x-x ---xx--- ------ xx-x- --xx-- ------- ---xx--- ---- - -------- Teinostoma lenticlare (H. C. Lea)
x --xxxx -x--- x------- ------ ----- ------ ------- -------- ---- - x------- Teinostoma milium (Dall)
x --xxxx --x-- ---x---- ------ ----- ------ ------- ---x---- ---- - -------- Teinostoma miocenica Olsson
x --xxxx --x-x -xxxxxxx x----- xx-x- --xx-- --x---- --xx---- ---- - -------- Teinostoma nana (Lea)
x --xxxx --x-- ---x---- ------ ----- ------ ------- ---x---- ---- - -------- Teinostoma steiratum (Dall)
x --xxxx --x-x -xxxx--- ------ xx--- ---x-- ------- ---xx--- ---- - -------- Teinostoma subconicum (H. C. Lea)
x --xxxx -x-x- xxxx---- ------ ----- ------ -xx---- -------- ---- - xxx----- Teinostoma tectispira Pilsbry
x --xxxx --x-- ---x---- ------ ----- ------ ------- ---x---- ---- - -------- Teinostoma thompsoni Olsson
x --xxxx xxx-x xxxxx--- ----xx xx--x --xx-- ------- -x------ -x-- - -------- Teinostoma umbilicata (H. C. Lea)
x --xxxx x---- ---x---- ------ ----- ------ ------- -------- x--- - -------- Teinostoma washingtonensis Mansfield
x --xxxx ----x -xxx---- ------ xx--- -x-x-- ------- -------- ---- - -------- Teinostoma virginica Campbell n. sp.
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             111 11111112 222222 22233 333333 3344444 44444555 5555 5 55666666
1 234567 89012 34567890 123456 78901 234567 8901234 56789012 3456 7 89012345
x -----x -xx-x ---xx--- ------ xxx-- --xx-- ------- ---xx--- ---- - -------- Macromphalina aperta (H. C. Lea)
x -----x ----x ---x---- ------ -x--- ---x-- ------- -------- ---- - -------- Macromphalina chuckatuckensis Campbell n. sp.
x -----x --x-- -xxx---- ------ ----- ------ ------- -x-x---- ---- - -------- Macromphalina duplinensis (Dall)
x -----x --xx- xx------ ------ ----- ------ -x----- -x------ ---- - -------- Macromphalina hanseni Ward & Blackwelder
x -----x -xx-- xxxx---- -----x ----- ------ -x----- -x------ ---- - xxx----- Macromphalina peirroti Gardner
x -----x --x-- ---x---- ------ ----- ------ ------- ---x---- ---- - -------- Macromphalina sp.
x ---xxx -xx-x xxxxx--- ------ xx--- --xx-- --x---- ---xx--- ---- - x-x----- Cochliolepis concava (H. C. Lea)
x ---xxx -xx-- xxxx---- --x-xx ----- ------ ------- ---x---- ---- - xxx----- Cochliolepis holmesii (Dall)
x ---xxx --x-- ---x---- ------ ----- ------ ------- ---x---- ---- - -------- Cochliolepis leai (Dall)
x ---xxx -x--- xx------ ----xx ----- ------ ------- -------- ---- - xx------ Cochliolepis parasitica Stimpson
x ---xxx -xx-x xx------ --x--x ----- x----- ------- -x-x---- ---- - xx------ Cochliolepis striata Dall
x ---xxx ----x ---x---- ------ x---- ---x-- ------- -------- ---- - -------- Cochliolepis virginica Pilsbry
x -xxxxx -x--- x------- -----x ----- ------ ------- x------- ---- - x------- Caecum carolinensis Dall
x -xxxxx -x--x ---x---- ------ x---- ---x-- ------- -------- ---- - --x----- Caecum chuckatuckensis Campbell n. sp.
x -xxxxx --x-- xx------ -x---- ----- ------ ------- -------- ---- - -x------ Caecum cinctum Olsson & Harbison
x -xxxxx -xxxx xxxxx--- ------ ----- x----- ------- --xxx--- ---- - x-x----- Caecum compactum Dall
x -xxxxx xxxxx xxxxx--- ----xx xx-xx x-xx-- x------ xx-xx--- x--- - x-x----- Caecum cooperi S. Smith
x -xxxxx -xx-- xxxx---- ------ ----- ------ ------- -x-x---- ---- - x-x----- Caecum coronellum Dall
x -xxxxx -xxxx xxxxx--- ------ xx-x- x-xx-- xx----- xx-xx--- x--- - x------- Caecum flemingi Gardner & Aldrich
x -xxxxx -xx-- xxxx---- -xx--x ----- ------ ------- -x------ ---- - xxx----- Caecum floridanum Stimpson
x -xxxxx -x--- ---x---- ------ ----- ------ ------- -------- ---- - --x----- Caecum cf. C. gurgulio Folin
x -xxxxx -x--- -xxx---- -----x ----- ------ ------- -------- ---- - -xx----- Caecum heladum Olsson & Harbison
x -xxxxx -x--- xxxx---- ------ ----- ---x-- ------- xx-x---- ---- - -------- Caecum ibex Dall
x -xxxxx -xxx- xxxx---- -xx-xx ----- ------ --x---- xx-x---- ---- - xxx----- Caecum imbricatum Carpenter
x -xxxxx -xx-x xxxx---- ----xx xx-x- x-xx-- -x----- xxxx---- ---- - x-x----- Caecum johnsoni Winkley
x -xxxxx --xxx xx------ --x-xx ----- x----- x------ -x------ ---- - -------- Caecum pulchellum Stimpson
x -xxxxx xxxx- xxxx---- --x--x ----- x----- -x----- xx------ x--- - xxx----- Caecum regulare Carpenter
x -xxxxx ----x -xxx---- ------ -x--- x--x-- ------- -------- ---- - -------- Caecum stevensoni Meyer
x -xxxxx -x--- ---x---- -----x ----- ------ ------- -------- ---- - --x----- Caecum textile Folin
x -xxxxx -xx-x xxxx---- -x---- x---- ---x-- ------- x--x---- ---- - -x------ Caecum tortile Dall
x -xxxxx -xx-- -xxx---- ------ ----- ------ ------- -x------ ---- - --x----- Caecum vestitum Folin
x -xxxxx --x-x ---xx--- ------ x---- --x--- ------- ----x--- ---- - -------- Caecum virginianum Meyer
x -xxxxx xxxx- xxxx---- -----x ----- ------ --x---- -x------ x--- - xxx----- Meioceras cingulatum Dall
x -xxxxx xx--- xxxx---- ------ ----- ------ ------- -------- x--- - xxx----- Meioceras nitidum (Stimpson)
x ---xxx x--xx ---xx--- ------ xxxxx --xx-- ----x-- -------- x--- - -------- Turritella alticostata Conrad
x ---xxx -x--- ---x---- ------ ----- ------ ------- -------- ---- - --x----- Turritella sp. cf. T. altilira Conrad
x ---xxx xx--- ---xx--- ------ ----- ------ ------- -------- xx-- - --x----- Turritella alumensis Mansfield
x ---xxx -x--- xx------ --x--- ----- ------ ------- -------- ---- - xx------ Turritella apicalis Heilprin
x ---xxx ---xx -xx----- ------ ----- -x---- -xx---- -------- ---- - -------- Turritella beaufortensis Ward & Blackwelder
x ---xxx ----x -------x ------ ----- -----x ------- -------- ---- - -------- Turritella bipertita Conrad
x ---xxx -x--- ---x---- ------ ----- ------ ------- -------- ---- - ----x--- Turritella buckinghamensis Mansfield
x ---xxx xxx-- ---xxxx- ------ ----- ------ ------- ---xxxx- -x-- - --x----- Turritella burdeni (Tuomey & Holmes)
x ---xxx -x--- ---x---- ------ ----- ------ ------- -------- ---- - ----x--- Turritella aff. T. cartagenensis Pilsbry & Brown
x ---xxx --x-- ---x---- ------ ----- ------ ------- ---x---- ---- - -------- Turritella constricta (Emmons)
x ---xxx xxx-x ---xxxx- ------ xx--- ---x-- ------- ---xx-x- x--- - --x----- Turritella fluxionalis Rogers & Rogers
x ---xxx xxx-- ---xxxx- ------ ----- ------ ------- ---xxxx- xx-- - --x----- Turritella etiwanensis (Tuomey & Holmes)
x ---xxx -x--- ---x---- ------ ----- ------ ------- -------- ---- - --x----- Turritella evergladensis
x ---xxx -x--- ---x---- ------ ----- ------ ------- -------- ---- - --x----- Turritella gladeensis Mansfield
x ---xxx --x-- ---xxxx- ------ ----- ------ ------- ---xxxx- ---- - -------- Turritella holmesii Dall
x ---xxx -x--- ---x---- ------ ----- ------ ------- -------- ---- - --x----- Turritella mansfieldi Olsson
x ---xxx xxxx- xxxxxxx- -xxxxx ----- ------ xxx---- xx-xxxx- xx-- - xxx----x Turritella perexilis Conrad
x ---xxx -x--- xxxxxx-- ------ ----- ------ ------- -------- ---- - xxx--x-- Turritella perattenuata Heilprin
x ---xxx -x--- xxxxxx-- ------ ----- ------ ------- -------- ---- - x-x--x-- Turritella pontoni Mansfield
x ---xxx ----x -------x ------ ----- -----x ------- -------- ---x - -------- Turritella terstriata Rogers and Rogers
x ---xxx --xxx --xxx--- ------ --xx- -xxx-- ------- ---xx--- ---- - -------- Turritella virginica Campbell n. sp.
x ---xxx -x--- ---x---- ------ ----- ------ ------- -------- ---- - --x----- Turritella wagneriana Olsson & Harbison
x --xxxx -xx-- -x------ ------ ----- ------ ------- x------- ---- - -x------ Vermicularia sp. cf. V. knorrii
x --xxxx -x--- xxxx---- --x--- ----- ------ ------- ----xx-- ---- - xxx----- Vermicularia recta Olsson & Harbison
x --xxxx -xxx- xxxx---- -x-xxx ----- ------ xx----- xx------ ---- - --x----- Vermicularia spirata (Philippi)
x --xxxx -xx-- x------- --x--x ----- ------ ------- x------- ---- - x------- Vermicularia weberi Olsson & Harbison
x --xxxx -xx-- xxxx---- ------ ----- ------ ------- -x--xx-- ---- - xxx----- Vermicularia woodringi Olsson & Harbison
x ----xx xxx-x xxxxxxx- --x-xx x----- ---x-- ------- -x-xxxx- x--- - --x----- Architectonica nobilis Roding
x ----xx -x--- -------- x-x--x ----- ------ ------- -------- ---- - -------- Heliacus bisulcatus (Orbigny)
x -----x x-x-x ---xxxxx ------ xx-xx --xx-x ------- ---xx--- -x-- - -------- Pseudotorinia nupera (Conrad)
x -----x -xx-- xx------ ------ ----- ------ ------- -x------ ---- - x------- Pseudotorinia retifera (Dall)
x -----x -x--- xx------ -----x ----- ------ ------- -------- ---- - xx------ Petaloconchus erectus (Dall)
x -----x -x--- ---x---- ------ ----- ------ ------- -------- ---- - --x----- Petaloconchus irregularis Orbigny
x -----x xxxxx ---xxxx- ------ xx-xx --xx-- ------- ---xxxx- xx-- - --xxxx-- Petaloconchus sculpturatus H. C. Lea
x -----x -x--- xxxx---- ----xx ----- ------ ------- -x------ ---- - xxx----- Petaloconchus varians (Orbigny)
x ---xxx --x-- xxxx---- --x-xx ----- ------ ------- -x------ ---- - xxx----- Lemintina decussata (Gmelin)
x ---xxx x-xxx ---xxxxx x----- xx--x -xxx-x -xx-x-- -x-xxxx- xx-- - --x----- Lemintina granifera (Say)
x ---xxx --x-- ---x---- ------ ----- ------ ------- ---xx--- ---- - -------- Lemintina granifera tenera (Dall)
x ---x-x -x--- ---x---- --x-xx ----- ------ ------- -------- ---- - --x----- Modulus carchedonius (Lamarck)
x ---x-x -x--- xxxx---- --x-xx ----- ------ ------- -------- ---- - xxx----- Modulus modulus (Linnaeus)
x ---x-x xx--- ---x---- ------ ----- ------ ------- -------- x--- - --x----- Modulus woodringi Mansfield
x ---x-x -x--- x------- ------ ----- ------ ------- -------- ---- - x------- Cerithidea callisoma (Dall) Olsson & Harbison
x ---x-x -x--- x------- --x--x ----- ------ ------- -------- ---- - x------- Cerithidea costata (da Costa)
x ---x-x -x--- xxxx---- -----x ----- ------ ------- -------- ---- - xxx----- Cerithidea pliculosa (Menke)
x ---x-x -x--- x------- ----xx ----- ------ ------- -------- ---- - x------- Cerithium algicola C. B. Adams
x ---x-x -x--- xxxx---- --x--x ----- ------ ------- -------- ---- - xxx----- Cerithium atratum (Born)
x ---x-x -x--- x------- ------ ----- ------ ------- -------- ---- - x------- Cerithium burnsii Dall
x ---x-x -x--- xxxx---- ------ ----- ------ ------- -------- ---- - xxx----- Cerithium caloosaense Dall
x ---x-x -x--- xxxx---- ------ ----- ------ ------- -------- ---- - xxx----- Cerithium coccodes Dall
x ---x-x -x--- ---x---- ------ ----- ------ ------- -------- ---- - --x----- Cerithium dalli Olsson & Petit
x ---x-x -x--- xxxxxx-- ------ ----- ------ ------- -------- ---- - x--- x-- Cerithium floridanum Morch
x ---x-x -x--- x------- ------ ----- ------ ------- -------- ---- - x------- Cerithium glaphyrea Dall
x ---x-x x---- ---x---- ------ ----- ------ ------- -------- x--- - -------- Cerithium harveyensis Mansfield
x ---x-x -x--- xx------ -x---- ----- ------ ------- -------- ---- - xx------ Cerithium litharium Dall
x ---x-x -x--- xx------ --x-xx ----- ------ ------- -------- ---- - xx------ Cerithium muscarum Say
x ---x-x -x--- xxxx---- ------ ----- ------ ------- -------- ---- - xxx----- Cerithium peratratum Olsson & Harbison
x ---x-x -x--- x------- ------ ----- ------ ------- -------- ---- - x------- Cerithium triticium Olsson & Harbison
x ---x-x -x--- xxxx---- ------ ----- ------ ------- -------- ---- - xxx----- Cerithium vicinia Olsson & Harbison
x ---x-x -x--- -x------ ------ ----- ------ ------- -------- ---- - -x------ Cerithium willcoxi Olsson & Harbison
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            111 11111112 222222 22233 333333 3344444 44444555 5555 5 55666666
1 234567 89012 34567890 123456 78901 234567 8901234 56789012 3456 7 89012345
x ---x-x -x--- xxxx---- --x--- ----- ------ ------- -------- ---- - xxx----- Pyrazus scalatus (Heilprin)
x ---x-x -x--- ---x---- ------ ----- ------ ------- -------- ---- - --x----- Pyrazus scalinus Olsson
x ---x-x -x--- xxxx---- -x---- ----- ------ ------- -------- ---- - x-x----x Rhinoclavis caloosaensis (Dall)
x ---xxx xx--- xxxx---- -xx--x ----- ------ ------- -x------ x--- - xx------ Finella adamsii (Dall)
x ---xxx -x--- xx------ --x-xx ----- ------ ------- -------- ---- - xx------ Finella dubia (Orbigny)
x -xxx-x -xx-- xxxx---- ------ ----- ------ ------- -x------ ---- - xxx----- Bittium annettae Dall
x -xxx-x ----x ---x---- ------ -x--- ---x-- ------- -------- ---- - -------- Bittium curtum (H. C. Lea)
x -xxx-x -x--- xx------ ------ ----- ------ ------- -x------ ---- - xx------ Bittium podagrinum Dall
x -xxx-x -x--- x------- -xx-xx ----- ------ ------- -------- ---- - x------- Bittium varium (Pfeiffer)
x --xxxx -x--- x------- -----x ----- ------ ------- -------- ---- - x------- Cerithiopsis abruptum Watson
x --xxxx -x--- -x------ ------ ----- ------ ------- -------- ---- - -x------ Cerithiopsis aralia Olsson & Harbison
x --xxxx -x--- xx------ ------ ----- ------ ------- -------- ---- - xx------ Cerithiopsis brassica Olsson & Harbison
x --xxxx -x--- xx------ ------ ----- ------ ------- -------- ---- - xx------ Cerithiopsis dauca Olsson & Harbison
x --xxxx -xx-x xxxxx--- --x-xx xx--- --xx-- ------- xx-xx--- ---- - xxx----- Cerithiopsis bicolor (C. B. Adams)
x --xxxx -x--- x------- ------ ----- ------ ------- -------- ---- - x------- Cerithiopsis floridana Dall
x --xxxx -x--- x------- --x-xx ----- ------ ------- -x-x---- ---- - x------- Cerithiopsis greeni (C. B. Adams)
x --xxxx -x--- -x------ ------ ----- ------ ------- -------- ---- - -x------ Cerithiopsis maisana Olsson & Harbison
x --xxxx -x--- x------- ------ ----- ------ ------- -------- ---- - x------- Cerithiopsis metaxae taeniolata Dall
x --xxxx -x--- x------- ------ ----- ------ ------- -------- ---- - x------- Cerithiopsis modesta Adams
x --xxxx -x--- -x------ ------ ----- ------ ------- -------- ---- - -x------ Cerithiopsis ophiura Olsson & Harbison
x --xxxx -xx-- xxxxx--- ------ ----- ------ ------- -x-xx--- ---- - x------- Cerithiopsis scariphus Dall
x --xxxx --x-x ---x---- ------ x---- --xx-- ------- ---x---- ---- - -------- Cerithiopsis smithfieldensis Olsson
x --xxxx -x--- -x------ ------ ----- ------ ------- -------- ---- - -x------ Cerithiopsis vinca Olsson & Harbison
x --xxxx ----x ---x---- ------ ----- --xx-- ------- -------- ---- - -------- Cerithiopsis sp. Campbell
x --xxxx xxxxx xxxxxxxx x-xxxx xx-xx x-xx-x xxx-x-- xx-xx--- x--- x xxx----- Seila adamsii (H. C. Lea)
x --xxxx -xx-x xxxxx--- ------ xx-x- --xx-- --x---- -x-x---- ---- - xx------ Triphora bartschi (Olsson)
x --xxxx -x--- xx------ ------ ----- ------ ------- -------- ---- - xx------ Triphora bolax Olsson & Harbison
x --xxxx -xxxx xxxxx--- ------ xx-x- --xx-- -x----- -x-xx--- ---- - -x------ Triphora submonilifera (Orbigny)
x --xxxx -x--- x------- -----x ----- ------ ------- -------- ---- - x------- Triphora modesta C. B. Adams,
x --xxxx -xx-- x------- --x-xx ----- ------ ------- xx------ ---- - x------- Triphora nigrocincta (C. B. Adams)
x --xxxx -x--- -x------ ------ ----- ------ ------- -------- ---- - -x------ Triphora oreodoxa Olsson & Harbison
x ----xx --x-- -x------ -----x ----- ------ ------- -x------ ---- - -------- Opalia burryi Clench & Turner
x ----xx -x--- xx------ ------ ----- ------ ------- -------- ---- - xx------ Opalia debouryi Dall
x ----xx ----x ---x---- ------ ----- --xx-- ------- -------- ---- - -------- Opalia textuvestitum (Maury)
x ----xx -x--- -------- x-x--x ----- ------ ------- -------- ---- - -------- Cirsotrema dalli Rehder
x ----xx -x--- -----x-- ------ ----- ------ ------- -------- ---- - -----x-- Cirsotrema woodringi Olsson
x ----xx -x--- -----x-- ------ ----- ------ ------- -------- ---- - -----x-- Scalina boylae Olsson
x xxxxxx --xxx xxxxx--- ------ xx--x --xx-- ----x-x xx------ ---- - -------- Epitonium aciculum (H. C. Lea)
x xxxxxx x---x ----x--- ------ ----- --xx-- ------- -------- x--- - -------- Epitonium alumensis Mansfield
x xxxxxx --x-- x------- ---xxx ----- ------ ------- xx------ ---- - -------- Epitonium angulatum (Say)
x xxxxxx ---x- ---?---- ------ -x--- ---x-- ----x-- -------- ---- - -------- Epitonium bolteni Gardner
x xxxxxx -xx-x xxxxxxxx ------ xx--- x-xx-x -xx---- xx-xx-x- ---- x xx------ Epitonium duplinianum (Olsson)
x xxxxxx ----x ---x---- ------ x---- ---x-- ------- -------- ---- - -------- Epitonium chuckatuckensis Campbell n. sp.
x xxxxxx ----x ---x---- ------ xx--- --xx-- ------- -x------ ---- - -------- Epitonium cornigerum (H. C. Lea)
x xxxxxx --xx- xxxx---- ------ ----- ------ -x----- ---x---- ---- - -------- Epitonium carolinae Gardner
x xxxxxx --x-- ---?---- ------ ----- ------ ------- ---?---- ---- - -------- Epitonium curtum (Emmons)
x xxxxxx ----x ---x---- ------ -x--- ---x-- ------- -------- ---- - -------- Epitonium druidi Campbell n. sp.
x xxxxxx ---x- ---?---- ------ x---- --?x-- ----x-- -------- ---- - -------- Epitonium edgecombense Gardner
x xxxxxx -x--- -x------ ------ ----- ------ ------- -------- ---- - -x------ Epitonium fargoi Olsson & Harbison
x xxxxxx --x-- ---x---- ------ ----- ------ ------- ---x---- ---- - -------- Epitonium fasciatum Gardner
x xxxxxx -x-x- xx------ --x--x ----- ------ -x----- -x------ ---- - xx------ Epitonium foliaceicostum (Orbigny)
x xxxxxx ---xx xxxxxxxx -----x ----x --xx-x -x----- -------- ---- - -------- Epitonium cf. E. fractum Dall
x xxxxxx -x--- x------- -----x ----- ------ ------- -------- ---- - x------- Epitonium frielei (Dall)
x xxxxxx -x--- -x------ ------ ----- ------ ------- -------- ---- - -x------ Epitonium helikum Olsson & Harbison
x xxxxxx -xx-- x------- ----xx ----- ------ ------- x------- ---- - x------- Epitonium humphreysii (Kiener)
x xxxxxx -xx-- -xxx---- --x--- -x--- ---x-- ------- ---x---- ---- - -x------ Epitonium junceum Gardner
x xxxxxx -x--- x------- ------ ----- ------ ------- -------- ---- x -------- Epitonium sp. aff. E. krebsii Morch
x xxxxxx ---x- -x------ ------ ----- ------ -x----- -------- ---- - -------- Epitonium leai Ward & Blackwelder
x xxxxxx --x-- ---x---- ------ ----- ------ ------- ---x---- ---- - -------- Epitonium magnolianum (Olsson)
x xxxxxx -xxxx xx-x---- ------ xx--- --xx-- ------- x--x---- x--- - x------- Epitonium micropleurum (H. C. Lea)
x xxxxxx ----x ---xx--- ------ xx--x --xx-- ------- -------- ---- - -------- Epitonium microstomum (H. C. Lea)
x xxxxxx --x-- ---x---- ------ ----- ------ ------- ---x---- ---- - -------- Epitonium muldrowi (Gardner & Aldrich)
x xxxxxx xxx-- xxxx---- ----xx ----- ------ ------- x------- x--- - x------- Epitonium multistriatum (Say)
x xxxxxx -x--x xxxxx--- --x--x ----- --xx-- ------- -------- ---- - x------- Epitonium novangeliae (Couthouy)
x xxxxxx -x--- -x------ ------ ----- ------ ------- -------- ---- - -x------ Epitonium obtusum Olsson & Harbison
x xxxxxx -x-x- ---x---- --x-xx ----- ------ -x----- --x----- ---- x xxx----x Epitonium rupicolum (Kurtz)
x xxxxxx ----x -------x ------ ----- -----x ------- -------- ---- - -------- Epitonium sheldoni (Olsson)
x xxxxxx ----x ---x---- ------ x---- ---x-- ------- -------- ---- - -------- Epitonium smithfieldensis Mansfield
x --xxxx --x-- x------- ------ ----- ------ ------- x------- ---- - -------- Epitonium pourtalesii (Verrill and Smith)
x --xxxx ----- -------- ---x-x ----- ------ ------- -------- ---- - -------- Epitonium antillarum (deBoury)
x --xxxx -xx-x xxxxx--- -----x xx--- --xx-- ------- -x------ ---- - x------- Melanella arcuata (C. B. Adams)
x --xxxx -xx-x xxxx---- ------ ----- ------ ------- -------- ---- - xx------ Melanella calkinsi Olsson & Harbison
x --xxxx ----x --x----- ------ ----- x---- ------- -------- ---- - -------- Melanella chesapeakensis Campbell n. sp.
x --xxxx xxxxx xxxxx--- ------ xx--- --xx-- x------ xx--xx-- ---- - x------- Melanella angulata (H. C. Lea)
x --xxxx -x--x -xxx---- ------ x---- ---x-- ------- -------- ---- - xx------ Melanella nisoformis (Olsson & Harbison)
x --xxxx -x--- -x------ ------ ----- ------ ------- -x------ ---- - -x------ Melanella fargoi Olsson & Harbison
x --xxxx -x--- -x------ ------ ----- ------ ------- -------- ---- - -x------ Melanella gibberula Olsson & Harbison
x --xxxx --x-- x------- -----x ----- ------ ------- x------- ---- - -------- Melanella gracilis (C. B. Adams)
x --xxxx --x-- x------- --x-xx ----- ------ ------- xx------ ---- - -------- Melanella intermedia (Cantraine)
x --xxxx --xx- -x------ ------ ----- ------ -x----- -x------ ---- - -------- Melanella juncea Gardner
x --xxxx x-xxx ---xxxxx ------ xx-x- -xxx-x -xx---- -------- x--- - -------- Melanella laevigata (H. C. Lea)
x --xxxx -x--- xx------ ------ ----- ------ ------- -------- ---- - xx------ Melanella locklini Olsson & Harbison
x --xxxx xxx-- -xxx---- ------ ----- ------ ------- ---x---- x--- - -xx----- Melanella magnoliana Gardner & Aldrich
x --xxxx -x--- xx------ ------ ----- ------ ------- -------- ---- - xx------ Melanella rectiuscula Dall
x --xxxx -x--- -x------ ------ ----- ------ ------- -------- ---- - -x------ Melanella suavis Olsson & Harbison
x --xxxx -x--- x------- -----x ----- ------ ------- -------- ---- - x------- Melanella subcarinata Orbigny
x ---xxx -x--- x------- -----x ----- ------ ------- -------- ---- - x------- Strombiformis auricinctus Abbott
x ---xxx ---x- x------- ------ ----- ------ -x----- -------- ---- - -------- S. beaufortensis (Ward and Blackwelder)
x ---xxx -xxx- xxxx---- ------ ----- ------ -x----- -x-x---- ---- - xx------ Strombiformis biconica Gardner
x ---xxx -xx-x -xxx---- ------ xx--- --xx-- ------- -x-x---- ---- - -x------ Strombiformis conchita (Olsson & Harbison)
x ---xxx -xx-- xx------ ------ ----- ------ ------- -x------ ---- - xx------ Strombiformis dalli Gardner & Aldrich
x ---xxx --x-- ---x---- ------ ----- ------ ------- ---x---- ---- - -------- Strombiformis lina Gardner
x ---xxx x-x-x ---xx--- ------ xx--- --xx-- ------- ---xx--- x--- - -------- Strombiformis migrans (Conrad)
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          111 11111112 222222 22233 333333 3344444 44444555 5555 5 55666666
1 234567 89012 34567890 123456 78901 234567 8901234 56789012 3456 7 89012345
x ---xxx --x-- ---x---- ------ ----- ------ ------- ---x---- ---- - -------- Strombiformis spatulata Gardner
x ----xx x-x-x xxxxx--- --x-xx ----- --xx-- ------- xx-xx--- x--- - -------- Niso aegeles  Bush
x ----xx -x--- xxxx---- ------ ----- ------ ------- -------- ---- - xxx----- Niso willcoxii Dall
x -----x --x-x ---x---- ------ x---- --x--- ------- ---x---- ---- - --x----- Mucronalia sp. Campbell
x ----xx ----x ---x---- ------ ----- --xx-- ------- -------- ---- - -------- Atlanta cordiformis Gabb
x -----x -x--- x------- -----x ----- ------ ------- -------- ---- - x------- Hipponix antiquata (Linnaeus)
x -----x -x--- -xxx---- ------ ----- ------ ------- -------- ---- - -xx----- Hipponix floridana Olsson & Harbison
x -----x xxx-x xxxxx--- --x--x xx--- --xx-- ------- -x-x---- xx-- - x-x----- Iselica globulus (H. C. Lea)
x ------ --xxx ---xxxxx ------ xx-x- --xx-x --xxx-- ---xx--- ---- - -------- Carinorbis lyra (Conrad)
x ------ --x-- ---x---- ------ ----- ------ ------- ---x---- ---- - -------- Carinorbis quadricostata (Emmons)
x ----xx xxxxx xxxxxxx- ----xx xx-x- --xx-- -xx-x-- xx-xxxx- xx-- - xxx----- Calyptraea centralis (Conrad)
x -----x -x--- xxxx---- -----x ----- ------ ------- -------- ---- - x-x----- Cheilea equestris (Linnaeus)
x ------ -x--- ---x---- ------ ----- ------ ------- -------- ---- - --x----- Trochita floridana Olsson & Petit
x -xxxxx -x--- xxxx---- -xx--x ----- ------ ------- -------- ---- x x-x----- Crucibulum auriculum (Gmelin)
x -xxxxx -xx-- xxxx---- -----x ----- ------ ------- xx-x---- ---- - x-x----- Crucibulum auriculum spinosum (Sowerby)
x -xxxxx --x-x ---xxxxx x----- -x--- --xx-x ----x-- ---x---- ---- - -------- Crucibulum grandis (Say)
x -xxxxx ---x- -xx----- ------ ----- ------ -xx---- ------- ---- - -------- Crucibulum lawrencei Ward & Blackwelder
x -xxxxx xxxxx ---xxxxx ------ xx--x -xxx-- --x-x-x ---x-xx- x--- - --x----- Crucibulum leanum Campbell  n. sp.
x -xxxxx ----x --x----- ------ ----- -x---- ------- -------- ---- - -------- Crucibulum leanum var. Campbell  n. sp.
x -xxxxx xxxxx xxxx---- --x--x ----- x----- --x---- xx-x---- x--- - xxx----- Crucibulum multilineatum (Conrad)
x -xxxxx xxxxx xxxxxxx- -----x xx-x- --xx-- --x---- x--xxxx- xx-- - xxx----- Crucibulum scutellatum (Wood)
x -xxxxx xxxxx xxxxxxxx xxxxxx xxxxx xxxx-- xxx-x-- xx-xxx-- xx-- x xxx----- Crepidula aculeata aculeata (Gmelin)
x -xxxxx --xxx ??-xxxxx x----- xxxxx -xxx-x x-x---- ---xxx-- ---- x -------- Crepidula aculeata ponderosa (Lea)
x -xxxxx ----? ---?---- ------ x---- ---x-- ------- -------- ---- - -------- Crepidula adunca Sowerby
x -xxxxx -xx-x xxxx---- ----xx x---- --xx-- ------- xx------ ---- x -------- Crepidula convexa (Say)
x -xxxxx xxx-x xxxxxx-- ------ xx--- --xx-- --x---- ---x-x-- --x-- - x------- Crepidula cymbaeformis Conrad
x -xxxxx xxxxx xxxxxxxx x-xxxx xxxxx xxxx-- xxx-x-x xxxxxxx- xx-- x xxx----x Crepidula fornicata (Linnaeus)
x -xxxxx -x--- xxxx---- -x--xx ----- ------ ------- -------- ---- - xxx----x Crepidula maculosa Conrad
x -xxxxx xxxxx xxxxxxxx xxxxxx xx-xx -xxx-- xxx-x-- xx-xxx-- xx-- x xxx----- Crepidula plana Say
x ---xxx -x--- x------- ------ ----- ------ ------- -------- ---- - x------- Strombus leidyi Heilprin
x ---xxx -x--- -------- --x--- ----- ------ ------- -------- ---- - -------- Strombus mayacensis Tucker & Wilson
x ---xxx -x--- x------- ----xx ----- ------ ------- -------- ---- - x------- Strombus pugilis Linnaeus
x ---xxx -x--- xxxx---- -xx-xx ----- ------ ------- -------- ---- - xxx----- Strombus pugilis alatus Gmelin
x ---xxx xx--- ---xx--- ------ ----- ------ ------- -------- xx-- - --x----- Strombus pugilis floridanus Mansfield
x ---xxx -x--- ---x---- ------ ----- ------ ------- -------- ---- - --x----- Strombus williamsi Olsson & Petit
x ---xxx -x--- ---x---- ------ ----- ------ ------- -------- ---- - --x----- Strombus sp.
x ---xxx -x--- ---x---- ------ ----- ------ ------- -------- ---- - --x----- Strombus sp.
x ----xx -x--- ---x---- ------ ----- ------ ------- -------- ---- - --x----- Strombus (Tricornis) n. sp.  Hargreve
x ----xx -x--- ---x---- ------ ----- ------ ------- -------- ---- - --x----- Strombus (Tricornis) n. sp.  Hargreve
x ----xx xxx-- xxxxxxx- --x--x ----- ------ ------- xx-x-xx- xx-- - xxx----- Xenophora conchyliophora (Born)
x ----xx ----x xxxx---- --x--x -x--- --xx-- ------- -------- ---- - -------- Lamellaria perspicua (Linnaeus)
x ----xx -xx-x xxxx---- -xx-xx xx--- ---x-- ------- xx-x---- ---- - xx------ Erato maugeriae Gray
x ----xx -xx-- xx------ --x--- ----- ------ -x----- -x-xxx-- ---- - xx------ Trivia floridana Olsson & Harbison
x ----xx -x--- x------- -----x ----- ------ ------- -------- ---- - x------- Trivia globosa Gray
x ----xx -x--- x------- ------ ----- ------ ------- -------- ---- - x------- Trivia incerta Tucker & Wilson
x ----xx -x--- xx------ ------ ----- ------ ------- -x------ ---- - xx------ Trivia islahispaniolae petrela Olsson & Harbison
x ----xx -xx-- xxxx---- -xx--x ----- ------ ------- xx-x---- ---- - --x----- Trivia pedicula (Linnaeus)
x ----xx -x--- -------- --x--- ----- ------ ------- -------- ---- - -------- Trivia pedicula permagna Johnson
x ----xx -xx-- xxxx---- -----x ----- ------ ------- xx-x---- ---- - -------- Trivia suffusa Gray
x ----xx -x--- ---x---- ------ ----- ------ ------- -------- ---- - --x----- Pusula crovoae Olsson
x ------ -x--- ---x---- ------ ----- ------ ------- -------- ---- - --x----- Jenneria lindae Petuch
x ------ -x--- ---x---- ------ ----- ------ ------- -------- ---- - --x----- Jenneria richardsi Olsson
x ------ -x--- -------- ------ ----- ------ ------- -------- ---- - -------- Jenneria loxahatachiensis (M. Smith)
x ------ -x--- ---x---- ------ ----- ------ ------- -------- ---- - --x----- Jenneria hepleri Olsson
x -----x xxxxx ---xxxx- ------ -x--- ---x-- ------- ---xx-x- x--- - --x----- Siphocypraea carolinensis (Conrad)
x -----x -x--- ---x---- ------ ----- ------ ------- -------- ---- - --x----- Siphocypraea carolinensis hughesi Olsson & Petit
x -----x -x--- ---x---- ------ ----- ------ ------- -------- ---- - --x----- Siphocypraea c. transitoria Olsson & Petit
x -----x -xx-- xx------ ------ ----- ------ ------- -x------ ---- - xx-----x Siphocypraea problematica (Heilprin)
x -----x -x--- ---x---- ------ ----- ------ ------- -------- ---- - --x----- Siphocypraea trippeana Parodiz
x ----xx -x--- ---x---- ------ ----- ------ ------- -------- ---- - --x----- Cypraea lindae Petuch
x ----xx --x-- x------- ----xx ----- ------ ------- x------- ---- - -------- Cyphoma gibbosa
x ----xx -x--- ---x---- ------ ----- ------ ------- -------- ---- - --x----- Cyphoma viaavenis Petuch
x ----xx -x--- ---x---- ------ ----- ------ ------- -------- ---- - --x----- Cyphoma carolae Petuch
x ----xx -x--- ---x---- ------ ----- ------ ------- -------- ---- - --x----- Cyphoma finkli Petuch
x ----xx -x--- ---x---- ------ ----- ------ ------- -------- ---- - --x----- Cyphoma miamiensis Petuch
x --xxxx --x-- ---x---- ------ ----- ------ ------- ---x---- ---- - -------- Neosimnia sp.
x --xxxx -x--- x------- ---xxx ----- ------ ------- -------- ---- x -------- Simnia uniplicata Sowerby
x xxxxxx -x--- ---x---- ------ ----- ------ ------- -------- ---- - --x----- Simnialena diegelae Petuch
x xxxxxx -x--- ---x---- ------ ----- ------ ------- -------- ---- - --x----- Simnialena donovanae Petuch
x xxxxxx xxx-- -xxx---- ------ ----- ------ ------- ---xx--- x--- - -xx----- Polinices caroliniana (Conrad)
x xxxxxx xx--- ---x---- ------ ----- ------ ------- -------- x--- - --x----- Polinices coensis (Dall)
x xxxxxx xxxxx xxxxxxxx xxx-xx xxx-- --xx-- xxx-x-- xx-xxx-- x--- x xxx----x Polinices duplicata (Say)
x xxxxxx -x--- x------- ------ ----- ------ ------- -------- ---- - x------- Polinices floridana Tucker & Wilson
x xxxxxx -x--- ---x---- ------ ----- ------ ------- -------- ---- - --x----- Polinices subclausa Sowerby
x xxxxxx --x-x ---xx--- ------ ----- --xx-- ------- ---x---- ---- - -------- Polinices sp. Campbell
x xxx--- ----- -------- ------ ----- ------ ------- -------- ---- - -------- Lunatia heros (Say)
x xxx--- x-x-x ---xxxxx ------ xxxxx --xx-x ------- ---xxx-- x--- - -------- Lunatia interna (Say)
x xxx--- --x-x ---xx--- ------ xxx-x --xx-- ------- ---x---- ---- - -------- Lunatia perspectivia (Rogers & Rogers)
x xxx--- x-xxx ---xxxxx ------ xx--x xxxx-- xxx-x-x xx-x-x-- -x-- - -------- Lunatia sayana Campbell n. sp.
x xxx--- ----x ---x---- ------ ----- --xx-- ------- -------- ---- - -------- Bulbus chesapeakensis Campbell n. sp.
x -----x -x--- -x------ ------ ----- ------ ------- -------- ---- - -x------- Stigmaulax polypum Olsson & Harbison
x ----xx -xx-- xxxx---- -----x ----- ------ ------- ---x---- ---- - x-x----- Sigatica carolinensis (Dall)
x ----xx -x--- ---x---- ------ ----- ------ ------- -------- ---- - --x----- Sigatica regia Guppy
x ----xx -x--- xx------ --x--x ----- ------ ------- -------- ---- - xx------ Sigatica semisulcata (Gray)
x --xxxx --x-x ---xxxxx x----- xx--- --xx-- ----x-- ---x--x- ---- - -------- Sinum chesapeakensis Campbell n. sp.
x --xxxx --x-- x------- ------ ----- ------ ------- xx------ ---- - x------- Sinum multiplicatum (Dall)
x --xxxx -xx-x xxxxxx-- --x-xx ----- --xx-- ------- xx-x-x-- ---- x -x------ Sinum perspectivum (Say)
x --xxxx -x--- xx------ ------ ----- ------ ------- -------- ---- - xx------ Sinum polandi M. Smith
x ----xx -xx-- xx-?---- ----xx ----- ------ ------- xx------ ---- - xxx----- Natica canrena (Linnaeus)
x ----xx -x--- ---x---- ------ ----- ------ ------- -------- ---- - --x----- Natica castrenoides Woodring
x ----xx -x--- ---x---- ------ ----- ------ ------- -------- ---- - --x----- Natica (Stigmaulax) guppyana Toula
x ----xx xxxxx xxxxxx-- ------ x---- ---x-- ------- xx-x-x-- xx-- - xxx----- Natica plicatella Conrad
x xxxxxx xxxxx xxxxxxxx xxx-xx xx-x- x-xx-- xxx---- xxxxx--- -x-- x xxx----- Tectonatica pusilla (Say)
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            111 11111112 222222 22233 333333 3344444 44444555 5555 5 55666666
1 234567 89012 34567890 123456 78901 234567 8901234 56789012 3456 7 89012345
x ---xxx -x--- ----x--- ------ ----- ------ ------- -------- ---- - ---x----  Cassis floridensis Tucker & Wilson
x ---xxx -x--- xxxx---- --x-xx ----- ------ ------- -------- ---- - --x-----  Phalium inflatum (Shaw)
x ---xxx -xx-- xxxx---- ----xx ----- ------ ------- -------- ---- - --x-----  Phalium granulatum (Born)
x ----xx xxxxx --xxxxx- ------ x-x-- --xx-- ------- ---xxxx- x--- - --x-----  Sconsia hodgeii (Conrad)
x ----xx -x--- x------- ------ ----- ------ ------- -------- ---- - x-------  Morum floridana Tucker & Wilson
x ----xx -x--- x------- ------ ----- ------ ------- -------- ---- - x-------  Morum macgintyi Maxwell Smith
x ----xx -x--- x------- ------ ----- ------ ------- -------- ---- - x-------  Morum obrienae Olsson & Petit
x ----xx xx--- ---x---- ------ ----- ------ ------- -------- x--- - --x-----  Cymatium floridanum Mansfield
x ----xx --x-- x------- -----x ----- ------ ------- x------- ---- - --------  Cymatium pileare (Linnaeus)
x ----xx -x--- ---x---- ------ ----- ------ ------- -------- ---- - --x-----  Cymatium valentinei Olsson & Petit
x ----xx --x-- x------- ----xx ----- ------ ------- x------- ---- - --------  Distorsio clathrata (Lamarck)
x ------ -xx-- ---xxx-- ------ ----- ------ ------- -----x-- ---- - --x- x--  Malea densecostata (Rutsch)
x ------ -x--- x------- ------ ----- ------ ------- -------- ---- - x-------  Malea springi Petuch, 1989
x ------ -x--- -------- --x--- ----- ------ ------- -------- ---- - --------  Malea petiti Petuch, 1989-Bermont
x ---xxx -xx-- xxxx---- -xx-xx ----- ------ ------- xx------ ---- - xxx-----  Ficus communis Roding
x ---xxx -x--- -x------ -----x ----- ------ ------- -------- ---- - -x------  Ficus carolae Clench
x ---xxx -xx-x ---xxx-- ------ ----- --xx-- ------- ---x-x-- ---- - --x-----  Ficus holmesii Conrad
x ---xxx x---- ---xxxx- ------ ----- ------ ------- -----x-- xx-- - -------  Ficus jacksonensis Olsson & Harbison
x ----xx -x--- xx------ --x--- ----- ------ ------- -------- ---- - --------  Haustellum anniae (M. Smith)
x ----xx -x--- -------- --x--- ----- ------ ------- -------- ---- - x-------  Haustellum bellegladeensis (E. Vokes)
x ----xx -x--- x------- ------ ----- ------ ------- -------- ---- - x-------  "Murex" micromeris Dall
x ---xxx -x--- xxxx---- --x-xx ----- ------ ------- -------- ---- - xxx-----  Haustellum rubidus (F. C. Baker)
x ---xxx ----- -------- ---xxx ----- ------ ------- -------- ---- - --------  Hexaplex fulvescens (Sowerby)
x ----xx -x--- ---x---- ------ ----- ------ ------- -------- ---- - --x-----  Hexaplex (Hexaplex) hertweckorum (Petuch)
x ----xx -x--- ---x---- ------ ----- ------ ------- -------- ---- - --x-----  Hexaplex trippae (Petuch)
x ----xx -x--- -------- --x--- ----- ------ ------- -------- ---- - --------  Chicoreus (Chicoreus) dilectus (A. Adams)
x ----xx xxx-x xxxxxx-- -x---- x---- --x--- ------- xx---x-- x--- - xxx----x  Chicoreus (Chicoreus) floridanus E. H. Vokes
x ----xx -x--- ---x---- ------ ----- ------ ------- -------- ---- - --x-----  Chicoreus (Chicoreus) shirleyae Vokes
x ----xx -x--- ---x---- ------ ----- ------ ------- -------- ---- - --x-----  Chicoreus (Chicoreus) xestos E. H. Vokes
x ----xx -xx-- xxxx---- -----x ----- ------ ------- xx------ ---- - x-x-----  Chicoreus (Phyllonotus) globosus (Emmons)
x ----xx xx--- ---x---- ------ ----- ------ ------- -------- x--- - --x-----  Chicoreus (Phyllonotus) leonensis E. H. Vokes
x ----xx -x--- xxxx---- --x-xx ----- ------ ------- -------- ---- x xx-----x  Chicoreus pomum (Gmelin)
x ----xx x---- ---x---- ------ ----- ------ ------- -------- x--- - --x-----  Chicoreus (Phyllonotus) riparius (E. H. Vokes)
x ----xx -xx-- xx------ --x--x ----- ------ ------- -x------ ---- - x-------  Murexiella glypta (M. Smith)
x ----xx -x--- -------- --x--- ----- ------ ------- -------- ---- - --------  Murexiella graceae (McGinty)
x ----xx -xx-- xxxx---- -----x ----- ------ -x----- -x------ ---- - xxx-----  Murexiella macgintyi (M. Smith)
x ----xx xxxx- xxxx??-? x----- ----- ------ x------ ---x---- x--- - --x-----  Murexiella macgintyi faceta (E. Vokes)
x ----xx --x-- -x------ ------ ----- ------ ------- -x------ ---- - --------  Murexiella petiti E. H. Vokes
x ----xx -xx-x xxxx-?-? x----- -x--- ---x-- ------- x------- ---- - x-x-----  Murexiella shilohensis (Heilprin)
x -xxx-x ----- -------- ------ x---- ---x-- ------- ---x---- ---- - --------  Murexiella burnsii (Whitfield)
x ------ xx--- xxxxxxxx x----- ----- ------ ------- -------- x--- - xxx-----  Murexiella (Subpterynotus) textilis (Gabb)
x ----xx xx--- ---xx--- ------ ----- ------ ------- -------- -x-- - --x-----  Poireria (Panamurex) clarksvillensis (Mansfield)
x ----xx --x-x ---xx--- ------ xx--x --xx-- ------- ---x---- ---- - --------  Scalaspira strumosa (Conrad)
x -xxx-x ----x ---x---- ------ x---- ---x-- ------- -------- ---- - --------  Urosalpinx barbitoides (Gardner)
x -xxx-x --x-- x------- ---xxx ----- ------ ------- xx------ ---- - -------x  Urosalpinx cinereus (Say)
x -xxx-x -xxxx xxxx---- ------ -x--- x--x-- -xx-x-- xx-x---- ---- - --x-----  Urosalpinx gardnerae Campbell n. sp.
x -xxx-x ----x -------x x----- ----- -----x ------- -------- ---- - --------  Urosalpinx rapahannockensis (Gardner)
x -xxx-x -xxxx xxxxxx-- ------ xxx-- x-xx-- -x----- xxxx-x-- ---- - xxx-----  Urosalpinx lepidota (Dall)
x -xxx-x -xxx- xxxx---- --x-xx ----- ------ xxx-x-- xx------ ---- x x-x----x  Urosalpinx perrugata (Conrad)
x -xxx-x -x--- -------- --x--x ----- ------ ------- -------- ---- - --------  Urosalpinx tampaensis (Conrad)
x -xxx-x -x--- ---x---- ------ ----- ------ ------- -------- ---- - --x-----  Urosalpinx (Trossulasalpinx) curtus Dall
x -xxx-x -xx-- xx------ ------ ----- ------ ------- xx------ ---- - xxx-----  Urosalpinx (Trossulasalpinx) subsidus Dall
x -xxx-x xxxxx xxxxxxx- ------ xx-xx xxxx-- ----x-x ---xxxx- xx-- - xxx-----  Urosalpinx trossula (Conrad)
x ------ -x--- ---x---- -----x ----- ------ ------- -------- ---- x --x-----  Vitularia salebrosa (King & Broderip)
x ------ -xxx- xx------ ------ ----- ------ -x----- xx------ ---- - xx------  Pterorytis conradi (Dall)
x ------ xxxxx ---xxxxx x----- xxx-x --xx-- ---xx-- ---xx-x- xx-- - --x-----  Pterorytis umbrifer (Conrad)
x ----xx -x--- xx------ ------ ----- ------ ------- -------- ---- - xx------  Aspella engonata (Dall)
x ----xx -x--- -------- ------ ----- ------ ------- -------- ---- - --------  Aspella elizabethae M. Smith
x ----xx -xx-- xxxx---- --x--x ----- ------ ------- -x------ ---- - xxx-----  Aspella senax Dall
x ----xx -x--- -------- --x--- ----- ------ ------- -------- ---- - --------  Aspella sp. cf. A. jani (Doderlein)
x ----xx -xx-- xx------ -----x ----- ------ ------- -x------ ---- - x-------  Favartia alta (Dall)
x ----xx xxx-- xxxx---- --x--x ----- ------ ------- xx-x---- ---- - xxx-----  Favartia cellulosa (Conrad)
x --xx-x -xxx- xxxx---- -x-xxx ----- ------ -xx---- xxx----- ---- x xx?----x  Eupleura caudata (Say)
x --xx-x xx--- xxxx---- ------ ----- ------ ------- -------- xx-- - x-x-----  Eupleura miocenica Dall
x --xx-x -x--- xxxx---- --x-xx ----- ------ ------- -------- ---- x --x-----  Eupleura sulcidentata Dall
x -----x -x--- x------- --x--x ----- ------ ------- -------- ---- - x-------  Acanthotrophon striatoides Vokes
x ---xxx x-x-- xxxxxx-- --x-xx ----- ------ ------- xx-x-x-- xx-- - --------  Calotrophon ostrearum (Conrad)
x ---xxx -x--- ---x---- ------ ----- ------ ------- -------- ---- - --x-----  Calotrophon ostrearum conradi (Mansfield)
x ---xxx -x--- ---x---- ------ ----- ------ ------- -------- ---- - --x-----  Calotrophon ostrearum emilyae Petuch
x -----x -x--- ---x---- ------ ----- ------ ------- -------- ---- - --x-----  Attiliosa viaavensis Petuch
x -----x -x--- xxxx---- --x--x ----- ------ ------- -------- ---- - x-x-----  Attiliosa striata (Gabb)
x -----x -x--- -xxx---- ------ ----- ------ ------- -------- ---- - -xx-----  Acantholabia floridana Olsson & Harbison
x xx---- ----x ----x--- ------ ---x- --xx-- ------- -------- ---- - --------  Trophonopsis petiti Campbell n. sp.
x xx---- ---xx ---xxxxx ------ xxx-x --xx-x ------- -------- ---- - --------  Boreotrophon tetricus (Conrad)
x xx---- ----x ---x---- ------ ----- --xx-- ------- -------- ---- - --------  Boreotrophon tetricus laevis (Martin)
x -----x x---- ---xx--- x----- ----- ------ ------- -------- xx-- - --------  Typhis acuticostata (Conrad)
x -----x --x-- -x------ ------ ----- ------ ------- -x------ ---- - --------  Typhis carolinensis Olsson & Petit
x -----x -x--- xxxx---- ------ ----- ------ ------- -------- ---- - xxx----x  Typhis floridanus Dall
x -----x xxx-- ---xx--- ------ ----- ------ ------- ---x---- xx-- - --x-----  Typhis harrisi Olsson
x -----x -x--- -------- --x--x ----- ------ ------- ------ ---- - --------  Pterotyphis triangularis (A. Adams)
x ---x-x -xx-- xxxx---- --x-xx ----- ------ ------- -x------ ---- - --x-----  Thais hemastoma floridana (Conrad)
x ---x-x -x--- -------- --x--- ----- ------ ------- -------- ---- - --------  Thais caloosana (Tucker & Wilson)
x ------ -xx-- ----xx-- ------ ----- ------ ------- ----xx-- ---- - ---x----  Ecphora bradleyae Petuch
x ------ xxxxx ---xxxxx ------ xxxxx -xxx-x ---xx-x ---xxxx- --x- - --xxxx--  Ecphora quadricostata (Say)
x ----xx -xx-- xx------ -----x ----- ------ ------- -x------ ---- - x-------  Coralliophila abbreviata (Lamarck)
x ----xx x-x-x ---x---- ------ x---- ---x-- ------- ---x---- x--- - --------  Coralliophila leonensis Mansfield
x ----xx -x--- x------- -----x ----- ------ ------- -------- ---- - x-------  Coralliophila mansfieldi (MacGinty)
x ----xx -x--- ---x---- ------ ----- ------ ------- -------- ---- - --x-----  Coralliophila lindae (Petuch)
x -----x -x--- x------- ------ ----- ------ ------- -------- ---- - x-------  Columbella cosmia Dall
x -----x -x--- xx------ --x-xx ----- ------ ------- -------- ---- - xx------  Columbella rusticoides Heilprin
x ------ -x--- -------- --x--- ----- ------ ------- -------- ---- - --------  Eurypyrene miccosukee Petuch
x -xxxxx ---x- xx------ ----xx ----- ------ --x---- x------- ---- - --------  Anachis avara (Say)
x -xxxxx -x--- x------- ------ ----- ------ ------- -------- ---- x x-------  Anachis avara amydra Dall
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            111 11111112 222222 22233 333333 3344444 44444555 5555 5 55666666
1 234567 89012 34567890 123456 78901 234567 8901234 56789012 3456 7 89012345
x -xxxxx -xx-- xxxx---- -xx--- ----- ------ ------- xx------ ---- - xxx----- Anachis avara caloosaensis Dall
x -xxxxx xxx-- xxxx---- ------ ----- ------ ------- xx------ x--- - xxx----- Anachis camax Dall
x -xxxxx -x--- -x------ ------ ----- ------ ------- -------- ---- - -x------ Anachis chariessa MacGinty
x -xxxxx x---- ----x--- ------ ----- ------ ------- -------- -x-- - -------- Anachis clappi Mansfield
x -xxxxx -x--- -x------ ------ ----- ------ ------- -------- ---- - -x------ Anachis clavatula Olsson & Harbison
x -xxxxx -x--- ---x---- ------ ----- ------ ------- -------- ---- - --x----- Anachis clewistonensis M. Smith
x -xxxxx -xxx- xx------ ---xxx ----- ------ x------ xx------ ---- x -------- Anachis lafresnayi (Fischer & Bernardi)
x -xxxxx -xxx- xxxx---- --xxxx ----- -x---- x------ xx-x---- ---- x -x------ Anachis obesa (C. B. Adams)
x -xxxxx --xxx xxxx---- ------ xx-x- -xxx-- -x----- xx-x---- ---- - -------- Anachis parvula (H. C. Lea)
x -xxxxx -xxxx xxxx---- ------ ----- --xx-- --x-x-- xx------ ---- - --x----- Anachis styliola Dall
x -xxxxx --x-- ---x---- ------ ----- ------ ------- ---x---- ---- - -------- Anachis sumterensis Gardner & Aldrich
x -xxxxx ---xx ---x---- ------ ----- --xx-- ---x--- -------- ---- - -------- Anachis virgilina Gardner
x -xxxxx xx--- ---x---- ------ ----- ------ ------- -------- x--- - --x----- Anachis wieserae Mansfield
x -----x --x-- ---x---- ------ ----- ------ ------- ---x---- ---- - -------- Strombina anomala (Gardner & Aldrich)
x -----x xx--- xxxx---- ------ ----- ------ ------- -------- x--- - xxx----- Strombina gunteri Mansfield
x -----x -x--- -x------ ------ ----- ------ ------- -------- ---- - -x------ Strombina margarita Olsson & Harbison
x xxxxxx --xxx ---xxxxx x----- xxxxx --xx-x --x-x-- ---x---- ---- - -------- Mitrella communis (Conrad)
x xxxxxx --xxx --xxx--- ------ xx--- --xx-- --x---- --xx---- ---- - -------- Mitrella edenensis Richards & Harbison
x xxxxxx -x--- x------- -----x ----- ------ ------- -------- ---- - x------- Mitellla fusiformis (Orbigny)
x xxxxxx -x--x xx------ ------ ----- -x---- ------- -------- ---- - xx------ Mitrella harbisonae Campbell n. sp
x xxxxxx -xx-- xx------ ------ ----- ------ -x----- xx------ ---- - xx------ Mitrella gardnerae (Olsson & Harbison)
x xxxxxx -xxx- xx------ --xxxx ----- -x---- x-x---- xxx----- ---- x xx------ Mitrella lunata (Say)
x xxxxxx -xx-- ---x---- ------ ----- ------ ------- ---x---- ---- - --x----- Mitrella matsoni (Mansfield)
x xxxxxx -x--- xx------ -----x ----- ------ ------- -------- ---- - xx------ Mitrella multilineata (Dall)
x xxxxxx --xxx xxx----- ------ ----- x----- -x----- xx------ ---- - -------- Mitrella waccamawensis Gardner
x xxxxxx -x--- ---x---- ------ ----- ------ ------- -------- ---- - --x----- Parametaria lindae Petuch
x ----xx -xx-x xxxx---- --x--x xx--- --xx-- ------- -x-x---- ---- - xx------ Nassarina glypta (Bush)
x ----xx -x--- x------- ------ ----- ------ ------- -------- ---- - x------- Aesopus coxi Locklin
x ----xx --x-- -x------ ------ ----- ------ ------- -x------ ---- - -------- Aesopus emmonsi (Conrad)
x ----xx -xxx- xxxx---- ------ ----- ------ -x----- xx-x---- ---- - xx------ Aesopus ithitoma (Dall)
x ----xx -x--- -x------ ------ ----- ------ ------- -------- ---- - -x------ Aesopus proctorae (Maxwell Smith)
x ----xx -xxxx xxxx---- -----x xx--- ---x-- -x----- -x-x---- ---- x -x------ Aesopus stearnsii (Tryon)
x ------ ----x ---x---- ------ ----- --xx-- ------- -------- ---- - -------- Juliamitrella chesapeakensis Campbell n. sp.
x ------ --xxx -xxx---- ------ xx--- --xx-- -x--x-- ---x---- ---- - -------- Juliamitrella gardnerae (Ward & Blackwelder)
x ------ ----x ---x---- ------ xx--- ---x-- ------- -------- ---- - -------- Juliamitrella smithfieldensis (Mansfield)
x ------ ----x --x----- ------ ----- x----- ------- -------- ---- - -------- Juliamitrella virginica Campbell n. sp.
x xxx--- ---xx --xx---- ------ -x--- -x-x-- --x---- -------- ---- - -------- Buccinum undatum Linnaeus
x xxx--- ----x ---x---- ------ ----- --xx-- ------- -------- ---- - -------- Buccinum sp.
x xxx--- ---xx -xxx---- ------ ----- -x??-- --x---- -------- ---- - -------- Tortifusus curvirostra (Conrad)
x ------ ----x ---xxxxx x----- xxx-x --xx-x ------- -------- ---- - -------- Ptychosalpinx altile (Conrad)
x ------ ----x ---x---- ------ ----- --xx-- ------- -------- ---- - -------- Ptychosalpinx chesapeakensis Campbell n. sp
x ------ x-xxx ---xx--- ------ xx--x --xx-- ------- ---x---- -x-- - --x----- Ptychosalpinx laqueatus (Conrad)
x ------ --x-x ---x---- ------ x---- --xx-- ------- ---x---- ---- - -------- Ptychosalpinx multirugatus (Conrad)
x ------ ----x -- x-- - ------ xx--- --xx-- ------- -------- ---- - -------- Ptychosalpinx tuomey (H. C. Lea)
x -----x -x--- -- x-- - ------ ----- ------ ------- -------- ---- - --x----- Metula robertsi Olsson
x ----xx -x--- x------- ------ ----- ------ ------- -------- ---- - x------ Phos floridensis Tucker & Wilson
x ----xx -x--- -- x-- - ------ ----- ------ ------- -------- ---- - --x----- Phos inornatus Gabb
x ----xx xxx-- -- x-- - ------ ----- ------ ------- -- x-- - x--- - --x----- Phos sloani Gardner & Aldrich
x ----xx xx--- -- x-- - ------ ----- ------ ------- -------- x--- - --x----- Phos vaughani Mansfield
x ------ -x--- ---x---- ------ ----- ------ ------- -------- ---- - --x----- Rhipophos metajonesae Petuch
x ------ xxx-- ---xxx-- ------ ----- ------ ------- ---x---- xx-- - --x--x-- Gemophos plicatilum (Bose)
x -----x -x--- -xxx---- ------ ----- ------ ------- -------- ---- - -xx----- Strombinophos maxwelli Olsson & Harbison
x -----x -xx-- xx------ ------ ----- ------ ------- -x------ ---- - xx------ Engina floridana Olsson & Harbison
x -----x -x--- -------- --x--x ----- ------ ------- -------- ---- - x------- Engina turbinella (Kiener)
x -----x -x--- xxxx---- ------ ----- ------ ------- -------- ---- - xxx----- Bailya roycei (Maxwell Smith)
x -----x -x--- x------- --x--x ----- ------ ------- -------- ---- - x------- Bailya intricata (Dall)
x ----xx -x--x xxxx---- ------ x---- ---x-- ------- -------- ---- - xxx----- Tritonoharpa floridensis Tucker & Wilson
x ----xx xxx-- xxxx---- --x--x ----- ------ ------- -x------ ---- - xxx----- Tritonoharpa lanceolata (Menke)
x -----x --x-- -x------ ------ ----- ------ ------- -x------ ---- - -------- Monostiolum petiti Olsson
x -----x -x--- -------- --x--- ----- ------ ------- -------- ---- - -------- Monostiolum thomasi Olsson
x ---xxx -xx-- xxxx---- -----x ----- ------ ------- x------- ---- - x-x----- Pisania auritula (Link)
x ---xxx x---- ---x---- ------ ----- ------ ------- -------- x--- - -------- Pisania harveyensis Mansfield
x ---xxx -xx-x ---xxxxx ------ x---- --xx-x ------- ---x-x-- ---- - --x----- Pisania (Celatoconus) nux (Dall)
x ---xxx -x--- x------- ----xx ----- ------ ------- -------- ---- - x------- Cantharus cancellarius (Conrad)
x ---xxx -x--- -x------ ------ ----- ------ ------- -------- ---- - -x------ Cantharus caloosana (Tucker & Wilson)
x ---xxx x---- ---x---- ------ ----- ------ ------- -------- x--- - --x----- Cantharus clarksvellensis (Mansfield)
x ---xxx -x--- x------- -----x ----- ------ ------- -------- ---- - x------- Cantharus floridanus (Conrad)
x ---xxx -x--- -xxx---- ------ ----- ------ ------- -------- ---- - -xx----- Cantharus lymani (Maxwell Smith)
x ---xxx -xx-- xxxx---- ------ ----- ------ ------- x------- ---- - xxx----- Cantharus multangula (Philippi)
x ---xxx -x--- xxxx---- --x--- ----- ------ ------- -------- ---- - xxx----- Cantharus perplexus Olsson & Harbison
x ---xxx -x--- -------- --xxxx ----- ------ ------- -x------ ---- - -------- Cantharus tinctus (Conrad)
x ---xxx -xx-- -x------ ------ ----- ------ ------- -x------ ---- - -x------ Cantharus tridentata (Tuomey & Holmes)
x ---xxx x---- ---x---- ------ ----- ------ ------- -------- x--- - -------- Cantharus watsonensis Mansfield
x ------ -x--- xxxx---- ------ ----- ------ ------- -------- ---- - xxx----- Solenosteira mengeana (Dall)
x ------ xx--- ---x---- ------ ----- ------ ------- -------- x--- - --x----- Solenosteira vaughani (Dall)
x ------ -x--- ---x---- ------ ----- ------ ------- -------- ---- - --x----- S. vaughani aclinensis Tucker & Wilson
x -----x -x--- -------- --x--x ----- ------ ------- -------- ---- - -------- Melongena bispinosa (Philippi)
x -----x -x--- ---x---- ------ ----- ------ ------- -------- ---- - --x----- Melongena consors (Sowerby)
x -----x -x--- xxxx---- --x--xx ----- ------ ------- -------- ---- - x-x----- Melongena corona (Gmelin)
x -----x -x--- xxxx---- --x--x ----- ------ ------- -------- ---- - xxx----x Melongena subcoronata Heilprin
x --xxxx --xx- xx------ ------ ----- ------ --x---- xx------ ---- - -------- Busycon amoenum Conrad
x --xxxx -xxx- x------- ---xxx ----- ------ x------ xx------ ---- x -------- Busycon carica (Gmelin)
x --xxxx xxxxx xxxxxx-- ------ xxxxx --xx-- --x-x-- --xxxxx- x--- x x-x--x-- Busycon maximum Conrad
x --xxxx xx--- ---x---- ------ ----- ------ ------- -------- x--- - --x----- Busycon maximum tudiculatum (Dall)
x --xxxx ---xx ---xx--- ------ xx--x --xx-- ----x-- -------- ---- - ?------- Busycon maximum filosum Conrad
x --xxxx -x--- xxxx---- ------ ----- ------ ------- -------- ---- - xxx----- Busycon rapum (Heilprin)
x --xxxx -x--- ---x---- ------ ----- ------ ------- -------- ---- - --x----- Busycon petiti (Olsson)
x --xxxx -x--- xx------ ------ ----- ------ ------- -------- ---- - xx------ Busycon echinatum (Dall)
x --xxxx -x--- -------- ------ ----- ------ ------- -------- ---- - --x----- Busycon echinatum helenae Olsson
x -xxxxx ----- -------- ------ ----- ------ ------- xx------ ---- - -------- Busycon conaliculatum (Linnaeus)
x --xxxx --xxx ---xxx-- ------ x---- --xx-- ----x-- ---xx--- ---- - -------- Busycon canaliferum Conrad
x --xxxx x-xxx ---xxx-- ------ xx-x- --xx-x ----x-- ---xxxx- x--- - -------- Busycon incile (Conrad)
x --xxxx --x-- xx------ ------ ----- ------ ------- xx------ ---- - -------- Busycon wilcoxi Gardner
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                111 11111112 222222 22233 333333 3344444 44444555 5555 5 55666666
1 234567 89012 34567890 123456 78901 234567 8901234 56789012 3456 7 89012345
x --xxxx ----- -------- ------ ----- ------ ------- -------- ---- - -------- B. chowanense Gardner (= Tortifusus)
x --xxxx --xx- xxxx---- ------ ----- ------ -x----- x--x---- ---- - -------- Busycon concinnum Conrad
x --xxxx xxxxx xxxxxxx- -xxxxx ----- -x?--- xxx-x-- xxxxxxx- xx-- x xxx----x Busycon contrarium (Conrad)
x --xxxx xxx-- xxxxxxx- ------ ----- ------ ------- xxxx-xx- x--- - x-x----- Busycon excavatum (Conrad)
x --xxxx -x--- xxxx---- -x--xx ----- ------ ------- -------- ---- x x-x----- Busycon spiratum (Lamarck)
x --xxxx -x--- xxxxx--- -x---- ----- ------ ------- -x------ ---- - xxx----x Busycon spiratum floridanum Olsson & Harbison
x --xxxx --x-- x------- --x--x ----- ------ -x----- -------- ---- - -------- Busycon spiratum pyruloides (Say)
x --xxxx --x-- ---x---- ------ ----- ------ ------- ---x---- ---- - -------- Busycon pyriformis (Conrad)
x --xxxx ----- -------- ------ ----- ------ ------- ----?--- ---- - -------- Busycon kerri Conrad
x --xxxx -xx-- xx------ ------ ----- ------ ------- xx------ ---- - --x----- Busycon bladenense Gardner
x --xxxx -x--- ---x---- ------ ----- ------ ------- -------- ---- - --x----- Busycon harasewychi (Petuch)
x --xxxx -x--- ---x---- ------ ----- ------ ------- -------- ---- - --x----- Busycon rugosicostata (Petuch)
x --xxxx -x--- ---x---- ------ ----- ------ ------- -------- ---- - --x----- Busycon seminole (Petuch)
x --xxxx -x--- ---x---- ------ ----- ------ ------- -------- ---- - --x----- Busycon osceola (Petuch)
x --xxxx -x--- ---x---- ------ ----- ------ ------- -------- ---- - --x----- Busycon sarasotaensis (Petuch)
x --xxxx -x--- ---x---- ------ ----- ------ ------- -------- ---- - --x----- Busycon demistriatum (Petuch)
x --xxxx -x--- ---x---- ------ ----- ------ ------- -------- ---- - --x----- Busycon laevis (Petuch)
x --xxxx -x--- ---x---- ------ ----- ------ ------- -------- ---- - --x----- Busycon turbinalis (Petuch)
x --xxxx -x--- xxxx---- ------ ----- ------ ------- -------- ---- - xxx----x Busycon planulatum (Dall)
x ------ ---xx ---xx--- ------ xx--x --xx-- ------- -------- ---- - -------- Lyrasoma sulcosa (Conrad)
x ------ ----x -------x ------ ----- -----x ------x -------- ---- - -------- Lirosoma sulcosa multicostata Olsson
x -xxxxx --x-- x------- ---xxx ----- ------ ------- x------- ---- - -------- Nassarius acutus (Say)
x -xxxxx -xxx- xx------ -xx-xx ----- ------ x------ xx------ ---- x xx------ Nassarius albus (Say)
x -xxxxx x---- ----x--- ------ ----- ------ ------- -------- -x-- - -------- Nassarius alumensis (Olsson)
x -xxxxx -xx-- xxxx---- -xx--- ----- ------ ------- ---x---- ---- - xxx----- Nassarius bidentatus (Emmons)
x -xxxxx xxxx- xxxx---- ------ ----- ------ --x---- xx------ x--- - xx------ Nassarius caloosaensis (Dall)
x -xxxxx xxx-x ---x-xx- ------ x---- ---x-- ------- ---x-xx- x--- - --x----- Nassarius consenoides (Olsson)
x -xxxxx -x--- ---x---- ------ ----- ------ ------- -------- ---- - --x----- Nassarius corbis (Olsson)
x -xxxxx xxx-- ---x---- ------ ----- ------ -x----- ---x---- x--- - --x----- Nassarius cornellianus (Olsson)
x -xxxxx -x--- xxxx---- ------ ----- ------ ------- -------- ---- - xxx----- Nassarius fargoi Olsson & Harbison
x -xxxxx x---- ---x---- ------ ----- ------ ------- -------- x--- - -------- Nassarius floridanus (Mansfield)
x -xxxxx -xx-- xx------ ------ ----- ------ ------- -x------ ---- - x------- Nassarius lapinotieri (Dall)
x -xxxxx -x--- -x------ ------ ----- ------ ------- -------- ---- - -x------ Nassarius locklini Olsson & Harbison
x -xxxxx --x-- ---x---- ------ ----- ------ ------- ---x---- ---- - -------- Nassarius moniliformis (Emmons)
x -xxxxx --x-- ---x---- ------ ----- ------ ------- ---x---- ---- - -------- Nassarius moniliformis smithianus (Olsson)
x -xxxxx --?-- ---?---- ------ ----- ------ ------- ---?---- ---- - -------- Nassarius multilineatus (Emmons)
x -xxxxx --x-- ---x---- ------ ----- ------ ------- ---x---- ---- - -------- Nassarius neogenensis (Gardner & Aldrich)
x -xxxxx x---- ---x---- ------ ----- ------ ------- -------- x--- - -------- Nassarius quadridentatus (Mansfield)
x -xxxxx --xxx --xxxxx- ------ xx-x- -xxx-- -xx---- --xxxxx- ---- - -------- Nassarius quadrulatus (H. C. Lea)
x -xxxxx -x--- -x------ ------ ----- ------ ------- -------- ---- - -x------ Nassarius rastus Olsson & Harbison
x -xxxxx ----- -------- ------ ----- ------ ------- -------- ---- - -------- Nassarius scalaris (Conrad)
x -xxxxx ----x -------x ------ ----- -----x ------- -------- ---- - -------- Nassarius shacklefordensis Olsson
x -xxxxx -xxx- xxxx---- -xxxxx ----- ------ x------ xx-x---- ---- x xxx----x Nassarius vibex (Say)
x -xxxxx --x-- xx------ ------ ----- ------ ------- xx------ ---- - -------- Nassarius zetus (Gardner)
x -xxx-- -x--- ---x---- ------ ----- ------ ------- -------- ---- - --x----- Ilyanassa floridana Maxwell Smith
x -xxx-- --x-x ---x---- ------ x---- ---x-- ------- ---x---- ---- - -------- Ilyanassa granifera (Conrad)
x -xxx-- --xxx -xxx---- ------ x---- -x-x-- ----x-- ---x---- ---- - -------- Ilyanassa harpuloides harpuloides (Conrad)
x -xxx-- --x-x xxxx---- ------ x---- --x--- ----x-- x--x---- ---- - -------- Ilyanassa harpuloides johnsoni (Dall)
x -xxx-- -xxxx xxxx---- ------ xx--- -xx--- -x----- xx-x---- ---- x --x----- Ilyanassa harpuloides scalaspira (Conrad)
x -xxx-- -xxxx xx------ ------ ----- -x---- x-x---- xx------ ---- x -------- Ilyanassa irrorata (Conrad)
x -xxx-- -xxx- xxx----- ------ ----- ------ --x---- xx------ ---- x -------- Ilyanassa isogramma (Dall)
x -xxx-- -x--- ---x---- ------ ----- ------ ------- -------- ---- - --x----- Ilyanassa marthae (Olsson)
x -xxx-- --x-- xx------ ---xxx ----- ------ ------- xx------ ---- - -------- Ilyanassa obsoleta (Say)
x -xxx-- x-x-x xxxx---- ------ -x--- -xxx-- ------- xx-x---- -x-- - -------- Ilyanassa porcina (Say)
x -xxx-- -xx-- x------- ------ ----- ------ x------ x------- ---- x x------- Ilyanassa porcina deleonensis Tucker
x -xxx-- --x-- xxxx---- ------ ----- ------ -x----- xx-x---- ---- - -------- Ilyanassa porcina schizopyga (Dall)
x -xxx-- -xxxx xxxx---- ------ ----- -x-x-- ----x-- xx-x---- ---- x -------- Ilyanassa sexdentata (Conrad)
x -xxx-- xxx-- ---x---- ------ ----- ------ ------- ---x---- x--- - --x----- Trajana pyta Gardner
x -xxx-- -x--- ---x---- ------ ----- ------ ------- -------- ---- - --x----- Trajana veracruzata E. Vokes
x -----x -x--- xx------ ----xx ----- ------ ------- -------- ---- - -x------ Latirus stephensae Lyons
x -----x -x--- xx------ ------ ----- ------ ------- -------- ---- - xx------ Latirus hypsipettus Dall
x -----x -x--- -------- ------ ----- ------ ------- -------- ---- - -------- Latirus jucundus McGinty
x -----x -x--- -------- ------ ----- ------ ------- -------- ---- - -------- Latirus cariniferus (Lamarck)
x -----x -x--- x------- ------ ----- ------ ------- -------- ---- - x------- Latirus maxwelli Pilsbry
x -----x -x--- ---?---- ------ ----- ------ ------- -------- ---- - --x----- Latirus miamiensis Petuch
x -----x -x--- x------- ------ ----- ------ ------- -------- ---- - x------- Latirus caloosahatchiensis Lyons
x -----x -x--- ---x---- ------ ----- ------ ------- -------- ---- - --x----- Latirus nosali Lyons
x ---xxx -xxx- xx-?---- -xx--- ----- ------ -x----- xx------ ---- x xxx----x Fasciolaria apicina Dall
x ---xxx -x--- xxxx---- ----xx ----- ------ ------- -------- ---- - xxx----- Fasciolaria lilium G. Fischer
x ---xxx -x--- x------- ------ ----- ------ ------- -------- ---- - x------- Fasciolaria monocingulata Dall
x ---xxx -x--- xxxx---- --x--- ----- ------ ------- -------- ---- - x-x----- Fasciolaria okeechobensis Tucker & Wilson
x ---xxx xxx-x ---xxxx- ------ xx--- --xx-- ------- ---x-xx- x--- - --x----- Fasciolaria rhomboidea Rogers & Rogers
x ---xxx -x--- xx------ -x--xx ----- ------ ------- -------- ---- - xx-----x Fasciolaria tulipa Linnaeus
x ------ -xx-x ---xxxx- ------ x-x-- ---x-- ------- ---xxx-- ---- - --x----- Terebraspira acuta (Emmons)
x ------ --x-- ----xx-- ------ ----- ------ ------- ----xx-- ---- - -------- Terebraspira elegans (Emmons)
x ------ -x--- xx-x---- ------ ----- ------ ------- -------- ---- - xxx----x Terebraspira scalarina (Heilprin)
x ------ -xx-- ---xxxx- ------ ----- ------ ------- -x--x--- -x-- - --x----- Terebraspira sparrowi (Emmons)
x ------ --xx- -x------ ------ ----- ------ -x----- -x------ ---- - -------- Triplofusus cronlyensis (Gardner)
x ---xxx xxx-x xxxxxx-- --x-xx ----- --xx-- ------- xx-x-xx- xx-- x xxx----x Triplofusus gigantica (Kiener)
x ------ -x--- xxxx---- ------ ----- ------ ------- -------- ---- - xxx----- Liochlamys bulbosa (Heilprin)
x ----xx xxxx- xxxx---- ------ ----- ------ -x----- xx------ xx-- x xxx----- Fusinus (Heilprinia) caloosaensis (Heilprin)
x ----xx x-x-- ---xxx-- ------ ----- ------ ------- ---xxxx- x--- - -------- Fusinus (Heilprinia) equalis (Emmons)
x ----xx x-x-x ---xxx-- ------ -x--x ---x-- ----x-- -----x-- -x-- - -------- Fusinus (Heilprinia) exilis (Conrad)
x ----xx ----x ---x---- ------ xx--- --xx-- ----x-- -------- ---- - -------- Fusinus (Heilprinia) exilis burnsii Dall
x ----xx ----x -------x ------ ----- -----x ------- -------- ---- - -------- Fusinus propeparilis Mansfield
x ----xx -x--- ---x---- --x--x ----- ------ ------- -------- ---- - --x----- Fusinus (Heilprinia) timessus (Dall)
x ------ xxxxx ---xxx-- ------ xx-xx --xx-- ------- ---x---- xx-- - --x----- Hesperisternia filicata (Conrad)
x ------ -x--- ---x---- ------ ----- ------ ------- -------- ---- - --x----- Hesperisternia insula (Olsson)
x --xxxx xxxxx ---xxxx- ------ -x--- --xx-- ------- ---xxxx- xx-- - --x----- Oliva canaliculata H. C. Lea
x --xxxx -xxx- xxxx---- -----x ----- ------ -x----- xx-x---- ---- - --x----- Oliva carolinensis (Conrad)
x --xxxx -x--- -------- --x--- ----- ------ ------- -------- ---- - -------- Oliva edwardsi Olsson
x --xxxx -x--- -------- --x--- ----- ------ ------- -------- ---- - -------- Oliva murielae Olsson
x --xxxx -x--- xx------ ----xx ----- ------ ------- -------- ---- - -x------ Oliva reticularis Lamarck
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1 234567 89012 34567890 123456 78901 234567 8901234 56789012 3456 7 89012345
x --xxxx --x-- ---x---- ------ ----- ------ ------- -------- ---- - --------  Oliva robesonensis Gardner
x --xxxx -xx-- xxxx---- -xxxxx ----- ------ ------- xx------ ---- x x-x-----  Oliva sayana Ravenel
x --xxxx -xx-x ---x---- ------ xx--- --xx-- ------- ---x---- ---- - --x-----  Olivella ancillariaeformis (H. C. Lea)
x --xxxx -xx-x xxxxxx-- ------ xx--- --xx-- ------- xx-x-x-- ---- x x-x-----  Olivella carolinae Gardner
x --xxxx -x--- ---x---- ------ ----- ------ ------- -------- ---- - --x-----  Olivella clewistonensis Olsson & Harbison
x --xxxx x---- ---xx--- ------ ----- ------ ------- -------- xx-- - --------  Olivella (Callianax) coensis Mansfield
x --xxxx -x--- -x------ ------ ----- ------ ------- -------- ---- - -x------  Olivella dodona Olsson & Harbison
x --xxxx -x--- ---x---- ------ ----- ------ ------- -------- ---- - --x-----  Olivella druidwilsoni Olsson & Petit
x --xxxx -x--- -xxx---- ------ ----- ------ ------- -------- ---- - -xx-----  Olivella fargoi Olsson & Harbison
x --xxxx x---- ---x---- ------ ----- ------ ------- -------- x--- - --------  Olivella (Niteoliva) floridana Mansfield
x --xxxx -x--- ---x---- ------ ----- ------ ------- -------- ---- - --x-----  Olivella locklini Olsson
x --xxxx x---- ---x---- ------ ----- ------ ------- -------- x--- - --------  Olivella (Dactylidia) mansfieldi Olsson
x --xxxx xxxxx xxxxxxxx xxxxxx xx--- --xx-- -xx---- xxxxx--- xx-- x xxx-----  Olivella mutica (Say)
x --xxxx -xx-- -x------ ------ ----- ------ ------- -x------ ---- - -x------  Olivella prefloralia Olsson & Harbison
x --xxxx -x--- -x------ ------ ----- ------ ------- -------- ---- - -x------  Olivella pugilis Olsson & Harbison
x --xxxx -x--- ---x---- ------ ----- ------ ------- -------- ---- - --x-----  Olivella tamiamiensis Mansfield
x --xxxx -x--- x------- ------ ----- ------ ------- -------- ---- - x-------  Olivella watermani McGinty
x --xxxx -x--- ---x---- ------ ----- ------ ------- -------- ---- - --x-----  Olivella wilsoni Olsson
x -----x -xx-- ---x---- --x--- ----- ------ ------- -------- x--- - --x-----  Jaspidella jacksonensis (Mansfield)
x -----x -x--- ---x---- ------ ----- ------ ------- -------- ---- - --x-----  Jaspidella jaspidea gladeensis (Mansfield)
x -----x -xx-- ---xxx-- ------ ----- ------ ------- ---xxx-- ---- - --xx----  Pleioptygma carolinensis (Conrad)
x -----x -x--- xxxx---- ------ ----- ------ ------- -------- ---- - xxx----x  Pleioptygma lineolata (Heilprin)
x -----x -x--- ---x---- ------ ----- ------ ------- -------- ---- - --x-----  Pleioptygma lindae Petuch
x -----x -x--- -xxx---- ------ ----- ------ ------- -------- ---- - -xx-----  Mitra compsa Maxwell Smith
x -----x xx--- ---x---- ------ ----- ------ ------- -------- x--- - --x-----  Mitra stephensoni Mansfield
x -----x -x--- ---?---- ------ ----- ------ ------- -------- ---- - --x-----  Mitra (Scabricola) lindae Petuch
x -----x -x--- x------- ------ ----- ------ ------- -------- ---- - x-------  Mitra (S.) caloosahatcheensis Petuch
x -----x -x--- ---x---- ------ ----- ------ ------- -------- ---- - --x-----  Conomitra sheldonae Tucker & Wilson
x ----xx -x--- x------- ------ ----- ------ ------- -------- ---- - x-------  Vexillum (Costellaria) cryptidulum Woodring
x ----xx -x--- -?------ x----- ----- ------ ------- -------- ---- - -x------  Vexillum (Uromitra) ctenotum Gardner
x ----xx xxxxx xxxxxx-- ------ xx--- --xx-- --x-x-- ---xxx-- x--- - xxx-----  Vexillum elaboratum (H. C. Lea)
x ----xx -x--- -x------ ------ ----- ------ ------- -------- ---- - -x------  Vexillum gunteri Olsson & Harbison
x ----xx --x-x -xxx---- ------ x---- x-x--- ------- -x-x---- x--- - --------  Vexillum reticulatum (Emmons)
x ----xx -x--- x------- ------ ----- ------ ------- -------- ---- - x-------  Vexillum (Uromitra) sp. cf. V. syntomum Woodring
x ----xx -xxx- xx------ ----xx ----- ------ -x----- x------- ---- - xx------  Vexillum wandoensis (Holmes)
x ----xx -x--- xx------ ------ ----- ------ ------- -------- ---- - xx------  Vexillum willcoxi (Dall)
x -----x -x--- -------- --x--- ----- ------ ------- -------- ---- - --------  Vasum floridanum McGinty
x -----x -x--- -------- ------ ----- ------ ------- -------- ---- - --x-----  *Nodicostellaria jonesae* Petuch
x -----x -x--- xxx?---- ------ ----- ------ ------- -------- ---- - xx?----x  Vasum (Hystrivasum) horridum Heilprin
x -----x -x--- ---x---- ------ ----- ------ ------- -------- ---- - ?-x-----  Vasum (Hystrivasum) locklini Olsson & Harbison
x -----x -x--- ---x---- ------ ----- ------ ------- -------- ---- - --x-----  Vasum (Hystrivasum) olssoni Vokes
x -----x -x--- ---x---- ------ ----- ------ ------- -------- ---- - --x-----  Vasum (Hystrivasum) squamosum Hollister
x -----x -x--- ---x---- ------ ----- ------ ------- -------- ---- - --x-----  Vasum (Hystrivasum) schrinerae Hollister
x -----x -x--- ---x---- ------ ----- ------ ------- -------- ---- - --x-----  Vasum (Hystrivasum) olssoni kissimmense Hollister
x -----x -x--- ---x---- ------ ----- ------ ------- -------- ---- - --x-----  Vasum (Hystrivasum) palmerae Hollister
x -----x -x--- ---x---- ------ ----- ------ ------- -------- ---- - --x-----  Vasum (Hystrivasum) vokesae Hollister
x -----x -x--- -------- --x--x ----- ------ ------- -------- ---- - --------  Turbinella angulata (Lightfoot)
x -----x -x--- -------- --x--- ----- ------ ------- -------- ---- - --------  Turbinella hoerlei Vokes
x -----x -x--- xxxx---- ------ ----- ------ ------- -------- ---- - xxx-----  Turbinella regina Heilprin
x -----x -x--- xxxx---- --x--x ----- ------ ------- -------- ---- - x-x-----  *Turbinella scolymoides* Dall
x ---xxx --x-- xx------ ------ ----- ------ ------- xx------ ---- - --------  Scaphella floridana brenmortoni Olsson & Petit
x ---xxx -x--- xx------ ------ ----- ------ ------- -------- ---- - xx?-----  Scaphella floridana (Heilprin)
x ---xxx --x-- -x------ ------ ----- ------ ------- -x------ ---- - --------  Scaphella precursor Gardner
x ---xxx ----x ---xxxxx ------ ----- --xx-x ------- -------- ---- - --------  Scaphella solitaria ricei Campbell n. ssp.
