



THE NAUTILUS

THE PILSBRY QUARTERLY
DEVOTED TO THE INTERESTS OF CONCHOLOGISTS

EDITORS AND PUBLISHERS

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\$4.25 per year (\$4.75 to Foreign Countries) \$1.25 a copy.

Mrs. Horace B. Baker, Business Manager
11 Cheltenham Road, Havertown, Pennsylvania 19083

Second-Class Postage paid at Spring House, Pa.

NAUTILUS:

A Quarterly Journal devoted to the study of Mollusks, edited and published by HORACE B. BAKER, CHARLES B. WURTZ and R. TUCKER ABBOTT.

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THE NAUTILUS is the official organ of the American Malacological Union. Information regarding membership in the Union may be obtained from Mrs. Margaret C. Teskey, Secretary, Route 2, Box 318, Marinette, Wisconsin 54143.

BACK ISSUES: Vols. 3-70, if available, can be obtained from KRAUS PERIODICALS, INC., 16 East 46th Street, New York, N. Y. 10017. Vols. 71 to date are available from the NAUTILUS, 11 Cheltenham Road, Havertown, Pennsylvania 19083, and vary in price.

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JULY, 1968 to APRIL, 1969

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PONY PRINTING, UPPER DARBY, PA.

THE NAUTILUS

Vol. 82

July, 1968

No. 1

SEXUAL DIMORPHISM IN *POLINICES LEWISI* (NATICIDAE)

By F. R. BERNARD

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Sexual dimorphism of the gastropod shell usually is limited to size differences. Gallien and Larambergue (1938) found that in the marine littorinid *Lacuna pallidula* [da Costa] females are more than twice the size of males. Quick (1920) showed that in the brackish water hydrobiid *Paludestrina stagnalis* [= *Hydrobia ventrosa* (Montagu)] the female shell spire is longer and more tumid than the male's. Cotton (1905) reported that the relative width of *Strombus pugilis alatus* (Gmelin) is greater in females than in males. Cotton's difference is small and its validity is doubtful, judging from his statistically insignificant sample. Analysis of Goodrich's (1944) measurements of the same species from Sanibel Island failed to show bimodal distribution of the relative width. Abbott (1949) working with Indo-Pacific *Strombus gibberulus* (Linné) and *Strombus flammeus* Link [= *S. mutabilis* Swainson], found that on the average males are smaller than females, though overlapping of the size ranges is so extensive that shell length cannot be used as an index to sex. Abbott (1961) showed that for *Lambis lambis* (Linné) males are from 30 to 45 per cent smaller than females and have a different sculpturing and that these differences are most pronounced in the central parts of its range, decreasing on the eastern and western limits.

Polinices lewisi (Gould) of all sizes from a population in Departure Bay, British Columbia, Canada, were sexed and measured. Annual check-marks or others age indices are not present in this species but because it has a seasonal breeding pattern and yearly recruitment is not uniform, one can infer the age structure of the population by means of size-frequency distributions.

Sheldon (1967) found that for *Crepidula fornicata* (Linné) the shell weight and age relationship is linear between ages 2 and 8 years. For *P. lewisi* this relationship is curvilinear, with the male curve being more pronounced. While linear growth decreases with

advancing age, the shell is continuously thickened from within. Calculation of the total weight/shell ratios of 1,875 specimens of *P. lewisi* gave a statistically significantly mean of 0.472 for the males and 0.401 for the females (see Fig. 1). Means are for the entire population comprising all size groups. Dimorphism is much more pronounced in the largest individuals, around 360 gm. total weight. For the 270 gm. total weight group the mean is 0.499 for the males and 0.411 for the females.

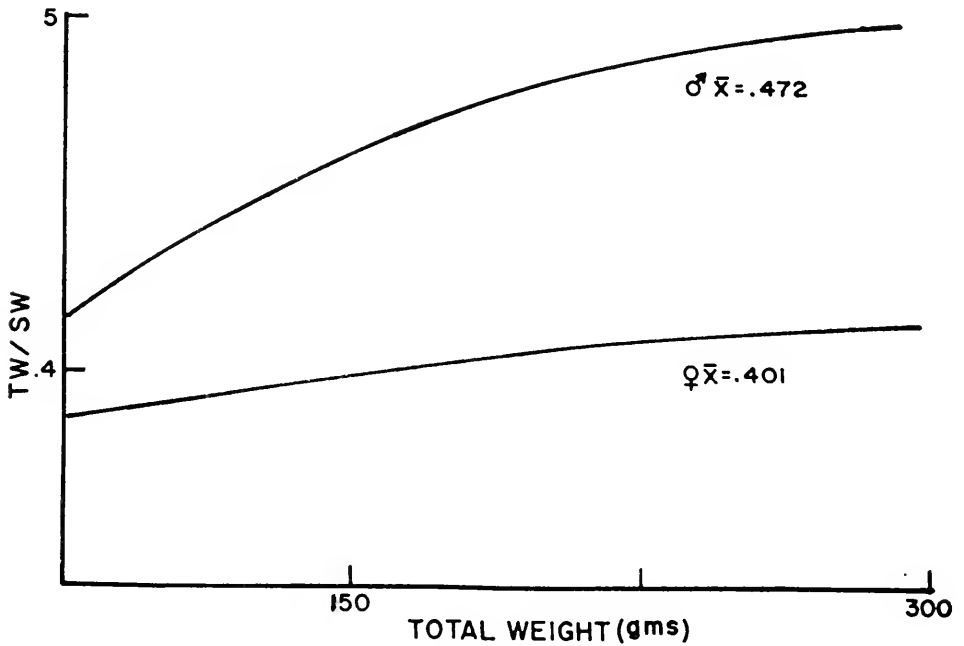


Figure 1. The total weight/shell weight ratio (TW/SW) of 1875 male and female *P. lewisi*. The mean curve of the graph was fitted by eye. The means (\bar{X}) for each sex is shown to the right of the curve.

Abbott (1949) found that in *Strombus gibberulus* and *S. flammeus* males are fewer than females, which comprise 60% of the population. The same situation is present in *P. lewisi*; of the total population only 38% is male. An interesting fact is that if the ratio is calculated for each size-group the disproportion of males is seen to increase with age. For small animals (total weight less than 50 gm.) the sex distribution is equal. In the largest group (total weight more than 270 gm.) only 15% of the population is male. There are two probable causes for decrease in the proportion of males as growth proceeds; the apparent 'telescoping' of males to junior size classes, due to a slower growth rate, and a different rate of mortality, male *P. lewisi* living on an average only $\frac{2}{3}$ as

long as females.

Measurement of small samples of *Natica clausa* Broderip and Sowerby and the Atlantic *Polinices heros* (Say) indicate similar shell differences. Further study is needed to determine whether sexual dimorphism is general in the Naticidae.

It was found that the shells of males, particularly the older ones, were proportionately thicker than those of same size females.

The author wishes to thank Dr. R. Tucker Abbott for his helpful suggestions and criticism of this paper.

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NOTE ON ECOLOGY OF GONIOBASIS PROXIMA IN NORTH CAROLINA

BY BRUCE Z. LANG

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An ecological study on a small leaf-choked stream (250 meters long, 0.3-1.0 m. wide, and 1-11 cm. deep) near Chapel Hill, North Carolina, indicated that *Goniobasis proxima* (Say) contributed 68% of the total biomass (dry weight) of the macrofauna present. In the stream, snails were observed on sand and silt substrates, leaves, and rocks. All *G. proxima* randomly sampled (132) had a positive correlation ($r = 0.613$) with silt volume from the samples. Snails which were 5 mm. and over in size (width at widest point of shell) gave a strong correlation with silt ($r = 0.656$), while smaller snails, 2 mm. and under, had no significant corre-

lation with silt ($r = 0.123$). Some aspects of the habitat selection of smaller snails differ from that of larger (older) snails. This is indicated by their preference for a clean, sandy substrate and their low correlation with bottom silt. Crutchfield (1966) has reported on positive rheotaxis in *G. proxima*; however, size categories were not indicated for his marked snails. He concluded that this orientation response has possible survival value for *G. proxima*. Whether snails of different size groups vary in their rheotaxis behavior remains to be seen.

No obligatory stream organism was found preying on *G. proxima*. From intestinal analyses and field observations on larger snails, apparently the main food source is dead leaves. The stream is choked with dead leaves throughout the year and food is no problem for the larger snails. This may explain the large biomass of this species as compared to other obligatory stream organism present in the samples. The main foodstuff for the smaller snails was not determined. Small snails (2 mm. and under) are usually found in the sand and could be eating algae, fungi, or bacterial organisms growing on sand grains and gravel.

Twenty-five percent of the sampled snails (23/132) contained larval trematode infections. These were identified as *Metagonioides oregonensis* (Lang and Gleason, 1967), and *Mosesia chordeilesia*. An unidentified member of the family Lecithodendriidae was also present. These parasites would constitute a fairly sizeable biomass, but the effects on the snail population are unknown. Snail collections for several years (1961-1963) above and below the study area revealed a marked seasonal fluctuation in infections with *M. oregonensis*. These snail collections were not random, and over 2000 specimens were collected. Infections were highest in winter (23%, 39.2%, and 52.7%) and lowest in spring (14.4% and 17.6%).

The trophic structure of the stream is based on animals that can feed on organic detritus. With the exception of *G. proxima*, the primary consumers are particulate feeders. Therefore, the energy stored in dead leaves is not available to them until it has been softened by water, bacteria and fungi, and broken up by the action of feeding snails and current flow. Feeding by the snails breaks up some of the leaves, hastening the action of the decomposers, and also makes energy available to the particular feeders

via fecal strings and leaf fragments. Since snails appear to be the only primary consumers which can feed directly on whole leaves, we might expect them to contribute a large biomass to the total standing crop. Only a small portion of leaf energy is being utilized by the stream community. The snail population, along with the microdecomposer populations, may be responsible for making energy available to other members of the community.

Teal (1957) reported that the most important source of energy for the spring community he studied was leaves. This is the case in the stream community considered here. The stream community is a relatively open system in that organic material is passively brought into the system in the form of leaves, litter, and wood fragments.

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DISTINCTION BETWEEN *CONUS JULIAE*, *C. DAUCUS* AND *C. BRASILIENSIS*

BY J.-J. VAN MOL AND B. TURSCH
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During a recent review of Brazilian Conidae (1), our attention was called upon the problem of the distinction between three somewhat similar species of west Atlantic cones: *C. daucus* Hwass in Brug., *C. juliae* Clench and *C. brasiliensis* Clench. The difficulty might not appear dubious unless one has seen series of *C. brasiliensis*. Therefore, it is to be stressed that the holotype of this species is rather untypical of the majority of the shells and that its color pattern seems restricted to shallow-water specimens from the coast of Espiritu Santo. *C. brasiliensis* presents a remarkable variability in its coloration and is frequently of the same nearly uniform reddish orange hue as *C. daucus* and *C. juliae*.

Although the distinction between *C. daucus* and *C. juliae* is quite easy from the radulae (2) and the external shape (higher spire and rather inflated body whorl for *C. juliae*); gross con-

chological features are sometimes not sufficient to discriminate *C. brasiliensis* from young *C. juliae*. Radulae of the two species are somewhat different (1), but the real significance of the minor variations observed is not really clear to us. The problem cannot be satisfactorily solved on the basis of geographical data since all the three species have common West Indian localities (Puerto Rico).

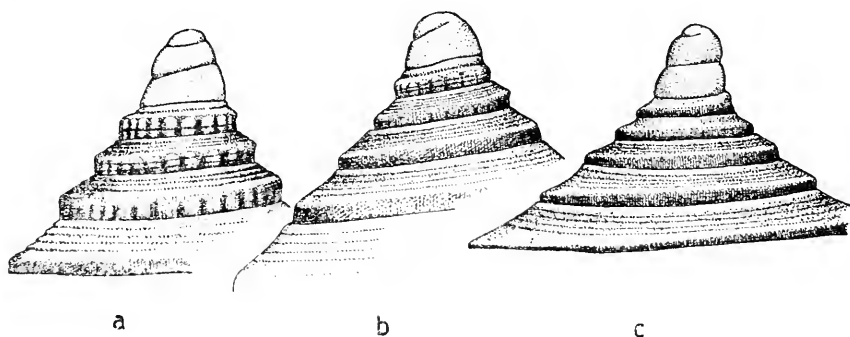


Figure 1. Apex of a: *Conus juliae* b : *C. brasiliensis* c : *C. daucus*.

A convenient criterion can be found by examination under magnification of the first whorls of the spire.

C. juliae (fig. 1a).* Nucleus : 3 whorls. Important axial sculpture on the sides of the three first postnuclear whorls, weakening progressively.

C. brasiliensis (fig. 1b). Nucleus : $1\frac{3}{4}$ whorl. Occasionally a few axial ribs on the sides of the first postnuclear whorls.

C. daucus (fig. 1c). Nucleus : 3 whorls. No sculpture on the sides of the whorls.

Our general observation on Brazilian Conidae has been that the microsculpture of the first postnuclear whorls is a constant character. It is particularly useful in the present cases, although it is naturally available only in perfect fresh specimens.

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G. L. Warmke, Nautilus, 73, 119, 1960.

* This description is based upon two intact specimens of *C. juliae* kindly lent to us by Dr. R. T. Abbott (A.N.S.P. 209733, 40 fath., 120 mi. E.N.E. from Alacran, N. of Yucatan; no. 234389, 50 fath. off Palm Beach, Florida).

OCCURRENCE AND DISTRIBUTION OF NEW JERSEY OPISTHOBRANCHIA

BY DAVID R. FRANZ

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The coastline of New Jersey, as well as that of other Middle Atlantic states, is characterized by extensive sand beaches, salt marshes, shallow bays and estuaries. The paucity of opisthobranch faunal records, in an area heavily collected by both amateur and professional malacologists over a period of many years, suggests that the fauna is small. However, studies in other regions with similar types of habitats have shown that systematic and diligent collecting may reveal many new records. This is exemplified by the collections of H. G. Wells (Marcus, 1961) from North Carolina and Swennen (1961) in the Netherlands. I hope that the following brief list of published and unpublished records will stimulate malacologists to undertake a more thorough examination of the New Jersey fauna.

Elysia chlorotica Gould.

Occurrence: Great Egg Harbor, 1873 (Verrill and Smith); Cheesequake State Park, 1965 (K. Clark - pers. comm.); Shark River Inlet, 1965 (pers. record). Further distribution: Minas Basin, N. S. (Bailey & Bleakney, 1967) at least as far south as Chesapeake Bay (Pfitzenmeyer, 1960).

This attractive species was collected from *Zostera* by Verrill and Smith. I have observed it on the open surface of a mud-flat at low water as well as feeding on the alga *Cladophora* sp.

Elysia catulua (Gould).

Occurrence: Great Egg Harbor, 1873 (Verrill and Smith); Barnegat Bay, 1965 (F. Phillips, Rutgers University - pers. comm.) Further distribution: Massachusetts to New Jersey (Johnson, 1934).

Very little is known of the biology of this species. Both of the above records were taken from *Zostera*.

Doridella obscura Verrill.

Occurrence: Great Egg Harbor, 1873 (Verrill and Smith); Raritan Bay, 30 VI. 1958 (D. Dean - Rutgers Univ. Coll.); Delaware Bay, 1965 (pers. record). Further distribution: This species is now known from the entire east coast of the United States from Vineyard Sound to the Gulf of Mexico. (Franz, 1967).

Polycerella emertoni Verrill.

Occurrence: Barnegat Bay near Beach Haven (record in Chambers, 1934). Further distribution: originally described from Woods Hole, Massachusetts, it is known from Newport, R. I. and New Haven, Connecticut.

Polycerella conyma Marcus.

Occurrence: Jarvis Sound, Cape May, X. 1965 (pers. record). Further distribution: Sau Paulo, Brazil; Virginia Key, Florida (Marcus, 1957, Marcus and Marcus, 1960); Mississippi City, Mississippi (collected by Mr. Leslie Hubricht, IX. 1967).

Five specimens were scraped from pier pilings. The adults appeared to be feeding on the bryozoan *Bowerbankia gracilis*, and many egg masses were present, attached to *Mytilus*. Marcus (1957) and Marcus and Marcus (1960) refer to the appearance of the living animal but the figures are somewhat sketchy and in one case based on the preserved slug. For this reason, a description of the New Jersey animals is included here. Measurements of the two largest slugs were as follows: length (mm.) — 3.34, 3.32; width — 0.85, 0.64; rhinophores — 0.58, 0.64; large papillae — 0.51, 0.58. The 3 pinnate branchiae (Fig. 1) are located mid-dorsally. They are erect and directed slightly posteriorly. The shaft of each branchia bears 3 to 6 triangular lamellae per side. Generally, the lamellae are opposite each other on each side of the shaft. Other small papillae may occur on the branchiae. In most specimens, the median branchia is somewhat smaller than the laterals but this is variable. The shafts are colorless but the lamellae appear yellow.

