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SMALL SPECIES OF NUCULIDAE (BIVALVIA) FROM THE TROPICAL WESTERN ATLANTIC[1]

Donald R. Moore

University of Miami,
Rosenstiel School of Marine and Atmospheric Science

ABSTRACT

Three small species of Nuculidae, two of which are the smallest known bivalves, are described from tropical western Atlantic sediments. Nucula calcicola *n. sp. is a small, less than 2.0 mm, clam found in calcareous sediments over much of the Caribbean region. The other two species are placed in a new genus,* Condylonucula, *with* C. cynthiae *n. sp. as the type.* C. cynthiae, *mature at around 600 μ, is found in the western Caribbean on atolls off the coast of Nicaragua.* C. maya *n. sp., mature at around 500 μ, has been found at Cozumel and Arrowsmith Bank at the northwestern extremity of the Caribbean. Recent and Upper Cenozoic Nuculidae of the area are listed, and some are discussed.*

A very small shallow-water species of *Nucula* is widely distributed throughout much of the Caribbean region. Specimens, when found, have apparently been identified as juvenile *N. proxima* Say or as *N. aegeensis* Jeffreys. However, *N. proxima* is a temperate species with a distribution from New England to Texas, and is a much larger species reaching a size of 10 mm. The small tropical species does not reach, at least in the material at hand, more than a length of two mm. *N. aegeensis*, in the western Atlantic, was identified by Dall in 1886, and this identification has not been challenged even though *N. aegeensis* was described from the Mediterranean. While most of the material ascribed to the species came from depths of more than 200 m, Dall (1889) gave a depth range of 5-464 fms (9-849 m). Later, Dall and Simpson (1901) reported a single worn juvenile valve from Mayaguez Harbor (Puerto Rico).

The American specimens of *N. aegeensis*, according to Dall, are fairly large, reaching a length of more than 10 mm. Dall did not give size or locality for the shallow water specimens, and apparently no one has studied them recently. Dall apparently considered small *Nucula* from shallow water to be either *N. proxima* or *N. aegeensis*. This was probably due to the amount and condition of the material that he had to study. He apparently did not have any of the rather distinctive species from northern South America at the time. South Caribbean shallow water species are *Nucula dalmasi* Dautzenberg 1900, *N. surinamensis* Altena, 1968, and *N. venezuelana* Weisbord, 1964.

OBSERVATIONS

I first found the new species in a bottom sample collected at a depth of two m in Lameshur Bay, St. John, U. S. Virgin Islands (Moore, 1970). Thinking that these were very young specimens, I did not attempt to identify them at the time. Several years later, I found more specimens in bottom samples from Serrana Bank (Bock and Moore, 1971), an atoll in the western Caribbean (Milliman, 1969). It was not until I found that I had 72 specimens from two stations made at Courtown Cays, a small atoll east of Nicaragua, that I became convinced that I had a small shallow-water-dwelling species. The largest specimen measures 1.90 mm.

By this time I had also found several specimens of a much smaller species with a peculiar prodissoconch. This nuculid gave every indication of having attained full growth at a length of about 600 μ. Naturally, I wanted more material before attempting to describe either

[1] Contribution from the University of Miami, Rosenstiel School of Marine and Atmospheric Science, and Contribution No. 5 from the West Indies Laboratory, Fairleigh Dickinson University.

species as there have been many cases of immature mollusks described as adults, often badly misclassified (Moore, 1966, Pilsbry, 1949). Searching through sediment samples from St. Croix, Virgin Islands, Key Largo in the Florida Keys, and from Bermuda all provided more material of the larger species.

Bottom samples from Chancanab Lagoon, Cozumel, Mexico, collected in November, 1971, provided a large suite of the largest species and over 30 specimens of another, very small species. The latter species was also found in sediments from Arrowsmith Bank, a flat topped bank about 34 km NNE of Cozumel. Since I now had well over 300 specimens of the largest species, and 52 of the two smaller ones, I felt that there was little doubt that all three species matured at a very small size. In the following descriptions, the largest species is assigned to *Nucula*, and a new genus is erected for the smaller two.