x ---xxx -xx-- ---xxx-- ------ ----- ------ ------- ---xx--- x--- - --xx----  Scaphella trenholmii (Tuomey & Holmes)
x ---xxx --x-- ----x--- ------ ----- ------ ------- ----xx-- ---- - --------  Scaphella n. sp.
x ----xx xxxxx ---xxxxx x----- xx-x- -xxx-- --x---- ---x-x-- -x-- - --x-----  Aurinia mutabilis (Conrad)
x ----xx -xxxx xxxxx--- ------ xx-x- xxxx-- -x--x-- xx-x---- ---- - --x-----  Aurinia obtusa (Emmons)
x ----xx ---xx ---xxxxx ------ -x--- --xx-x ------- ---x---- ---- - --------  Aurinia sinuosa (Gabb)
x ----xx -x--- x------- ------ ----- ------ ------- -------- ---- - x-------  Cancellaria amoena Olsson & Harbison
x ----xx -x--- xxxx---- ------ ----- ------ ------- -------- ---- - x-x-----  Cancellaria baretti Guppy
x ----xx -xx-- xxxx---- -x---- ----- ------ ------- xx------ ---- x xxx----x  Cancellaria *conradiana* Dall
x ----xx -xx-x ---xx--- ------ -x--- --xx-- ------- ---x---- ---- - --x-----  Cancellaria depressa Tuomey & Holmes
x ----xx -x--- ---x---- ------ ----- ------ ------- -------- ---- - --x-----  Cancellaria galvestonensis Harris
x ----xx x---- ---x---- ------ ----- ------ ------- -------- x--- - --------  Cancellaria macneili Mansfield
x ----xx -x--- -------- ------ ----- ------ ------- -------- ---- - --------  Cancellaria moorei pachia M. Smith
x ----xx ----x ---x---- ------ x---- --x--- ------- -------- ---- - --------  Cancellaria plagiostoma Conrad
x ----xx xxx-x ---xxx-- ------ x---- ---x-- ------- ---x---- xx-- - --x-----  Cancellaria rapella Johnson
x ----xx -?--- ---?---- --xxxx ----- ------ ------- -------- ---- - --x-----  Cancellaria reticulata (Linnaeus)
x ----xx -xx-x ----xxxx ------ ----- --xx-- ------- ---x-x-- ---- - --x-----  Cancellaria rotunda Dall
x ----xx -xx-- xx------ ------ ----- ------ ------- xx------ ---- - xx?-----  Cancellaria venusta Tuomey & Holmes
x ----xx x---- ---x---- ------ ----- ------ ------- -------- x--- - --------  Panarona agria (Mansfield)
x ----xx x---- ---x---- ------ ----- ------ ------- -------- x--- - --------  Panarona coensis (Mansfield)
x ----xx -x--- -------- --x--x ----- ------ ------- -------- ---- - --------  Axelella smithii (Dall)
x ----xx ----x ---x---- ------ ----- --xx-- ------- -------- ---- - --------  Axelella williamsi (Petit)
x ----xx -x--- ---x---- ------ ----- ------ ------- -------- ---- - --x-----  Agatrix epomis (Woodring)
x ----xx -x--- ---x---- ------ ----- ------ ------- -------- ---- - --x-----  Trigonostoma senarium Petit & Hoerle
x ----xx ----- -------- ------ ----- ------ ---x--- -------- ---- - --------  Trigonostoma n. sp.
x ----xx --x-- -x------ ------ ----- ------ ------- -x------ ---- - --------  Trigonostoma betsiae Olsson & Petit
x ----xx -x--- x------- ------ ----- ------ ------- -------- ---- - x-------  Trigonostoma caloosahatchiensis (Tucker & Wilson)
x ----xx -x--- xx------ --x--x ----- ------ ------- -x------ ---- x xx-----x  Trigonostoma tenera (Philippi)
x ----xx -xx-x ---xxx-- ------ x---- ---x-- ------- ---x-x-- xx-- - --x-----  Trigonostoma tenera carolinensis Emmons
x ----xx -xx-- ---x---- ------ ----- ------ ------- ---x---- ---- - --x-----  Trigonostoma druidi Olsson & Petit
x ----xx --x-- -x------ ------ ----- ------ ------- -x------ ---- - --------  Trigonostoma elizabethae Olsson & Petit
x ----xx -x--- ---x---- ------ ----- ------ ------- -------- ---- - --x-----  Trigonostoma helenae Olsson & Petit
x ------ -xx-x ---x---- ------ x---- ---x-- ------- ---x---- ---- - --x-----  Trigonostoma (Extractrix) hoerlei Olsson
x ----xx -x--- x------- ------ ----- ------ ------- -------- ---- - x-------  Trigonostoma marthae Olsson
x ----xx -xx-x ---xxx-- ------ x-xx- --xx-- ------- ----xx-- xx-- - --x-----  Trigonostoma perspectivia (Conrad)
x ----xx -x--- xx------ ------ ----- ------ ------- -------- ---- - xx------  Trigonostoma sericea (Dall)
x ----xx -x--x ---x---- ------ ----- ---x-- ------- -------- ---- - --x-----  Trigonostoma smithfieldensis Oleksyshyn
x ------ -x--- xxxx---- ------ ----- ------ ------- -------- ---- - xxx-----  Perplicaria perplexa Dall
x -----x xxxxx ---xxx-- ------ ----- ---x-- ---x--- ---x-x-- x--- - --x-----  Bullata antiqua (Redfield)
x -----x xx-x- ---xx--- ------ ----- ------ ---x--- -------- xx-- - --x-----  Bullata taylori (Olsson)
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x -----x -x--- ---x---- ------ ----- ------ ------ -------- ---- - --x-----   Microspira donovani Olsson
x -----x -xx-- ---x---- ------ ----- ------ ------- ---xx--- ---- - --x-----   Microspira oliviformis (Tuomey & Holmes)
x -----x ----x ----x--- ------ ---x- --xx-- ------- -------- ---- - --x-----   Microspira oviformis (Conrad)
x --xxxx -x--- ---x---- ------ ----- ------ ------- -------- ---- - --x-----   Dentimargo aclinensis (Tucker & Wilson)
x --xxxx xxxxx xxxxxxxx x-x-xx xx--- xxxx-- xx----- xx-x---- xx-- - xxx-----   Dentimargo aureocincta (Stearns)
x --xxxx -x--- x------- --x--- ----- ------ ------- -------- ---- - x-------   Dentimargo caloosana (Olsson & Harbison)
x --xxxx ----x --x----- ------ ----- xx---- ------- -------- ---- - --------   Dentimargo chesapeakensis Campbell, n. sp.
x --xxxx xxx-x xxxxxxxx x-x--x xx--- -xxx-x --x---- x---x--- xx-- - x-x-----   Dentimargo eburneola (Conrad)
x --xxxx -x--- -------- --x--- ----- ------ ------- -------- ---- - --------   Dentimargo haematita (Kiener)
x --xxxx -x--- ---x---- --x--- ----- ------ ------- -------- ---- - --x-----   Dentimargo mansfieldi (Tucker & Wilson)
x --xxxx -x--- xxxx---- ------ ----- ------ ------- -------- ---- - xxx-----   Dentimargo polyspira (Olsson & Harbison)
x --xxxx x-x-- ---x---- ------ ----- ------ ------- ---x---- x--- - --------   Dentimargo schmidti (Olsson)
x --xxxx -x--- xx------ --x--x ----- ------ ------- -------- ---- - -x------   Prunum amabilis (Redfield)
x --xxxx -xx-- xxxx---- -xx-xx ----- ------ ------- -x------ ---- x --x-----   Prunum apicinum (Menke)
x --xxxx xxxxx xxxxxx-- ------ xx--x -xxx-x x-x-x-- xx-x-x-- x--- x x-x-----   Prunum bellum (Conrad)
x --xxxx -xx-- xxxx---- -x---- ----- ------ ------- xx------ ---- - xxx-----   Prunum eulimum (Dall)
x --xxxx -x--- ---x---- ------ ----- ------ ------- -------- ---- - --x-----   Prunum formosum M. Smith
x --xxxx x---- ---x---- ------ ----- ------ ------- -------- x--- - --------   Prunum hosfordensis (Mansfield)
x --xxxx xxxxx xxxxxx-- ------ xx-x- --xx-- xxx-x-- xxxxxx-- -x-- x x-x-----   Prunum limatulum (Conrad)
x --xxxx -x----xx------ ------ ----- ------ ------- -------- ---- - xx------   Prunum oncholidea Dall
x --xxxx -x--- xxxx---- ------ ----- ------ ------- -------- ---- - xxx-----   Prunum pardalis (Dall)
x --xxxx -x--- xx------ ------ ----- ------ ------- -------- ---- - xx------   Prunum pinellasensis (Olsson & Harbison)
x --xxxx xxx-- xxxxxx-- ------ ----- ------ ------- xx-x-x-- xx-- - xxx-----   Prunum precursor (Dall)
x --xxxx --xx- xx------ ------ ----- ------ x------ xx------ ---- - --------   Prunum contractum (Conrad)
x --xxxx ----x xxx----- ----xx ----- x----- ------- -------- ---- - --------   Prunum roscidum (Redfield)
x --xxxx --x-- xxxx---- ------ ----- ------ ------- xx-x---- ---- - --------   Prunum subinflexum (Redfield)
x --xxxx x-xxx ---xxx-- ------ xx-x- --xx-- ---x--- ---xxx-- -x-- - --------   Prunum virginianum Conrad
x --xxxx -x--- xxxx---- ------ ----- ------ ------- -------- ---- - x-x-----   Prunum willcoxianum (Dall)
x ----xx -xx-- xxxx---- ------ ----- ------ ------- ---x---- ---- - xxx-----   Granula floridana (Dall)
x ----xx xxxxx xxxx---- --x-xx xx--- ---x-- ------- -x-x---- xx-- - x-x-----   Granula lavalleeana (Orbigny)
x --xxxx ----x --x----- ------ ----- -x---- ------- -------- ---- - --------   Granula sp.
x -----x xxxxx xxxxxx-- ------ xx--- ---x-- ------- ---xxx-- xx-- - xxx-----   Persicula ovula Conrad
x -----x -x--- x------- --x--x ----- ------ ------- -------- ---- - x-------   Hyalina pallida (Linnaeus)
x ----xx -xxx- -------- --x--x ----- ------ -x----- -x------ ---- - x-------   Volvarina avena (Kiener)
x ----xx -xx-- xxxx---- -----x ----- ------ ------- -x-x---- ---- - x-------   Volvarina avenacea (Deshayes)
x ----xx -x--- -xxx---- --x--- ----- ------ ------- -------- ---- - -xx-----   Volvarina belloides (Olsson & Harbison)
x ----xx -x--- xxxx---- ------ ----- ------ ------- -------- ---- - x-x-----   Volvarina clenchi (M. Smith)
x ----xx -x--- x?------ -----x ----- ------ ------- -------- ---- - x?------   Volvarina styria (Dall)
x ----xx -x--- -------- --x--- ----- ------ ------- -------- ---- - --------   Volvarina succinea Conrad
x ----xx xxxxx ---xx--- ------ xx--- --xx-- ------- ---x---- xx-- - --x-----   Volvarina tersa (Mansfield)
x --xxxx -xx-- xx------ ------ ----- ------ ------- -x------ ---- - x-------   Granulina amaintula (Dall)
x --xxxx -xx-- xx------ ------ ----- ------ ------- xx------ ---- - --?-----   Granulina dacria (Dall)
x --xxxx -x--- ---?---- ------ ----- ------ ------- -------- ---- - --?-----   Granulina gabbi (Dall)
x --xxxx x-xxx -xxx---- ------ ----- x----- -x----- ---x---- xx-- - --------   Granulina mansfieldi Campbell n. sp.
x --xxxx -xxxx xxxxx--- -xx-xx xx-x- -xxx-x --x---- xx-x-- - ---- - xxx-----   Granulina hadria (Dall)
x --xxxx -xx-- -xxx---- ------ ----- ------ ------- -x---- - ---- - --x-----   Granulina n. sp.
x ----xx xxxxx xxxxxxx- ------ ---x- --xx-- -x----- xx-xxxx- xx-- - xxxxxx--   Conus adversarius Conrad
x ----xx -x--- ---x---- ------ ----- ------ ------- -------- ---- - --x-----   Conus apium Woodring
x ----xx -x--- ---x---- ------ ----- ------ ------- -------- ---- - --x-----   Conus cherokus Olsson & Petit
x ----xx ----- -------- --x--x ----- ------ ------- -------- ---- - xxx-----   Conus daucus Hwass
x ----xx -x--- x------- --x--x ----- ------ ------- -------- ---- - x-------   Conus delessertii Recluz
x ----xx -x--- ---x---- ------ ----- ------ ------- -------- ---- - --x-----   Conus druidi Olsson
x ----xx xx--- xxxx---- --x-xx ----- ------ ------- -------- x--- - x-x-----   Conus floridanus Gabb
x ----xx x---- ---x---- ------ ----- ------ ------- -------- x--- - --------   Conus harveyensis Mansfield
x ----xx -x--- ---x---- ------ ----- ------ ------- -------- ---- - --x-----   Conus hertwecki Petuch
x ----xx -x--- -------- --x-xx ----- ------ ------- -------- ---- - --------   Conus jaspideus Gmelin
x ----xx -xxxx ---xxxxx ------ xx-x- --xx-x ------- ---xxxx- ---- - ---x----   Conus marylandicus Green
x ----xx -x--- ----?--- ------ ----- ------ ------- -------- ---- - ---?----   Conus (Virgoconus) miamiensis Petuch
x ----xx -xx-- -xxxxx- ------ ----- ------ ------- -x-x-xx- ---- - --x-----   Conus presozoni Olsson & Petit
x ----xx -x--- xxxx---- ----xx ----- ------ ------- -------- ---- - x-x-----   Conus proteus Hwass
x ----xx -x--- x------- ------ ----- ------ ------- -------- ---- - x-------   Conus robertsi Olson & Harbison
x ----xx -x--- xxxx---- ------ ----- ------ ------- -------- ---- - xxx-----   Conus spuroides Olsson & Harbison
x ----xx -x--- xx------ -x--xx ----- ------ ------- -------- ---- - xx------   Conus stearnsii Conrad
x ----xx x---- ---x---- ------ ----- ------ ------- -------- x--- - --------   Conus testudinarius leonensis Mansfield
x ----xx -x--- ---x---- ------ ----- ------ ------- -------- ---- - --x-----   Conus violetae Petuch
x ----xx -xx-- xxxx---- ------ ----- ------ ------- xx------ ---- - -xx-----   Conus waccamawensis B. Smith
x ----xx -x--- ---x---- ------ ----- ------ ------- -------- ---- - --x-----   Conus yaquensis Gabb
x ----xx -x--- ---x---- ------ ----- ------ ------- -------- ---- - --x-----   Conus bassi Petuch
x ----xx -x--- ---x---- ------ ----- ------ ------- -------- ---- - --x-----   Conus protocardinalis Petuch
x ----xx -x--- ---x---- ------ ----- ------ ------- -------- ---- - --x-----   Conus paranobilis Petuch
x ----xx -x--- -------- --x--- ----- ------ ------- -------- ---- - --------   Conus spengleri Petuch
x ----xx -x--- ---x---- ------ ----- ------ ------- -------- ---- - --x-----   Conus trippae Petuch
x --xxxx -x--- ---x---- ------ ----- ------ ------- -------- ---- - --x-----   Terebra aclinica Olsson
x --xxxx xx--- ---x---- ------ ----- ------ ------- -------- x--- - --x-----   Terebra binodosa (Mansfield)
x --xxxx x---x ---xx--- ------ ----- ---x-- ------- -------- x--- - --------   Terebra blakei Mansfield
x --xxxx -x--- ---x---- ------ ----- ------ ------- -------- ---- - --x-----   Terebra brightonensis (Olsson)
x --xxxx -xxx- ---x---- ------ ----- ------ ----x-- ---x---- ---- - --x-----   Terebra carolinensis (Conrad)
x --xxxx xxxxx xxxxx--- -xxxxx xx--- --xx-- ------- xx-x---- -x-- x xxx-----   Terebra concava (Say)
x --xxxx -xx-- xxxx---- -xxxxx ----- ------ ------- xx------ ---- x xxx-----   Terebra dislocata (Say)
x --xxxx -xxxx ---xx--- ------ ----- --xx-- --x---- ---x---- ---- - --x-----   Terebra emmonsi Dall
x --xxxx ----x ----x--- ------ ----- --xx-- ------- -------- ---- - --------   Terebra emmonsi grayi Gardner
x --xxxx ----x ----x--- ------ ----- --xx-- ------- -------- ---- - --------   Terebra emmonsi hamptonensis Campbell n. ssp.
x --xxxx -x--- ---x---- ------ ----- ------ ------- -------- ---- - --x-----   Terebra hunterae Olsson
x --xxxx xxxxx ---xx--- ------ xx--- --xx-- ------- ---xx--- xx-- - --x-----   Terebra indenta Conrad
x --xxxx ----x ----x--- ------ ----- --xx-- ------- -------- ---- - --------   Terebra sp. near T. indenta Conrad
x --xxxx -x--- ---x---- ------ ----- ------ ------- -------- ---- - --x-----   Terebra miamica Olsson
x --xxxx --x-- -x------ ------ ----- ------ ------- -x------ ---- - --------   Terebra petiti (Olsson)
x --xxxx ---x- -x------ ------ ----- ------ -x----- -------- ---- - --------   "Strioterebrum sp. cf. S. petiti Olsson"
x --xxxx xxx-- xxxx---- --x-xx ----- ------ ------- xx------ x--- x xx------   Terebra protexta Conrad
x --xxxx -x--- ---x---- ------ ----- ------ ------- -------- ---- - --x-----   Terebra seminolum (Olsson)
x --xxxx -xx-- ---xxxx- ------ ----- ------ ------- ---x--x- ---- - --x-----   Terebra unilineata (Conrad)
x --xxxx -x--- -x------ ------ ----- ------ ------- -------- ---- - -x------   Terebra vertebralis Olsson & Harbison
x -----x ----- -------- -----x ----- ------ ------- -------- ---- - xx------   Polystira sp. cf. P. albida (Perry)
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            111 11111112 222222 22233 333333 3344444 44444555 5555 5 55666666
1 234567 89012 34567890 123456 78901 234567 8901234 56789012 3456 7 89012345
x ----xx -xx-- ---x---- -----x ----- ------ ------- ---x---- ---- - --x-----  Cochlespira cedonulli (Reeve)
x ----xx ----x -------x ------ ----- -----x ------- -------- ---- - --------  Cochlespira n. sp.
x ---xxx -x--- xxxx---- -xx-xx ----- ------ ------- -------- ---- - xxx-----  Pyrgospira ostrearum (Stearns)
x ---xxx -xx-x ---xx--- ------ xx--- --xx-- ------- ---x---- ---- - --x-----  Pyrgospira tricatenaria (Conrad)
x -----x -x--- xx------ -x---- ----- ------ ------- -------- ---- - xx------  Mitrolumna cincta (Dall)
x -----x -x--- ---x---- ------ ----- ------ ------- -------- ---- - --x-----  Mitrolumna gunteri (Mansfield)
x -----x --x-- ---x---- ------ ----- ------ ------- ---x---- ---- - --------  Mitrolumna mitrodita (Gardner & Aldrich)
x -----x -x--- xx------ ------ ----- ------ ------- -------- ---- - xx------  *Mitrolumna pygmaea* (Dall)
x -----x ----x ---xx--- ------ xx--- --xx-- ------- -------- ---- - --------  Mitrolumna smithfieldensis (Olsson)
x -----x ----x --x----- ------ ----- x----- ------- -------- ---- - --------  Mitrolumna yadkinensis Campbell n. sp.
x ----xx -x--- x------- -----x ----- ------ ------- -------- ---- - x-------  Drillia albomaculata Dall of DuBar
x ----xx ----x ---x---- ------ x---- ---x-- ------- -------- ---- - --------  Drillia (Drillia) chuckatuckensis Campbell n. sp.
x ----xx -xx-- xxxx---- -----x ----- ------ ------- ---x---- ---- - x-------  Drillia ebur Reeve of DuBar
x ----xx --x-- ---?---- ------ ----- ------ ------- ---?---- ---- - --------  Drillia flexuosa (Emmons)
x ----xx --x-- ---x---- ------ ----- ------ ------- ---x---- ---- - --------  Drillia macgrawensis Olsson
x ----xx --x-- ---x---- ------ ----- ------ ------- ---x---- ---- - --------  Drillia magnoliana Olsson
x ----xx --x-- ---x---- ------ ----- ------ ------- ---x---- ---- - --------  Drillia precursor Gardner & Aldrich
x ----xx -xx-- xxxx---- -----x ----- ------ ------- x------- ---- - xxx-----  Drillia solida C. B. Adams
x ----xx --xx- xxxx---- ------ ----- ------ x------ ---x---- ---- - --------  Drillia sumterensis Gardner & Aldrich
x ----xx -xx-- xx------ ------ ----- ------ ------- -x------ ---- - xx------  Drillia (Clathrodrillia) acurugata (Dall)
x ----xx x---- ---xx--- ------ ----- ------ ------- -------- xx-- - --------  Drillia (Clathrodrillia) anteaphanitoma Mansfield
x ----xx -xx-- xxxx---- ------ ----- ------ ------- xx-x---- ---- x --------  Drillia (Clathrodrillia) emmonsii Olsson
x ----xx x---- ---x---- ------ ----- ------ ------- -------- x--- - --------  Drillia (Clathrodrillia) gracilina Mansfield
x ----xx --x-x ---xx--- ------ x---- --xx-- ------- ---x---- ---- - --------  Drillia (Clathrodrillia) impressa Conrad
x ----xx ----x ---xx--- ------ x---- --xx-- ------- ------- ---- - --------  Imaclava haleii Campbell
x ----xx -x--- x------- -----x ----- ------ ------- -------- ---- - x-------  Cerodrillia perryae Bartsch & Rehder
x ----xx -xx-- xxxx---- ------ ----- ------ ------- ---x---- ---- - x-------  Cerodrillia perpolita (Dall)
x ----xx -x--- -------- --x--x ----- ------ ------- ------- ---- - --------  Cerodrillia simpsoni (Dall)
x ----xx -xxxx -xxx---- ------ xx--- ---x-- -x----- xx-x---- ---- - -x------  Cerodrillia simpsoni cingulata Gardner
x ----xx -x--- xx------ ------ ----- ------ ------- -------- ---- - xx------  Cerodrillia simpsoni recticostata Fargo
x ----xx -x--- xx------ --x-xx ----- ------ ------- -------- ---- - xx------  Cerodrillia thea (Dall)
x -----x xxx-- xx------ ------ ----- ------ ------- -----x-- x--- - --x-----  Crassispira antealesidota Mansfield
x -----x --x-- ---xxx-- ------ ----- ------ ------- ---x---- ---- - --------  Crassispira ecphorae (Olsson)
x -----x --x-- ---x---- ------ ----- ------ ------- ---x---- ---- - --------  Crassispira gastrophila (Olsson)
x -----x -x--- xxx----- ------ ----- ------ ------- -------- ---- - xxx-----  Crassispira perspirata Dall
x -----x -x--- xx------ ------ ----- ------ x------ -x------ ---- - x-------  Crassispira perrugata Dall
x -----x ---xx ---xx--- ------ x---- --xx-- ----x-- -------- ---- - --------  Crassispira pyrenoides (Conrad)
x -----x -xxxx xxxx---- ------ xx--- ---x-- ---x--- xx-x-x-- ---- - --x-----  Crassispira (Crassispirella) virginiana (Conrad)
x -----x -x--- -x------ ------ ----- ------ ------- -------- ---- - -x------  Monilispira archeri Fargo
x -----x -x--- xx------ ------ ----- ------ ------- -------- ---- - xx------  Monilispira bigemma (Dall)
x -----x -x--- xx------ --x--x ----- ------ ------- -------- ---- - xx------  Monilispira leucocyma (Dall)
x -----x -xx-- xx------ --x--- ----- ------ ------- xx------ ---- - xx------  Sedilia acucincta (Dall)
x -----x -x--- xx------ ------ ----- ------ ------- -------- ---- - xx------  Sedilia aphanitoma (Dall)
x -----x -x--- -x------ ------ ----- ------ ------- ---x---- ---- - --x-----  Sedilia aphanitoma oxia (Dall)
x -----x ----x ---x---- ------ x---- ---x-- ------- -------- ---- - --------  Sedilia bella (Conrad)
x -----x ----x ---x---- ------ x---- ---x-- ------- -------- ---- - --------  Sedilia belloides (Olsson)
x -----x -x--- xx------ ------ ----- ------ ------- -------- ---- - xx------  Sedilia hoplophorus (Dall)
x -----x -xx-- xxxx---- ------ ----- ------ ------- ---x---- ---- - xx------  Sedilia myrmecoon (Dall)
x -----x -x--- -x------ ------ ----- ------ ------- -------- ---- - -x------  Sedilia ochoidia Fargo
x -----x -x--- -x------ ------ ----- ------ ------- -------- ---- - -x------  Sedilia ondulum Fargo
x -----x -x--- xx------ ------ ----- ------ ------- -------- ---- - xx------  Sedilia piscator (Dall)
x -----x xx--- xx------ ------ ----- ------ ------- -------- x--- - xx------  Sedilia podagrina (Dall)
x -----x ----x ----x--- ------ ----x --xx-- ------- -------- ---- - --------  Sedilia rushmerensis (Mansfield)
x -----x -x--- -x------ ------ ----- ------ ------- -------- ---- - -x------  Sedilia sapa Fargo
x -----x -x--- xx------ ------ ----- ------ ------- -------- ---- - xx------  Sedilia schismatica (Dall)
x -----x -x--- xx------ ------ ----- ------ x------ -------- ---- - xx------  Sedilia sedilia (Dall)
x -----x ---x- -x------ ------ ----- ------ -x----- -------- ---- - --------  *Sedilia sp. cf. S. sedilia* (Dall)
x -----x -x--- xx------ ------ ----- ------ ------- -------- ---- - xx------  Sedilia sigela (Dall)
x -----x --x-- xx------ -----x ----- ------ ------- -x------ ---- - --------  Clathrodrillia ebenia (Dall)
x -----x -x--- xx------ ------ ----- ------ ------- -------- ---- - xx------  Sedilia transa Fargo
x -----x -x--- xx------ ------ ----- ------ ------- -------- ---- - xx------  Carinodrillia pylonia Fargo
x -----x ----x -------- ------ x---- ---x-- ------- -------- ---- - --------  Carinodrillia smithfieldensis (Olsson)
x -----x -x--- xx------ ------ ----- ------ ------- -x------ ---- - xx------  Syntomodrillia scissurata (Dall)
x -----x --x-- ---x---- ------ ----- ------ ------- ---x---- ---- - --------  Syntomodrillia ziczac (Gardner)
x -----x -x--- xx------ -----x ----- ------ ------- -------- ---- - -x------  Fenimorea fucata paria (Reeve)
x -----x -x--- xx------ --x--x ----- ------ ------- -------- ---- - xx------  Fenimorea moseri (Dall)
x -----x -x--- xxxx---- ------ ----- ------ ------- -x-x---- ---- - xx------  Fenimorea pagodula (Dall)
x -----x ----x -------x ------ ----- -----x ------- -------- ---- - --------  Splendrillia arata (Conrad)
x -----x -x--- xx------ -----x ----- ------ ------- -------- ---- - -x------  Splendrillia fucata (Reeve)
x -----x -xx-- ---x---- ------ ----- ------ ------- ---x---- ---- - --x-----  Cymatosyrinx aclinica Tucker & Wilson
x -----x -x--- xx------ ------ ----- ------ ------- -------- ---- - xx------  Cymatosyrinx aepynota acila Dall
x -----x x---- ---xx--- ------ ----- ------ ------- -------- xx-- - --------  Cymatosyrinx aepytuberculata Mansfield
x -----x xxxxx xxxxxx-- ------ xx--- -xxx-- -xx-x-- xxxx-x-- xx-- x xxx-----  Cymatosyrinx lunata (H. C. Lea)
x -----x -x--- xx------ ------ ----- ------ ------- -------- ---- - xx------  Cymatosyrinx perpolita (Dall)
x -----x xx--- xxxx---- ------ ----- ------ ------- -------- x--- - -xx-----  Cymatosyrinx porrecta Mansfield
x -----x x---- ---x---- ------ ----- ------ ------- -------- x--- - --------  Cymatosyrinx propeaepynota Mansfield
x -----x ----x ----x--- ------ ----- --xx-- ------- -------- ---- - --------  Cymatosyrinx riceii Campbell
x -----x --x-- ---x---- ------ ----- ------ ------- ---x---- ---- - --------  Cymatosyrinx tiara Gardner
x ----xx -xx-x ---xx--- ------ xx--- --xx-- ------- -x-x---- ---- - --x-----  Bellaspira virginiana (Conrad)
x -----x -x--- -x------ ------ ----- ------ ------- -------- ---- - -x------  Compsodrillia calesi Fargo
x -----x ---x- --x----- ------ ----- ------ --x---- -------- ---- - --------  Compsodrillia chowanensis Gardner
x -----x --x-- ---x---- ------ ----- ------ ------- -x-x---- ---- - --------  Compsodrillia drewi (Gardner)
x -----x -x--- -x------ ------ ----- ------ ------- -------- ---- - -x------  Compsodrillia drewi pinellas Fargo
x -----x x--x- ----x--- ------ ----- ---?-- ----x-- -------- -x-- - --------  Compsodrillia eburnea (Conrad)
x -----x -x--- -x------ ------ ----- ------ ------- -------- ---- - -x------  Compsodrillia lipana Fargo
x ----xx -xx-- xx------ ----xx ----- ------ ------- xx------ ---- - xx------  Stellatoma stellata (Stearns)
x --xx-x ----x ---x---- ------ x---- ---x-- ------- -------- ---- - --------  Mangelia andrewi Campbell n. sp.
x --xx-x -x--- -------- --x--- ----- ------ ------- -------- ---- - --------  Mangelia bartletti (Dall)
x --xx-x -xx-- x------- ----xx ----- ------ ------- x------- ---- - x-------  Mangelia cerina  Kurtz & Stimpson
x --xx-x x---- x------- -----x ----- ------ ------- -------- ---- - x-------  Mangelia quadrata Reeve
x ----xx ----x ---x---- ------ x---- ---x-- ------- -------- ---- - --------  Cryoturris maesii Campbell n. sp.
x ----xx ---xx xx------ ----xx ----- ------ ------- x------- ---- - xx------  Cryoturris cerinella (Dall)
x ----xx x-xxx ---xx--- ------ xx--- --xx-- ----x-- ---x---- x--- - --------  Cryoturris magnoliana (Olsson)
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                111 11111112 222222 22233 333333 3344444 44444555 5555 5 55666666
1 234567 89012 34567890 123456 78901 234567 8901234 56789012 3456 7 89012345
x ----xx --x-- xx------ ------ ----- ------ --x---- xx------ ---- - -------- Cryoturris magnoliana chariessa Gardner
x ----xx -x--- xx------ ------ ----- ------ ------- -------- ---- - xx------ Cryoturris serta Fargo
x ----xx -x--- -xxx---- ------ ----- ------ ------- -------- ---- - -xx----- Cryoturris padolina (Fargo)
x --xxxx -x--- -x------ ------ ----- ------ ------- -------- ---- - -x------ Kurtziella atrostyla (Tryon)
x --xxxx xx--- -x------ ------ ----- ------ ------- -------- x--- - -x------ Kurtziella gardnerae Mansfield
x --xxxx -xx-- xxxx---- --x-xx ----- ------ ------- xx------ ---- - xxx----- Kurtziella limonitella (Dall)
x --xxxx ----x ---xx--- ------ xx--- --xx-- ------- -------- ---- - -------- Kurtziella smithfieldensis (Olsson)
x --xxxx -x--- xx------ ----xx ----- ------ ------- -------- ---- - xx------ Kurtziella rubella (Kurtz & Stimpson)
x -----x -x--- xxxx---- ------ ----- ------ ------- -------- ---- - xxx----- Ithycythara kellumi Fargo
x -----x -x--- -------- --x--- ----- ------ ------- -------- ---- - -------- Ithycythara lanceolata (C. B. Adams)
x -----x -x--- -x------ --x--- ----- ------ ------- -------- ---- - -x------ Ithycythara maera rata Fargo
x -----x -x--- xx------ -----x ----- ------ ------- -x------ ---- - xx------ Ithycythara psila (Bush)
x -----x xxxxx xxxx---- --xx-- x---- --xx-- ------- xx-x---- x--- - xxx----- Pyrgocythara (Vitricythara) metria (Dall)
x -----x -xxxx xxxx---- ------ x---- --xx-- -x----- -x-x---- ---- - xxx----- Pyrgocythara (Vitricythara) micromeris (Dall)
x -----x -x--- xxxx---- --x--- ----- ------ ------- -x------ ---- - xxx----- Pyrgocythara coxi Fargo
x -----x -x--- x------- -----x ----- ------ ------- -------- x--- - x------- Pyrgocythara balteata (Reeve)
x -----x -x--- -x------ ------ ----- ------ ------- -------- ---- - -x------ Pyrgocythara emeryi Fargo
x -----x -x--- x------- ----xx ----- ------ ------- -------- ---- - x------- Pyrgocythara plicosa (C. B. Adams)
x -----x -x--- -x------ ------ ----- ------ ------- -------- ---- - -x------ Thelecythara floridana Fargo
x -----x -x--- -------- --x--x ----- ------ ------- -------- ---- - -------- Brachycythara biconica (C. B. Adams)
x -----x -x--- -x------ -----x ----- ------ ------- -------- ---- - -x------ Brachycythara brevis (C. B. Adams)
x -----x -x--- -x------ ------ ----- ------ ------- -------- ---- - -x------ Brachycythara galae Fargo
x -----x -x--- -x------ ----x- ----- ------ ------- -x------ ---- - -x------ Brachycythara galae dimonia Fargo
x -----x -x--- -x------ ------ ----- ------ ------- -------- ---- - -x------ Brachycythara gibba (Guppy )
x -----x -x--- -x------ ------ ----- ------ ------- -------- ---- - -x------ Brachycythara gordonae Fargo
x -----x ---x- -------- ------ ----- ------ -x----- -------- ---- - -------- Brachycythara reidenbachi Ward & Blackwelder
x -----x -x--- xxxx---- ------ ----- ------ ------- -------- ---- - xxx----- Brachycythara terminula (Dall)
x -----x xx--- ---x---- ------ ----- ------ ------- -------- x--- - --x----- Brachycythara turrita (Mansfield)
x -----x -x--- -x------ ------ ----- ------ ------- -x------ ---- - -x------ Glabrocythara locklini Fargo
x -----x ---x- -------- ------ ----- ------ -x----- -------- ---- - -------- Glabrocythara sp. Ward & Blackwelder
x -----x -xxx- xx------ -----x ----- ------ x---x-- xx------ ---- - xx------ Glyphoturris ertima (Bush)
x -----x -x--- -x------ --x--x ----- ------ ------- -------- ---- - -x------ Glyphoturris rugirima (Dall)
x ----xx -x--- xxxx---- --x--x ----- ------ ------- xx------ ---- - xxx----- Daphnella cingulata Dall
x ----xx -x--- xxxx---- ------ ----- ------ ------- -------- ---- - xxx----- Daphnella modesta Dall
x ----xx -x--- -x------ ------ ----- ------ ------- -------- ---- - -x------ Glyphostoma celosia Fargo
x ----xx xx--- xxxx---- -----x ----- ------ ------- -------- x--- - x------- Glyphostoma gratula (Dall)
x ----xx --x-- ---x---- ------ ----- ------ ------- ---x---- ---- - -------- Glyphostoma johnsoni Dall
x ----xx -x--- -xxx---- ------ ----- ------ ------- -------- ---- - -xx----- Glyphostoma marionae Fargo
x ----xx -x--- xxxx---- ------ ----- ------ ------- -------- ---- - xxx----- Glyphostoma polysculpta Fargo
x ----xx -x--- xx------ ------ ----- ------ ------- -------- ---- - xx------ Glyphostoma sapita Fargo
x ----xx -xx-- -x------ --x--- ----- ------ ------- -x------ ---- - -x------ Glyphostoma scoptes Dall
x ----xx -x--- -x------ ------ ----- ------ ------- -------- ---- - -x------ Glyphostoma typhonoides Fargo
x ----xx --x-x ---x---- ------ xx--- ---x-- ------- ---x---- ---- - -------- Glyphostoma zoster Gardner
x ----xx -x--- -x------ ------ ----- ------ ------- -------- ---- - -x------ Lioglyphostoma sp.
x ----xx -x--- -x------ ------ ----- ------ ------- -------- ---- - -x------ Lioglyphostoma woodringi Fargo
x ----xx -x--- -x------ ------ ----- ------ ------- -------- ---- - -x------ Glyphostomops pinellasensis Fargo
x ----xx -x--- -x------ ------ ----- ------ ------- -------- ---- - -x------ Nannodiella amicta Woodring
x ---- xx -x--- x------- --x--x ----- ------ ------- -------- ---- - x------- Nannodiella melanitica (Dall)
x ----xx -x--- xx------ --x--- ----- ------ ------- -------- ---- - -x------ Nannodiella pauca Fargo
x xx---- ----x ---?---- ------ ----- ---?-- ------- -------- ---- - -------- Oenopota pumilus (I. Lea)
x --xxxx -x--- xxxx---- -----x ----- ------ ------- -------- ---- - --x----- Longchaeus candida Morch
x --xxxx -x--- -x------ ------ ----- ------ ------- -------- ---- - -x------ Longchaeus galesi Bartsch
x --xxxx -xxxx xxxxxxx- -x--xx xx-x- --xx-- ----x-- xx-xxxx- ---- - -x------ Longchaeus suturalis (H. C. Lea)
x ---xxx -x--- -x------ ------ ----- ------ ------- -------- ---- - -x------ Eulimella fargoi (Bartsch)
x ---xxx ----- -------- ------ ----- ------ ------- -------- ---- - -------- Eulimella marylandica Martin
x ---xxx -x--- -x------ ------ ----- ------ ------- -------- ---- - -x------ Eulimella pinellasi Bartsch
x ---xxx -x--- -x------ ------ ----- ------ ------- -------- ---- - -x------ Eulimella tampaensis Bartsch
x xxxxxx -x--- x------- ----x- ----- ------ ------- -------- ---- - x------- Odostomia acutidens Dall
x xxxxxx ----x -------x ------ ----- -----x ------- -------- ---- - -------- Odostomia (Odostomia) alpha Campbell n. sp.
x xxxxxx ----x ----x--- ------ ----- --xx-- ------- -------- ---- - -------- Odostomia (Odostomia) beta Campbell n. sp.
x xxxxxx ----x ----x--- ------ ----- --xx-- ------- -------- ---- - -------- Odostomia (Odostomia) gamma Campbell n. sp.
x xxxxxx ----x ----x--- ------ ----- --xx-- ------- -------- ---- - -------- Odostomia (Odostomia) epsilon Campbell n. sp.
x xxxxxx ----x ----x--- ------ ----- --xx-- ------- -------- ---- - -------- Odostomia (Odostomia) mu Campbell n. sp.
x xxxxxx -x--- xx------ -----x ----- ------ ------- -x------ ---- - xx------ Odostomia (Odostomia) laevigata (Orbigny)
x xxxxxx ---x- -x------ ------ ----- ------ -x----- -------- ---- - -------- O.(Chrysallida) auroraensis (Ward & Blackwelder)
x xxxxxx ---x- -x------ ------ ----- ------ -x----- -------- ---- - -------- O.(C.) beaufortensis (Ward & Blackwelder)
x xxxxxx -x--- -x------ ------ ----- ------ ------- -------- ---- - -x------ Odostomia (Chrysallida) aldrichi (Bartsch)
x xxxxxx -x--x -x------ ------ ----- x----- ------- -------- ---- - -x------ Odostomia (Chrysallida) archeri (Bartsch)
x xxxxxx --xxx ---xx--- ------ xx-x- --xx-- ------- ---xx--- ---- - -------- Odostomia (Chrysallida) granulata (H. C. Lea)
x xxxxxx ----x ---x---- ------ x---- ---x-- ------- -------- ---- - -------- Odostomia (Chrysallida) eta Campbell n. sp.
x xxxxxx ----x ----x--- ------ ----- --xx-- ------- -------- ---- - -------- Odostomia (Chrysallida) theta Campbell n. sp.
x xxxxxx ----x ---x---- ------ -x--- ---x-- ------- -------- ---- - -------- Odostomia (Chrysallida) zeta Campbell n. sp.
x xxxxxx ----x ---x---- ------ x---- ---x-- ------- -------- ---- - -------- Odostomia (Chrysallida) omicron Campbell n. sp.
x xxxxxx -xxx- xxx----- -xxxxx ----- ------ x-x-x-- xx------ ---- - -x------ Odostomia (Chrysallida) seminuda (C. B. Adams)
x xxxxxx -x--- -x------ ------ ----- ------ ------- -------- ---- - -x------ Odostomia tuomeyi (Bartsch)
x xxxxxx -x--- -x------ ------ ----- ------ ------- -------- ---- - -x------ Odostomia (Chrysallida) leai (Bartsch)
x xxxxxx -x--- -x------ ------ ----- ------ ------- -------- ---- - -x------ Odostomia (Chrysallida) woodringi (Bartsch)
x xxxxxx ----x ----x--- ------ -x--- --xx-- ------- -------- ---- - -------- Odostomia (Menestho) iota Campbell n. sp.
x xxxxxx -xxx- xx------ ----xx ----- ------ x------ -x------ ---- - x------- Odostomia (Menestho) impressa (Say)
x xxxxxx --x-x ---xx--- ------ xx-x- --xx-- ------- -x-xx--- ---- - -------- Odostomia (Menestho) milium (H. C. Lea)
x xxxxxx --x-x ---xx--- ------ xx-x- --xx-- -x----- -x-xx--- ---- - -------- Odostomia (Evalea) diaphana (H. C. Lea)
x xxxxxx ---xx ---xx--- ------ x---- --xx-- ------- -------- ---- - -------- Odostomia (Evalea) ovula (H. C. Lea)
x xxxxxx ----x ----x--- ------ ----- --xx-- ------- -------- ---- - -------- Odostomia (Evalea) lambda Campbell n. sp.
x xxxxxx ----x ----x--- ------ ----- --xx-- ------- -------- ---- - -------- Odostomia (Evalea) nu Campbell n. sp.
x xxxxxx ----x ----x--- ------ ----- --xx-- ------- -------- ---- - -------- Odostomia (Evalea) xi Campbell n. sp.
x xxxxxx ----x ---x---- ------ x---- --xx-- ------- -------- ---- - -------- Odostomia (Evalina) sculpturata (H. C. Lea)
x xxxxxx ----x ---x---- ------ x---- ---x-- ------- -------- ---- - -------- Odostomia (Eulimastoma) rho Campbell n. sp.
x xxxxxx ---xx xxxx---- ------ x---- ---x-- -x----- -------- ---- - -------- Odostomia (Eulimastoma) simplex (H. C. Lea)
x xxxxxx -xx-- xx------ ---xxx ----- ------ ------- xx------ ---- - x------- Odostomia (Sayella) fusca (C. B. Adams)
x xxxxxx ----x ----x--- ------ ----- --xx-- ------- -------- ---- - -------- Odostomia (Chesapeakella) sigma Campbell n. sp.
x xxxxxx --x-- xxxx---- ------ ----- ------ ------- x--x---- ---- - -------- Odostomia attenuata (Dall)
x xxxxxx -x--- -x------ ------ ----- ------ ------- -------- ---- - -x------ Odostomia balchi (Bartsch)
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             111 11111112 222222 22233 333333 3344444 44444555 5555 5 55666666
1 234567 89012 34567890 123456 78901 234567 8901234 56789012 3456 7 89012345
x xxxxxx -x--- -x------ ------ ----- ------ ------- -------- ---- - -x------ Odostomia calesi (Bartsch)
x xxxxxx -x--- x------- ----xx ----- ------ ------- -------- ---- - x------- Odostomia conoidea (Brocchi)
x xxxxxx -x--- -x------ ------ ----- ------ ------- -------- ---- - -x------ Odostomia fargoi (Bartsch)
x xxxxxx -x--- -x------ ------ ----- ------ ------- -------- ---- - -x------ Odostomia gordonae (Bartsch)
x xxxxxx -x--- -x------ ------ ----- ------ ------- -------- ---- - -x------ Odostomia harbisonae (Bartsch)
x xxxxxx -x--- -x------ ------ ----- ------ ------- -------- ---- - -x------ Odostomia johnsoni Bartsch
x xxxxxx ----x ---?---- ------ ----- ---?-- ------- -------- ---- - -------- Odostomia limnia Conrad
x xxxxxx ----x ----?--- ------ ----- ---?-- ------- -------- ---- - -------- Odostomia protexta Conrad
x xxxxxx -x--- -x------ ------ ----- ------ ------- -------- ---- - -x------ Odostomia wagneri (Bartsch)
x xxxxxx -x--- -x------ ------ ----- ------ ------- -------- ---- - -x------ Odostomia willcoxi Bartsch
x -----x -xx-x xxxx---- -x---- x---- ---x-- ------- ---x---- ---- - x------- Tryptychus biseriatus (Gabb)
x -----x -x--- -------- --x--- ----- ------ ------- -------- ---- - -------- Tryptychus niveus Morch
x -----x -x--- -x------ -----x ----- ------ ------- -------- ---- - -x------ Tryptychus pliocena Bartsch
x ---xxx -x--- -x------ ------ ----- ------ ------- x------- ---- - -x------ Peristichia martschi Bartsch
x ---xxx -x--- ---x---- ------ ----- ------ ------- -------- ---- - --x----- Peristichia sp. aff. P. toreta Dall
x xxxxxx ----x ---x---- ------ x---- ---x-- ------- -------- ---- - -------- Turbonilla (Chemnitzia) alpha Campbell n. sp.
x xxxxxx ----x ----x--- ------ ----- --xx-- ------- -------- ---- - -------- Turbonilla (Chemnitzia) beta Campbell n. sp.
x xxxxxx ----x ----x--- ------ ----- --xx-- ------- -------- ---- - -------- T. (Strioturbonilla) delta Campbell n. sp.
x xxxxxx ----x ----x--- ------ ----- --xx-- ------- -------- ---- - -------- Turbonilla (Pyrgiscus) kappa Campbell n. sp.
x xxxxxx ----x ----x--- ------ x---- ---x-- ------- -------- ---- - -------- Turbonilla (Pyrgiscus) digamma Campbell n. sp.
x xxxxxx ----x -x------ ------ ----- x---- ------- -------- ---- - -------- Turbonilla (Pyrgiscus) zeta Campbell n. sp.
x xxxxxx ----x ----x--- ------ ----- --xx-- ------- -------- ---- - -------- Turbonilla (Pyrgiscus) eta Campbell n. sp.
x xxxxxx ----x ----x--- ------ ----- --xx-- ------- -------- ---- - -------- Turbonilla (Bartschella) iota Campbell n. sp.
x xxxxxx ---x- xx------ -----x ----- ------ -x---- -------- ---- - -------- Turbonilla abrupta Bush Ward & Blackwelder
x xxxxxx -x--- -x------ ------ ----- ------ ------- -------- ---- - -x------ Turbonilla acisi Bartsch
x xxxxxx -x--- -x------ ------ ----- ------ ------- -------- ---- - -x------ Turbonilla admeta Bartsch
x xxxxxx -x--- -x------ ------ ----- ------ ------- -------- ---- - -x------ Turbonilla adonisi Bartsch
x xxxxxx ----x ---xx--- ------ xx--- --xx-- ------- -------- ---- - -------- Turbonilla daedalea (H. C. Lea)
x xxxxxx ----x ---x---- ------ x---- ---x-- ------- -------- ---- - -------- Turbonilla eburnea (H. C. Lea)
x xxxxxx ----x ---xx--- ------ xx--- --xx-- ------- -------- ---- - -------- Turbonilla exarata (H. C. Lea)
x xxxxxx --x-- x------- ------ ----- ------ ------- x------- ---- - -------- Turbonilla fragilis (Dall)
x xxxxxx -x--- -x------ ------ ----- ------ ------- -------- ---- - -x------ Turbonilla gardnerae (Bartsch)
x xxxxxx -x--- xx------ -----x ----- ------ ------- -------- ---- - -x------ Turbonilla hybridus (Bartsch)
x xxxxxx -xxx- xx------ ---xxx ----- ------ --x---- xx------ ---- - -x------ "Turbonilla interrupta" (Totten)
x xxxxxx -x--- -x------ ------ ----- ------ ------- -------- ---- - -x------ Turbonilla inoae (Bartsch)
x xxxxxx -x--- xx------ ------ ----- ------ ------- -------- ---- - xx------ Turbonilla locklini (Bartsch)
x xxxxxx --x-- x------- ----xx ----- ------ ------- x------- ---- - -------- Turbonilla multicostata (C. B. Adams)
x xxxxxx -x-x- x------- ----xx ----- ------ --x---- -------- ---- - x------- Turbonilla nivea (Stimpson)
x xxxxxx -x--- xx------ -x---- ----- ------ ------- -------- ---- - xx------ Turbonilla parkeri (Bartsch)
x xxxxxx ----x ----?--- ------ ----- --?x-- ------- -------- ---- - -------- Turbonilla paucistriata? Jefferies of Meyer
x xxxxxx --x-- ---x---- ------ ----- ------ ------- ---x---- ---- - -------- Turbonilla protracta (Dall)
x xxxxxx -xx-- x------- ----xx ----- ------ ------- x------- ---- - x------- Turbonilla reticulata (C. B. Adams)
x xxxxxx --x-x ---x---- ------ x---- --xx-- ------- ---x---- ---- - -------- Turbonilla reticulata (Emmons)
x xxxxxx -x--- -x------ ------ ----- ------ ------- -------- ---- - -x------ Turbonilla sylvanusi (Bartsch)
x xxxxxx ----x ---x---- ------ xx--- --xx-- ------- -------- ---- - -------- Turbonilla subula (H. C. Lea)
x xxxxxx -x--- -x------ ------ ----- ------ ------- -------- ---- - -x------ Turbonilla thestiusi (Bartsch)
x xxxxxx -x--- -x------ ------ ----- ------ ------- -------- ---- - -x------ Turbonilla vaughani (Bartsch)
x xxxxxx -x--- xx------ ------ ----- ------ ------- -------- ---- - xx------ Turbonilla yamai (Bartsch)
x xxxxxx -x--- x------- ----x- ----- ------ ------- -------- ---- - x------- Turbonilla speira Ravenel,
x xxxxxx -x--- -------- ------ ----- ------ ------- -------- ---- - -------- Turbonilla exilis (C. B. Adams)
x xxxxxx -x--- x------- -----x ----- ------ ------- -------- ---- - x------- Turbonilla textilis (Kurtz)
x xxxxxx -x--- x------- -----x ----- ------ ------- -------- ---- - x------- Turbonilla obeliscus (C. B. Adams)
x xxxxxx -x--- x------- -----x ----- ------ ------- -------- ---- - x------- Turbonilla virga Dall
x xxxxxx -x--- x------- -----x ----- ------ ------- -------- ---- - x------- Turbonilla punicea Dall
x ---x-x --x-x ---x---- ------ xx--- --xx-- ------- -x-x---- ---- - -------- Cyclostremella magnoliana Olsson
x ---x-x ----x ---x---- ------ ----- --xx-- ------- -------- ---- - -------- ? Cyclostremella miniscula Campbell n. sp.
x --xxxx ----x ---x---- ------ xx--- --xx-- ------- -------- ---- - -------- Acteon novellus Conrad
x --xxxx -xx-- xx------ --x--x ----- ------ ------- -x------ ---- x xx------ Acteon pelecais E. Marcus
x --xxxx x-x-x ---xx--- ------ ----- --xx-- ------- ---xx--- x--- - -------- Acteon vaughani Mansfield
x ---xxx -x--- -------- --x--- ----- ------ ------- -------- ---- - -------- Rictaxis myakkanus (Dall)
x ---xxx x---- ---x---- ------ ----- ------ ------- -------- x--- - -------- Rictaxis oryza (Gabb)
x ---xxx --x-- -x------ ------ ----- ------ -x----- -------- ---- - -------- Ringicula semistriata Orbigny
x ---xxx -xx-- xxxx---- -x---- ----- ------ ------- xx------ ---- - xxx----- Ringicula floridana Dall
x ---xxx xxx-x xxxxx--- --x--- ----- x----- ------- ---xx--- x--- - x------- Ringicula guppyi Dall
x ---xxx ----x ---x---- ------ ----- --xx-- ------- -------- ---- - -------- Ringicula sp. Campbell
x -xxxxx -x--- -------- --x--x ----- ------ ------- -------- ---- - -------- Acteocina bullata (Kiener)
x -xxxxx xxxxx xxxxx--- --xxxx xx--- ---x-- --x--x- xx-xx--- xx-- x xxx----- Acteocina canaliculata (Say)
x -xxxxx -xxx- xxxxx--- --x-xx xx--- x-xx-- -x----- x--x---- ---- - -xx----- Acteocina candei (Orbigny)
x -xxxxx --x-x ---x---- ------ ?---- ---?-- ------- ---xx--- ---- - -------- Acteocina cylindrica (Emmons
x -xxxxx x---- ---x---- ------ ----- ------ ------- -------- x--- - -------- Acteocina coensis Mansfield
x -xxxxx --x-- xxxx---- --xx-x ----- ------ ------- xx-x---- ---- - --x----- Acteocina lepta Woodring
x -xxxxx -xx-x xxxxxx-x ------ ----- -----x ------- -x-xxx-- ---- - -x------ Acteocina myrmecoon (Dall)
x -xxxxx -xx-- xxxx---- -----x ----- ------ ------- xx-x---- ---- - --x----- Acteocina recta (Orbigny)
x xxxxxx -x--- x------- --x-xx ----- ------ ------- -------- ---- - x------- Cylichna bidentata (Orbigny)
x xxxxxx --x-- ---x---- ------ ----- ------ ------- ---x---- ---- - -------- Cylichna duplinensis (Dall)
x xxxxxx ----x -------x ------ ----- -----x ------- -------- ---- - -------- Cylichna johnsoni Campbell n. sp.
x xxxxxx -x--- xx------ -x---- ----- ------ ------- -------- ---- - xx------ Cylichnella gabbi (Dall)
x xxxxxx x---- ---x---- ------ ----- ------ ------- -------- x--- - -------- Cylichnella jacksonensis Mansfield
x xxxxxx ----x ----x--- ------ ----- --xx-- ------- -------- ---- - -------- Philine williamsii Campbell n. sp.
x -----x -x--- x------- -----x ----- ------ ------- -------- ---- - x------- Haminoea virescens (Sowerby)
x -----x ----x ----x--- ------ ----- --xx-- ------- -------- ---- - -------- Haminoea sp.
x ----xx -x--- xxxx---- -x--xx ----- ------ ------- -------- ---- - xxx----- Bulla striata Bruguiere
x ----xx -x--- xxxx---- -xx-xx ----- ------ ------- -------- ---- - xxx----- Bulla occidentalis Adams
x ----xx -x--- xxxx---- --x--x ----- ------ ------- -------- ---- - --x----- Bulla solida Gmelin
x ----xx -x--- ---x---- ------ ----- ------ ------- -------- ---- - --x----- Bulla sp. Gardner
x xxx-xx xxx-- xxxxx--- --x--x ----- ------ ------- ----x--- xx-- - xxx----- Retusa sulcata (Orbigny)
x xxx-xx ----x ----x--- ------ -x--- --xx-- ------- -------- ---- - -------- R. (Cylichnina) chesapeakensis Campbell n. sp.
x xxx-xx --x-x ---xx--- ------ xx--- --xx-- ------- ---xx--- ---- - -------- Retusa (Cylichnina) microtrema (Dall)
x ----xx -x--- xx------ -x---- ----- ------ ------- -------- ---- - xx------ Atys obscuratus Dall
x ----xx ---x- ----?--- ------ ----- ------ ----?-- -------- ---- - -------- Atys ornata Gardner
x ----xx -x--- xx------ -x---x ----- ------ ------- -------- ---- - xx------ Atys sandersoni Dall
x ----xx x-x-x ---xx--- ------ xx--- --xx-- ------- ---xx--- x--- - --x----- Volvulella cylindra (H. C. Lea)
x ----xx -x--- xxxx---- --x--x ----- ------ ------- -------- ---- - xxx----- Volvulella persimilis (Morch)
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            111 11111112 222222 22233 333333 3344444 44444555 5555 5 55666666
1 234567 89012 34567890 123456 78901 234567 8901234 56789012 3456 7 89012345
x ----xx --x-x -xxx---- ------ ----- --xx-- ------- -x--x--- ---- - --------  Limacina chesapeakensis Campbell n. sp.
x ----xx xxx-x xxxxx--- ----xx xx--- --xx-- ------- -x--x--- ---- - --------  Creseis acicula (Rang)
x ----xx ----x xxxx---- -----x ----- --xx-- ------- -------- ---- - --------  Hyalocylis striata (Rang)
x ----xx ----x ---x---- ------ ----- --xx-- ------- -------- ---- - --------  Cavolinia cf. C. ventricosa (Guppy)
x ----xx ----x xxxx---- -----x ----- --xx-- ------- -------- ---- - --------  Cavolinia uncinata (Rang)
x ---x-x --x-- x------- -----x ----- ------ ------- x--?---- ---- - --------  Melampus bidentatus Say
x ---x-x --x-- x------- ------ ----- ------ ------- x------- ---- - --------  Marinula n. sp
```

APPENDIX IV: DISTRIBUTION OF VIRGINIA AND NORTHERN NORTH CAROLINA PLIOCENE MOLLUSCS THROUGH TIME

R = RECENT, from literature
0 = JAMES CITY type area, from literature
9 = AURORA OF WARD AND BLACKWELDER, 1987
8 = CHOWAN RIVER, Chesapeake, VA, and type area
7 = CRANE LAKE AND EQUIVALENTS, UPPERMOST YORKTOWN, *Panopea* bed at Chuckatuck, and uppermost beds at Rock Wharf
6 = CHUCKATUCK CROSSBEDS, MORGARTS BEACH, AND EQUIVALENTS
5 = RICE'S PIT, *Chama* BEDS, AND EQUIVALENTS
4 = TYPE RUSHMERE
3 = AURORA CALCARENITE AND EQUIVALENTS
2 = ZONE 1 YORKTOWN
M = MIOCENE from literature

? = exact stratigraphic placement uncertain.

w = within range, species present in older and younger beds, but not yet reported from indicated bed.

Pliocene distribution within study area only, ranges may vary in other areas

BIVALVES

---------2-	*Modiolus pulchellus*
---------2M	*Pecten smithii*
---------2-	*Placopecten clintonius*
---------2-	?*Pycnodonte* sp
---------2M	*Astarte exaltata*
---------2-	*Astarte undulata deltoidea*
---------2-	*Astarte undulata vaginulata*
---------2?	*Mercenaria* sp
---------2-	*Chione cortinaria*
---------2-	*Pandora undulata*
--------32-	*Chesapecten jeffersonius*
------54w2M	*Striarca centenaria*
------5ww2M	*Lucinoma contracta*
------5ww2-	*Clinocardium virginianum*
------?---M	*Semele carinata*
------5ww2M	*Glossus fraternus*
------5wwwM	*Panopea goldfussi*
------54w2M	*Teredina fistula*
-----654w2M	*Lucina cribraria*
-----654wwM	*Spisula delumbis*
-----65wwwM	*Periploma* sp., cf *P. peralta*
----7654w2-	*Noetia incile*
----765ww2-	*Ctena speciosa*
----7w54w2M	*Diplodonta subvexa*
----7654w2-	*Eucrassatella virginica cycloptera*
----7654w2M	*Spisula confraga*
----765ww2M	*Ensis ensiformis*
----765ww2M	*Macoma virginiana*
----7654wwM	*Semele subovata*
----765wwwM	*Macrocallista albraria reposta*
----7654w2M	*Dosinia acetabula*
----7654wwM	*Pleiorytis centenaria*
----7654w2-	*Panopea reflexa*
---8765432?	*Ostreacompressirostra*
---87654w2M	*Parvilucina crenulata*
---87654w2M	*Tellina declivis*
---8765wwwM	*Corbula cuneata*
---87654wwM	*Corbula inaequalis*
--9ww65wwwM	*Nucula taphria*
--987654w2M	*Yoldia laevis*
--987654w2M	*Glycymeris subovata*
--987654wwM	*Pitar sayana*
-098765432-	*Carolinapecten eboreus*
-098765432M	*Plicatula marginata*
-098765432-	*Ostrea sculpturata*
-09w765ww2M	*Pseudomiltha anodonta*
-0987654w2M	*Carditamera arata*
-0987654w2M	*Cyclocardia granulata*
R0987654w2M	*Nucula proxima*
R098765wwwM	*Nuculana acuta*
R09wwwwwwwM	*Quadrilatera adamsi*
Rwwwww?wwwM	*Glycymeris pectinata*
R098765ww2M	*Anomia simplex*
R098765ww2M	*Divalinga quadrisulcata*
Rwww765ww2M	*Diplodonta nucleiformis*
Rww87654w2?	*Chama congregata*
R0987654?2M	*Crassinella lunulata*
R0987654w2M	*Ensis directus*
Rwwww65wwwM	*Chione latilirata*
Rww87654w2M	*Hiatella arctica*
--------3--	*Leptopecten leonensis*
--------3--	*Chesapecten madisonius carolinensis*
------543--	*Chlamys decemnarius*
------543--	*Chlamys decemnarius virginianus*
------543--	*Chesapecten septenarius*
Rwwwwwww?--	*Placopecten* sp., cf. *P. magellanicus*
-------4---	*Astarte roanokensis*
---?--54---	*Mercenaria corrugata*
-----654---	*Mercenaria corrugata "tridacnoides"*
----7654---	*Modiolus gigas*
----7654---	*Chesapecten madisonius*
----7654---	*Astarte undulata*
----7654---	*Eucrassatella virginica*
----7654---	*Clinocardium acutilaqueatum*
--987654---	*Astarte concentrica*
------?----	*Nucula diaphana*
------5----	*Anadara propatula*
------?----	*Noetia trigintinaria*
------?----	*Lithophaga pectinicola*
------5----	*Arcoperna williamsi*
------5----	*Musculus ricei*
------5----	*Amusium mortoni*

------5----	*Leptopecten wilsoni*
------5----	*Chlamys rogersi*
------5----	*Placunanomia plicata*
------5----	*Limatulavirginiana*
------5----	*Parvilucinapostalveata*
------?----	*Parvilucinatrisulcata multistriata*
------5----	*Diplodonta conradi*
------?----	*Mysella velaini*
------?----	*Solecardia cossmani*
------5----	*Montacuta chesapeakensis*
------?----	*Montacuta petropolitana*
------?----	*Montacuta sagrinata*
------?----	*Orobitella laevis*
------?----	*Sportella calpix*
------5----	*Sportella chesapeakensis*
------?----	*Astarte arata*
------?----	*Astarte coheni*
------?----	*Astarte griftonensis*
------5----	*Papyridea turtoni*
------?----	*Spisula duplinensis*
------5----	*Spisula harrisi*
------5----	*Raeta alta*
------5----	*Ensis schmidti*
------?----	*Tellina verdevilla*
------5----	*Macoma cookei*
------5----	*Donax cuneola*
------5----	*Semele alumensis*
------?----	*Coralliophaga microreticulata*
------?----	*Mercenaria inflata*
------?----	*Mercenaria nucea*
------?----	*Pitar castoriana*
------?----	*Gemma cravenense*
------?----	*Gemma verdevilla*
------?----	*Ziphraea rhomboidea*
------5----	*Martesia* sp., cf *M ovalis*
------5----	*Lyonsia* sp.
-----5----	*Pandora crassidens majorina*
------?----	*Thracia maddelysensis*
-----?5----	*Clinocardium taenopleura*
-----65---?	*Anadara carolinensis*
-----65----	*Pododesmus* sp.
-----65----	*Tellina egena*
-----65----	*Thracia magna*
----765----	*Nucula dolabella*
----765----	*Anadara improcera*
----765----	*Anadara improcera buccula*
----765----	*Musculus virginicus*
----765---?	*Atrina harrisi*
----765----	*Lima carolinensis*
----765----	*Chama corticosa*
----765----	*Bornia rota*
----7w5----	*Mysella spatula*
----7w5----	*Pythinella filicaticola*
----765----	*Sportella pelex*
----765----	*Sportella petropolitana*
----765----	*Sportella yorkensis*
----7w5----	*Ensitellops compressa*
----7w5----	*Anisodonta americana*
----765----	*Spisula modicella*
----765----	*Ervilia lata*
----765----	*Macoma arctata*
----7w5----	*Florimetis magnoliana*
----765----	*Cumingia subtellinoides*
----765----	*Cooperella parilis*
----765----	*Cyrtopleura arcuata*
----765----	*Margaritaria abrupta*
----765----	*Pandora crassidens*
----765----	*Cyathodonta dalli*
----765----	*Verticordia rogersi*
---8765----	*Mytilus edulis alaeformis*
---87w5----	*Argopecten comparilis*
---8w65----	*Mysella bladenensis*
---8ww5----	*Sportella constricta*
---?765----	*Astarte symmetrica*
---8ww5----	*Mesodesma spatha*
---8765----	*Tellina dupliniana*
---8765----	*Abra subreflexa*
---8765----	*Mercenaria campechiensis permagna*
---8765----	*Gastrochaena ligula*
---8765----	*Thracia transversa*
--98765----	*Anadara lienosa*
--9w765----	*Lithophaga yorkensis*
--98ww5----	*Diplodonta acclinis*
--98765----	*Diplodonta punctulata*
--98765----	*Chama emmonsi*
--98765----	*Erycinella ovalis*
--98765----	*Crassinella johnsoni*
--98765----	*Gouldia metastriata*
--9ww65----	*Rupellaria pectarosa*
--98765----	*Corbula retusa*
--9ww65----	*Cochlodesma antiqua*
-098765----	*Bornia triangula*
-098765----	*Aligena striata*
-098765----	*Pteromeris abbreviata*
-098765----	*Laevicardium sublineatum*
-09w765----	*Chione cribraria*
-0ww765----	*Transenella carolinensis*
-098765----	*Gemma magna*
R098765----	*Glycymeris americana*
Rwww765----	*Crenella aequilatera*
Rwww7w5----	*Pteria colymbus*
Rw98--?----	*Parvilucina multilineata*
Rw9w765----	*Ensitellops protexta*
Rw98765----	*Paramya subovata*
Rww8765----	*Pleuromeris tridentata*
Rw9www5----	*Crassinella dupliniana*
Rwwwww5----	*Mactra fragilis*
RwwwwW5wwwM	*Tellina aequistriata*
Rwww765----	*Semelina nuculoides*
Rw98765----	*Chione grus*
Rw9www5----	*Petricola pholadiformis*
Rw9www?----	*Mya arenaria*
R098765----	*Sphenia dubia*
Rwww765----	*Pandora arenosa*
-----6-----	*Pecten hemicyclicus*
-----6-----	*Mysella stantoni*
-----6-----	*Astarte vicina*
-----6-----	*Ensis hughesi*
-----6-----	*Donax chuckatuckensis*

-----6-----	*Macrocallista albraria*
-----6-----	*Pholas memmingeri*
----76-----	*Anadara callicestosa*
----76-----	*Bornia lioica*
---8w6-----	*Crenella precursor*
---8w6-----	*Erycina carolinensis*
---8w6-----	*Varicorbula chowanensis*
--98w6-----	*Rangia clathrodonta*
--98w6-----	*Corbicula densata*
--9ww6-----	*Pandora tuomeyi*
-0www6-----	*Mulinia congesta*
Rw98w6-----	*Tagelus plebeius*
----?------	*Anadara staminea*
Rwww7------	*Lima pellucida*
---8-------	*Nuculana hypsoma*
---8-------	*Anadara* sp., aff. *Compyla*
---8-------	*Noetia carolinensis*
---8-------	*Brachidontes* sp.
---8-------	*Carolinapecten eboreus chesapeakensis*
---8-------	*Chlamys* sp., cf. *C. sentis*
---8-------	*Chlamys* sp.
---8-------	*Aligena chowanensis*
---8-------	*Parvilucina waccamawensis delandensis*
---8-------	*Parvilucina trisulcata albermarlensis*
---8-------	*Diplodonta* sp., cf. *D. caloosaensis*
---8-------	*Astarte yadkinensis*
---8-------	*Spisula subparilis*
---8-------	*Tellina propetenera*
---8-------	*Tellina suberis*
---8-------	*Donax emmonsi*
---8-------	*Gari dalli*
---8-------	*Pandora* sp.
---8-------	*Verticordia* sp.