The simple, contractile, colorless rhinophores arise close to each other and range in length from 1 to 1.5 times the length of the branchiae.

Dorsally, the head appears subtriangular and sometimes notched in front. The sides of the head from a ridge (pallial ridge) which gradually fuses with the body contour in front of the branchiae (Fig. 1). Along the side of the head, the pallial ridge forms several low angular projections. At the level of the branchiae, the presence of the ridge is indicated by a series of small papillae which continue to the tail. In addition to these, there are two pairs of larger papillae; one pair located just behind the branchiae and a much smaller pair near the tail. (Fig. 1). These larger papillae are

located medial to the pallial ridge but may be connected to it by a series of very small papillae. A median, unpaired papilla occurs on the dorsal surface of some animals, sometimes in front, sometimes behind the branchiae.

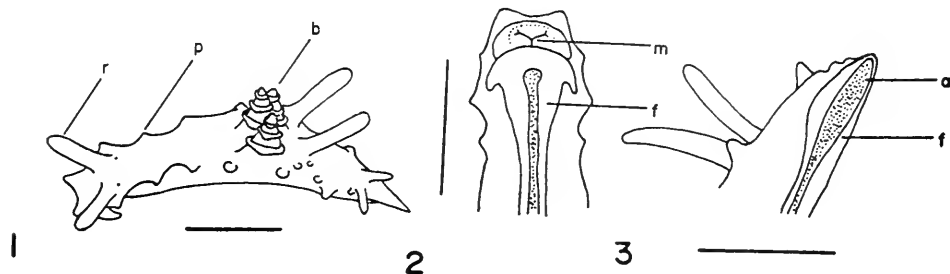


Fig. 1. *Polycerella conyma*, left dorso-lateral view of living animal. r, rhinophore; b, branchia; p, pallial ridge. Fig. 2. Anterior end, ventral view, m, mouth; f, foot. Fig. 3. Posterior end, left ventro-lateral view. f, foot, a, adhesive disc. Scale in all figures equals 1 mm.

On the ventral surface, the foot is very narrow, widening anteriorly (Fig. 2). It is prehensile over its entire length. At its posterior end (Fig. 3) the foot expands somewhat to form an adhesive disc. The oral tentacles are small, simple and bluntly rounded.

The animal is translucent and the entire body is more or less evenly covered with minute yellow pigment spots which are denser on the dorsal surface and on the tips of the papillae. In addition to the yellow coloring, the body is lightly peppered with groups of black pigment spots. The effect of the black and yellow coloration is to give the animal a greenish hue. The rust-colored hepatopancreas is evident through the integument in the posterior half of the body. The large papillae are devoid of any coloration.

The occurrences of this species close to the type localities of both of the other two known members of this genus, *P. emertoni* Verrill and *P. davenportii* Balch, makes it imperative that the taxonomy and biology of all 3 species be examined in order to establish their identities. Differences among the 3 described forms are discussed by Marcus (1957) and Marcus and Marcus (1960). *P. emertoni* was not figured by Verrill and its external appearance must be surmised from the description. The only other taxonomic information available is Bergh's anatomical analysis (1883). *P. davenportii* is inadequately described and, to the best of my knowledge, has never been rediscovered. Consequently, the conclusions drawn con-

cerning the taxonomic identity of these two species and *P. conyma* Marcus must be considered tentative at best and the possibility that we are dealing with only two, or even a single species cannot be ignored.

Cratena pilata (Gould).

Occurrence: Delaware Bay, VIII & X. 1965. (pers. record); Barnegat Bay, 1965 (F. Phillips - pers. comm.). Further distribution: New England states to North Carolina. This species may be the one identified only as "cuthonidae" by Cory (1967) from the Patuxent River, Maryland.

In New England and North Carolina, *C. pilata* has been observed feeding on the hydroid *Pennaria*. In Connecticut and New Jersey, I have always found it in association with *Tubularia crocea*. *Tenellia fuscata* (Gould).

Occurrence: Barnegat Bay (record in Chambers, 1934); Shark River, 13. X to 13. XII, 1961 (pers. record); Delaware Bay, VIII. 1967 (G. Hendler, Rutgers University - pers. comm.). Further distribution: Maine south through the New England states to New Jersey. The *Tenellia* sp. reported by Cory (1967) from the Patuxent River, Maryland, is probably this species.

Chambers reported this species feeding on the bryozoan *Amathia dichotoma* (= *vidovici*). At Shark River, I found it on *Obelia geniculata* and in Connecticut it is most commonly associated with this species.

The taxonomic characteristics which separate this species from the closely related European form, *T. pallida* (Alder & Hancock), are the possession of an unarmed penis and a hermaphroditic valve. This is based on Chambers' (1934) study of the reproductive system of New Jersey slugs. Since, however, the species is described from Massachusetts and no comparative studies have been made on animals from there, it is possible, although unlikely, that the New England form may be *T. pallida* or even another species. Since *T. pallida* is now known to occur in the New World on the coast of Brazil (Marcus, 1960) it is important that the Massachusetts animal be re-examined.

Tergipes despectus Forskal.

Occurrence: Shark River, 2. XI. 1961 (pers. record). Further distribution: Arctic seas to New Jersey on this coast; eastern atlantic from England south to the Mediterranean; the Black Sea.

The single animal at Shark River was found in company with *Tenellia*.

Aeolidia papillosa (Linné).

Occurrence: Shark River, VIII. 1964 (pers. record). Further distribution: North Atlantic south to Portugal; on the American coast from eastern Canada to Ocean City, Maryland, and from Alaska to southern California; Japan.

The range extension of this species, as well as another boreo-arctic species, *Acanthodoris pilosa*, as far south as Maryland (Marcus, 1961) may be facilitated by the colonization of man-made jetties.

Doto coronata (Gmelin).

Occurrence: Great Egg Harbor, 1874 (Verrill and Smith). Further distribution: Bay of Fundy to New Jersey on this coast; Europe from the Scandinavian states to France and the Mediterranean.

DISCUSSION

Any zoogeographic conclusions based on the above records are bound to be tentative because of the preliminary state of our knowledge. Nevertheless, a few generalizations may be suggested. The New Jersey fauna represents a southern extension of the New England fauna. Of the 10 species, only one, *Polycerella conyma*, is not derived from the north although, admittedly, the origin of *Doridella obscura* cannot be determined. The major barrier preventing a larger representation of northern faunistic members is probably the change from a predominantly rocky shore to the sandy-muddy coast of New Jersey. Indirect evidence for this is the shift in the composition of the fauna. Thus, the Doridacea make up about 30 percent. of all New England species of nudibranchs and sacoglossans (excluding the pelagic nudibranchs *Fiona* and *Scyllaea*). Of the 9 New England species which occur in New Jersey, only two are dorids and both of these are species not closely associated with the rocky shore. Thus, the rocky shore New England forms exemplified by species of *Onchidoris*, *Acanthodoris*, *Ancula* and *Polycera* are absent in New Jersey.

Despite the overall similarity in physiography of the New Jersey and North Carolina coasts, their opisthobranch faunas are unrelated. Of the 16 species of North Carolina sacoglossans and nudibranchs, only *Doridella obscura* and *Cratena pilata* occur in

New Jersey. Rather, the North Carolina fauna is related to the tropical faunas of North and South America. Thus, 17 percent of the North Carolina species also occurred in a collection of opisthobranchs from Miami, Florida (Marcus and Marcus, 1960) and 62 percent are known from middle Brazil (Marcus, 1961). Further, the composition of the fauna is entirely different in that 50 percent of the nudibranch and sacoglossan species are dorids. Of these, only the ubiquitous *Doridella obscura* occurs in New Jersey.

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GONIOBASIS CURREYANA LYONI, A PLEUROCERID SNAIL OF WEST-CENTRAL KENTUCKY

BY DAVID BICKEL

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A heavily ornamented form of *Goniobasis* occurs in northern headwater streams of the Rough and Nolin River drainages in Kentucky. Populations are present in some spring streams of the area that empty directly into the Ohio River. It is the *Goniobasis* sp. discussed by Minckley (1962, 1963) in an ecological survey of Doe Run in Meade County, Kentucky. This animal is *Goniobasis lyoni* Lea, 1863, a species that Tryon (1865) placed in the synonymy of *Goniobasis glauca* (Anthony). It was subsequently transferred along with *G. glauca* to the synonymy of *Goniobasis athleta* (Anthony) by Tryon (1873), and Goodrich (1940) shifted it to the synonymy of *Goniobasis laqueata* (Say). *Goniobasis lyoni* is a form of *Goniobasis curreyana* (Lea) and is distinct enough to merit recognition.

Description. Lea (1863, p. 266) gave a sufficient description of the holotype of *Goniobasis curreyana lyoni* (Fig. 2) but the specimen is further characterized by having:

Measurements of holotype, USNM. 119147. Total height 23.1 mm., aperture height 8.0 mm., aperture width 5.1 mm., number of whorls, 9+.

Total shell height about 3 times aperture height; juvenile whorls ornamented and flattened, adult whorls slightly convex; body whorl convex, not distinctly rounded or protruded beyond spiral angle; first 5 to 6 apical whorls with a carina on lower third of whorl surfaces; juvenile whorls plicate, plicae indistinct on sixth to seventh whorl; first 3 whorls with 4 striae, two equally spaced above the carina, one atop carina, one below carina; fourth and fifth whorls with four equally spaced striae above carina; sixth whorl with all striae equally spaced; striae merge into pattern of irregular wrinkles on adult whorls; body whorl without sculpture; periostracum light greenish brown, upper third of whorl surfaces light brown.

Body whorls of other specimens vary from rounded to slightly convex. Egg masses of populations in Doe Run and Otter Creek are plano-convex, 1.3 - 2.0 mm. in diameter, and partly covered

with fine sand grains. Masses are deposited singly, although rare adjacent capsules seem to share the same external cover (Fig. 4). Each packet contains from 3 to 18 individual eggs, with most capsules having about 6 eggs. Minckley (1962) reported larger numbers of eggs per mass (up to 27 per capsule).

Lea gave only Grayson County, Kentucky, as the locality. The type locality is here further restricted to Spring Fork Creek (Short Creek on some maps), Grayson County, Kentucky. Spring Fork Creek is the first large southern tributary of Rough River downstream from the Falls of Rough River. The holotype resembles material from this stream quite closely.

Goniobasis curreyana s. s. is part of a large group of (*Melasma*) pleurocerids characterized by *Goniobasis laqueata*. *Goniobasis curreyana lyoni* can be distinguished from typical *G. laqueata* by the well developed ornamentation pattern just described, carinate juvenile and early adult whorls, and the tall spire with its greater number of whorls (11). The profile of *lyoni* is like that of *G. curreyana* and both have similar variations in whorl shape and proportions. This relationship is obscured by the large plicae on *G. curreyana*. Shell sculpture is identical to the pattern on *G. curreyana*. However, plicae on *G. curreyana lyoni* are low and rounded whereas those on *G. curreyana* are high and sharp. Striae are raised and often present on the adult whorls of *G. curreyana lyoni*, while *G. curreyana* has fine hair-like spirals confined to its juvenile whorls. The prominent carina of *G. curreyana lyoni* is absent or only partly developed on the apical whorls of *G. curreyana*. The aperture on *lyoni* is similar to that of *G. curreyana* but is generally slightly wider in proportion to height than is the aperture of the latter. Shells from Doe Run and Otter Creek have very slender spires and single broad color bands. They are often heavily ornamented, with the pattern extending onto body whorls (Fig. 1). Lightly sculptured upstream populations superficially resemble *Goniobasis semicarinata* (Say) rather than any species in the group of *Goniobasis laqueata*. Egg mass characteristics confirm its position in the *Goniobasis laqueata* group.

Two paratypes (USNM. 668553) of *Goniobasis viridicata* Lea, 1863 were compared with the type of *G. lyoni* and the other material at hand. This name is a synonym for *G. curreyana lyoni* and these paratypes, although smaller, are similar to my specimens

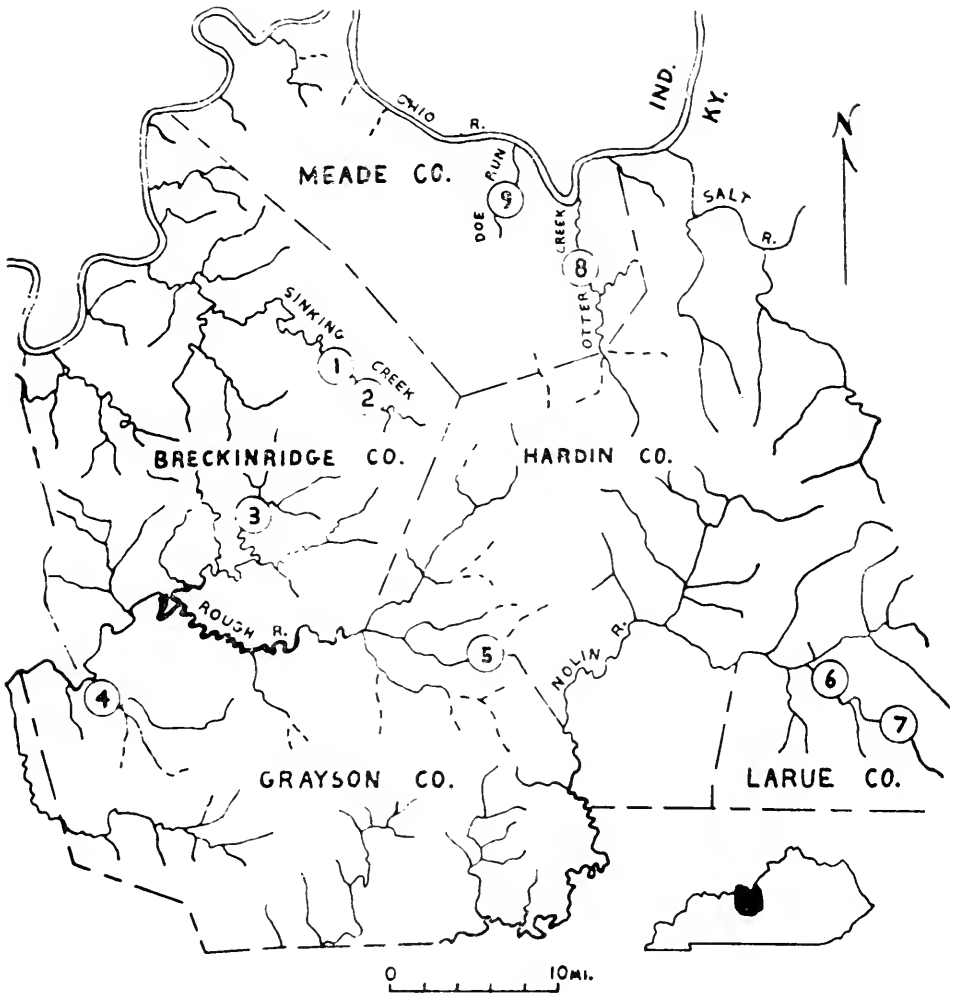


Fig. 5. Localities of *Goniobasis curreyana lyoni* Lea. Breckinridge Co.: (1) Sinking Creek 2.2 mi. NW. of Rosetta, (2) Sinking Creek at Rosetta, (3) North Fork of Rough River (Lost Run) 1.2 mi. SE. of Westview. Grayson Co.: (4) Spring Fork of Rough River at Ky. Rt. 736, (5) Meeting Creek 2.3 mi. NW. of Big Clifty. Larue Co.: (6) South Fork of Nolin R. 2 mi. SW. of Hodgenville, (7) South Fork of Nolin R. at Buffalo. Meade Co.: (8) Otter Creek at Ky. Rt. 1638, (9) Doe Run 4 mi. SE. of Brandenburg.

from Meeting Creek in Grayson County.

Distribution. *Goniobasis curreyana lyoni* occurs in tributaries of Rough River and Nolin River, Kentucky (Fig. 5). The form is abundant in three streams, Sinking Creek, Doe Run, and Otter Creek, that flow directly into the Ohio River in Breckinridge and Meade Counties. It is probably present in other northern tributaries of Green River and southern tributaries of the Ohio River. This distribution range is flanked on the east by the Salt River drainage, which is inhabited by *Goniobasis semicarinata*, *Lithasia*

obovata, and *Pleurocera acuta*. To the south it is bounded by the larger streams of the Green River system that are inhabited by *Goniobasis curreyana*, *Pleurocera canaliculatum*, and several forms of *Lithasia obovata*. *Goniobasis laqueata* occurs in southern tributaries of Green River. Apparently the Ohio River limits its northward distribution.

This subspecies is the most northern representative of the *Goniobasis laqueata* group. The group as delineated by Goodrich (1940) is distributed throughout the Cumberland and Tennessee River systems and associated streams, as well as the Green River system.