DESCRIPTIONS

Genus *Nucula* Lamarck, 1799

Type species by monotypy, *Arca nucleus* Linnaeus

Nucula calcicola *new species*

Description: A small species of *Nucula* maturing at a length of about 1.5 mm. The prodissoconch is about 220 μ long, somewhat flattened, pitted, and has a small knob near the posterior edge. The dissoconch is about 25% longer than high; thickness of an adult specimen is about one half the length. The anterior end is extended and rounded; posterior end truncate. The posterior margin forms a straight or nearly straight line. The ventral margin is well-rounded and weakly dentate. Both concentric and radial sculpture are present, but are exceedingly weak. A thin brownish periostracum is present on fresh specimens.

The resilifer is internal, short, and nearly at right angles to the hinge line. The anterior limb of the hinge is broad, and is widest distally between the last two teeth. Mature specimens usually have seven anterior teeth in the left valve, six in the right. The posterior limb of the hinge is short and broad with four teeth in the left valve, four in the right. The adductor muscle scars are located at each end of the hinge. Shell structure in fresh specimens is transparent; there is no nacre, or at most, an extremely thin wash of this material.

Material: Holotype. Specimen collected alive, 1.74 mm long and 1.38 mm high. U. S. N. M. No. 758535.

Type locality: Chancanab Lagoon, depth 2 m, Cozumel, Quintana Roo, Mexico.

Paratypes and other localities: Courtown Cays, western Caribbean, Lagoon, depth 11 m, 59 separate valves. North end of the atoll, depth 2 m, 13 separate valves. Serrana Bank, western Caribbean: Lagoon, 14 valves, 2 complete specimens. St. John, Virgin Islands: Lameshur Bay, depth 2 m, 15 separate valves. St. Croix, Virgin Islands: West side of Cottongarden Point, depth 1 m, one valve. Tague Bay, depth 3 m, 3 valves and one complete specimen; depth 4 m, one complete specimen; station at inside edge of outer reef, 4 m, 3 valves and one complete specimen. Glovers Reef, Belize (British Honduras): depth 2 m, 3 valves, 2 complete specimens. Cozumel, Quintana Roo, Mexico: Chancanab Lagoon, depth 2 m, 74 complete, 98 separate valves, and 14 identifiable fragments: depth 5 m, one valve. Key Largo, Florida: Harry Harris Park, depth 2 m, 2 complete, 17 separate valves, some badly broken. Andros Island, Bahamas: one mile east of Wax Cut, depth 3 m, one complete specimen. Harrington Sound, Bermuda: notch at 4.6 m, 2 complete, 3 separate valves.

The paratypes range in length from 0.38 mm, for a complete specimen from Cozumel to 1.90 mm for a single valve from the same locality. One typical complete mature specimen from Cozumel measured 1.60 long by 1.24 mm high by 0.86 mm thick.

Paratypes have been placed in the following institutions: National Museum of Natural History, Smithsonian Institution (USNM 758537); Delaware Museum of Natural History (DMNH 120581); Academy of Natural Sciences Philadelphia (ANSP 344387); American Museum of Natural History (AMNH 183857); Museum of Comparative Zoology (MCZ); British Museum (Natural History); Rijksmuseum van Natuurlijke Historie, Leiden; Laboratoire de Malacologie,

Museum National d'Histoire Naturelle, Paris; University of Miami Marine Laboratory Museum (UMML 28-2812).

Name: From *calcis*, lime, and *cola*, dweller in, referring to the calcareous sediments the new species seems to prefer.

Remarks: At first I thought that *N. calcicola* should go into *Pronucula* Hedley, 1902, but I could not find any character in the new species, except lack of nacre, that was actually distinct from other species of *Nucula*. The one character that seems to set *Pronucula* off from other genera is the large smooth area surrounding the umbones, with the sculptured area coming in relatively late. Both *N. venezuelana* Weisbord, 1964, from the lower Caribbean and *N. exigua* Sowerby, 1833, in the eastern Pacific, have this feature, but no one has assigned these species to *Pronucula*. Furthermore, a species dredged by me in 45 m off Abidjan, Côte d'Ivoire, looks like a *Pronucula* with a size of 1.0 to 1.5 mm. The large prodissoconch, the arched hinge, and the teeth distant from the resilifer are all characters used by Hedley in forming his new genus. However, the largest specimen is 17 mm long, and has the characters of a typical *Nucula*. The above mentioned characters for *Pronucula* thus appear to be juvenile characters, at least in some species. Whether *P. decorosa* Hedley and its allies in Australian waters are described from immature specimens or are adults, I do not know.