--98-------	*Pleuromeris auroraensis*
--98-------	*Pteromeris perplana*
--98-------	*Astarte berryi*
--98-------	*Eucrassatella kauffmani*
--98-------	*Macrocallista greeni*
-098-------	*Anadara aequicostata*
-098-------	*Noetia limula*
-0w8-------	*Gemma trigona*
-0w8-------	*Parastarte triquetra*
R0w8-------	*Ischadium recurvum*
Rw98-------	*Crenella* sp cf *C decussata*
Rww8-------	*Anomia aculeata*
R098-------	*Crassostreavirginica*
Rww8-------	*Arcinella cornuta*
R098-------	*Pleuromeris decemcostata*
Rww8--?----	*Eucrassatella speciosa*
R0w8-------	*Trachycardium isocardia*
R098-------	*Dinocardium robustum*
Rw98-------	*Spisula similis*
R098-------	*Mulinia lateralis*
R0w8-------	*Tellina texana*
Rw98-------	*Donax fossor*
Rw98-------	*Abra aequalis*
R098-------	*Mercenaria campechiensis*
R098-------	*Mercenaria mercenaria*
R098-------	*Chione cancellata*
R098-------	*Transenella stimpsoni*
R098-------	*Corbula contracta*
R0w8-------	*Pandora trilineata*
--9--------	*Nucula pilkeyi*
--9--------	*Glycymeris duplinensis sloani*
--9--------	*Pododesmus fragosus*
--9--------	*Parvilucina (Radiolucina) waccamawensis*
--9--------	*Diplodonta heronensis*
--9--------	*Mysella beaufortensis*
--9--------	*Sportella waccamawensis*
--9--------	*Anisodonta carolina*
--9--------	*Thracia brioni*
--9--------	*Verticordia lockei*
-09--------	*Glycymeris aratus*
-09--------	*Argopecten vicenarius*
-09--------	*Ostrea lawrencei*
Rw9--------	*Musculus lateralis*
Rw9--------	*Callucina keenae*
Rw9--------	*Spisula solidissima*
Rw9--------	*Raeta plicatella*
Rw9--------	*Tellina agilis*
Rw9--------	*Macoma brevifrons*
Rw9--------	*Semele bellastriata*
Rw9--------	*Cumingia tellinoides*
Rw9--------	*Gastrochaena hians*
-0---------	*Carolinapecten eboreus solarioides*
-0---------	*Panopea floridana*
-0---------	*Panopea* n. sp.
R0---------	*Gastrochaena cuneiformis*

GASTROPODS, SCAPHOPODS, AND CHITONS

---------?-	*Diodora catilliformis*
---------2-	*Diodora redimicula*
---------2-	*Solariella olssoni*
---------2-	*Solariella shacklefordensis*
---------2-	*Calliostoma sarae*
---------2-	*Calliostoma mitchelli johnsoni*
---------2-	*Calliostoma shacklefordensis*
---------2-	*Calliostoma virginicum harrisianum*
---------2-	*Calliostoma virginicum harrisii*
---------2-	*Calliostoma virginicum jeffersonium*
---------2-	*Turritella bipertita*
---------2-	*Turritella terstriata*
---------2-	*Epitonium sheldoni*
---------2M	*Urosalpinx rappahannockensis*
---------2-	*Lyrosoma sulcosa multicostata*
---------2-	*Nassarius shacklefordensis*
---------2-	*Fusinus propeparilis*
---------2-	*Cochlespira* sp.
---------2-	*Odostomia (Odostomia) alpha*
---------2-	*Cylichna johnsoni*
------5wwwM	*Boreotrophon tetricus laevis*
------5ww2-	*Scaphella solitaria ricei*

------5ww2M	*Acteocina myrmecoon*
-----654w2?	*Crucibulum grandis*
-----65ww2-	*Aurinia sinuosa*
----7654w2M	*Dentalium attenuatum*
----7654w2M	*Cadulus thallus*
----765wwwM	*Teinostoma nana*
----7654w2-	*Pseudotorinia nupera*
----7654w2M	*Serpulorbis granifera*
---?7654w2-	*Carinorbis lyra*
----7654w2M	*Crepidula aculeata ponderosa*
----7654w2?	*Lunatia interna*
----765wwwM	*Sinum chesapeakensis*
----7654wwM	*Pterorytis umbrifer*
----7654w2M	*Boreotrophon tetricus*
----7654w2M	*Mitrella communis*
----7654w2-	*Ptychosalpinx altile*
----765432?	*Ecphora quadricostata*
----7654w2-	*Busycon incile*
----7654wwM	*Aurinia mutabilis*
----765ww2-	*Granulina virginiana*
----765ww2-	*Conus marylandicus*
--98765ww2-	*Cyclostremiscus obliquestriatus*
--9w765ww2-	*Epitonium duplinianum*
--9w765ww2?	*Melanella laevigata*
-0987654ww?	*Lunatia sayana*
-0w8765ww2-	*Prunum bellum*
Rwww765ww2M	*Chaetopleura apiculata*
R0987654w2M	*Seila adamsi*
Rw9www5ww2-	*Epitonium fractum*
R0987654w2M	*Crepidula fornicata*
R0987654w2M	*Crepidula aculeata aculeata*
R0987654wwM	*Crepidula plana*
R098765---?	*Polinices duplicatus*
R0987654wwM	*Tectonatica pusilla*
Rwww765ww2M	*Dentimargo eburneola*
-------4---	*Chicoreus floridanus*
-------?---	*Sedilia rushmerensis*
-----654---	*Calliostoma mitchelli philanthropus*
----7654---	*Calliostoma labrosum*
----7654---	*Calliostoma virginicum virginicum*
----7654---	*Turritella alticostata*
----7654---	*Petaloconchus sculpturatus*
----7654---	*Epitonium microstomum*
----7654---	*Lunatia perspectivia*
----7654---	*Scalaspira strumosa*
----7654---	*Ptychosalpinx laqueata*
----7654---	*Busycon maximum*
----7654---	*Fusinus exilis exilis*
----7654---	*Hesperisternia filicata*
---87654---	*Crucibulum leanum*
---87654---	*Urosalpinx trossula*
---87654---	*Nassarius quadrulatus*
R0w87654---	*Caecum cooperi*
------?----	*Diodora carolinensis*
------5----	*Solariella ricei*
------5----	*Calliostoma mitchelli conradianum*
------5----	*Calliostoma nottowayense*
------?----	*Calliostoma virginicum carolinensis*
------5----	*Calliostomavirginicum gizehi*
------?----	*Calliostoma virginicum hertfordense*
------5----	*Tegula exoluta*
------5----	*Skenea yorktownensis*
------5----	*Leptogyra davidi*
------5----	*Pelycidion matthewi*
------5----	*Arene tuomeyi*
------5----	*Didianema* sp.
------5----	*Solariorbis variabilis*
------5----	*Caecum virginianum*
------5----	*Cerithiopsis* sp.
------5----	*Opalia textuvestitum*
------?----	*Epitonium bolteni*
------5----	*Epitonium alumensis*
------5----	*Atlanta cordiformis*
------5----	*Polinices* sp.
------5----	*Bulbus chesapeakensis*
------5----	*Ficus holmesi*
------5----	*Trophonopsis petiti*
------5----	*Anachis styliola*
------5----	*Anachis virgilina*
------5----	*Juliamitrella chesapeakensis*
------5----	*Ptychosalpinx chesapeakensis*
------5----	*Ptychosalpinx multirugata*
------5----	*Cancellaria rotunda*
------?----	*Cancellaria plagiostoma*
------5----	*Agatrix williamsi*
------?----	*Bullata antiqua*
-----5----	*Bullata (Microspira) oviformis*
------5----	*Terebra blakei*
------5----	*Terebra emmonsii emmonsii*
------5----	*Terebra emmonsii grayi*
------5----	*Terebra emmonsii hamptonensis*
------?----	*Crassispira pyrenoides*
------?----	*Splendrillia arata*
------5----	*Cymatosyrinx ricei*
------?----	*Compsodrillia* sp.
------?----	*Compsodrillia eburnea*
------?----	*Mangelia emissaria*
------?----	*Oenopota pumilus*
------5----	*Odostomia (Odostomia) beta*
------5----	*Odostomia (Odostomia) gamma*
------5----	*Odostomia (Odostomia) epsilon*
------5----	*Odostomia (Odostomia) mu*
------5----	*Odostomia (Chrysallida) theta*
------5----	*Odostomia (Chrysallida) zeta*
------5----	*Odostomia (Menestho) iota*
------5----	*Odostomia (Evalea) lambda*
------5----	*Odostomia (Evalea) nu*
------5----	*Odostomia (Evalea) xi*
------5----	*Odostomia (Chesapeakella) sigma*
------?----	*Odostomia limnia*
------?----	*Odostomia nitens*
------?----	*Odostomia protexta*
------5----	*Odostomia turbinatus*
------5----	*Turbonilla (Chemnitzia) beta*
------5----	*Turbonilla (Strioturbonilla) delta*
------5----	*Turbonilla (Pyrgiscus) kappa*
------5----	*Turbonilla (Pyrgiscus) eta*
------?----	*Turbonilla (Pyrgiscus) daedaleum*

------5----	*Turbonilla (Bartschella) iota*
------5----	*Cylichnella* sp.
------5----	*Philine williamsi*
------5----	*Retusa chesapeakensis*
------?----	*Atys ornata*
------5----	*Limacina chesapeakensis*
-----65----	*Cyclostremiscus pseudaeorbis*
-----65----	*Busycon maximum filosum*
-----65----	*Ilyanassa granifera*
-----65---	*Ilyanassa harpuloides harpuloides*
-----65----	*Ilyanassa harpuloides johnsoni*
----765----	*Dentalium carolinense*
----765----	*Diodora oblonga*
----765----	*Calliostoma bellum*
----765----	*Calliostoma lapidosum*
----765----	*Calliostoma mitchelli mitchelli*
----765----	*Calliostoma mitchelli basicum*
----765----	*Gibbula rustica*
----765----	*Skenea smithfieldensis*
----765----	*Alvania lipeus*
----765----	*Vitrinella lipara*
----765----	*Circulus costulatus*
----765----	*Parviturboides* sp.
----765----	*Teinostoma lenticlare*
----765----	*Teinostoma subconica*
----765----	*Macromphalina aperta*
----765----	*Cochliolepis concava*
----765----	*Cochliolepis virginica*
----765----	*Turritella fluxionalis*
----765----	*Turritella virginica*
----765----	*Bittium curtum*
----765----	*Cerithiopsis smithfieldensis*
----765----	*Triphora submonilifera*
----765----	*Epitonium aciculum*
----765----	*Epitonium cornigerum*
----7w?----	*Epitonium edgecombense*
----765----	*Epitonium micropleurum*
----765----	*Epitonium smithfieldensis*
----765----	*Strombiformis conchita*
----765----	*Strombiformis migrans*
----765----	*Mucronalia* sp.
----765----	*Crepidula cymbaeformis*
----765----	*Sconsia* sp., cf *S. hodgei*
----7w5----	*Urosalpinx barbitoides*
----765----	*Ptychosalpinx tuomeyi*
----7w5----	*Cantharus nux*
----765----	*Busycon canaliferum*
----765----	*Lyrasoma sulcosa*
----7w5----	*Fasciolaria rhomboidea*
----765----	*Terebraspira acuta*
----765----	*Fusinus exilis burnsi*
----765----	*Oliva canaliculata*
----765----	*Olivella ancillariaeformis*
----765----	*Olivella carolinae*
----765----	*Vexillum elaboratum*
----765----	*Cancellaria depressa*
----765----	*Trigonostoma perspectiva*
----765----	*Prunum virginianum*
----765----	*Persicula ovula*
----765----	*Volvarina tersa*
----765----	*Terebra indenta*
----765----	*Terebra* sp.
----765----	*Pyrgospira tricatenaria*
----765----	*Mitrolumna smithfieldensis*
----765----	*Drillia (Clathrodrillia) impressa*
----765----	*Imaclava halei*
----765----	*Crassispira(Crassispirella) virginiana*
----765----	*Bellaspira virginiana*
----765----	*Cryoturris magnoliana*
----765----	*Kurtziella smithfieldensis*
----765----	*Pyrgocythara (Vitricythara) micromeris*
----765----	*Longchaeus simplex*
----765----	*Odostomia (Chrysallida) granulata*
----7w5----	*Odostomia (Chrysallida) omicron*
----765----	*Odostomia (Menestho) milium*
----765----	*Odostomia (Evalea) diaphana*
----765----	*Odostomia (Evalea) ovula*
----765----	*Odostomia (Evalina) sculpturata*
----765----	*Turbonilla (Strioturbonilla) exarata*
----765----	*Turbonilla (Strioturbonilla) subula*
----765----	*Turbonilla (Strioturbonilla) eburnea*
----765----	*Turbonilla (Pyrgiscus) digamma*
----765----	*Cyclostremella magnoliana*
----765----	*Acteon novellus*
----765----	*Retusa microtrema*
----765----	*Volvulella cylindra*
---8765----	*Skenea harrisi*
---8ww5----	*Caecum stevensoni*
---8765----	*Mitrella edenensis*
---8ww5----	*Tortifusus curvirostra*
---8w65----	*Ilyanassa harpuloides scalaspira*
--9w765----	*Triphora bartschi*
--9w765----	*Melanella angulata*
--98765----	*Urosalpinx lepidota*
--98ww5----	*Urosalpinx gardnerae*
--98765----	*Anachis parvula*
--9w765----	*Juliamitrella gardnerae*
--98w65----	*Ilyanassa porcina*
--98765----	*Aurinia obtusa*
--9w765----	*Prunum limatulum*
--9www5----	*Conus adversarius*
--9w765----	*Cerodrillia simpsoni cingulata*
--9w765----	*Cymatosyrinx lunata*
-098765----	*Caecum flemingi*
Rwww765----	*Ischnochiton* sp.
Rw98765----	*Teinostoma goniogyrus*
Rwww765----	*Teinostoma umbilicata*
Rw9w765----	*Caecum johnsoni*
Rwww765----	*Architectonica nobilis*
Rwww765----	*Cerithiopsis bicolor*
Rwwwww5----	*Epitonium novangeliae*
Rwww765----	*Melanella arcuata*
Rwww765----	*Iselica globosa*
Rw98765----	*Calyptraea centralis*
Rwww765----	*Crucibulum scutellatum*
Rwwww65----	*Lamellaria perspicua*
Rwww765----	*Erato maugeriae*

Rwwwww5----	*Sinum perspectivium*
Rw9w765----	*Nassarina glypta*
Rw9w765----	*Aesopus stearnsi*
R098ww?----	*Busycon contrarium*
Rwwwww5----	*Triplofusus gigantea*
Rw9w765----	*Olivella mutica*
R098765----	*Dentimargo aureocincta*
Rwww765----	*Gibberula lavalleeana*
Rwww765----	*Terebra concava*
Rww8765----	*Longchaeus suturalis*
Rw9w765----	*Acteocina candei*
Rwww765----	*Creseis acicula*
Rwwwww5----	*Hyalocylis striata*
Rwwwww5----	*Cavolinia uncinata*
Rwwwww5----	*Cavolinia ventricosa*
-----6-----	*Arene* sp.
-----6-----	*Cingula* sp.
-----6-----	*Teinostoma virginica*
-----6-----	*Macromphalina chuckatuckensis*
-----6-----	*Epitonium druidi*
-----6-----	*Cypraea carolinensis*
-----6-----	*Murexiella shilohensis*
-----6-----	*Ilyanassa procina schyzopyga*
-----6-----	*Mangelia andrewi*
-----6-----	*Glyphostoma zoster*
----76-----	*Drillia (Drillia) chuckatuckensis*
---8w6-----	*Buccinum* sp.
---8w6-----	*Ilyanassa sexdentata*
---8w6-----	*Viviparus* sp
--9w76-----	*Teinostoma bushi*
Rwwww6-----	*Crepidula adunca*
Rwwww6-----	*Crepidula convexa*
----7------	*Cingula geraea*
----7-----	*Rissoina* sp., cf *R. striatocostata*
----7------	*Aorotrema cistronium*
----7------	*Cyclostremiscus schmidti*
----7------	*Caecum chuckatuckensis*
----7------	*Caecum tortile*
----7------	*Epitonium chuckatuckensis*
----7------	*Melanella nisoformis*
----7------	*Crepidula aculeata costata*
----7------	*Natica plicatella*
----?------	*Coralliophila leonensis*
----7------	*Juliamitrella smithfieldensis*
----7------	*Tritonoharpa floridensis*
----7------	*Nassarius consenoides*
----7------	*Olivella* sp.
----7------	*Cancellaria (Massyla) rapella*
----7------	*Trigonostoma tenerum carolinensis*
----7------	*Trigonostoma smithfieldensis*
----7------	*Trigonostoma (Extractrix) hoerlei*
----?------	*Terebra unilineata*
----?------	*Carinodrillia smithfieldensis*
----7------	*Sedilia bella*
----?------	*Sedilia belloides*
----7------	*Cryoturris maesi*
----7------	*Pyrgocythara (Vitricythara) metria*
----7------	*Odostomia (Chrysallida) eta*
----7------	*Odostomia (Eulimastomia) rho*
----7------	*Triptychus biseriatus*
----7------	*Turbonilla (Chemnitzia) alpha*
---87------	*Vexillum reticulatum*
--987------	*Teinostoma alexanderi*
Rwww7------	*Acteocina lepta*
---8-------	*Solariorbis yadkinensis*
---8-------	*Melanella chesapeakensis*
---8-------	*Crucibulum leanum* variety
---8-------	*Mitrella harbisonae*
---8-------	*Juliamitrella virginica*
---8-------	*Ilyanassa isogramma*
---8-------	*Dentimargo chesapeakensis*
---8-------	*Granula* sp.
---8-------	*Terebra* sp.
---8-------	*Mitrolumna yadkinensis*
---8-------	*Compsodrillia chowanensis*
---8-------	*Odostomia (Chrysallida) archeri*
---8-------	*Turbonilla (Pyrgiscus) zeta*
---8------	*Ringicula guppyi*
---8-------	*Lioplax* sp.
--98-------	*Cyclostremiscus undula*
--98-------	*Didianema carolinae*
--98-------	*Turritella beaufortensis*
--98-------	*Crucibulum lawrencei*
--98-------	*Mitrella waccamawensis*
--98-------	*Busycon carica amoenum*
--98-------	*Granulina mansfieldi*
-098-------	*Ilyanassa irrorata*
Rw98-------	*Cadulus tetraschistus*
R0w8-------	*Diodora cayenensis*
Rw98-------	*Arene tricatenaria*
Rww8-------	*Cochliolepis striata*
Rw98-------	*Caecum imbricatum*
R098-------	*Caecum pulchellum*
Rw98-------	*Caecum regulare*
Rww8-------	*Meioceras cingulatum*
Rww8-------	*Epitonium humprheysi*
Rww8-------	*Crucibulum multilineatum*
Rww8-------	*Anachis avara*
R0w8-------	*Anachis lafresnayi*
R0w8-------	*Mitrella lunata*
Rww8-------	*Busycon canaliculatum*
Rww8-------	*Prunum roscidum*
R0w8-------	*Glyphoturris ertima*
R0w8------	*Odostomia (Chrysallida) seminuda*
Rw98-------	*Turbonilla nivea*
Rww8-------	*Turbonilla (Strioturbonilla) interrupta*
Rww8-------	*Acteocina canaliculata*
--9--------	*Diodora auroraensis*
--9--------	*Diodora nucula*
--9--------	*Diodora pamlicoensis*
--9--------	*Calliostoma mitchelli pontoni*
--?--------	*Arene pergemma*
--9--------	*Littorina irrorata carolinensis*
--9--------	*Didianema duplinensis*
--9--------	*Teinostoma beaufortensis*
--9--------	*Teinostoma tectispira*
--9--------	*Macromphalina hanseni*
--9--------	*Macromphalina peirroti*
--9--------	*Caecum beaufortensis*

--9--------	*Bittium podagrinum*
--9--------	*Epitonium carolinae*
--9--------	*Epitonium leai*
--9--------	*Melanella juncea*
--9--------	*Strombiformis beaufortensis*
--9--------	*Strombiformis biconica*
--9--------	*Trivia floridana*
--9--------	*Murexiella macgintyi*
--9--------	*Pterorytis conradi*
--9--------	*Mitrella gardnerae*
--9--------	*Aesopus ithitoma*
--9--------	*Nassarius caloosaensis*
--9--------	*Nassarius cornellianus*
--9--------	*Fasciolaria apicina*
--9--------	*Triplofusus cronlyensis*
--9--------	*Fusinus caloosaensis*
--9--------	*Oliva carolinensis*
--9--------	*Terebra petiti*
--9--------	*Sedilia sedilia*
--9--------	*Brachycythara reidenbachi*
--9--------	*Odostomia (Chrysallida) auroraensis*
--9--------	*Odostomia (Chrysallida) beaufortensis*
Rw9--------	*Turritella perexilis*
R09--------	*Vermicularia spirata*
Rw9--------	*Epitonium foliaceicostum*
Rw9--------	*Epitonium rupicolum*
Rw9--------	*Urosalpinx perrugata*
Rw9--------	*Eupleura caudata*
R09--------	*Anachis obesa*
R09--------	*Busycon carica*
Rw9--------	*Busycon spiratum pyruloides*
Rw9--------	*Vexillum wandoensis*
Rw9--------	*Volvarina avena*
Rw9--------	*Turbonilla abrupta*
Rw9--------	*Ringicula semistriata*
-0---------	*Diodora carditella*
-0---------	*Calliostoma erosum*
-0---------	*Murexiella macgintyi faceta*
-0---------	*Ilyanassa porcina deleonensis*
-0---------	*Prunum contractum*
-0---------	*Crassispira perrugata*
R0---------	*Nassarius albus*
R0---------	*Nassarius vibex*
R0---------	*Odostomia (Menestho) impressa*

APPENDIX V
REPOSITORIES, CATALOG NUMBERS, TYPE LOCALITIES, AND FORMATIONS FOR THE ORIGINAL TYPES

SPECIES	ORIGINAL TYPE	ORIGINAL FORMATION	TYPE LOCALITY
1. Nucula diaphana	ANSP 1591	Yorktown	Petersburg, VA 1
2. N. proxima	ANSP missing	Recent	Southeastern USA
3. N. dolabella	ANSP 1590	Yorktown	Petersburg, VA 1
4. N. taphria	USNM 114951	Duplin	Natural Well, NC
5. Nuculana acuta	ANSP 30613	Yorktown	Virginia
6. N. hypsoma	USNM 115024	Duplin	Natural Well, NC
7. Yoldia laevis	BM missing	Yorktown	"MD", unknown VA locality
8. Anadara callicestosa	USNM 146246	Yorktown	Gaskins Wharf, VA
9. A. carolinensis	WFIS missing	Duplin	Duplin Co., NC
10. A. propatula	ANSP 30637	Yorktown	Ware River, VA
11. A. improcera	ANSP 1631	Waccamaw	Wilmington, NC
12. A. i. buccula	ANSP 30615	Duplin	Natural Well, NC
13. A. aequicostata	ANSP lost	Chowan River ?	Neuse River, NC
14. A. lienosa	ANSP lost	Duplin	Santee River, SC
15. A. staminea	ANSP lost	Duplin	Santee River, SC
16. Striarca centenaria	BM L-13206	Yorktown?	"MD", unknown VA locality
17. Noetia incile	BM L-13205	Yorktown?	"MD", unknown VA locality
18. N. limula	ANSP 18841	Chowan River ?	NC
18a. N. trigintinaria	ANSP 13409	Duplin	SC
19. Glycymeris americana		Recent ?	Southeastern USA
20. G. pectinata		Recent	Southeastern USA
21. G. subovata	BM L-13209	Yorktown	"MD", unknown VA locality
22. Mytilus edulis alaeformis	BM L-43246		British Crag
23. Brachidontes sp.	USNM 265740	Chowan River	Chesapeake, VA 1
24. Crenella aequilatera	ANSP 1593	Yorktown	Petersburg, VA 1
25. C. cf. C. decussata		Recent	North Atlantic
26. C. precursor	USNM 325498	Yorktown	Suffolk
27. Arcoperna williamsii	USNM 265742	Yorktown	Rice's Pit, Hampton, VA
28. Musculus ricei	USNM 265743	Yorktown	Rice's Pit, Hampton, VA
29. M. virginicus	ANSP lost	Yorktown	Yorktown, VA
30. Lithophaga pectinicola	PRI 1372	Yorktown	Yorktown, VA
31. L. yorkensis	PRI 3491, 3	Yorktown	Yorktown, VA
32. Modiolus gigas	WFIS 5354	unknown	unknown
33. M. pulchellus	PRI 3506, 8	Yorktown z. 1	Kings Mill, VA
34. Atrina harrisii	USNM 145988	Choptank	Jones Wharf, MD
35. Pteria colymbus		Recent	Western Atlantic
36. Pecten hemicyclicus	Charleston Mus.	Goose Creek Lms.	Charleston, SC
37. P. smithii	PRI 3502, 3	Yorktown	Kings Mill, VA
38. Amusium mortoni	unknown	"Goose Creek beds"	Charleston, SC
39. Leptopecten leonensis	USNM 371256	Jackson Bluff	Leon Co., FL
40. L. wilsoni	USNM 265753	Yorktown	Wilson's Pit, Hampton, VA
41. Argopecten comparilis	USNM 11447	"Goose Creek beds"	Charleston, SC
42. Carolinapecten eboreus	ANSP lost	Yorktown	Suffolk, VA
42a. C. e. chesapeakensis	USNM 265808	Chowan River	Chesapeake, VA
43. Chlamys decemnarius	ANSP lost	Yorktown	James River, VA
44. C. d. virginianus	ANSP 1620	Yorktown	Hopewell, VA
44a. C. sp.	USNM 265757	Chowan River	Chesapeake, VA 1
44b. C. rogersii	ANSP 12581	Yorktown	James River, VA
45. Placopecten clintonius	BM L-13203	Yorktown, z.1	"MD", unknown VA locality

46. Chesapecten jeffersonius	BM L-13212	Yorktown, z.1	"MD", unknown VA locality
47. C. madisonius	ANSP 31787	Yorktown	"MD", unknown VA locality
48. C. septenarius	BM L-13197	Yorktown	"MD", unknown VA locality
50. L. peedeensis	AMNH 10822	Goose Creek Lms.	Pee Dee River, SC
51. Plicatula marginata	BM L-13199	Yorktown	"MD", unknown VA locality
52. Anomia simplex		Recent	Cuba
53. Pododesmus sp.	USNM 265764	Yorktown	Rice's Pit, Hampton, VA
54. Placuanomia plicata	AMNH 10836	"Goose Creek beds"	Charleston, SC
55. Lima carolinensis	USNM 107801	Duplin	Darlington, SC
56. L. pellucida	MCZ 155585	Recent	Jamaica
57. Limatula virginiana	USNM 265768	Yorktown	Rice's Pit, Hampton, VA
58. Ostrea compressirostra	BM L-13204	Yorktown	"MD", unknown VA locality
59. O. sculpturata	ANSP 30611	Yorktown	Smithfield, VA
60. Crassostrea virginica		Recent	VA
61. ?Pycnodonte sp.	USNM 258373	Yorktown z.1	Claremont Wharf, VA
62. Parvilucina crenulata	ANSP 2718	Yorktown	Suffolk, VA
63. P. multilineata	AMNH lost	Waccamaw	Waccamaw River, SC
64. P. postalveata	USNM 325539	Yorktown	Yorktown, VA
65. P. trisulcata multistriata	ANSP 30632	Waccamaw	Wilmington, NC
66. Ctena speciosa	MCZ missing	Yorktown	James River, VA
67. Lucina cribraria	BM unnumbered	Yorktown ?	"MD", unknown VA locality
68. Lucinoma contracta	BM L-13196	Yorktown ?	"MD", unknown VA locality
69. Pseudomiltha anodonta	BM L-13198	Yorktown ?	"MD", unknown VA locality
70. Divalinga quadrisulcata		Recent	Cuba
71. Diplodonta acclinis	ANSP lost	Yorktown	Yorktown, VA
72. D. conradi	ANSP 16014	Yorktown	Yorktown, VA
73. D. nucleiformis	WFI	Yorktown	Meherrin River, NC
74a. D. punctulata	ANSP 1587	Yorktown	Petersburg, VA 1
75. D. subvexa	USNM 405226	Yorktown	Rushmere, VA
76. Chama congregata	ANSP 30561	Yorktown	James River, VA
77. C. corticosa	ANSP lost	Yorktown	Smithfield, VA 1
78. C. emmonsi	Emmons coll.	Duplin ?	NC
79. Erycina carolinensis	USNM 115096	Duplin	Natural Well, NC
80. Bornia lioica	USNM 115263	Caloosahatchie	Caloosahatchie River, FL
81. B. rota	USNM 115094	Duplin	Natural Well, NC
82. B. triangula	ANSP 1597	Yorktown	Petersburg, VA 1
83. Aligena striata	ANSP 3305	Yorktown	Petersburg, VA 1
84. Solecardia cossmani	USNM 155776	Yorktown	Petersburg, VA 1
85. Montacuta chesapeakensis	USNM 265786	Yorktown	Chesapeake, VA 2
86. M. petropolitana	USNM 155770	Yorktown	Petersburg, VA 1
87. M. sagrinata	USNM 155772	Yorktown	York River, VA
88. Orobitella laevis	ANSP 1582	Yorktown	Petersburg, VA 1
89. Mysella bladenensis	USNM 325550	Yorktown	Walkers Bluff NC
90. M. spatula	USNM 265788	Yorktown	Chesapeake, VA 2
91. M. stantoni	USNM 115102	Duplin	Natural Well, NC
92. Pythinella filicaticola	PRI 3515	Yorktown	Smithfield, VA 1
93. Sportella chesapeakensis	USNM 265790	Yorktown	Chesapeake, VA 2
94a. S. constricta	ANSP lost	Duplin	Natural Well, NC
95. S. pelex	USNM 155726	Yorktown	Petersburg, VA 1
96. S. petropolitana	USNM 155725	Yorktown	Petersburg, VA 1
97. S. yorkensis	USNM 144323	Yorktown	York River, VA

98. Ensitellops compressa	ANSP 1596	Yorktown	Petersburg, Va 1
99. E. protexta	ANSP 18847	Waccamaw	Wilmington, NC
100. Anisodonta americana	USNM 145814	Caloosahatchie	Caloosahatchie River, FL
101. Paramya subovata	ANSP missing	Yorktown	VA
102. Carditamera arata	ANSP 20022	Yorktown?	Newbern, NC
103. Pleuromeris decemcostata	ANSP missing	Recent	Tampa Bay, FL
104. P. tridentata	ANSP missing	Recent	SC
104a. P. auroraensis	USNM 203942	"James City"	Aurora, NC
105. Pteromeris abbreviata	ANSP lost	Waccamaw	Wilmington, NC
106. Cyclocardia granulata	BM unnumbered	Yorktown?	"MD", unknown VA locality
107. Erycinella ovalis	ANSP 30621	Yorktown	Yorktown, VA
108. Astarte arata	ANSP missing	Yorktown	City Point, Hopewell, VA
109. A. berryi	USNM 325533	Chowan River	Chocowinity, NC
110. A. coheni	ANSP 30610	Yorktown	Lancaster Co., VA
111. A. exaltata	ANSP 30628	Calvert	Calvert Cliffs, MD
112. A. lineolata	ANSP 1586	Yorktown	Petersburg, VA 1
113. A. roanokensis	USNM 325523	Chowan River	Halifax, NC
114. A. symmetrica	ANSP missing	Yorktown	Yorktown, VA
115. A. undulata	BM missing	Yorktown?	"MD", unknown VA locality
116. A. vicina	BM missing	Yorktown?	"MD", unknown VA locality
117. A. yadkinensis	USNM 403295	Chowan River	Chesapeake, VA 1
118. Eucrassatella virginica	BM	Yorktown	"Virginia"
119. E. virginica cycloptera	AMNH lost	Duplin ?	Sumter, SC
119a. E. kauffmani	USNM 203950	"James City"	Aurora, NC
120. Crassinella lunulata	ANSP lost	Yorktown	Suffolk, VA
121. C. johnsoni	USNM 203955	"James City"	Aurora, NC
122. C. duplinensis	USNM 114922	Duplin	Natural Well, NC
123. Papyridea turtoni	USNM 157547	Caloosahatchie	Caloosahatchie
124. Laevicardium sublineatum	ANSP 30605	Waccamaw	Wilmington, NC
125. Clinocardium acutilaqueatum	ANSP lost	Yorktown	VA
126. C. taenopleura	USNM 146223	Yorktown	Suffolk, VA
127. C. virginianum	WFIS 4624	Yorktown	James River near Smithfield, VA
127a. Dinocardium robustum	unknown	Recent	Southeastern USA
128. Mactra fragilis	ANSP lost	Recent	Western Atlantic
129. Spisula confraga	ANSP 30560	Yorktown	"MD", unknown VA locality
130. S. delumbis	ANSP 30532	Yorktown	Yorktown, VA
130a. S. duplinensis	USNM 153784	Duplin	Natural Well, NC
131. S. harrisi	PRI 3487	Duplin	Pee Dee River, SC
132. S. modicella	ANSP 4311	Yorktown	Yorktown, VA
132a. M. clathrodon	ANSP 3309	Yorktown	"MD", unknown VA locality
133. Mulinia congesta	ANSP 30559	Recent	Southeastern USA
134. M. lateralis	ANSP 52663	Yorktown	Yorktown, VA
135. Rangia clathrodonta	ANSP 16242	Yorktown	Yorktown, VA
136. Raeta alta	ANSP lost	Yorkown ?	NC
137. Mesodesma spatha	USNM 325591	Yorktown	Suffolk, VA
138. Ervilia lata	USNM 115054	Duplin	Natural Well, NC
139. Ensis directus	ANSP lost	Yorktown ?	Newbern, NC
139a. "E. magnodentata"	ANSP 3304	Yorktown	Petersburg, VA 1
140. E. ensiformis	ANSP 16306	St. Marys	St. Marys River, MD
141. E. hughesi	USNM 403322	Pinecrest beds	Kissiminee, FL
142. E. schmidti	PRI 3494-6	Yorktown	Nansemond River
143. Tellina aequistriata	BM missing	Yorktown	"MD", unknown VA locality
144. T. egena	ANSP 16016	Yorktown	James River near Smithfield, VA 2
145. T. declivis	ANSP 4306	Yorktown	Yorktown, VA

146. T. dupliniana	USNM 115040	Duplin	Magnolia, NC
146a. T. suberis	USNM 157872	Caloosahatchie	Caloosahatchie River, FL
147. Macoma cookei	USNM 325592	Yorktown	Yorktown, VA
148. M. virginiana	ANSP lost	Yorktown	Yorktown, VA
149. M. arctata	ANSP lost	Yorktown ?	NC
150. Florimetis magnoliana	AMNH missing	Duplin	Pee Dee River, SC
151. Donax chuckatuckensis	USNM 325589	Yorktown	Chuckatuck, VA 1
151a. D. cuneola	USNM 325588	Waccamaw	Neill's Eddy Landing, NC
152. D. emmonsi	USNM 115034	Waccamaw ?	Cape Fear River, NC
153. Gari dalli	PRI 199	Chowan River	Chocowinity, NC
154. Semele subovata locality	BM L-13208	Yorktown ?	"MD", unknown VA
155. S. subovata carinata	ANSP lost	St. Marys	St. Marys River, MD
155a. S. alumensis	USNM 114861	Jackson Bluff	Jackson Bluff, West FL
156. S. nuculoides	ANSP missing	Waccamaw	Wilmington, NC
157. Cumingia subtellinoides	ANSP missing	Yorktown	Petersburg, VA 1
158. Abra aequalis	ANSP missing	Recent	Southeastern USA
159. A. subreflexa	ANSP 4305	Yorktown	Suffolk, VA
160. Tagelus plebeius		Recent	Western Atlantic
161. Coralliophaga microreticulata	USNM 325560	Yorktown	Suffolk, VA
162. Glossus fraternus	BM L-13202	Yorktown ?	"MD", unknown VA locality
163. Corbicula densata	ANSP 30636	Yorktown	Petersburg, VA 1
164. Mercenaria campechiensis		Recent	Southeastern USA
164a. M. campechiensis permagna	ANSP missing	Yorktown ?	Newbern, NC
165. M. corrugata	Paris	Yorktown	VA ?
166. M. mercenaria		Recent	Western Atlantic
167. M. inflata	ANSP 20117	Choptank	Choptank River, MD
167a. M. nucea	USNM 163418	Yorktown z. 1	Bellefield, VA
168. M. tridacnoides	Lister's figure Yorktown ?	VA ?	
169. M. sp. USNM 403349	Yorktown z. 1	Williamsburg, VA 1	
170. Chione cortinaria	MCZ lost	Yorktown z. 1	Williamsburg, VA
171. C. cribraria	ANSP 30635	Waccamaw	Wilmington, NC
172. C. latilirata	ANSP 20139	Calvert	Calvert Cliffs, MD
173. C. grus	AMNH lost	uncertain	Simmons Bluff, SC (Pleistocene)
174. Transenella carolinensis	USNM 115165	Duplin	Natural Well, NC
175. Gouldia metastriata	ANSP 30608	Yorktown	James River, VA
176. Pitar sayana	BM L-13210	Yorktown ?	"MD", unknown VA locality
176a. "Cytherea elevata"	ANSP 1581	Yorktown	Petersburg, VA 1
177. Macrocallista albraria	ANSP missing	Duplin	Santee River, SC
178. M. a. reposta	ANSP 30586	Yorktown	Suffolk, VA
178a. M. greeni	USNM 203986	"James City"	Aurora, NC
179. Dosinia acetabula	ANSP unnumbered uncertain	"MD & VA"	
180. Gemma magna	USNM 115174	Duplin	Natural Well, NC
181. Petricola pholadiformis		Recent	Southeastern USA
182. Rupellaria pectarosa	ANSP 16341	Yorktown	Suffolk
183. Pleiorytis centenaria	ANSP 4304	Yorktown ?	James River, VA
184. Cooperella parilis	unknown	Yorktown ?	NC
185. Mya arenaria	Linnean Society	Recent	North Atlantic
187. Sphenia dubia	ANSP 1580	Yorktown	Petersburg, VA 1
187a. "Mya reflexa"	ANSP 1588	Yorktown	Petersburg, VA
188. Varicorbula chowanensis	USNM 241806	Chowan River	Chowan River, NC
189. Corbula cuneata	BM lost	Yorktown ?	"MD", unknown VA locality
190. C. retusa	USNM 325604	Chowan River	Edenhouse Point, Chowan River, NC

191. C. inaequalis	BM lost	Yorktown ?	"MD", unknown VA locality
192. Gastrochaena ligula	ANSP missing	Yorktown	Petersburg, VA 1
193. Hiatella arctica		Recent	North Atlantic
194. Panopea goldfussi	WFIS missing	Yorktown	Meherrin River, NC
195. P. reflexa	BM L-13200a	Yorktown	"MD", unknown VA locality
196. Cyrtopleura arcuata	ANSP missing	Yorktown	Suffolk, VA
197. Pholas memmingerii	AMNH 11005	Duplin	Sumter, SC
198. Ziphraea rhomboidea	ANSP 1583	Yorktown	Petersburg, VA 1
199. Martesia cf. M. ovalis	ANSP lost	Calvert	Calvert Co., MD
200. Teredina fistula	ANSP lost	Yorktown	Petersburg, VA 1
201. Margaritaria abrupta	ANSP 20386	Yorktown	Yorktown, VA
202. Lyonsia sp.	USNM 403376	Yorktown	Chesapeake, VA 2
203. Pandora arenosa	ANSP 30584	Yorktown	Yorktown, VA
204. P. crassidens	ANSP lost	Yorktown	James River near Smithfield, VA
205. P. crassidens majorina	USNM 325501	Yorktown	Halifax, NC
206. P. undulata	USNM 403380	Yorktown z. 1	Williamsburg, VA 1
207. P. sp.	USNM 403381	Chowan River	Chesapeake, VA 1
208. P. tuomeyi	USNM 325502	Waccamaw	Walkers Bluff, Cape Fear River, NC
209. Thracia magna	USNM 403383	Yorktown	Rice's Pit, Hampton, VA
210. T. transversa	ANSP 1585	Yorktown	Petersburg, VA 1
210a. T. maddelysensis	USNM 325508	Yorktown	Maddely's Bluff, Meherrin River, VA
211. Cyathodonta dalli	USNM 352442	Yorktown	Benns Church, VA
212. Periploma cf. P. peralta	ANSP 13989	Calvert	NJ
213. Cochlodesma antiqua	ANSP 19648	Yorktown	Yorktown, VA
214. Verticordia rogersii	USNM 325506	Yorktown	Smithfield, VA 1
215. V. sp.	USNM 403388	Chowan River	Chesapeake, VA 1
216. Dentalium attenuatum	BM unnumbered	Yorktown ?	"MD", unknown VA locality
217. D. carolinense	ANSP unnumbered	unknown	NC
218. Cadulus thallus	ANSP unnumbered	Yorktown	Suffolk, VA
219. Ischnochiton sp.	USNM 403392	Yorktown	Chuckatuck, VA 2
220. Chaetopleura apiculata	ANSP lost	Recent	Southeastern USA
221. Diodora catilliformis	MCZ lost	Yorktown ?	Shell Bank, Prince George Co., VA
222. D. oblonga	ANSP 1562	Yorktown	Petersburg, VA 1
223. D. redimicula	BM missing	Yorktown	"MD", unknown VA locality
224. Solariella olssoni	USNM 403396	Yorktown z. 1	Williamsburg, VA 1
225. S. ricei	USNM 403397	Yorktown	Rice's Pit, Hampton VA
226. S. shacklefordensis	PRI 3513	Yorktown ?	Shackleford, VA
227. Calliostoma bellum	ANSP 30587	Yorktown z. 1	Williamsburg, VA 1
228. C. sarae	USNM 403398	Yorktown	Suffolk, VA
229. C. labrosum	ANSP missing	Yorktown	Suffolk, VA
230. C. lapidosum "C. conus"	ANSP 1544	Yorktown	Petersburg, VA 1
230a. C. lapidosum "C. conradi"	USNM 325468	Yorktown	Yorktown, VA
231. C. mitchelli mitchelli	ANSP 1619	Yorktown	James River, VA
232. C. mitchelli basicum	USNM 113036	Yorktown	Petersburg, VA 1
233. C. mitchelli conradianum	ANSP 31403	Yorktown	Petersburg ?, VA 1
234. C. mitchelli johnsoni	USNM 403399	Yorktown z. 1	Williamsburg, VA 1
235. C. mitchelli philanthropus	ANSP 30588	Yorktown	James River, VA
236. C. nottowayense	USNM 325466	Yorktown	Sycamore, Nottoway River, VA
237. C. shacklefordensis	PRI lost	Yorktown ?	Shackleford, VA
238. C. virginicum virginicum	USNM 113036	Yorktown	Yorktown, VA
238B. C. virginicum carolinensis	USNM 325472	Yorktown	Martin Co., NC
239. C. virginicum gizehi	USNM 325467	Yorktown	Yorktown, VA

240. C. virginicum harrisianum	PRI 204	Yorktown z. 1	Bellefield, VA
241. C. virginicum harrisii	USNM 113052	Yorktown z. 1	Bellefield, VA
241C. C. virginicum hertfordense	USNM 325469	Yorktown	Murfreesboro, NC
242. C. virginicum jeffersonium	USNM 403400	Yorktown z. 1	Williamsburg, VA 1
243. Tegula exoluta	ANSP 30634	Waccamaw	Wilmington, NC
244. Gibbula rustica	ANSP missing	Yorktown	Petersburg, VA 1
245. Skenea harrisi	PRI 1377	Duplin	Natural Well
246. S. smithfieldensis	PRI lost	Yorktown	James River near Smithfield, VA 1
247. S. yorktownensis	USNM 403404	Yorktown	Chesapeake, VA 2
247a. Leptogyra davidi	USNM 403405	Yorktown	Chesapeake, VA 2
247b. Pelycidion matthewi	USNM 403406	Yorktown	Chesapeake, VA 2
248. Arene sp.	USNM 403407	Yorktown	Chesapeake, VA 2
248a. A. tuomeyi	USNM 403408	Yorktown	Chesapeake, VA 2
249. Littorina irrorata		Recent	Western Atlantic
250. Alvania lipeus	USNM 113569	Caloosahatchie	Caloosahatchie River, FL
251. Cingula geraea	USNM 113572	Duplin	Cape Fear River, NC
252. C. sp.	USNM 403411	Yorktown	Chuckatuck, VA 2
253. Rissoina sp. cf. R. striatocostata	USNM 403412	Yorktown	Chuckatuck, VA 2
254. Vitrinella lipara	ANSP 1542	Yorktown	Petersburg, VA 1
255. Aorotrema cistronium	MCZ	Recent	off North Carolina
256. Circulus costulatus	ANSP 1549	Yorktown	Petersburg, VA 1
257. Cyclostremiscus obliquestriatus	ANSP 1541	Yorktown	Petersburg, VA 1
258. C. pseudaeorbis	USNM 112653	Yorktown	Temple Place near Yorktown, VA
259. C. schmidti	PRI 4494	Duplin	Natural Well, NC
260. C. undula	USNM 114446	Duplin	Natural Well, NC
261. Parviturboides sp.	USNM 403418	Yorktown	Chesapeake, Va 2
262. Didianema carolinae	USNM 325476	Waccamaw	Walkers Bluff, Cape Fear River, NC
263. D. sp.	USNM 403420	Yorktown	Williamsburg, VA 3
264. Solariorbis variabilis	PRI 3512	Yorktown	Yorktown, VA
265. S. yadkinensis	USNM 403422	Chowan River	Chesapeake, VA 1
266. Teinostoma alexanderi	PRI 959	Duplin	Natural Well, NC
267. T. bushi	PRI 1374	Duplin	Natural Well, NC
268. T. goniogyrus	ANSP	Recent	off Destin, FL, in 18 to 20 fathoms
269. T. beaufortensis	USNM 204027	"James City"	Aurora, NC
270. T. lenticlare	ANSP 1567	Yorktown	Petersburg, VA 1
271. T. nana	ANSP 1569	Yorktown	"MD", unknown VA locality
272. T. subconica	ANSP 1568	Yorktown	Petersburg, VA 1
273. T. umbilicata	ANSP 1565	Yorktown	Petersburg, VA 1
274. T. virginica	USNM 403427	Yorktown	Williamsburg, VA 3
275. Macromphalina aperta	ANSP 1540	Yorktown	Petersburg, VA 1
276. M. chuckatuckensis	USNM 403429	Yorktown	Chuckatuck, VA 2
277. Cochliolepis concava	ANSP 1538	Yorktown	Petersburg, VA 1
278. C. striata		Recent	Florida
279. C. virginica	USNM 156070	Yorktown	Petersburg, VA 1
280. Caecum chuckatuckensis	USNM 403431	Yorktown	Chuckatuck, VA 2
281. C. pulchellum		Recent	Western Atlantic
282. C. cooperi		Recent	Western Atlantic
283. C. stevensoni	AMNH lost	Yorktown	Yorktown, VA
284. C. tortile	USNM 112332	Waccamaw	Tilly's Lake, SC
285. C. flemingi	USNM 325448	Waccamaw	Neill's Eddy Landing, NC
286. C. johnsoni		Recent	Western Atlantic
287. C. virginianum	AMNH lost	Yorktown	Yorktown, VA
288. Turritella alticostata	ANSP 30592	Yorktown	James River, VA
289. T. beaufortensis	USNM 204038	"James City"	Aurora, NC
290. T. virginica	USNM 403442	Yorktown	Smithfield, VA 3
291. T. fluxionalis	MCZ lost	Yorktown	Williamsburg, VA

292. T. bipertita	ANSP lost	Yorktown	Petersburg, VA 1
293. T. terstriata	MCZ lost	Yorktown	Williamsburg, VA
295. Architectonica nobilis		Recent	Western Atlantic
296. Pseudotorinia nupera	ANSP 15384	Yorktown	Suffolk, VA
297. Petaloconchus sculpturatus	ANSP 1575	Yorktown	Petersburg, VA 1
298. Serpulorbis granifera	BM GG12662	Yorktown	"MD", unknown VA locality
299. Bittium curtum	ANSP 1531	Yorktown	Petersburg, VA 1
300. Cerithiopsis smithfieldensis	PRI 1361	Yorktown	Smithfield, VA 3
301. C. bicolor	MCZ	Recent	
302. C. sp.	USNM 403452	Yorktown	Chesapeake, VA 2
303. Seila adamsii	MCZ 156200	Recent	New Bedford, MA
304. Triphora bartschi	PRI 1375	Duplin	Natural Well
305. T. submonilifera	ANSP 4313	Yorktown	Petersburg, VA 1
306. Opalia textuvestitum	PRI 28846	Gurabo	Santo Domingo, Dominican Republic
307. Epitonium bolteni	USNM 325438	Yorktown	Greenville, NC
"E. arctata"	ANSP 17138	Yorktown ?	unspecified
308. E. cornigerum	ANSP 1535	Yorktown	Petersburg, VA 1
309. E. edgecombense	USNM 3255431	Yorktown	Tar River, NC
310. E. fractum	USNM 108015	Recent	off Fernadina, FL
311. E. sheldoni	PRI 1363-4	Yorktown	Kings Mill, VA
312. E. smithfieldensis	USNM 352440	Yorktown	Smithfield, VA 1
313. E. druidi	USNM 403461	Yorktown	Smithfield, VA 3
314. E. spp.	USNM 403462	Chowan River	Chesapeake, Va 1
315. E. aciculum	ANSP 1536	Yorktown	Petersburg, VA 1
316. E. microstomum	ANSP 1537	Yorktown	Petersburg, VA 1
317. E. chuckatuckensis	USNM 403464	Yorktown	Chuckatuck, VA 2
318. E. duplinianum	PRI 1360	Duplin	Natural Well, NC
319. E. micropleurum	ANSP 1534	Yorktown	Petersburg, VA 1
320. E. novangeliae		Recent	Western Atlantic
320a. E. alumensis	USNM 112711	Jackson Bluff	Jackson Bluff, FL
321. Melanella arcuata	MCZ lost	Recent	Jamaica
322. M. chesapeakensis	USNM 403470	Chowan River	Chesapeake, VA 1
323. M. angulata	ANSP missing	Yorktown	Petersburg, VA 1
324. M. laevigata	ANSP 1526	Yorktown	Petersburg, VA 1
325. M. nisoformis	ANSP 19091	Caloosahatchie	St. Petersburg, FL
326. Strombiformis conchita	ANSP 19088	Caloosahatchie	St. Petersburg, FL
327. S. migrans	ANSP 15583	Yorktown	Suffolk, VA
328. Niso aegeles		Recent	Southeastern USA
329. Mucronalia sp.	USNM 403476	Yorktown	Chesapeake, VA 2
330. Atlanta cordiformis	ANSP 2896		Santo Domingo, Dominican Republic
331. Carinorbis lyra	ANSP 30731	Yorktown	James River, VA
332. Iselica globosa	ANSP 1518	Yorktown	Petersburg, VA
333. Calyptraea centralis	ANSP lost	Duplin	Natural Well, NC
334. Crucibulum scutellatum		Recent	Eastern Pacific
335. C. grandis	BM Q-12190	Yorktown	"MD", unknown VA locality
336. C. multilineatum	ANSP 15359	Duplin	Duplin Co., NC
337. C. leanum	USNM 403486	Yorktown	Chesapeake, VA 2
338. C. leanum variety	USNM 403487	Chowan River	Chesapeake, VA 1
339. Crepidula adunca		Recent	Eastern Pacific
340. C. convexa	ANSP missing	Recent	Western Atlantic
341. C. cymbaeformis	ANSP missing	Yorktown	Petersburg, VA 1
342. C. fornicata		Recent	Western Atlantic
343. C. aculeata aculeata		Recent	uncertain
343a. C. a. ponderosa	ANSP 15298	Yorktown	Petersburg, VA 1
343b. C. a. costata	ANSP 15294	Yorktown	"MD", unknown VA locality
344. C. plana	ANSP 19495	Recent	Western Atlantic

345. Lamellaria perspicua		Recent	North Atlantic
346. Erato maugeriae	BM 19741011	Recent	Eastern Atlantic
347. Cypraea carolinensis	ANSP 18858	Duplin	Duplin Co., NC
348. Polinices duplicatus	ANSP lost	Recent	Western Atlantic
348a. P. sp.	USNM 403500	Yorktown	Rice's Pit, Hampton
349. Lunatia interna	BM unnumbered	Yorktown	"MD", unknown VA locality
350. L. perspectivia	MCZ lost	Yorktown	Williamsburg, VA
351. L. sayana	USNM 403503	Yorktown	Chesapeake, VA 2
352. Bulbus chesapeakensis	USNM 403504	Yorktown	Chesapeake, VA 2
353. Sinum chesapeakensis	USNM 403505	Yorktown	Chesapeake, VA 2
354. S. perspectivium	ANSP lost	Recent	Southeastern USA
355. Natica plicatella	ANSP 15107	Duplin	Duplin Co., NC
356. Tectonatica pusilla	ANSP missing	Recent	Southeastern USA
357. Sconsia sp. cf. S. hodgeii	ANSP 18860	Duplin	Natural Well, NC
358. Ficus holmesii	AMNH missing	Duplin	Sumter, SC
359. Chicoreus floridanus	USNM 644823	Pinecrest beds	Brighton, FL
360. Murexiella shilohensis	ANSP 4081	Calvert	Cumberland Co., NJ
361. Scalaspira strumosa	ANSP 13818	Yorktown	James River near Smithfield, VA 1
362. Urosalpinx barbitoides	USNM 325429	Yorktown	Yorktown, VA
363. U. cannabinus	ANSP missing	Yorktown	Petersburg, VA 1
363a. "U. suffolkensis"	USNM 325425	Yorktown	Suffolk, VA
363b. "U. lepidota"	USNM 112186	Caloosahatchie	Fort Thompson, FL
364. U. gardnerae	USNM 325424	Waccamaw	Neill's Eddy Landing, NC
365. U. trossula	ANSP 14858	Yorktown	James River, VA
366. U. rappahannockensis	USNM 325397	Eastover	Bowlers Wharf, VA
367. Pterorytis umbrifer	ANSP 13787	Yorktown	James River, VA
368. Trophonopsis petitii	USNM 403520	Yorktown	Williamsburg, VA 2
369. Boreotrophon tetricus	ANSP 13616	Yorktown	James River, VA
369a. B. t. laevis	USNM 353131	St. Marys	St. Marys Co., MD
370. Coralliophila leonensis	USNM 496425	Jackson Bluff	Jackson Bluff, FL
371. Anachis parvula	ANSP 1577	Yorktown	Petersburg, VA 1
372. A. styliola	USNM 113259	Duplin	Cape Fear River, NC
373. A. virgilina	USNM 325412	Yorktown	Greenville, NC
374. Parvianachis obesa	MCZ 156016	Recent	Jamaica
375. Mitrella comminis	ANSP 30735	Yorktown	James River, VA
376. M. lunata	ANSP missing	Recent	Southeastern USA
376a. M. harbisonae	ANSP 18530	Caloosahatchie	St. Petersburg, FL
377. M. edenensis	ANSP 16761	Yorktown ?	Edenton, NC
378. M. waccamawensis	USNM 325417	Waccamaw	Cape Fear River, NC
379. Nassarina glypta		Recent	Western Atlantic
380. Aesopus stearnsii	ANSP 17019	Recent	Tampa Bay, FL
381. Juliamitrella chesapeakensis	USNM 403534	Yorktown	Chesapeake, VA 2
382. J. gardnerae	USNM 325411	Chowan River	Colerain Landing, NC
383. J. smithfieldensis	USNM 352438	Yorktown	Smithfield, VA 1
384. J. virginica	USNM 403536	Chowan River	Chesapeake, VA 1
385. Buccinum sp.	USNM 403537	Yorktown	Chuckatuck, VA 1
386. Tortifusus curvirostra	ANSP missing	Chowan River	NC
387. Ptychosalpinx altile	ANSP 14349	Yorktown	James River near Smithfield, VA
388. P. chesapeakensis	USNM 403541	Yorktown	Chesapeake, VA 2
389. P. laqueata	ANSP 14199	Yorktown	James River, VA
390. P. multirugata	ANSP 1516	Duplin	Duplin Co., NC
391. P. tuomeyi	ANSP missing	Yorktown	Petersburg, VA 1
392. Tritonoharpa floridensis	PRI missing	Pinecrest beds	Prairie Creek FL
393. Cantharus nux	USNM 113224	Duplin	Cape Fear River, NC
394. Ecphora quadricostata	BM GG 12661	Yorktown ?	"MD", unknown VA locality
395. Busycon maximum	ANSP 17191	Yorktown	Yorktown, VA
396. B. m. filosum	ANSP 14310	Yorktown	Yorktown, VA
397. B. canaliferum	AMNH 11081	Waccamaw	Waccamaw River,

			SC
398. B. incile	ANSP 1637	Yorktown	Yorktown, VA
398b. "B. alveatum"	ANSP 2697	Yorktown	"MD", unknown VA locality
399. B. contrarium	ANSP 14295	Duplin	Duplin Co., NC
400. Lyrasoma sulcosa	ANSP missing	St. Marys	St. Marys Co., MD
401. L. s. multicostata	PRI 3516	Yorktown z. 1	Kings Mill, VA
402. Nassarius consenoides	PRI 207	Duplin	Natural Well, NC
403. N. quadrulatus	ANSP 1558	Yorktown	Petersburg, VA 1
404. N. shacklefordensis	PRI 201	Yorktown ?	Shackleford, VA
405. Ilyanassa granifera	ANSP 14258	Yorktown	VA
406. I. harpuloides harpuloides	ANSP missing	Yorktown	Petersburg, VA 1
407. I. h. johnsoni	USNM 124961	Duplin	Cape Fear River, NC
408. I. h. scalaspira	ANSP missing	Yorktown	VA
409. I. porcina	BM Q-12191	Yorktown	"MD", unknown VA locality
410. I. sexdentata	ANSP missing	uncertain	none given
410b."I. isogramma"	USNM 87751	Waccamaw	Wilmington, NC
411. Fasciolaria rhomboidea	MCZ missing	Yorktown	Williamsburg, VA
412. Triplofusus gigantea		Recent	Southeastern USA
413. Terebraspira acuta	PRI missing	Duplin	Cape Fear River, NC
414. Fusinus exilis exilis	ANSP 13843	Yorktown	James River, VA
415. F. e. burnsii	USNM 97843	Yorktown	Petersburg, VA 1
416. F. propeparilis	USNM 370828	Yorktown z. 1	Bellefield, VA
417. Hesperisternia filicata	ANSP missing	Yorktown	James River, VA
418. Oliva canaliculata	ANSP 31412?	Yorktown	Petersburg, VA 1, not St. Marys, MD
419. Olivella ancillariaeformis	ANSP 1573	Yorktown	Petersburg, VA 1
420. O. carolinae	USNM 325378	Duplin	Lumberton, NC
421. O. mutica	ANSP missing	Recent	Southeastern USA
422. O. sp.	USNM 403575	Yorktown	Chuckatuck, VA 2
423. Vexillum elaboratum	ANSP 1564	Yorktown	Petersburg, VA 1
424. V. reticulatum	PRI missing	uncertain	NC
426. Scaphella solitaria ricei	USNM 403578	Yorktown	Rice's Pit, Hampton, VA
427. Aurinia mutabilis	ANSP 30700	St. Marys	St. Marys, MD
428. A. obtusa	PRI missing	uncertain	Bladen Co., NC
429. A. sinuosa	ANSP 14405	Yorktown	unknown
430. Cancellaria depressa	AMNH 11119/1	Waccamaw	Horrey Co., SC
431. C. plagiostoma	ANSP 1609	Yorktown	James River, VA
432. C. rotunda	USNM missing	Duplin	Magnolia, NC
433. C. (Massyla) rapella	WFIS 11597	Duplin	Duplin Co., NC
434. Agatrix williamsii	USNM 220090	Yorktown	Rice's Pit, Hampton, VA
435. Trigonostoma perspectiva	ANSP 3314	Yorktown	James River, VA
436. T. tenerum carolinensis	PRI missing	Duplin	Cape Fear, Bladen Co., NC
437. T. smithfieldensis	USNM 563929	Yorktown	Smithfield, VA 1
438. T. (Extractrix) hoerlei	USNM 645162	Pinecrest beds	Kissimmee, FL
439. Bullata antiqua	ANSP 2518	Yorktown	Petersburg, VA 1
440. B. (Microspira) oviformis	ANSP 1617	Yorktown	VA
441. Dentimargo aureocincta		Recent	Southeastern USA
442. D. chesapeakensis	USNM 403590	Chowan River	Chesapeake, VA 1
442a. D. schmidti	PRI 210	Duplin	Natural Well, NC
443. D. eburneola	ANSP 2516	Yorktown	Suffolk, VA
444. Prunum bellum	ANSP 2513	Yorktown	VA
445. P. limatulum	ANSP 2512	Yorktown	Suffolk, VA
446. P. roscidum		Recent	Southeastern USA
447. P. virginianum	ANSP 2514	Yorktown	James River, VA
448. Gibberula lavalleeana	BM	Recent	Cuba
449. Granula sp.	USNM 403596	Chowan River	Chesapeake, VA 1
450. Persicula ovula	ANSP 2511	Yorktown	James River, VA
451. Volvarina tersa	USNM 370050	Jackson Bluff	Washington Co., FL
452. Granulina mansfieldi	USNM 403600	Chowan River	Chesapeake, VA 1

453. G. hadria	MCZ	Recent	
454. Conus adversarius	ANSP 30699	Duplin	Duplin Co., NC
455. C. marylandicus	unknown	Yorktown	"MD", unknown VA locality
456. Terebra blakei	USNM 496423	Jackson Bluff	Jackson Bluff, FL
457. T. concava	ANSP missing	Recent	Southeastern USA
458. T. emmonsii emmonsii	PRI missing	Duplin	NC
459. T. e. grayi	USNM 325369	Yorktown	Yorktown, VA
460. T. e. hamptonensis	USNM 403607	Yorktown	Rice's Pit, Hampton, VA
461. T. indenta	ANSP missing	Duplin	Natural Well, NC
462. T. sp.	USNM 403609	Yorktown	Chesapeake, VA 2
463. T. sp.	USNM 403610	Chowan River	Chesapeake, VA 1
464. Cochlespira sp.	USNM 403611	Yorktown	Chippoaks Plantation, VA
465. Pyrgospira tricatenaria	ANSP 1604	Yorktown	James River, VA
465a. "Surcula nodulifera"	ANSP 30738	uncertain	"VA"
466. Mitrolumna smithfieldensis	PRI 4021	Yorktown	Smithfield, VA 1
467. M. yadkinensis	USNM 403614	Chowan River	Chesapeake, VA 1
468. Drillia (Drillia) chuckatuckensis	USNM 403615	Yorktown	Chuckatuck, VA 2
469. D. (Clathrodrillia) impressa	ANSP 1606	Yorktown	James River, VA
470. Imaclava haleii	USNM 403617	Yorktown	Chuckatuck, VA 2
471. Cerodrillia simpsoni cingulata	USNM 114040	Duplin	Natural Well, NC
472. Crassispira pyrenoides	ANSP 30589	Yorktown	James River, VA
473. C. (Crassispirella) virginiana	ANSP 30589	Yorktown	Smithfield, VA 1
475. Sedilia bella	ANSP 1607	Yorktown	VA
476. S. belloides	PRI 1362	Yorktown	James River near Smithfield, Va 3
477. S. rushmerensis	USNM 352436	Yorktown	Rushmere, VA
478. Carinodrillia smithfieldensis	PRI 22941	Yorktown	Smithfield, VA 3
479. Splendrillia arata	ANSP 1605	Yorktown	VA
480. Cymatosyrinx lunata	ANSP missing	Yorktown	Petersburg, VA 1
481. C. ricei	USNM 403625	Yorktown	Rice's Pit, Hampton, VA
482. Bellaspira virginiana	ANSP 30737	Yorktown	Yorktown, VA
483. Compsodrillia sp.	ANSP 1611	Yorktown	VA
484. C. eburnea	ANSP 1608	Yorktown	VA
485. Mangelia andrewi	USNM 403627	Yorktown	Williamsburg, VA 3
486. Cryoturris maesi	USNM 403628	Yorktown	Chuckatuck, VA 2
487. C. magnoliana	PRI 208	Duplin	Natural Well, NC
488. Kurtziella smithfieldensis	PRI 209	Yorktown	Smithfield, VA 3
489. Glyphostoma zoster	USNM 497852	Duplin	Natural Well, NC
490. Pyrgocythara (Vitricythara) micromeris	USNM 163993	Caloosahatchie	Shell Creek, FL
490a. P. (V.) metria	USNM 163985	Caloosahatchie	Shell Creek, FL
491. Oenopota pumilus	ANSP 13827a	Yorktown	"MD", unknown VA locality
492. Longchaeus suturalis	ANSP 1565	Yorktown	Petersburg, VA 1
493. L. simplex	ANSP 1519	Yorktown	Petersburg, VA 1
494. Odostomia (Odostomia) alpha	USNM 403637	Yorktown z. 1	Williamsburg, VA 1
495. O. (O.) beta	USNM 403638	Yorktown	Rice's Pit, Hampton, VA
496. O. (O.) gamma	USNM 403639	Yorktown	Chesapeake, VA 2
497. O. (O.) epsilon	USNM 403640	Yorktown	Chesapeake, VA 2
498. O. (O.) mu	USNM 403641	Yorktown	Chesapeake, VA 2
499. O. (Chrysallida) granulata	ANSP 1533	Yorktown	Petersburg, VA 1
500. O. (C.) archeri	USNM 31319	Caloosahatchie	St. Petersburg, FL
501. O. (C.) eta	USNM 403645	Yorktown	Williamsburg, VA 3
502. O. (C.) theta	USNM 403646	Yorktown	Chesapeake, VA 2
503. O. (C.) zeta	USNM 403647	Yorktown	Chuckatuck, VA 2
503a. O. (C.) omicron	USNM 403648	Yorktown	Chuckatuck, VA 2
504. O. (Menestho) iota	USNM 403649	Yorktown	Williamsburg, VA 3
505. O. (M.) milium	ANSP 1522	Yorktown	Petersburg, VA 1
506. O. (Evalea) diaphana	ANSP 1523	Yorktown	Petersburg, VA 1

507. O. (E.) ovula	ANSP 1524	Yorktown	Petersburg, VA 1
508. O. (E.) lambda	USNM 403654	Yorktown	Chesapeake, VA 2
509. O. (E.) nu	USNM 403655	Yorktown	Chesapeake, VA 2
510. O. (E.) xi	USNM 403656	Yorktown	Chesapeake, VA 2
511. O. (E.) sculpturata	ANSP missing	Yorktown	Petersburg, VA 1
512. O. (Eulimastomia) rho	USNM 403659	Yorktown	Smithfield, VA 3
513. O. (Chesapeakella) sigma	USNM 403660	Yorktown	Chesapeake, VA 2
514. O. limnia	ANSP missing	Yorktown	Yorktown, VA
515. O. nitens	ANSP missing	Yorktown	Petersburg, VA 1
516. O. protexta	ANSP 15631?	Yorktown	Yorktown, VA
517. O. turbinatus	ANSP missing	Yorktown	Petersburg, VA 1
518. Triptychus biseriatus	ANSP 3212	Moin	Costa Rica
519. Turbonilla (Chemnitzia) alpha	USNM 403662 Yorktown	Smithfield, VA 3	
520. T. (C.) beta	USNM 403663	Yorktown	Chesapeake, VA 2
521. T. (Strioturbonilla) exarata	ANSP 1528	Yorktown	Petersburg, VA 1
522. T. (S.) subula	ANSP 1529	Yorktown	Petersburg, VA 1
523. T. (S.) delta	USNM 403666	Yorktown	Chesapeake, VA 2
524. T. (S.) eburnea	ANSP missing	Yorktown	Petersburg, VA 1
525. T. (Pyrgiscus) kappa	USNM 403668	Yorktown	Chesapeake, VA 2
526. T. (P.) digamma	USNM 403669	Yorktown	Smithfield, VA 3
527. T. (P.) zeta	USNM 403670	Chowan River	Chesapeake, VA 1
528. T. (P.) eta	USNM 403671	Yorktown	Williamsburg, VA 2
529. T. (P.) daedaleum	ANSP missing	Yorktown	Petersburg, VA 1
530. T. (Bartschella) iota	USNM 403672	Yorktown	Chesapeake, VA 2
532. Cyclostremella magnoliana	PRI 2352	Duplin	Natural Well, NC
533. Acteon novellus	ANSP 1600	Yorktown	Suffolk, VA
534. A. vaughani	USNM 369881	Jackson Bluff	Jackson Bluff, FL
535. Ringicula guppyi	USNM 97466	Caloosahatchie	Fort Thompson, FL
536. R. sp.	USNM 403676	Yorktown	Rice's Pit, Hampton, VA
537. Acteocina candei	BM 1854.10.4.17	Recent	"Antilles", probably Cuba
538. A. myrmecoon	USNM 113875	Duplin	Natural Well, NC
539. A. cylindrica	PRI missing	Duplin ?	NC
540. Cylichna johnsoni	USNM 403680	Yorktown z. 1	Williamsburg, VA 1
541. Cylichnella sp.	USNM 403681	Yorktown	Chesapeake, VA 2
542. Philine williamsi	USNM 403682	Yorktown	Chesapeake, VA 2
543. Haminoea sp.	Williams collection	Yorktown	Rice's Pit, Hampton
544. Retusa microtrema	USNM 113887	Duplin	Natural Well, NC
545. R. chesapeakensis	USNM 403684	Yorktown	Chesapeake, VA 2
546. Volvulella cylindra	ANSP 1554	Yorktown	Petersburg, VA 1
547. Limacina chesapeakensis	USNM 403686	Yorktown	Chesapeake, VA 2
548. Creseis acicula		Recent	
549. Hyalocylis striata		Recent	
550. Cavolinia uncinata		Recent	
551. C. ventricosa	USNM 115625	Bowden	Jamaica
552. Viviparus sp."Turbo glaber"	USNM 113554	Yorktown	Petersburg, VA 1
553. Viviparus sp.	USNM 403692	Chowan River	Chesapeake, VA 1
554. Viviparus sp.	W & M collections	Yorktown	Williamsburg, VA 3
555. Lioplax sp.	USNM 403694	Chowan River	Chesapeake, VA 1
556. Incerta sedis	USNM 403695	Yorktown	Chesapeake, VA 2

PLATES

MUSEUM ABBREVIATIONS AND LOCALITY CODES FOR PLATES 1 THROUGH 43

MUSEUM ABBREVIATIONS

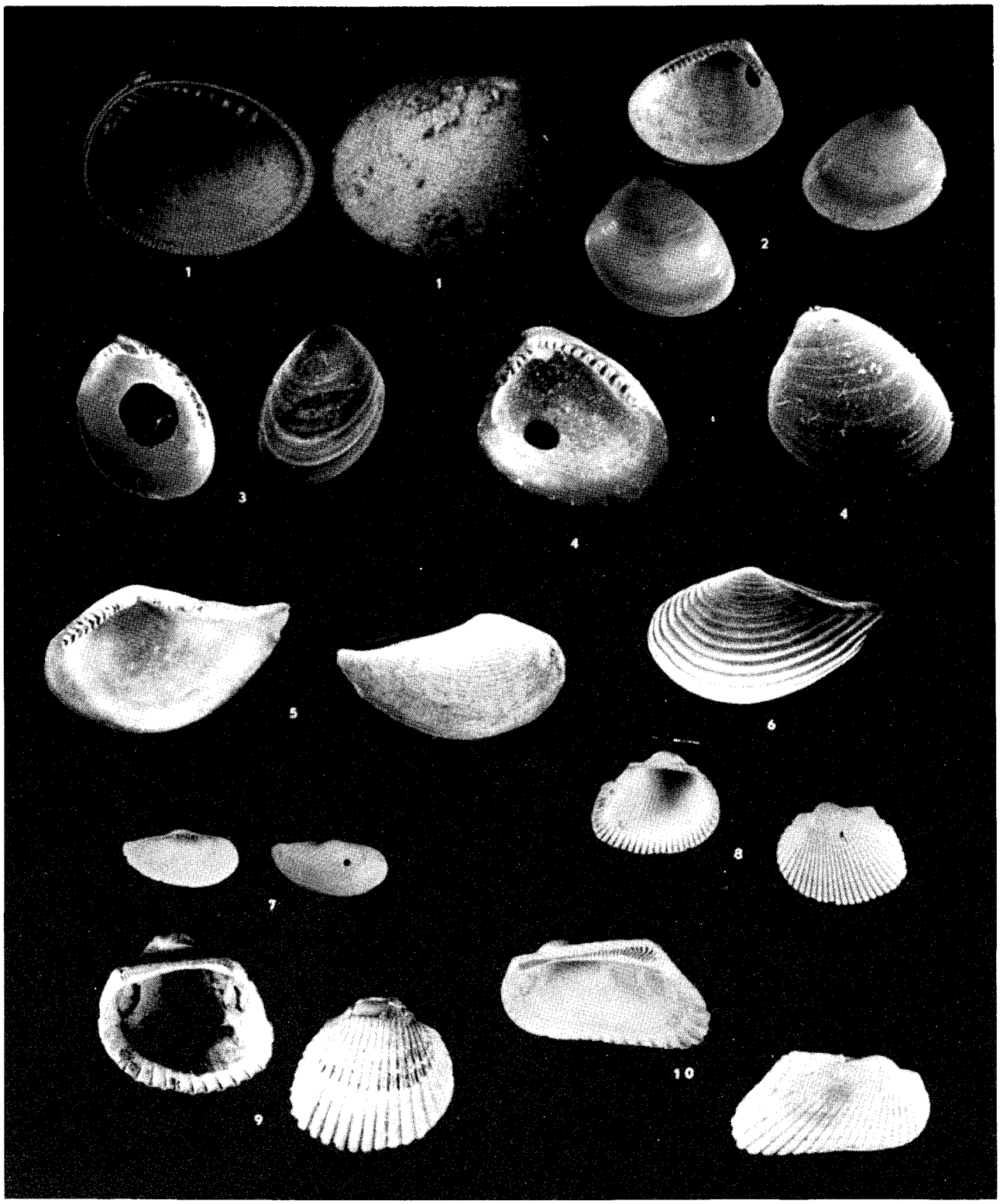
AMNH-American Museum of Natural History;
ANSP-Academy of Natural Sciences, Philadelphia;
BM-British Museum;
MCZ-Museum of Comparative Zoology;
WFI-Wagner Free Institute, Philadelphia;
USNM-United States National Museum.

LOCALITY CODES

Chesapeake, VA	1. Deep Creek Industries Pit, 2 miles west of Deep Creek, Chesapeake, Virginia, at the end of Cooke's Mill Road. Level 1 is the upper, iron-stained shelly sands of the Chowan River Formation (Upper Pliocene) found along the East and South walls.
Chesapeake, VA	2. Same locality, middle horizon, a blue-gray shelly sand of middle Zone 2, Yorktown Formation, found throughout the pit.
Chesapeake, VA	3. Same locality, basal, silty beds with many paired scallops.
Chuckatuck, VA	1. Crane Lake (formerly Lone Star Cement Company pit), about one mile north of Chuckatuck, City of Suffolk, Virginia; cross-bedded, coarse shell sands. Upper Zone 2, Yorktown Formation.
Chuckatuck, VA	2. Same locality, uppermost beds on West wall, with common *Panopea* and diverse fauna. Upper Zone 2, Yorktown Formation.
Petersburg, VA	1. Literature citations without precise locality.
Petersburg, VA	2. Lieutenent Run.
Smithfield, VA	1. Literature citations without precise locality.
Smithfield, VA	2. Rock Wharf, approximately 2 miles northwest of Smithfield on the James River. This site was collected by Conrad in the last century, and by Olsson (1914, 1916), Mansfield (1929), Gardner (1944, 1948), and many others. The present ownership does not permit collecting. Level 2 refers to the Mogarts Beach Clay beds in the base of the river bluffs.
Smithfield, VA	3. Rock Wharf, shelly sands overlying the clay beds.
Williamsburg, VA	1. Tutter's Neck Pond spillway, approximately 2 miles east of town.
Williamsburg, VA	2. *Chama* beds next to maintenance shed, Golden Horseshoe Golf Course.
Williamsburg, VA	3. Stream bank to right of bridge between the football stadium and Yates Hall dormatory, the College of William and Mary.

PLATE 1

1. *Nucula diaphana* (holotype figured ANSP 1591), Petersburg 1, figure from Gardner, 1944, (X 17).
2. *Nucula proxima* (figured hypotype, USNM 265719), Chuckatuck 2, SEM (X 4).
3. *Nucula dolabella* (figured hypotype, USNM 265720), Chuckatuck 2, SEM (X 10).
4. *Nucula taphria* (figured hypotype, USNM 265721), Chesapeake 2, SEM (X 9.5).
5. *Nuculana acuta* (figured hypotype, USNM 265722), Chuckatuck 2, SEM (X 4.5).
6. *Nuculana hypsoma* (figured hypotype, USNM 265723), Chesapeake 1, SEM (X 10).
7. *Yoldia laevis* (figured hypotype, USNM 265724), Rice's Pit, Hampton, VA (X 0.9).
8. *Anadara callicestosa* (figured hypotype, USNM 265725), Chuckatuck, 1, (X 0.9).
9. *Anadara carolinensis* (figured hypotype, USNM 265726), Carter's Grove, VA, (X 0.5).