Ecology. *Goniobasis curreyana lyoni* lives in shallow areas of permanent headwater streams. It is commonly found on firm surfaces in riffle areas but is more abundant in shallow spots near shore where water is in motion although slow moving and less turbulent. The water in such partially protected situations is often 2 to 3 in. deep and the bottom is usually silt, or rock covered with a thin silt layer. Minckley (1963) reported densities of 243-329 individuals per square foot with an average of 296 per square foot during his study of Doe Run. He noted even higher densities in vegetation beds. Several of the localities discussed here, such as Sinking Creek and Spring Fork Creek have low stream velocities, and the Spring Fork Creek station has a mud bottom. Egg masses are deposited on the undersides of stones near shore and occasionally on the shells of living snails. Eggs are abundant during April in Otter Creek and Minckley (1962) found masses in Doe Run from July through September as well as during October, January, and April.

The shells in some portions of Doe Run are heavily encrusted with marl, and Minckley (1962) suggested that living snails were killed by marl accumulations. Examinations of over 200 heavily covered living snails showed that shell growth apparently keeps ahead of carbonate accretion and the thickest deposits occur on older portions of shells. Movements of these snails in their habitat appear to be unhampered by calcium carbonate accumulations just as movements of many other pleurocerids seem unaffected by thick masses of algae, marl, or nondescript material on shell exteriors. John G. Anthony (1858) during the summer of 1853 observed pleurocerids heavily encrusted with marl while collecting

from Caney Fork of the Cumberland River. He remarked (p. 82):

"I found every specimen in a small run, enveloped with a thick deposit of calcareous matter, so that they looked like slender hazel nuts — the deposits being probably three or four times the weight of the nucleus, the enclosed *Melania*. Not a particle of the shell was visible, yet the animal within was alive, and apparently as well circumstanced as a *Melania* ought to be."

Acknowledgements. I wish to thank Dr. Joseph Rosewater of the U. S. National Museum for arranging the loan of Lea's types. Mr. Edwin H. Bickel provided valuable field assistance.



Fig. 1. A large specimen of *Goniobasis curreyana lyoni* from Doe Run, whitened to show heavy sculpture. Fig. 2. Holotype of *Goniobasis lyoni* Lea, 1863 (USNM 119147). Fig. 3. Specimen from Spring Fork Creek, All 1.5x. Fig. 4. Two egg masses from Doe Run (15x).

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THE SYSTEMATIC POSITION OF GLYPTAESOPUS

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During the course of a taxonomic revision of the Columbellidae of the western Atlantic, *Glyptaesopus proctorae* (M. Smith, 1936) [fig. D], previously known only from the Pliocene of Florida, was discovered to be still a living species. An adult specimen was collected alive by Mr. Daniel Steger at Islamorada, Florida Keys, and a second one, a juvenile collected in the Bahamas, was found in the mollusk collection of the U. S. National Museum.

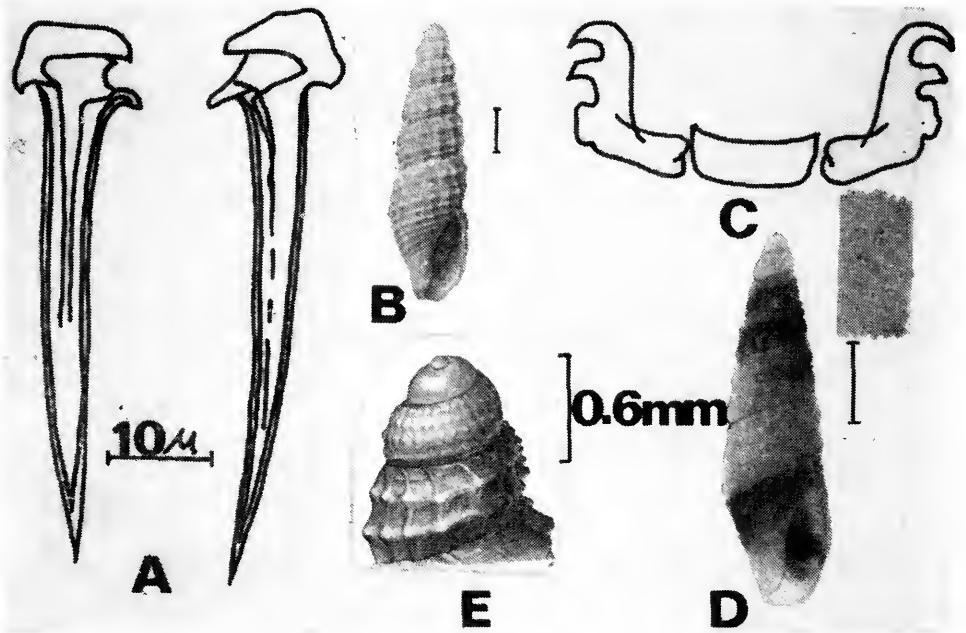


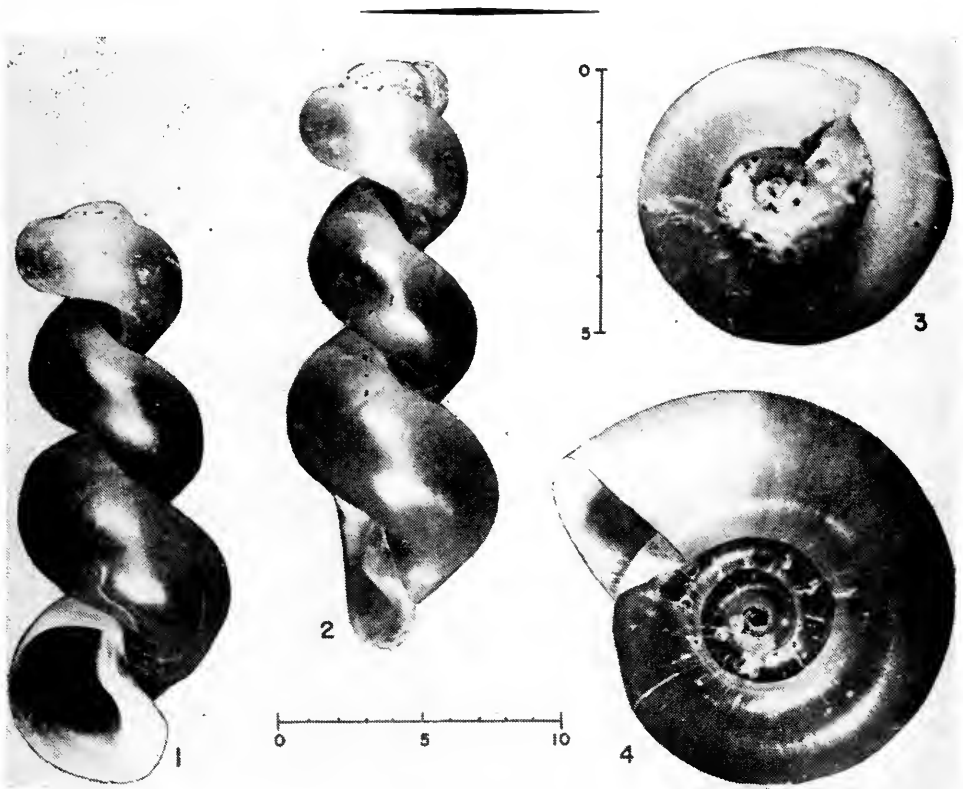
Fig. A. Two radular teeth of *Glyptaesopus cetolaca* showing two different views. Fig. B. Shell of *G. cetolaca*. Fig. C. Typical columbellid radula: one transverse tooth-row. Fig. D. Shell of *G. proctorae*. Fig. E. Protoconch of *G. cetolaca*. The lines beside figs. B & D indicate natural size.

The genus *Glyptaesopus* (Pilsbry & Olsson, 1941), whose type species is *G. xenicus* (Pilsbry & Lowe, 1932) [= *Mangelia cetolaca* Dall, 1908] was originally described as a subgenus of the columbellid genus *Aesopus* Gould. In addition, two species, *G. perornatus* (Pilsbry & Olsson, 1941) and *G. polypholus* (Pilsbry &

Olsson, 1941) have been described from the Pliocene of western Ecuador.

An examination of the radula of *G. cetolaca* has shed some light on the proper systematic position of this genus. The typical columbellid radula (fig. C) is distinctively stenoglossate, comprising a long narrow ribbon bearing a large number of transverse, across rows of 3 solid chitinous teeth. In contrast to this, the radula of *Glyptaesopus cetolaca* (Dall) comprises a small cluster of 6 tiny (70 microns long) hollow darts similar to those of many species assigned to the turrid subfamily Mangeliinae (fig. A). In addition, the regular, cylindrically coiled protoconch found in *G. cetolaca* (fig. E) agrees well with that of other mangeliine species.

This information suggests that the assignment of *Glyptaesopus cetolaca* to the Columbellidate is ill-advised and that this species and the genus it typifies should be assigned to the Turridae, Mangeliinae.



Scalariform specimen of *Biomphalaria glabrata*. Fig. 1, Apertural view. Fig. 2, Shell rotated approximately 90°. Fig. 3, Apical view, showing normal early whorls. Fig. 4, Normal shell from a snail of the same population, viewed from the left side. Magnification of Figs. 1, 2, and 4 is the same (horizontal scale), of Fig. 3 approximately twice as large.

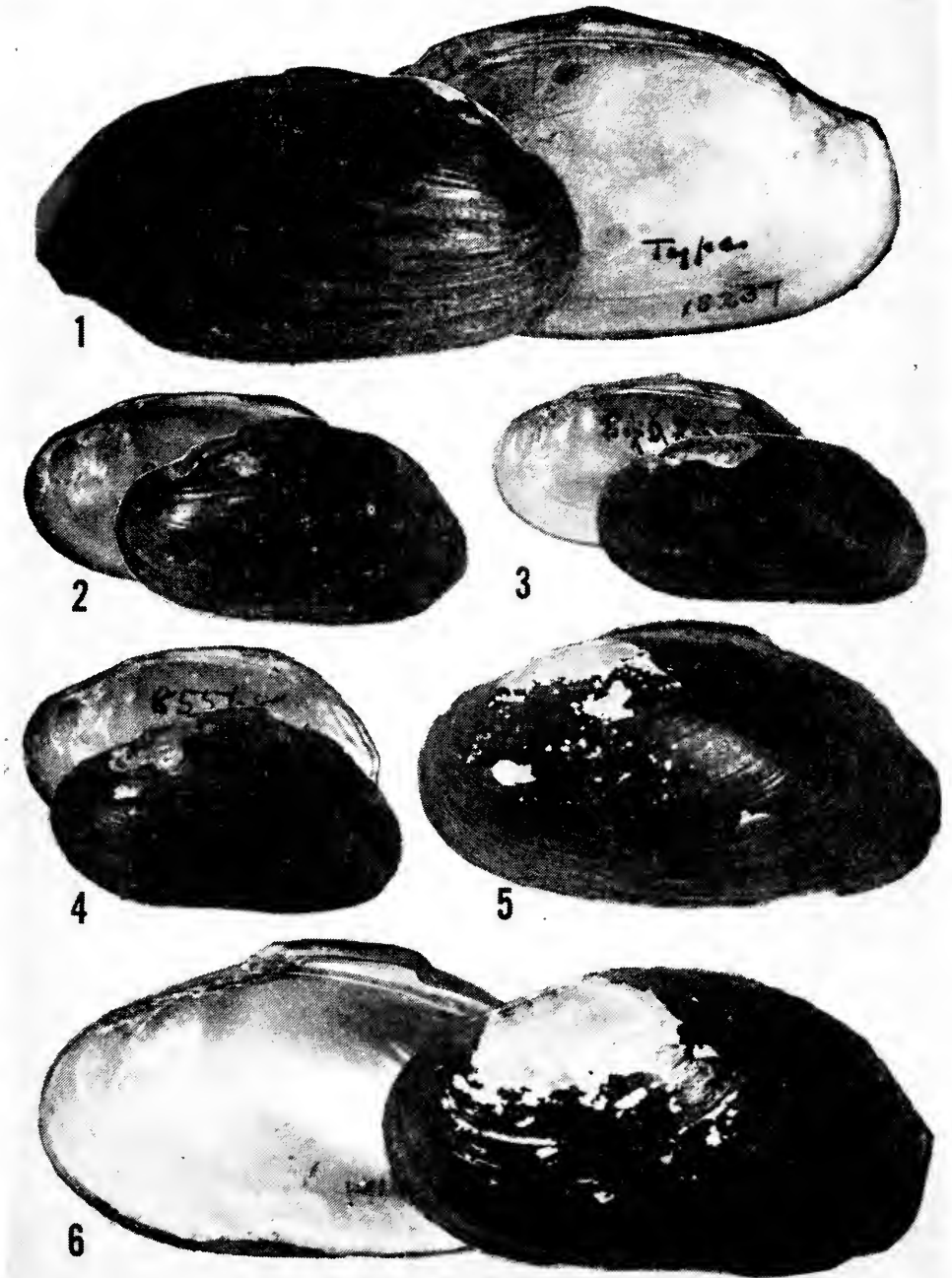


Fig. 1. *Elliptio chipolaensis* (Walker). Chipola River, Florida. Holotype MZUM. 96363. Length 56.5, height 32, width 22 mm. (nat. size). Figs. 2-6. *Elliptio nigella* (Lea): 2. *Unio nigellus* Lea. Chattahoochee River, near Columbus [Muscogee Co.], Georgia. Holotype USNM. 85567. Length 39, height 23, width 14 mm. (nat. size). 3. *Unio purpurellus* Lea. Flint River, near Albany [Dougherty Co.], Georgia. Holotype USNM. 85675. Length 36, height 19, width 13 mm. (nat. size). 4. *Unio denigratus* Lea. streams near Columbus [Muscogee Co.], Georgia. Holotype USNM. 85568. Length 39, height 22, width 14 mm. (nat. size). 5. Flint River, Recovery, Decatur Co., Georgia. MCZ. 191112. Length 58, height 31, width 20 mm. (nat. size). 6. *Ibid.* Length 61, height 34, width 20 mm. (nat. size).

A SCALARIFORM BIOMPHALARIA GLABRATA

By PAUL F. BASCH

The G. W. Hooper Foundation, University of California
San Francisco Medical Center

The specimen illustrated here appeared in a laboratory colony of *Biomphalaria glabrata* (Say) bred from specimens collected on the island of St. Lucia, West Indies, by Dr. Robert F. Sturrock of the Research and Control Department, St. Lucia. Dimensions of this specimen were: height, 20.7 mm.; width, 8 mm.; weight, almost exactly 100 mg.; number of whorls, almost 6. A normal shell of 6 whorls weighs about 200 mg.

As soon as I noted that this snail was abnormal, it was isolated and maintained in a separate one-liter aquarium with constant aeration and fed only red-leaf lettuce like the rest of the breeding colony. During its isolation (about 2 months) the snail continued to grow, adding the last 2½ whorls, and it deposited several egg masses. Whether this individual had mated prior to its separation is not known, but all offspring were normally coiled. Presumably an accident of some sort rather than a genetic factor was responsible for the abnormality of the shell.

The snail spent most of its time floating apex downward in the water, and appeared to be in no great distress. Upon its death the animal was carefully extracted and dissected, but no peculiarities were noted.

This shell has been deposited in the University of Michigan Museum of Zoology, Division of Mollusks, accession number 230637.

Acknowledgements. I am grateful to Mr. C. Glen Sawyer of the G. W. Hooper Foundation for taking the accompanying photographs. This work was supported by the University of California International Center for Medical Research and Training, Hooper Foundation, under research grants TW 00144 and AI 07054 from the National Institutes of Health, U. S. Public Health Service.



**ELLIPTIO NIGELLA, OVERLOOKED UNIONID
FROM APALACHICOLA RIVER SYSTEM**

By RICHARD I. JOHNSON
Museum of Comparative Zoology

Among the numerous specimens of Unionidae collected by Drs. W. J. Clench, R. D. Turner and D. H. McMichael during the summer of 1954, when they were surveying the Apalachicola River system, were three specimens of *Elliptio nigella* (Lea), which was recognized by Simpson (1914, Cat. Naiades, 2: 646) but has not been reported on since that time.

I wish to thank Dr. Joseph Rosewater, United States National Museum (USNM.) and Dr. John B. Burch, Museum of Zoology, University of Michigan (MZUM.), for allowing me to borrow the types of Lea and Walker which are figured here. Thanks are also extended to Dr. Kenneth J. Boss, Museum of Comparative Zoology (MCZ.) for critically reading the manuscript.