The collection of 330 specimens of *N. calcicola* with a maximum size of 1.90 mm from nine localities in the western Atlantic left little doubt this was a distinct small species of *Nucula*. The only locality where a different *Nucula* was collected along with the new species was at Glovers Reef, Belize, where two specimens of another, perhaps undescribed, species were collected. Large specimens of *N. calcicola* (1.4 to 1.9 mm) were examined for signs of maturity, and in this material a thickening on the inside of the valves was noted as well as some irregularity of the inner surface. The adductor muscle scars were sunken, indicating that shell material had been deposited on the inner surface after growth had been completed. However, this is not the smallest species of *Nucula*. For instance, Powell (1939) described *Austronucula schencki* whose length was 1.15 mm, and recently Marincovich (1973) described a 1.12 mm species as *Nucula interfluc-ta*. Marincovich had more than 2,000 specimens.

The range of *N. calcicola* now extends from Courtown Cays and Serrana Bank, atolls off the coast of Central America, to Belize, to Cozumel off the east coast of Yucatan, and the Florida Keys. Far to the eastward, it is found in the Virgin Islands, and it almost certainly must live in the Greater Antilles between the two areas. It has also been collected at Bermuda.

This appears to be a very shallow-water-dwelling stenohaline species. All of the known localities are around coral reefs, in lagoons behind reefs, or where at least a few corals are living. Chancanab Lagoon, where *N. calcicola* was most abundant, is a small shallow landlocked body of water, Moore (1973), but it is connected with the open sea by a short underground passage. Several coral colonies were observed growing on rocks in the lagoon, and the other animals observed were all marine in habitat.

The greatest depth of any of the material of *N. calcicola* was 11 m in the lagoon of Courtown Cays. All of the specimens taken at this locality were rather worn separate valves making it a distinct possibility that the clams had been carried to that depth by water movement from nearby shallows. Live material was only collected in 2 m at Chancanab Lagoon; the depth range for empty valves is one to 11 m. Some of the Key Largo material (2m) was very fresh in appearance, but none were alive when collected.

N. calcicola has apparently been considered in the past to be young *N. aegeensis* Jeffreys. Our knowledge of this species in the western Atlantic stems mainly from Dall's (1886) discussion. There is a brief description of *N. aegeensis* in Dall and Simpson (1901), but it is based on the "one young left valve" found at Mayaguez, Puerto Rico, or on larger specimens in the U. S. National Museum. There is also a brief description and figure of a 2.7 mm specimen ascribed to *N. aegeensis* in McLean (1951), and another very brief description and figure in Warmke and Abbott (1961) of a specimen collected in a shallow dredging at Puerto Rico. It is not certain what species these specimens represent. It is interesting to note that Dall first (1886) reported *N. aegeensis* at a depth

range of 175 to 464 fathoms (320 to 849 m). Later, he decided that shallow water material from the shelf off North Carolina also was *N. aegeensis*. Probably this material should be reexamined.

At least a dozen Recent species of *Nucula* have been described or reported, from the Caribbean region. In the following list, the maximum reported size of the species is given, and also the known depth range in the Caribbean area. No attempt has been made to arrange the species according to the latest classification, or to provide a synonymy.

Recent species of western Atlantic *Nucula* from northern South America to the southeastern United States.