10. *Anadara propatula* (figured hypotype, USNM 265727), Rice's Pit, Hampton, VA, (X 0.5).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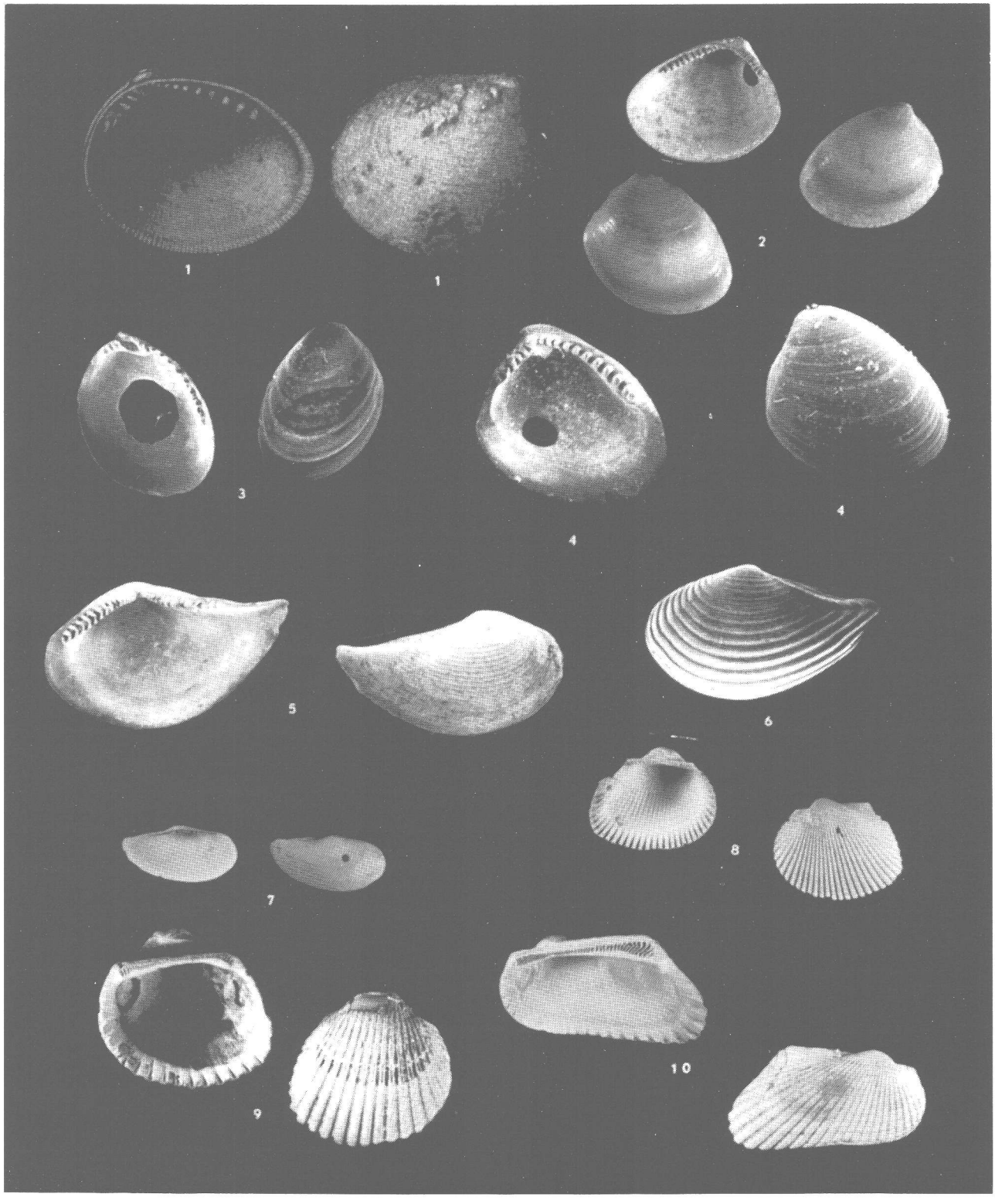
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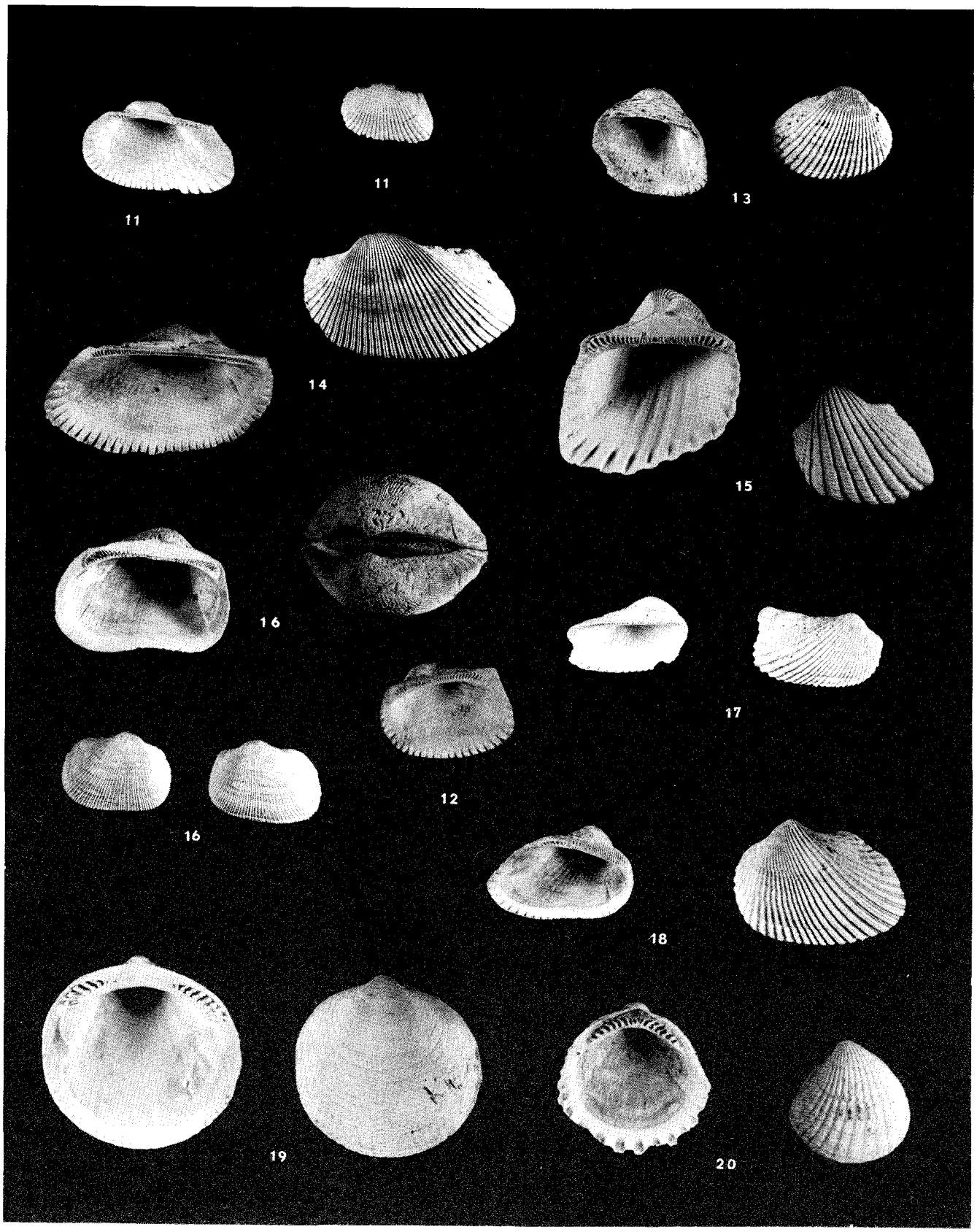
PLATE 2

11. *Anadara improcera* (figured hypotype, USNM 265728), Chuckatuck, VA 1, (X 1.2).
12. *Anadara improcera buccula* (figured hypotype, USNM 265729), Zook's Pit, Yorktown, VA, (X 1.7).
13. *Anadara aequicostata* (figured hypotype, USNM 265730), Chesapeake, VA 1, (X 0.5).
14. *Anadara lienosa* (figured hypotype, USNM 265731), Rice's Pit, Hampton, VA, (X 0.5).
15. *Anadara staminea* (figured hypotype, USNM 265732), Rice's Pit, Hampton, VA, (X 0.8).
16. *Striarca centenaria* (figured hypotype, USNM 265733), Williamsburg, VA 2, (X 0.6).
17. *Noetia incile* (figured hypotype, USNM 265734), Petersburg, VA 2, (X 0.9).
18. *Noetia limula* (figured hypotype, USNM 265735), Chesapeake, VA 1, (X 0.6).

18a. *Noetia trigintinaria* not figured.

19. *Glycymeris americana* (figured hypotype, USNM 265736), Chesapeake, VA 2, (X 0.5).
20. *Glycymeris pectinata* (figured hypotype, USNM 265737), Yorktown, VA, (X 2.0).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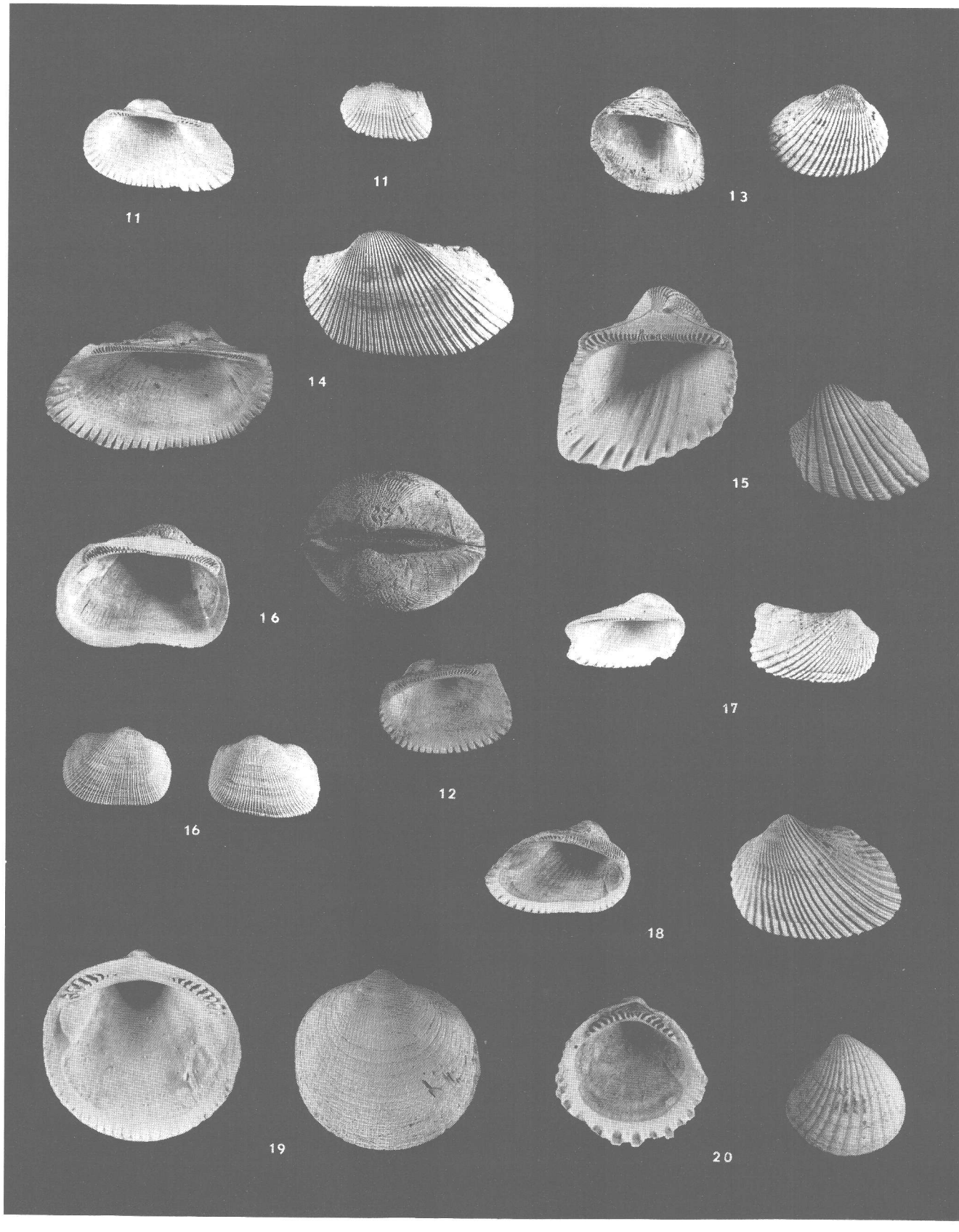
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PLATE 3

21. *Glycymeris subovata* (figured hypotypes, USNM 265738), Chesapeake, VA 2, (X 0.5).

22. *Mytilus edulis alaeformis* (figured hypotype, USNM 265739), Chesapeake, VA 2, (X 1.0).

23. *Brachidontes* sp. (figured hypotype, USNM 265740), Chesapeake, VA 1, SEM (X 20).

24. *Crenella aequilatera* (syntype figured, ANSP 1593), Petersburg, VA 1, SEM (X 23).

24a. *Crenella aequilatera* (figured hypotype, USNM 265809), Chesapeake, VA 2, SEM (X 23).

25. *Crenella* sp. cf. *C. decussata* (figured hypotype, USNM 265742). Chesapeake, VA 1, SEM (X 27).

26. *Crenella precursor* (figured hypotype, USNM 325498), Suffolk, VA, figure from Gardner, 1944, (X 2.5).

27. *Arcoperna williamsi* (holotype figured, USNM 265743), Rice's Pit, Hampton, VA, (X 1.3).

28. *Musculus ricei* (holotype figured, USNM 265744), Rice's Pit, Hampton, VA, SEM (X 9.0).

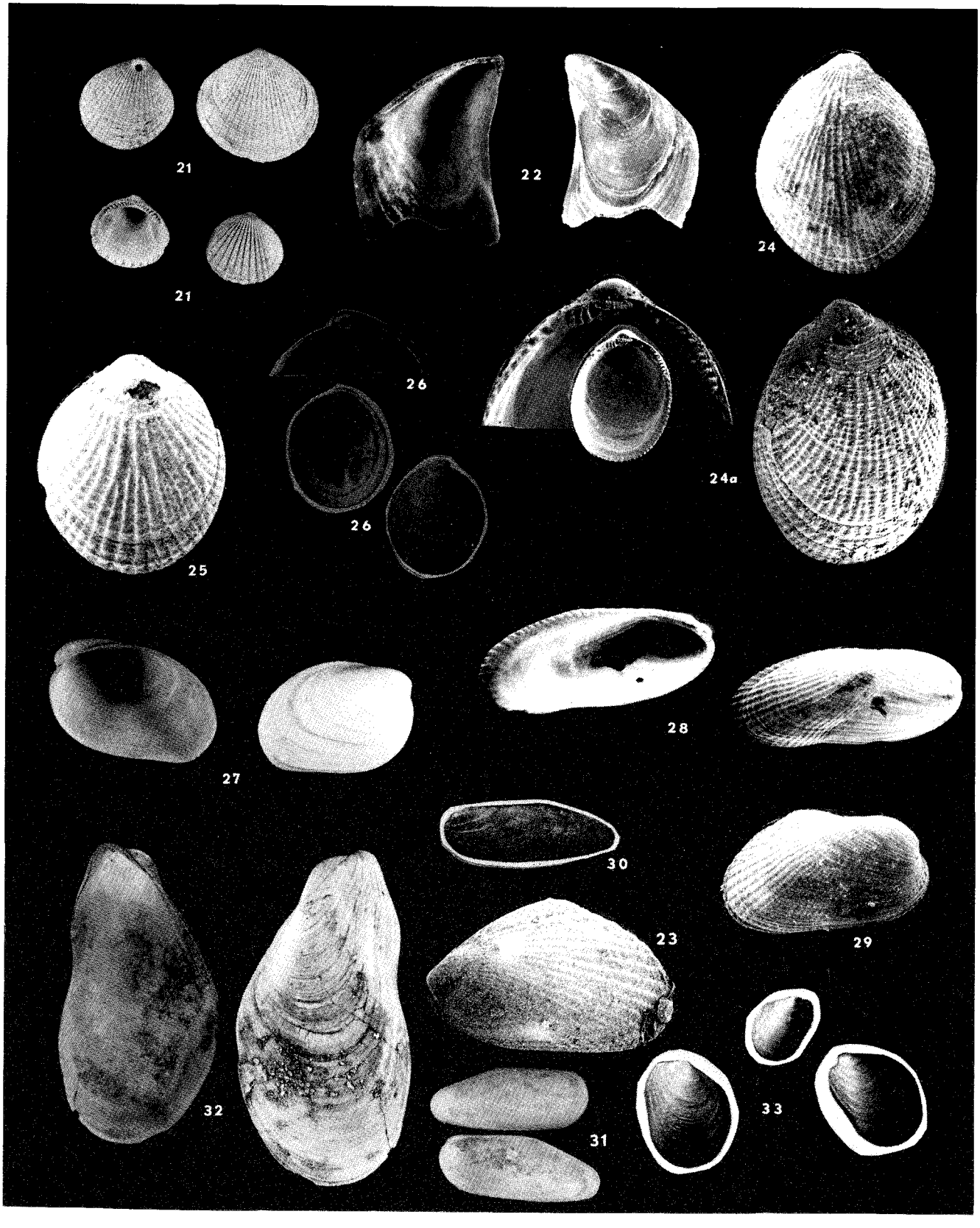
29. *Musculus virginicus* (figured hypotype, USNM 265745), Chesapeake, VA 2, SEM (X 10).

30. *Lithophaga pectinicola* (holotype figured, PRI 1372), Yorktown, VA, figure from Olsson, 1914, (X 2.5).

31. *Lithophaga yorkensis* (figured hypotype, USNM 265746), Chuckatuck, VA 2, (X 2.0).

32. *Modiolus gigas* (figured hypotype, USNM 265747), Chuckatuck, VA 1, (X 0.5).

33. *Modiolus pulchellus* (syntypes figured, PRI 3506, 8) Yorktown, Zone 1 Kings Mill, VA, figures from Olsson, 1914, (X 1.5).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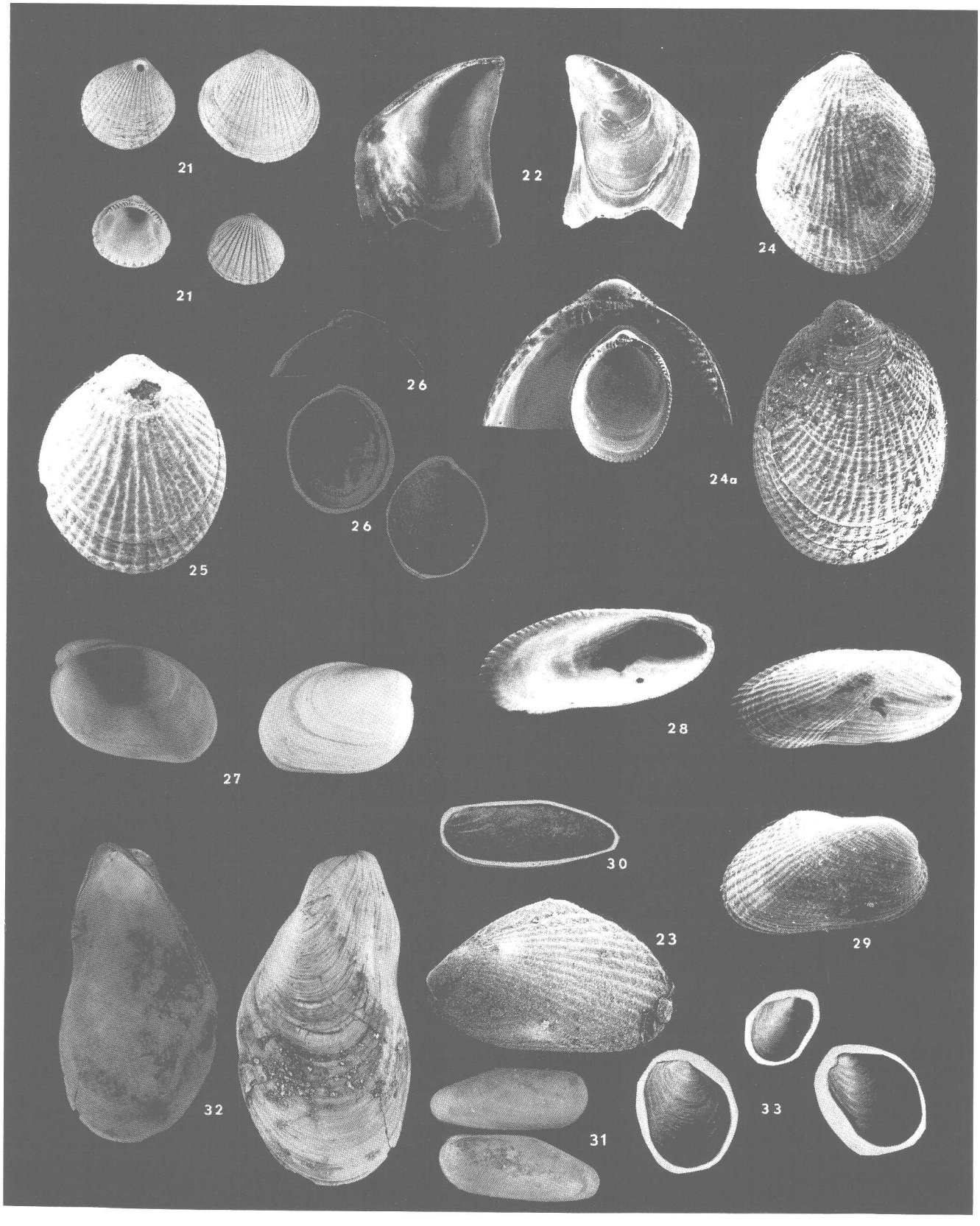
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PLATE 4

34. *Atrina harrisi* (figured hypotype, USNM 265748), Chuckatuck VA 2, (X 0.7).

35. *Pteria colymbus* (figured hypotype, USNM 265749), Rice's Pit, Hampton, VA, (X 0.8).

36. *Pecten hemicyclicus* (figured hypotype, USNM 265750), Chuckatuck, VA 1, (X 0.5).

37. *Pecten smithii* (figured hypotypes, USNM 265751), Chippokes Plantation, (X 0.3).

38. *Amusium mortoni* (figured hypotype, USNM 265752), Rice's Pit, Hampton, VA, (X 0.3).

39. *Leptopecten leonensis* (figuredhypotypes, USNM 265753), Gloucester Co., VA (X 0.8).

40. *Leptopecten wilsoni* (holotype figured, USNM 265754), Wilson's Pit, Hampton, VA (X 1.3).

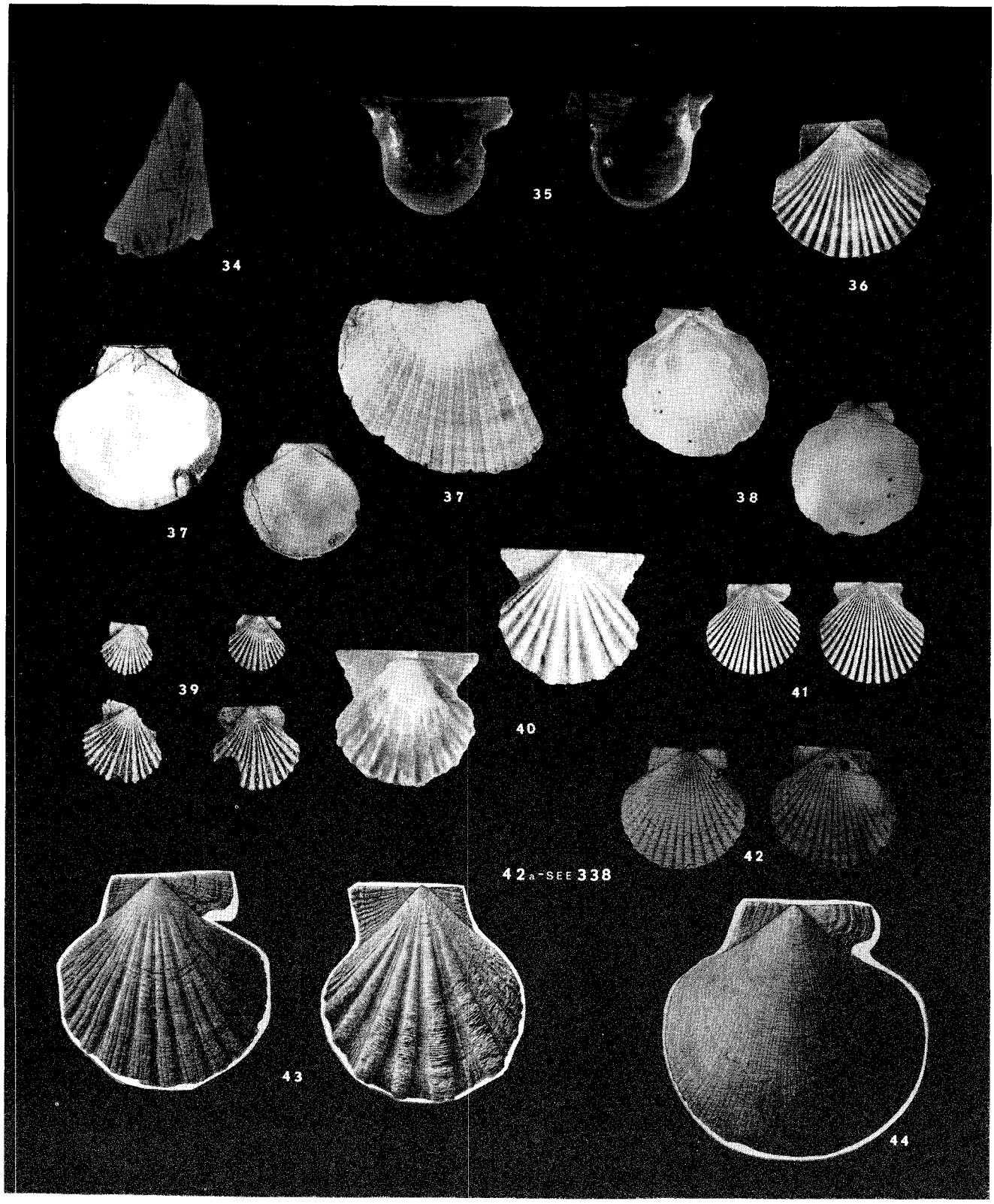
41. *Argopecten comparilis* (figured hypotype, USNM 265755), Chesapeake, VA 2, (X 0.5).

42. *Carolinapecten eboreus* (figured hypotype, USNM 265756), Chesapeake, VA 2, (X 0.3).

42a. *Carolinapecten eboreus* chesapeakensis (holotype figured, USNM 265808), Chesapeake, VA 1, figured on plate 31, (X 0.7).

43. *Chlamys decemnarius* (figured hypotypes, USNM 325494-5), Sycamore, VA, figure from Gardner, 1944, (X 0.9).

44. *Chlamys decemnarius virginianus* (holotype figured, ANSP 1620) City Point, VA, figure from Gardner, 1944, (X 1.0).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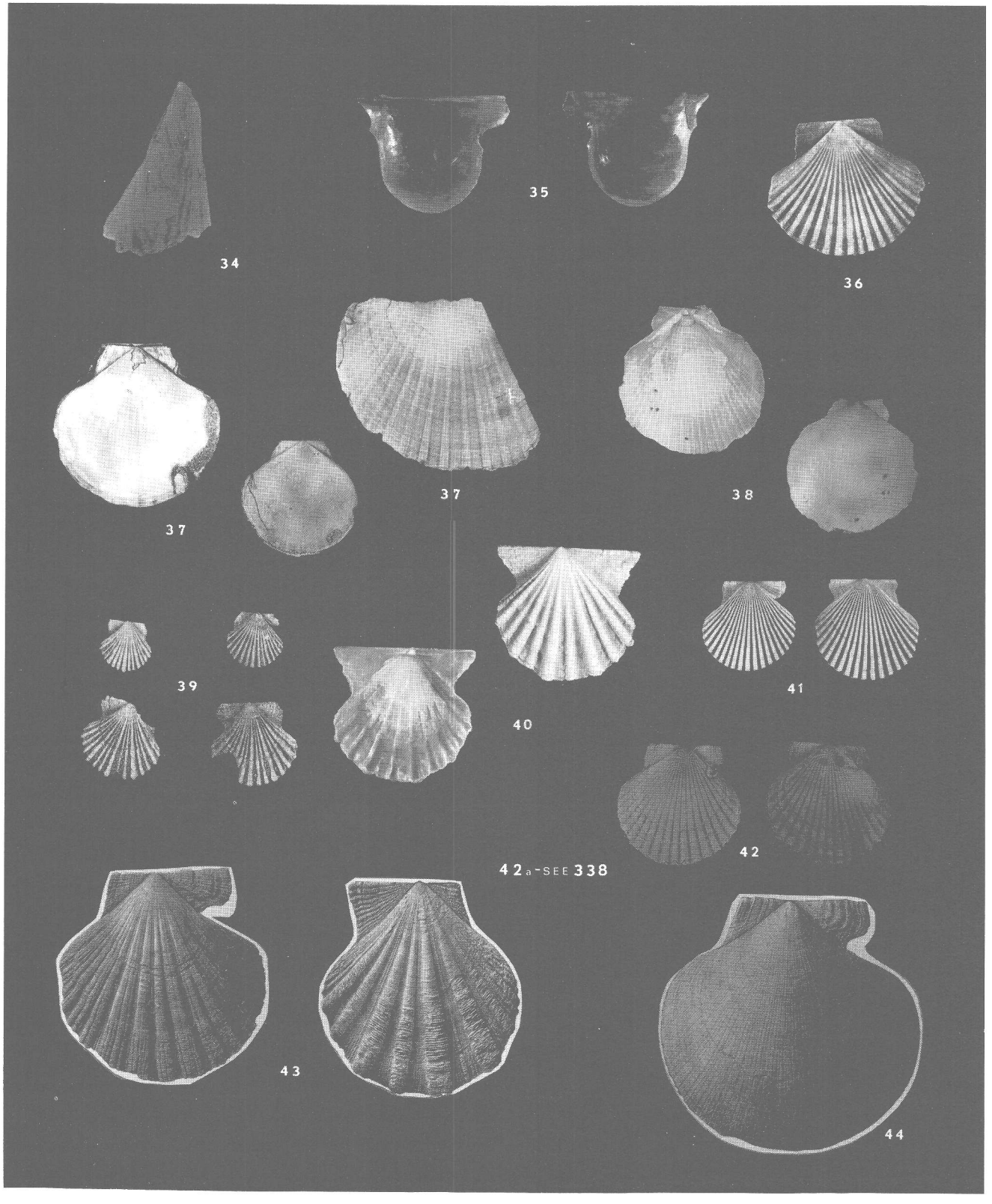
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PLATE 5

44a. *Chlamys* sp. (figured hypotype, USNM 265757), Chesapeake, VA 1 (X 0.6).

44b. *Chlamys rogersi* (figured hypotype, USNM 495374), Sycamore Bend, VA, (X 1.2).

45. *Placopecten clintonius* (figured hypotype, USNM 265758), Chippokes, VA, (X 0.3).

46. *Chesapecten jeffersonius* (figured hypotype, USNM 265759), Williamsburg, VA 1, (X 0.3).

47. *Chesapecten madisonius* (figured hypotype, USNM 265760), Chesapeake, VA 2, (X 0.3).

48. *Chesapecten septenarius* (figured hypotype, USNM 265761), Rice's Pit, Hampton, VA, (X 0.6).

50. *"Nodipecten peedeensis"* ("Lectotype" of Tucker, 1938, is figured, USNM 9526), the specimen is of European origin (X 0.3).

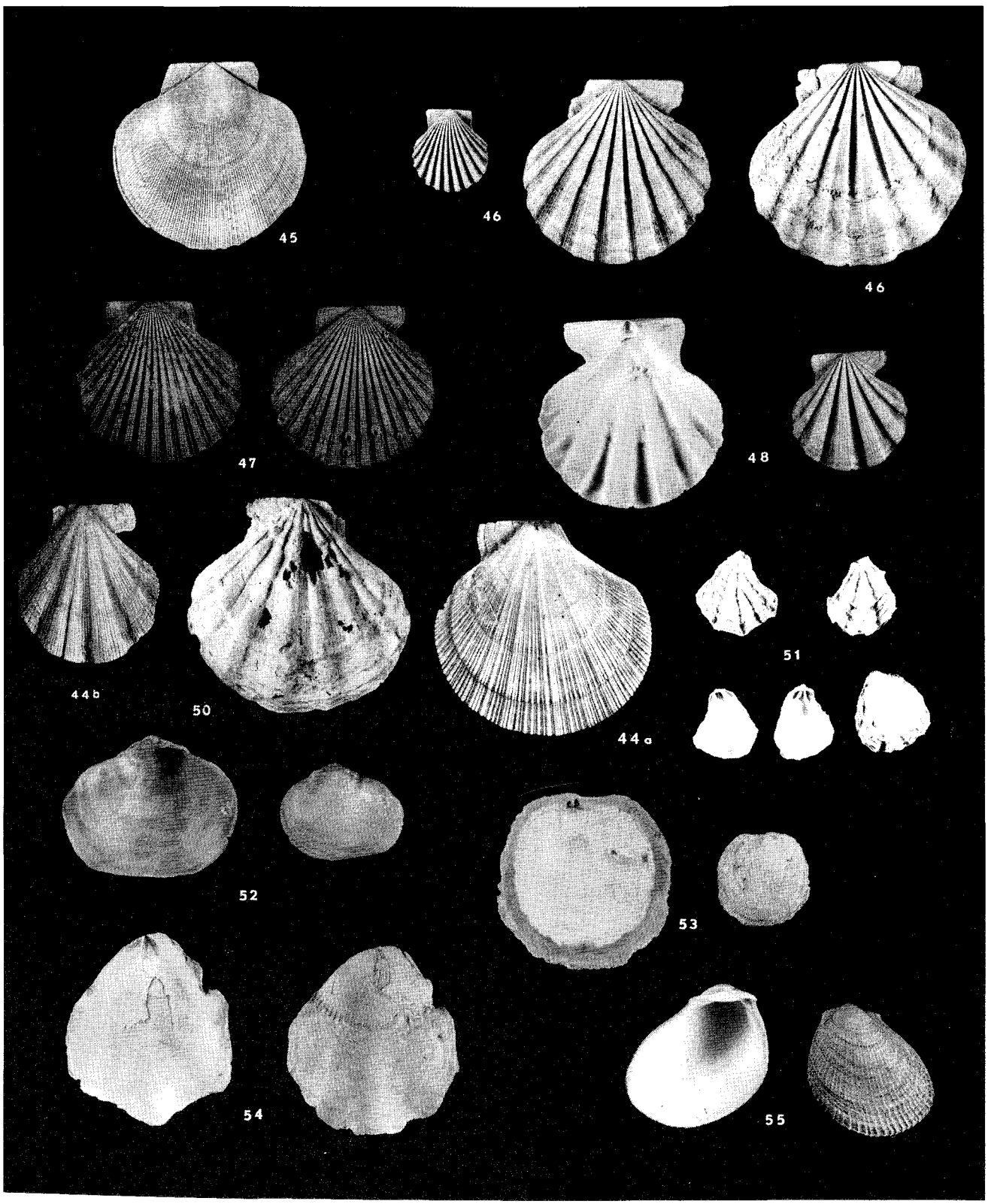
51. *Plicatula marginata* (figured hypotypes, USNM 265762), Petersburg, VA 1, (X 0.7).

52. *Anomia simplex* (figured hypotype, USNM 265763), Rice's Pit, Hampton, VA, (X 1.2).

53. *Pododesmus* sp. (figured hypotype, USNM 265764), Rice's Pit, Hampton, VA, (X 1.0).

54. *Placunanomia plicata* (figured hypotype, USNM 265765), Rice's Pit, Hampton, VA, (X 0.6).

55. *Lima carolinensis* (figured hypotype, USNM 265766), Rice's Pit, Hampton, VA, (X 0.9).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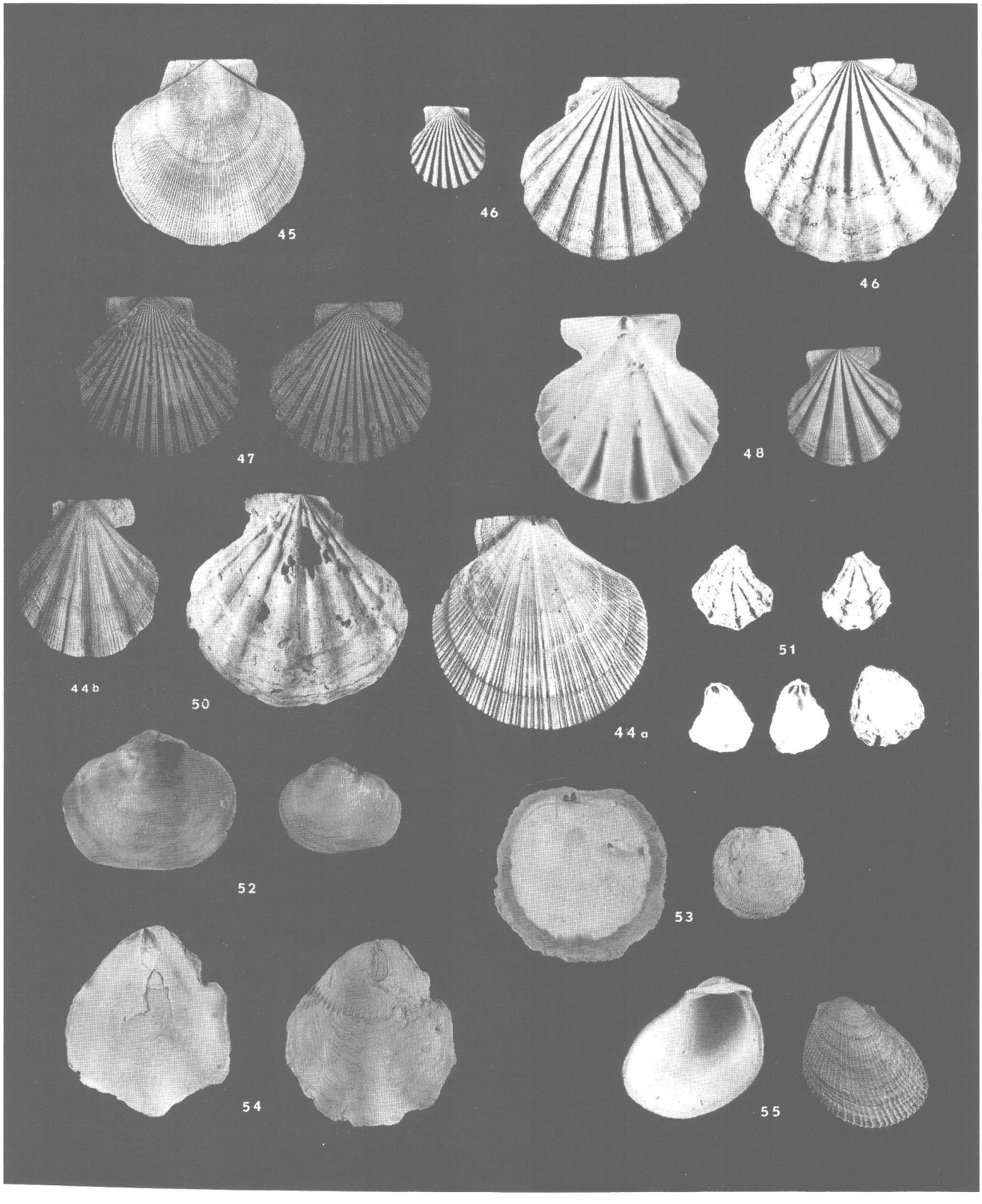
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PLATE 6

56. *Lima pellucida* (figured hypotype, USNM 265767), Chuckatuck, VA 2, (X 1.0).

57. *Limatula virginiana* (holotype figured, USNM 265768), Rice's Pit, Hampton, VA, SEM (X 11).

58. *Ostrea compressirostra* (figured hypotypes, USNM 265769), Williamsburg, VA 1, (X 0.4).

59. *Ostrea sculpturata* (figured hypotypes, USNM 265770), Chesapeake, VA 2, (X 0.4).

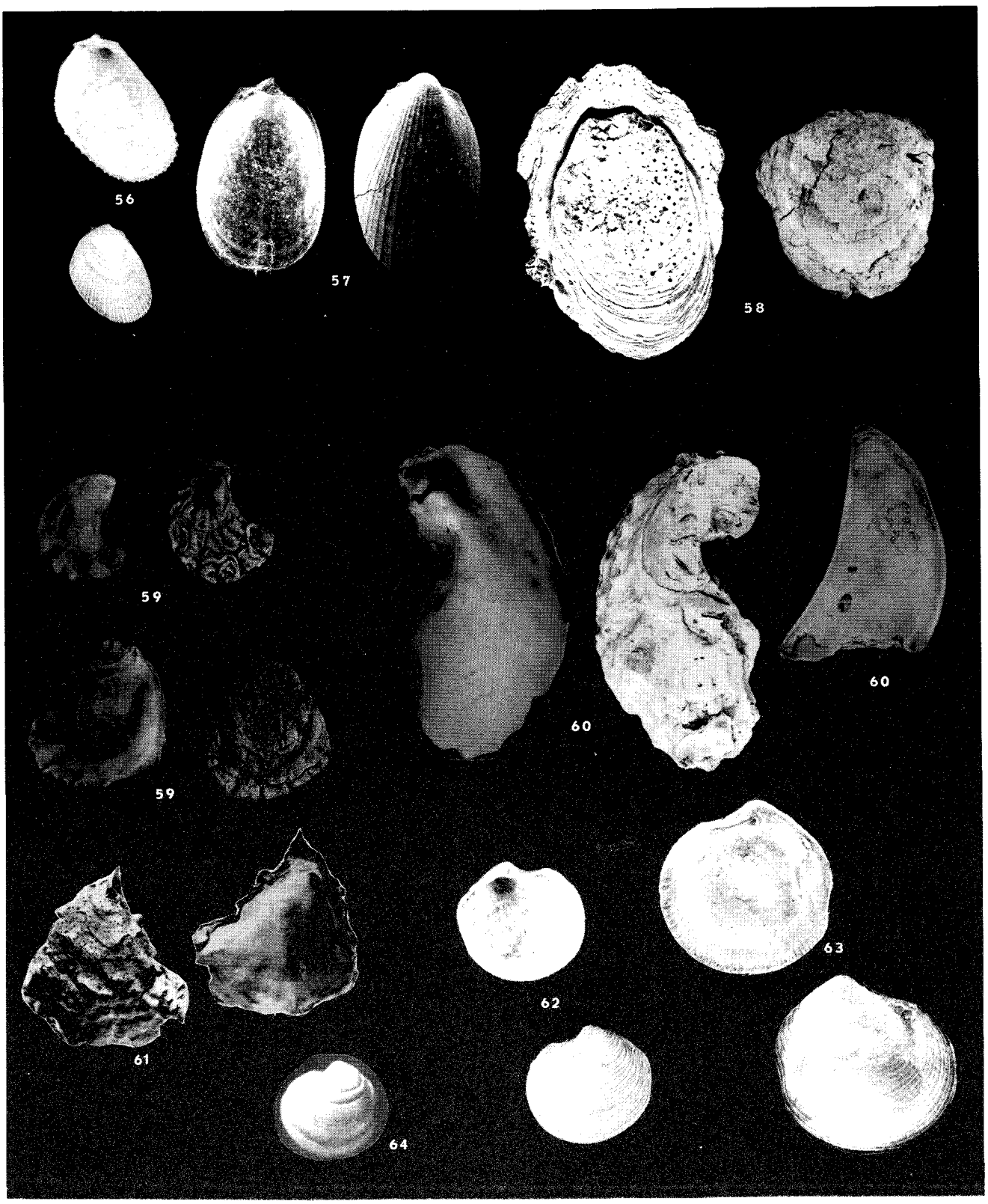
60. *Crassostrea virginica* (figured hypotype, USNM 265771), Chesapeake, VA 1, (X 0.7).

61. *?Pycnodonte* sp. (figured hypotype, USNM 258373), Zone 1 Claremont Wharf, VA, figure from Blackwelder, 1980, (X 0.6).

62. *Parvilucina crenulata* (figured hypotype, USNM 265772), Chuckatuck, VA 2, (X 2.8).

63. *Parvilucina multilineata* (figured hypotype, USNM 265773), Suffolk, VA, (X 6.0).

64. *Parvilucina postalveata* (holotype figured, USNM 325539), Yorktown, VA, figure from Gardner, 1944, (X 5.0).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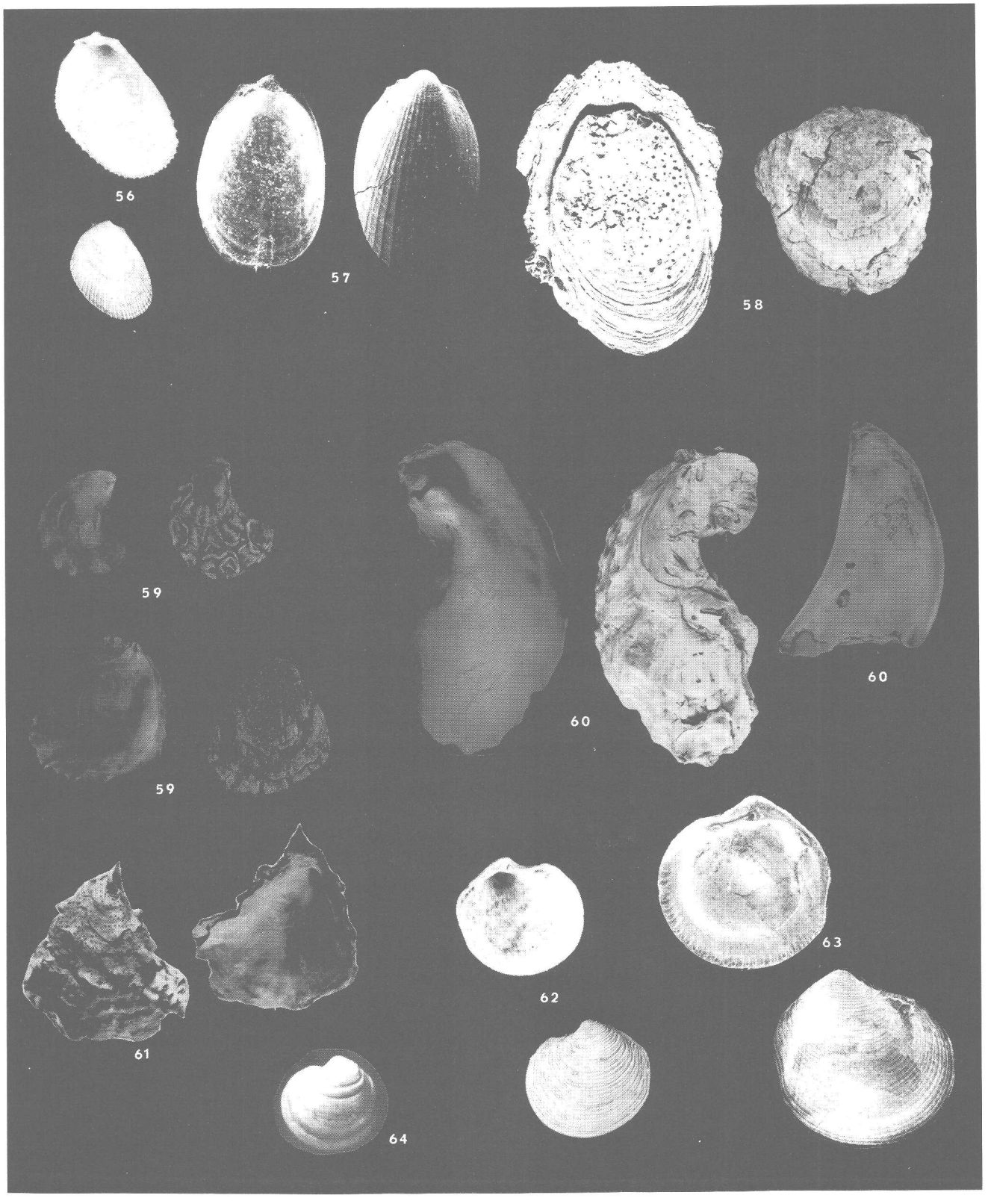
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PLATE 7

65. *Parvilucinatrisulcata multistriata* (figured hypotype, USNM 265774), 12 miles below Zuni, VA, (X 5.6).

66. *Ctena speciosa* (figured hypotype, USNM 265775), Chuckatuck, VA 2, (X 2.0).

67. *Lucina cribraria* (figured hypotype, USNM 265776), Rice's Pit, Hampton, VA, (X 1.4).

68. *Lucinoma contracta* (figured hypotype, USNM 265777), Suffolk, VA, (X 0.5).

69. *Pseudomiltha anodonta* (figured hypotype, USNM 265778), Petersburg, VA 2, (X 0.4).

70. *Divalinga quadrisulcata* (figured hypotype, USNM 265780), Petersburg, VA 2, (X 2.0).

71. *Diplodonta acclinis* (figured hypotype, USNM 155582), Yorktown, VA, (X 0.7).

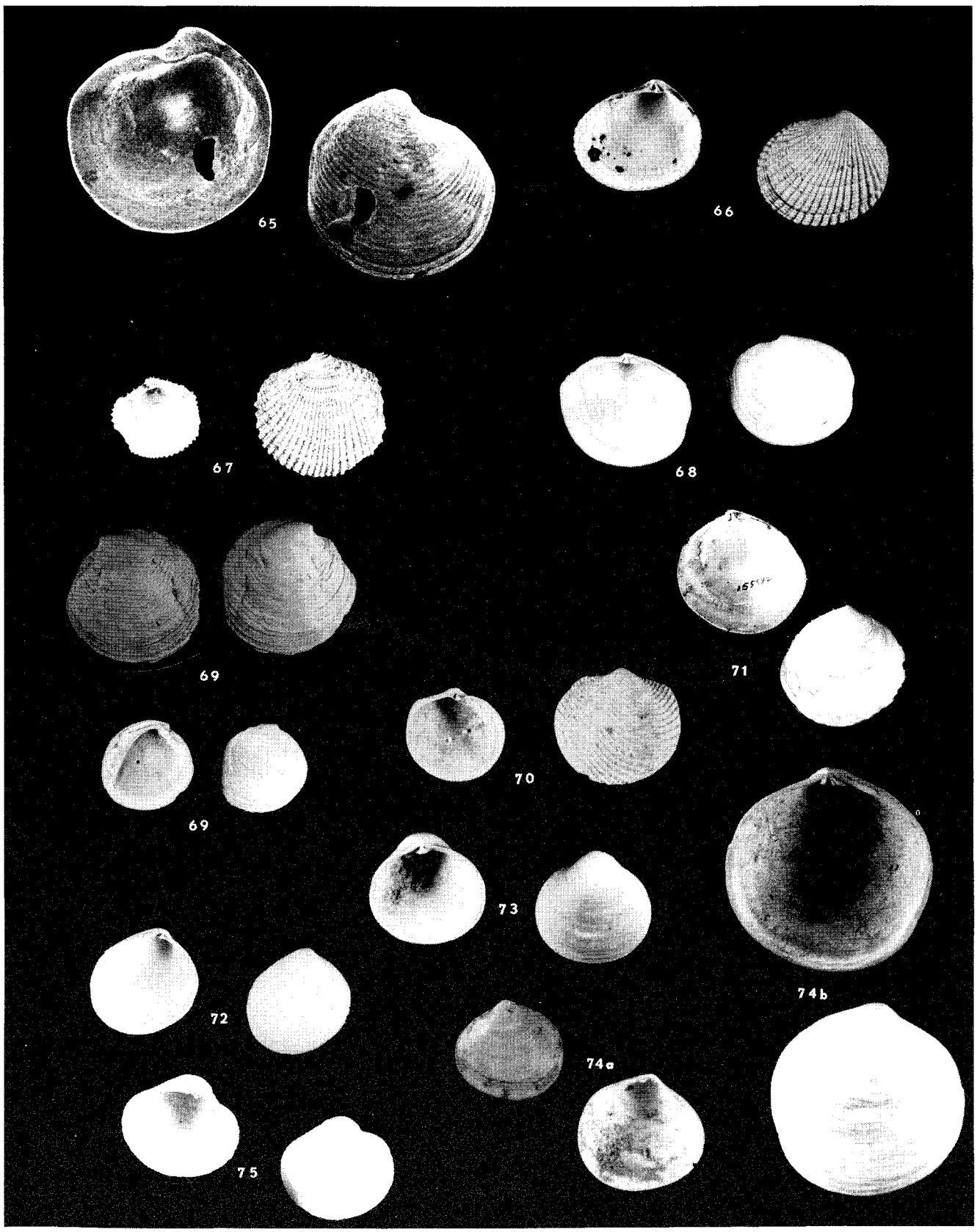
72. *Diplodonta conradi* (figured hypotype, USNM 265781), Rice's Pit, Hampton, VA, (X 1.2).

73. *Diplodonta nucleiformis* (figured hypotype, USNM 265782), Chesapeake, VA 2, (X 3.7).

74a. *Diplodonta punctulata* (holotype figured, ANSP 1587), Petersburg, VA 1, (X 2.2).

74b. *Diplodonta punctulata* (holotype of Diplodonta berryi, ANSP 16013), Yorktown, VA, (X 2.6).

75. *Diplodonta subvexa* (figured hypotype, USNM 265783), Chuckatuck, VA 2, (X 0.7).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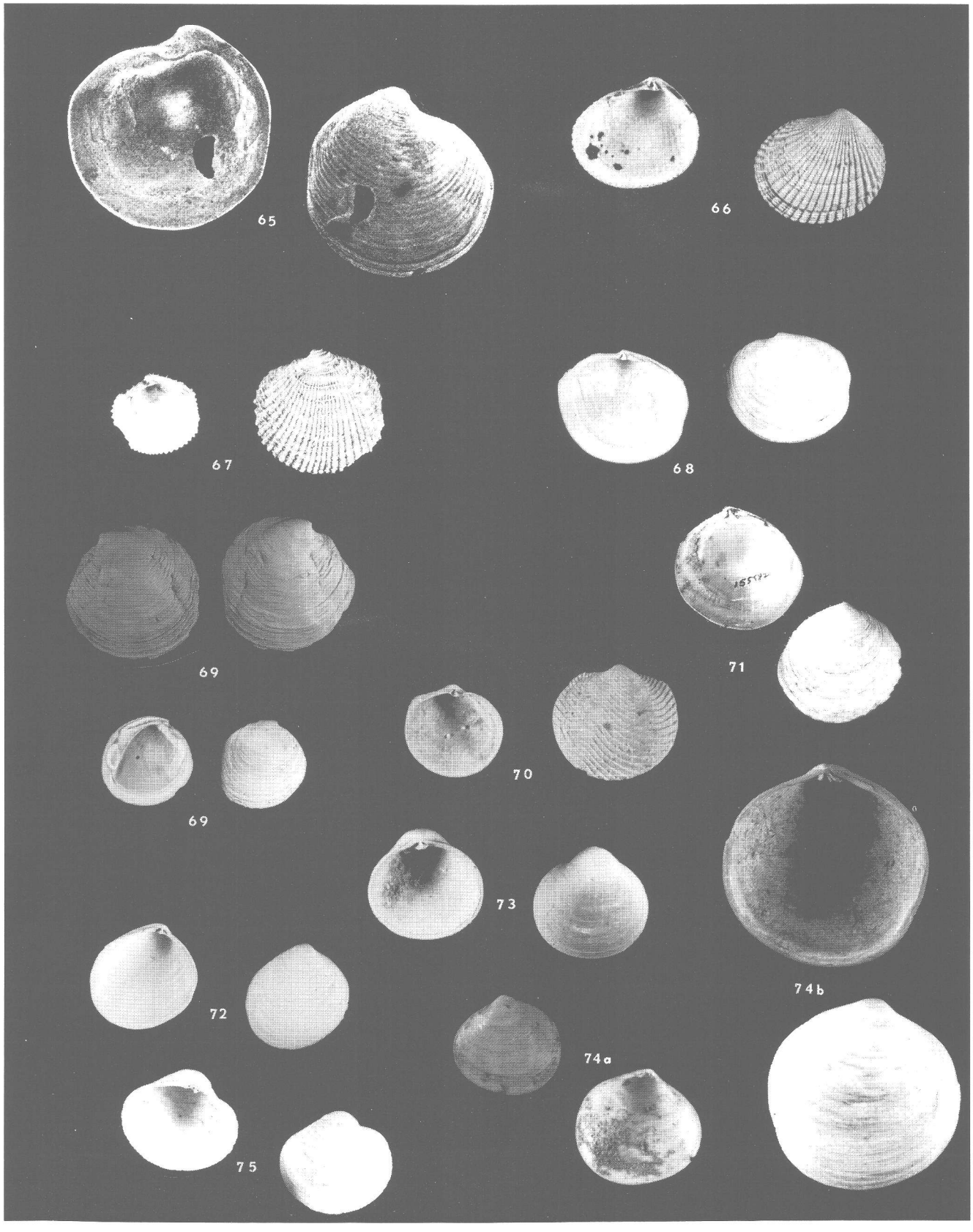
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PLATE 8

71. *Diplodonta acclinis* (figured hypotype, USNM 155582), Yorktown, VA, (X 1.1).

72. *Diplodonta conradi* (figured hypotype, USNM 265781), Rice's Pit, Hampton, VA, (X 1.2).

73. *Diplodonta nucleiformis* (figured hypotype, USNM 265782), Chesapeake, VA 2, (X 3.7).

74b. *Diplodonta punctulata* (holotype of Diplodonta berryi, ANSP 16013), Yorktown, VA, (X 2.6).

75. *Diplodonta subvexa* (figured hypotype, USNM 265783), Chuckatuck, VA 2, (X 0.7).

76. *Chama congregata* (figured hypotype, USNM 265784), Williamsburg, VA 3, (X 1.0).

77. *Chama corticosa* (figured hypotype, USNM 265785), Williamsburg, VA 2, (X 0.6).

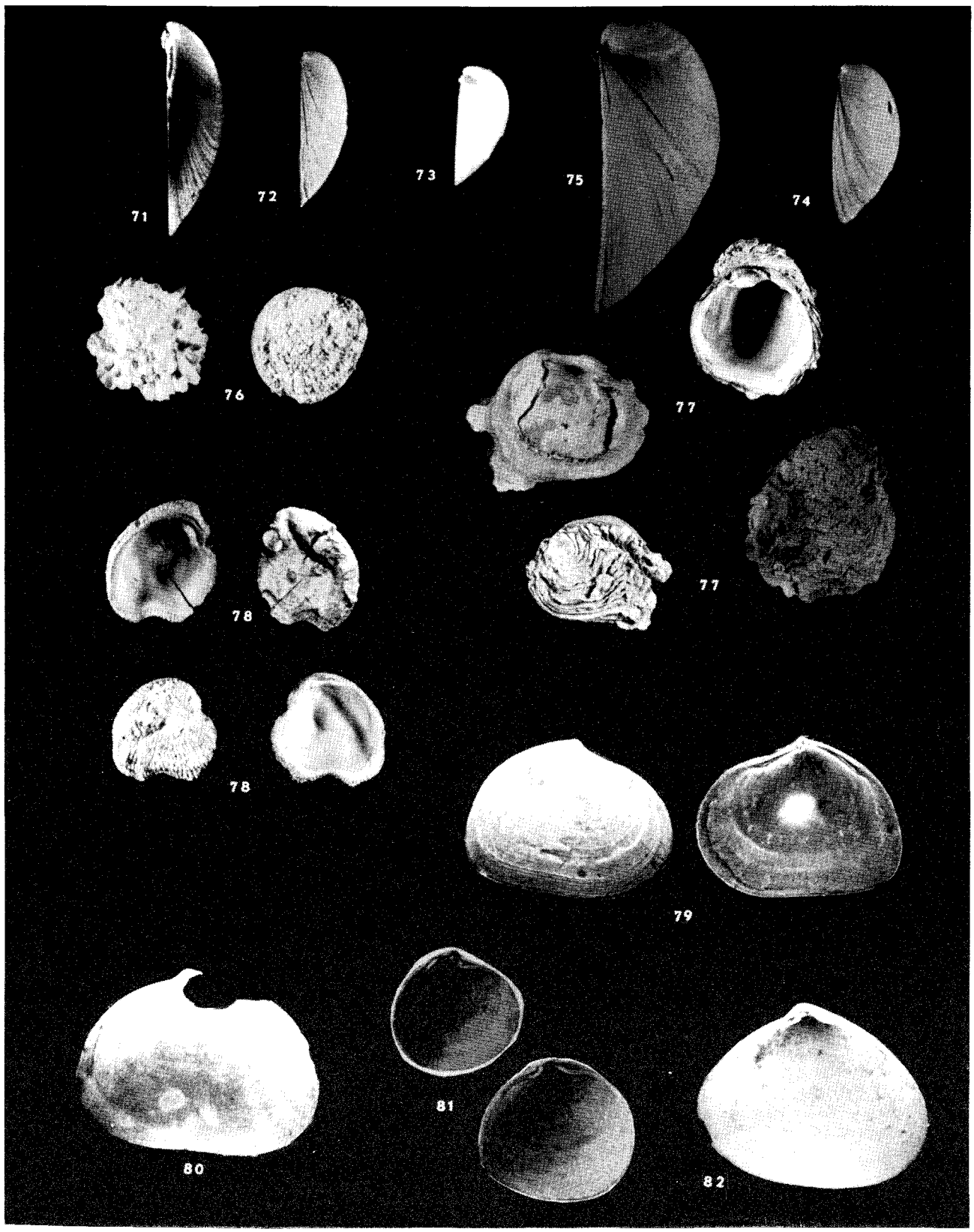
78. *Chama emmonsi* (figured hypotype, USNM 265786), Chuckatuck, VA 2, (X 1.5).

79. *Erycina carolinensis* (figured hypotype, USNM 265787), Chuckatuck, VA 1, (X 4.6).

80. *Bornia lioica* (figured hypotype, USNM 265788), Chuckatuck, VA 2, SEM (X 6.8).

81. *Bornia rota* (paratype of Bornia triangula, USNM 325547), Yorktown, VA, figure from Gardner, 1944, (X 7.0).

82. *Bornia triangula* (figured hypotype, USNM 265789), Chuckatuck, VA 2, SEM (X 5.5).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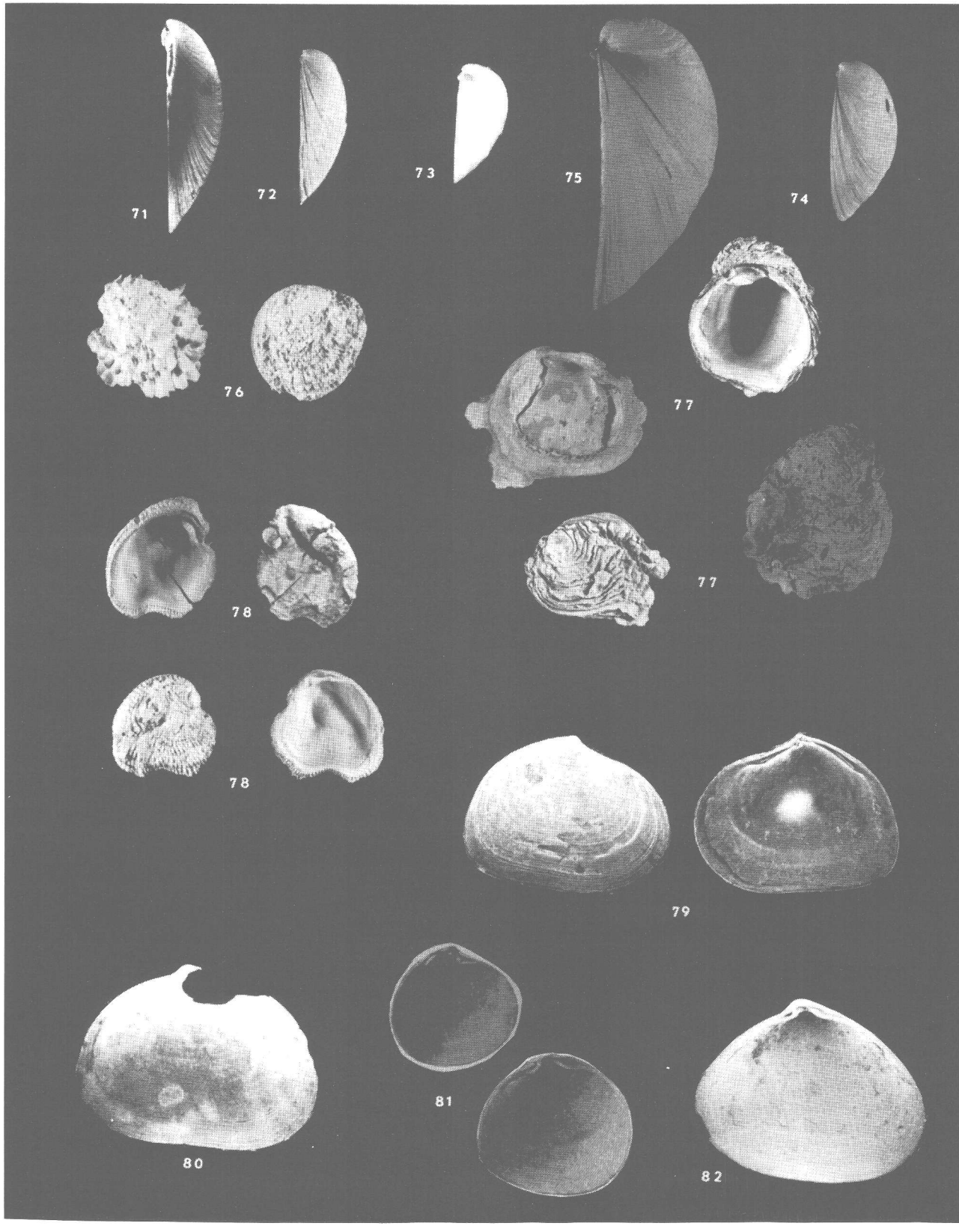
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PLATE 9

83. *Aligena striata* (figured hypotype, USNM 265790), Chuckatuck, VA 2, SEM (X 4.5).

84. *Solecardia cossmani* (holotype figured, USNM 155776), Petersburg, VA 1, figure from Dall, 1900, (X 4.6).

85. *Montacuta chesapeakensis* (holotype figured, USNM 265791), Chesapeake, VA 2, SEM (X 17).

86. *Montacuta petropolitana* (holotype figured, USNM 155770), Petersburg, VA 1, figure from Dall, 1900. (X 7.1).

87. *Montacuta sagrinata* (holotype figured, USNM 155772), York River, VA, figure from Dall, 1900, (X 3.6).

88. *Orobitella laevis* (holotype figured, ANSP 1582), Petersburg, VA 1, figure from Gardner, 1944, (X 3.8).

89. *Mysella bladenensis* (figured hypotype, USNM 265792), Chuckatuck, VA 2, SEM (X 7.5).

90. *Mysella spatula* (holotype figured, USNM 265793), Chesapeake, VA 2, SEM (X 12).

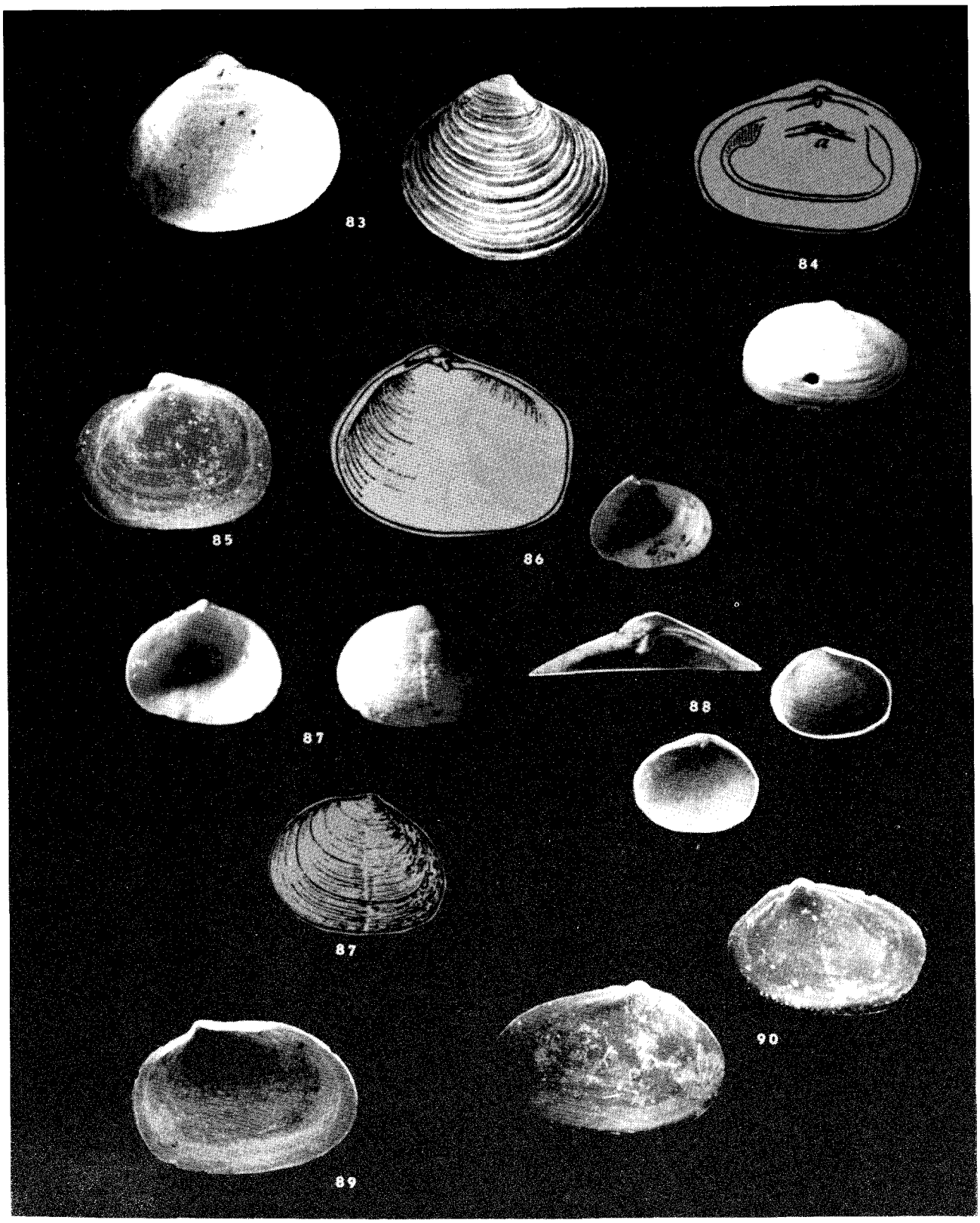
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PLATE 10

91. *Mysella stantoni* (figured hypotype, USNM 265794), Chesapeake, VA 2, SEM (X 8.0).

92. *Pythinella filicaticola* (syntypes figured, PRI 3515), Smithfield, VA 3, figures redrawn from Olsson, 1914, by Jeanne Kowalczyk, (X 10).

93. *Sportella chesapeakensis* (holotype figured, USNM 265795), Chesapeake, VA 2, SEM (X 11.5).

94a. *Sportella constricta* (holotype figure, ANSP missing), Natural Well, NC, figure redrawn from Conrad, 1841, by Jeanne Kowalczyk, (X 2.0).

94b. *Sportella constricta* (ANSP missing), Natural Well, NC, figure redrawn from Conrad, 1845, by Jeanne Kowalczyk, (X 2.0).

94c. *Sportella constricta* (figured hypotype, USNM 265807), Chesapeake, VA 1, (X 2.0)

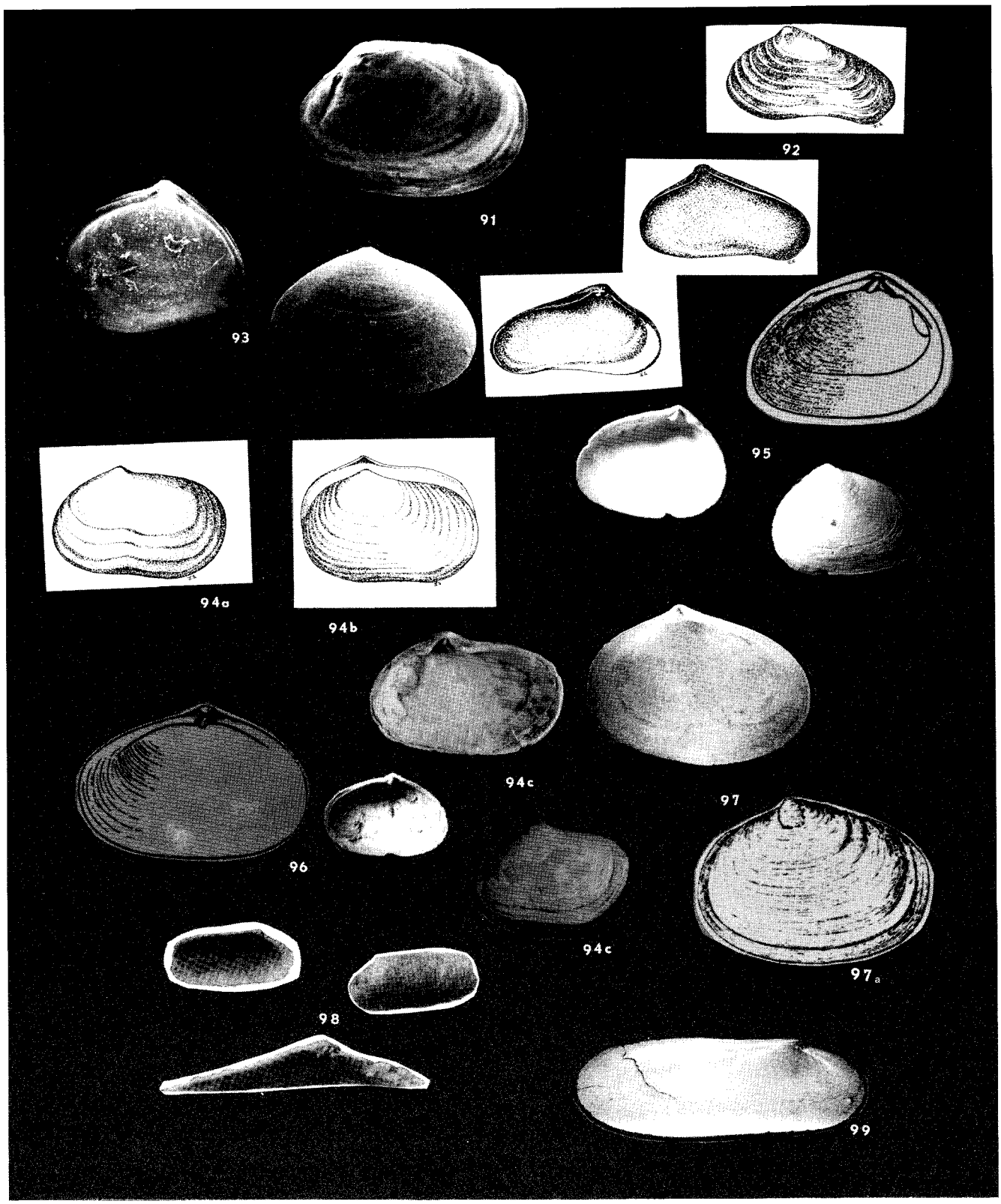
95. *Sportella pelex* (holotype figured, USNM 155726), Petersburg, VA 1 figure from Dall, 1900, (X 3.7).

96. *Sportella petropolitana* (holotype figured, USNM 155725), Petersburg, VA 1, figure from Dall, 1900, (X 7.0).

97. *Sportella yorkensis* (figured hypotype, USNM 265796), Chuckatuck, VA 2, SEM (X 5.5); drawing from Dall, 1900, USNM 114323.

98. *Ensitellops compressa* (holotype figured, ANSP 1596) Petersburg, VA 1, figure from Gardner, 1944, (X 3.5).

99. *Ensitellops protexta* (figured hypotype, USNM 265797), Chuckatuck, VA 2, SEM (X 4.4).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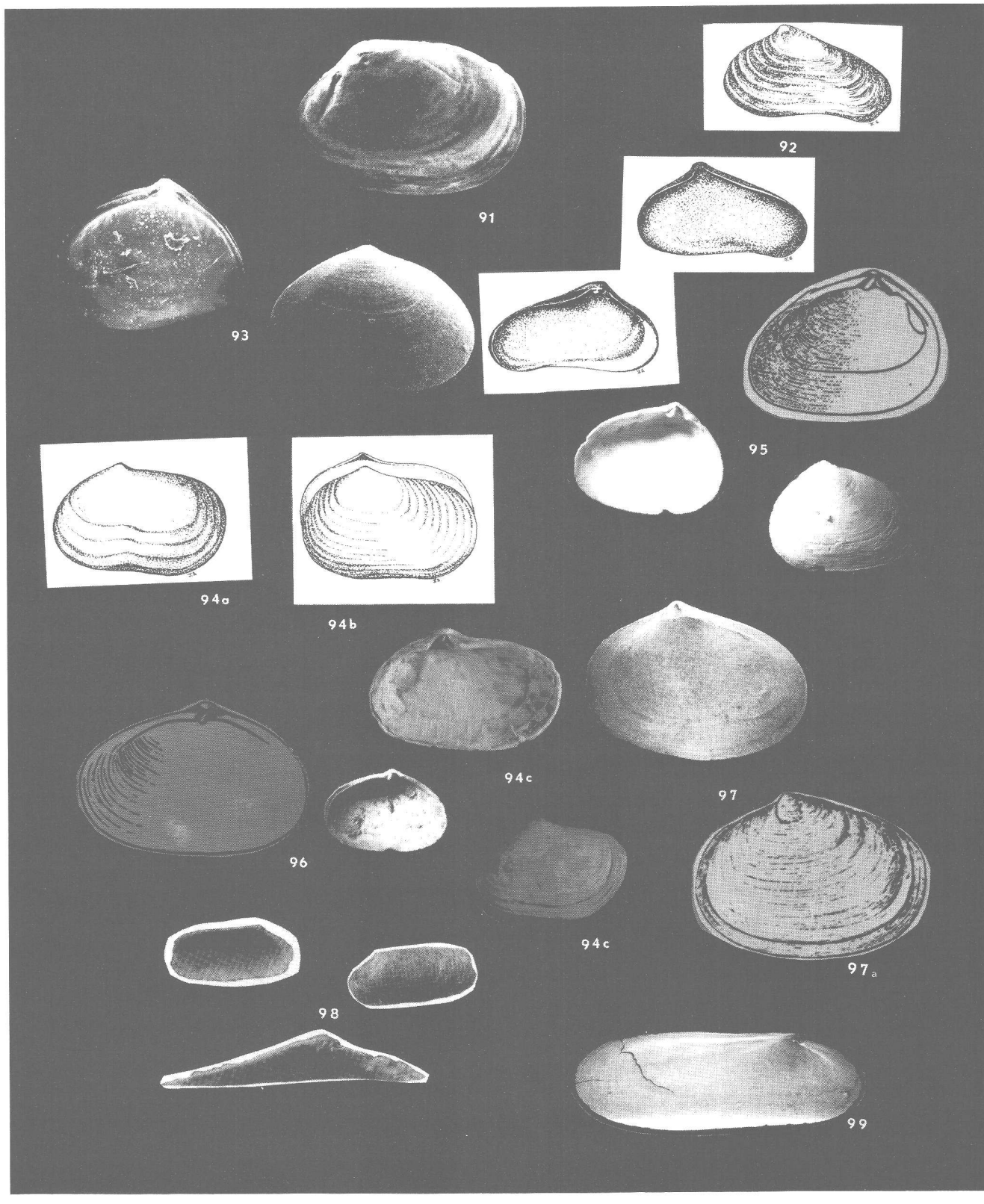
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PLATE 11

100. *Anisodonta americana* (figured hypotype, USNM 265798), Rice's Pit, Hampton, VA, (X 4.0).