Elliptio nigella (Lea)

- Unio nigellus* Lea 1852, Proc. Amer. Philos. Soc. 5: 251 (Chattahoochee River, near Columbus [Muscoogie Co.], Georgia). Lea, 1852. Trans. Amer. Philos. Soc., 10: 283, pl. 24, fig. 42; figured holotype USNM. 85567. Lea, 1852, Obs. Unio, 5: 39.
- Unio denigratus* Lea 1857, Proc. Acad. Nat. Sci. Phila. 9: 171 (streams near Columbus [Muscoogie Co.], Georgia). Lea, 1859, Jour. Acad. Nat. Sci. Phila. (2) 4: 200, pl. 23, fig. 83; figured holotype USNM. 85566. Lea, 1859, Obs. Unio, 7: 18.
- Unio purplellus* Lea 1857, Proc. Acad. Nat. Sci. Phila. 9: 171 (Flint River, near Albany [Dougherty Co.], Georgia). Lea, 1859, Jour. Acad. Nat. Sci. Phila. (2) 4: 19, pl. 23, fig. 81; figured holotype USNM. 85675. Lea, 1859, Obs. Unio, 7: 16.
- Unio nigellus* Lea. Simpson, 1914, Cat. Naiades, 2: 646.
- Elliptio nigellus* (Lea). Frierson, 1927, Check List North American Naiades, p. 28.
- Elliptio strigosus* (Lea). *partim*. Clench and Turner, 1956, Bull. Florida State Mus. 1: 166.

Description. Shell small, seldom exceeding 60 mm. in length. Outline subelliptical or subrhomboid, generally slightly arcuate. Valves subinflated, solid, inequilateral. Anterior end regularly rounded; posterior end more broadly rounded, somewhat biangulate and extending slightly below the base line. Ventral margin straight, or slightly arcuate. Posterior margin slightly curved, usually indistinctly joining the obliquely descending posterior margin.

Hinge ligament prominent, located near the middle of the shell. Posterior ridge rather acute toward the umbos, distinctly double, ending in a faint biangulation near the base of the shell. Posterior slope very flat, or slightly convex between the ridges. Umbos slightly inflated and raised above the hinge line, located in the anterior fifth of the shell, their sculpture consisting of numerous corrugated, somewhat double looped, ridges. Disk generally slightly concave, with a trace of an umbonalventral sulcus. The greatest inflation is along the posterior ridge. Surface with irregular, delicate growth lines, often smooth and shiny or subshiny. Periostracum usually dirty greenish and rayed in immatures, becoming black in adults.

Left valve with two low, chunky, somewhat triangular, pseudo-cardinal teeth. Hinge line short and narrow, with two low straight lateral teeth. Right valve with one rather chunky pseudocardinal; one lateral tooth. Beak cavities very shallow, with a few dorsal muscle scars under the hinge plate. Anterior adductor muscle scars well impressed, posterior one less so. Pallial line distinct, especially anteriorly. Nacre dirty white, salmon, copper colored or purplish, iridescent posteriorly.

Length	Height	Width (mm.)	
61	34	21	Flint River, Recovery, Decatur Co., Georgia.
58	31	20	<i>Ibid.</i>
51	27	18	<i>Ibid.</i>

Habitat. Lives among rocks in muddy sand.

Remarks. *Elliptio nigella* (Lea), from the Chattahoochee and Flint rivers, appears to be allopatric with *Elliptio chipolaensis* (Walker)¹ which is endemic to the Chipola River. While both species occur in the Apalachicola River system, they appear restricted to the drainage systems mentioned. *E. nigella* is close only to *chipolaensis*, but the latter is consistently ovate, with the ventral margin straight or slightly curved. It has an unrayed chestnut colored periostracum which often has darker brown bands. *E. nigella* is often subrhomboidal, with the posterior end higher than the anterior one, which often extends below the base line. The

¹ *Unio chipolaensis* Walker 1905, *Nautilus* 18: 135, pl. 9, figs. 6, 7 (Chipola River, Florida; figured holotype MZUM. 96363). Type locality restricted to: Chipola River, 1 mi. N. of Marianna, Jackson Co., Florida, by Clench and Turner, 1956, *Bull. Florida State Mus.*, 1: 176.

greatest diameter is on the posterior ridge. The periostracum by contrast often has green rays and becomes black with age rather than brown as in *chipolaensis*.

Distribution. Known only from the Chattahoochee and Flint rivers of the Apalachicola River system. In addition to the localities of the several type lots, the only known localized specimens are those whose measurements are included above.

THE LAND SNAILS OF MAMMOTH CAVE NATIONAL PARK, KENTUCKY

BY LESLIE HUBRICHT

With its river bluffs and floodplain, ravines, sinks and caves, Mammoth Cave National Park, located in west-central Kentucky, offers a wide variety of habitats for land snails. The summits of the ridges are of sandstone, while the slopes of the ravines and the river bluffs are limestone. The deeper sinks are usually cooler and more moist in summer than surrounding areas, so that species of land snails may be found in them that are not found in other places. The caves also provide an unusual habitat. The smaller caves, such as White Cave, have more species of land snails in them than the larger caves, such as Mammoth Cave, Colossal Cave and Long Cave. No land snails at all were found in the latter two caves.

The following list is based on collections made by the author from 1956 through 1958. Four erroneous records cited by Pilsbry (1939-1948) from near Mammoth Cave are listed, but enclosed in brackets.

Polygyra pustuloides (Bland). Near the Big Spring of Buffalo Creek; and near Robbins Branch.

Polygyra leporina (Gould). On the Green River floodplain.

Polygyra plicata Say. Common in dry, limestone woods.

Stenotrema barbatum (Clapp). Common on the Green River floodplain.

Stenotrema angellum Hubricht. In ravines, sinks, and on the Green River bluffs.

Stenotrema stenotrema stenotrema (Pfeiffer). In ravines, sinks, and on the Green River bluffs.

Stenotrema hirsutum (Say). Common in dry upland woods, on both limestone and sandstone.

- Stenotrema fraternum fraternum* (Say). On the Nolin River bluff near First Creek Lake.
- Mesodon thyroidus* (Say). Common on the Green River floodplain.
- Mesodon clausus clausus* (Say). Common on the Green River floodplain.
- Mesodon zaletus* (Binney). On the Green River bluffs, and in sinks.
- Mesodon elevatus* (Say). On the Green River bluffs, and in Cedar Sink.
- Mesodon laevior* Pilsbry. In ravines, sinks, the Green River bluffs, and in White Cave.
- Mesodon rugeli* (Shuttleworth). Found only in Cedar Sink.
- Mesodon inflectus* (Say). Generally distributed.
- Triodopsis tridentata tridentata* (Say). In ravines, sinks, and on river bluffs.
- Triodopsis vulgata* Pilsbry. Near Mammoth Dome Sink.
- Triodopsis obstricta obstricta* (Say). Along Dry Prong of Buffalo Creek, and the Green River bluffs.
- Triodopsis denotata* (Férrusac). In ravines, and on the Green River bluffs. There is some hybridization between this species and *T. obstricta* on the Green River bluffs.
- Triodopsis albolabris* (Say). In upland woods.
- Allogona profunda* (Say). A single dead shell was found in drift of Dry Prong of Buffalo Creek.
- Haplotrema concavum* (Say). Generally distributed.
- Euconulus chersinus chersinus* (Say). On river bluffs and in ravines.
- Guppya sterkii* (Dall). On the Green River bluffs, not common.
- Glyphyalinia wheatleyi* (Bland). On the Green River bluffs.
- Glyphyalinia lewisiana* (Clapp). On river bluffs, not common.
- Glyphyalinia specus* Hubricht. In White Cave. This species is known only from the total darkness of caves.
- Glyphyalinia indentata* (Say). Generally distributed.
- Glyphyalinia solida* (H. B. Baker). Known only from a single specimen collected on a sandstone glade near the western edge of the Park.
- Glyphyalinia praecox* (H. B. Baker). In Turnhole Sink.
- [*Mesomphix inornatus* (Say)]. Reported by Pilsbry, but the speci-

men is a dead shell of two whorls and is unidentifiable. Its occurrence in the Park is very doubtful.

Mesomphix vulgatus H. B. Baker. In ravines and sinks, and on river bluffs.

Mesomphix ruidus Hubricht. On the Green River floodplain.

Mesomphix friabilis (W. G. Binney). In dry upland woods.

Paravitrea capsella (Gould). In ravines and sinks, and on river bluffs.

Paravitrea lapilla Hubricht. On the Green River floodplain at Dennison Ferry.

[*Paravitrea pontis* H. B. Baker]. Pilsbry's record is probably the result of mixed labels.

Hawaiiia minuscula minuscula (Binney). Generally distributed on limestone.

Ventridens gularis (Say). In upland woods.

Ventridens demissus (Binney). Known only from Short Cave Sink, which is just outside of the Park.

Ventridens ligerus (Say). Common on the Green River floodplain.

Ventridens intertextus (Binney). A single specimen was collected at the old CCC. camp near Maple Spring.

Zonitoides arboreus (Say). Generally distributed.

Zonitoides limatulus (Binney). Common on the Green River floodplain.

Zonitoides lateumbilicatus (Pilsbry). Dead shells were found in drift in a cave in Cedar Sink, and it was found living in Short Cave Sink just outside of the Park.

Striatura meridionalis (Pilsbry & Ferriss). On river bluffs, and in ravines and sinks.

[*Striatura milium* (Morse)]. Reported by Pilsbry, but the two specimens are dead shells of *S. meridionalis*.

Deroceras laeve (Müller). Common on the Green River floodplain.

Anguispira alternata (Say). Near the Green River and in sinks.

[*Discus cronkhitei* (Newcomb)]. Reported by Pilsbry, but his specimens are *Zonitoides limatulus*.

Discus patulus patulus (Deshayes). Generally distributed.

Helicodiscus notius notius Hubricht. Generally distributed in upland woods; and in White Cave.

Helicodiscus parallelus (Say). Generally distributed.

- Helicodiscus punctatellus* Morrison. Dead shells were collected in White Cave, the type locality.
- Punctum minutissimum* (Lea). On river bluffs and in ravines.
- Punctum vitreum* H. B. Baker. On the Green River floodplain near Echo River.
- Punctum smithi* Morrison. On river bluffs and in ravines.
- Philomycus carolinianus* (Bosc). Generally distributed.
- Philomycus carolinianus* form *lividus* (Rafinesque). Near Mammoth Dome Sink.
- Pallifera mutabilis* Hubricht. Generally distributed, but not common.
- Pallifera marmorea* Pilsbry. Cedar woods near White Cave.
- Pallifera fosteri* F. C. Baker. Low woods near First Creek Lake.
- Pallifera secreta* (Cockerell). Mouth of Dixons Cave.
- Succinea ovalis ovalis* Say. Common on the Green River floodplain.
- Catinella vermeta* (Say). Common on the Green River floodplain.
- Strobilops labyrinthica* (Say). Common in upland woods.
- Strobilops aenea* Pilsbry. Common in upland woods.
- Gastrocopta armifera* (Say). Common in cedar woods.
- Gastrocopta clappi* (Sterki). Common in cedar woods.
- Gastrocopta contracta* (Say). Generally distributed.
- Gastrocopta pentodon* (Say). In upland woods.
- Gastrocopta tappaniana* (C. B. Adams). In wet woods.
- Gastrocopta corticaria* (Say). In sinks, not common.
- Gastrocopta procera procera* (Gould). In dry upland woods and clearings.
- Pupoides albilabris* (C. B. Adams). In dry upland woods and clearings.
- Vertiga ovata ovata* Say. Near Sloans Crossing Pond.
- Columella edentula* (Drapernaud). In sinks and ravines, not common.
- Cionella morseana* Doherty. In ravines and sinks, not common.
- Carychium clappi* Hubricht. On the Green River bluff near Mammoth Cave.
- Carychium exile exile* H. C. Lea. Generally distributed.
- Carychium stygium* Call. In most of the caves in the Park (see Hubricht, 1960). This species is known only from the total darkness of caves.

Carychium nannodes Clapp. On river bluffs, and in ravines and sinks.

Helicina orbiculata orbiculata (Say). On the bluff in Big Spring Hollow.

Pomatiopsis cincinnatiensis (Lea). Abundant near the Green River.

Pomatiopsis lapidaria (Say). Abundant on the Green River floodplain, and in ravines.

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DEATH FROM DESICCATION IN THE MUD-SNAIL, NASSARIUS OBSOLETUS: EFFECTS OF SIZE

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In an earlier paper (Schaefer, Milch, and Levin, 1968a) on desiccation in *Nassarius obsoletus* (Say) [or *Ilyanassa obsoleta*], we suggested that water is lost from the body surface, as well as from the shell aperture. This raised the question of whether the area of the aperture increased at the same rate as over-all shell area, as snails increase in size. If the rates are different, more (or less) of the water lost from snails of different sizes, would be lost from the body surface than from the aperture surface.

In this paper we consider changes in these areas in addition to changes in shell volume, with increasing size (weight) of *Nassarius*. The results are approximate, because of the assumptions we have had to make, but we feel that they are nevertheless of interest.

Materials and methods. Snails were collected at Jamaica Bay, Long Island, and divided into four arbitrary weight-classes (based on damp-dried weights of living snails), as in earlier work (Schaefer, Milch, and Levin, 1968a, b). The error introduced by the use of arbitrary weight classes is not significant, as the scatter-

ing in the terminal (open-ended) population classes is no greater than that in the medial ones.

The shape of the *Nassarius* shell approximates a right circular cone. Shell thickness was not taken into account in our measurements and calculations. Since the shell may be disproportionately thicker in older (= heavier) specimens, some bias is probably introduced here.

We used the following formulas:

1. Volume of a cone = $\pi/3 (r^2h)$

2. Area of a right cone = $\pi r \sqrt{r^2 + h^2}$
where r = width of shell at widest point and
 h = length (or height) of shell

3. Area of an ellipse = πab
where a and b are the length and
 width of the aperture

Results and discussion: Table 1 presents the measured and calculated results. Shell volume increases at a disproportionately greater rate than does shell area (see Table 2), as expected. If shell thickness does *not* increase faster than shell volume, older (= larger) snails will contain relatively more tissue than younger (= smaller) snails. That is to say, a greater proportion of an older snail's weight will be tissue. Of importance to our desiccation studies, older snails will have relatively more water to lose than younger ones. It follows that older snails will take a disproportionately longer time to lose their water when desiccated, and therefore that they are more apt to withstand short-term desiccation than younger snails. Our data (1968a) substantiate this point.

Data in Tables 2 and 3 show that the area of the aperture increases at a faster rate than the area of the shell surface as a whole. That is, in an older snail, a greater proportion of the *total* area is aperture. If water is lost primarily from the aperture, an older snail would be at a disadvantage compared to a younger snail. This disadvantage might be great enough to counteract any advantage conferred on an older snail by its relatively increased volume.

Our results on death-points from desiccation (1968a) indicate that older snails are indeed more susceptible to water-loss at the

Table 1. Shell measurements and calculations in Nassarius

Weight-class (g)	< 0.6	0.6-0.99	1.0-1.39	> 1.39
Shell length (mm)	10.25 (N=32)	15.3 (N=45)	17.3 (N=103)	17.7 (N=44)
Shell width (mm)	6.3 (N=32)	10.0 (N=45)	10.8 (N=103)	11.7 (N=44)
Length aperture (mm)	---	8.7 (N=14)	9.4 (N=72)	10.5 (N=41)
Width aperture (mm)	---	5.0 (N=14)	7.1 (N=72)	7.2 (N=41)
Shell area (mm ²)	110.9	257.5	308.9	342.1
Shell volume (mm ³)	105.2	400.0	528.7	635.5
Aperture area (mm ²)	---	136.6	209.5	237.5

Table 2. Per-cent increases from size-class to size-class in Nassarius

Weight class (g)	< 0.6	0.6-0.99	1.0-1.39	>> 1.39
Shell area	132%	20%	11%	
Aperture area	---	54%	13%	
Shell volume	280%	33%	20%	

Table 3. Ratios of shell area to aperture area in Nassarius

Weight-class (g)	0.6-0.99	1.0-1.39	> 1.39
$\frac{\text{Shell area}}{\text{Aperture area}}$	1.9	1.5	1.4

relatively high temperature of 25°C. We tentatively attributed this susceptibility to the greater age and weakness of older snails. The calculations here suggest, however, that an additional factor might be a relatively greater water loss through a relatively larger aperture. At a temperature closer to what the snails naturally experience (11°C), the stress is less on older snails. The advantage of their relatively increased volume almost counterbalances the disadvantage of their relatively increased aperture area. At 11°C, the mortality of older snails approximates that of intermediate snails (Schaefer, Milch, and Levin, 1968a).