Nucula aegeensis Jeffreys, 1879	10.7 mm	9-849 m
N. tenuis Montagu, 1808	10 mm	320-823 m
N. crenulata A. Adams, 1856	6 mm	55-805 m
N. proxima Say, 1822	10 mm	2-183 m
N. cymella Dall, 1886	5 mm	375-2013 m
N. verrilli Dall, 1886	5 mm	538-3084 m
N. fernandinae Dall, 1927	4 mm	538 m
N. dalmasi Dautzenberg, 1900	6 mm	22-67.5 m
N. surinamensis Altena, 1968	4.5 mm	shallow water
N. venezuelana Weisbord, 1964	2.4 mm	shallow water
N. cancellata Jeffreys, 1881	4 mm	1610 m
N. callicredemna Dall, 1890	12.5 mm	1610 m
N. calcicola n. sp.	1.9 mm	1-11 m
N. culebrensis Smith, 1885	6 mm	715 m

There are also more than twenty Cenozoic fossil species described from various formations from Trinidad to the southeastern United States. The list as it stands may not be complete as the paleontological literature is now enormous. Again, no effort was made to revise the classification, but maximum size and presumed age are listed. *N. venezuelana* is listed again since it was originally described from the Pliocene, but the other species are apparently known only from the fossil record.

Cenozoic fossil species of *Nucula* from lands bordering the Caribbean and Gulf of Mexico are:

Nucula venezuelana Weisbord, 1964	2.7 mm	Pliocene
N. mareana Weisbord, 1964	4.4 mm	Pleistocene
N. limonensis Gabb, 1881	3 mm	? Miocene
N. moenensis Gabb, 1881	3.5 mm	? Miocene
N. tuberculata Gabb, 1873	7 mm	Miocene
N. tenuisculpta Gabb, 1873	4 mm	Miocene
N. vieta Guppy, 1867	4.9 mm	Miocene
N. baccata Guppy, 1867	7 mm	Miocene
N. orbicella Olsson, 1922	11 mm	Miocene
N. cahuitensis Olsson, 1922	3.5 mm	Miocene
N. chipolana Dall, 1898	4 mm	Miocene
N. chipolana waltonia Gardner, 1926	4 mm	Miocene
N. sinaria Dall, 1898	4.75 mm	Oligocene & Miocene
N. taphria Dall, 1898	3.8 mm	Miocene (fig. sp.)
N. prunicola Dall, 1898	6 mm	Miocene
N. tampae Dall, 1915	7.3 mm	L. Miocene
N. dasa Gardner, 1926	3.5 mm	Miocene
N. defuniak Gardner, 1926	5 mm	Miocene
N. gadsdenensis Mansfield, 1937	3 mm	Miocene
N. moratensis Woodring, 1925	4.8 mm	Miocene
N. hilli Woodring, 1925	8.9 mm	Miocene

All of the 32 other species enumerated in the two lists are distinctly larger than *N. calcicola*. The only Recent species close in size is *N. venezuelana*, but this species is only known from the northern coast of South America, is heavily sculptured, and lives in a muddy environment. However, immature specimens of one or more species could be confused with *N. calcicola*. Material of the unidentified species found with *N. calcicola* at Glovers Reef consists of two right valves, 2.2 and 2.64 mm long. This was the only station where a similar species was found along with *N. calcicola*. However, the Glovers Reef material, a 4.16 mm right valve from Hook Bank (Belize), 13 valves from 19°14′ N., 91°20′ W (max. size 2.0 mm), and six valves (max size 4.0 mm) from a depth of 113.5 m (east of Port Aransas, Texas), all agree with *N. proxima* in having a narrow elongate resilifer directed anteriorly. The shape and sculpture is similar to that of *N. calcicola*, but the resilifer of *N. calcicola* is quite different from *N. proxima* and its allies. A record of *Nucula proxima* from Panama, based on material collected by Olsson and McGinty, appears to be an undescribed species. A specimen donated to the Academy of Natural Sciences of Philadelphia is a single valve measuring about 2.3 mm in length.

There are many species in the ancient family Nuculidae, and most of these are small simple clams without strong characters setting them off from other species. Perhaps the most divergent of the genera is *Acila* with divaricate external sculpture. *Acila* is not known from the Atlantic. Species in the tropical western Atlantic range from smooth to somewhat sculptured, and have little diversity of form. Thus identification is often difficult, and this is especially true for the smaller species.