101. *Paramya subovata* (figured hypotype, USNM 265799), Rice's Pit, Hampton, VA, SEM (X 3.6).

102. *Carditamera arata* (figured hypotype, USNM 265800), Chesapeake, VA 2, (X 0.6).

103. *Pleuromeris decemcostata* (figured hypotype, USNM 265801), Chesapeake, VA 1, (X 3.4).

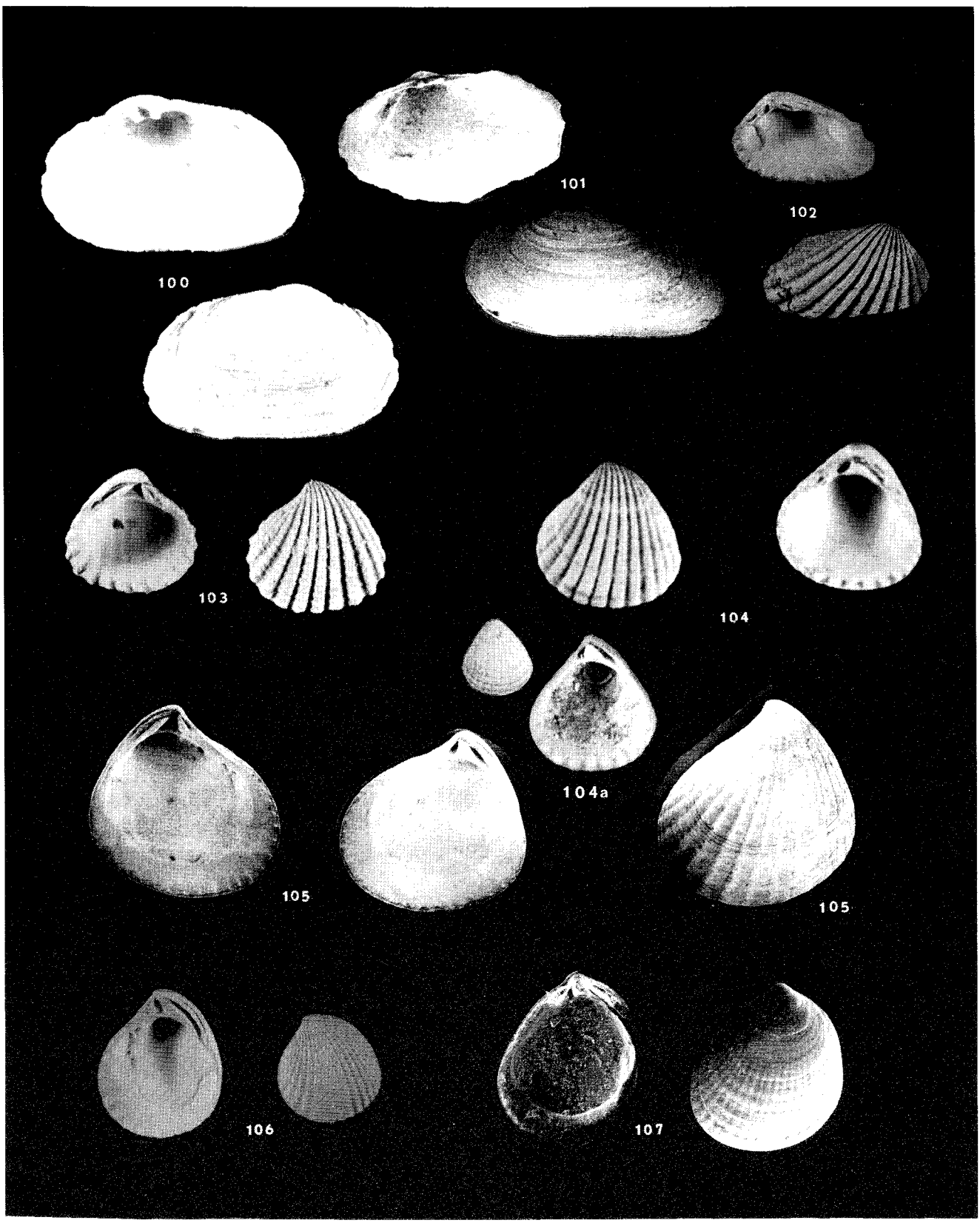
104. *Pleuromeris tridentata* (figured hypotype, USNM 265802), Chuckatuck, VA 2, (X 3.7).

104a. *Pleuromeris auroraensis* (figured hypotype, USNM 265806), Chesapeake, VA 1, (X 5.0).

105. *Pteromeris abbreviata* (figured hypotype, USNM 265803), Chuckatuck, VA 1, SEM (X 5.5).

106. *Cyclocardia granulata* (figured hypotype, USNM 265804), Chuckatuck, VA 1, (X 0.9).

107. *Erycinella ovalis* (figured hypotype, USNM 265805), Chuckatuck, VA 1, SEM (X 10.5).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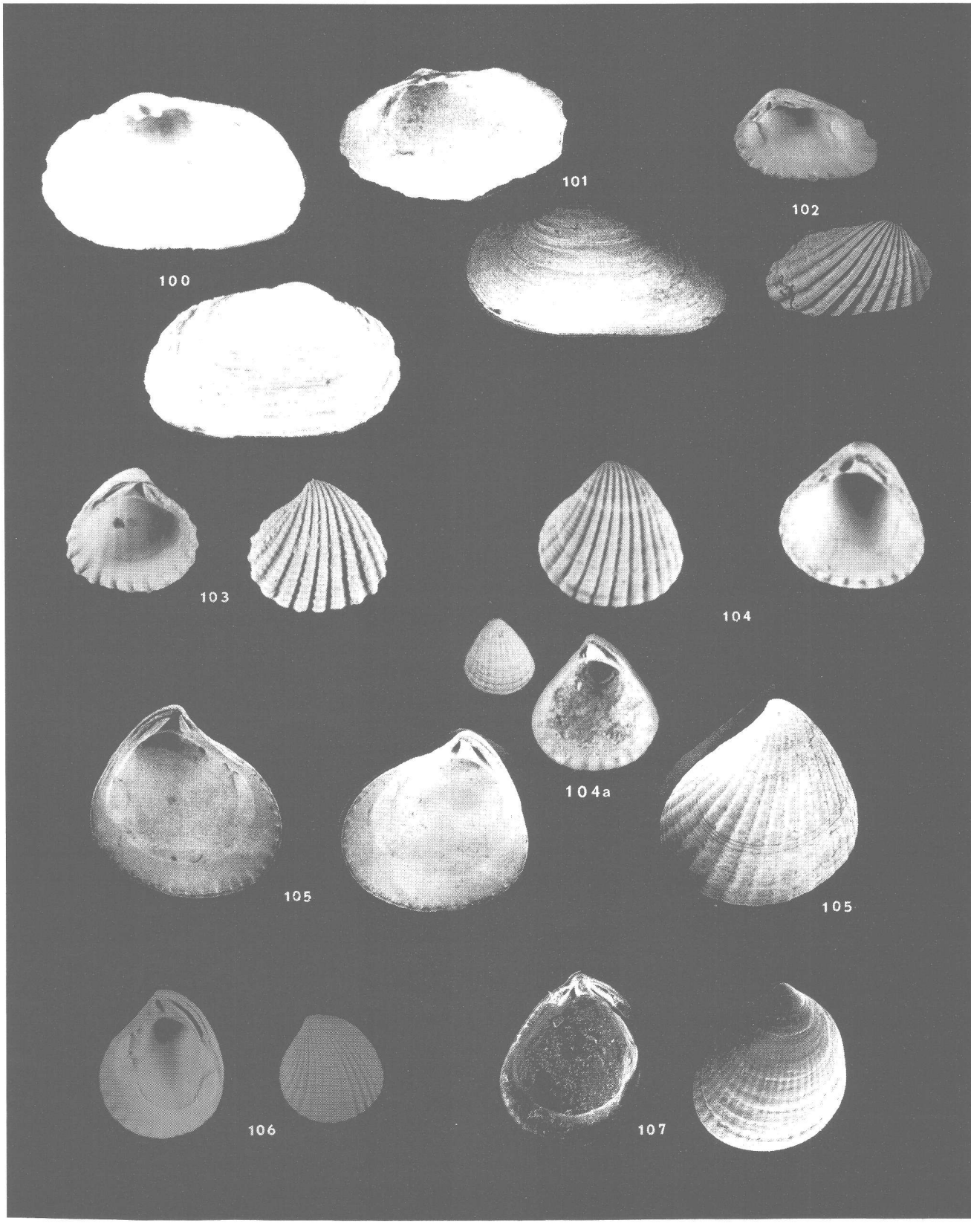
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PLATE 12

108. *Astarte arata* (ANSP missing). City Point, Hopewell, VA figure from Conrad, 1840.

109. *Astarte berryi* (figured hypotype, USNM 403289), Chesapeake, VA 1, (X 1.1).

110. *Astarte coheni* (holotype figured, ANSP 30610), Lancaster Co., VA, (X 1.6).

110A. *Astarte griftonensis* (holotype figured, USNM 325524), Grifton, NC, figure from Gardner, 1944.

111. *Astarte exaltata* (holotype figured, ANSP 30628), Calvert Cliffs, MD (X 1.6).

111a & b. *Astarte exaltata* (figured hypotype, USNM 325519), Bailey's Creek on the James River, VA, figure from Gardner, 1944.

111c. *Astarte exaltata* (figured hypotype, USNM 403293), Williamsburg, VA 1.

112. *Astarte concentrica* (figured hypotype, USNM 403290) Petersburg, VA 2, (X 1.2).

113. *Astarte roanokensis* (holotype figured USNM 325523) Halifax, NC, figure from Gardner, 1944, (X 0.8).

113a. *Astarte roanokensis* (holotype of Astarte hertfordensis USNM 325526), Murfreesboro, NC, figure from Gardner, 1944, (X 0.8).

113b. *Astarte roanokensis* (holotype of Astarte stephensoni USNM 325528), Halifax, NC, figure from Gardner, 1944, (X 0.8).

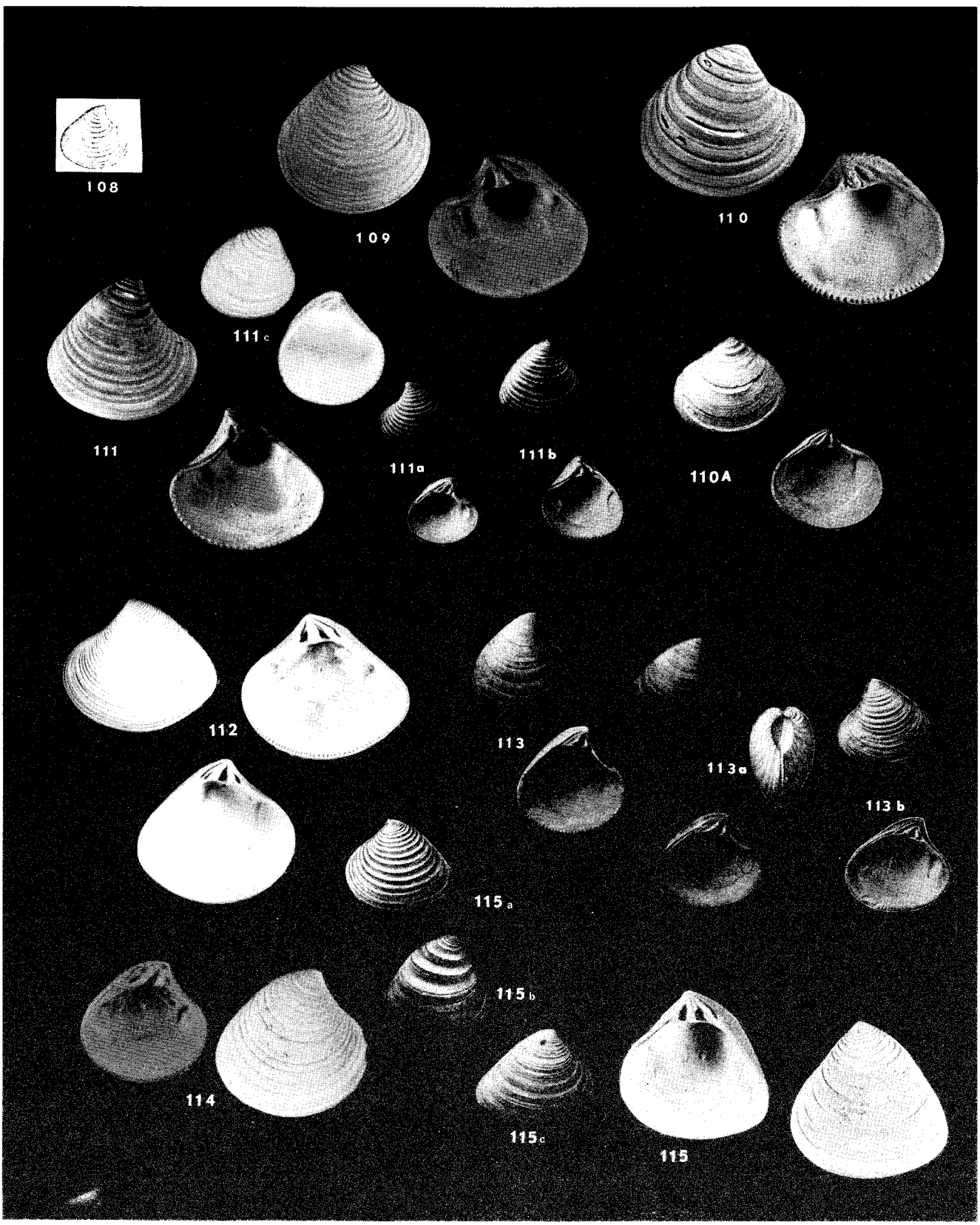
114. *Astarte symmetrica* (figured hypotype, USNM 403291), Chesapeake, VA 2, (X 0.9).

115. *Astarte undulata* (figured hypotype, USNM 403292), Chuckatuck, VA 1, (X 1.0).

115a. *Astarte undulata deltoidea* (USNM 325520), Murfreesboro, NC, figure from Gardner, 1944.

115b. *Astarte undulata vaginulata* (USNM 146121), Grove Wharf, VA, figure from Gardner, 1944.

115c. *Astarte undulata deltoidea* (USNM 325525), Zuni, VA, figure from Gardner, 1944.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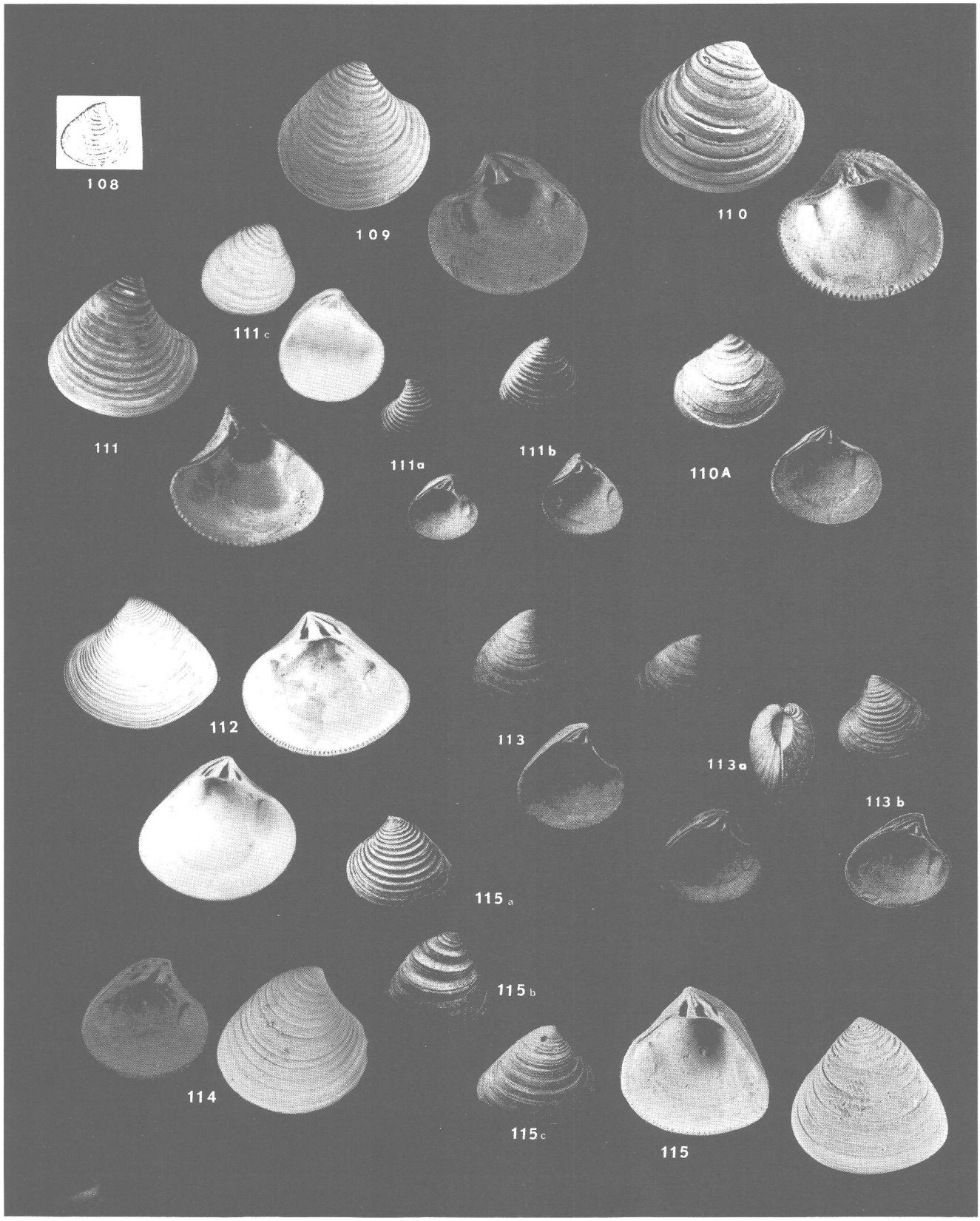
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PLATE 13

115d. *Astarte undulata deltoidea* (USNM 325532), Zuni, VA, figure from Gardner, 1944.

116. *Astarte vicina* (figured hypotype, USNM 403294), Williamsburg, VA 3, (X 1.3).

116a. *Astarte vicina* (BM missing) "MD": actually, an unknown VA locality, figure from Say, 1824.

117. *Astarte yadkinensis* (figured hypotype, USNM 403295), Chesapeake, VA 1, SEM (X 4.0).

118. *Eucrassatella virginica* (figured hypotype, USNM 403296), Chesapeake, VA 2, (X 0.4).

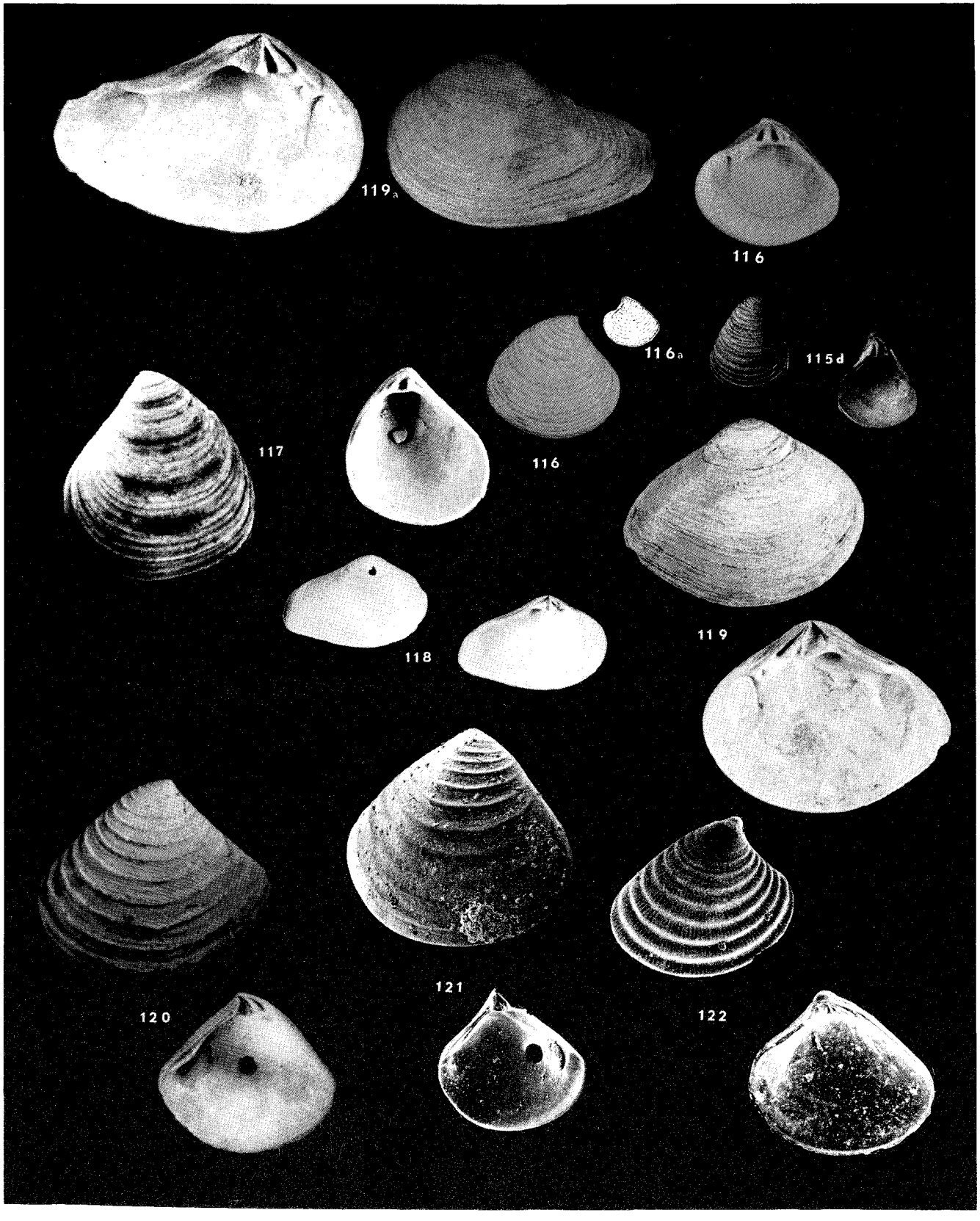
119. *Eucrassatella virginica cycloptera* (figured hypotype, USNM 403297), Williamsburg, VA 1, (X 0.4).

119a. *Eucrassatella kauffmani* (figured hypotype, USNM 402298), Chesapeake, VA 1, (X 0.7).

120. *Crassinella lunulata* (figured hypotype, USNM 403299), Chesapeake, VA 2, SEM (X 5.7).

121. *Crassinella johnsoni* (figured hypotype, USNM 403300), Chuckatuck, VA 2, SEM (X 20).

122. *Crassinella dupliniana* (figured hypotype, USNM 403301), Chesapeake, VA 2, SEM (X 29).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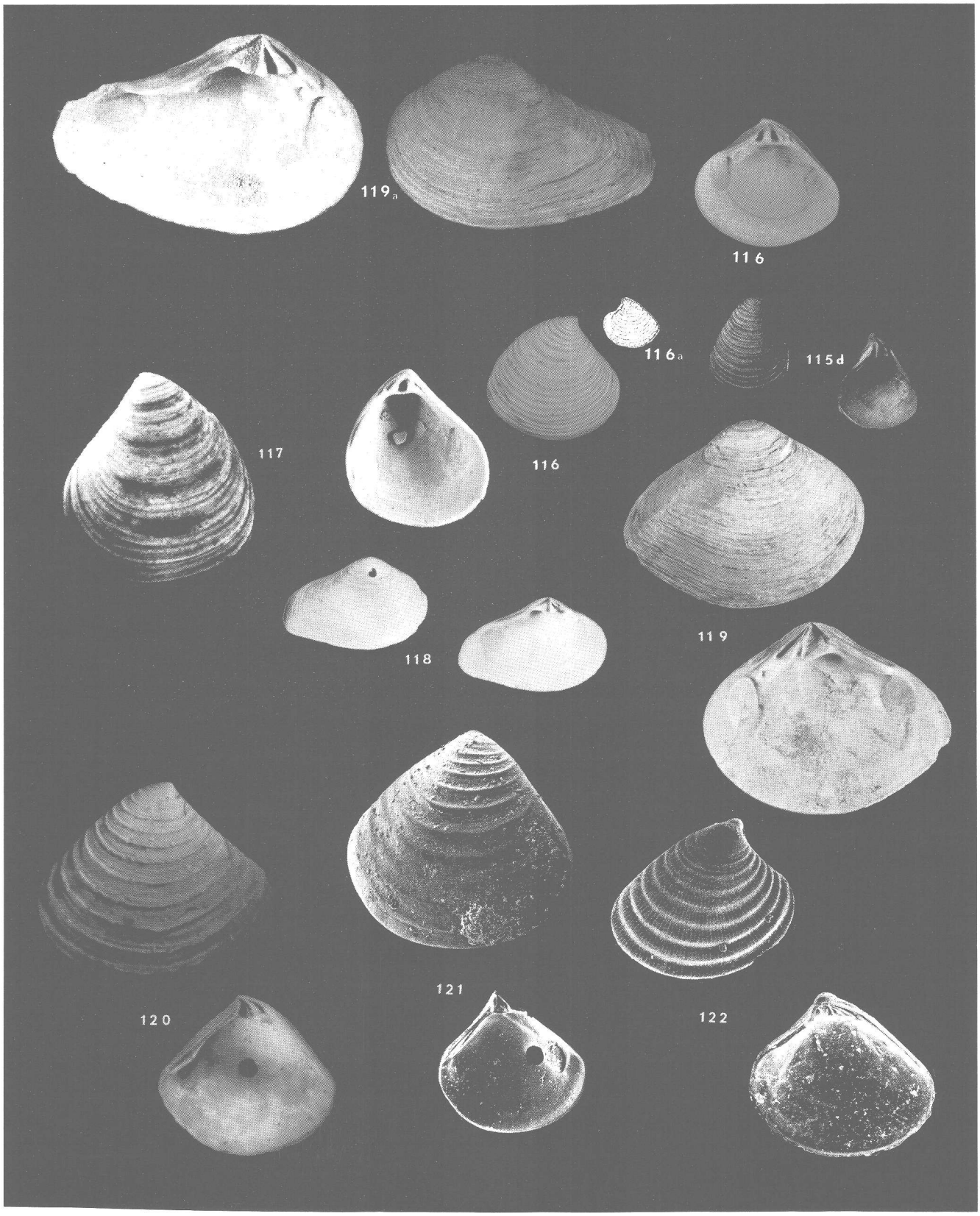
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PLATE 14

123. *Papyridea turtoni* (figured hypotype, USNM 403302), Rice's Pit, Hampton, VA, (X 0.7).

124. *Laevicardium sublineatum* (figured hypotype, USNM 403303), Chesapeake, VA 2, (X 1.2).

125. *Clinocardium acutilaqueatum* (figured hypotype, USNM 403304), Chuckatuck, VA 1, (X 0.35).

125a. *Clinocardium acutilaqueatum* (figured hypotype, USNM 403305), Williamsburg, VA 3.

125b. *Clinocardium acutilaqueatum* (figured hypotype, USNM 403306), Chuckatuck, VA 1.

126. *Clinocardium taenopleura* (figured hypotype, USNM 403308), Rice's Pit, Hampton, VA, (X 0.6).

127. *Clinocardium virginianum* (figured hypotype, USNM 403309), Rice's Pit, Hampton, VA, (X 0.45).

127a. *Dinocardium robustum* (figured hypotype, USNM 403310), Chesapeake, VA 1, (X 0.8).

128. *Mactra fragilis* (figured hypotype, USNM 403311), Chesapeake, VA 2, (X 1.0).

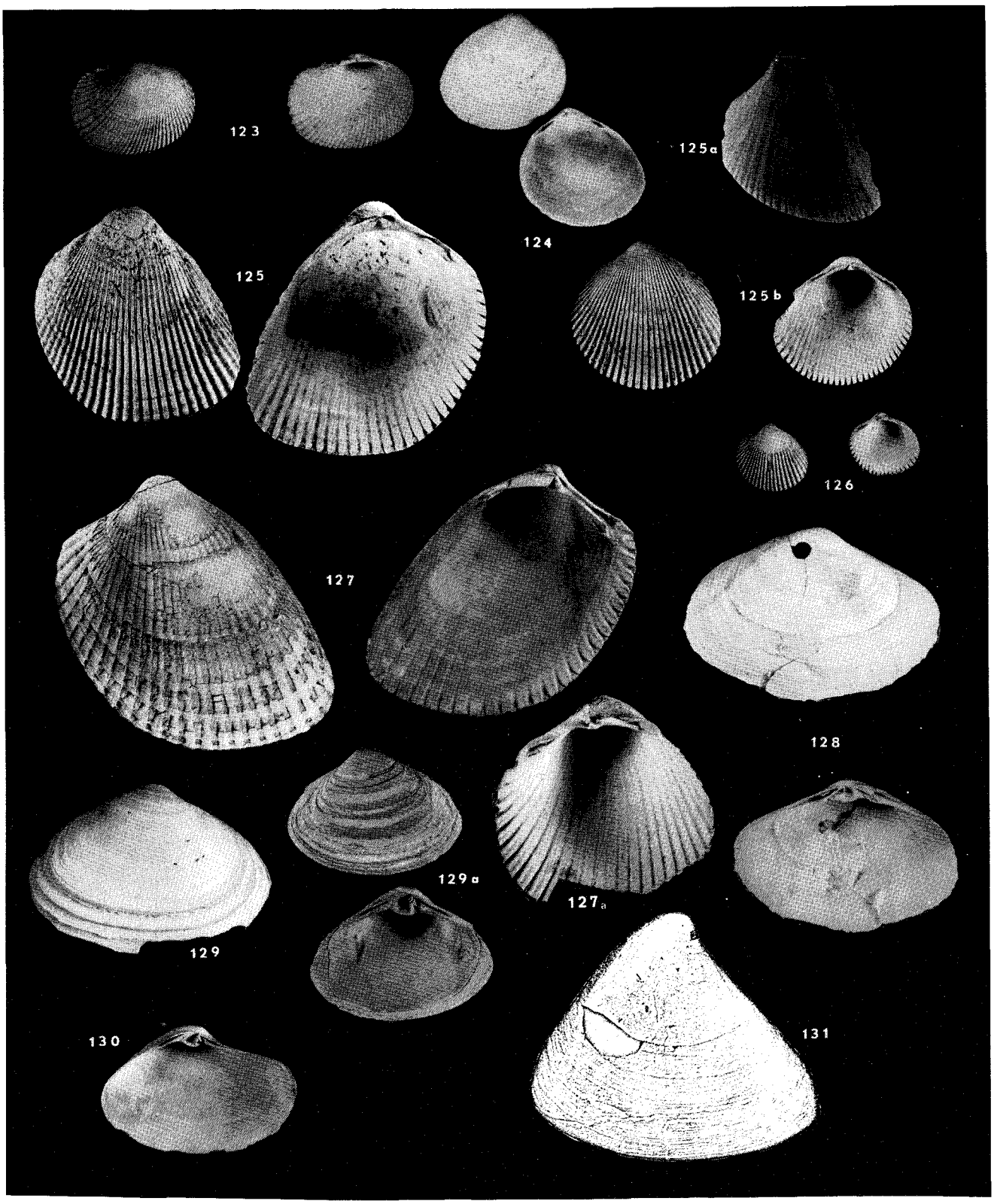
129. *Spisula confraga* (figured hypotype, USNM 403674), Chesapeake, VA 2, (X 0.5).

129a. *Spisula confraga* (figured hypotype, USNM 403312), Williamsburg, VA 1, (X 0.5).

130. *Spisula delumbis* (figured hypotype, USNM 403313), Rice's Pit, Hampton, VA, (X 0.5).

130a. *Spisula duplinensis* not illustrated.

131. *Spisula harrisi* (holotype figured, PRI 3487), Pee Dee River, SC, figure from Olsson, 1914, (X 0.5).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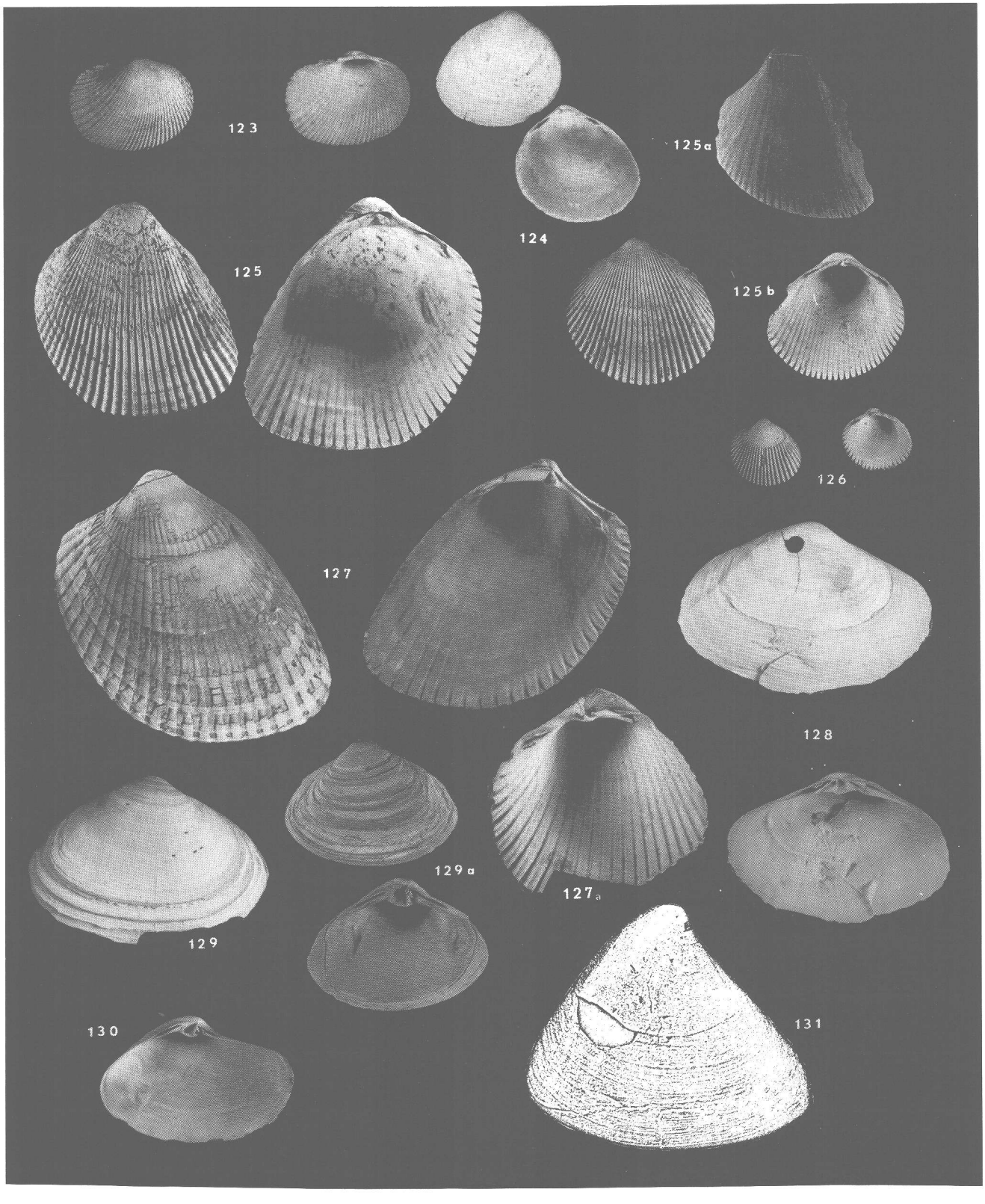
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PLATE 15

132. *Spisula modicella* (figured hypotype, USNM 403314), Chuckatuck, VA 1, (X 1.0).

132a. *Mactra clathrodon* (holotype figured, ANSP 3309), "MD", actually an unknown VA locality, (X 3.0).

133. *Mulinia congesta* (figured hypotype, USNM 403315), Days Point, VA, (X 1.4).

134. *Mulinia lateralis* (figured hypotype, USNM 403316), Chesapeake, VA 1, (X 3.0).

135. *Rangia clathrodonta* (figured hypotype, USNM 403317), Chesapeake, VA 1, (X 0.7).

136. *Raeta alta* (figured hypotype, USNM 403318), pit at bypass just east of Suffolk, VA, (X 0.5).

137. *Mesodesma spatha* (holotype figured, USNM 325591), Suffolk, VA, figure from Gardner, 1944, (X 3.7).

138. *Ervilia lata* (figured hypotype, USNM 403319), Chuckatuck, VA 2, (X 7.2).

139. *Ensis directus* (figured hypotype, USNM 403320), Langley Pit, Hampton, VA, (X 0.35).

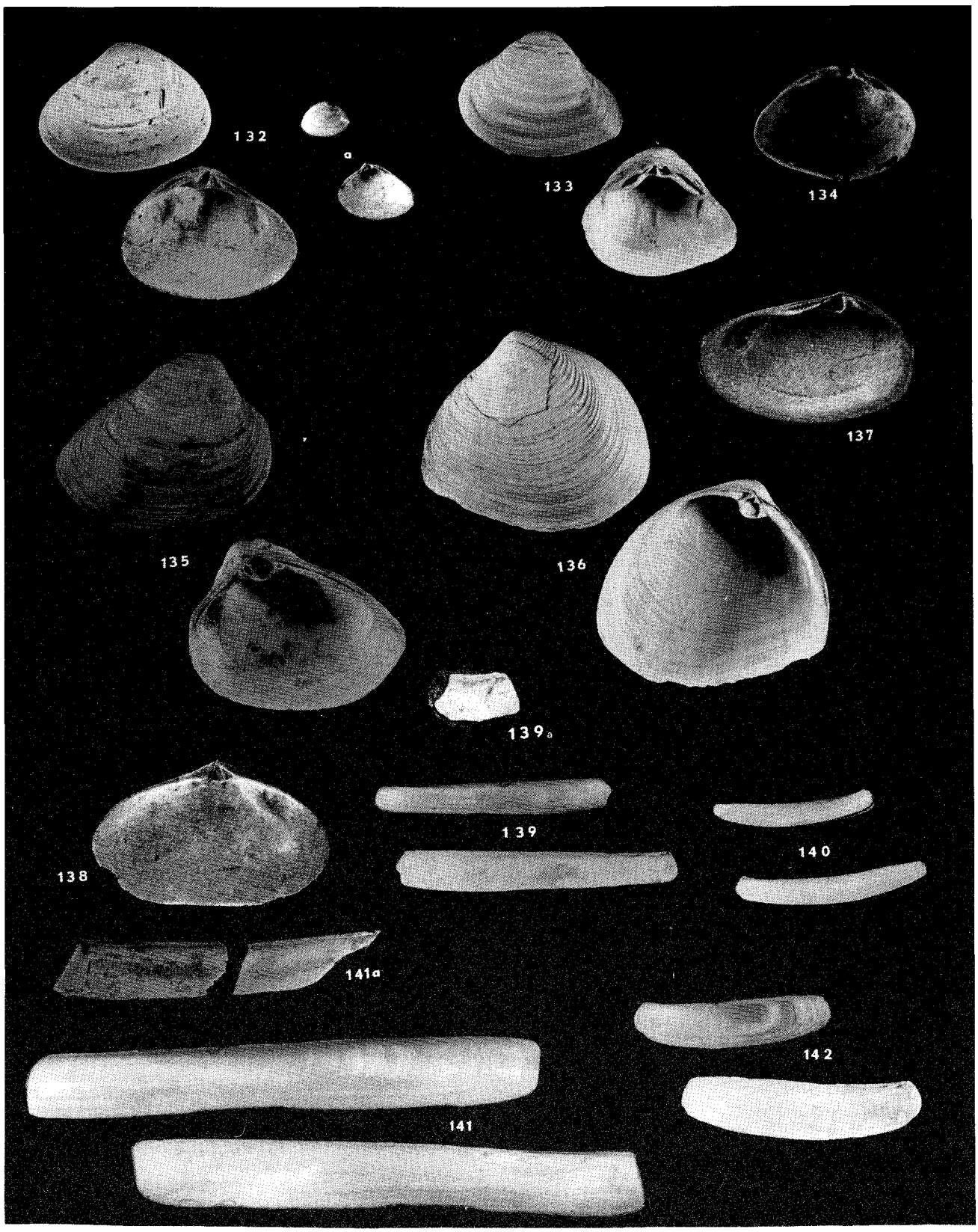
139a. *Ensis* sp. (holotype of *Solen magnodentata* is figured, ANSP 3304), Petersburg, VA 1, (X 2.0).

140. *Ensis ensiformis* (figured hypotype, USNM 403321), Rice's Pit, Hampton, VA, (X 0.5).

141. *Ensis hughesi* (holotype figured, USNM 403322), Pinecrest beds, Kissiminee, FL, (X 0.4).

141a. *Ensis hughesi* (paratypes figured, USNM 403323), Williamsburg, VA 3, (X 0.4).

142. *Ensis schmidti* (figured hypotype, USNM 403324), Rice's Pit, Hampton, VA, (X 0.4).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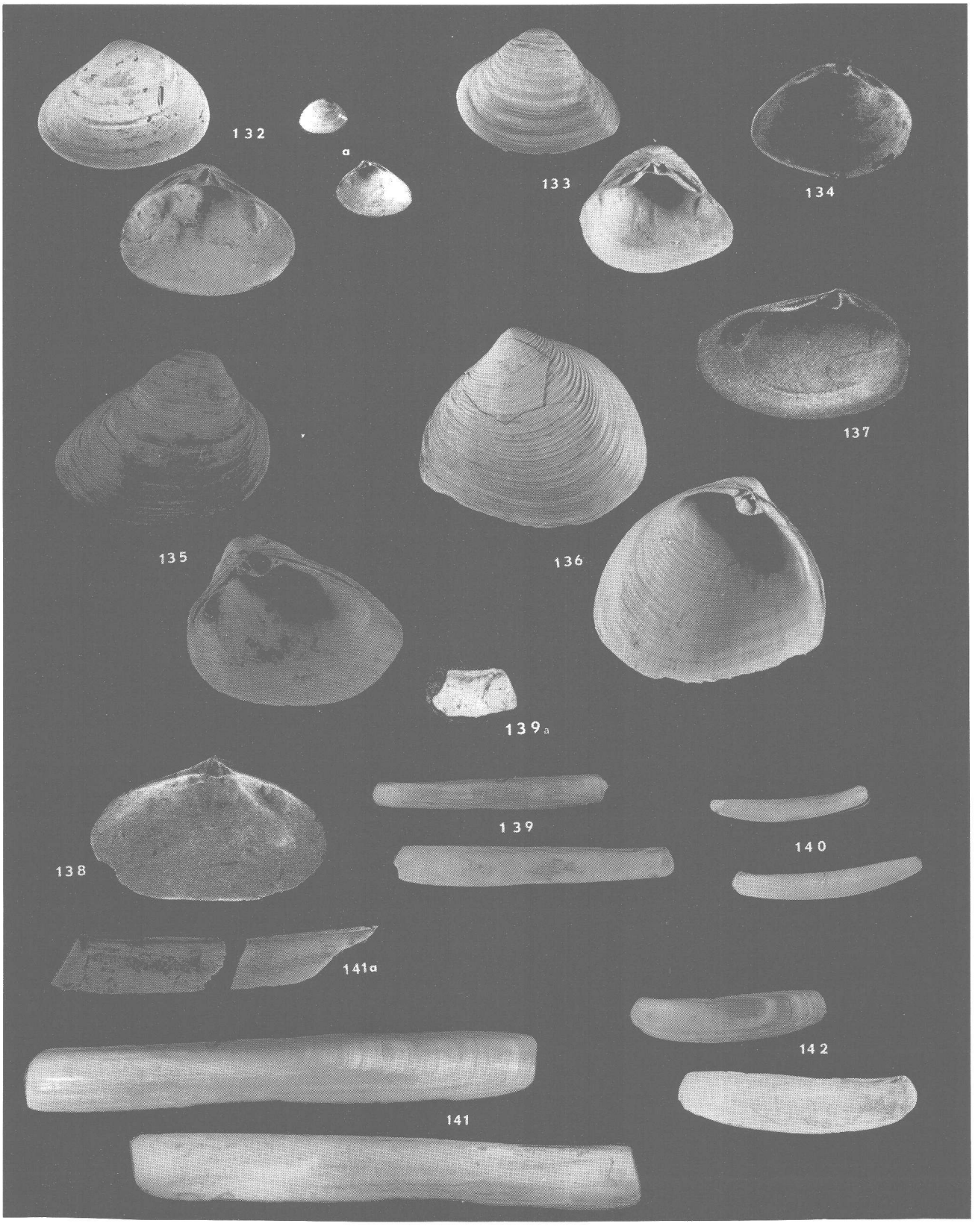
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PLATE 16

143. *Tellina aequistriata* (figured hypotype, USNM 403325), Rice's Pit, Hampton, VA, (X 1.0).

144. *Tellina egena* (holotype figured, ANSP 16016), James River near Smithfield, VA 2, (X 1.0).

145. *Tellina declivis* (figured hypotype, USNM 403326), Chuckatuck, VA 2, (X 1.5).

146. *Tellina dupliniana* (figured hypotype, USNM 403327), Chuckatuck, VA 2, (X 3.5).

146a. *Tellina suberis* (figured hypotype, USNM 403328), Chesapeake, VA 1, (X 3.0).

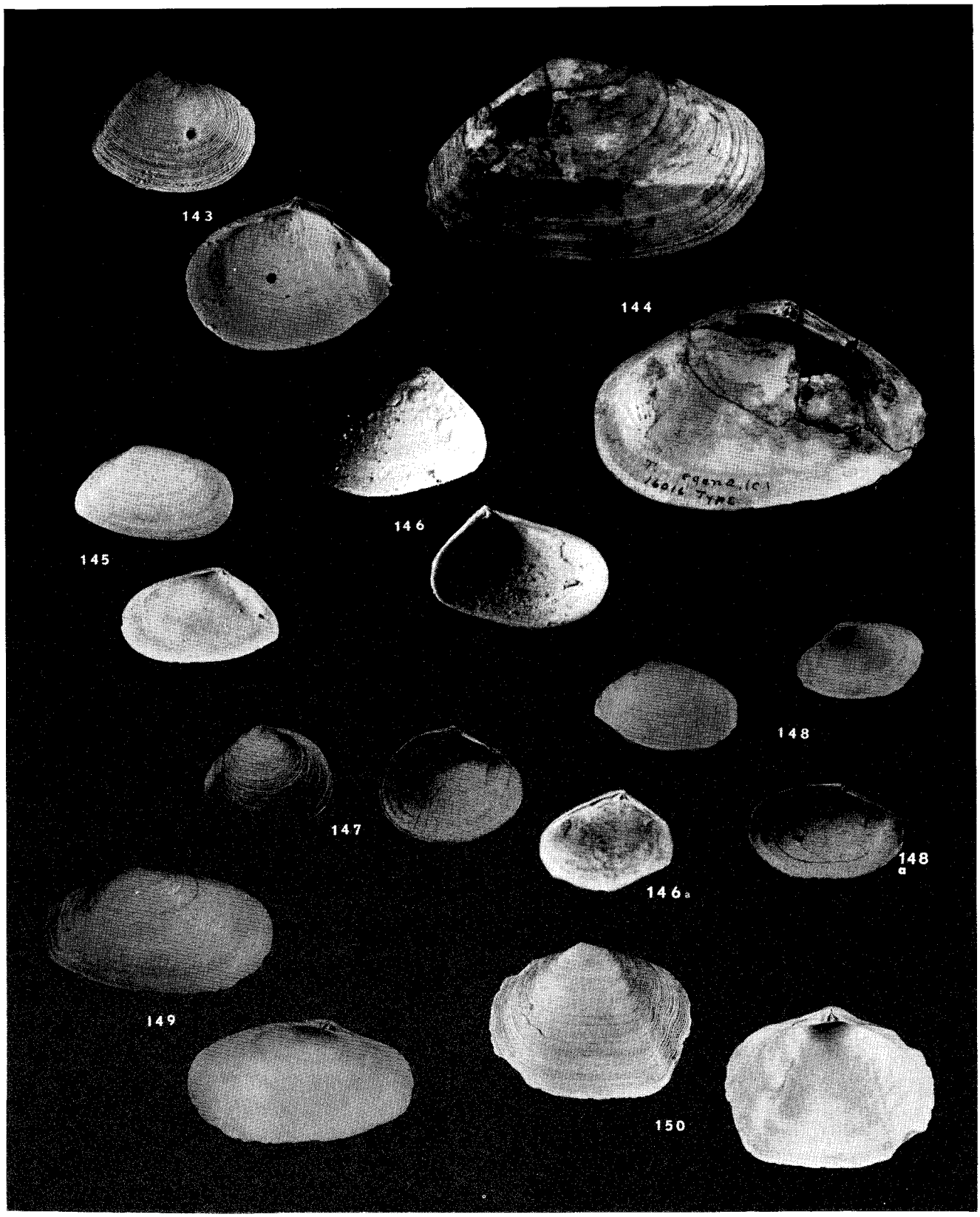
147. *Macoma cookei* (holotype figured, USNM 325592), Yorktown, VA (figure from Gardner, 1944), (X 0.7).

148. *Macoma virginiana* (figured hypotype, USNM 403329), Chesapeake, VA 2, (X 1.0).

148a. *Macoma virginiana* (figured hypotype, USNM 325594), Suffolk, VA, figure from Gardner, 1944, (X 1.0).

149. *Macoma arctata* (figured hypotype, USNM 403330), Chesapeake, VA 2, (X 1.0).

150. *Florimetis magnoliana* (figured hypotype, USNM 403331), Chuckatuck, VA 2, (X 0.6)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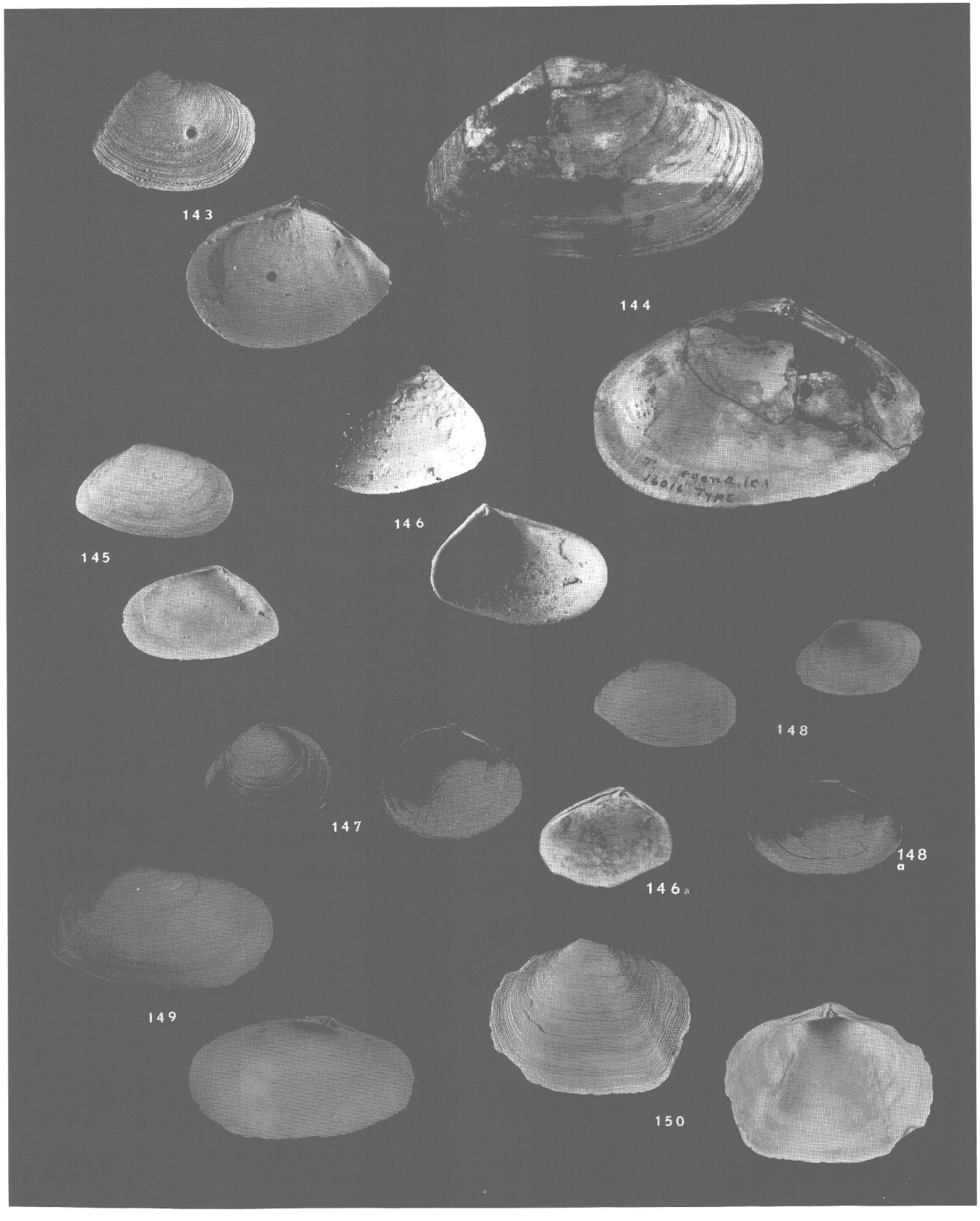
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PLATE 17

151. *Donax chuckatuckensis* (holotype figured, USNM 325589) Yorktown Chuckatuck 1, (figure from Gardner, 1944), (X 4.0).

151a. *Donax cuneola* (figured hypotype, USNM 403332) Zook's Pit near Yorktown, VA, (X 2.8).

152. *Donax emmonsi* (figured hypotype, USNM 403333), Chesapeake, VA 1, (X 1.6).

153. *Gari dalli* (figured hypotype, USNM 403334), Chesapeake, VA 1, (X 0.8).

154. *Semele subovata* (figured hypotype, USNM 403335), Chesapeake, VA 2, (X 1.0).

155. *Semele carinata* not illustrated

155a. *Semele alumensis* (figured hypotype, USNM 403336), Rice's Pit, Hampton, VA, (X 5.4).

156. *Semelina nuculoides* (figured hypotype, USNM 403337), Chesapeake, VA 2, (X 7.3).

157. *Cumingia subtellinoides* (figured hypotype, USNM 403338), Chuckatuck, VA 2, (X 1.0).

158. *Abra aequalis* (figured hypotype, USNM 403339), Chesapeake, VA 1, (X 2.5).

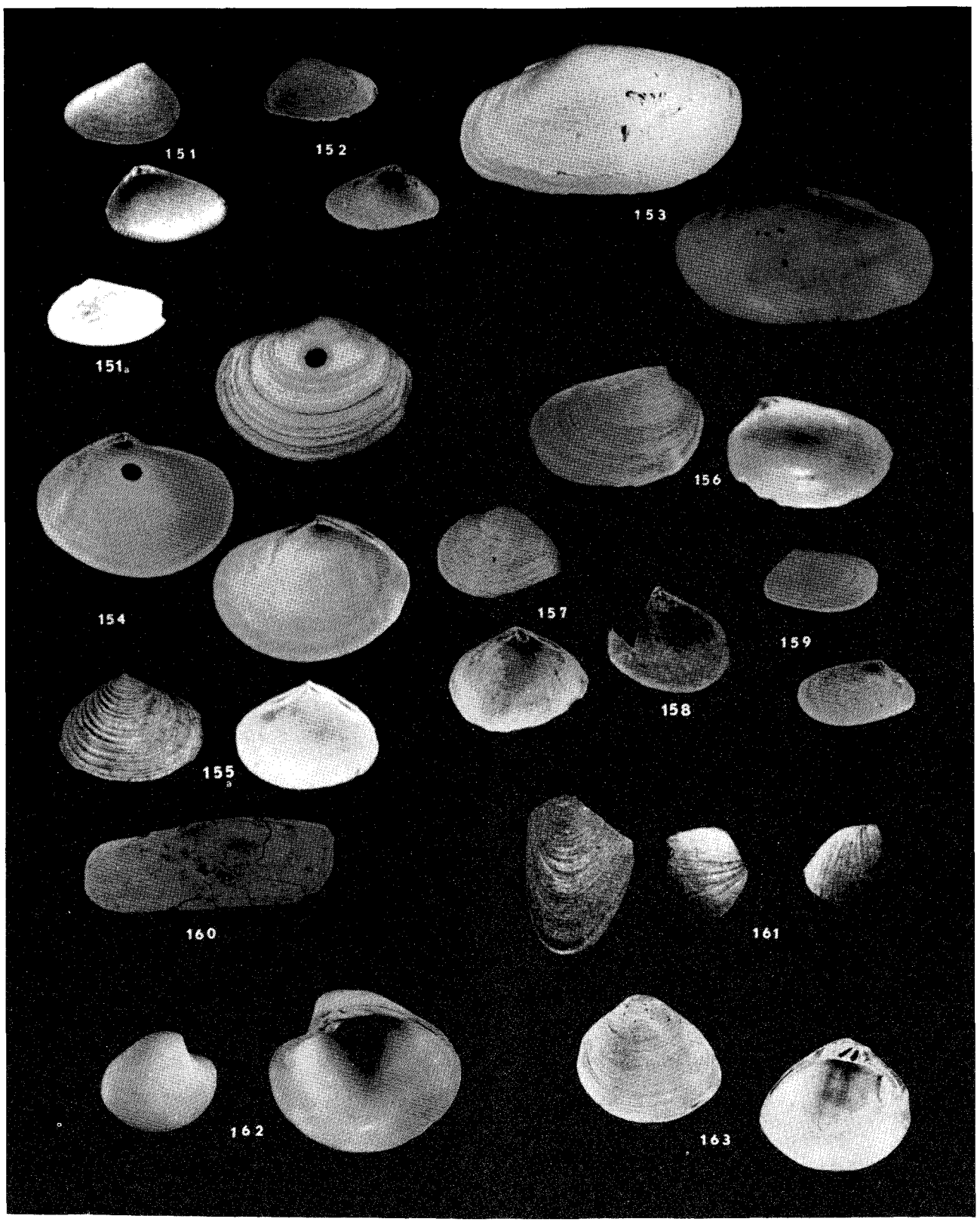
159. *Abra subreflexa* (figured hypotype, USNM 403340), Chesapeake, VA 2, (X 1.6).

160. *Tagelus plebeius* (figured hypotype, USNM 403341), Williamsburg, VA 3, (X 0.6).

161. *Coralliophaga microreticulata* (holotype figured, USNM 325560), Suffolk, VA, figure from Gardner, 1944, (X 1.5).

162. *Glossus fraternus* (figured hypotype, USNM 403342), Rice's Pit, Hampton, VA, (X 0.3).

163. *Corbicula densata* (figured hypotype, USNM 403343), Chesapeake, VA 1, (X 0.6).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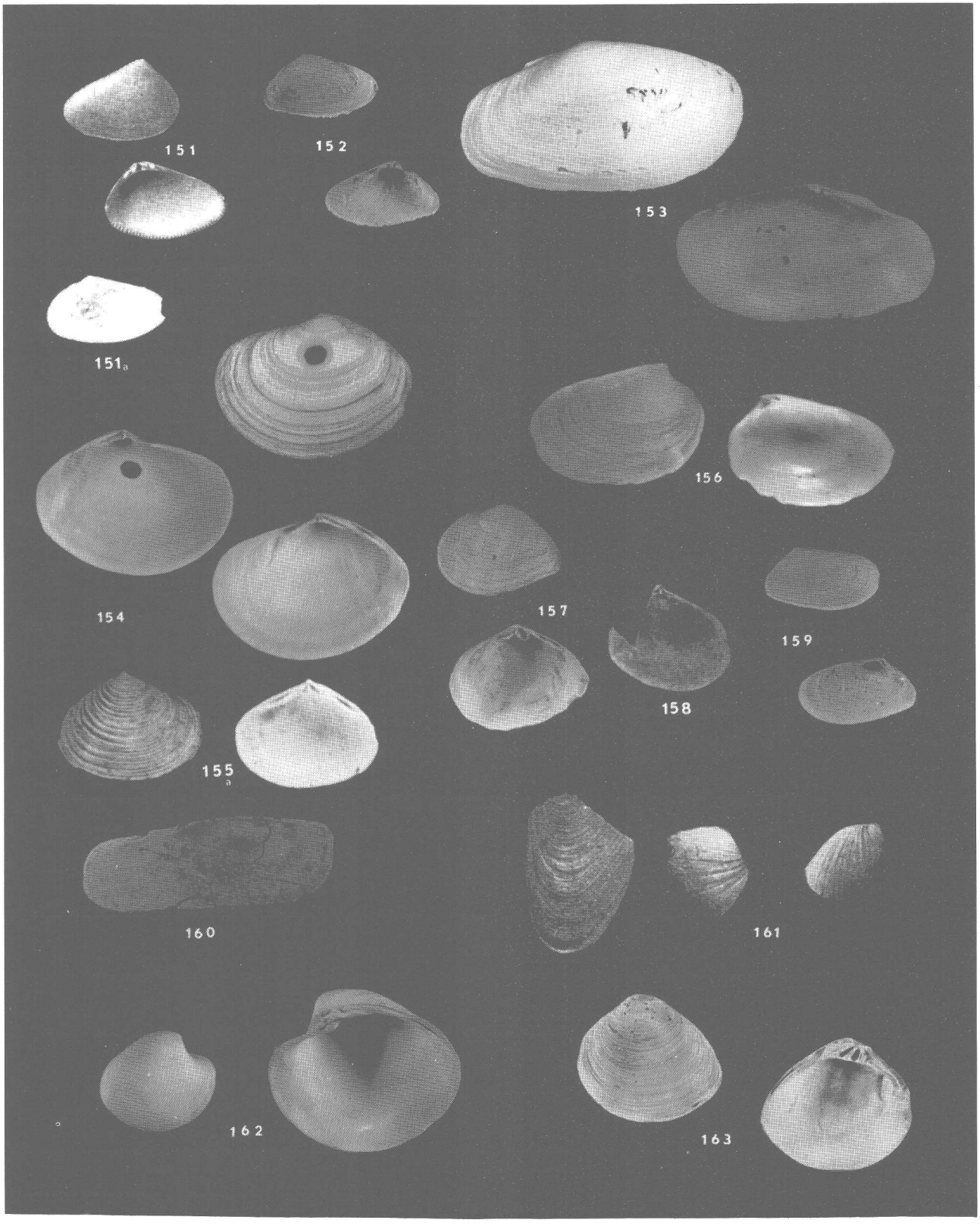
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PLATE 18

164. *Mercenaria campechiensis permagna* (figured hypotype, USNM 403345), Chuckatuck, VA 1, (X 0.5).

164a. *Mercenaria campechiensis* (figured hypotype, USNM 403344), Chesapeake, VA 1, (X 0.6).

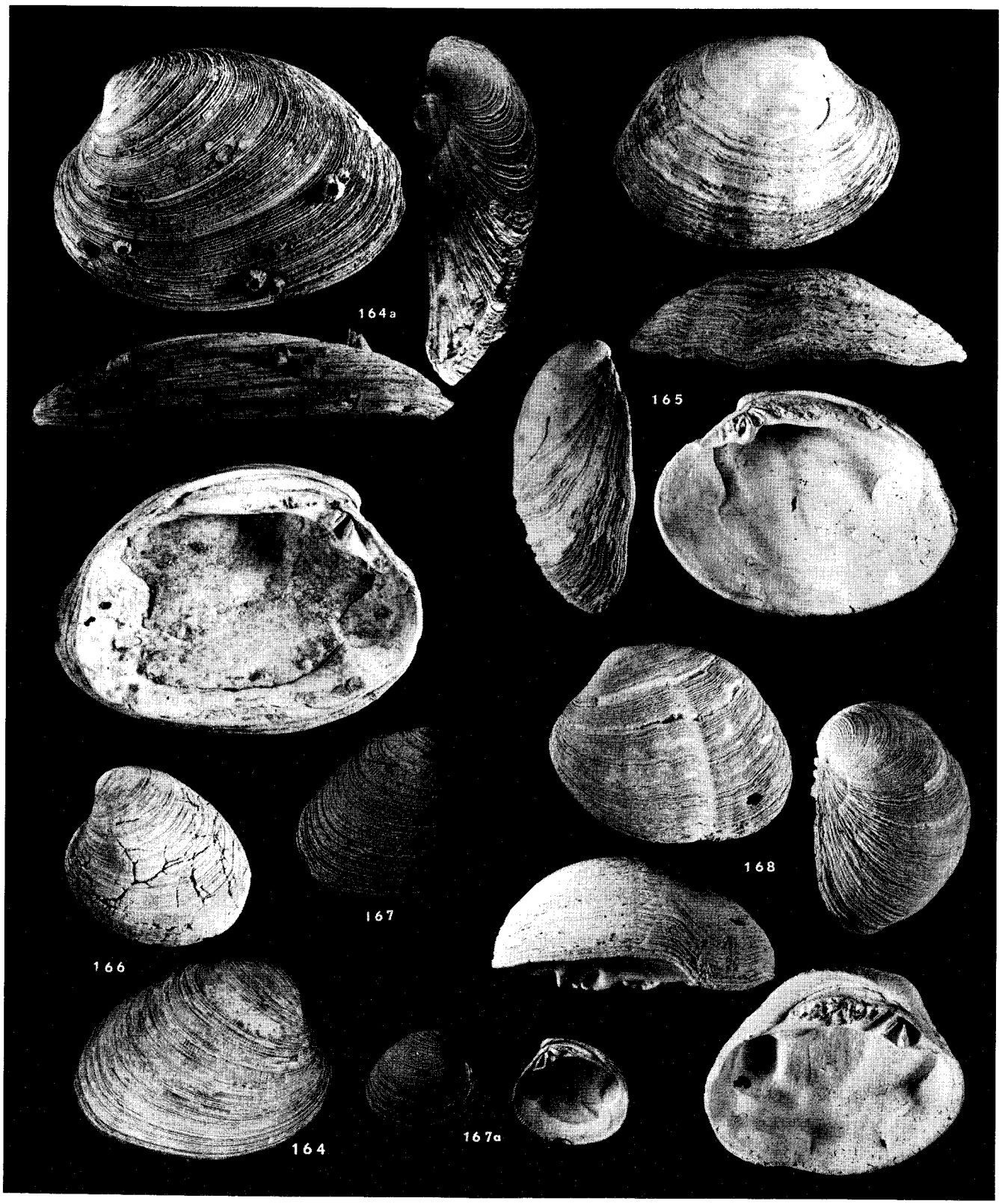
165. *Mercenaria corrugata* (figured hypotype, USNM 403346), Williamsburg, VA 2, (X 0.6).

166. *Mercenaria mercenaria* (figured hypotype, USNM 403347), Chesapeake, VA 1, (X 0.4).

167. *Mercenaria inflata* (figured hypotype, USNM 163419), Bellefield, VA, figure from Gardner, 1944, (X 0.6).

167a. *Mercenaria nucea* (figured hypotype, USNM 163418), Bellefield, VA, figure from Gardner, 1944, (X 0.8).

168. *Mercenaria tridacnoides* (figured hypotype, USNM 403348), Williamsburg, VA 3, (X 0.5).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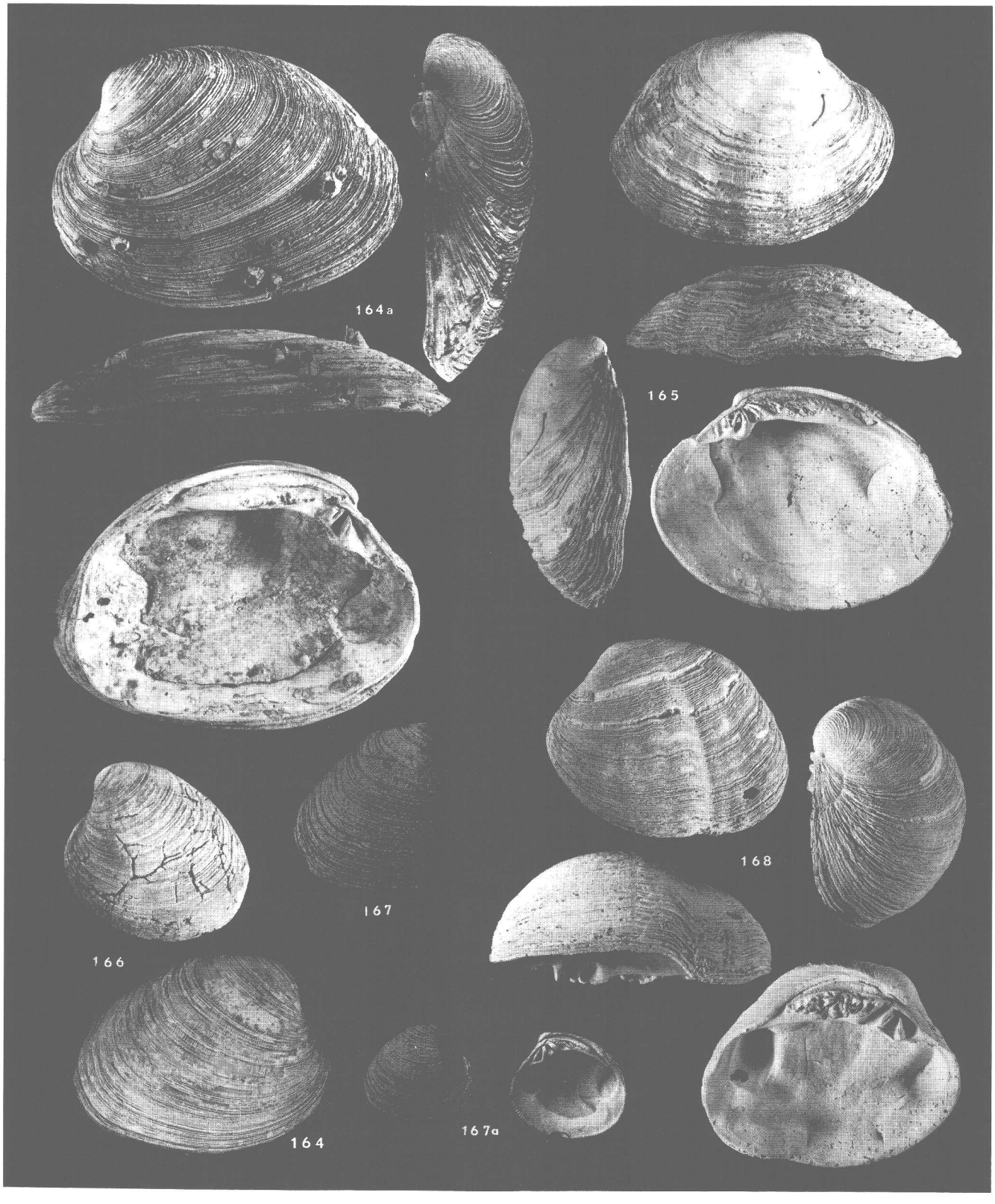
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PLATE 19

165a. *Mercenaria tridacnoides* copy of Lister,1684, Virginia, locality unknown.

169. *Mercenaria* sp. (figured hypotype, USNM 403349), Zone 1 Williamsburg, VA 1, (X 0.5).

170. *Chione cortinaria* (figured hypotype, USNM 146126), Grove Wharf, figure from Gardner, 1944, (X 1.5).

171. *Chione cribraria* (figured hypotype, USNM 265779), Rice's Pit, Hampton, VA, (X 1.0).

172. *Chione latilirata* (figured hypotype, USNM 403350), Williamsburg, VA 2, (X 1.0).

173. *Chione grus* (figured hypotype, USNM 403351), Chesapeake, VA 2, SEM (X 5.5).

174. *Transenella carolinensis* (figured hypotype, USNM 403352), Chesapeake, VA 2, (X 2.0).

175. *Gouldia metastriata* (figured hypotype, USNM 403353), Smithfield, VA 3, (X 2.5).

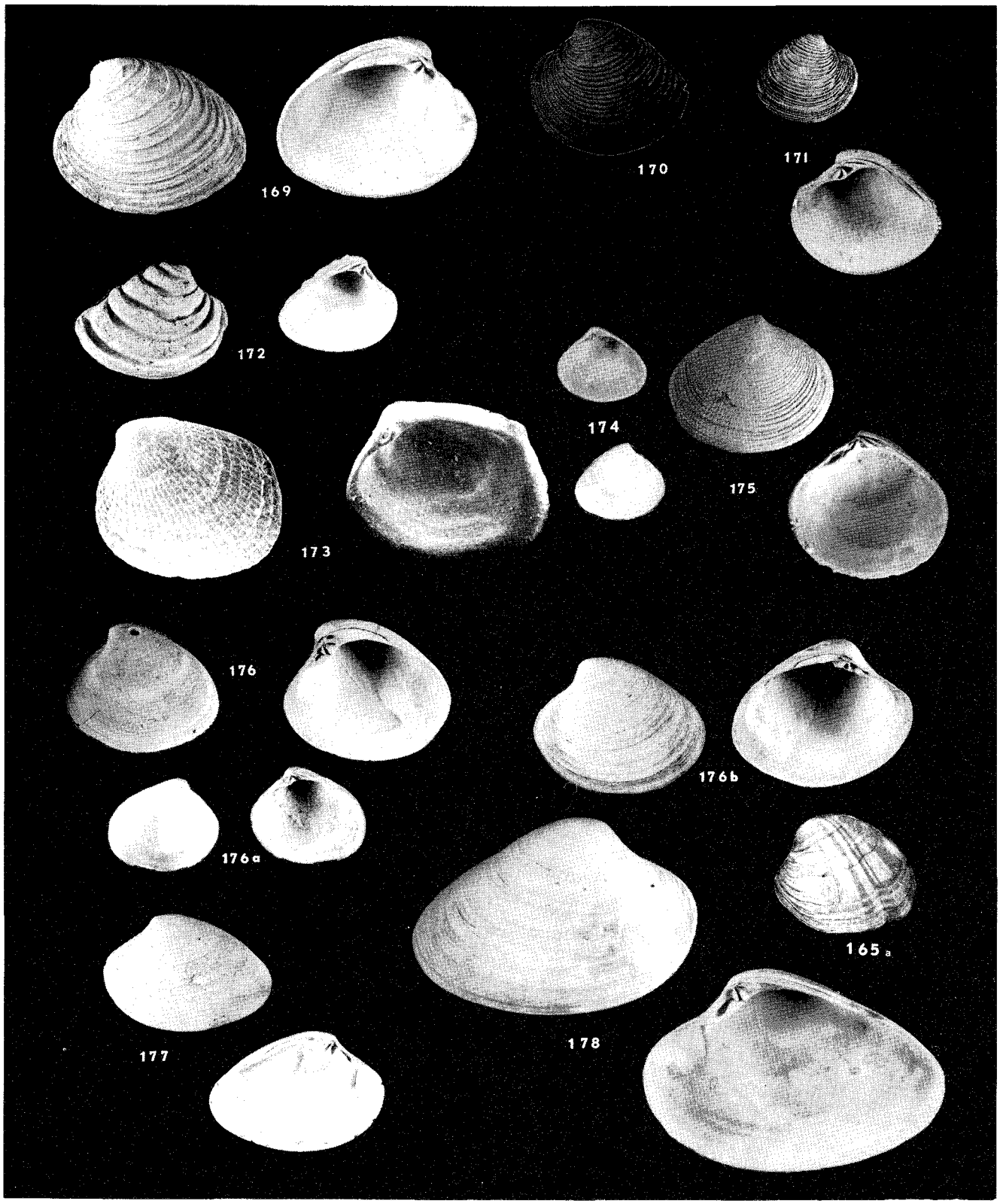
176. *Pitar sayana* (figured hypotype, USNM 403354), Chesapeake, VA 2, (X 0.6).

176a. *Pitar sayana* (holotype of "*Cytherea elevata*", ANSP 1581, Petersburg, VA 1, (X 2.0).

176b. *Pitar sayana* (figured hypotype, USNM 403307), Williamsburg, VA 3, (X 0.5)

177. *Macrocallista albraria* (figured hypotype, USNM 403355), Williamsburg, VA 3, (X 0.4).