CONCLUSIONS

Our hypothesis then is this: Small examples of *Nassarius* (<0.99g) have a relatively high area; volume ratio and a thin

shell; they lose water rapidly when desiccated and have a high mortality. Intermediate snails (1.0-1.39g) have a lower area: volume ratio, their shells are somewhat thicker, and their aperture area is larger relative to that of small snails. They lose water more slowly (because of the lower area: volume ratio), and they have a lower mortality. (They are also probably sexually immature [Scheltema, 1964], which may affect resistance to drying.) The area: volume ratio of large snails ($>1.4g$) is lower still, the shell is again somewhat thicker, and the aperture area is larger relative to those of both small and intermediate snails. In addition, large snails are old and somewhat weakened by age: Under conditions of temperature-stress ($25^{\circ}C$), the combined disadvantages of age and a larger aperture area outweigh the advantages of increased volume and a thicker (= less water-permeable) shell; at $25^{\circ}C$ large snails have a higher mortality than intermediate snails. Under more natural temperature-conditions ($11^{\circ}C$), the advantages tend to outweigh the disadvantages, and large snails have a mortality about equal to that of intermediate snails.

Our earlier results (1968a) are explained by the hypothesis, but we emphasize again that it is based on a number of as yet unproved assumptions.

Acknowledgements. We are grateful to Mrs. Dorothy Peckham, who did the calculations.

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NOTES AND NEWS

DATES OF THE NAUTILUS. — Vol. 81, no. 1, pp. 1-36, iii, iv, including pls. 1 & 2, was mailed July 6, 1967. No. 2, pp. 37-72, iii, iv, Oct. 16, 1967. No. 3, pp. 77-108, iii. Jan. 25, 1968. No. 4, pp. 109-144, iii, and index, pp. iii-vi, April 18, 1968. — H. B. B.

GIANT COWRIES. — I have examined two unusually large shells of live-taken *Cypraea cervus* Linné, one of which is probably the largest known specimen of any living cowrie. Both were dredged by shrimp boats working off Dry Tortugas, Florida, in 1967. The largest, 178 mm. in length, is owned by Captain Riley Black of Fort Myers. The other is 175 mm. (7 inches) in length, 92 mm. in width, and 82 mm. in height. The outer lip has 43 teeth. This specimen is owned by Carolyn Lowry, also of Fort Myers. — R. TUCKER ABBOTT.

ARION FASCIATUS IN WISCONSIN. — Gentner (1917; in Pilsbry, 1948) reported *Arion fasciatus* Nilsson (= *circumscriptus* Johnston) from "gardens in Madison," Wisconsin. There has been no additional report of this species in Wisconsin. cursory collecting during the fall of 1967 indicates *A. fasciatus* is now widespread over the state.

A total of 27 localities were examined in northern, central, and southcentral regions of the state. A variety of situations were examined in each region; these included camp grounds, picnic areas, disturbed sites (including garbage dumps, areas adjacent to houses and gardens, roadsides, and log piles) as well as natural, relatively undisturbed habitats. *A. fasciatus* was found at 7 localities as follow:

5 mi. W. Belleville, Wisconsin; picnic area.

1 mi. W. Eagle River, Wisconsin; maple grove back of motel.

4 mi. SE. Eagle River, Wisconsin; alongside road in birch-maple stand.

1 mi. SE. Three Lakes, Wisconsin; alongside lake in second growth birch-maple-hemlock stand with many boards on ground.

1 mi. S. Hazelhurst, Wisconsin; picnic area in second growth upland birch-maple stand.

3 mi. S. Pelican Lake, Wisconsin; picnic area in second growth birch-maple stand.

Madison, Wisconsin; numerous habitats within and around the city.

All individuals examined were characteristic of the typical *A. fasciatus* Nilsson.

A. fasciatus now occurs throughout most sections of Madison and the immediate surrounding region (Robert Mesibov, personal communication) and is especially abundant in the University of Wisconsin Arboretum. It was found in practically all habitats

within the Arboretum, including deciduous forest, bluegrass field, tall grass prairie, grass-sedge marsh, as well as in refuse dumps and nursery beds.

The distribution of *A. fasciatus* in Wisconsin is essentially limited to sites reflecting human disturbance; none was found in natural or undisturbed habitats. This agrees with the distribution of the species in northeastern North America (Chichester, 1967; Getz and Wakefield, 1963) and in southern Michigan (Getz, 1959). Many apparently suitable "disturbed" situations also did not yield *A. fasciatus*, however; its distribution is not as uniform in Wisconsin as it is in northeastern North America. This indicates a later introduction into the region and/or a slower spread from the original site(s) of introduction than has occurred in the northeast.

Although its present-day distribution in Wisconsin is spotty, *A. fasciatus* does occur widely over the state. This indicates that eventually it probably will become as common as it now is in the northeast.

The above conclusions are based on examination of relatively few sites. More extensive work in the north central part of North America is needed to determine the status of *Arion fasciatus* in this region. The few published records from southern Michigan (Getz, 1959) and Minnesota (Jensen and Corbin, 1966) indicate that the species may be much more widely distributed than the literature now indicates. — LOWELL L. GETZ, University of Connecticut, Storrs.

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SNAIL SHELLS AS OVIPOSITION SITES OF WATER MITES. — Living snails with extensive areas of pink material on their shells have been collected from ponds in central New York. These colored areas are egg masses of 4 species of red water mites (Hydrachnellae: *Eylais*). The pink color results from the deposition of a white, translucent matrix over red eggs.

Single eggs are small (145 to 207 microns in diameter), varying according to species. However, masses containing up to 2500 eggs in one to several layers may cover nearly the entire shell of a large *Viviparus georgianus* or *Helisoma trivolvis*. During the summer, many snails that were partly covered with eggs in various developmental stages were observed and collected. In one instance, eggs on a shell of *V. georgianus* were hatching when the living snail was collected. Since the incubation period is 19 to 36 days, the snail had carried this egg mass for a considerable time.

The larvae (150 to 200 microns) that emerge from the eggs swim to the water surface and attach to their proper insect hosts. The parasitized aquatic insects, Coleoptera and Hemiptera, provide nutrition and a means of dispersal for the mites. After engorgement, the larvae metamorphose into nymphs (1.5 to 2.0 mm.) while still on the insects. Then they leave the insects and prey on small crustaceans of the subclass Ostracoda. After a period of feeding, the mites attach to an aquatic plant and metamorphose again, this time to free-living adults which also feed on ostracods.

In nature, females oviposit on flat, relatively firm surfaces, usually twigs, bark, fallen leaves of deciduous trees, or growing leaves of pond weeds. In the laboratory, females lay eggs on the walls of glass rearing containers and on leaves of aquatic plants. Most egg-covered snails were collected from small artificial ponds that lack higher vegetation and a firm substrate but support large populations of snails. Apparently female mites select snail shells as oviposition sites merely because they have hard, smooth surfaces.

Unlike water mites in the genera *Unionicola* and *Najadicola* which parasitize fresh-water clams (Unionidae), mites of the genus *Eylais* apparently have no significant relationship to mollusks except this frequent use of snail shells as oviposition

sites. The major effect on snails may be to increase the risk of predation. Because the egg masses contrast sharply with the background, they presumably make snails much more conspicuous to visually oriented predators. — CARMINE A. LANCIANI AND WILLARD N. HARMAN.

THE CONCHOLOGICAL PAPERS OF ARCANGELO SCACCHI. — During the course of a revision of the western Atlantic Semelidae, I encountered a bibliographical problem in tracing the original references of the 19th century Neapolitan scientist, Arcangelo Scacchi. In many cases the original works of this author were reprinted subsequent to their initial appearance in an umber of relatively obscure Italian journals while in others they were entirely reset and repaginated so that considerable confusion has obtained in citing species descriptions and compiling synonymies. The object of this short note is to provide a bibliographic guidepost to the conchological writings of Scacchi.

I am indebted to the cooperative staffs of the libraries of the Museum of Comparative Zoology, Harvard University, the U. S. National Museum, Smithsonian Institution, and the Academy of Natural Sciences of Philadelphia.

Arcangelo Scacchi was born 8 February, 1810 at Gravina di Puglia, Italy and died 11 October, 1893 in Naples. During his long, active, and productive career he held a post as lecturer in medicine at Naples. His earliest interests were in zoological and conchological matters, but he later contributed significantly to the earth sciences, particularly mineralogy and crystallography.

1832 (15 December). Lettera / di / Arcangelo Scacchi / Dottore in medicina / su vari Testacei Napolitani / al signor / D. Carlo Tarentino / Prof. di Storia Naturale Nel R. Liceo / Di Catanzaro / Napoli / 1832. [8 unnumbered pp., 8°].

1833 (February). Osservazioni zoologiche / di / Arcangelo Scacchi / Dottore in medicina. / Napoli Febraro 1833 / Pe' Tipi Della Societa' Tipografica. [part one, unnumbered of the series of two, pp. 1-12, 8°].

1833 (May). Num. 2°. / Maggio 1833 / Osservazioni zoologiche / di / Arcangelo Scacchi / Testacei. [part two, numbered of the series of two, pp. 13-27, 8°].

1834. Notizie / Intorno alle conchiglie ed a' zoofiti fossili / che sitrovano nelle vicinanze di Gravina in Puglia. Ananli Civili del Regno Delle due Sicilie, (Novembre e Dicembre), vol. VI, fasc. XII, pp. 75-84 [part one, Bivalves, 4°].

1835. Notizie / Intorno alle conchiglie ed a' zoofiti fossili / che si trovano nelle vicinanze di Gravina in Puglia. Annali Civili del Regno Delle due Sicilie, (Gennaio e Febbraio), vol. VII, fasc. XIII, pp. 5-18, pls. 1 and 2 [Parte II, Conchiglie Univalvi, pp. 5-13; Parte III, Zoofitii, pp. 14-17; plate caption, p. 18, 4°].
1836. Notizie Intorno alle conchiglie ed a' zoofiti fossili che si trovano nelle vicinanze di Gravina in Puglia. [The same, of all 3 parts, reprinted in Naples, (Tipogr. Fernandes) in 8°].
1836. Catalogus / Conchyliorum / Regni Neapolitani / quae usque adhuc reperit / A. Scacchi / Neapoli / Typis Filiatre-Sebetii / 1836. [18 pp., 1 unnumbered plate with 28 figures, 8°].
1841. Notizie geologiche sulle conchiglie che si trovano fossili nell'isola d'Ischia e lungo la spiaggia tra Pozzuoli e Monte nuovo. Antologia di Scienze Naturali pubblicata da R. Piria ed A. Scacchi, Napoli. Vol. 1, pp. 33-48, 8°.
- 1841 (March). Memoria sopra una specie of *Clavagella* che vive nel Golfo di Napoli. Antologia di Scienze Naturali pubblicata da R. Piria ed A. Scacchi, Napoli. Vo. 1, fasc. 2, pp. 152-161, 1 pl., 8°.
1842. Notizie geologiche e conchiologiche ricavata da una lettera del Dott. R. A. Philippi ad A. Scacchi (in nota). Rendiconto, vol. 1, n. °3, pp. 86-88, 4°.
1857. Catalogus / Conchyliorum / Regni Neapolitani / quae usque adhuc reperit / A. Scacchi / Neapoli Typis Filiatre-Sebetii 1836 / et Denuo Neapoli Typis Francisci Xaverii Tornese 1857. [Back of title page]: Monitum / Opusculum hoc sine ulla immutatione, auctoris venia, denuo / edere curavit Albertus Detken. [19 pp., 1 unnumbered plate with 28 figures, 8°; this is the Detken reprint which is *not* the same as the original 1836 edition, either word for word or for pagination]. — KENNETH J. Boss

PUBLICATIONS RECEIVED

Stratton, Leonard W. 1968. Your Book of Shell Collecting. Faber and Faber, London. 64 pp., 1 color plate, 28 text figs. A useful guide for children and beginners interested in mollusks of the British Isles. About \$1.00.

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THE NAUTILUS

Vol. 82

October, 1968

No. 2

ARE PELECYPODS PRIMARILY INFAUNAL ANIMALS?

By DAVID NICOL

Department of Geology, University of Florida, Gainesville

Thorson (1957, pp. 465-466) summarized the numbers of epifaunal and infaunal species of marine animals in these few sentences:

“Of an estimated 1,000,000 species of Recent animals described, only something like one-fifth are aquatic and only about one-sixth live in the sea. The graphs also show that, although the number of epifauna and infauna species is practically of the same order of size in arctic seas, the epifauna species greatly outnumber the infauna species in tropical waters. Exact figures are not available, but it is estimated that the total number of epifauna species in the sea is at least 4 times as large as that of infauna species.”

For those of us who are not quick with arithmetic, let us convert the fractions to numbers of species as follows: There are 200,000 aquatic species, of which 33,333 are fresh-water species and 166,667 are marine species; of the marine species, 33,333 are infaunal and 133,334 are epifaunal. I am assuming that Thorson included in the total of epifaunal marine species those animals that swim or float above the sea bottom: the nekton and the plankton.

C. M. Yonge (1949, p. 228) in his book “The Sea Shore” had this to say about the habitat of marine pelecypods:

“Of all marine animals, the bivalve molluscs are the most perfectly adapted for life within soft substrata of sand or mud. Their fundamental characters, including the lateral flattening of the body and foot, the enclosure within a hinged, bivalved shell, and the great development of the gills within the enlarged gill chamber so created, all unite to this end. With the evolution of the bivalve form the molluscs were able to exploit the rich possibilities of life beneath the protective surface of sand or mud while drawing in food from surface deposits or from the suspended plankton. While it is true that some took to attached life secured by byssus threads or cement to a hard surface, the great majority of bivalves remain burrowers and the further development of this habit, with suitable

modifications of shell and foot, has led to the successful boring into rock and timber already described."

In an excellent recent paper, Stanley (1968) has emphasized the point that since the beginning of the Mesozoic several superfamilies of pelecypods have developed large incurrent and excurrent siphons which adapt these animals admirably for a life within the sea bottom.

We now know the habits of enough living species of marine pelecypods to estimate with a good degree of accuracy the number of infaunal and epifaunal species described within a region. The greatest difficulty for accurate estimates lies within superfamilies such as the arcaceans and mytilaceans which have some species that lie attached on the bottom (epifaunal) whereas other species burrow or bore into the bottom (infaunal). Another difficult group is the erycinaceans, many of which are commensal and crawl around on other invertebrates, but these tiny pelecypods have been so little studied in many regions that we are not sure that all are epifaunal in habit. Furthermore, again because of lack of study, species allocated to the erycinaceans in many faunas do not belong to that large superfamily; the Erycinacea have become a taxonomic catch-all for many small species of pelecypods. More observations need to be made on many species allocated to these 3 aforesaid superfamilies.

I have selected 15 recent pelecypod faunas and 15 fossil pelecypod faunas, ranging in age from Late Jurassic to Pleistocene, and have recorded the number of epifaunal and infaunal species in each one. The percentage of infaunal species in the total fauna has been estimated in each selected example.

In the recent faunas (Table 1) the high percentage of infaunal species in the abyssal region is not surprising. In fact, one is surprised that it is not even higher because of the large number of species of protobranchs and septibranchs in the fauna; these two groups of pelecypods are all infaunal in habit.

There is no increasing percentage of epifaunal species as compared to infaunal species from cold shallow to warm shallow water. The number of both infaunal and epifaunal pelecypod species appears to increase at about the same rate from cold to warm water, unlike the general trend of invertebrates. For most

other invertebrates, the number of epifaunal species increases greatly and the number of infaunal species little as one goes from cold water to warm water.

In the faunas of the subantarctic and antarctic regions, no more than 60 per cent. of the species are infaunal, whereas in other regions the infaunal species represent at least 71 per cent. of the faunas. The subantarctic and antarctic faunas have a large number of philobryids, which are byssally attached forms, and a large number of species of erycinaceans and leptonaceans, most of which are commensal and live on other animals. All these species are of small size, commonly less than 10 mm. Have Australian and New Zealand malacologists paid more attention to the small-sized pelecypods than have malacologists in other parts of the world? Or are the subantarctic and antarctic pelecypod faunas populated with an unusually large number of small-sized epifaunal pelecypods? In an earlier paper (Nicol, 1966), I had noted the uncommonly large percentage of small-sized pelecypod species in the antarctic fauna.

Table 1. Percentage of infaunal species of pelecypods in 15 Recent marine faunas. Data taken from the following sources in the sequence shown below: 1. Clarke, 1962; 2. La Rocque, 1953; 3. Keen, 1958; 4. Taki, 1951; 5. Nicklès, 1950; 6. Smith & Gordon, 1948; 7. Perry & Schwengel, 1955; 8. Warmke & Abbott, 1961; 9. Olsson, 1961; 10. Macpherson & Gabriel, 1962; 11. Nicol, 1967; 12. Cotton & Godfrey, 1938; 13. Carcelles & Williamson, 1951; 14. Nicol, 1967; 15. Powell, 1946.