The other new species of Nuculidae herein considered are distinctive for several reasons: their extremely small size, few hinge teeth, and comparatively large sculptured and pitted prodissoconchs. They appear to be so different from other nuculids that a new genus is hereby erected to contain them.

Condylonucula *new genus*

Extremely small nuculids with a large caplike prodissoconch. The valves are inflated, well-rounded, and have concentric sculpture. The anterior end is longer than the posterior; the prodissoconch is pitted and sculptured and as much as 40% of the length of the dissoconch. Hinge teeth few in number, while the resilifer is small and more or less normal to the hinge line. There is no nacre on the interior of the shell. The adductor muscle scars are paired, roughly equal in size, and the valve margins are smooth.

Type species: Condylonucula cynthiae, new species

Name: from *condylus,* a knob on the end of a bone, referring to the prodissoconch, and *nucula,* a small nut. *Gender:* feminine.

The genus is erected for a pair of species, both new, from the western Caribbean. They are characterized by the relatively enormous pitted and sculptured prodissoconch, few hinge teeth, concentric sculpture, and smooth ventral margins. They are also smaller than any other species in the family.

Condylonucula cynthiae *new species*

Description: An extremely small species maturing at a length of about 600 μ (0.6 mm). The shell is compact, a little longer than high, and is rather thick. The prodissoconch is large, about 210 μ long, and has a large knob centrally located adjacent to the hinge line. There are two concentric ridges, an inner one about half way to the edge of the prodissoconch, and an outer ridge forming the projecting outer edge. Both ridges are best developed in the anterior and posterior areas, the inner ridge especially so on the posterior side. The surface of the prodissoconch is pitted. The anterior end of the dissoconch is well-developed, the posterior end short. The ventral margin is well rounded. About ten to twelve concentric ribs are present on the adult. There are fine concentric striae between the ribs. The interior of the shell is without nacre. Two oval adductor muscle scars are present, the ventral margin is smooth, and the hinge plate is short and broad. There are four anterior, three posterior hinge teeth in the right valve, four anterior, two posterior in the left valve. There is a slight depression or notch on the inside at either end of the hinge. The resilifer is short and almost normal to the hinge.

Name: named for Cynthia Moore, wife of the author.

Material: Holotype. Complete specimen 600 μ long, 480 μ high. USNM No. 758534.

Type locality: About 800 m west of outer reef (lagoon) Courtown Cays (Cayos del E.S.E.) in the western Caribbean off Nicaragua. Depth, 7.5 m.

Paratypes: (specimens are complete unless otherwise noted). Courtown Cays, depth 1.5 m, one 350 μ long, one (bored) 600 μ long, one 460 μ long, one 460 μ long, one 630 μ long, one broken right valve, one fragment, USNM No. 758538. Courtown Cays, depth 1.5 m, one 620 μ long, one right valve 560 μ long, ANSP No. 344388. Courtown Cays, depth 1.5 m one 570 μ long, one left valve 620 μ long DMNH No. 120580. Courtown Cays, north end, about two m, one 465 μ long, one left valve 600 μ long, one left valve 580 μ long, MCZ No. Unknown. Courtown Cays, outer reef, one m, one 630 μ long, one left valve 590 μ long. Serrana Bank, lagoon, one 590 μ long, UMML No. 28-2811.

Two specimens from Serrana Bank, one complete, one a left valve, both 600 μ long, were lost after being photographed with the Scanning Electron Microscope at the University of Illinois. Hence there were originally eighteen good specimens available for this study.

Remarks: The minute size of *C. cynthiae* makes it unlikely that it would be confused with any other species of Nuculidae except another new species (*C. maya*) described in this paper (for comparison of the two species, see remarks after the description of *C. maya*). The young of other species such as *C. calcicola* may look superficially like *C. cynthiae,* but do not have the

strongly sculptured prodissoconch or show signs of maturity.

Maturity is always a problem when studying very small mollusks. There have been many cases of a larval or immature shell being described as an adult. Externally, one should look for a differentiated prodissoconch or protoconch to be certain that the specimen is beyond the larval stage. In bivalves, indications of maturity should be looked for on the inside of the valves. The shell is usually thickened internally after reaching maximum growth, and this is often accompanied by irregularities of the inner surface. Adductor muscle scars become sunken while changes in the hinge line may also occur.