178. *Macrocallista albraria reposta* (figured hypotype, USNM 403356), Chuckatuck, VA 1, (X 0.5).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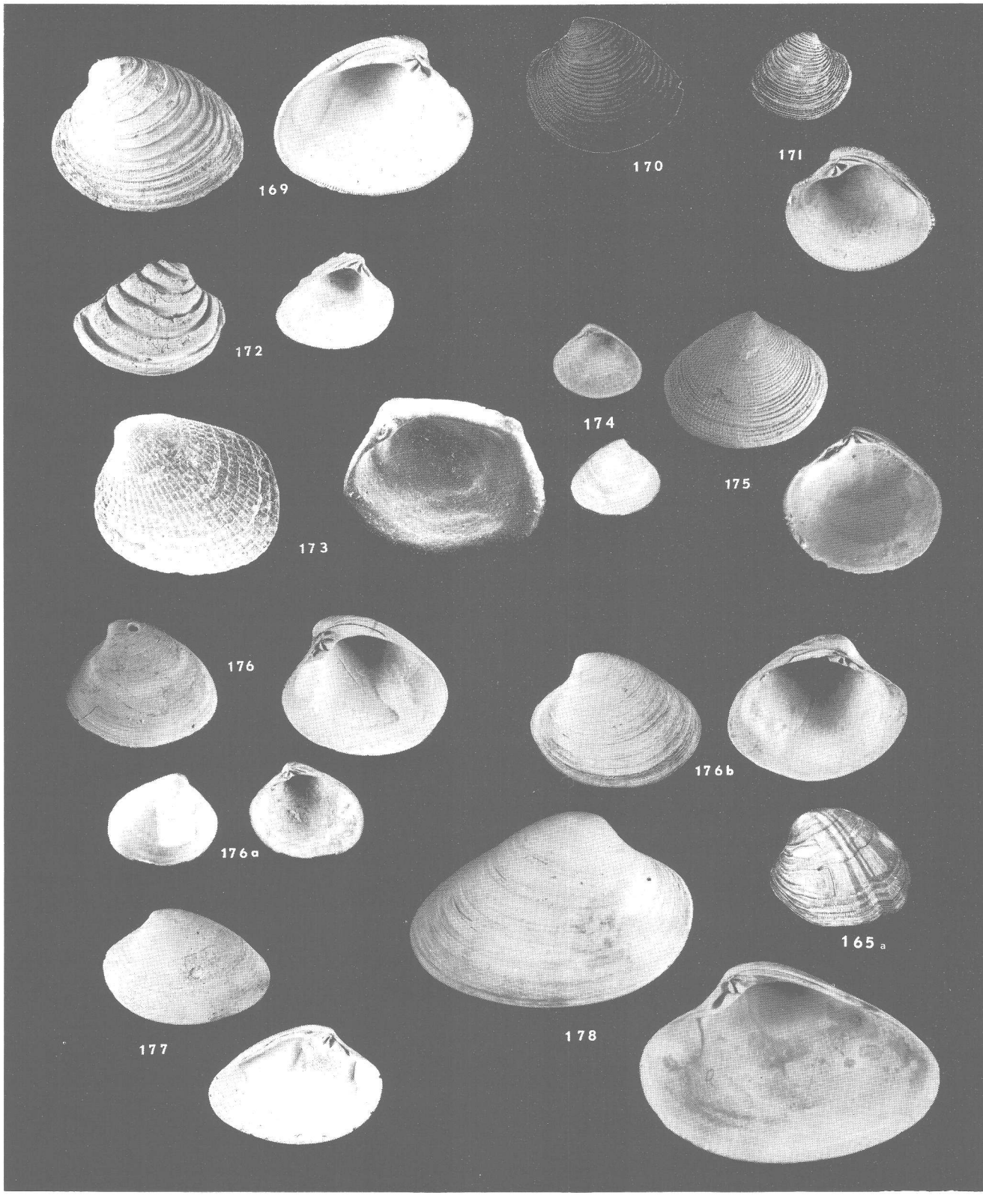
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PLATE 20

179. *Dosinia acetabula* (figured hypotype, USNM 403357), Chuckatuck, VA 1, (X 0.4).

180. *Gemma magna* (figured hypotype, USNM 403358), Williamsburg, VA 3, SEM (X 11).

181. *Petricola pholadiformis* (holotype of *Petricola rogersi*, ANSP 16015), Yorktown, VA, (X 1.5).

182. *Rupellaria pectarosa* (figured hypotype, USNM 403359), Chuckatuck, VA 1, (X 1.7).

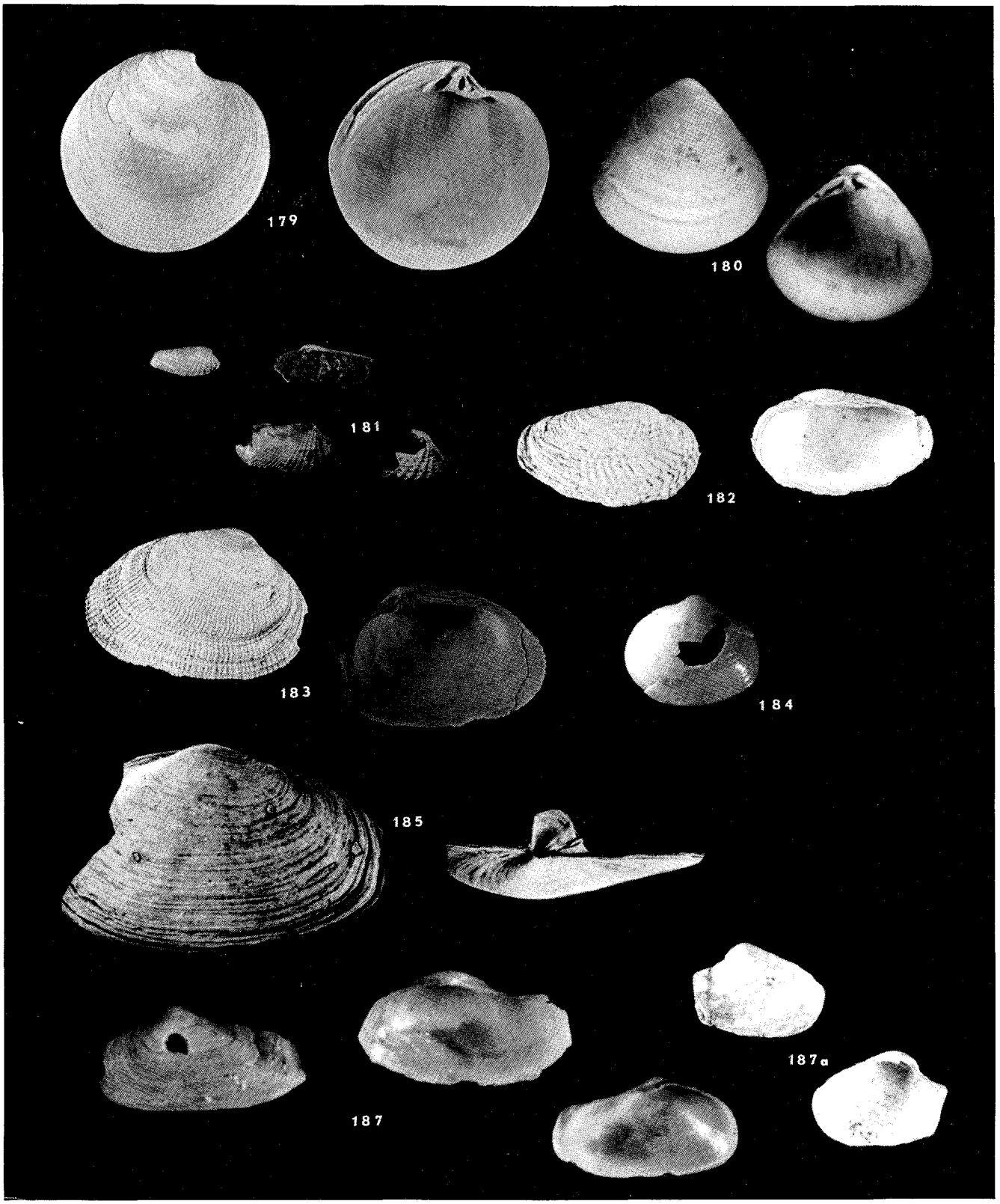
183. *Pleiorytis centenaria* (figured hypotype, USNM 403360), Chuckatuck, VA 2, (X 0.7).

184. *Cooperella parilis* (holotype of *Diplodonta yorkensis*, USNM 144548), Yorktown, VA, (X 1.8).

185. *Mya arenaria* (figured hypotype, USNM 644278), Petersburg, VA 1, figure from MacNeil, 1964, (X 0.9).

187. *Sphenia dubia* (figured hypotype, USNM 403361), Chesapeake, VA 2, (X 17).

187a. *Sphenia dubia* (holotype of *Mya reflexa*, ANSP 1588), Petersburg, VA 1, (X 15).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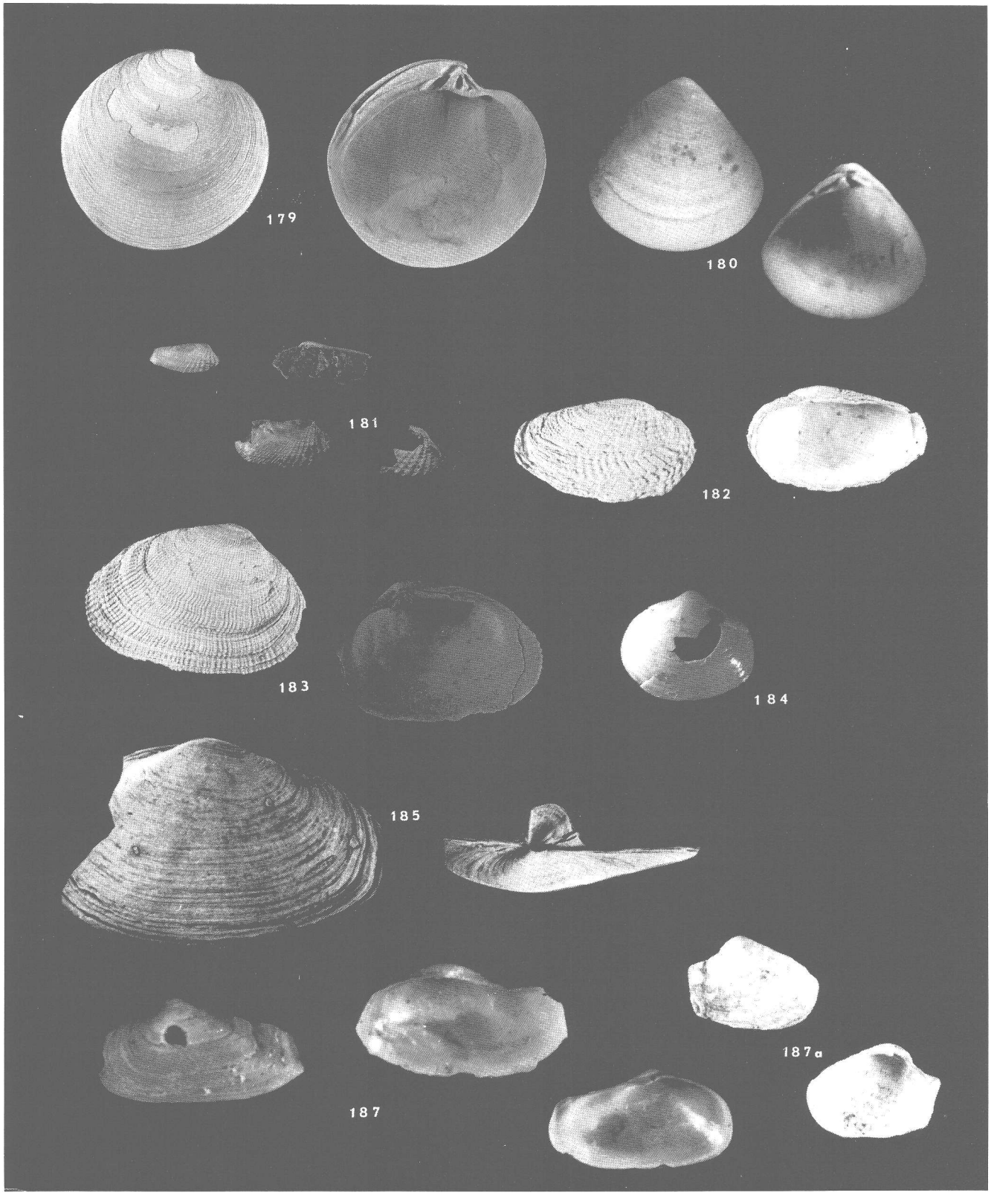
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PLATE 21

188. *Varicorbula chowanensis* (figured hypotype, USNM 403362), Chuckatuck, VA 1, (X 1.7).

189. *Corbula cuneata* (figured hypotype, USNM 403363), Chuckatuck, VA 2, (X 1.6).

190. *Corbula retusa* (figured hypotype, USNM 403364), Chuckatuck, VA 2, (X 1.7).

191. *Corbula inaequalis* (figured hypotype, USNM 403365), Chesapeake, VA 2, (X 1.9).

192. *Gastrochaena ligula* (figured hypotype, USNM 403366), Chuckatuck, VA 2, (X 1.8).

193. *Hiatella arctica* (figured hypotype, USNM 403367), Chuckatuck, VA 1, (X 2.9).

193a. *Hiatella arctica* (figured hypotype, USNM 403368), Chesapeake, VA 2, (X 10), juvenile showing posterior radial sculpture.

194. *Panopea goldfussi* (figured hypotype, USNM 403369), Rice's Pit, Hampton, VA, (X 0.5).

195. *Panopea reflexa* (figured hypotype, USNM 403370), Chuckatuck, VA 2, (X 0.3).

196. *Cyrtopleura arcuata* (figured hypotype, USNM 403371), Suffolk, VA, (X 0.5).

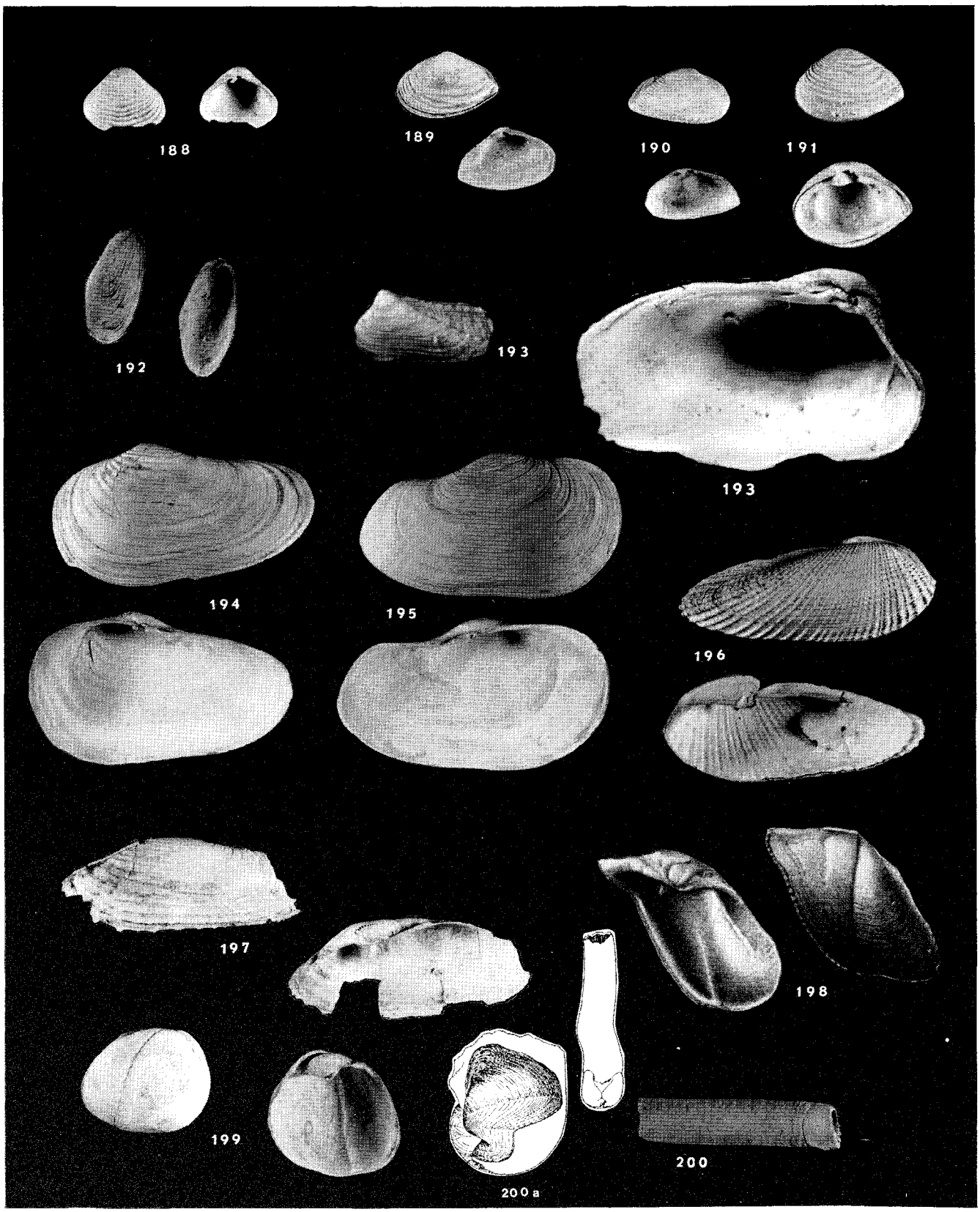
197. *Pholas memmingeri* (figured hypotype, USNM 403372), Williamsburg, VA 3, (X 0.8).

198. *Ziphraea rhomboidea* (holotype figured, ANSP 1583), Petersburg, VA 1, (figure from Gardner, 1944), (X 5.0).

199. *Martesia* sp., cf. *M. ovalis* (figured hypotype, USNM 403373), Rice's Pit, Hampton, VA, (X 0.9).

200. *Teredina fistula* (figured hypotype, USNM 403374), Williamsburg, VA 2, (X 0.9).

200a. *Teredina fistula* figure from Johnson, 1904, showing original shell.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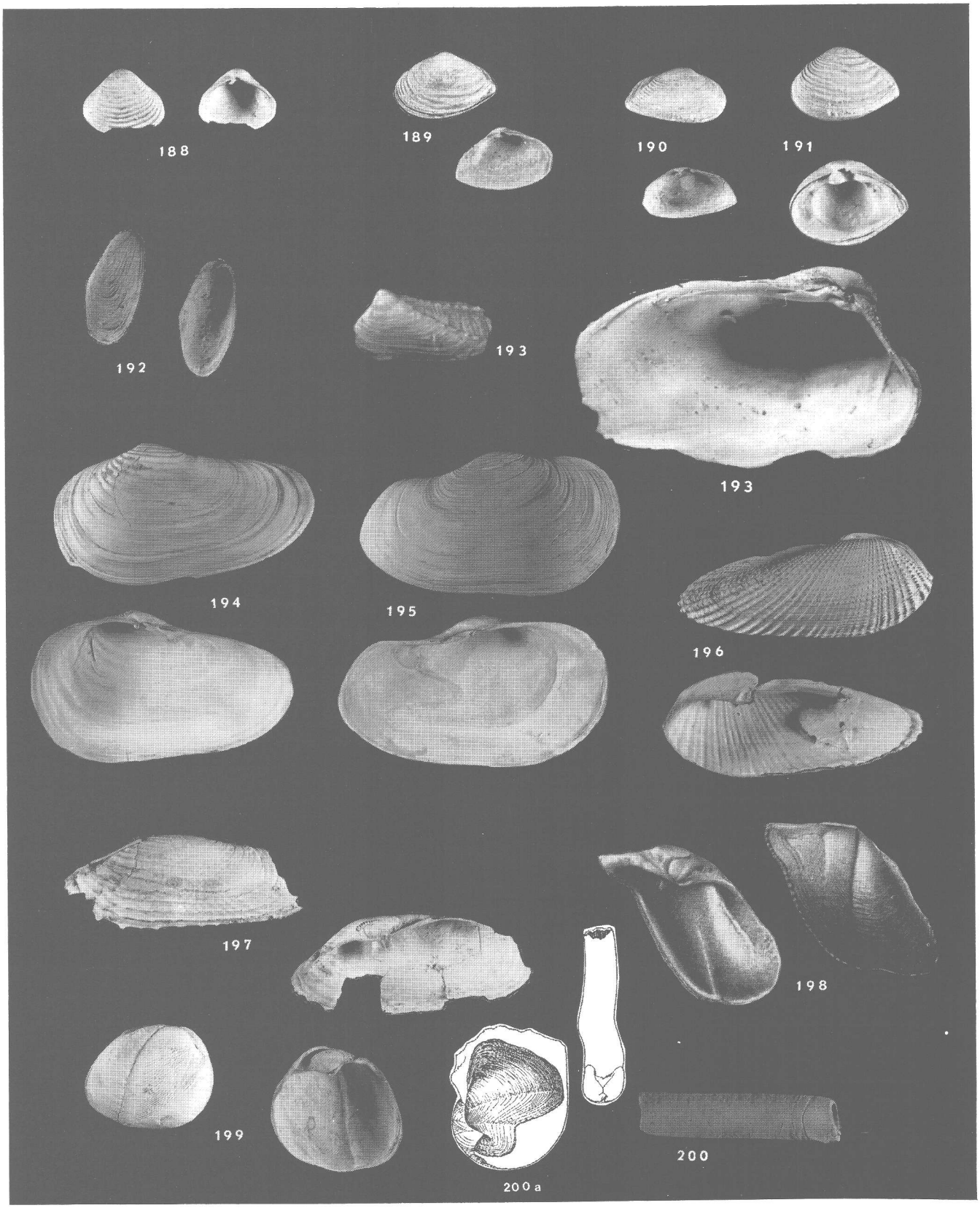
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PLATE 22

201. *Margaritaria abrupta* (figured hypotype, USNM 403375), Chesapeake, VA 2, (X 0.8).

202. *Lyonsia* sp. (figured hypotype, USNM 403376), Chesapeake, VA 2, (X 2.77).

202a. *Lyonsia* sp. (figured hypotype, USNM 403377), Chesapeake, VA 2, SEM (X 10).

203. *Pandora arenosa* (figured hypotype, USNM 403378), Chuckatuck, VA 2, (X 1.0).

204. *Pandora crassidens* (figured hypotype, USNM 403379), Chesapeake, VA 2, (X 0.7).

205. *Pandora crassidens majorina* (figured hypotype, USNM 403695), Rice's Pit, Hampton, VA, (X 0.6).

206. *Pandora undulata* (holotype figured, USNM 403380), Zone 1, Williamsburg, VA 1, (X 1.2).

207. *Pandora* sp. (figured hypotype, USNM 403381), Chesapeake, VA 1 (X 2.0).

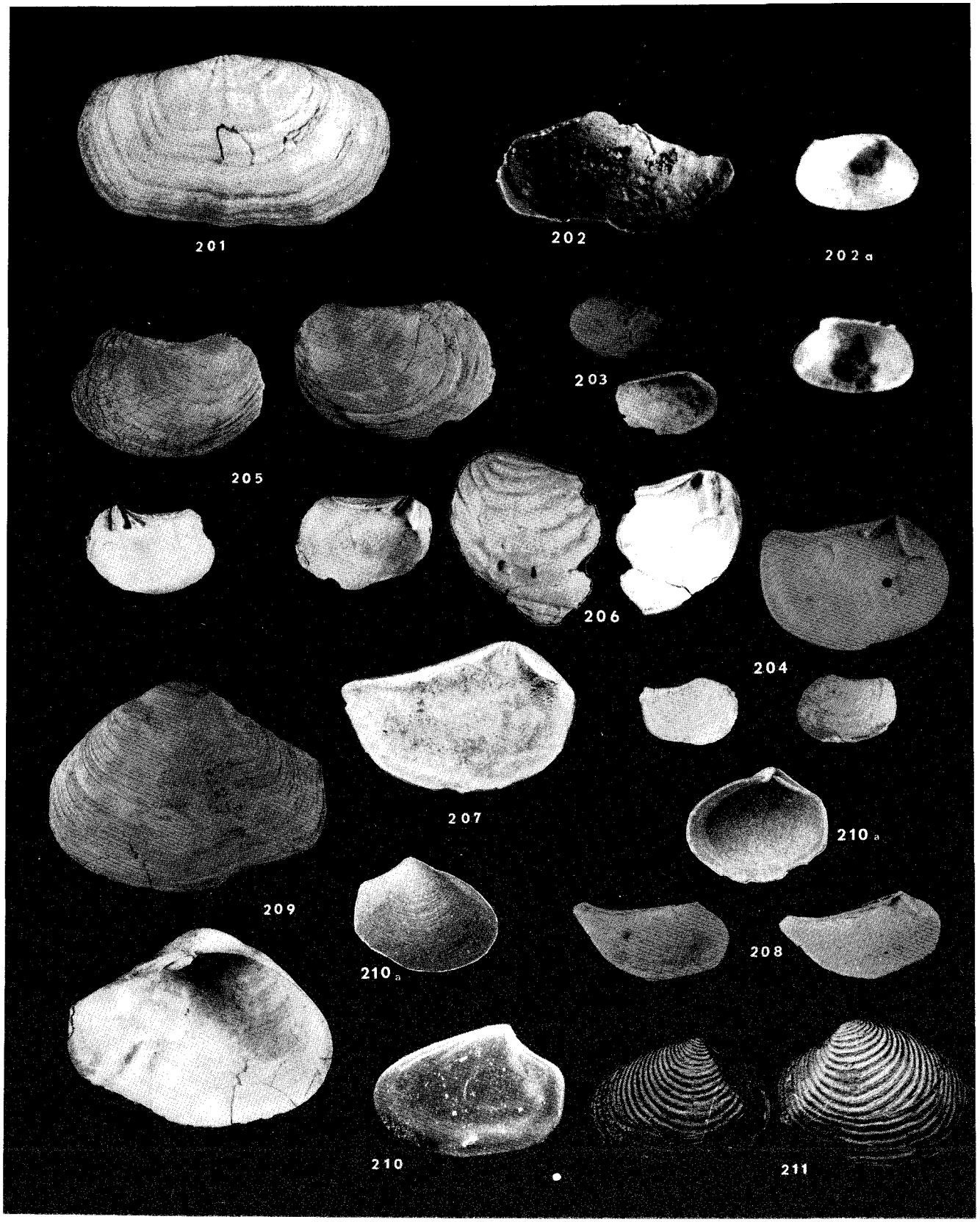
208. *Pandora tuomeyi* (figured hypotype, USNM 403382), Williamsburg, VA 3, (X 1.5).

209. *Thracia magna* (holotype figured, USNM 403383), Rice's Pit, Hampton, VA, (X 0.4).

210. *Thracia transversa* (figured hypotype, USNM 403384), Chesapeake, VA 2, SEM (X 10).

210a. *Thracia maddelysensis* (holotype figured, USNM 325508) Maddely's Bluff, Meherrin River, VA, figure from Gardner, 1944, (X 5.2).

211. *Cyathodonta dalli* (holotype figured, USNM 352442), Benns Church, VA, figure from Mansfield, 1929, (X 0.9).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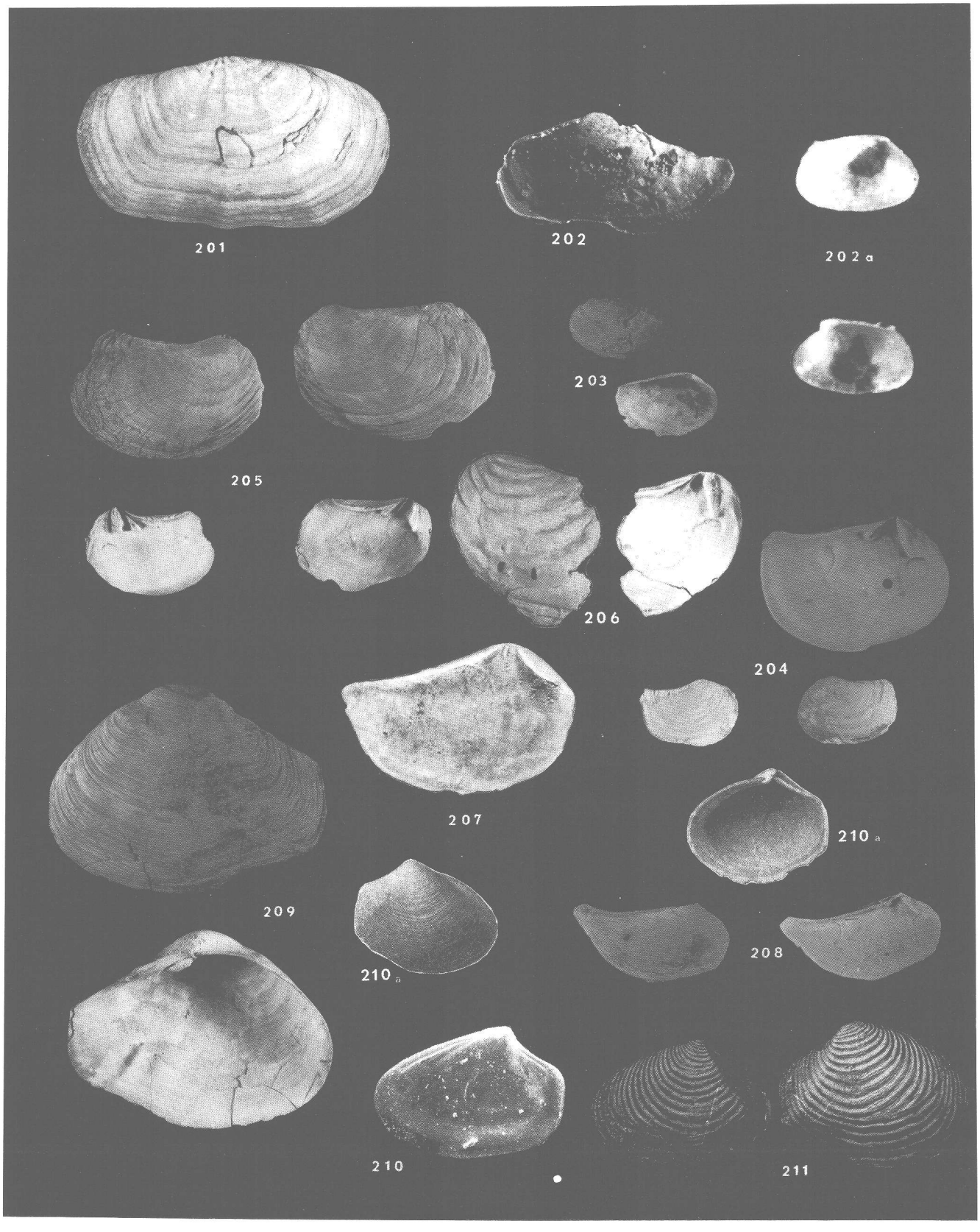
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PLATE 23

212. *Periploma* sp. cf. *P. peralta* (figured hypotype, USNM 403385), Rice's Pit, Hampton, VA, (X 1.2).

213. *Cochlodesma antiqua* (figured hypotype, USNM 403386), Chuckatuck, VA 1, (X 0.7).

214. *Verticordia rogersi* (figured hypotype, USNM 403387), Chesapeake, VA 2, SEM (X 12).

215. *Verticordia* sp. (figured hypotype, USNM 403388), Chesapeake, VA 1, (X 4.5).

216. *Dentalium attenuatum* (figured hypotype, USNM 403389), Williamsburg, VA 1, (X 0.9).

217. *Dentalium carolinense* (figured hypotype, USNM 403390), Chesapeake, VA 2, (X 0.9).

218. *Cadulus thallus* (figured hypotype, USNM 403391), Smithfield, VA 2, (X 3.9).

219. *Ischnochiton* sp. (figured hypotype, USNM 403392), Chuckatuck, VA 2, SEM, (X 15).

220. *Chaetopleura apiculata* (figured hypotype, USNM 403393), Chuckatuck, VA 2, SEM, (X 5.0).

221. *Diodora catilliformis* (MCZ lost), Shell Bank, Prince George Co., VA, figure from Gardner, 1948 (X 2.5).

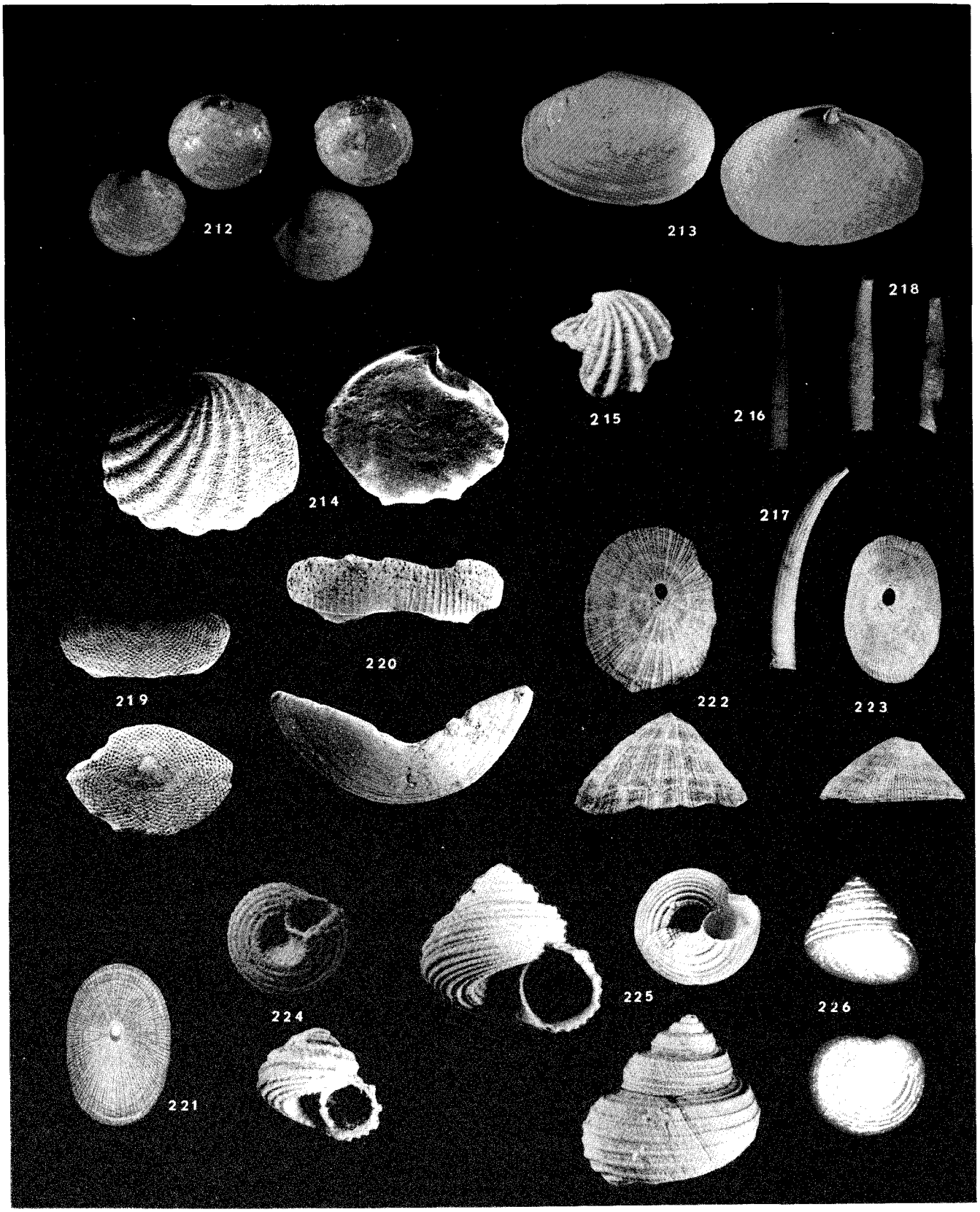
222. *Diodora oblonga* (figured hypotype, USNM 403394), Chuckatuck, VA 1, (X 0.7).

223. *Diodora redimicula* (figured hypotype, USNM 403395), Scotland Wharf, VA, (X 0.7).

224. *Solariella olssoni* (holotype figured, USNM 403396), Zone 1, Williamsburg, VA 1, (X 3.0).

225. *Solariella ricei* (holotype figured, USNM 403397), Rice's Pit, Hampton VA, (X 2.9).

226. *Solariella shacklefordensis* (holotype figured, PRI 3513Shackleford, VA, figure from Olsson, 1914, (X 3.0).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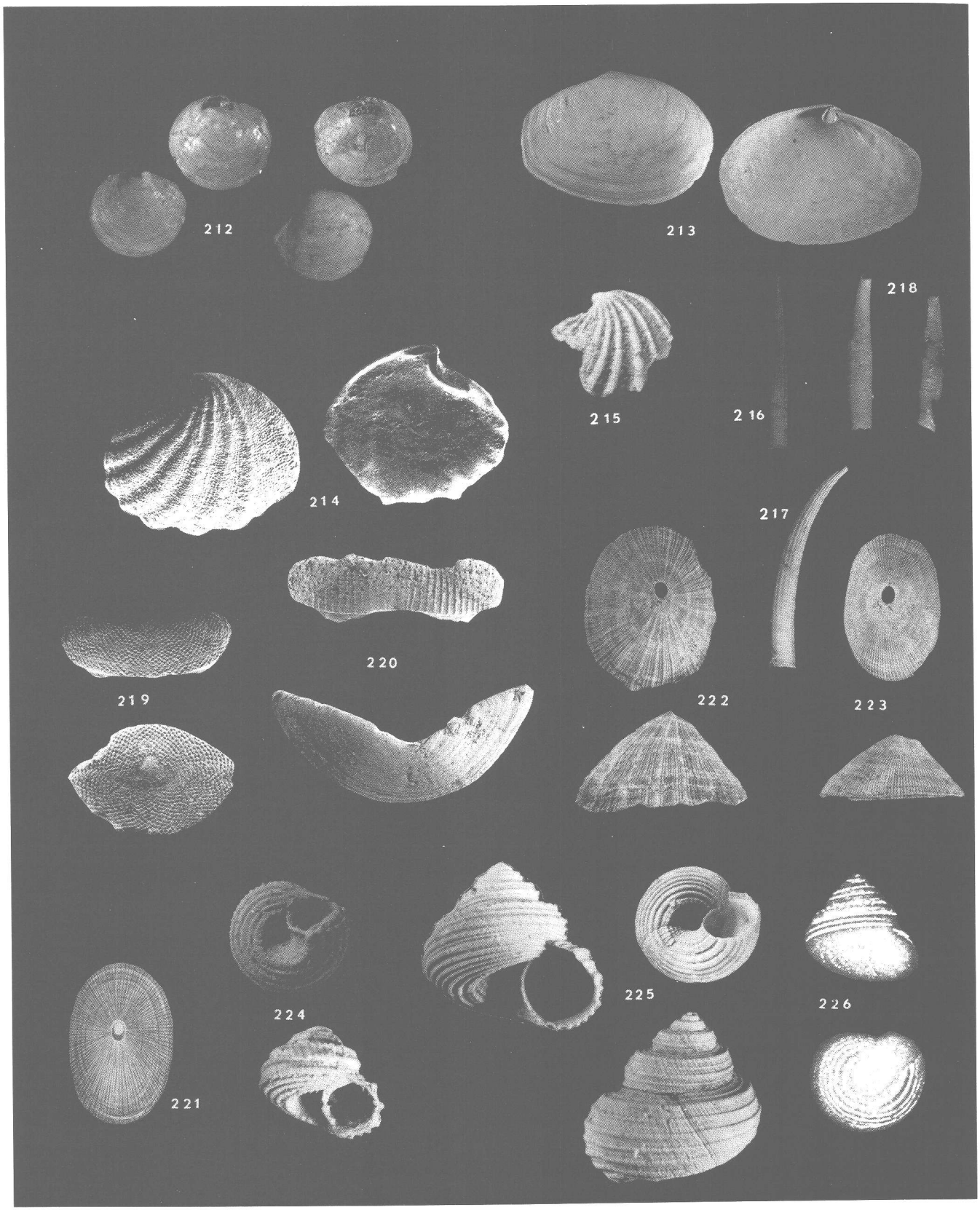
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PLATE 24

227. *Calliostoma bellum* (syntype figured, ANSP 30587), Smithfield, VA, (X 2.5).

228. *Calliostoma sarae* (holotype figured, USNM 403398), Zone 1 Williamsburg, VA 1, (X 3.5).

229. *Calliostoma labrosum* (figured hypotype, USNM 113050), James River, VA, figure from Gardner, 1948, (X 2.4).

230. *Calliostoma lapidosum* (holotype of *Trochus conus*, ANSP 1544) Petersburg, VA 1, (X 2.2).

230a. *Calliostoma lapidosum* (holotype of *Calliostoma conradi*, USNM 325468), Yorktown, VA, figure from Gardner, 1948, (X 2.0).

231. *Calliostoma mitchelli mitchelli* (holotype figured, ANSP 1619), figure from Gardner, 1948, (X 1.2).

232. *Calliostoma mitchelli basicum* (figured hypotype, USNM 113036), Petersburg, VA 1, figure from Gardner, 1948, (X 1.2).

233. *Calliostoma mitchelli conradianum* (ANSP 31403), Petersburg ?, VA 1, figure from Dall, 1892, (X 0.8).

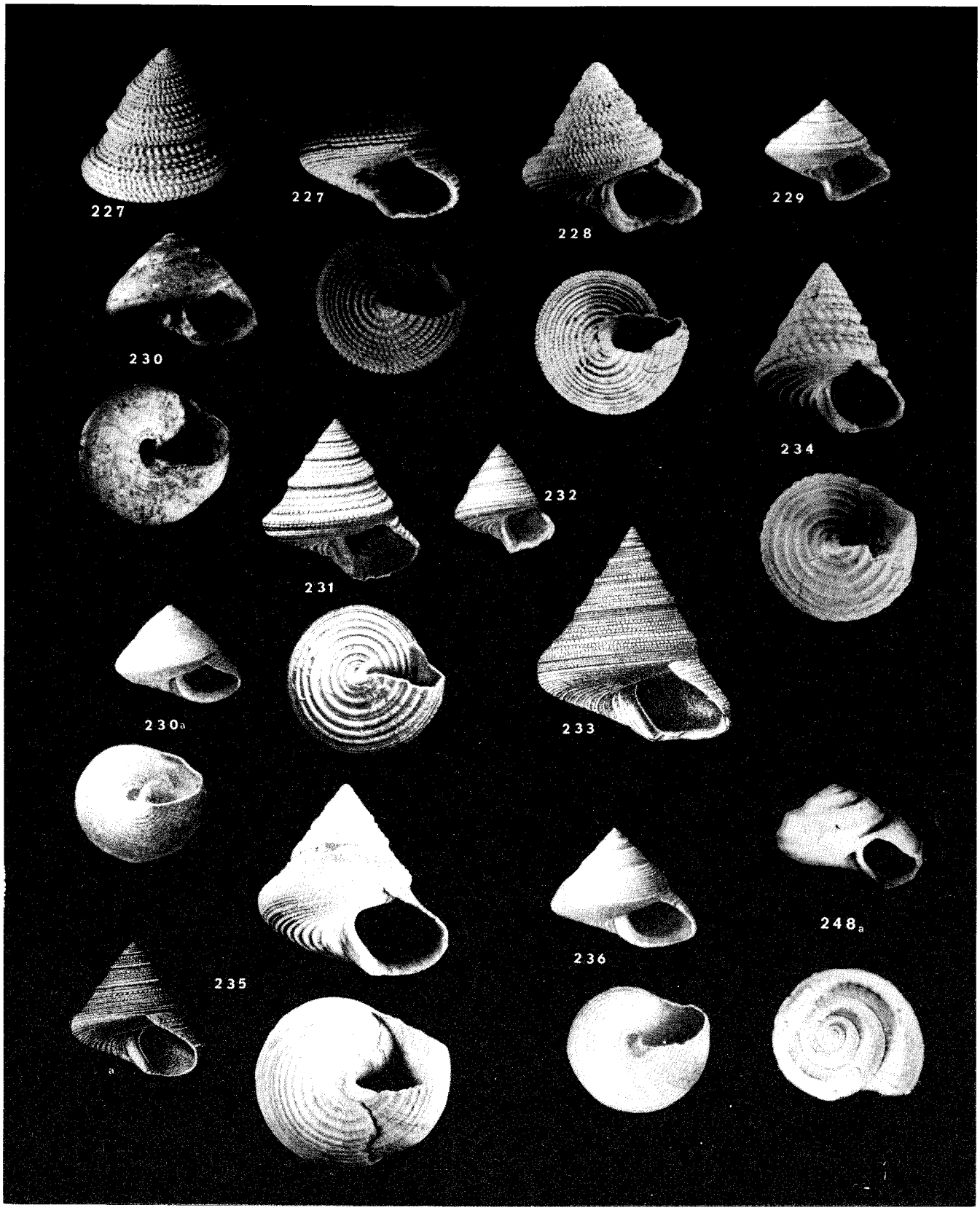
234. *Calliostoma mitchelli johnsoni* (holotype figured, USNM 403399), Zone 1, Williamsburg, VA 1, (X 2.3).

235. *Calliostoma mitchelli philanthropus* (figured hypotype, USNM 113021), Yorktown, VA, figure from Dall, 1892, (X 1.8).

235a. *Calliostoma mitchelli philanthropus* (figured hypotype, USNM 403400), Williamsburg, VA 2, (X 1.8)

236. *Calliostoma nottowayense* (holotype figured, USNM 325466), Sycamore, Nottoway River, VA, figure from Gardner, 1948. (X 2.9).

248a. *Arene tuomeyi* (holotype figured, USNM 403408), Chesapeake, VA 2, (X 2.8).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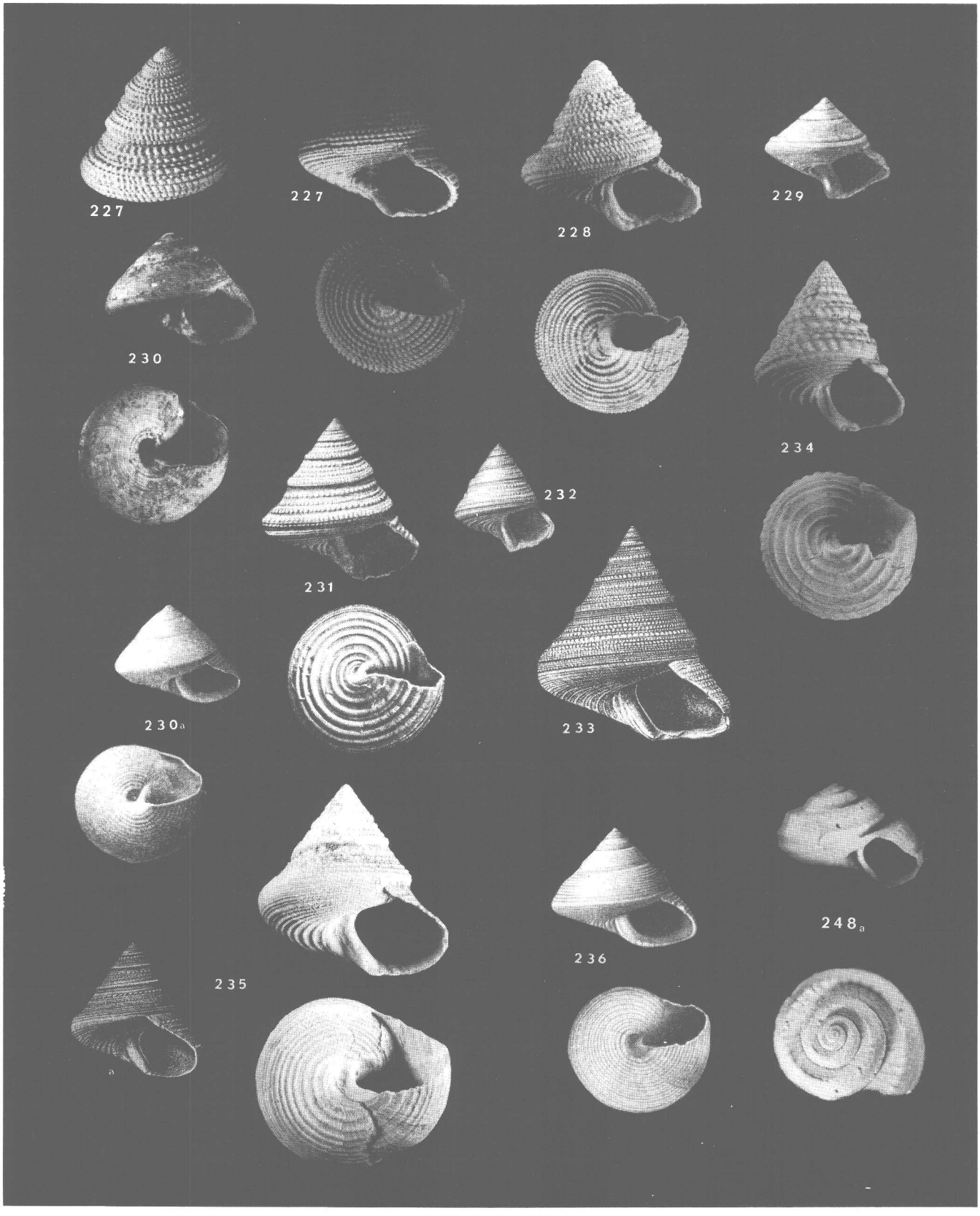
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PLATE 25

237. *Calliostoma shacklefordensis* (PRI lost), Shackleford, VA, not illustrated.

238. *Calliostoma virginicum virginicum* (figured hypotype, USNM 113036), Yorktown, VA, figure from Gardner, 1948, (X 2.1).

238B. *Calliostoma virginicum carolinensis* (holotype figured, USNM 325472), Martin Co., NC, figure from Gardner, 1948, (X 2.1).

239. *Calliostomavirginicum gizehi* (holotype figured, USNM 325467), Yorktown, VA, figure from Gardner, 1948, (X 2.2).

240. *Calliostoma virginicum harrisianum* (PRI 204, missing), Zone 1, Bellefield, VA, not illustrated.

241. *Calliostoma virginicum harrisii* (holotype figured, USNM 113052), Zone 1, Bellefield, VA, figure from Gardner, 1948, (X 2.1).

241C. *Calliostoma virginicum hertfordense* (holotype figured, USNM 325469), Murfreesboro, NC, figure from Gardner, 1948, (X 2.7).

242. *Calliostoma virginicum jeffersonium* (holotype figured, USNM 403400), Zone 1 Williamsburg, VA 1, (X 3.0).

242a. *Calliostoma virginicum jeffersonium* (paratype figured, USNM 403688), Zone 1 Williamsburg, VA 1, (X 3.0).

243. *Tegula exoluta* (figured hypotype, USNM 403401), Williamsburg, VA 2, (X 1.7).

244. *Gibbula rustica* (figured hypotype, USNM 325463), Suffolk, VA, figure from Gardner, 1948, (X 5.5).

245. *Skenea harrisi* (figured hypotype, USNM 403402), Chesapeake, VA 2, SEM (X 33).

246. *Skenea smithfieldensis* (figured hypotype, USNM 403403), Chesapeake, VA 2, SEM (X 43).

247. *Skenea yorktownensis* (holotype figured, USNM 403404), Chesapeake, VA 2, SEM (X 23).

247a. *Leptogyra davidi* (holotype figured, USNM 403405), Chesapeake, VA 2, SEM (X 24).

247b. *Pelycidion matthewi* (holotype figured, USNM 403406), Chesapeake, VA 2, SEM (X 24).

248. *Arene* sp. (figured hypotype, USNM 403407), Chesapeake, VA 2, SEM (X 22).

248a. *Arene tuomeyi* (holotype figured, USNM 403408), Chesapeake, VA 2, (X 2.8). see plate 24.

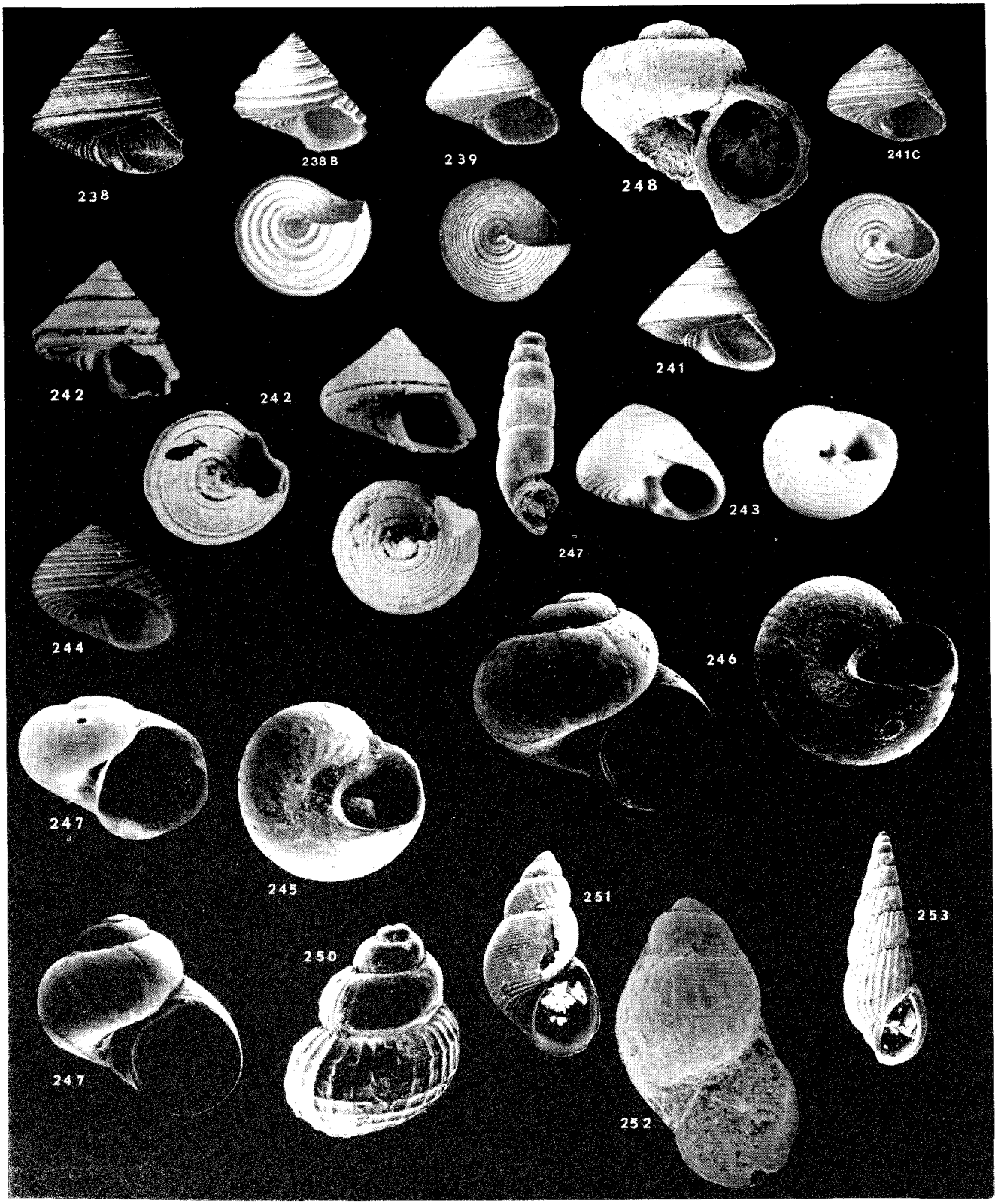
249. *Littorina irrorata* not illustrated.

250. *Alvania lipeus* (figured hypotype, USNM 403409), Chesapeake, VA 2, SEM (X 40).

251. *Cingula geraea* (figured hypotype, USNM 403410), Chesapeake, VA 2, SEM (X 12.5).

252. *Cingula* sp. (figured hypotype, USNM 403411), Smithfield, VA 2, SEM (X 37).

253. *Rissoina* sp. cf. *R. striatocostata* (figured hypotype, USNM 403412), Chuckatuck, VA 2, SEM (X 14).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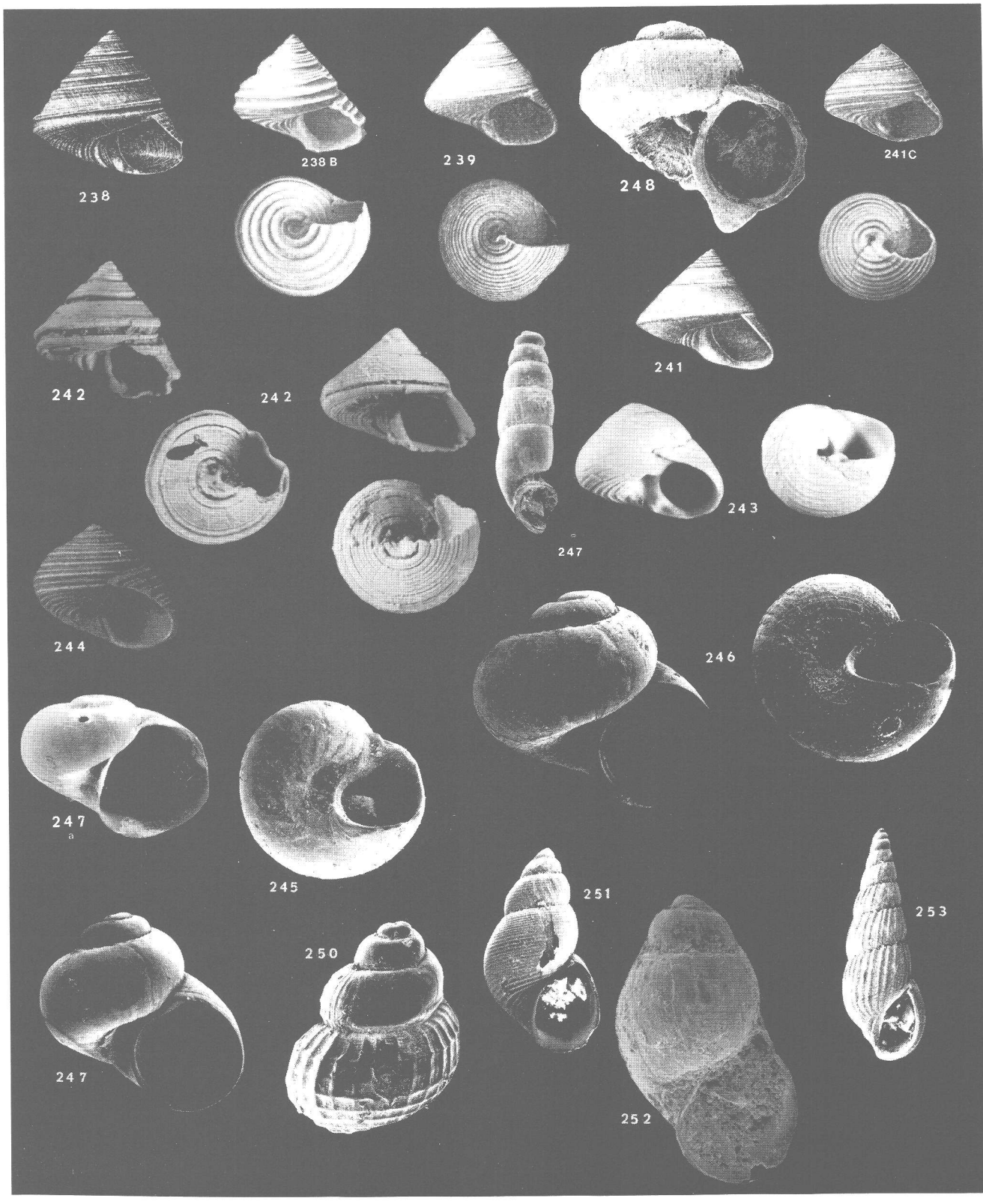
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PLATE 26

254. *Vitrinella lipara* (holotype figured, ANSP 1542), Petersburg, VA 1, figure from Gardner, 1948, (X 8.5).

255. *Aorotrema cistronium* (figured hypotype, USNM 403413), Chuckatuck, VA 2, SEM (X 18).

256. *Circulus costulatus* (figured hypotype, USNM 403414), Chuckatuck, VA 2, SEM (X 10).

257. *Cyclostremiscus obliquestriatus* (figured hypotype, USNM 403415), Chuckatuck, VA 2, SEM (X 16).

258. *Cyclostremiscus pseudaeorbis* (holotype figured, USNM 112653), Temple Place near Yorktown, VA, figure from Dall, 1892, (X 5).

259. *Cyclostremiscus schmidti* (figured hypotype, USNM 403416), Chuckatuck, VA 2, SEM (X 19).

260. *Cyclostremiscus undula* (figured hypotype, USNM 403417), Chesapeake, VA 1, SEM (X 22).

261. *Parviturboides* sp. (figured hypotype, USNM 403418), Chesapeake, Va 2, SEM (X 40).

262. *Didianema carolinae* (figured hypotype, USNM 403419), Chesapeake, VA 1, SEM (X 31).

263. *Didianema* sp. (figured hypotype, USNM 403420), Williamsburg, VA 3, SEM (X 24).

264. *Solariorbis variabilis* (figured hypotype, USNM 403421), Petersburg, VA 1, SEM (X 20).

265. *Solariorbis yadkinensis* (holotype figured, USNM 403422), Chesapeake, VA 1, SEM (X 26).

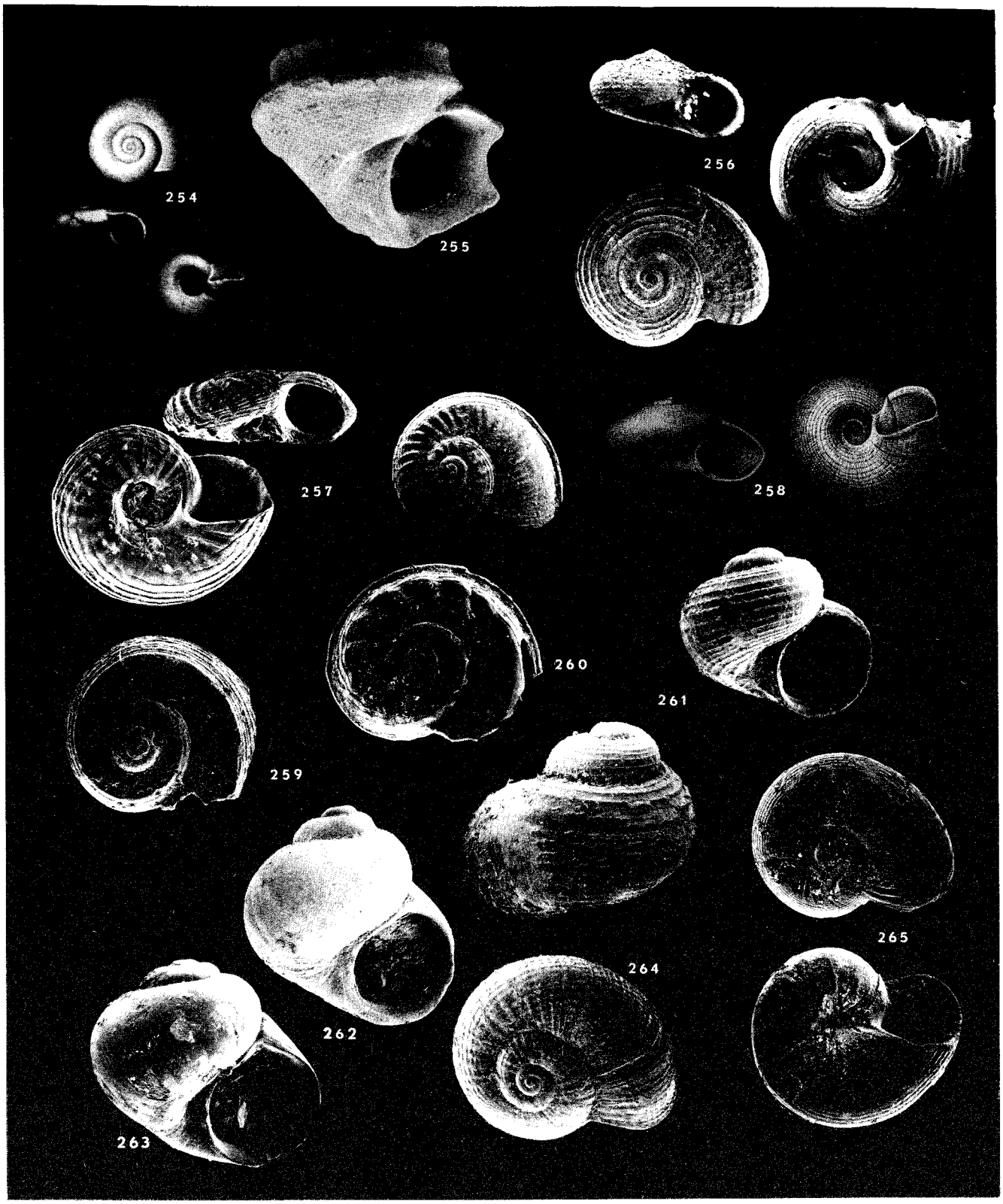
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PLATE 27

263. *Didianema* sp. (figured hypotype, USNM 403420), Williamsburg, VA 3, SEM (X 24), repeated for comparison with species # 272.

266. *Teinostoma alexanderi* (figured hypotype, USNM 403423), Chesapeake, VA 2, SEM (X 15.5).

267. *Teinostoma bushi* (figured hypotype, USNM 403424), Williamsburg, VA 2, SEM (X 26).

268. *Teinostoma goniogyrus* (figured hypotype, ANSP not given), Smithfield, VA, figure from Pilsbry, 1953 (X 21).

269. *Teinostoma beaufortensis* (figured hypotype, USNM 403425), Chuckatuck, VA 2, SEM (X 17).

270. *Teinostoma lenticlare* (holotype figured, ANSP not given), Smithfield, VA 1, figure from Pilsbry, 1953, (X 12).

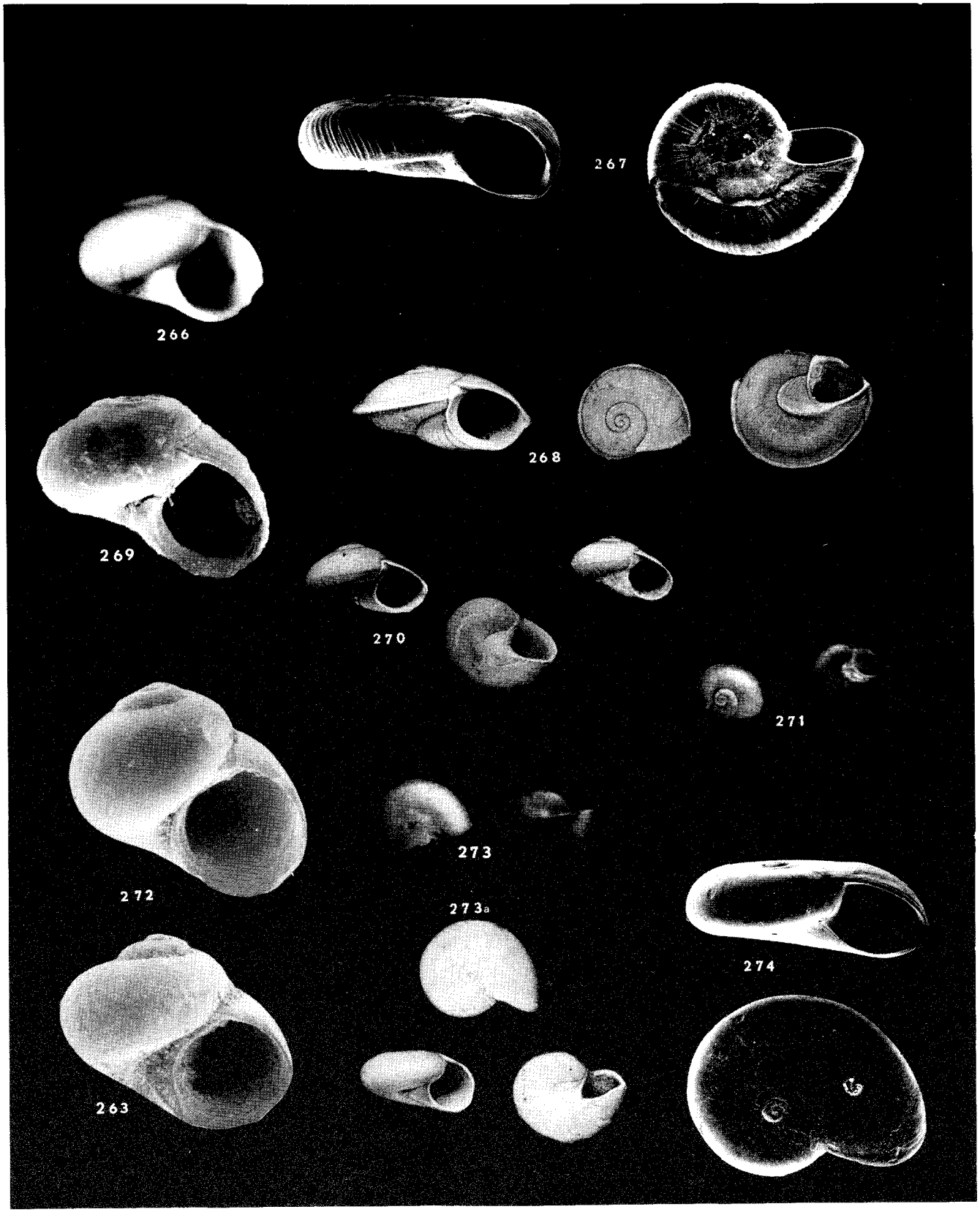
271. *Teinostoma nana* (holotype figured, ANSP 1569), "MD", unknown VA locality, figure from Gardner, 1948, (X 15).

272. *Teinostoma subconica* (figured hypotype, USNM 403426), Chesapeake, VA 2, SEM (X 35).

273. *Teinostoma umbilicata* (figured holotype, ANSP 1565), Smithfield, VA 1, figure from Gardner, 1948, (X 9.5).

273a. *Teinostoma umbilicata* (figured hypotype, ANSP not given), Petersburg, VA 1, figure from Pilsbry, 1953, (X 9.5).

274. *Teinostoma virginica* (holotype figured, USNM 403427), Williamsburg, VA 3, SEM (X 19).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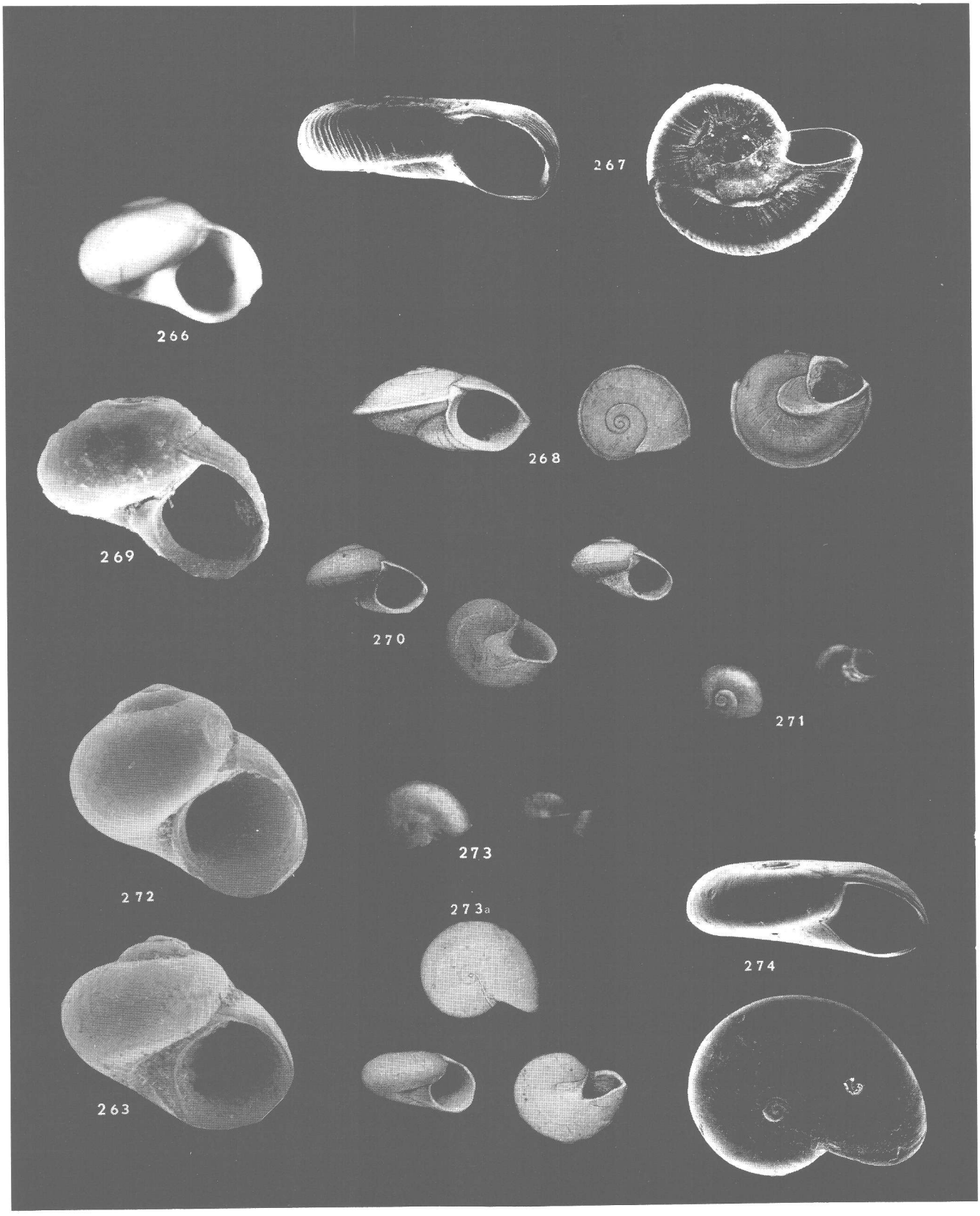
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PLATE 28

275. *Macromphalina aperta* (figured hypotype, USNM 403428), Smithfield, VA 3, SEM (X 27).

276. *Macromphalina chuckatuckensis* (holotype figured, USNM 403429), Chuckatuck, VA 1, SEM (X 4.4).

277. *Cochliolepis concava* (holotype figured, ANSP 1538), Petersburg, VA 1, figure from Gardner, 1948, (X 5.7).

278. *Cochliolepis striata* (figured hypotype, USNM 403430), Chesapeake, VA 2, (X 5.5).

278a. *Cochliolepis striata* (drawing from Dall, 1892), (X 5.5).

279. *Cochliolepis virginica* (holotype figured, USNM 156078a) Petersburg, VA 1, figure from Pilsbry, 1953, (X 5.5).

280. *Caecum chuckatuckensis* (holotype figured, USNM 403431), Chuckatuck, VA 2, SEM (X 8.0).

281. *Caecum pulchellum* (figured hypotype, USNM 403432), Chesapeake, VA 1, SEM (X 18).

282. *Caecum cooperi* (figured hypotype, USNM 403434), Chesapeake, VA 2, SEM (X 6.6).

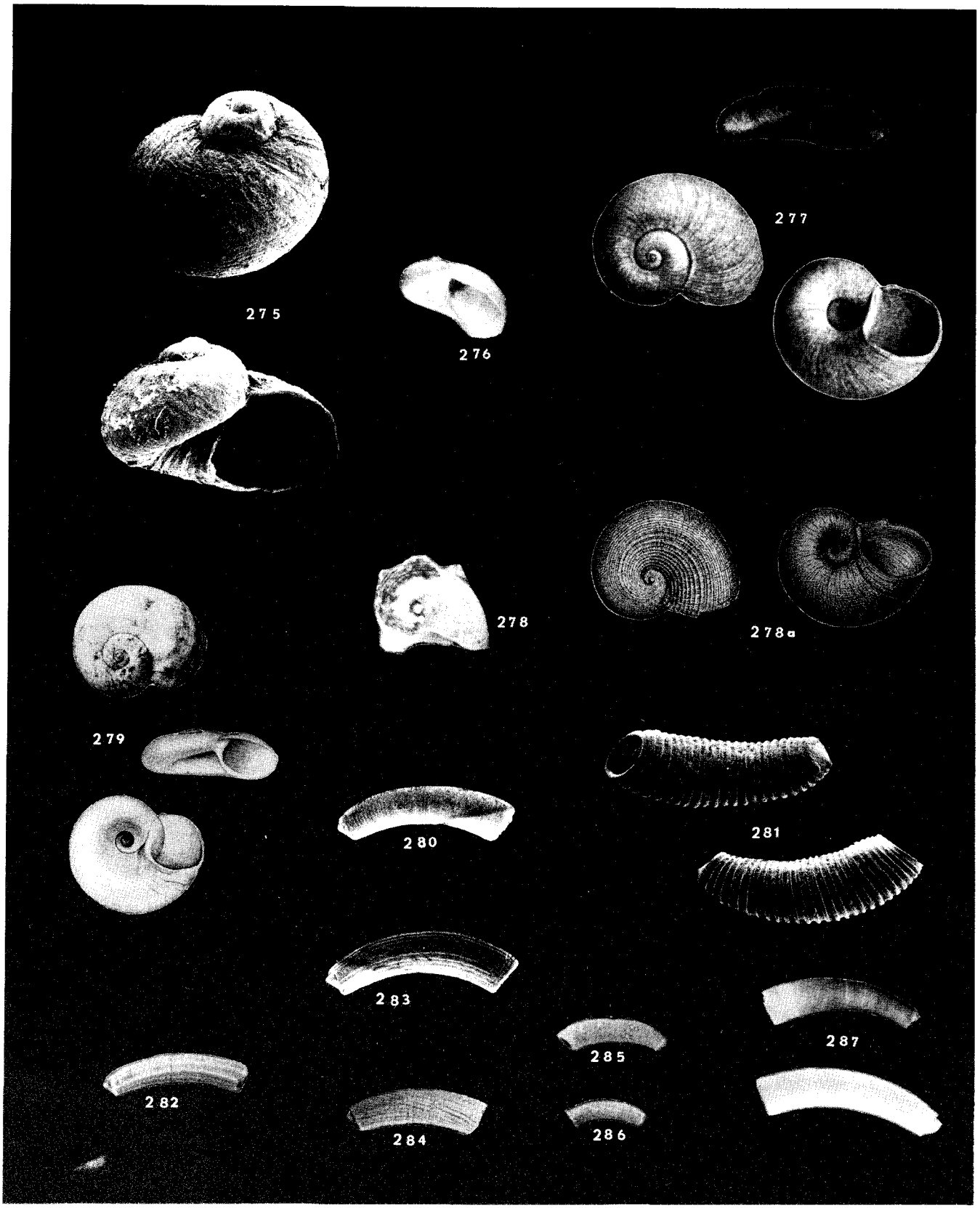
283. *Caecum stevensoni* (figured hypotype, USNM 403435), Chesapeake, VA 1, SEM (X 8.0).