<i>Geographic Region</i>	<i>Total No. Species</i>	<i>% Infauna</i>
Abbyssal	391	79
Canada	381	79
Northern Panamic	585	78
Japan	302	77
West Africa	158	76
Monterey, California	179	76
Western Florida	151	75
Caribbean	241	75
Southern Panamic	505	74
Victoria, Australia	193	74
Arctic	66	73
South Australia	315	71
Magellanic	180	60
Antarctic	68	59
New Zealand	281	56
Mean per cent. of infaunal species in all 15 faunas is 72.		

Paleontologists have begun to show an interest in paleoecological analyses of pelecypod faunas, and a good example is that of Logan (1967, pp. 10-11) on the Permian pelecypod fauna of northern England.

I have deliberately restricted myself in this study to Late Jurassic and younger faunas because most of the species in these younger faunas can be allocated to living families or superfamilies in which the habitat is well known.

Table 2. Percentage of infaunal species of pelecypods in 15 fossil marine faunas. Data taken from the following sources in the sequence shown below: 1. Vokes, 1939; 2. G6rges, 1952; 3. Mansfield, 1932; 4. Vokes, 1957; 5. Gardner, 1926-1928; 6. Gardner, 1933; 7. Chavan, 1952; 8. Mansfield, 1937; 9. Stephenson, 1953; 10. DuBar, 1958; 11. Stenzel, Krause & Twining, 1957; 12. Woodring, 1925; 13. Stephenson, 1941; 14. Arkell, 1929-1937; 15. Hayami, 1965-1966.

<i>Age & Geographic Region</i>	<i>Total No. Species</i>	<i>% Infauna</i>
Middle Eocene, California	93	82
Late Oligocene, Germany	83	76
Late Miocene, Florida	174	74
Middle Miocene, Maryland	120	74
Middle Miocene, Florida	301	74
Paleocene, Texas	60	73
Late Jurassic, France	90	72
Late Oligocene & Early Miocene, Florida	126	70
Middle Cretaceous, Texas	93	70
Plio-Pleistocene, Florida	108	69
Middle Eocene, Texas	60	68
Late Miocene, Jamaica	180	65
Late Cretaceous, Texas	172	63
Late Jurassic, England	176	57
Early Cretaceous, Japan	152	56
Mean per cent. of infaunal species in all 15 fossil faunas is 70.		
Mean per cent. of infaunal species in the 10 Cenozoic faunas is 73.		
Mean per cent. of infaunal species in the 5 Mesozoic faunas is 64.		

The analysis of the fossil pelecypod faunas has also provided some surprising results (Table 2). I would have assumed that the infaunal species would have a greater likelihood of being preserved than most of the epifaunal species because the infaunal species are much more likely to be found in areas of deposition and the attached forms found in areas of non-deposition or erosion.

However, the mean percentage of the infaunas among the 10 Cenozoic marine examples is almost identical to that of the mean percentage of all 15 Recent pelecypod faunas. This seems to indicate that if a large enough sample (representing more than 50 total species) is taken, it will represent an unbiased sample of the infaunal and epifaunal species living in a certain geographic area at a given time span in the past.

The 5 Mesozoic faunas analyzed, however, have a markedly lower percentage of infaunal species than do the 10 Cenozoic faunas. The 3 lowest infaunal percentages of all 15 fossil faunas are of Mesozoic age, and the highest infaunal percentage for any Mesozoic fauna does not quite equal the mean for all the Cenozoic faunas. The Late Corallian of England is a reef fauna, and the low percentage of infaunal species may be explained by the reef environment which favors a great diversity of epifaunal species, but this does not explain the low percentage in the other Mesozoic marine faunas. One notable feature of the Mesozoic faunas, as compared with the Cenozoic faunas, is the much greater diversity of the Pteriacea and Isognomonacea and to a lesser extent the Ostreidae. Most epifaunal filibranch families are well represented in these Mesozoic faunas. Even the Recent faunas have a mean percentage of infaunal species considerably higher than the mean percentage of the Mesozoic faunas (72 per cent. as compared to 64 per cent.) despite the erycinaceans and leptonaceans present in Recent faunas, which are absent or rare in Mesozoic faunas. However, the small sample of 5 Mesozoic faunas may prove to be insufficient to demonstrate that Mesozoic faunas generally had a higher percentage of epifaunal pelecypod species.

In conclusion, I must agree with Yonge that pelecypods are primarily infaunal animals, based on the percentages of infaunal species in all 30 pelecypod faunas analyzed, but perhaps not so overwhelmingly as one might judge from Yonge's statements.

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NEW RECORDS FOR INTRODUCED MOLLUSKS

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According to Pilsbry (1948) and Burch (1962), the introduced slug, *Limax maximus* Linn., is found throughout much of the U.S. In July of 1966, Dr. D. S. Franzen reported finding *L. maximus* at 202 and 204 E. Walnut, Bloomington, Illinois. The slugs were found under shrubbery after a heavy rain which followed a prolonged drought. This is the second reported location for this slug in Illinois, the Chicago area being the first.

Other new distribution records for *L. maximus* are Winder, Georgia, November, 1967 (by L. Cooper), and near railroad tracks, corner of Mitchell and St. Thomas Streets, Athens, Georgia, January, 1968 (by the authors).

Based on reports by Pilsbry (1948) and Burch (1962), the distribution of *Limax marginatus* Müller in the United States seems to be spotty. These authors report this species from Arizona, California, Colorado (greenhouse in Boulder), Missouri (greenhouse in St. Louis) and New York.

Dundee (1967) documented the spread of *L. marginatus* southward through Mississippi and Louisiana since 1948. By 1965, it was found as far south as Hattiesburg, Mississippi. In December, 1967, it was again found, this time beneath a slab of marble at Greenwood Cemetery in New Orleans. This species recently has been collected by the authors from 3 localities in Athens, Georgia. These are: near railroad tracks, corner of Foundry and Hancock Streets, January, 1968; from one of the University of Georgia greenhouses, March, 1968; and near railroad tracks at 710 E. Broad Street, April, 1968.

Lamellaxis clavulinus (Potiez and Michaud), which has thus far been reported from Pennsylvania (Pilsbry, 1946, and Burch, 1962), is now reported by the authors from 710 E. Broad, Athens, Georgia, April, 1968.

A brief evaluation of new mollusk records may include the following considerations. Factors accounting for new distribution records may be: 1) collecting is underway in areas not previously covered adequately or not covered at all, 2) occurrences that were previously known are now being published, and 3) the mollusks are extending their range.

Since our new records come from areas in which previous investigators have collected, there is some indication that these species were either rare enough to have been missed by earlier collectors or absent from the areas until recently. Mollusks may often be present in restricted localities within an area for a considerable time before they proliferate and disperse in sufficient numbers to be noticed by even a fairly thorough collector. However, many areas of the United States have been collected heavily without turning up these species that are appearing presently in collections. In short, it is likely that mollusks are spreading to these new localities.

There may be several modes of range extension involved, but based on what we know about the distribution and treatment of commercial plants shipped in soil, a highly likely means of dispersal may be with these plants. Snails and slugs uncommon or

absent in nearby open areas are often found in greenhouses where commercial plants are housed. Dispersal may more commonly involve the zygote (or developing) stage which would be harder to detect than the adult.

Published reports of thorough and repeated collecting in specific areas would greatly enhance our knowledge of mollusk introduction and dispersal.

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CHROMOSOME NUMBER IN NINE FAMILIES OF MARINE PELECYPOD MOLLUSKS

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Introduction. Until recent years there have been few studies of the chromosomes of marine pelecypod mollusks. Makino (1951) lists only two genera. Some of the earlier studies of species of oysters were later shown to be in error. The earlier studies were made from sectional material, which by its nature does not give an accurate analysis. Rosenfield (1951) and Menzel and Menzel (1965) used squashes of fixed and stained eggs and zygotes, a more reliable technique. Ahmed and Sparks (1967), Longwell, Stiles and Smith (1967) and Menzel (1968) used this method to report a total of 9 species of oysters.

During an investigation of the cytotaxonomy of species of quahog clams and species of oysters, chromosome counts have been made of species of mollusks in 8 families, including 10 species which have not been reported previously. In addition, previous investigations of 13 species of marine pelecypods are listed, including an additional family.

The majority of the species for which chromosome numbers are reported for the first time were collected locally near the site of

¹ Contribution No. 226, Department of Oceanography, Florida State University, Tallahassee, Florida 32306. Supported by NSF, Grant No. GB-5034.

the Marine Laboratory of the Florida State University in Franklin County on the northwest coast of Florida. These were spawned by the writer or by students and prepared for examination. Fixed eggs and zygotes of 4 species were supplied through the kindness of Mr. Paul Chanley, Virginia Institute of Marine Science. Exotic species of oysters (*Crassostrea* spp.) were supplied to the writer through the kindness of several individuals in other areas. These were spawned in our laboratory and the material fixed. The following individuals supplied oysters: Peter Wolf, Australia; Peter Walne, England; Narcisso Ligeralde, Philippines; Luiss Almodovar and Horace Loften, Puerto Rico and Canal Zone; Kenneth Chew and Ronald Westerly, Washington. The following are thanked for collecting, spawning and fixing some of the local species: Edwin Cake, Sidney Pierce, Theodore Ritchie and William Tiffany.

Methods. Sexually mature mollusks were induced to spawn by heat and sperm suspension technique or were "stripped" and the gametes mixed (Loosanoff and Davis, 1963). The methods of chromosome analyses have been described by Menzel and Menzel (1965). The eggs and zygotes were fixed at intervals in acetic acid-ethanol and stored at a temperature of -15°C . Storage at this low temperature gave satisfactory results after two years. Aceto-carmine, aceto-orcein and propio-carmine were used as stains; aceto-carmine has proven as good as any of the others and generally was used. A Zeiss microscope with phase contrast was used for examination. The figures are camera lucida drawings and photomicrographs made with a Polaroid camera attachment. A 12-volt illuminator was used for the photomicrograph to allow for a short time exposure under phase contrast. In all the mollusks examined meiosis is not completed until after sperm penetration of the egg.

Results. The species examined are listed below according to the classification of Abbott (1954, 1961). The chromosomes at meiosis and mitosis are pictured for all the species examined by the writer, except for two species of quahog clams (Menzel and Menzel, 1965). Species for which no locality and donor are listed were collected locally.

Order: FILIBRANCHIA

Mytilidate

Mytilus eduliss L. Virginia (Chanley; fixed material).

N=12; 2N=24. Figure 1.

Ostreidae

- Crassostrea amasa* (Iredale). Australia (Wolf).
N=10; 2N=20. Figure 2.
- C. angulata* (Lam.) (Cultured in) England (Walne).
N=10; 2N=20. Figure 3.
- C. commercialis* (Iredale & Roughly) Australia (Wolf).
N=10; 2N=20. Figure 4.
- C. iredalei* (Quoy & Gaimard). Philippines (Ligeralde).
N=10; 2N=20. Figure 5.
- C. gigas* (Thunberg) (cultured in) Washington (Chew & Westerly).
N=10; 2N=20. Figure 6.
- C. rhizophorae* (Guilding). Puerto Rico & Canal Zone (Almodovar & Lofte).
N=10; 2N=20. Figure 7.
- C. virginica* (Gmelin). Florida (local).
N=10; 2N=20. Figure 8.
- Ostrea edulis* L. Europe.
N=10; 2N=20 (ex. Longwell, Stiles & Smith, 1967).
- O. equestris* Say. Florida (local).
2N=20 (mitosis only). Figure 9.
- O. lurida* Carpenter. Washington.
N=10; 2N=20 (ex. Ahmed and Sparks, 1967).

Order: EULAMELLIBRANCHIA

Cardiidae

- Dinocardium robustum* (Solander). Florida (local).
N=12; 2N=24. Figure 10.

Veneridae

- Chione cancellata* (Lamarck). Florida (local).
N=19; 2N=38. Figure 11.
- Mercenaria mercenaria* (Linné). Atlantic Coast of United States.
N=19; 2N=38 (ex. Menzel & Menzel, 1965).
- M. campechiensis* (Gmelin). Florida (local).
N=19; 2N=38. (ex. Menzel & Menzel, 1965).

Petricolidae

- Petricola pholadiformis* (Lam.). Virginia (Chanley - fixed material).
N=23; 2N=46. Figure 12.

Semelidae

- Cumingia tellinoides* Conrad. New England.
N=16 (ex. Morris, 1917, 1918).

Donacidae

- Donax variabilis* Say. Florida (local).
N=19; 2N=38. Figure 13.

Mactridae

- Labiosa plicatella* (Lam.). Florida (local).
N=18; 2N=36. Figure 14.
- Mactra* sp. (presumably) Mediterranean.

N=18; 2N=36. (ex. Kostanecki, 1904²).

Mulinia lateralis Say. Virginia (Chanley - fixed material).

N=18; 2N=36. Figure 15.

Pholodaidea

Cyrtopleura costata (Lamarck). Florida (local).

N=17; 2N=34. Figure 16.

Barnea truncata (Say.). Virginia (Chanley - fixed material).

N=17; 2N=34. Figure 17.

Discussion. Chromosome analyses from squash preparations of pelecypod eggs and early zygotes are more reliable than those made from sectioned material. Inconsistencies occur in using sectional material, e.g. Galtsoff (1964) summarized the studies on several species of oysters of previous investigators as well as his own, and the reported diploid number varied from 8 to 24. Kobayashi (1954) reported the 2N number of two species of Japanese oysters to be 24. Ahmed and Sparks (1967), Longwell, Stiles and Smith (1967) and Menzel (1968) found that a total of 10 species in the genera *Crassostrea* and *Ostrea* all have N=10; 2N=20, and these species include those for which other numbers had been reported previously. All these latter investigators used stained squash preparations of eggs and zygotes.

It is easier to determine the chromosome number at meiosis than at mitosis, partly because of the halved number and partly because at metaphase I the chromosomes are usually rather compact discrete bodies (vide the several figures). At mitotic divisions, it is usually difficult to see all the chromosomes in one focal plane under the magnification needed. Longwell et. al. (1967) used colchicine treatment and also extracted some of the yolk material from the egg, which aided in the examination. Camera lucida drawings in which focusing can be done, give a more reliable count than photomicrographs.

It is interesting that in 4 families studied all the species and genera within a family had the same number of chromosomes. Relatively few mollusks have been examined as yet, and the constancy of numbers of chromosomes within a family may be a coincidence. The data indicate, however, that chromosome studies of pelecypod mollusks may be useful as a systematic tool. There are

² Makino (1951 erroneously cited Kostanecki (1904) as giving N=12 for *Maetra*. Kostanecki saw 12 chromosome bodies in the polar body of the fertilized eggs but later in the paper stated "Die Zahl der Chromosomen betragt die Halfte von jener in befruchteten Wiern namlich 18 statt 36."

available locally several families of marine bivalves with multiple species and genera. Attempt will be made to examine these to determine if the chromosome number within a family is constant.

SUMMARY

1. The chromosome numbers of 23 species of marine pelecypod mollusks in 9 families are reported, 10 for the first time.

2. Acetocarmine squashes of eggs and zygotes, that have been fixed in acetic acid-ethanol, are reliable for rapid chromosome analysis.

3. There is an indication chromosome numbers are constant within a family and hence may be of importance in systematic studies.

Explanation of figures 1 to 17. An actual photomicrograph of a meiosis or mitosis usually is followed by a camera lucida drawing of the chromosomes in the same or a similar preparation. In some of the photomicrographs, all chromosomes are not in focus.

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NEW SONORELLA FROM ARIZONA

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WESTERNMOST SPECIES

In the description of *Sonorella coltoniana* Pilsbry (1939), there is a reference to a race of shells from the vicinity of Oatman, Arizona, which represents the westernmost known population of the genus. Pilsbry states: "Around Oatman, in western Mojave (sic) County, Ferriss took several hundred 'bones', a few of them fresh enough to encourage the hope that living snails could be found, although the most laborious search failed to discover them. He did not supply the exact locations of his collecting stations." Pilsbry referred this Oatman population to *S. coltoniana* because of the similarity of embryonic sculptures.

Munroe L. Walton began looking for specimens of this population in the vicinity of Oatman in 1946. He searched sporadically for years in the hills below Oatman without success. On 15 March, 1967, he looked in the Black Mountains along the Goldroad highway, just east of Sitgreaves Pass, and was rewarded with two dead shells. Again, on 13 April, 1967, he collected two more dead shells from the same locality. On 13 October, 1967, M. L. Walton, Dr. J. C. Bequaert, and I worked the same rockslide and were rewarded with one live adult. The embryonic sculpture and shell diameter agree with Ferriss' shells as described under *S. coltoniana* by Pilsbry. The genitalia, however, reveal it to be closely related to *S. coloradoensis* (Stearns). It is described below as a subspecies of *coloradoensis*.