One other species in the family, *Nucula calcicola*, has been found at both Courtown Cays and Serrana Bank. At present, these two atolls (Milliman, 1969), some 250 km apart, are the only known localities for *C. cynthiae*. A number of islands, islets, and shallow banks, however, are located off Nicaragua and Honduras, and probably have other populations of the species. There is also very little information on the vertical range of *C. cynthiae*. All of the specimens were collected in quite shallow water 1 to 7.5 m deep.

Condylonucula maya *new species*

Description: This is an extremely small species maturing at a length of about 500 μ. The shell is compact, oval in shape when viewed from the side, and moderately thick.

The prodissoconch is large, 220 μ long, and has a small knob centrally located next to the hinge line. The edge of the prodissoconch is somewhat raised above the adult shell, but does not form a distinct ridge. An inner concentric ridge is extremely weak or absent on the anterior and median area of the prodissoconch, but becomes an upright projection on the posterior part. This projecting ridge is about the same height as the central knob. The surface of the prodissoconch is pitted. The dissoconch is oval in side view, and has most of the prodissoconch confined to the posterior half. The anterior end is more elongate than the posterior; both ends are rounded to about the same degree. The ventral margin is moderately well rounded, and there are about 10 to 12 weak concentric ribs.

The shell is transparent when fresh. Two oval adductor muscle scars are present; the ventral margin is smooth; and the hinge plate rather narrow. The hinge teeth number three anterior, two posterior in both valves. The resilifer is a short triangular notch beneath the prodissoconch.

Name: Named for the inhabitants of the Yucatan Peninsula.

Material: Holotype. Complete specimen 500 μ long, 380 μ high. USNM No. 758536.

Type locality: Chancanab Lagoon, Cozumel, Quintana Roo, Mexico.

Paratypes: Chancanab Lagoon, depth 2 m. Seven complete, 365, 270, 430, 530, 480, 500, and 480 μ long; one right valve 500 μ long. USNM No. 758536. One 540 μ, one 520 μ, and a right valve 480 μ long, MCZ No. Unknown. One 460 μ, one 520 μ, one 325 μ, and a left valve 500 μ long. ANSP No. 344389. One 460 μ, one 425 μ, and a left valve 445 μ long, AMNH No. 183858. One 500 μ, one 490 μ, one 380 μ, and 510 μ long. DMNH No. 120579. One 490 μ long. Fm (Field Museum) No. 198080.

Five complete specimens ranging from 470 to 510 μ long, and three separate valves ranging from 370 to 465 μ long have been kept by the author.

Arrowsmith Bank, "Gerda" Sta. 899, September 10, 1967, depth 110 to 220 m, two specimens both 520 μ long. UMML No. 28-2810.

Remarks: C. maya is clearly closely related to *C. cynthiae*. The chief differences are: in *C. maya* the prodissoconch is not as strongly sculptured, the central knob is weaker, and the dissoconch is

FIG. 1. *Interior view of right valve of holotype of* Nucula calcicola.

FIG. 2. *Exterior view of left valve of holotype of* Nucula calcicola, *length for both is 1.74 mm.*

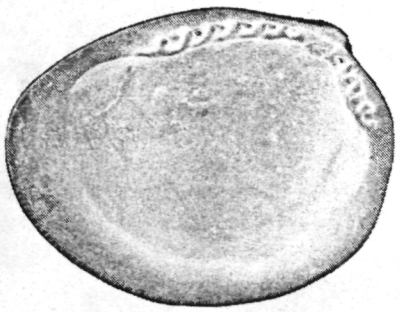
FIG. 3. *Interior view of left valve of paratype of* Nucula calcicola. *This was a large specimen, 1.9 mm long, and shows signs of old age, irregular shelly deposits on the inteior and strongly developed hinge. This specimen was later lost.*

FIG. 4. *Exterior view of right valve of holotype of* Condylonucula maya.

FIG. 5. *Interior view of left valve of holotype of* Condylonucula maya, *both 500 μ in length.*

FIG. 6. *Exterior view of left valve of holotype of* Condylonucula cynthiae.