284. *Caecum tortile* (figured hypotype, USNM 403436), Chuckatuck, VA 2, SEM (X 7.0).

285. *Caecum flemingi* (figured hypotype, USNM 403437), Chesapeake, VA 2, SEM (X 7.5).

286. *Caecum johnsoni* (figured hypotype, USNM 403438), Chesapeake, VA 2, SEM (X 7.5).

287. *Caecum virginianum* (figured hypotype, USNM 403439), Chesapeake, VA 2, SEM (X 5.0).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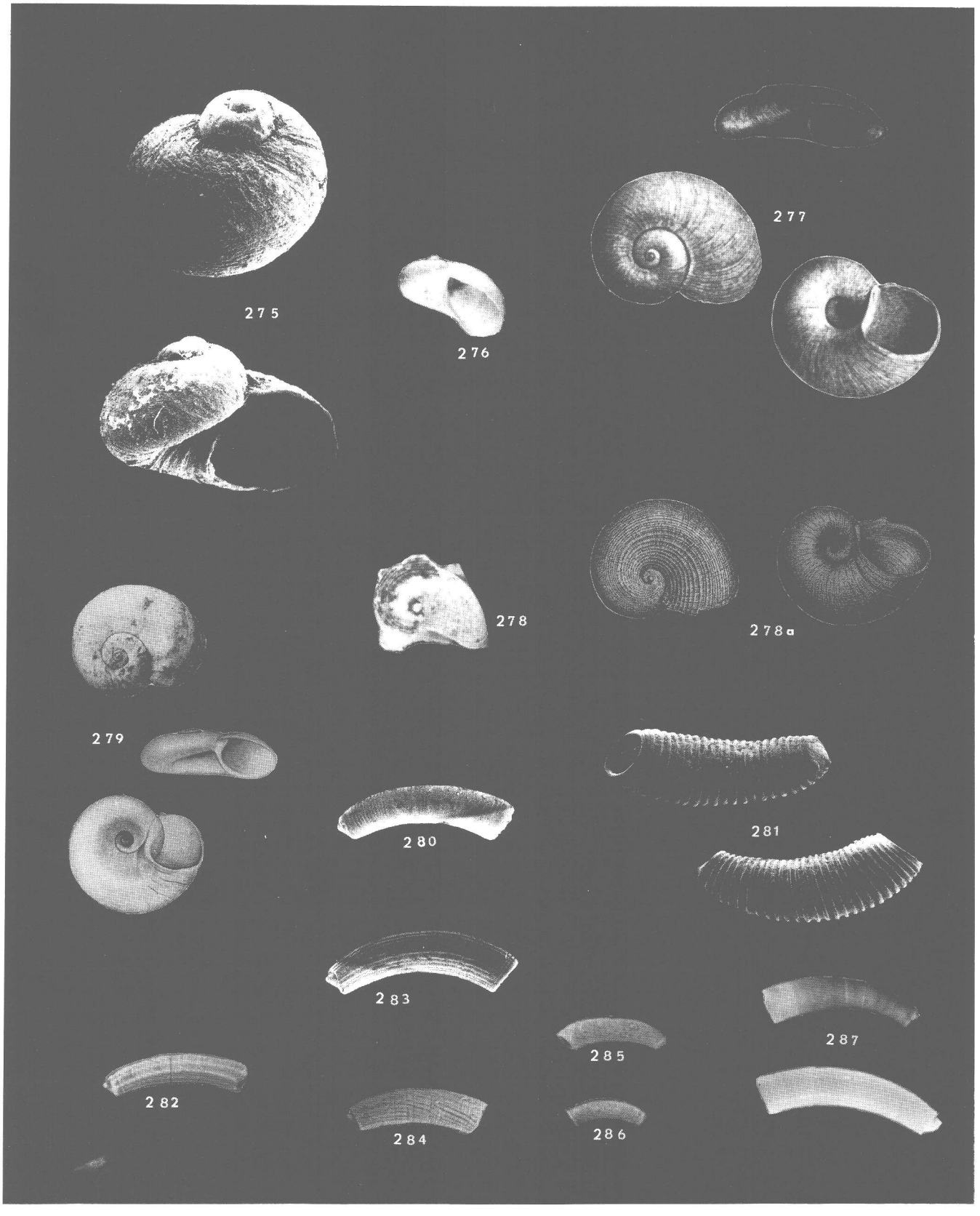
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PLATE 29

288. *Turritella alticostata* (lectotype figured, ANSP 30592), James River, VA, (X 0.8).

288a. *Turritella alticostata* (figured hypotype, USNM 403440), Poquosan, VA, (X 0.8)

289. *Turritella beaufortensis* (figured hypotype, USNM 403441), Chesapeake, VA 1, (X 0.5).

290. *Turritella virginica* (holotype figured, USNM 403442), Smithfield, VA 3, (X 0.5).

291. *Turritella fluxionalis* (figured hypotype, USNM 403443), Williamsburg, VA 3, (X 0.65).

292. *Turritella bipertita* (figured hypotypes, composite figure, USNM 403444), Zone 1, Williamsburg, VA 3, and (USNM 403694), Carter's Grove, VA (X 1.0).

293. *Turritella terstriata* (figured hypotype, USNM 325456), Zone 1, Walkerton,VA, figure from Gardner, 1948, (X 0.8).

293a. *Turritella terstriata* (specimen from type lot of *Turritella alticostata*, ANSP 30592), Zone 1, James River, VA, (X 0.8).

295. *Architectonica nobilis* (figured hypotype, USNM 403445), Chuckatuck, VA 2, (X 3.5).

296. *Pseudotorinia nupera* (figured hypotype, USNM 403446), Chuckatuck, VA 2, (X 2.7).

297. *Petaloconchus sculpturatus* (figured hypotype, USNM 403447), Smithfield, VA 3, adult colony and solitary adult, (X 1.0).

297a. *Petaloconchus sculpturatus* (figured hypotype, USNM 403447), Smithfield, VA 3, protoconch (X 15).

297b. *Petaloconchus sculpturatus* (figured hypotype, USNM 403447), Smithfield, VA 3, broken section showing internal septa (X 10).

298. *Serpulorbis granifera* (figured hypotype, USNM 403448), Rice's Pit, Hampton, VA, (X 1.0).

299. *Bittium curtum* (figured hypotypes, USNM 403449), Petersburg, VA 2, SEM (X 10.5).

300. *Cerithiopsis smithfieldensis* (figured hypotype, USNM 403450), Petersburg, VA 2, SEM (X 15).

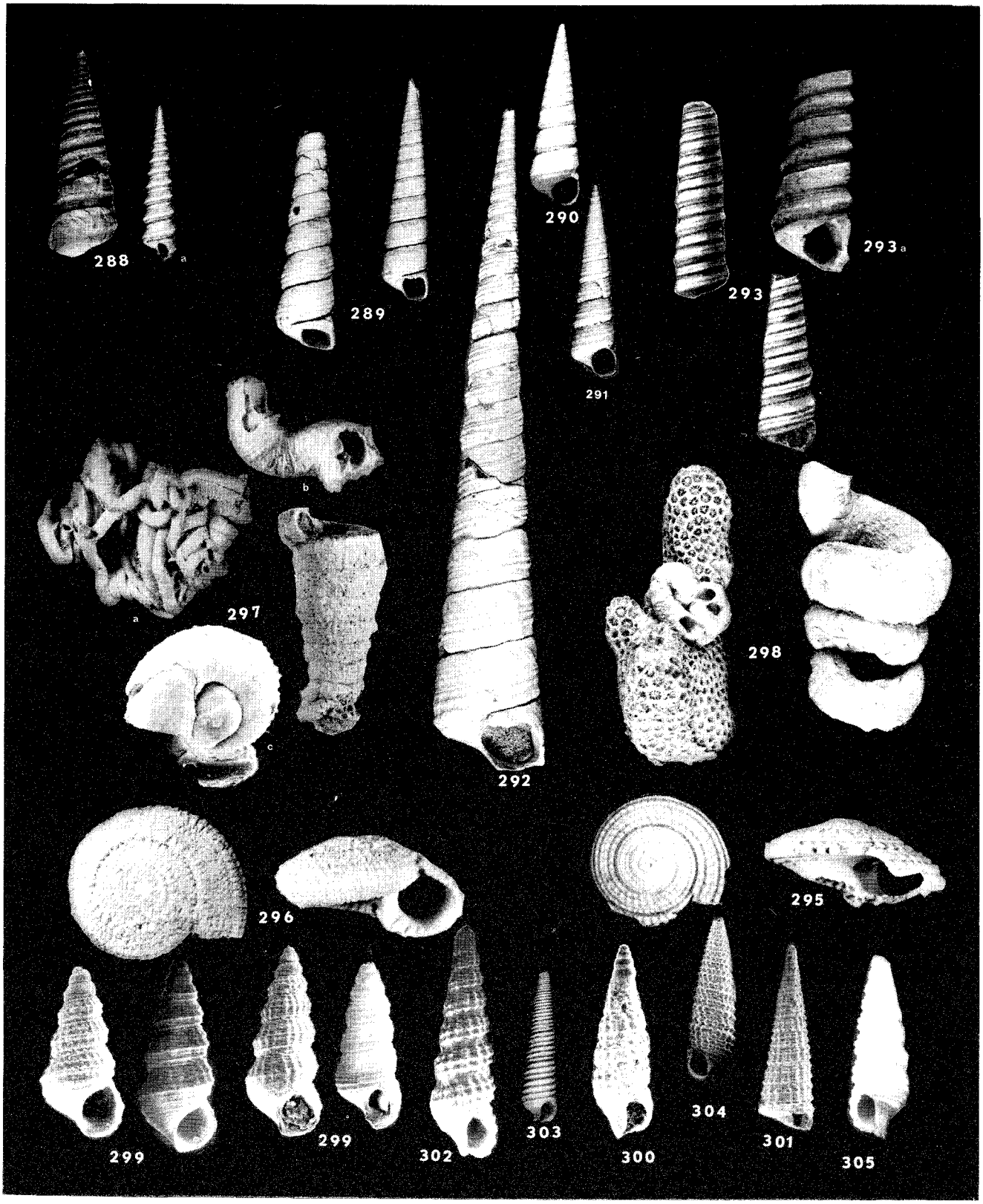
301. *Cerithiopsis bicolor* (figured hypotype, USNM 403451), Chuckatuck, VA 2, SEM (X 4.8).

302. *Cerithiopsis* sp. (figured hypotype, USNM 403452), Chesapeake, VA 2, SEM (X 12).

303. *Seila adamsii* (figured hypotype, USNM 403453), Chuckatuck, VA 2, (X 1.7).

304. *Triphora bartschi* (figured hypotype, USNM 403454), Smithfield, VA 3, SEM (X 7.6).

305. *Triphora submonilifera* (figured hypotype, USNM 403455), Smithfield, VA 3, SEM (X 5.8).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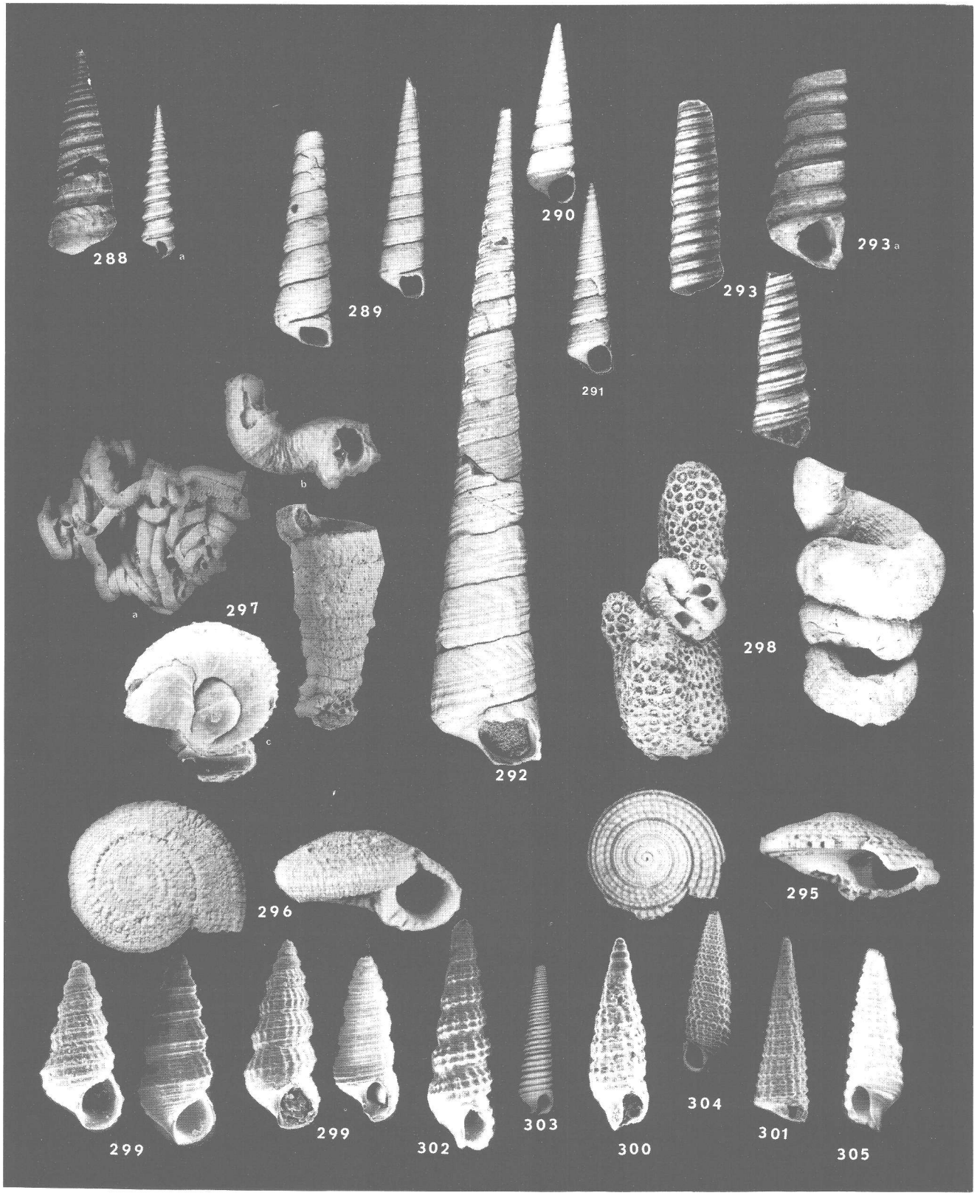
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PLATE 30

306. *Opalia textuvestitum* (figured hypotype, USNM 403456 Rice's Pit, Hampton, Va, (X 3.0).

307. *Epitonium bolteni* (figured specimen is *Epitonium arctata*, a Conrad manuscript name, ANSP 17138), Yorktown?, locality unspecified, (X 3.0).

308. *Epitonium cornigerum* (figured hypotype, USNM 403457), Chuckatuck, VA 2, (X 3.0).

309. *Epitonium edgecombense* (figured hypotype, USNM 403458), Chuckatuck, VA 2, (X 3.2).

310. *Epitonium fractum* (figured hypotype, USNM 403459), Rice's Pit, Hampton, VA, (X 2.5).

311. *Epitonium sheldoni* (holotype figured, PRI 1363-4), Zone 1, Kings Mill, VA, (X 2.5).

312. *Epitonium smithfieldensis* (holotype figured, USNM 352440), Smithfield, VA 1, figure from Mansfield, 1929, (X 2.5).

312a. *Epitonium smithfieldensis* (figured hypotype, USNM 403460), Chuckatuck, VA 2, (X 2.5).

313. *Epitoniumdruidi* (holotype figured, USNM 403461), Chuckatuck, VA 2, SEM (X 11.7).

314. *Epitonium* spp. not illustrated

315. *Epitonium aciculum* (figured hypotype, USNM 403463), Poquoson, VA, (X 2.2).

316. *Epitonium microstomum* (holotype figured, ANSP 1537), Petersburg, VA, figure from Gardner, 1948 (X 4.7).

317. *Epitonium chuckatuckensis* (holotype figured, USNM 403464), Chuckatuck, VA 2, SEM (X 21.5).

318. *Epitonium duplinianum* (figured hypotype, USNM 403465), Chuckatuck, VA 2, (X 2.8).

319. *Epitonium micropleurum* (figured hypotype, USNM 403466), Chesapeake, VA 2, (X 10.5).

320. *Epitonium novangeliae* (figured hypotype, USNM 403467), Rice's Pit, Hampton, VA, (X 1.5).

320a. *Epitonium alumensis* (figured hypotype, USNM 403468), Rice's Pit, Hampton, VA (X 3.5).

321. *Melanella arcuata* (figured hypotype, USNM 403469), Chuckatuck, VA 2, (X 17).

322. *Melanella chesapeakensis* (holotype figured, USNM 403470), Chesapeake, VA 1, (X 4.5).

323. *Melanella angulata* (figured hypotype, USNM 403471), Chesapeake, VA 2, (X 7.0).

324. *Melanella laevigata* (figured hypotype, USNM 403472), Chesapeake, VA 2, (X 3.4).

325. *Melanella nisoformis* (figured hypotype, USNM 403473), Chuckatuck, VA 2, (X 3.6).

326. *Strombiformis conchita* (figured hypotype, USNM 403474), Chuckatuck, VA 2, (X 12.5).

327. *Strombiformis migrans* (figured hypotype, USNM 403475), Chesapeake, Va 2, (X 3.0).

328. *Niso aegeles* not illustrated.

329. *Mucronalia* sp. (figured hypotype, USNM 403476), Chesapeake, VA 2, (X 5.5).

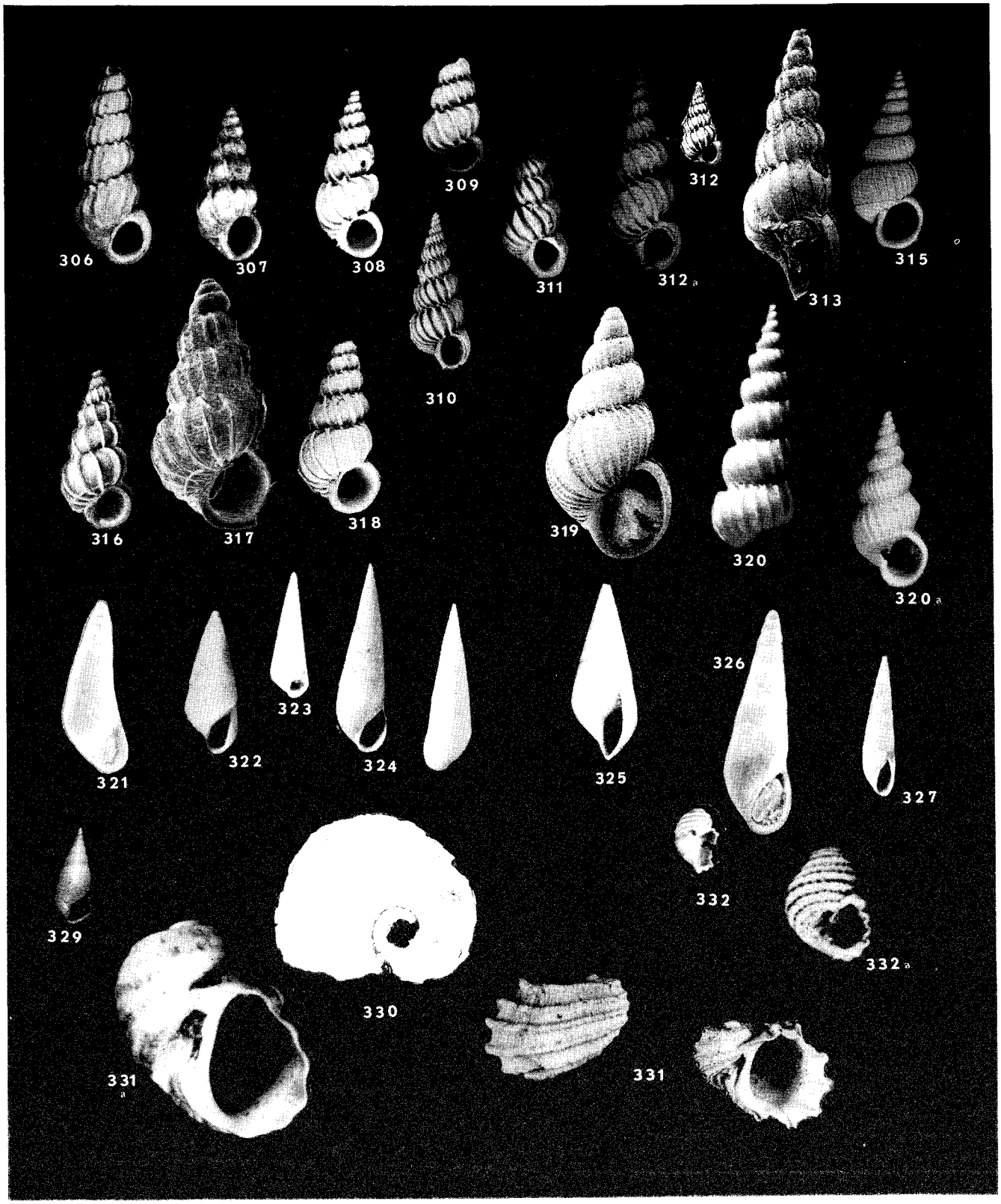
330. *Atlanta cordiformis* (figured hypotype, USNM 403477), Chesapeake, VA 2, (X 18).

331. *Carinorbis lyra* (figured hypotype, USNM 403478), Chuckatuck, Va 2, (X 2.6).

331a. *Carinorbis lyra* (figured hypotype, USNM 403479), Chuckatuck, VA 2, (X 13.5)

332. *Iselica globosa* (holotype figured, ANSP 4312), Petersburg, VA 1, (X 6.8).

332a. *Iselica globosa* (figured hypotype, USNM 403480), Williamsburg, VA 3, (X 6.8).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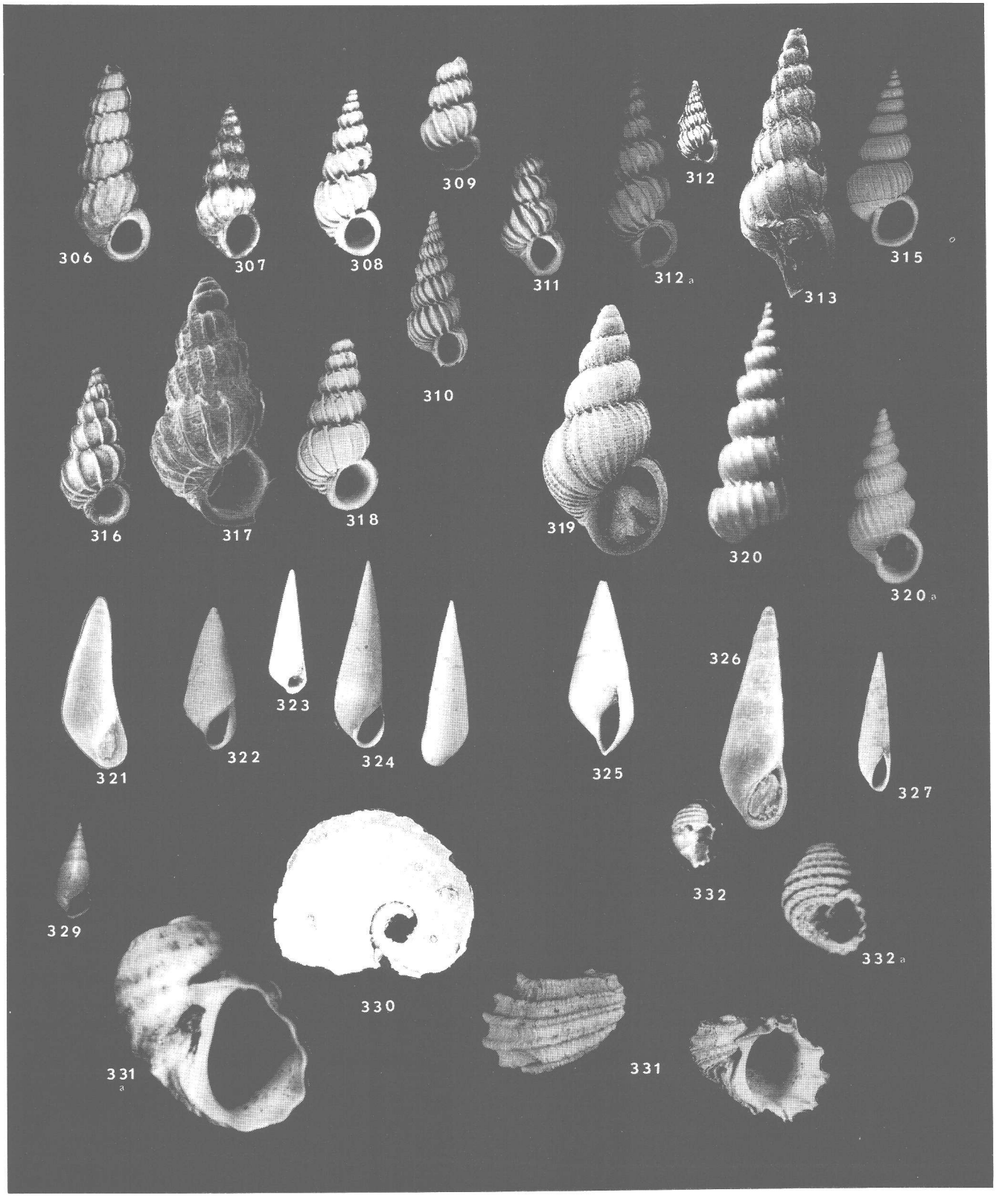
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PLATE 31

42a. *Carolinapecten eboreus chesapeakensis* (holotype figured, USNM 265808), Chesapeake, VA 1, (X 0.7)

333. *Calyptraea centralis* (figured hypotype, USNM 403481), Chucatuck, VA 1, (X 1.5).

334. *Crucibulum scutellatum* (figured hypotype, USNM 403482), Smithfield, VA 3, (X 0.8).

335. *Crucibulum grandis* (figured hypotype, USNM 403483), Zone 1, thickened morphology, Carter's Grove, VA, (X 0.75).

335a. *Crucibulum grandis* (figured hypotype, USNM 403484, Chesapeake, VA 2, (X 0.75).

336. *Crucibulum multilineatum* (figured hypotype, USNM 403485), Chesapeake, VA 1, (X 2.1).

337. *Crucibulum leanum* (figured hypotype, USNM 403486), Chesapeake, VA 2, (X 0.75).

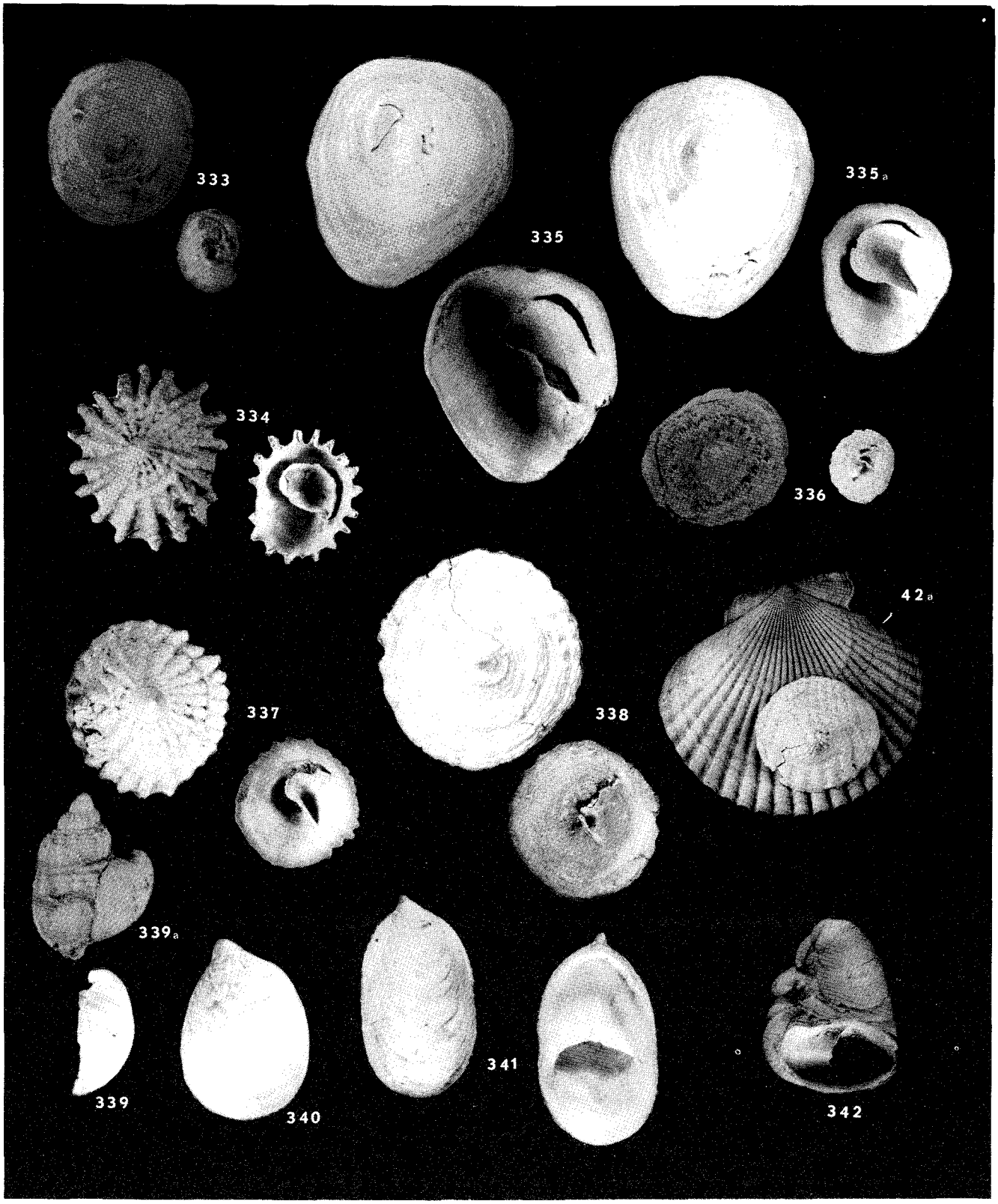
338. *Crucibulum leanum* variety (figured hypotype, USNM 403487), Chesapeake, VA 1, (X 0.8).

339. *Crepidula adunca* (figured hypotype, USNM 403488), Chesapeake, VA 2, (X 3.5).

340. *Crepidula convexa* (figured hypotype, USNM 403489), Williamsburg, VA 3, (X 1.4).

341. *Crepidula cymbaeformis* (figured hypotype, USNM 403490), Chesapeake, VA 2, (X 0.8).

342. *Crepidula fornicata* (figured hypotype, USNM 403491), Chuckatuck, VA 1, (X 1.0).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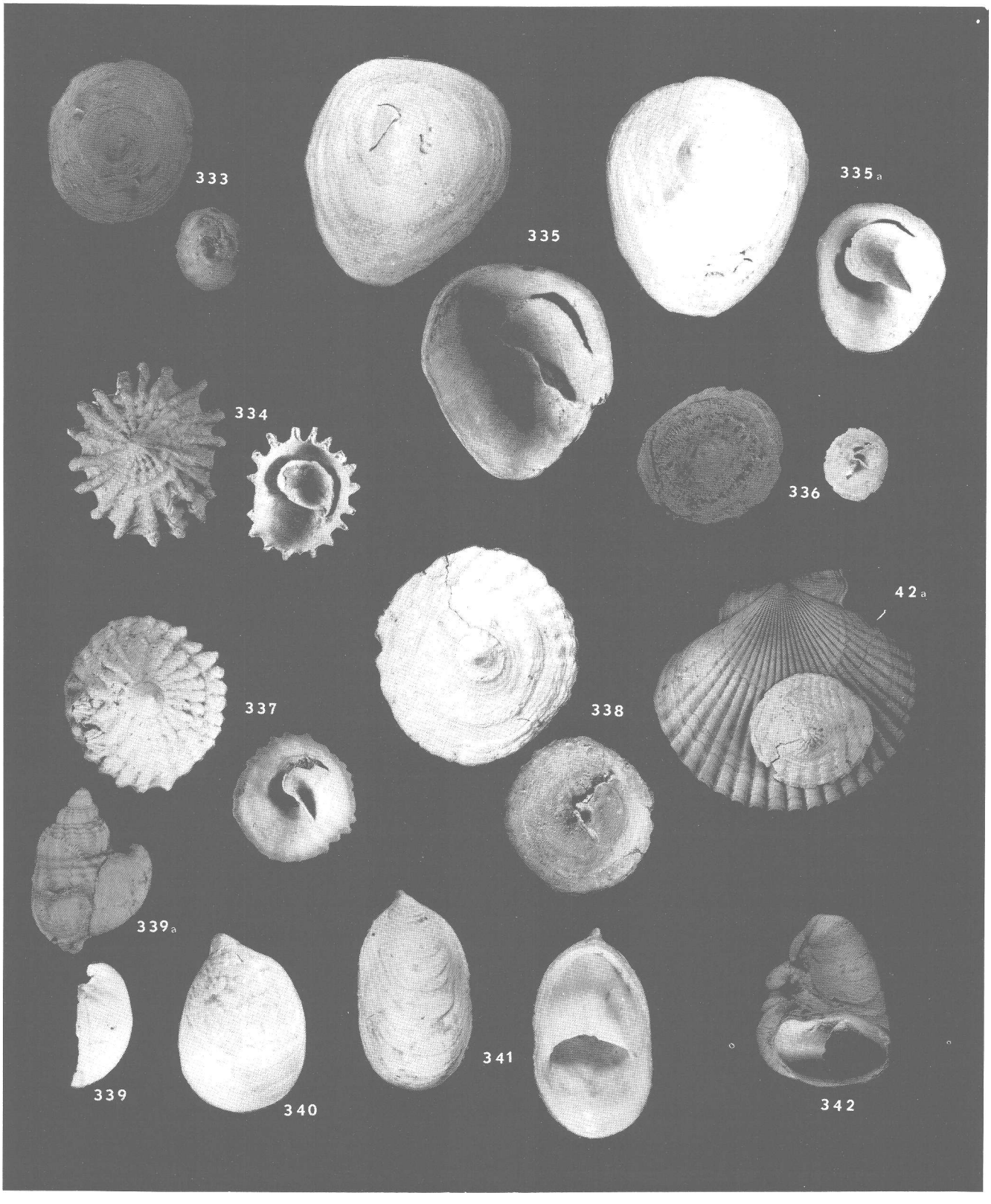
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PLATE 32

343. *Crepidula aculeata aculeata* (figured hypotype, USNM 403492), Smithfield, VA 3, (X 1.7).

343a. *Crepidula aculeata ponderosa* (figured hypotype, USNM 403493), Smithfield, VA 3, (X 0.9).

343b. *Crepidula aculeata costata* (figured hypotype, USNM 403494), Smithfield, VA 3, (X 1.1).

344. *Crepidula plana* (figured hypotype, USNM 403495), Chesapeake, VA 2, (X 0.9).

345. *Lamellaria perspicua* (figured hypotype, USNM 403496), Chuckatuck, VA 1, SEM (X 6.2).

346. *Erato maugeriae* (figured hypotype, USNM 403497), Chuckatuck, VA 1, (X 9.8).

347. *Cypraea carolinensis* (figured hypotype, USNM 403498), Williamsburg, Va 3, (X 0.8).

348. *Polinices duplicatus* (figured hypotype, USNM 403499), Chesapeake, VA 2, (X 0.8).

348a. *Polinices* sp. (figured hypotype, USNM 403500), Rice's Pit, Hampton, (X 2.5).

349. *Lunatia interna* (figured hypotype, USNM 403501), Poquoson, VA, (X 1.6).

350. *Lunatia perspectivia* (figured hypotype, USNM 403502), Chuckatuck, VA 1, (X 1.5).

351. *Lunatia sayana* (holotype figured, USNM 403503), Chesapeake, VA 2, (X 0.5).

352. *Bulbus chesapeakensis* (holotype figured, USNM 403504), Chesapeake, VA 2, (X 5.5).

353. *Sinum chesapeakensis* (holotype figured, USNM 403505), Chesapeake, VA 2, (X 0.9).

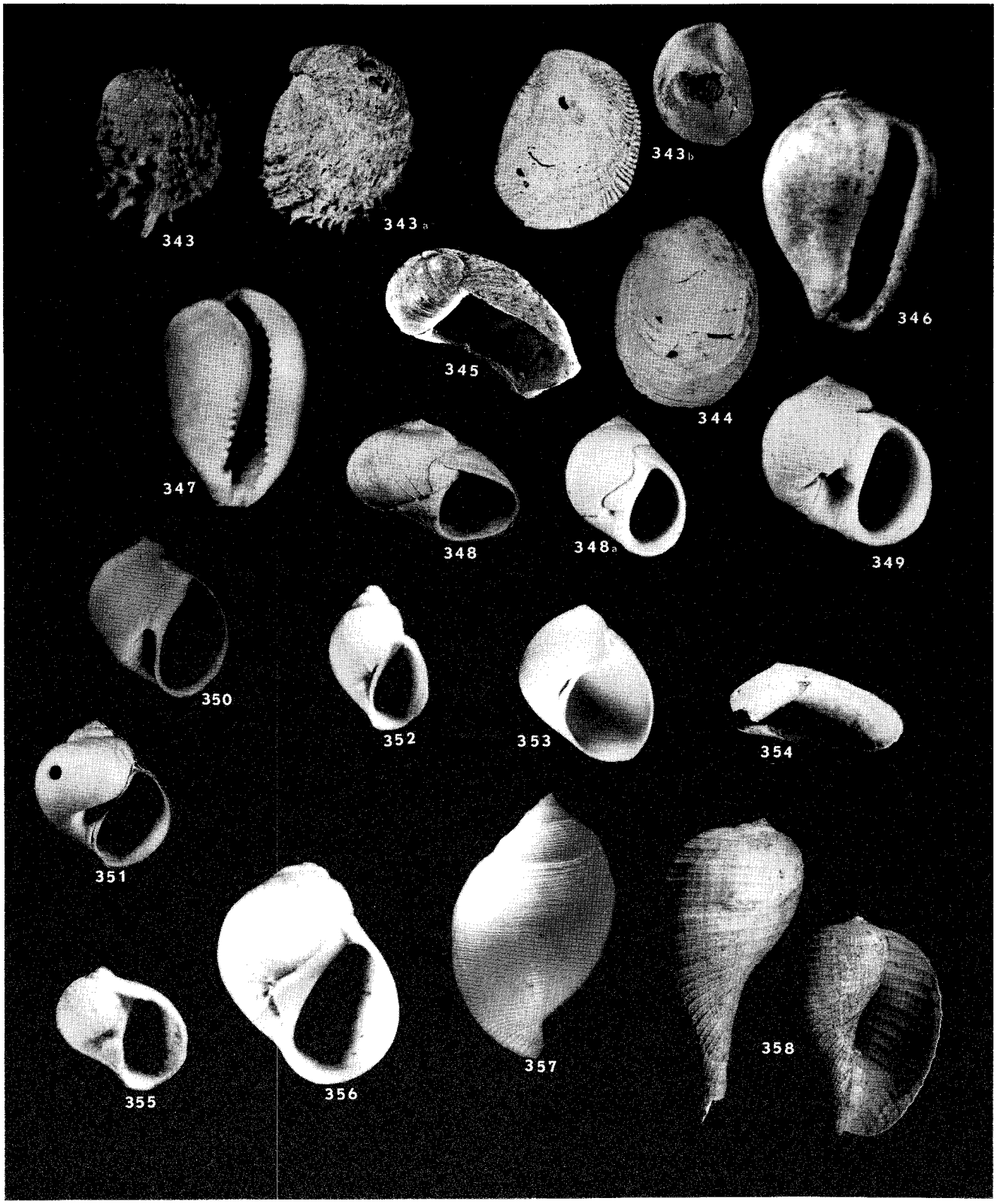
354. *Sinum perspectivium* (figured hypotype, USNM 430506), Rice's Pit, Hampton, VA, (X 1.0).

355. *Natica plicatella* (figured hypotype, USNM 403507), Chuckatuck, VA 2, (X 4.8).

356. *Tectonatica pusilla* (figured hypotype, USNM 403508), Chesapeake, VA 2, (X 12.8).

357. *Sconsia* sp. cf. *S. hodgei* (figured hypotype, USNM 403509), Rice's Pit, Hampton, VA, (X 0.8).

358. *Ficus holmesi* (figured hypotypes, USNM 403510), Rice's Pit, Hampton, VA, (X 0.8).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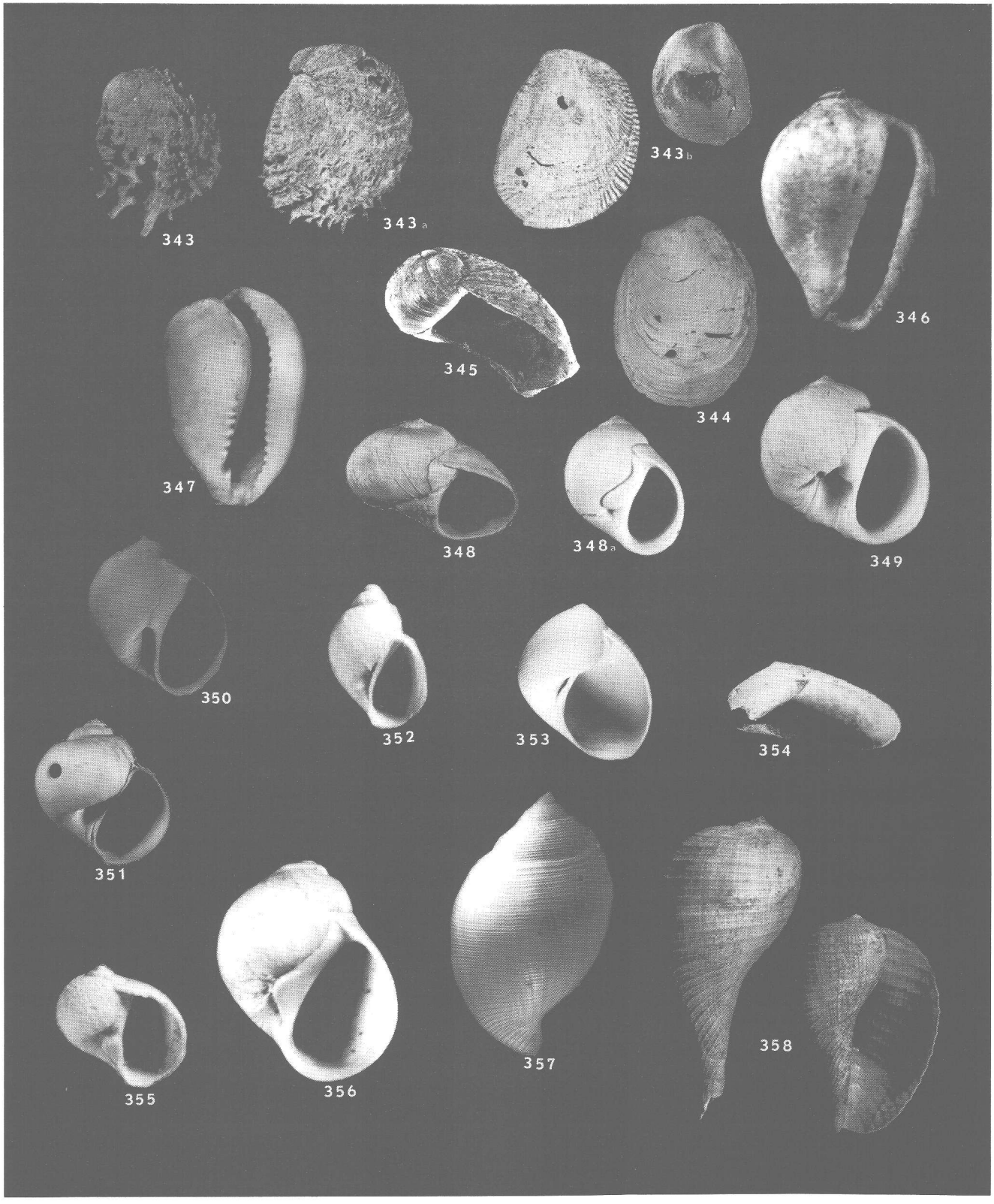
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PLATE 33

359. *Chicoreus floridanus* sketch of specimen in the Rice's Pit Museum.

360. *Murexiella shilohensis* (figured hypotype, USNM 403511), Williamsburg, VA 3, (X 3.0).

361. *Scalaspira strumosa* (figured hypotype, USNM 403512), Chesapeake, VA 2, (X 1.8).

362. *Urosalpinx barbitoides* (figured hypotype, USNM 325429), Yorktown, VA, figure from Gardner, 1948, (X 1.9).

362a. *Urosalpinx barbitoides* (figured hypotype, USNM 403513), Smithfield, VA 3

363. *Urosalpinx lepidota* (figured hypotype, USNM 403515), Chuckatuck, Va 2, (X 1.3).

363a. *Urosalpinx lepidota* (holotype of *Urosalpinx suffolkensis*, USNM 325425 Suffolk, VA, figure from Gardner, 1948, (X 1.0).

363b. *Urosalpinx lepidota* (figured hypotype, USNM 403514), Chuckatuck, Va 3, (X 1.3).

364. *Urosalpinx gardnerae* (holotype figured, USNM 403516), Williamsburg, VA 3, (X 1.2).

365. *Urosalpinx trossula* (figured hypotype, USNM 403517), Chuckatuck, Va 2, (X 1.0).

366. *Urosalpinx rappahannockensis* (figured hypotype, USNM 403518), Williamsburg, VA 1, (X 1.2).

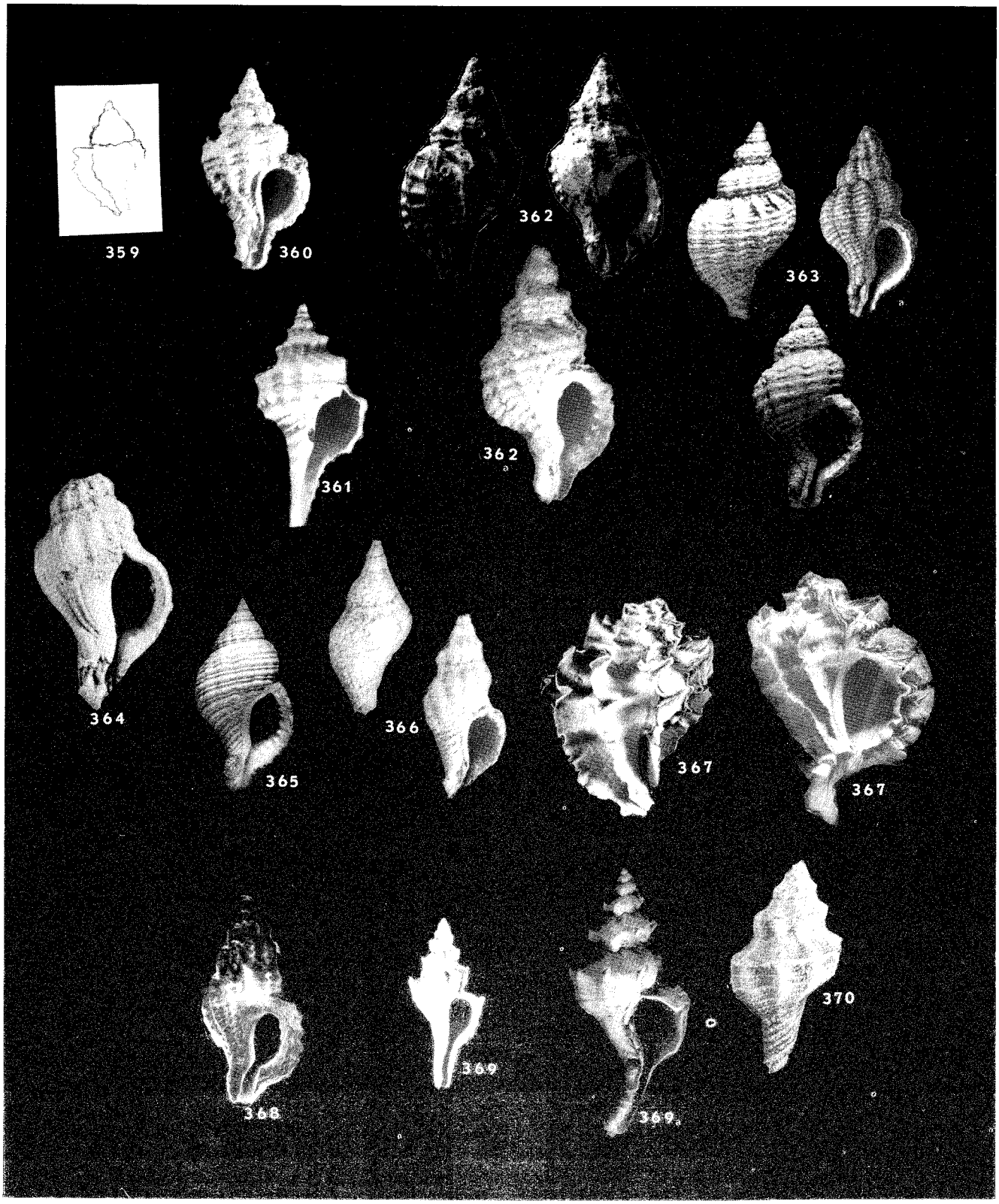
367. *Pterorytis umbrifer* (figured hypotype, USNM 403519), Chuckatuck, VA 2, (X 1.4).

368. *Trophonopsis petiti* (holotype figured, USNM 403520), Williamsburg, VA 2, SEM (X 5.4).

369. *Boreotrophon tetricus* (figured hypotype, USNM 403521), Chuckatuck, VA 2, (X 0.8).

369a. *Boreotrophon tetricus laevis* (figured hypotype, USNM 403522), Rice's Pit, Hampton, VA, (X 0.8).

370. *Coralliophila leonensis* (figured hypotype, USNM 403523), Chuckatuck, VA 2, (X 2.0).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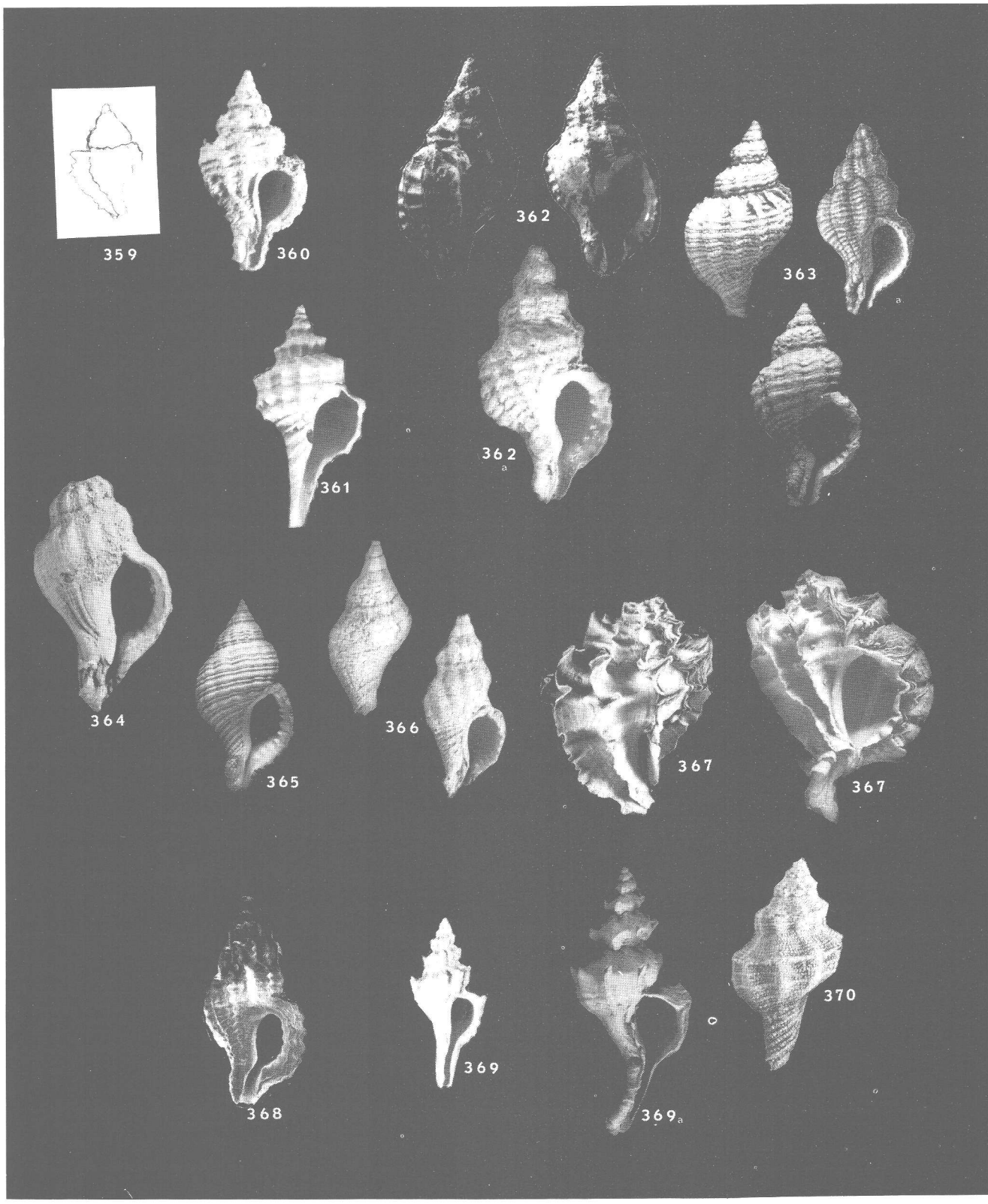
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PLATE 34

371. *Anachis parvula* (holotype figured, ANSP 1577), Smithfield, VA 1, (X 5).

371a. *Anachis parvula* (figured hypotype, USNM 403524), Smithfield, VA 1, (X 2.1).

372. *Anachis styliola* (figured hypotype, USNM 403525), Chesapeake, VA 2, (X 2.7).

373. *Anachis virgilina* (figured hypotype, USNM 403526), Rice's Pit, Hampton, VA, (X 2.0).

374. *Anachis obesa* not illustrated

375. *Mitrella communis* (figured hypotype, USNM 403527), Smithfield, VA 3, (X 2.7).

376a. *Mitrella harbisonae* (figured hypotype, USNM 403528), Chesapeake, VA 1, (X 3.5).

377. *Mitrella edenensis* (figured hypotype, USNM 403529), Chesapeake, VA 2, (X 4.4).

378. *Mitrella waccamawensis* (figured hypotype, USNM 403530), Chesapeake, VA 1, (X 2.0).

379. *Nassarina glypta* (figured hypotype, USNM 403531), Chesapeake, VA 2, SEM (X 5.6).

380. *Aesopus stearnsii* (figured hypotype, USNM 403532), Chuckatuck, VA 2, SEM (X 6.8).

380a. *Aesopus stearnsii* (figured hypotype, USNM 403533), Chuckatuck, VA 1, SEM (X 6.8).

381. *Juliamitrella chesapeakensis* (holotype figured, USNM 403534), Chesapeake, VA 2, SEM (X 11).

382. *Juliamitrella gardnerae* (figured hypotype, USNM 403535), Chesapeake, VA 2, SEM (X 11).

383. *Juliamitrella smithfieldensis* (figured hypotype, USNM 352438), Smithfield, VA 1, figure from Gardner, 1948, (X 4.4).

384. *Juliamitrella virginica* (holotype figured, USNM 403536), Chesapeake, VA 1, SEM (X 6.4).

385. *Buccinum* sp. (figured hypotype, USNM 403537), Chuckatuck, VA 1, (X 1.3).

386. *Tortifusus curvirostra* (figured hypotype, USNM 403538), Chesapeake, VA2, (X 0.6).

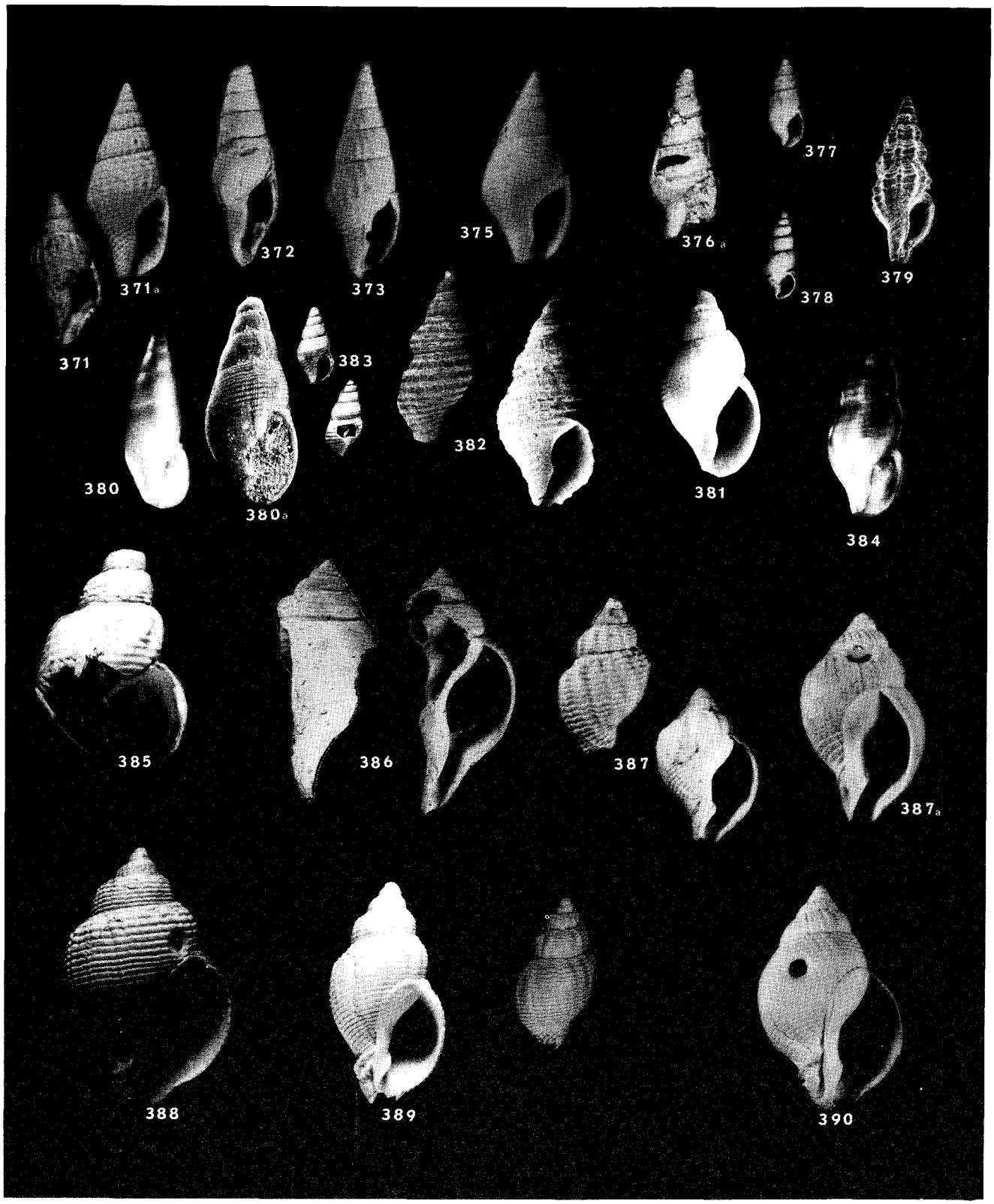
387. *Ptychosalpinx altile* (figured hypotype, USNM 403539), Chuckatuck, VA 1, (X 0.75).

387a. *Ptychosalpinx altile* (figured hypotype, USNM 403540), Smithfield, VA 3, (X 0.75).

388. *Ptychosalpinx chesapeakensis* (holotype figured, USNM 403541), Chesapeake, VA 2, (X 1.1).

389. *Ptychosalpinx laqueata* (figured hypotype, USNM 403542), Chesapeake, VA 2, (X 0.8).

390. *Ptychosalpinx multirugata* (figured hypotype, USNM 403543), Chesapeake, VA 2, (X 0.8).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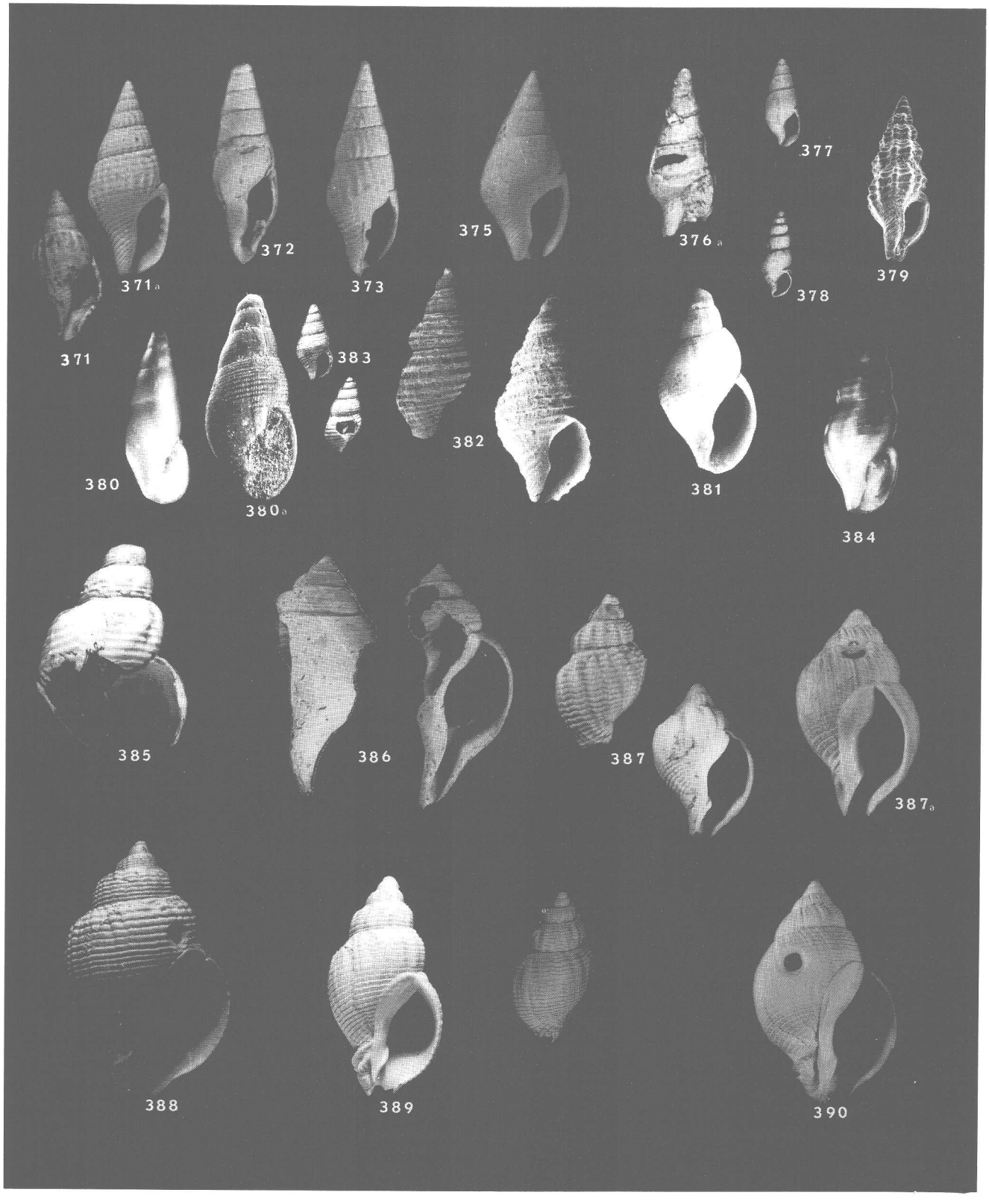
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PLATE 35

391. *Ptychosalpinx tuomeyi* (figured hypotype, USNM 403544), Chesapeake, VA 2, (X 1.0).

392. *Tritonoharpa* floridensi (figured hypotype, USNM 403545), Chuckatuck, VA 2, (X 2.0).

393. *Cantharus nux* (figured hypotype, USNM 403546), Chuckatuck, VA 2, (X 1.8).

394. *Ecphora quadricostata* (figured hypotype, USNM 403547), Chesapeake, VA, 2 (X 0.6).

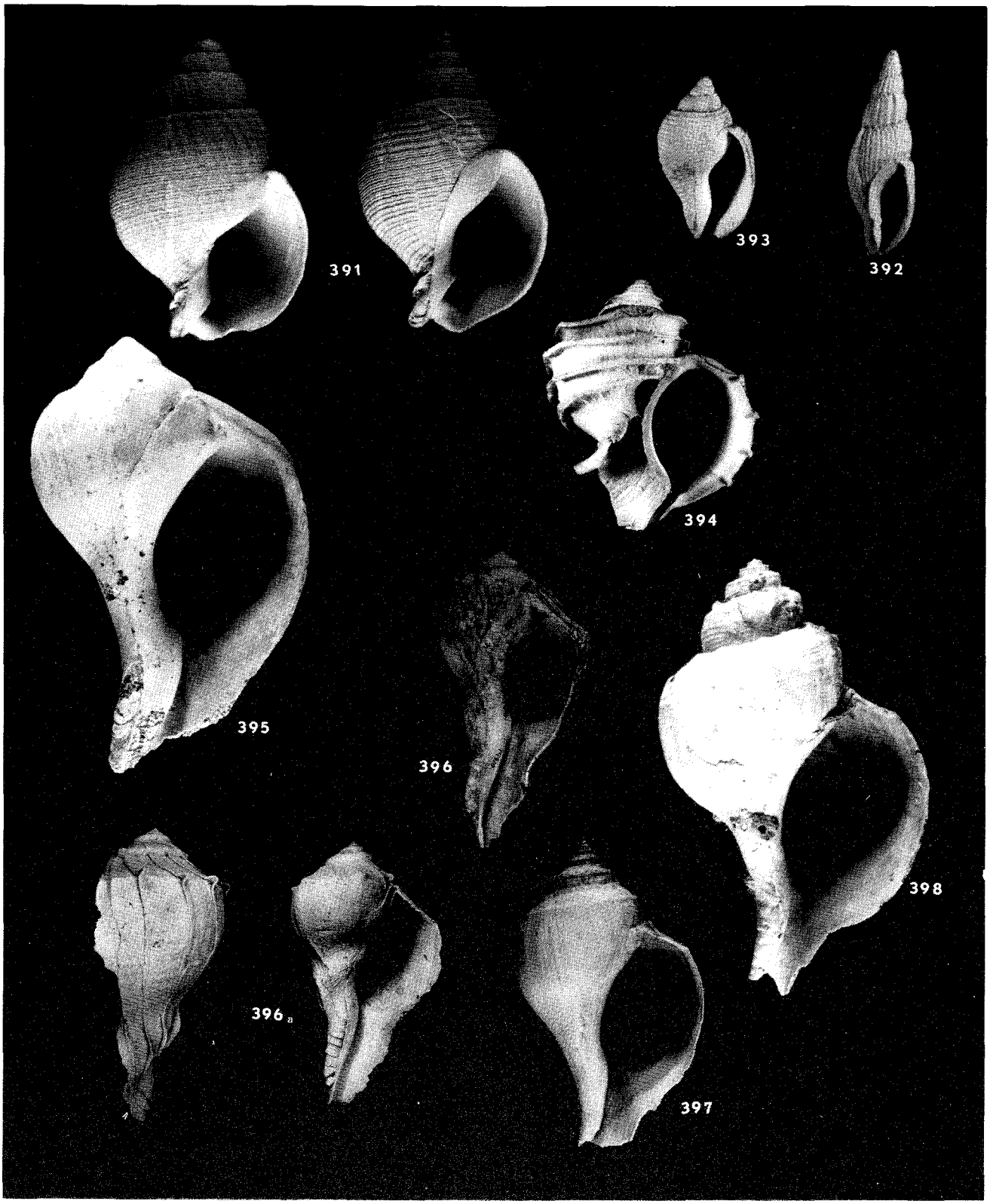
395. *Busycon maximum* (figured hypotype, USNM 403548), Chesapeake, VA 2, (X 0.3).

396. *Busycon maximum filosum* (holotype figured, ANSP 14310), Yorktown, VA, (X 0.4).

396a. *Busycon maximum filosum* (figured hypotype, U. Nebraska State Museum 28), Yorktown, VA, figure from Fagerstrom, 1961, (X 0.4).

397. *Busycon canaliferum* (figured hypotype, USNM 403549), Chesapeake, VA 2, (X 0.6).

398. *Busycon incile* (figured hypotype, USNM 403550), Chesapeake, VA 2, (X 0.4).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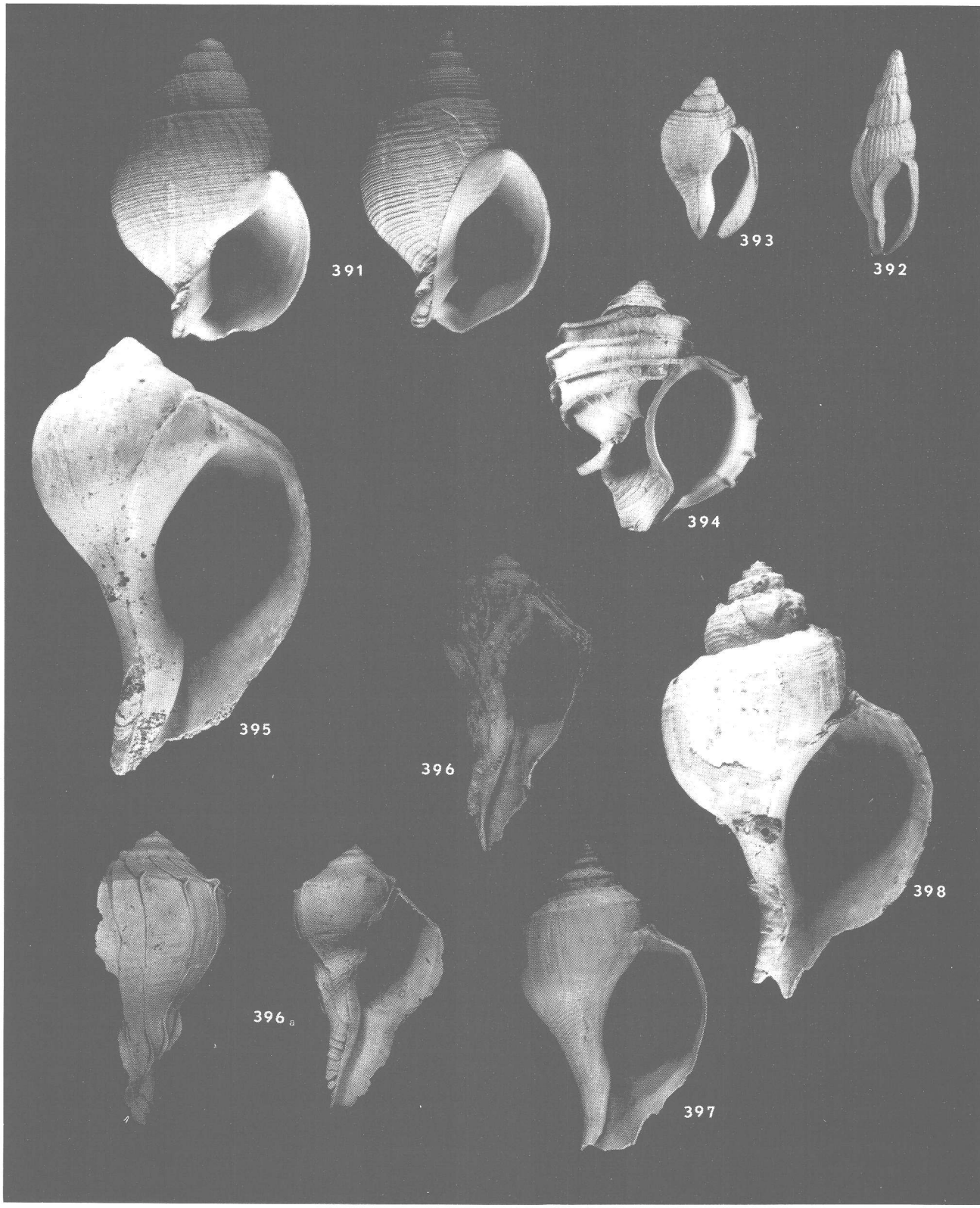
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PLATE 36

398a. *Busycon incile* (figured hypotype, USNM 403551), Chesapeake, VA 2, juvenile morphology, (X 0.7).

398b. *Busycon incile* ? (holotype of *Busycon alveatum*, ANSP 2697), locality unknown, Maryland or Virginia, (X 0.7).

399. *Busycon contrarium* (figured hypotype, USNM 403552), Chesapeake, VA 1, (X 3.0).

400. *Lyrasoma sulcosa* (figured hypotype, USNM 403553), Chesapeake, VA 2, (X 1.2).

401. *Lyrosoma sulcosa multicostata* (figured hypotype, USNM 403554), Williamsburg, VA 1, (X 1.8).

402. *Nassarius consenoides* (figured hypotype, USNM 403555), Chuckatuck, VA 2, (X 2.6).

403. *Nassarius quadrulatus* (holotype of *Uzita suffolkensis*, USNM 325406), Suffolk, VA, figure from Gardner, 1948, (X 2.9).

404. *Nassarius shacklefordensis* (holotype figured, PRI 201), Shackleford, VA, (X 3.5).

405. *Ilyanassa granifera* (figured hypotype, USNM 403556), Williamsburg, VA 3, (X 1.4).

405a. *Ilyanassa granifera* (figured hypotype, USNM 124951), Yorktown, VA, figure from Gardner, 1948, (X 1.4).

406. *Ilyanassa harpuloides harpuloides* (figured hypotype, USNM 403557), Williamsburg, VA 3, (X 1.3).

407. *Ilyanassa harpuloides johnsoni* (figured hypotype, USNM 403558), Williamburg, VA 3, (X 1.3).

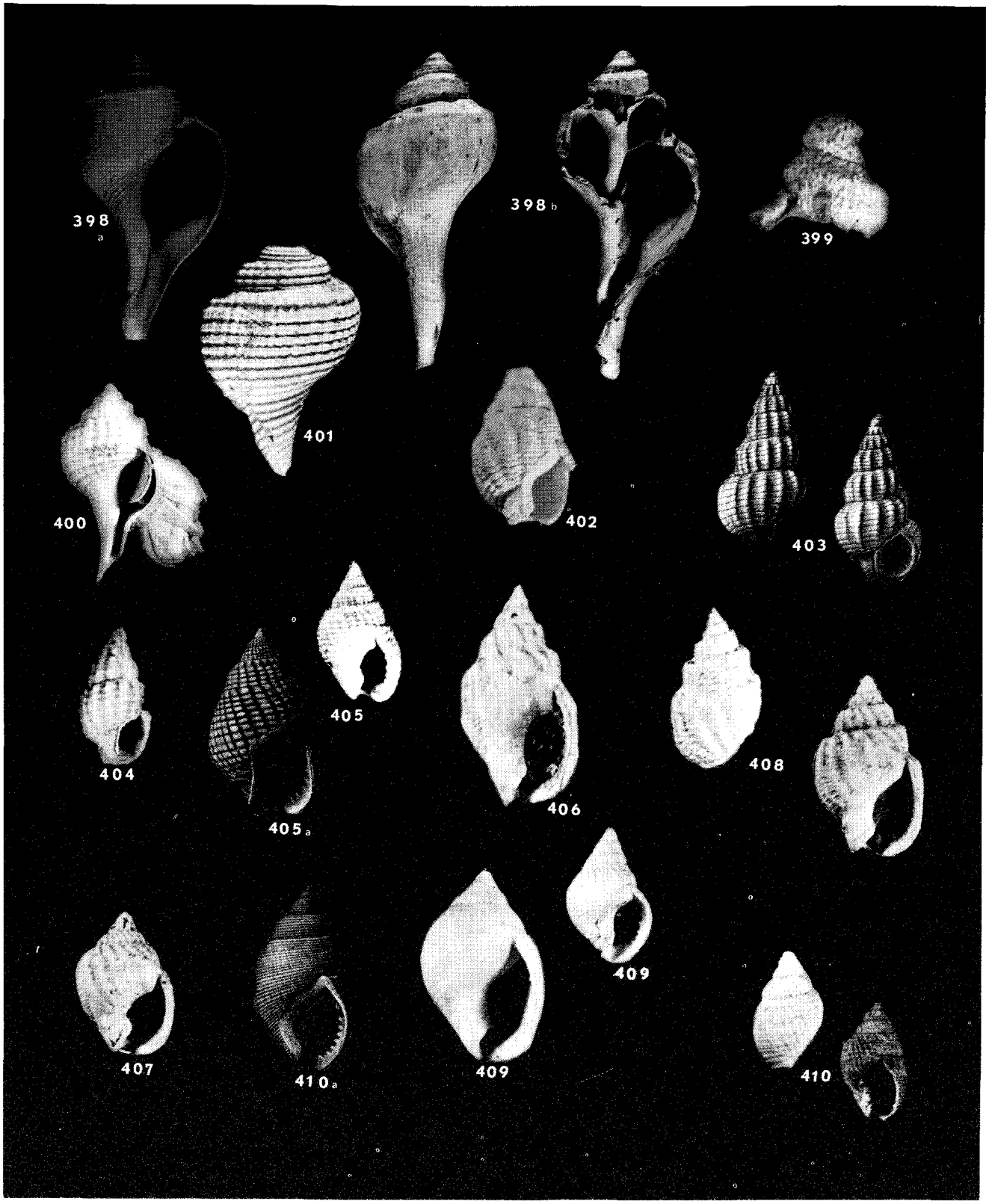
408. *Ilyanassa harpuloides scalaspira* (figured hypotype, USNM 403559), Williamsburg, VA 3, (X 1.4).