In citing this population of *Sonorella* as westernmost, a comment should be made on the status of *Sonorella (Mohavelix) micrometallius* (Berry) 1943 (Pilsbry, 1948, p. 1094) from the El Paso Mts. of California. Although *micrometallius* has genitalia

which fit the description of *Sonorella* genitalia, my opinion is that *Mohavelix* had a different phylogenetic origin from *Sonorella*, having most probably arisen from a nearby *Micrarionta* ancestor and that therefore *Mohavelix* should be given full generic standing (Miller, 1967).

SONORELLA COLORADOENSIS MOHAVEANA new subspecies. Fig. 1, D-F.

Description: Shell depressed-globose, heliciform, thin, glossy, light tan, with chestnut spiral band on the well-rounded shoulder; umbilicate, the umbilicus contained about 9 times in the diameter. Embryonic shell of about $1\frac{1}{2}$ whorls, its apex silky-smooth, not glossy; the remainder with fine, irregular radial wrinkles over which are lengthened papillae arranged in obliquely spiral trends but not anastomosing into threads. Post-embryonic whorls marked with light growth wrinkles and scars of worn-off periostracal projections; these scars becoming sparse to absent on the body whorl. The body whorl with numerous, distinct, microscopic spiral grooves above the shoulder. The periostracum presents a silky, lustrous appearance. The last whorl descends slightly and abruptly to the peristome. Aperture oblique, rounded, slightly wider than high. Peristome slightly expanded, partly reflected over the umbilicus, the margins converging; parietal callus very thin.

Holotype measurements: Height 12.2 mm; max. diam. 19.9 mm; umbilicus 2.2 mm; whorls 5.

Genitalia of holotype (Fig. 3, B): The slender penis is enveloped at its base by a short sheath and contains a club-shaped, blunt, scarcely annulated verge for nearly half its length; the seminal duct orifice is terminal. The slightly shorter epiphallus has a very small, not detached caecum. The vagina is about $\frac{2}{3}$ the length of the penis.

Type locality: Black Mts., ca. Oatman, Mohave Co., Arizona, in a west-facing, igneous rockslide on the north side of the Gold-road highway (old US. 66), east of Sitgreaves Pass, at a point 2.3 road miles easterly from the pass; elevation ca. 3200 ft. (Munroe L. Walton, Joseph C. Bequaert, and Walter B. Miller, 13 Oct., 1967). Holotype ANSP. 314850. Paratypes in collections of Dept. of Biological Sciences, University of Arizona (3122), Munroe L. Walton (9377 & 9644), and the author (5005).

The type lot consists of 7 adult and 5 immature shells. Only the holotype was found alive. There is some variation in shell diam-

eter, from 18.9 to 21.1 mm., and in the extent of peristome reflections, body-whorl spiral striations and spire elevation. In general, the spire is more elevated than in most other species of the genus.

In shell characteristics, *S.c. mohaveana* differs from *S.c. coloradoensis* in its larger size. Pilsbry reported variations in the diameter of *coloradoensis* from 14 to 18.5 mm. In the lots of Oatman shells, which Pilsbry listed under *S. coltoniana*, he reported shell diameters of 15 to 18 mm. in one lot and up to 20.5 mm. in another. The embryonic sculpture of *mohaveana* is similar to that of the nominate species. Likewise the presence of body-whorl spiral grooves in *coloradoensis* varies from prominent to absent in individuals of the same population.

In the genitalia, *mohaveana* differs from *coloradoensis* (Fig. 3, A) mainly in the shape of the verge, which is club-shaped and scarcely annulate in the former while it is cylindrical and strongly annulate in the latter. It also differs in the diameter of the penis and the length of the penial sheath, but these characteristics are often inconsistent in *Sonorella*. Comparative measurements are as follows (lengths, in mm., unless otherwise stated):

	<i>C.c. mohaveana</i> (#5005-A holotype)	<i>C.c. coloradoensis</i> (#4908-D, Bright Angel)
penis length	6.0	6.0
penis max. diam.	0.9	1.4
penial sheath	1.2	3.0
verge	2.7	2.7
vagina	4.0	4.0
epiphallus	5.0	5.0
caecum	minute, not detached	minute, not detached

In my opinion, the characteristics which differentiate *mohaveana* from *coloradoensis*, namely shell size and verge shape, are not sufficient to warrant specific separation. Hybridization tests would be highly desirable to determine reproductive isolation, if any. Additional field exploration would also be desirable to determine the possible presence of intervening, and perhaps intergrading, populations between the Black Mts. and the Grand Canyon.

This subspecies is named after Mohave County, where it is found.

PELONCILLO MOUNTAINS

Pilsbry (1939, p. 277) mentioned a record of an immature shell in the U.S. National Museum from "Doubtful Canyon," Peloncillo Mountains, and indicated that it was probably *Sonor-*

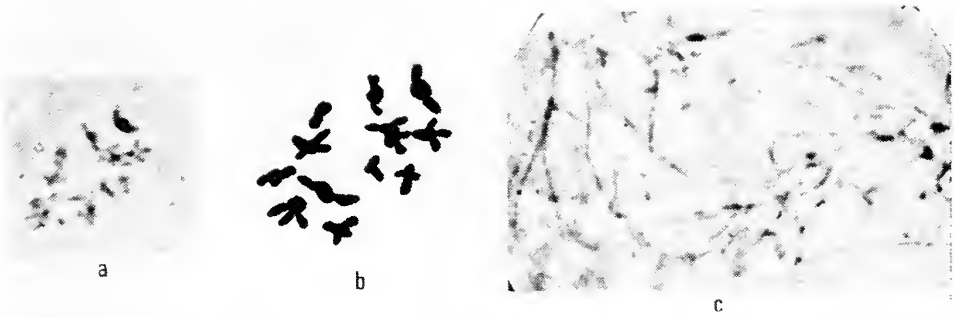


Fig. 1

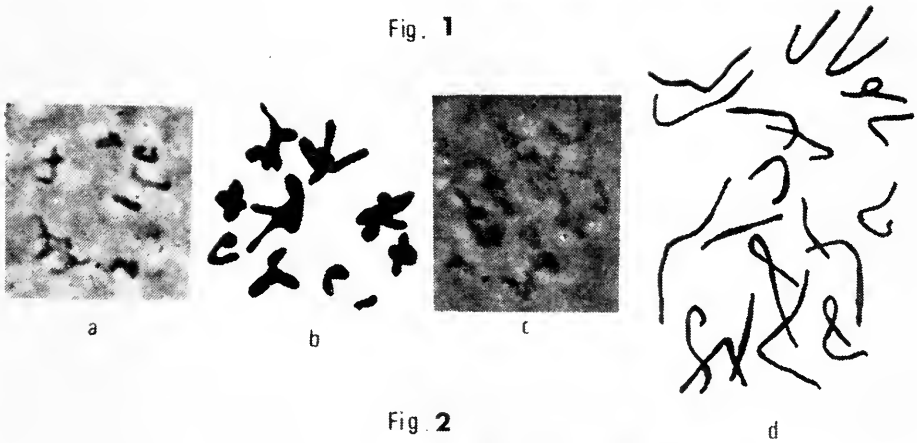


Fig. 2

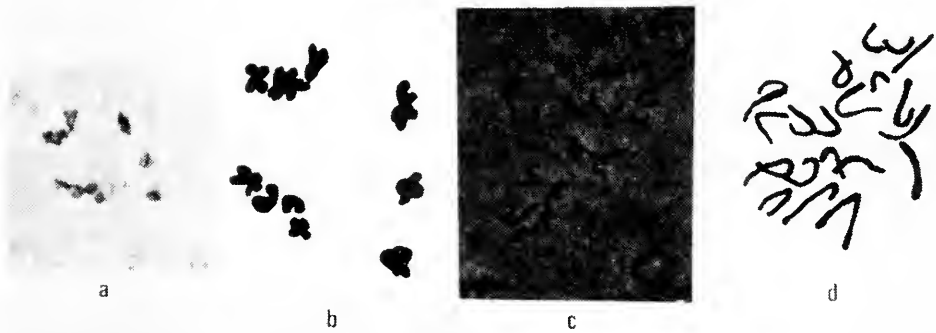


Fig. 3

Fig. 1, *Mytilus edulis*. $N=12$; $2N=24$. a, photomicrograph of metaphase meiosis. b, drawing of photomicrograph a. c, photomicrograph of mitotic prophase; all chromosomes not in focus.

Fig. 2, *Crassostrea amasa*. $N=10$; $2N=20$. a, photomicrograph of metaphase meiosis. b, drawing of metaphase meiosis. c, metaphase mitosis; all chromosomes not in focus. d, drawing of late prophase mitosis.

Fig. 3, *C. angulata*. $N=10$; $2N=20$. a, photomicrograph of metaphase meiosis. b, drawing of a. c, metaphase mitosis. d, drawing of c.

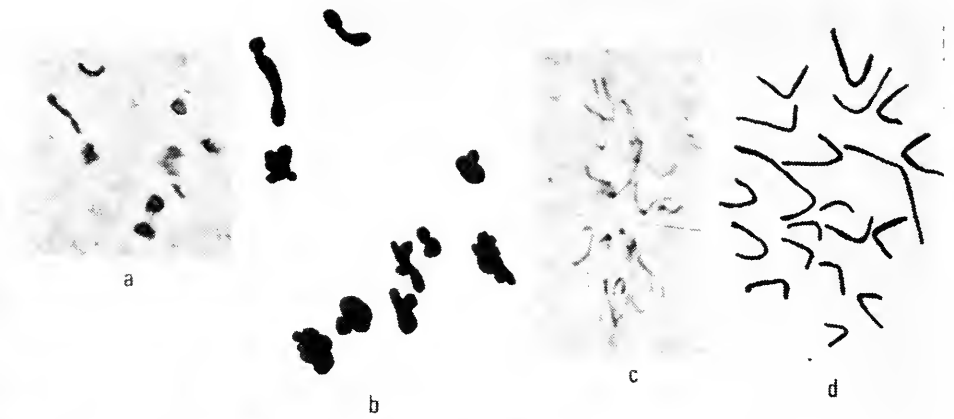


Fig. 4.

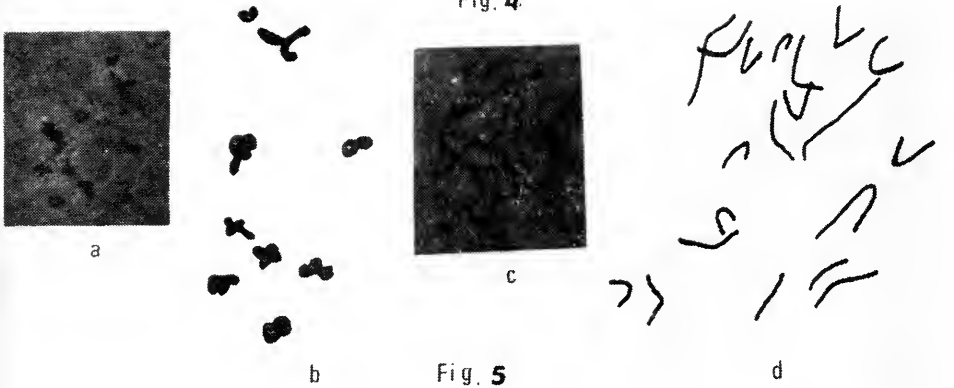


Fig. 5

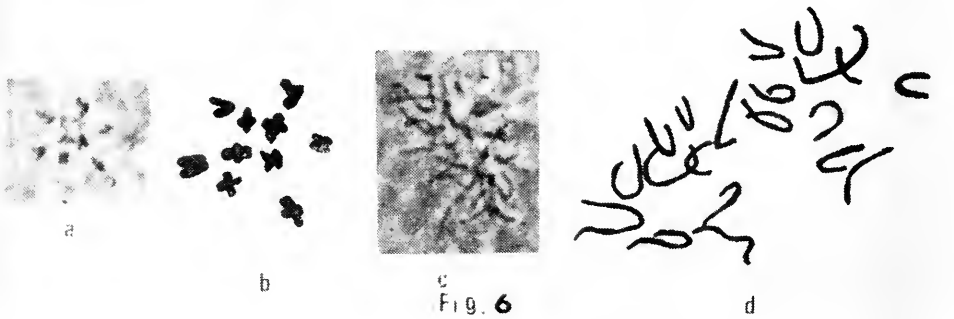


Fig. 6

Fig. 4, *Crassostrea commercialis*. $N=10$; $2N=20$. a. photomicrograph of metaphase meiosis. b. drawing of a. c. metaphase mitosis; all chromosomes not in focus. d. drawing of metaphase mitosis.

Fig. 5, *C. iredalei*. $N=10$; $2N=20$. a. photomicrograph of metaphase meiosis. b. drawing of a. c. metaphase mitosis. d. drawing of metaphase mitosis.

Fig. 6, *C. gigas*. $N=10$; $2N=20$. a. photomicrograph of metaphase meiosis. b. drawing of a. c. metaphase mitosis; all chromosomes not in focus. d. drawing of metaphase mitosis.

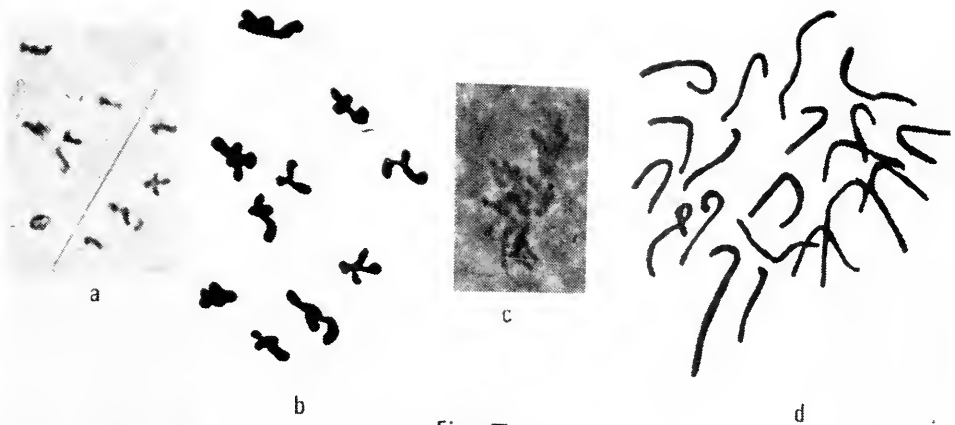


Fig. 7

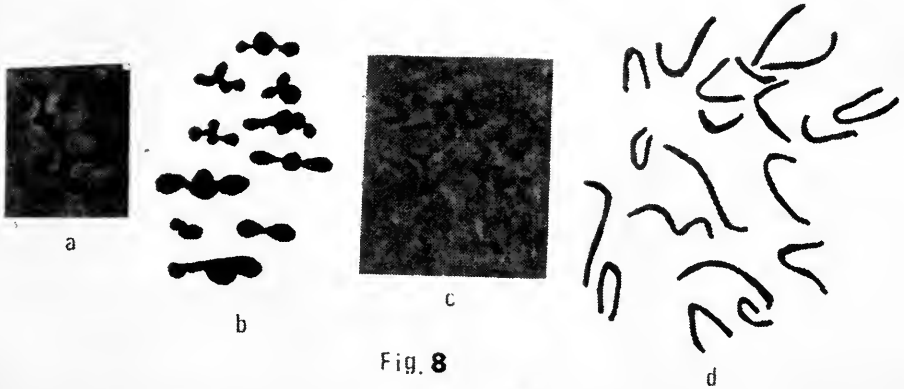


Fig. 8

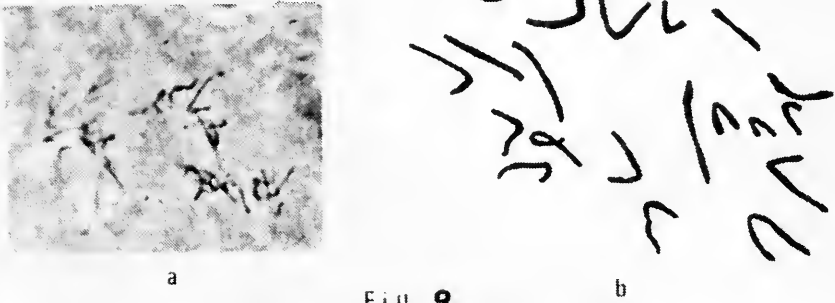


Fig. 9

Fig. 7. *Crassostrea rhizophorae*. $N=10$; $2 N=20$. a, photomicrograph of metaphase meiosis. b, drawing of a. c, metaphase mitosis; all chromosomes not in focus. d, drawing of metaphase mitosis.

Fig. 8. *C. virginica*. $N=10$; $2 N=20$. a, photomicrograph of metaphase meiosis. b, drawing of metaphase meiosis. c, metaphase mitosis. d, drawing of metaphase mitosis.

Fig. 9. *Ostrea equestris*. $2 N=20$. a, photomicrograph of late prophase mitosis; all chromosomes not in focus. b, drawing of late prophase mitosis.