FIG. 7. *Interior view of right valve of holotype of* Condylonucula cynthiae, *both 600 μ in length.*



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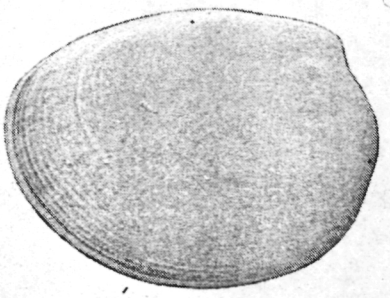

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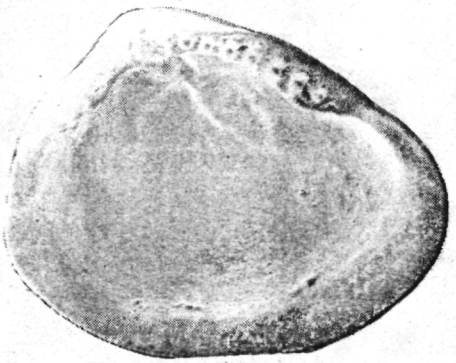

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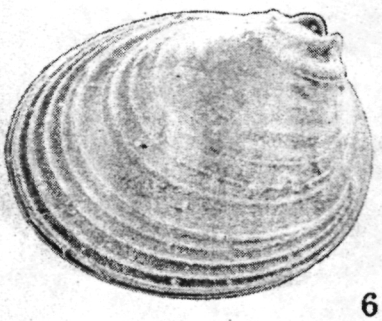

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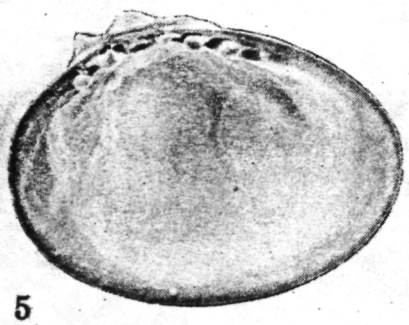

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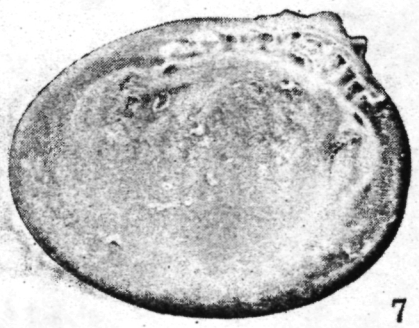

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New Nuculidae—D. R. Moore (see explanation on opposite page)

more elongate. Two representative adult specimens had the following measurements: (In each case, the percentage refers to the length of the specimen).

	Length	*Height*	*Thickness*
C. cynthiae	600 μ	480 μ	380 μ
	100%	80%	63%
C. maya	520 μ	390 μ	280 μ
	100%	75%	54%

Another comparative feature is the concentric sculpture. It is stronger in *C. cynthiae*, and this species also has fine concentric striae between the ribs.

C. maya is presently known only from Cozumel and Arrowsmith Bank, some 34 km to the NNE of Cozumel. The examples from Cozumel are all from a depth of two m. The Arrowsmith Bank specimens were collected dredging up the steep slope of the side of the bank. They were probably in sediment that poured over the edge of the bank, and, if so, must have been living at a depth of 25 to 35 m.

It is interesting that all known specimens of the two species have been found at atolls or shallow banks, and not on the continental shelf. I have recently examined reef sediment samples from Belize. These samples were taken from continental shelf reefs, and while rich in micromollusks, did not contain any *Condylonucula*.

Other species of bivalves slightly less than a millimeter in length have been described. Usually, these descriptions have been based on very scanty material, often dredged, and little has been done since to ascertain whether these are truly mature specimens or only partially grown. The smallest of these appears to be *Cuna gemmula* Turton, 1932, from South Africa described as fully grown at 0.5 mm. There was only one quite transparent valve which was supposed to be quite similar to *C. concentrica* Bartsch, 1915, but not so pointed at the top! It is hardly necessary to point out that the validity of this species is extremely doubtful.