409. *Ilyanassa porcina* (figured hypotype, USNM 403560), Williamsburg, VA 3, (X 1.4).

409a. *Ilyanassa procina schyzopyga* (figured hypotype, USNM 403561), Williamsburg, VA 3, (X 1.8).

410. *Ilyanassa sexdentata* (figured hypotype, USNM 403562), Chesapeake, VA 1, (X 1.1).

410a. *Ilyanassa isogramma* (holotype figured, USNM124948), Wilmington, NC, figure from Gardner, 1948, (X 1.4).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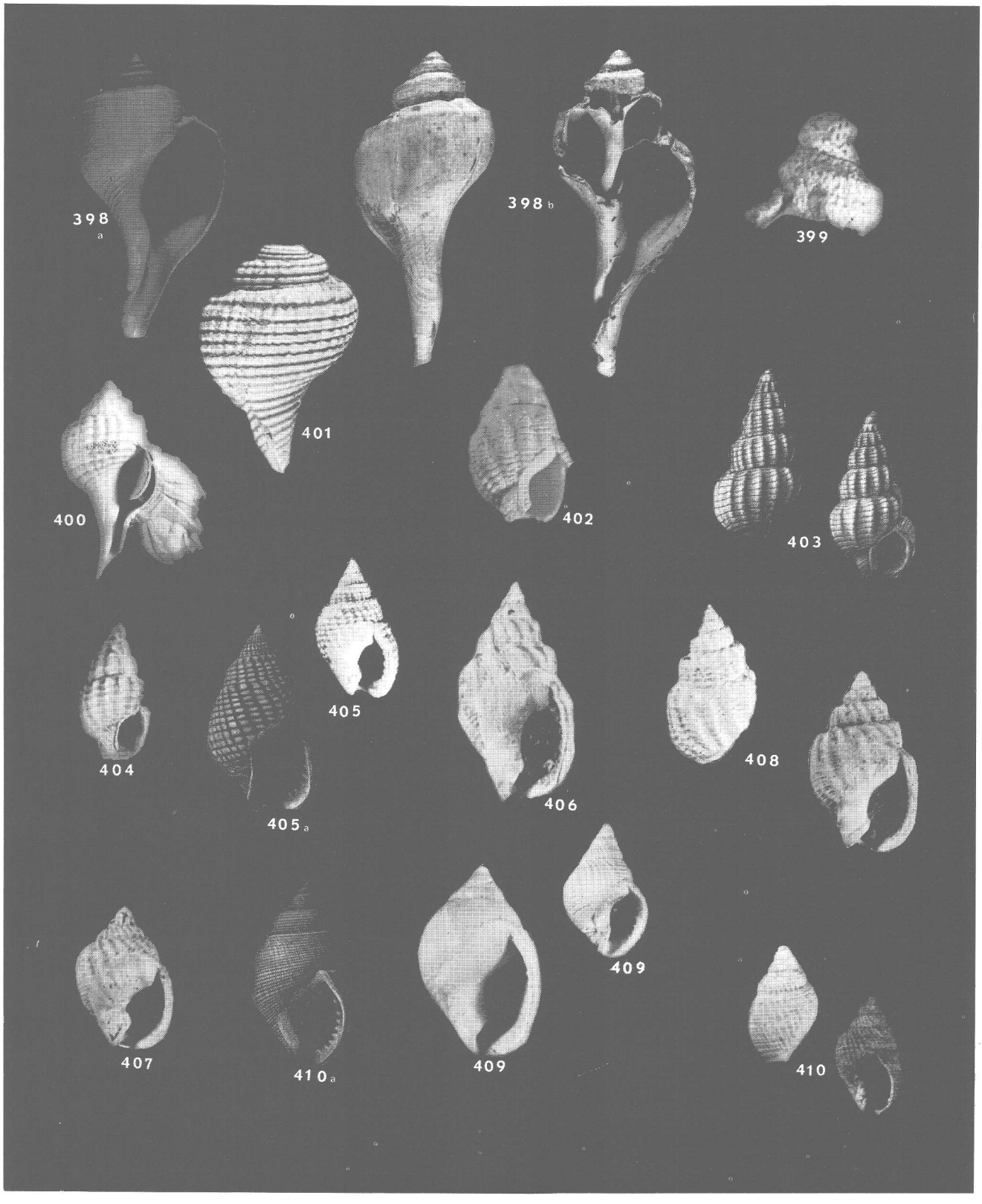
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PLATE 37

411. *Fasciolaria rhomboidea* (figured hypotype, USNM 403564), Smithfield, VA 3, (X 0.8).

412. *Triplofusus gigantea* (drawing from photograph, specimen from Rice's Pit museum), Hampton, VA (X 0.25).

413. *Terebraspira acuta* (figured hypotype, USNM 403565), Chesapeake, VA 2, (X 0.7).

414. *Fusinus exilis exilis* (figured hypotype, USNM 403566), Chesapeake, VA 2, (X 0.7).

415. *Fusinus exilis burnsii* (figured hypotype, USNM 403567), Chesapeake, VA 2, (X 0.7).

416. *Fusinus propeparilis* (holotype figured, USNM 370828), Zone 1, Bellefield, VA, figure from Mansfield, 1929, (X 0.6).

417. *Hesperisternia filicata* (figured hypotype, USNM 403568), Chuckatuck, VA 2, (X 1.1).

418. *Oliva canaliculata* (figured hypotype, USNM 403569), Rice's Pit, Hampton, VA, (X 1.1).

418a. *Oliva canaliculata* (figured hypotype, USNM 403570), Petersburg, VA 2, (X 1.1).

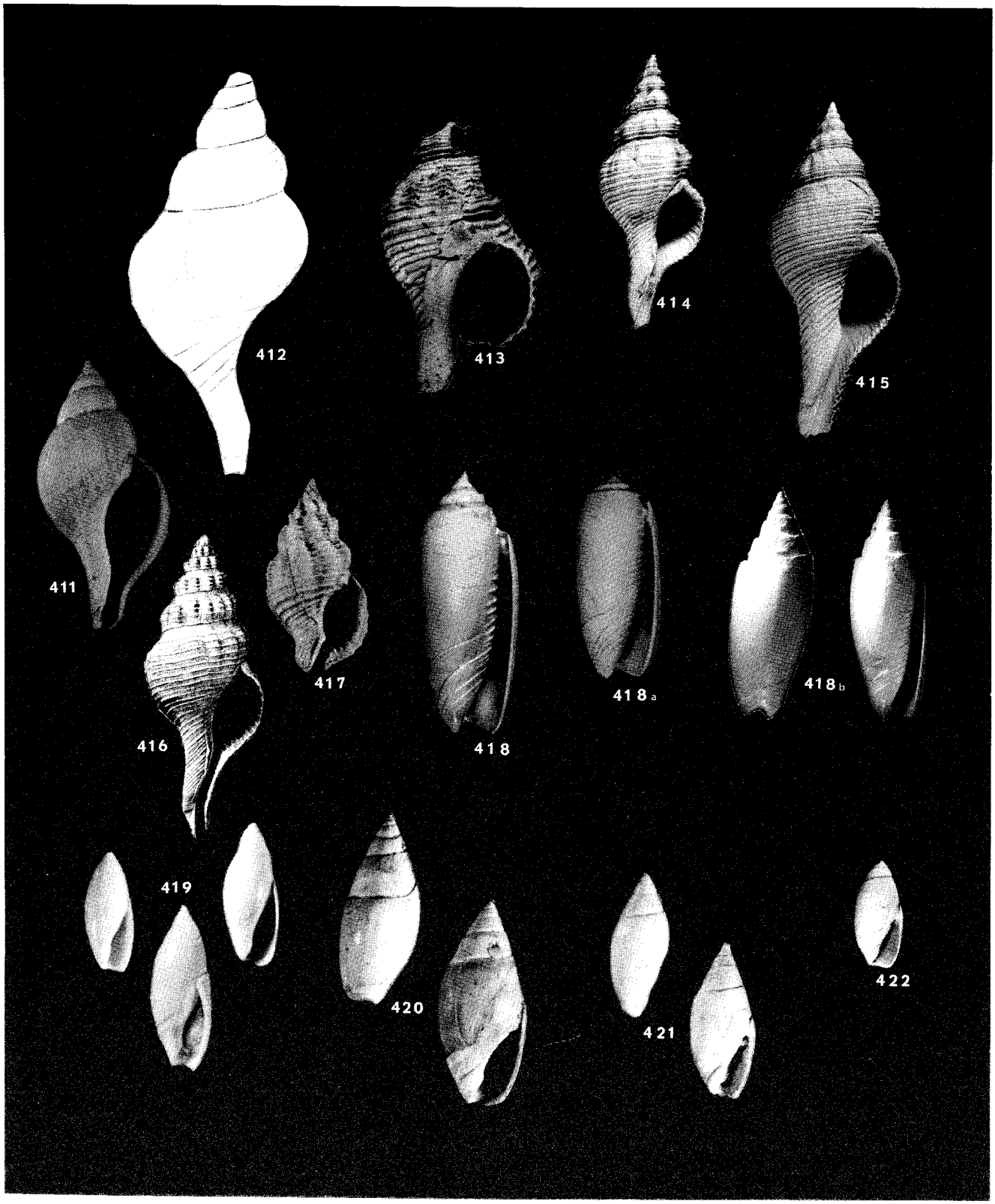
418b. *Oliva canaliculata* (figured hypotype, USNM 403571), Rice's Pit, Hampton, VA 2, (X 1.1).

419. *Olivella ancillariaeformis* (figured hypotype, USNM 403572), Smithfield, VA 3, (X 3.0).

420. *Olivella carolinae* (figured hypotype, USNM 403573), Chuckatuck, VA 1, (X 1.9).

421. *Olivella mutica* (figured hypotype, USNM 403574), Williamsburg, VA 3, (X 2.6).

422. *Olivella* sp. (figured hypotype, USNM 403575), Chuckatuck, VA 2, (X 3.1).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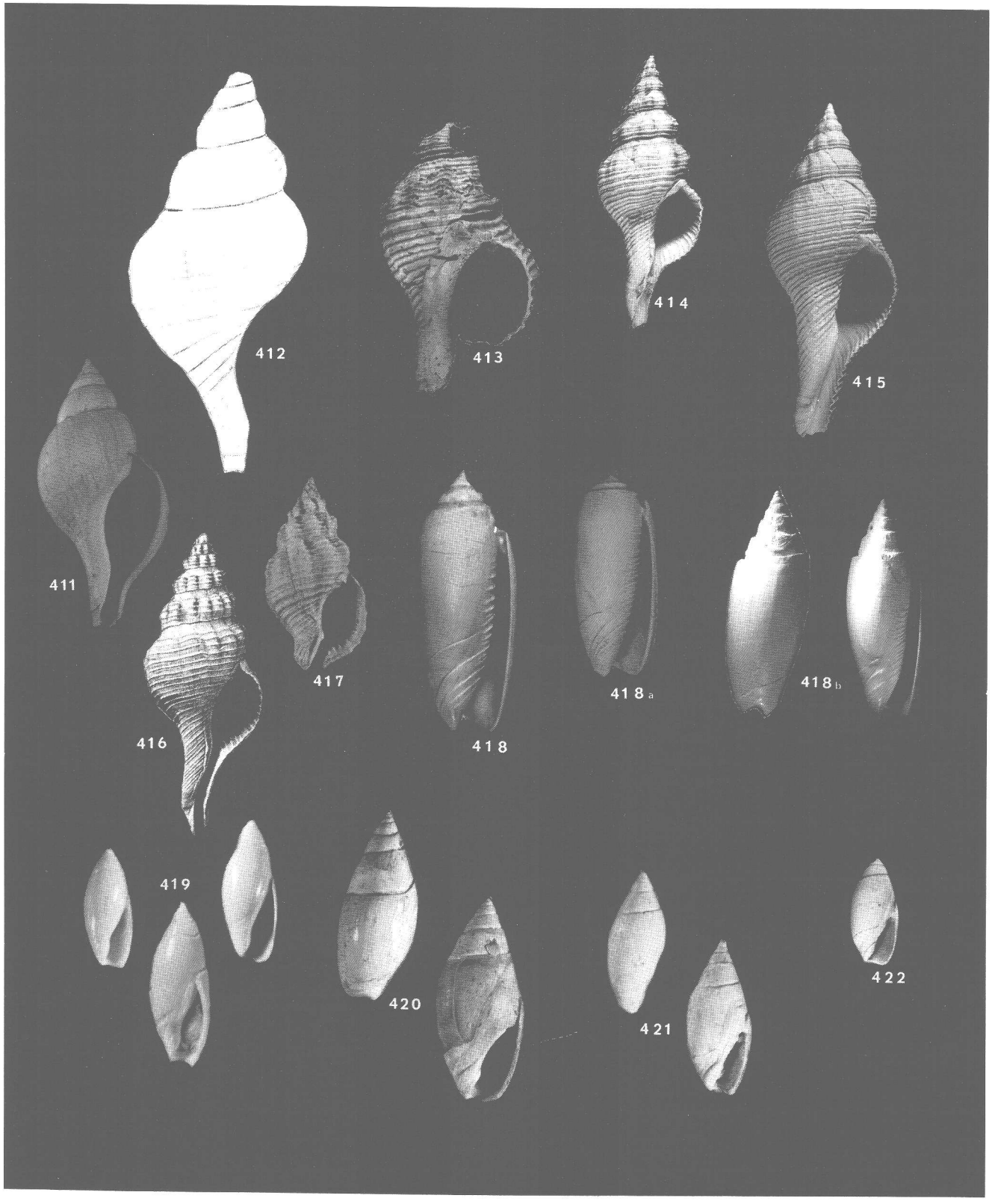
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PLATE 38

423. *Vexillum elaboratum* (figured hypotype, USNM 403576), Williamsburg, VA 3, SEM (X 3.3).

424. *Vexillum reticulatum* (figures hypotype, USNM 403577), Chesapeake, VA 1, SEM (X 5.7).

426. *Scaphella solitaria ricei* (holotype figured, USNM 403578), Rice's Pit, Hampton, VA, (X 1.4).

427. *Aurinia mutabilis* (figured hypotypes, USNM 403579), Chesapeake, VA 2, (X 0.5).

428. *Aurinia obtusa* (figured hypotypes, USNM 403580), Chesapeake, VA 2, (X 0.6).

429. *Aurinia sinuosa* (larger hypotype, USNM 403581), Chesapeake, VA 2, (X 0.6); (smaller hypotype, USNM 403657), Rice's Pit, Hampton, VA, (X 0.6).

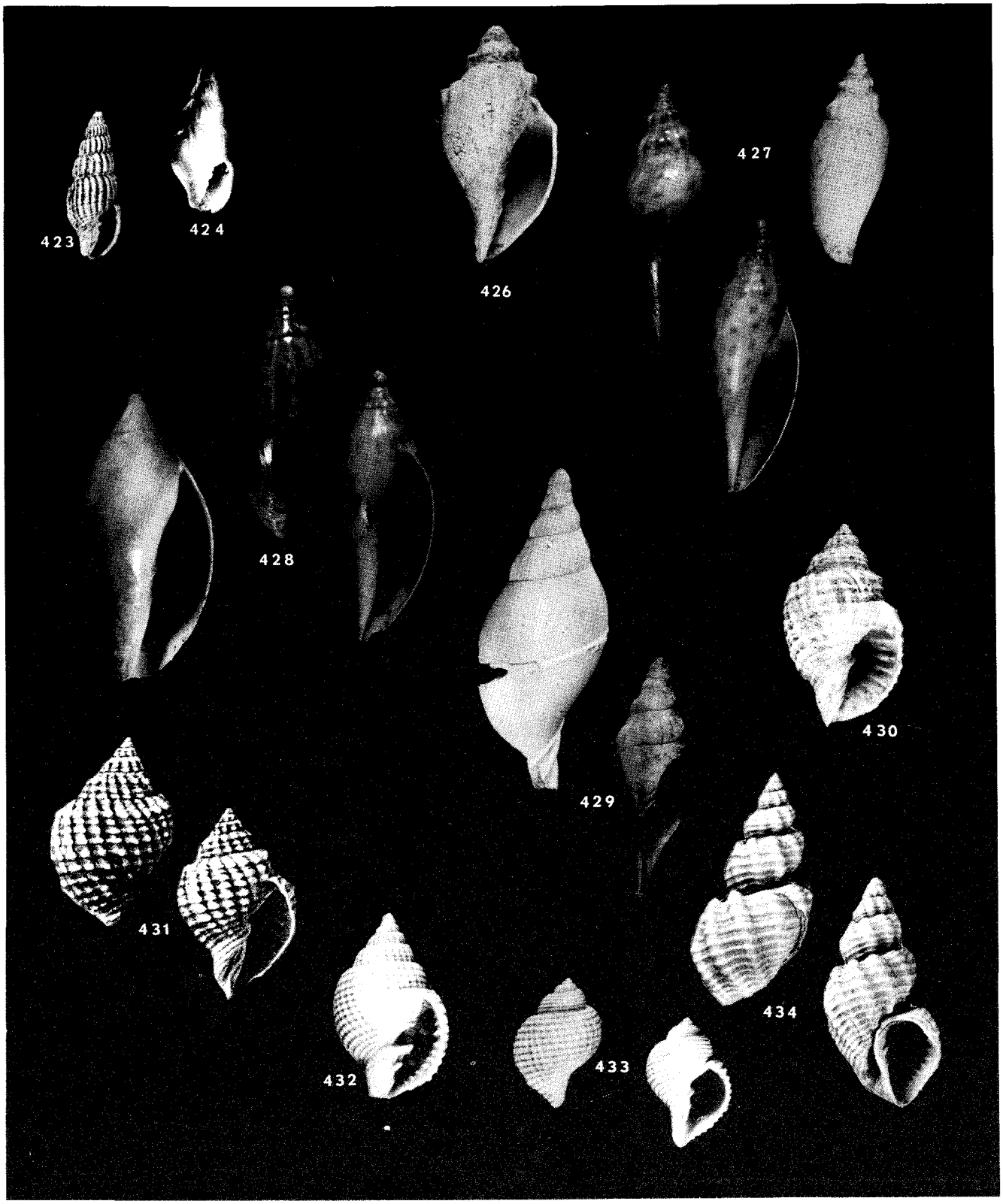
430. *Cancellaria depressa* (figured hypotype, USNM 403582), Smithfield VA 3. (1.2).

431. *Cancellaria plagiostoma* (holotype figured, ANSP 1609), James River, VA, figure from Gardner, 1948, (X 5.6).

432. *Cancellaria rotunda* (figured hypotype, USNM 403583), Rice's Pit, Hampton, VA, (X 2.0).

433. *Cancellaria (Massyla) rapella* (figured hypotype, USNM 403584), Chuckatuck, VA 2, (X 1.7).

434. *Agatrix williamsii* (holotype figured, USNM 220090), Rice's Pit, Hampton, VA, figure from Petit, 1978, (X 2.3).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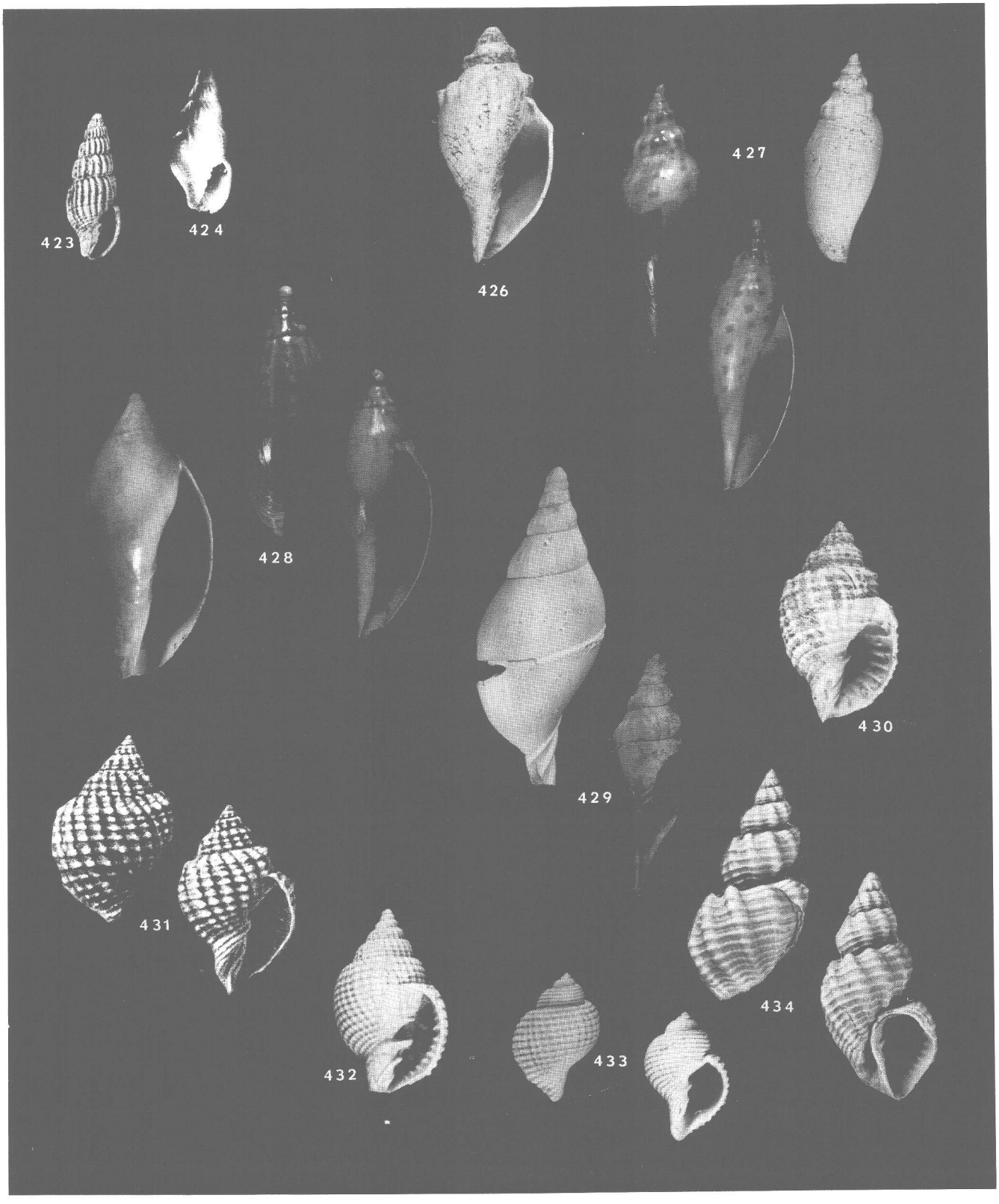
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PLATE 39

435. *Trigonostoma perspectiva* (figured hypotype, USNM 403585), Chesapeake, VA 2, (X 1.6).

436. *Trigonostoma tenerum carolinensis* (figured hypotype, USNM 403586), Chuckatuck, VA 2, (X 1.5).

437. *Trigonostoma smithfieldensis* (holotype figured, USNM 563929) Smithfield, VA 1, (figure from Oleksyshyn, 1960), (X 1.8).

438. *Trigonostoma(Extractrix) hoerlei* (figured hypotype, USNM 403587), Chuckatuck, VA 2, (X 2.5).

439. *Bullata antiqua* not illustrated

440. *Bullata (Microspira) oviformis* (holotype figured, ANSP 1617), Yorktown, VA, figure from Gardner, 1948, (X 1.5).

440a. *Bullata (Microspira) oviformis* (figured hypotype, USNM 403588), Rice's Pit, Hampton, VA (X 2.0)

441. *Dentimargo aureocincta* (figured hypotype, USNM 403589), Smithfield, VA 3, (X 6.4).

442. *Dentimargo chesapeakensis* (holotype figured, USNM 403590), Chesapeake, VA 1, (X 5.2).

442a. *Dentimargo schmidti* (holotype figured, PRI 210), Natural Well, NC, (X 3.2).

443. *Dentimargo eburneola* (figured hypotype, USNM 403591), Smithfield, VA 3, (X 3.2).

444. *Prunum bellum* (figured hypotype, USNM 403592), Smithfield, VA 3, (X 3.2).

445. *Prunum limatulum* (figured hypotype, USNM 403593), Williamsburg, VA 3, (X 2.7).

445a. *Prunum limatulum* (figured hypotype, USNM 403594), Smithfield, VA 3.

446. *Prunum roscidum* (figured hypotype, USNM 403595), Chesapeake, VA 1, (X 2.9).

447. *Prunum virginianum* (holotype figured, ANSP 2514), James River, VA = Smithfield, VA 3, (X 3.9).

448. *Gibberula lavalleeana* (figured hypotype, USNM 403596), Smithfield, VA 3, SEM (X 5.4).

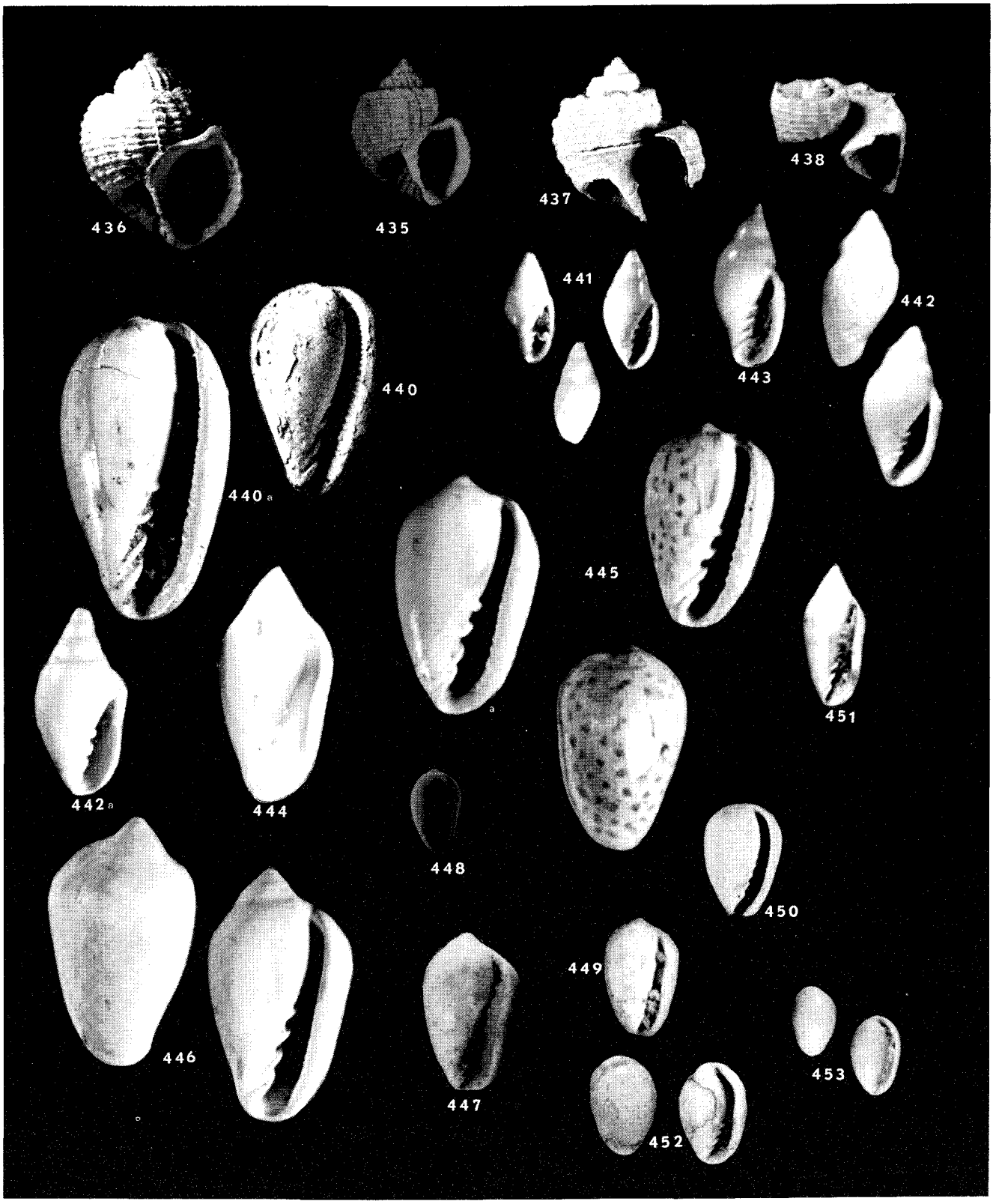
449. *Granula* sp. (figured hypotype, USNM 403597), Chesapeake, VA 1, (X 6.0).

450. *Persicula ovula* (figured hypotype, USNM 403598), Smithfield, Va 3, (X 2.4).

451. *Volvarina tersa* (figured hypotype, USNM 403599), Smithfield, VA 3, (X 3.3).

452. *Granulina mansfieldi* (holotype figured, USNM 403600), Chesapeake, VA 1, SEM (X 3.4).

453. *Granulina virginiana* (holotype figured, USNM 403601), Smithfield, VA 3, SEM (X 5.1).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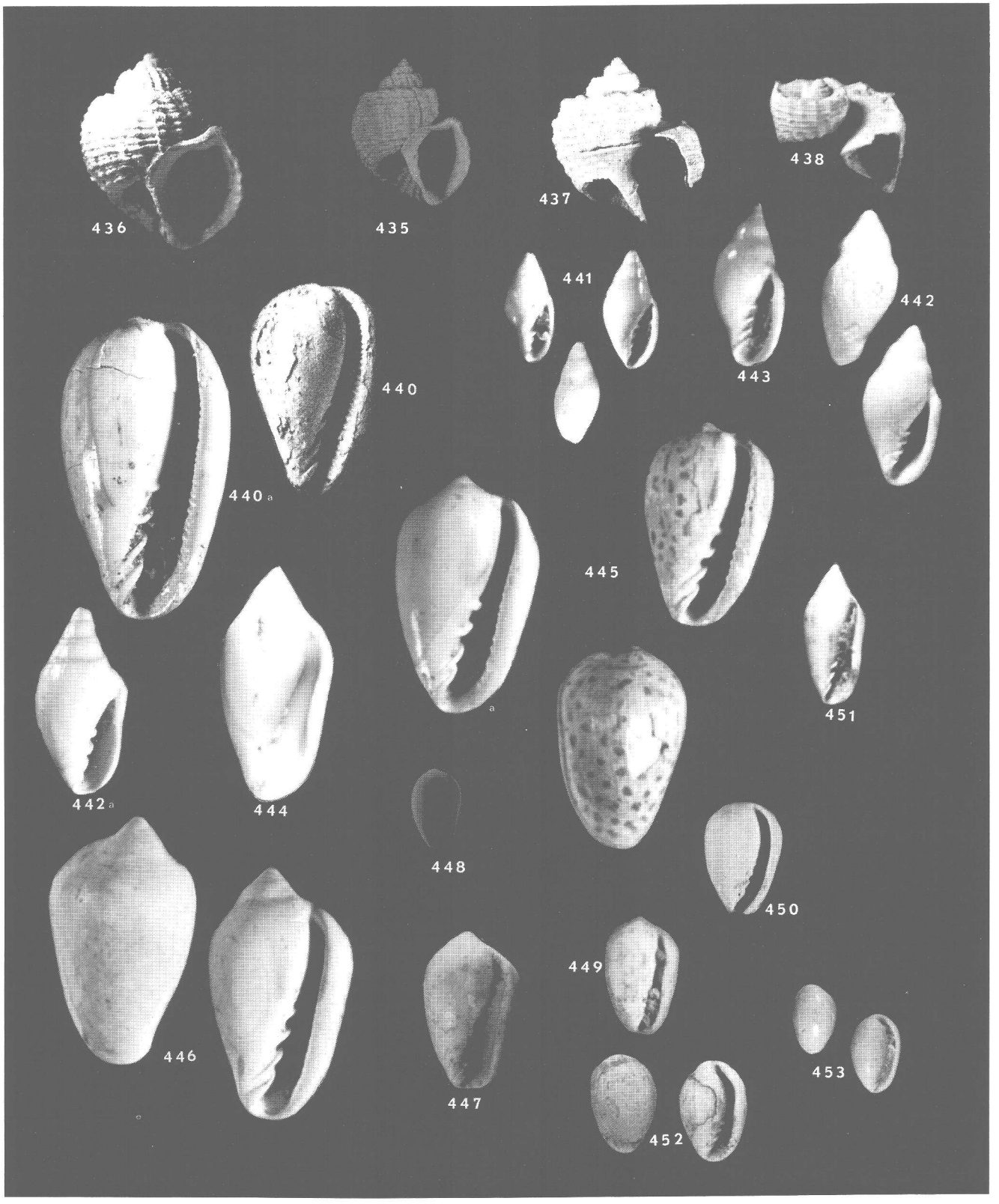
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PLATE 40

454. *Conus adversarius* (figured hypotype, USNM 403602), Rice's Pit, Hampton, VA, (X 0.5).

455. *Conus marylandicus* (figured hypotype, USNM 403603),Chesapeake, Va 2, (X 0.5).

456. *Terbra blakei* (figured hypotype, USNM 403604), Rice's Pit, Hampton, VA, (X 1.0).

457. *Terebra concava* (figured hypotype, USNM 403605), Chesapeake, VA 2, (X 1.1).

458. *Terebra emmonsii emmonsii* (figured hypotype, USNM 403606), Rice's Pit, Hampton, VA, (X 1.1).

459. *Terebra emmonsii grayi* (figured hypotype, USNM 325369), Yorktown, VA, figure from Gardner, 1948, (X 1.1).

460. *Terebra emmonsii hamptonensis* (holotype figured, USNM 403607), Rice's Pit, Hampton, VA, (X 1.0).

461. *Terebra indenta* (figured hypotype, USNM 403608), Chesapeake, VA 2, (X 1.2).

462. *Terebra* sp. (figured hypotype, USNM 403609), Chesapeake, VA 2, (X 1.2).

463. *Terebra* sp. (figured hypotype, USNM 403610), Chesapeake, VA 1, (X 1.5).

464. *Cochlespira* sp. (figured hypotype, USNM 403611), Zone 1, Chippoaks Plantation, VA, (X 1.0).

465. *Pyrgospira tricatenaria* (figured hypotype, USNM 403612), Chuckatuck, VA 2, (X 1.4).

465a. *"Surcula nodulifera"* (holotype figured, ANSP 30738), locality uncertain, "VA" on Conrad lable, (X 2.5).

466. *Mitrolumna smithfieldensis* (figured hypotype, USNM 403613), Smithfield, VA 3, SEM (X 8.4).

467. *Mitrolumna yadkinensis* (holotype figured, USNM 403614), Chesapeake, VA 1, SEM (X 8.3).

468. *Drillia (Drillia)chuckatuckensis* (holotype figured, USNM 403615), Chuckatuck, VA 2, (X 1.5).

469. *Drillia (Clathrodrillia) impressa* (holotype figured, ANSP 1606), James River, VA, figure from Gardner, 1948, (X 2.8).

469a. *Drillia (Clathrodrillia)impressa* (figured hypotype, USNM 403616), Smithfield, Va 3, (X 2.8)

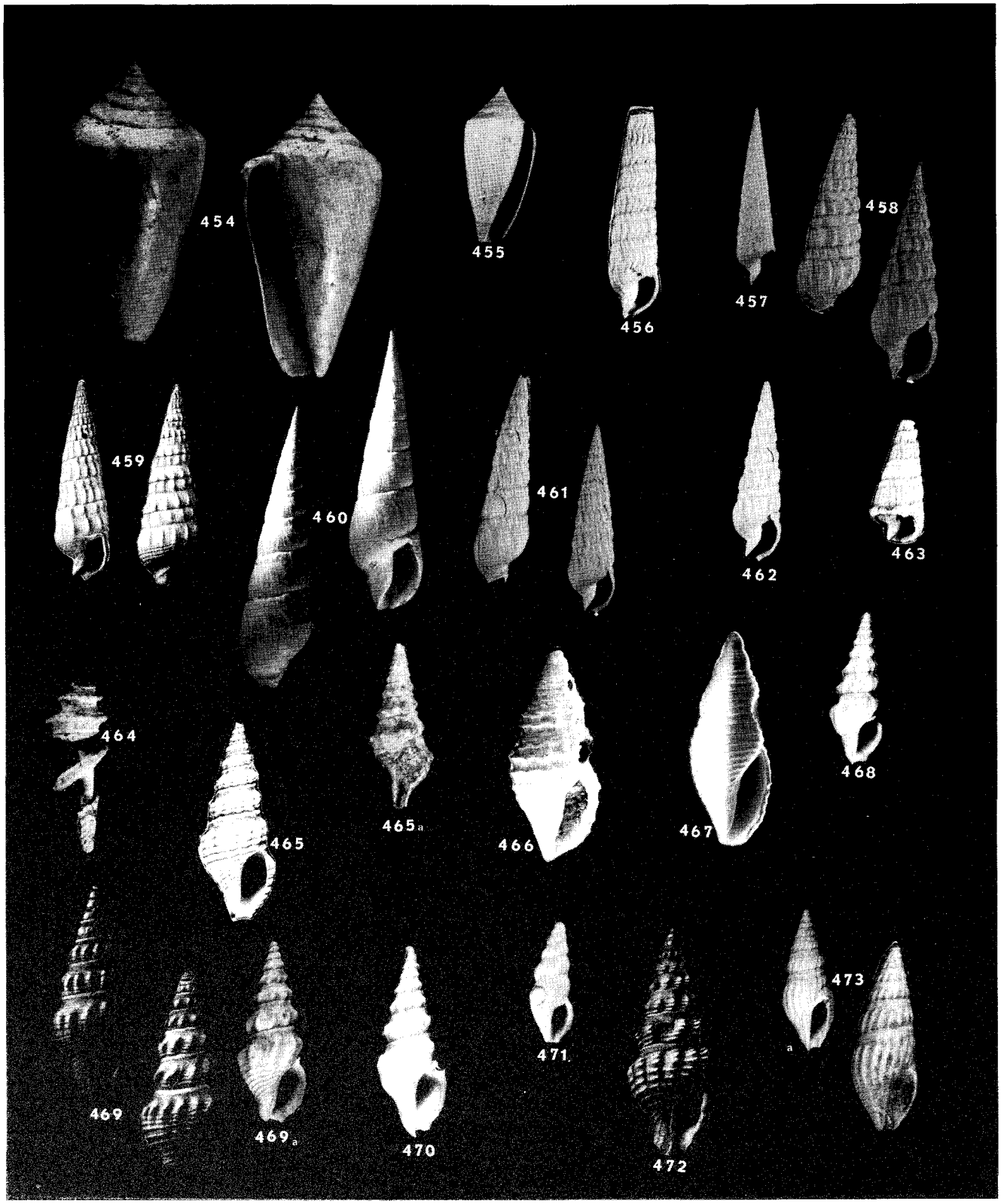
470. *Imaclava halei* (holotype figured, USNM 403617), Chuckatuck, VA 2, (X 1.4).

471. *Cerodrillia simpsoni cingulata* (figured hypotype, USNM 403618), Smithfield, VA 3, (X 2.7).

472. *Crassispira pyrenoides* (holotype figured, ANSP 1602), James River, VA, figure from Gardner, 1948, (X 2.1).

473. *Crassispira (Crassispirella) virginiana* (specimen from type lot, ANSP 30589), Smithfield, VA 1, (X 1.7).

473a. *Crassispira (Crassispirella) virginiana* (figured hypotype, USNM 403619), Smithfield, VA 3, (X1.7).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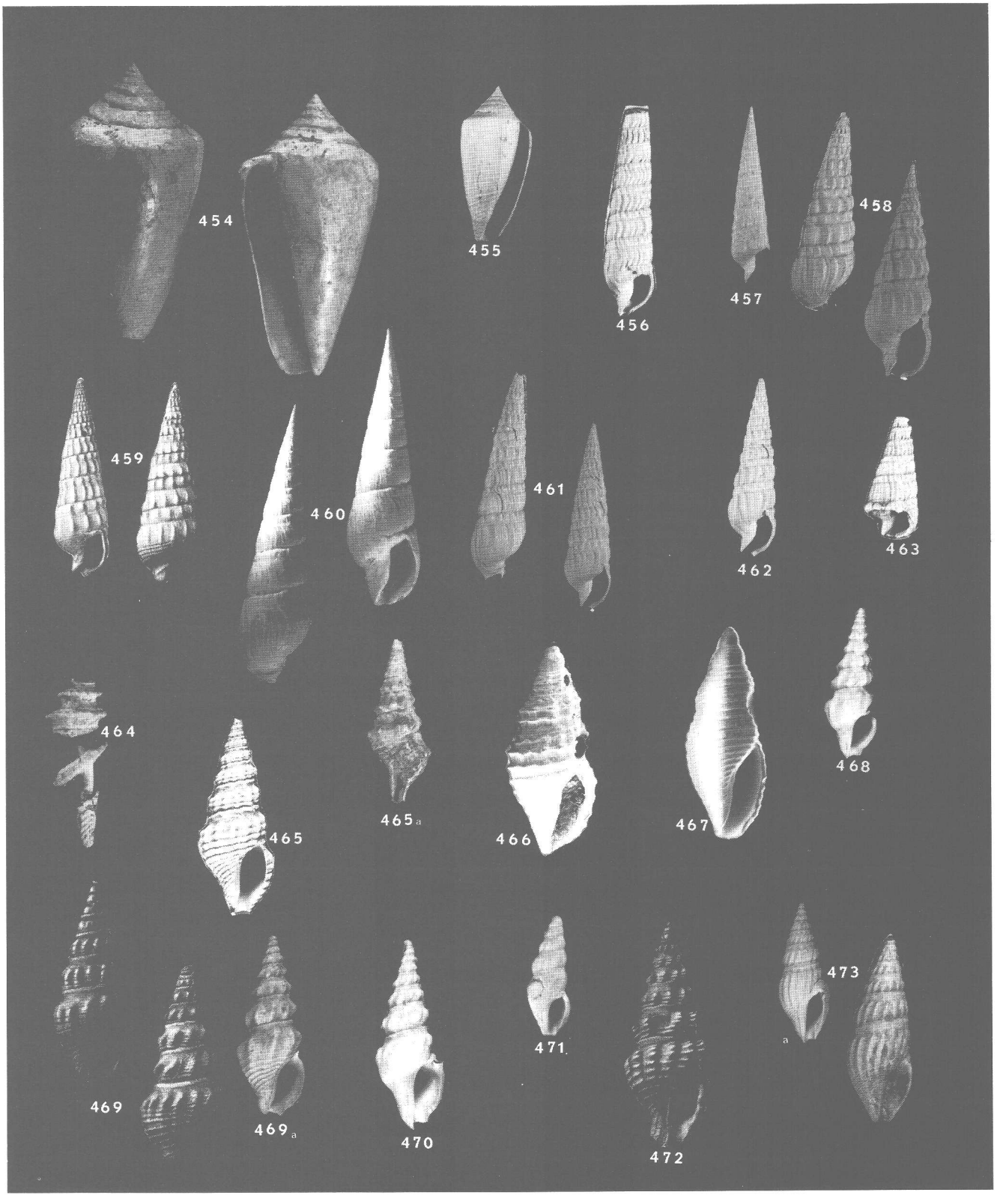
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PLATE 41

475. *Sedilia bella* (holotype figured, ANSP 1607), Yorktown, VA, figure from Gardner, 1948, (X 2.4).

475a. *Sedilia bella* (figured hypotype, USNM 403620), Smithfield, VA 3, (X 2.8).

476. *Sedilia belloides* (figured hypotype, USNM 403621), James River near Smithfield, Va 3, (X 2.7).

477. *Sedilia rushmerensis* (holotype figured, USNM 352436), Rushmere, VA, figure from Mansfield, 1929, (X 3.7).

477a *Sedilia rushmerensis* (figured hypotype, USNM 403622), Smithfield, VA 3, (X 3.7).

478. *Carinodrillia smithfieldensis* (figured hypotype,USNM 403623), Williamsburg, VA 3, (X 2.7).

479. *Splendrillia arata* (holotype figured, ANSP 1605), Yorktown, VA, figure from Gardner, 1948, (X 2.5).

480. *Cymatosyrinx lunata* (figured hypotype, USNM 403624), Williamsburg, VA 3, (X 1.2).

481. *Cymatosyrinx ricei* (holotype figured, USNM 403625), Rice's Pit, Hampton, VA, (X 2.1).

482. *Bellaspira virginiana* (figured hypotype, USNM 403626),Chucktuck, VA 2, (X 1.5).

483. *Compsodrillia* sp. ("type" figured, ANSP 1611), Yorktown, VA, figure from Gardner, 1948, (X 4.0).

484. *Compsodrillia eburnea* (holotype figured, ANSP 1608), Yorktown VA, figure from Gardner, 1948, (X 3.5).

485. *Mangelia andrewi* (holotype figured, USNM 403627), Williamsburg, VA 3, SEM (X 3.0).

486. *Cryoturris maesi* (holotype figured, USNM 403628), Chuckatuck, VA 2, SEM (X 4.3).

487. *Cryoturris magnoliana* (figured hypotype, USNM 403629), Chucktuck, VA 1, SEM (X 4.0).

488. *Kurtziella smithfieldensis* (figured hypotype, USNM 403630), Smithfield, VA 3, SEM (X 3.1).

489. *Glyphostoma zoster* (figured hypotype, USNM 403631), Smithfield, VA 3, (X 4.1).

490. *Pyrgocythara (Vitricythara) micromeris* (figured hypotype, USNM 403632), Smithfield, VA 3, SEM (X 8.4).

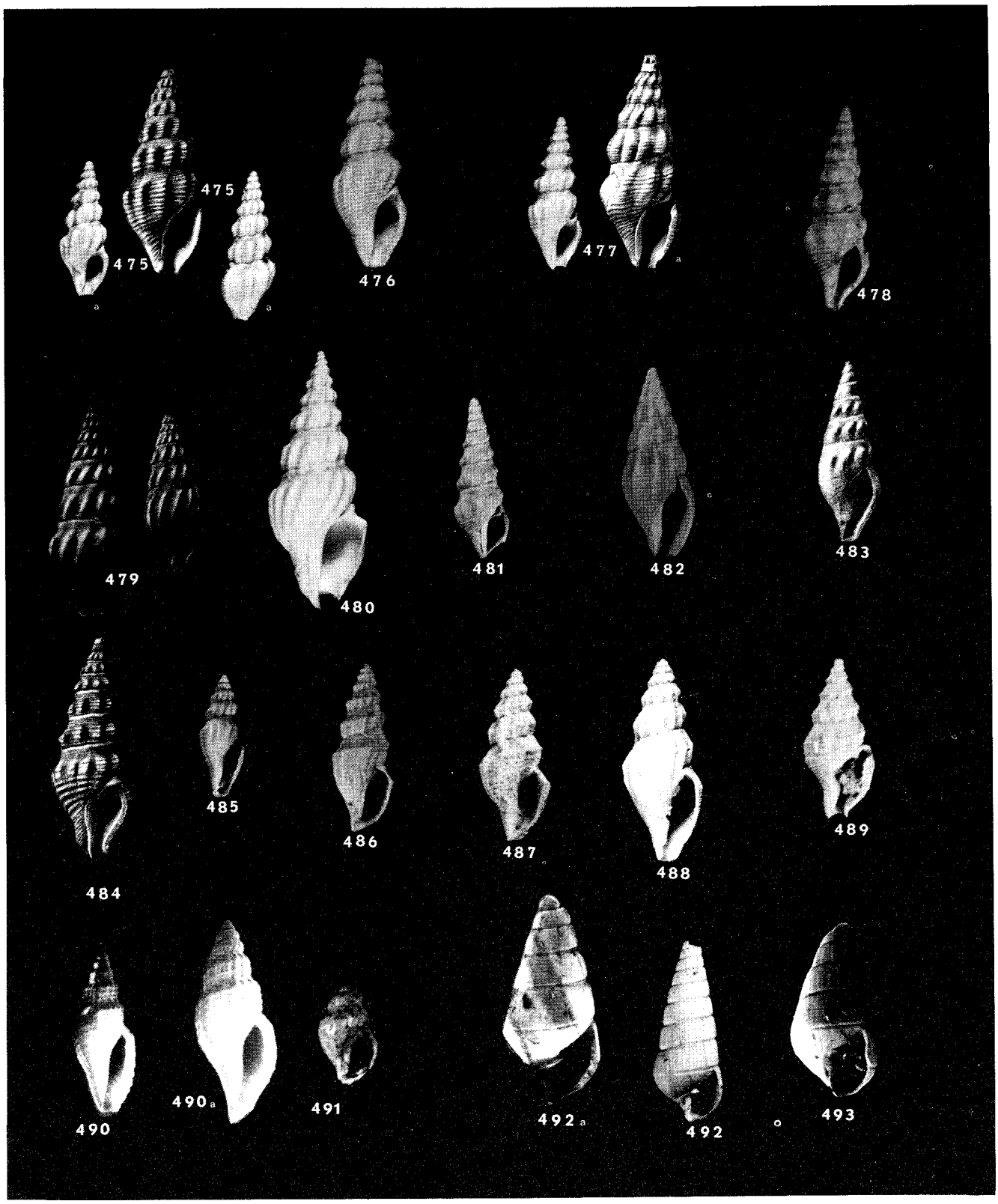
490a. *Pyrgocythara (Vitricythara) metria* (figured hypotype, USNM 403633), Chuckatuck, VA 2, SEM (X 6.0).

491. *Oenopota pumilus* (lectotype figured, ANSP 13827a), "MD", unknown VA locality, (X 6.0).

492. *Longchaeus suturalis* (figured hypotype, USNM 403634), Chucktuck, VA 2, (X 2.7).

492a. *Longchaeus suturalis* (figured hypotype, USNM 403635), Chucktuck, VA 2, SEM (X 12.0).

493. *Longchaeus simplex* (figured hypotype, USNM 403636), Smithfield, Va 3, SEM (X 14.8).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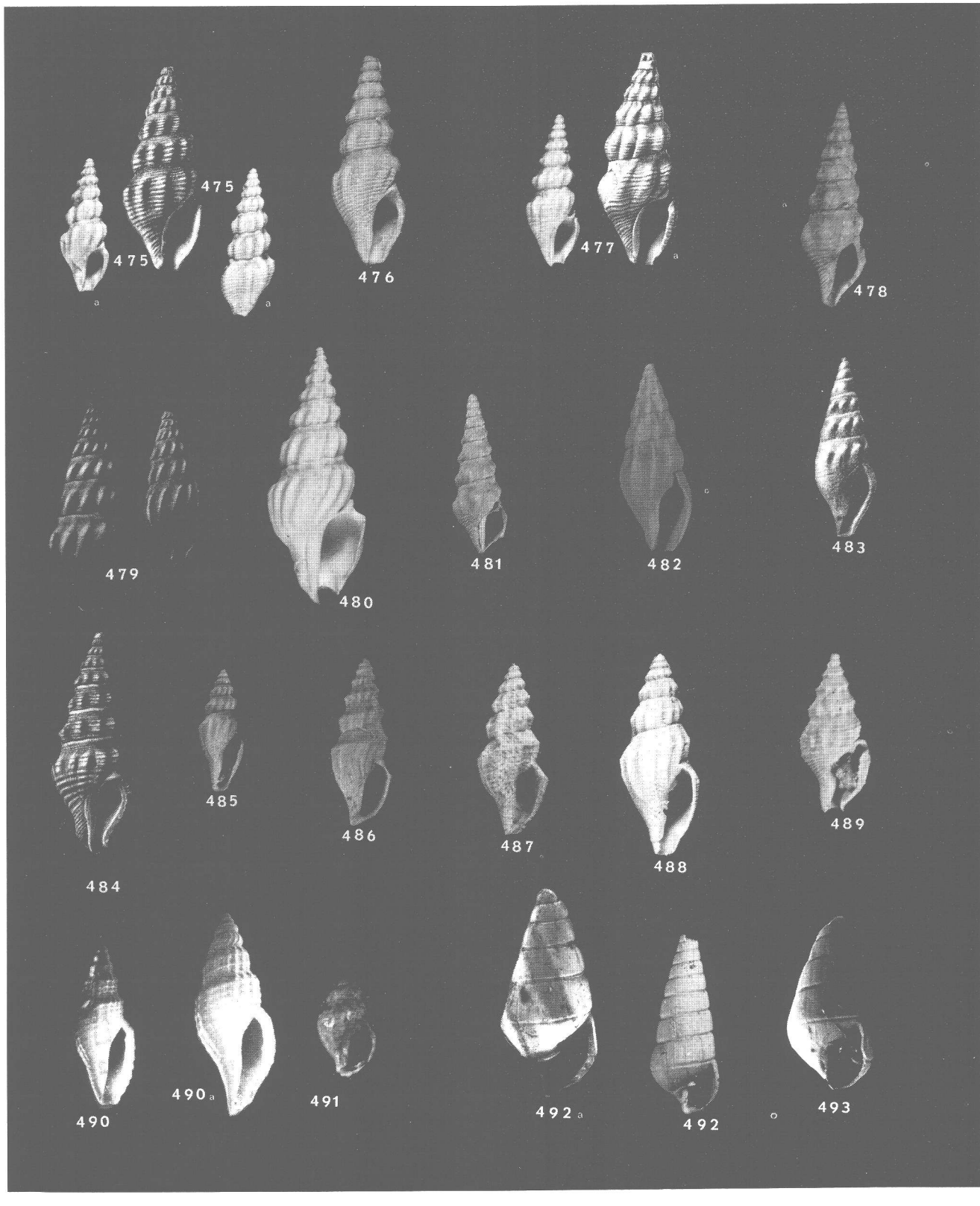
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PLATE 42

494. *Odostomia(Odostomia) alpha* (holotype figured, USNM 403637), Zone 1, Williamsburg, VA 1, SEM (X 6.5).

495. *Odostomia (Odostomia) beta* (holotype figured, USNM 403638), Rice's Pit, Hampton, VA, SEM (X 6.9).

496. *Odostomia (Odostomia) gamma* (holotype figured, USNM 403639), Chesapeake, VA 2, SEM (X 7).

497. *Odostomia (Odostomia) epsilon* (holotype figured, USNM 403640, Chesapeake, VA 2, SEM (X 10.6)>

498. *Odostomia) mu* (holotype figured, USNM 403641), Chesapeake, VA 2, SEM (X 10.7).

499. *Odostomia (Chrysallida) granulata* (figured hypotype, USNM 403642), Chesapeake, VA 2, SEM (X 9.6).

499a. *Odostomia (Chrysallida) granulata* (figured hypotype, USNM 403643, Chesapeake, VA 2, SEM (X 9.6).

500. *Odostomia (Chrysallida) archeri* (figured hypotype, USNM 403644), Chesapeake, VA 1, SEM (X 8.4).

501. *Odostomia (Chrysallida) eta* (holotype figured, USNM 403645), Williamsburg, VA 3, SEM (X 8.4).

502. *Odostomia (Chrysallida) theta* (holotype figured, USNM 403646), Chesapeake, VA 2, SEM (X 7.4).

503. *Odostomia (Chrysallida) zeta* (holotype figured, USNM 403647), Chuckatuck, VA 2, SEM (X 8.0).

503a. *Odostomia (Chrysallida) omicron* (paratype figured, adapertual view, USNM 403690), Chesapeake, VA 2, SEM (X 25.8).

504. *Odostomia (Menestho) iota* (holotype figured, USNM 403649), Williamsburg, VA 3, SEM (X 6.8).

505. *Odostomia (Menestho) milium* (holotype figured, USNM 403650), Chesapeake, VA 2, SEM (X 17).

505a. *Odostomia (Menestho) milium* (figured hypotype, USNM 403651), Chesapeake, VA 2, SEM (X 17).

506. *Odostomia (Evalea) diaphana* (figured hypotype, USNM 403652), Chesapeake, VA 2, SEM (X 9.2).

507. *Odostomia (Evalea) ovula* (figured hypotype, USNM 403653), Chesapeake, VA 2, SEM (X 8.75).

508. *Odostomia (Evalea) lambda* (holotype figured, USNM 403654), Chesapeake, VA 2, SEM (X 10.4).

509. *Odostomia (Evalea) nu* (holotype figured, USNM 403655), Chesapeake, Va 2, SEM (X 9.4).

510. *Odostomia (Evalea) xi* (holotype figured, USNM 403656), Chesapeake, VA 2, SEM (X 8.2).

511. *Odostomia (? Evalina) sculpturata* (figuredhypotype, USNM 403658), Chesapeake, VA 2, SEM (X 14.2).

512. *Odostomia (Eulimastomia) rho* (holotype figured, USNM 403659), Smithfield, VA 3, SEM (X 12.7).

513. *Odostomia (Chesapeakella) sigma* (holotype figured, USNM 403660), Chesapeake, Va 2, SEM (X 24.5)

514. *Odostomia* limnia (not illustrated, ANSP missing), Yorktown, VA.

515. *Odostomia nitens* (not illustrated, ANSP missing), PetersburgVA 1.

516. *Odostomia protexta* (holotype illustrated, ANSP 15631), Yorktown, VA, (X 4).

517. *Odostomia turbinatus* not illustrated

518. *Triptychus biseriatus* (figured hypotype, USNM 403661), Chucktuck, VA 2, SEM (X 14.2).

519. *Turbonilla (Chemnitzia) alpha* (holotype figured, USNM 403662), Smithfield, VA 3, SEM (X 8.3).

520. *Turbonilla (Chemnitzia) beta* (holotype figured, USNM 403663), Chesapeake, VA 2, SEM (X 14.1).

521. *Turbonilla (Strioturbonilla) exarata* (figured hypotype, USNM 403664), Rice's Pit, Hampton, VA, SEM (X 4.5).

522. *Turbonilla (Strioturbonilla) subula* (figured hypotype, USNM 403665), Smithfield, VA 3, SEM (X 7.5).

523. *Turbonilla (Strioturbonilla) delta* (holotype figured, USNM 403666), Chesapeake, VA 2, (X 7).

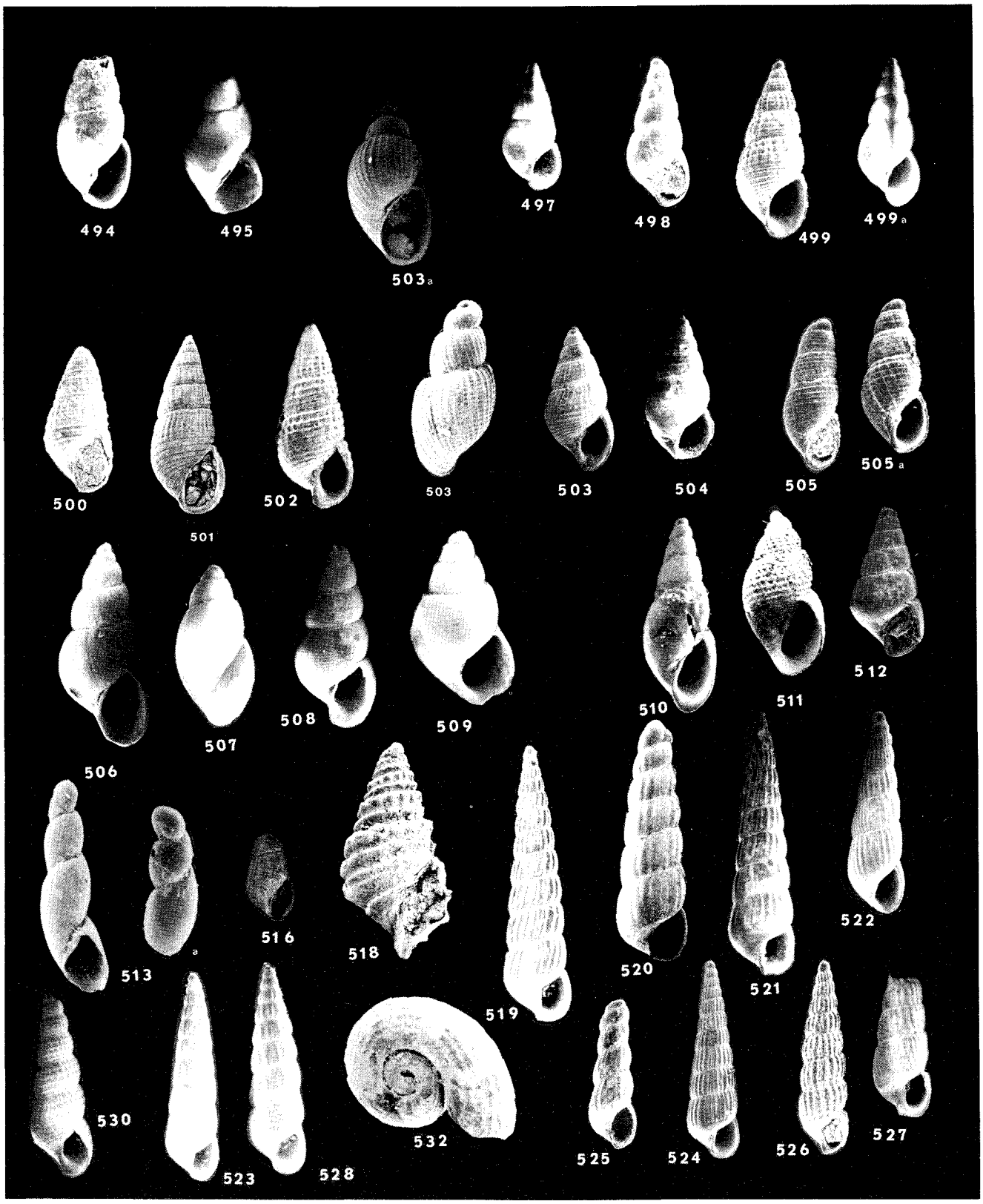
524. *Turbonilla (Strioturbonilla) eburnea* (figured hypotype, USNM 403667), Smithfield, VA 3, SEM (X 5.2).

525. *Turbonilla(Pyrgiscus) kappa* (holotype figured, USNM 403668), Chesapeake, VA 2, SEM (X 30.3).

526. *Turbonilla (Pyrgiscus) digamma* (holotype figured, USNM 403669), Smithfield, VA 3, SEM (X 7.5).

527. *Turbonilla (Pyrgiscus) zeta* (holotype figured, USNM 403670), Chesapeake, VA 1, SEM (X 8.1).

532. *Cyclostremella magnoliana* (figured hypotype, USNM 403673), Chesapeake, Va 2, SEM (X 19.5).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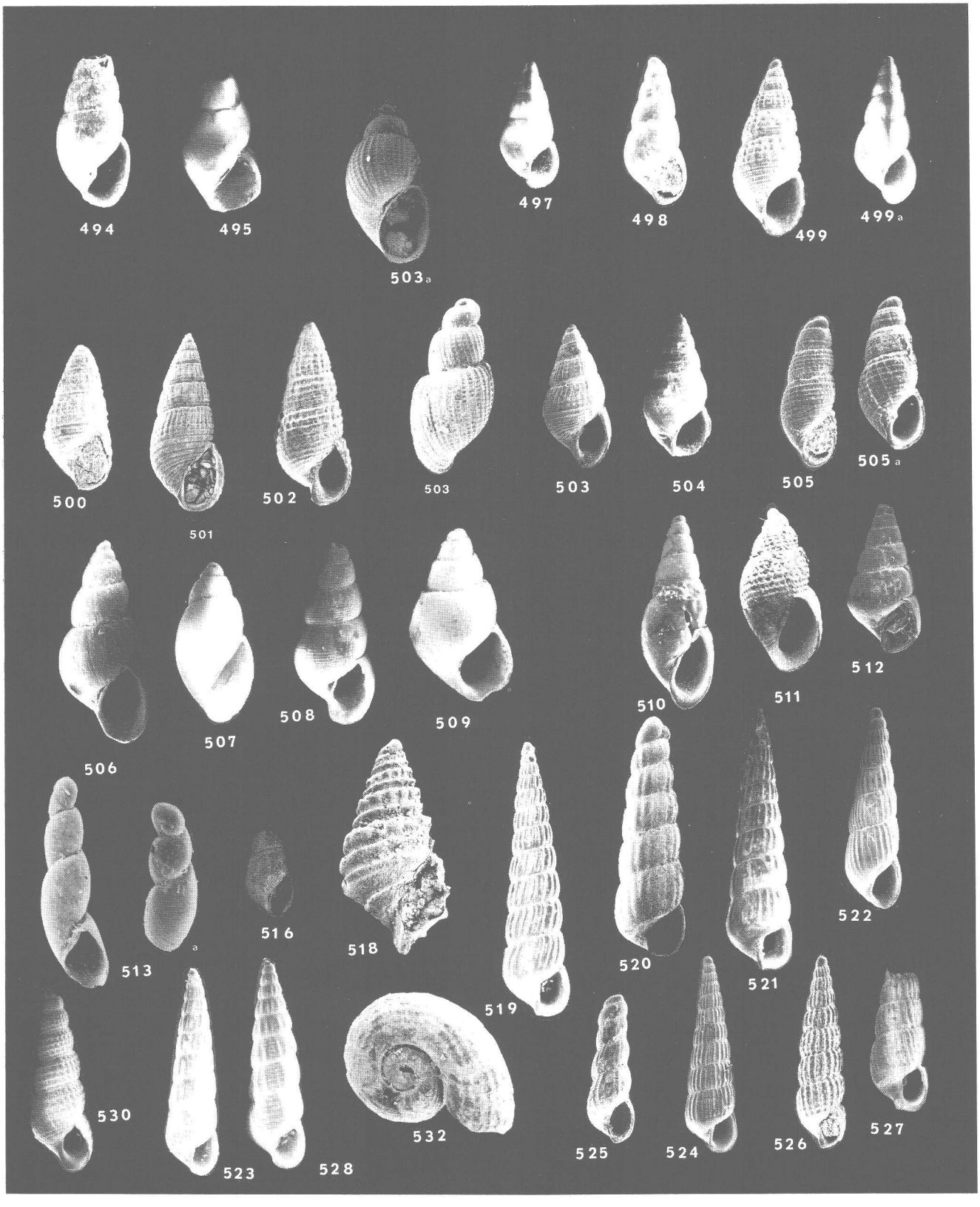
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PLATE 43

528. *Turbonilla (Pyrgiscus) eta* (holotype figured, USNM 403671), Williamsburg, VA 2, SEM (X 4.2).

529. *Turbonilla(Pyrgiscus) daedaleum* not illustrated

530. *Turbonilla (Bartschella) iota* (holotype figured, USNM 403672), Chesapeake, VA 2, SEM (X 6.8).

532. *Cyclostremella magnoliana* (figured hypotype, USNM 403673), Chesapeake, Va 2, SEM (X 19.5), see Plate 42.

533. *Acteon novellus* (holotype figured, ANSP 1600), Suffolk, VA, figure from Gardner, 1948, (X 6.1).

533a. *Acteon novellus* (holotype of *Acteon novellus nansemondensis*, USNM 325367), 1 mile north of Suffolk, VA, figure from Gardner, 1948, (X 6.0)

534. *Acteon vaughani* not illustrated

535. *Ringicula guppyi* (figured hypotype, USNM 403675), Chesapeake, VA 1, SEM (X 10.3).

536. *Ringicula* sp. (figure from Wally Williams, specimen lost), Rice's Pit, Hampton, VA, (X 8).

537. *Acteocina candei* (figured hypotype, USNM 403677), Smithfield, VA 3, SEM (X 3.7).

538. *Acteocina myrmecoon* (figured hypotype, USNM 403678),Williamsburg, Va 1, (X 3.3).

539. *Acteocina lepta* (figured hypotype, USNM 403679), Smithfield, VA 3, SEM (X 7.7).

540. *Cylichna johnsoni* (figured hypotype, USNM 403680), Zone 1, Williamsburg, VA 1, (X 3.0).

541. *Cylichnella* sp. (figured hypotype, USNM 403681), Chesapeake, VA 2, SEM (X 9.9).

542. *Philine williamsi* (holotype figured, USNM 403682), Chesapeake, Va 2, SEM (x 8.6).

543. *Haminoea* sp. not illustrated

544. *Retusa microtrema* (figured hypotype, USNM 403683), Chuckatuck, VA 1, SEM (X 18).

545. *Retusa chesapeakensis* (holotype figured, USNM 403684), Chesapeake, VA 2, SEM (X 11.4).

546. *Valvulella cylindra* (holotype figured, ANSP 1554), Petersburg, VA 1, figure from Gardner, 1948, (X 6.0).

546a. *Volvulella cylindra* (figured hypotype, USNM 403685), Smithfield, VA 3, SEM (X 6.0).

547. *Limacina chesapeakensis* (holotype figured, USNM 403686), Chesapeake, VA 2, planorbid holotype adult, SEM (X 29); umbilical view, SEM (X 25), specimen subsequently disintegrated; high spired juvenile paratype, (USNM 403687), SEM (X 78); unfigured paratype, (USNM 403689).

548. *Creseis acicula* (figured hypotype, USNM 403688), Chesapeake, VA 2, (X 9).

549. *Hyalocylis striata* Chesapeake, VA 2, specimen lost, figure from Abbott, 1974.

550. *Cavolinia uncinata* Chesapeake, VA 2, specimen lost, figure from Abbott, 1974.

551. *Cavolinia ventricosa* Rice's Pit, Hampton, VA, specimen lost, figure from Abbott, 1974.

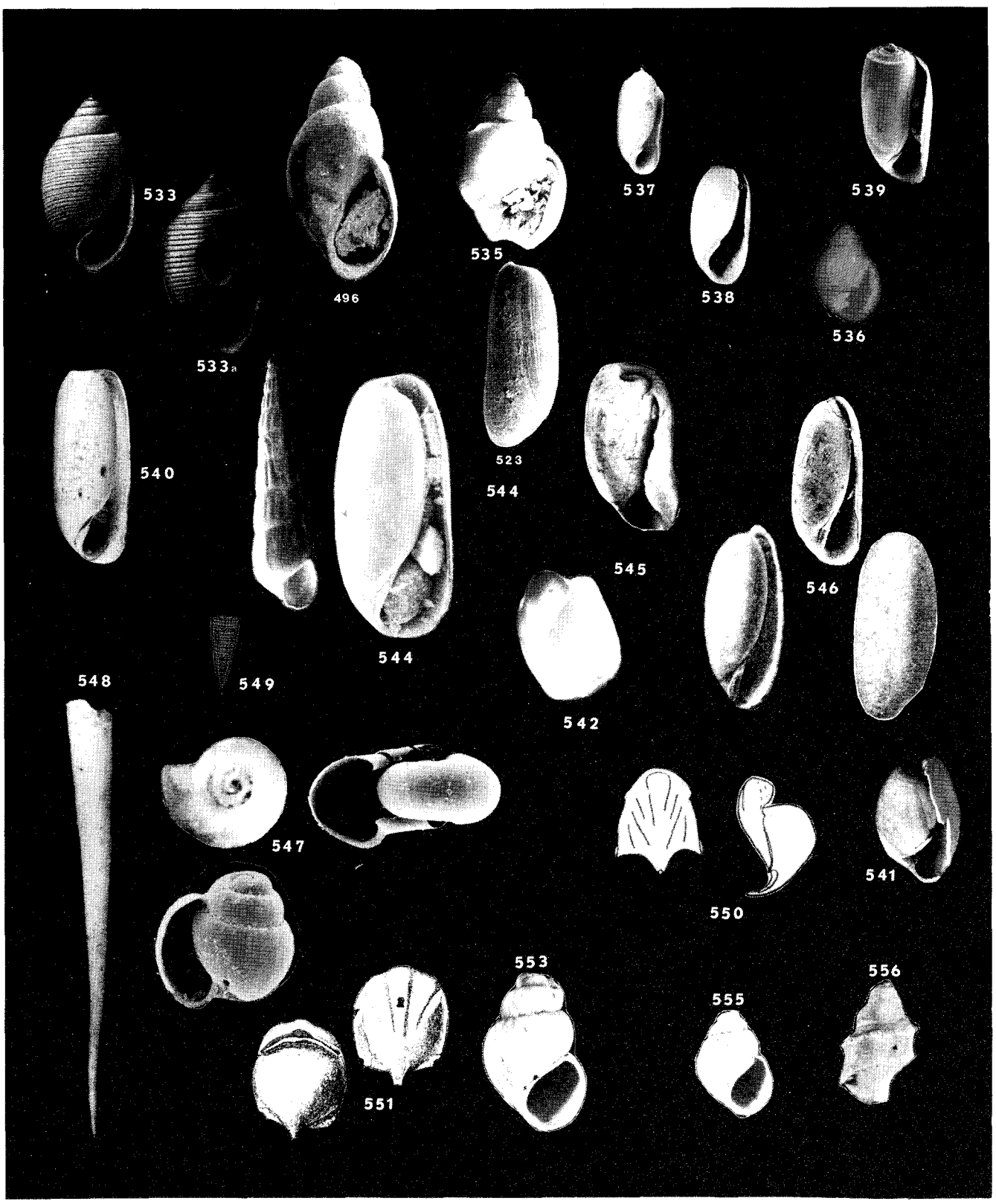
552. *Viviparus* sp. not illustrated

553. *Viviparus* sp. (figured hypotype, USNM 403691), Chesapeake, VA 1, (X 1.3).

554. *Viviparus* sp. not illustrated

555. *Lioplax* sp. (figured hypotype, USNM 403692), Chesapeake, VA 1, (X 1.4).

556. *Incerta sedis* (figured hypotype, USNM 403693), Chesapeake, VA 2, (X 1.5).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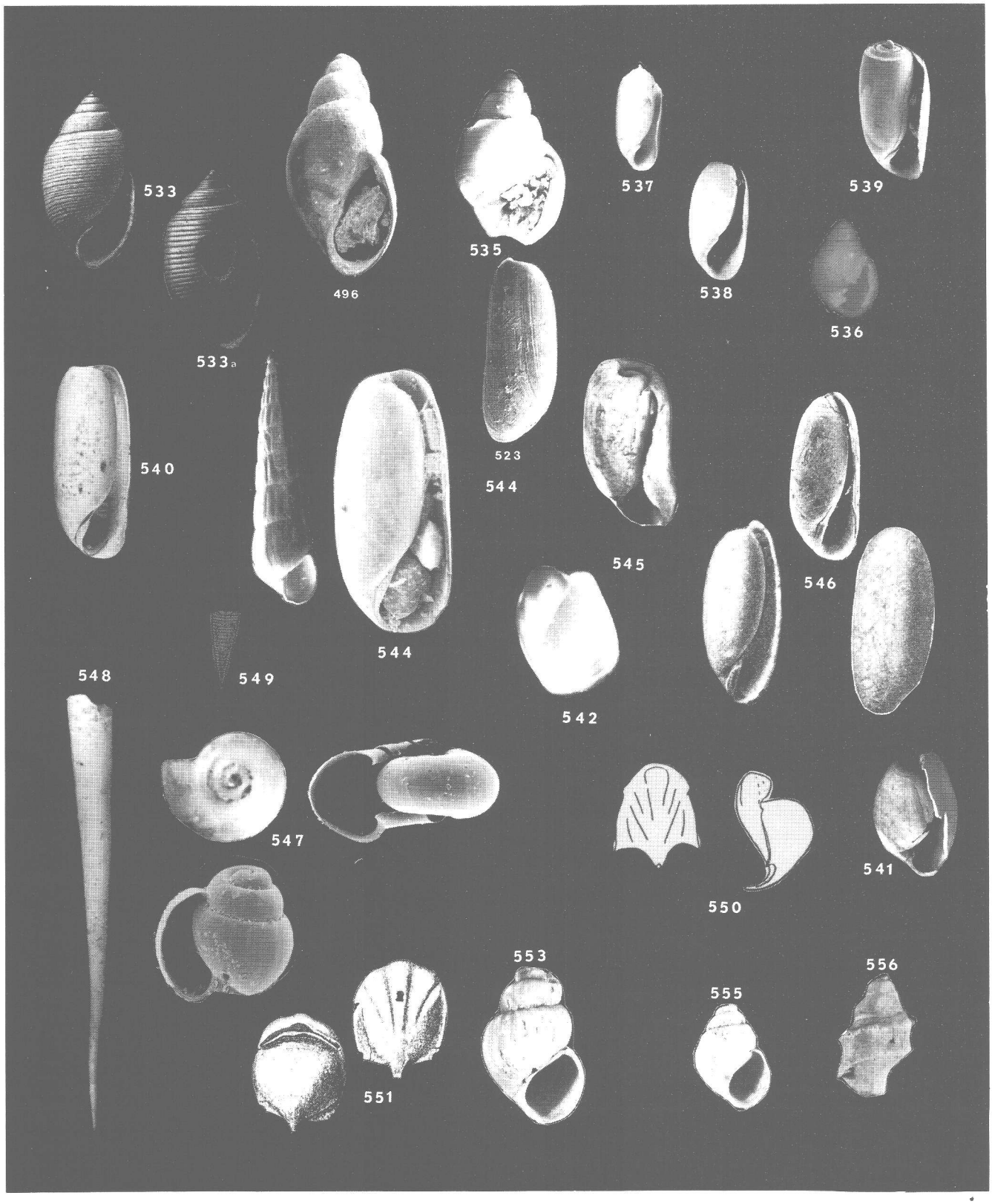
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