There are signs of maturity to look for in bivalves. These are: thickening of the shell, sunken adductor muscle scars, rugosity of the interior surface, thickening of the hinge line, and, sometimes formation of denticles along the ventral margin. Even with these guides, one must exercise caution, as there is considerable variation in the appearance of the adult from one species to another. It is best to have a series of specimens, preferably from more than one locality, so that morphological changes from sub-adult to adult can be observed. These changes are sometimes dramatic although the maximum dimensions of the shell may be almost unchanged.

SUMMARY

The three species herein described present quite a contrast. *Nucula calcicola* is ubiquitous in the Caribbean and adjacent areas, while the two species of *Condylonucula* appear to be confined to two small areas in the western Caribbean. All three species, however, have only been found in calcareous sediments. Information is usually lacking on ecological requirements of species, but Hampson (1971) has shown that *N. proxima* Say lives in fine to medium quartz sand, and that the similar appearing *N. annulata* Hampson lives in muddy areas.

N. calcicola has been found in back reef to stenohaline inshore areas in quite shallow water. The depth range of the present material is one to 11 m, but live or fresh material has only been found at two meters. *C. cynthiae* has been found only in back reef and lagoonal deposits from one to 7.5 m in fairly coarse sediments. *C. maya* has been found in 2 m in quiet water and at 25 to 35 m (dead material from steep slope). It may well be a deeper water species that shuns the turbulent water of shallow reefs. Chancanab Lagoon, however, provides a quiet environment with oceanic water, and this seems to prove an acceptable niche for *C. maya*. Chancanab sediments are much finer than those in which *C. cynthiae* are found.

The three species have a number of characteristics in common. They are very small (two are the smallest known bivalves), and are rather similar in appearance. They are stenohaline and tropical in distribution. They live in quite shallow water, and in areas with calcareous sediments. Thus their ecological requirements are similar to those of hermatypic reef corals. The

two species of *Condylonucula* especially seem to be confined to a very narrow range of physical conditions. Their very limited geographic range may signify a very brief planktonic larval stage, or none at all.

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VARICORBULA CHOWANENSIS A NEW SPECIES (BIVALVIA: MYACEA) FROM THE PLIOCENE OF NORTH CAROLINA

Richard H. Bailey

Dept. of Earth Sciences
Northeastern University
Boston, Mass. 02115

ABSTRACT

Varicorbula chowanensis n. sp. occurs in the late Pliocene deposits along the Chowan River of northeastern North Carolina. This is the first report of the genus in the Neogene Chesapeake Group of Virginia and North Carolina.

Late Pliocene deposits along the Chowan River in northeastern North Carolina contain diverse molluscan assemblages that are indicative of shallow shelf and estuarine environments. Within these assemblages the family Corbulidae is represented by *Caryocorbula inequalis* (Say), *C.* cf. *conradi* Gardner, and *Varicorbula chowanensis* n. sp. The genus *Varicorbula* has not been reported from well-exposed late Miocene and Pliocene strata of the Chesapeake Group of Virginia and northern North Carolina; however, specimens of *Varicorbula*, labeled *V. caloosae* (Dall), from the Pleistocene Waccamaw Formation of southeastern North Carolina are in the collections of the United States National Museum.

Varicorbula is unique in that it exhibits the inequivalved condition of the Corbulidae to a very high degree. The right valve is extremely convex and bears coarse concentric rugae. The smaller left valve is flatter and bears concentric growth lines crossed by irregular radial riblets. Yonge (1949) demonstrated that *Varicorbula gibba* (Olivi) lives with the plane of the commissure vertical despite the asymmetry of the valves. He suggests that the large overlap of the valves may allow the animal to compress water in the mantle cavity periodically to expel pseudofeces. The inhalent siphon of *V. gibba* is flush with the sediment surface so that when the clam is actively pumping, large quantities of fine sediment, along with diatoms, bacteria, and organic detritus are carried into the mantle cavity (Yonge, 1949). In order to utilize such a food resource *Varicorbula* needs an effective mechanism to dispose of the sediment accompanying the food. *Varicorbula chowanensis* also lived in bottoms consisting of