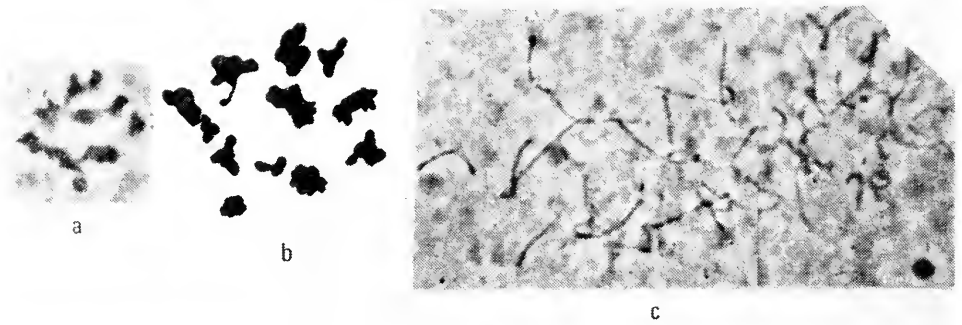


Fig. 10



Fig. 11



Fig. 12

Fig. 10, *Dinocardium rubustum*. $N=12$; $2N=24$. a, photomicrograph of metaphase meiosis. b, drawing of a. c, prophase mitosis.

Fig. 11, *Chione cancellata*. $N=19$; $2N=38$. a, photomicrograph of metaphase meiosis. b, drawing of metaphase meiosis. c, prophase mitosis; all chromosomes not in focus.

Fig. 12, *Petricola pholadiformis*. $N=23$; $2N=46$. a, photomicrograph of metaphase meiosis. b, drawing of metaphase meiosis. c, metaphase mitosis; all chromosomes not in focus.

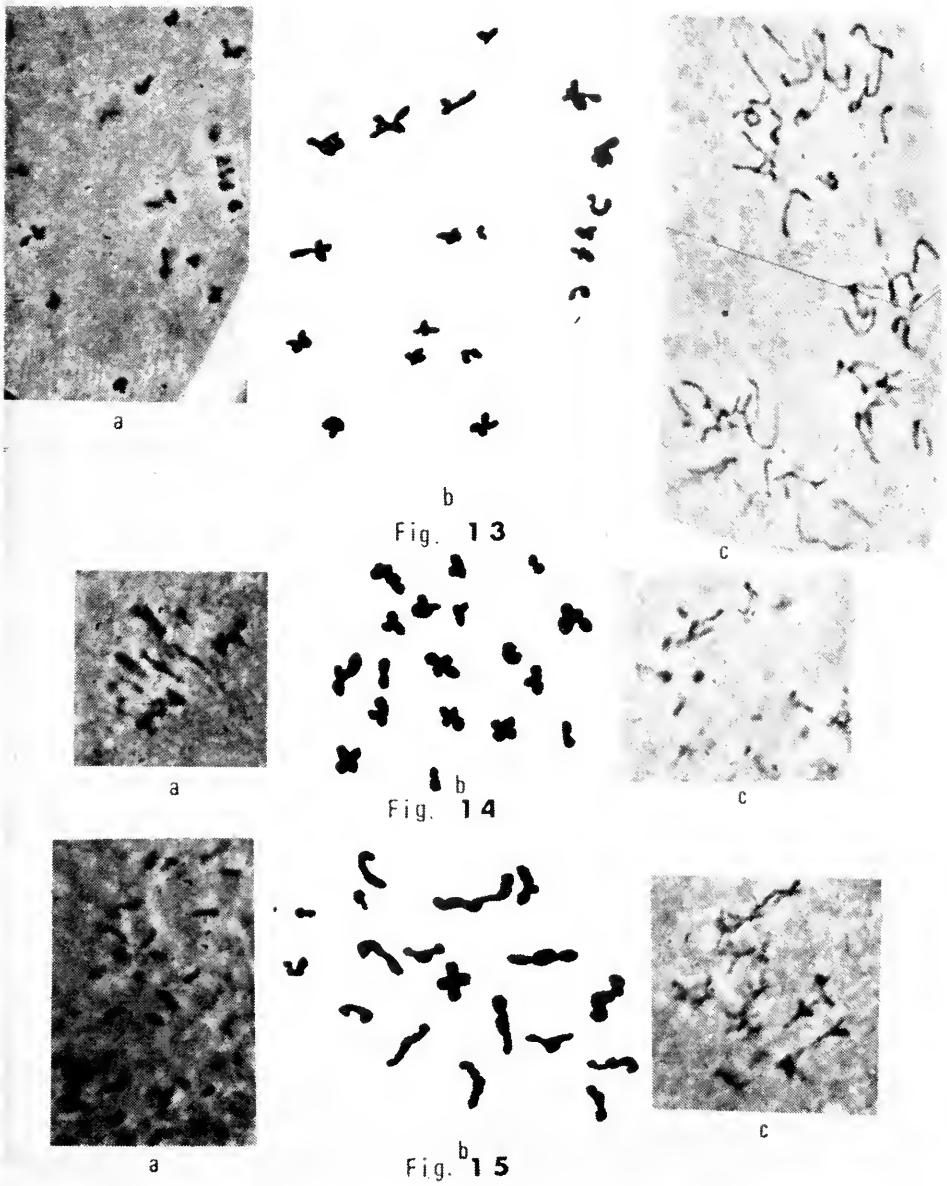


Fig. 13, *Donax variabilis*. N=19; 2 N=38. a, photomicrograph of metaphase meiosis. b, drawing of a. c, prophase mitosis; all chromosomes not in focus.

Fig. 14, *Labiosa plicatella*. N=18; 2 N=36. a, photomicrograph of metaphase meiosis. b, drawing of metaphase meiosis. c, metaphase mitosis; all chromosomes not in focus.

Fig. 15, *Mulinia lateralis*. N=18; 2 N=36. a, photomicrograph of metaphase meiosis. b, drawing of metaphase meiosis. c, metaphase mitosis; all chromosomes not in focus.

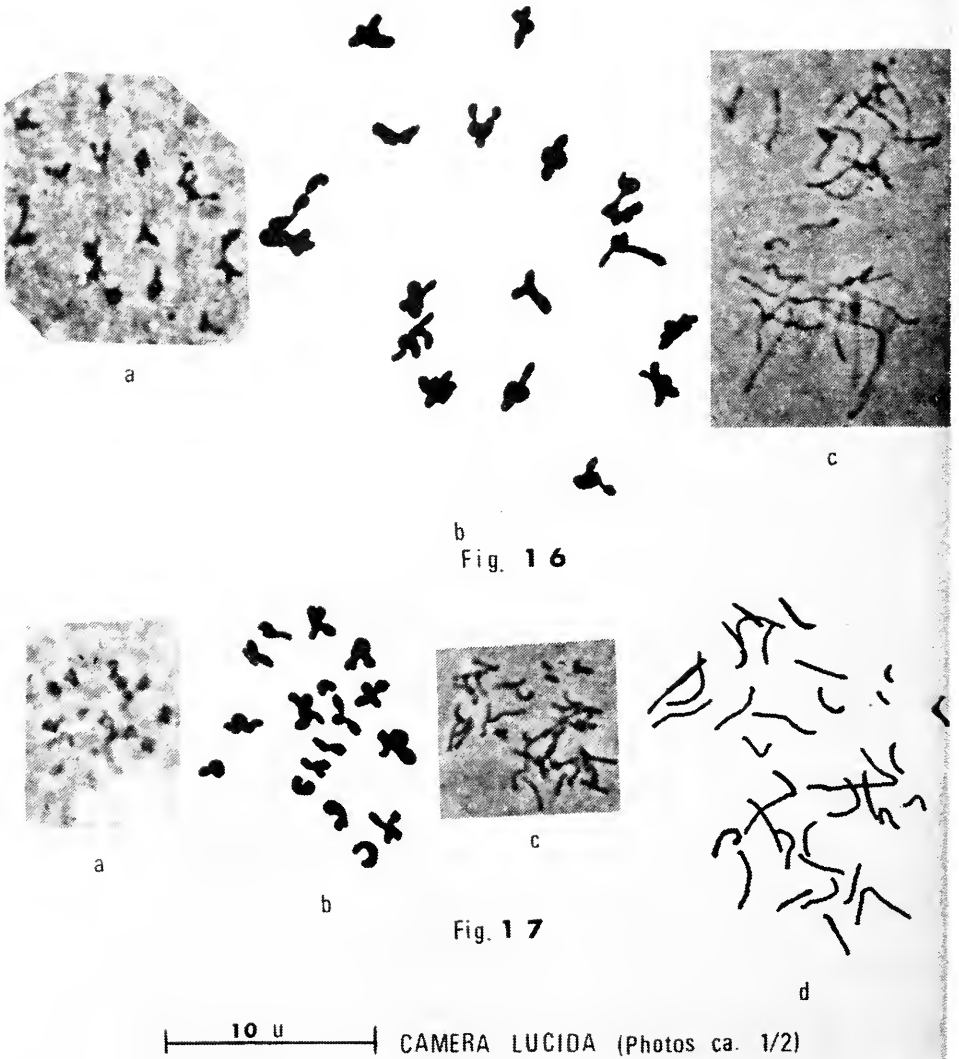


Fig. 16, *Cyrtopleura costata*. $N=17$; $2N=34$, a, photomicrograph of metaphase meiosis. b, drawing of a. c, prophase mitosis; all chromosomes not in focus.

Fig. 17, *Barnea truncata*. $N=17$; $2N=34$. a, photomicrograph of metaphase meiosis. b, drawing of a. c, photomicrograph of metaphase mitosis. d, drawing of c.

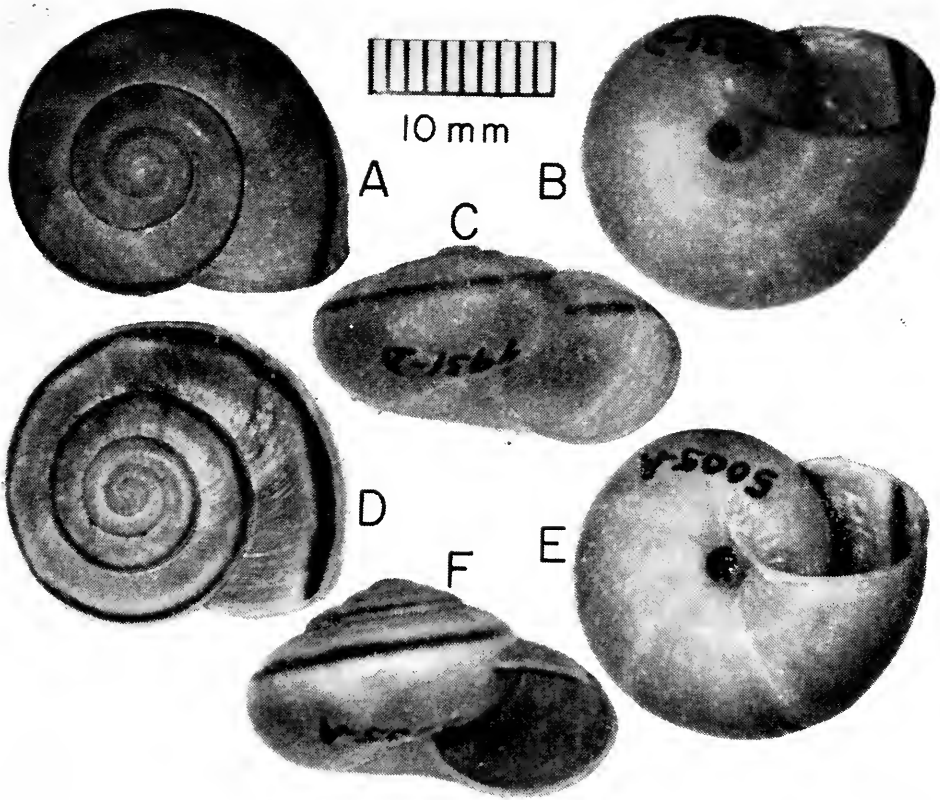


Figure 1: Holotypes. A-C. *Sonorella waltoui* W.B. Miller. D-F. *S. coloradoensis mohaveana* W. B. Miller.

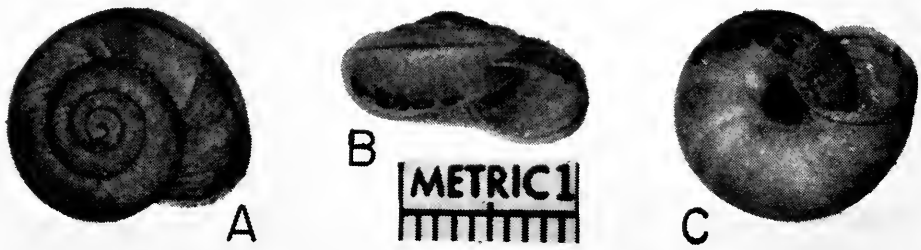


Figure 2: A-C. *Sonorella superstitionis* subsp. W. B. Miller.

ella hachitana peloncillensis Pilsbry and Ferriss.

Spurred by this record, Munroe L. Walton made two trips to the vicinity of Doubtful Canyon in 1955 and 1960 and collected large quantities of dead shells in a rockslide in West Doubtful Canyon, about two miles from Doubtful Canyon. On 23 Oct.

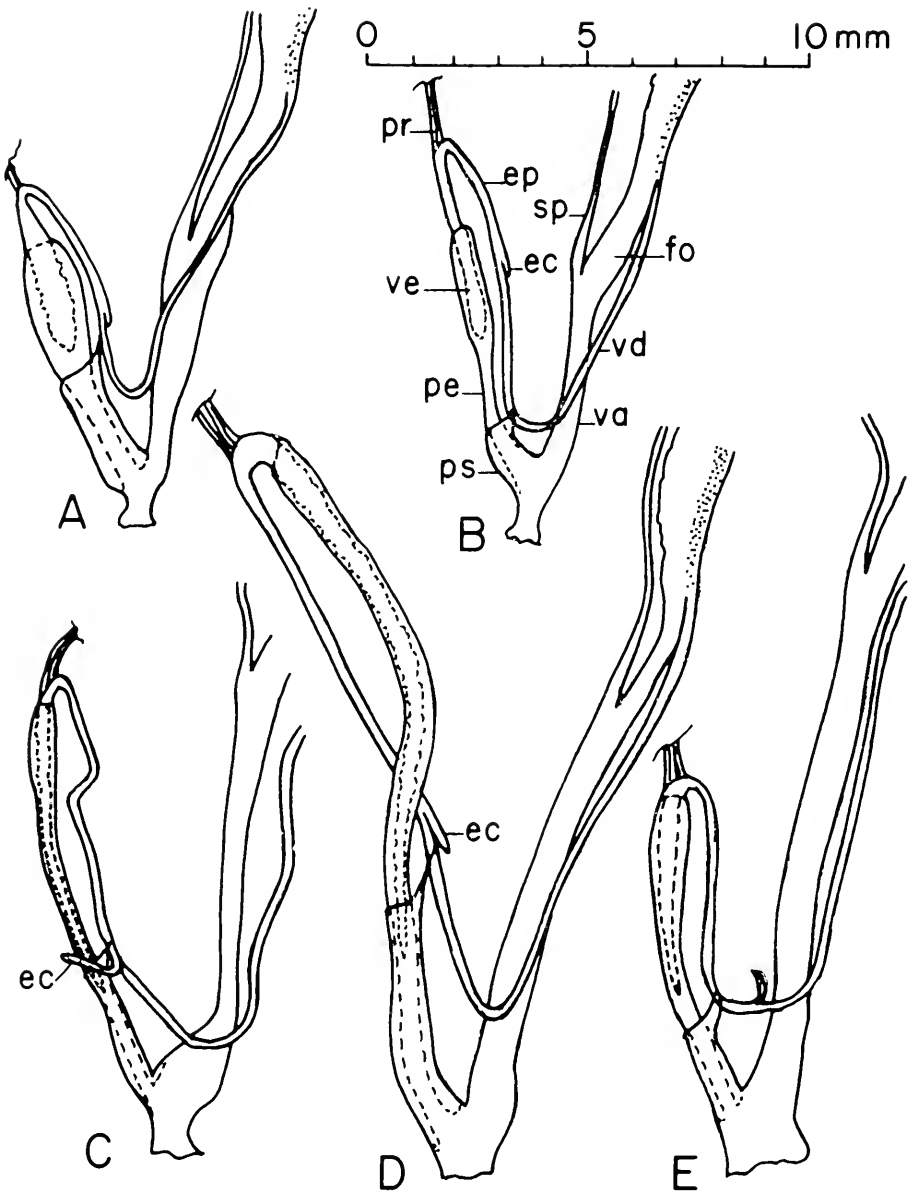


Figure 3: Lower genitalia. A. *Sonorella coloradoensis coloradoensis* (Stearns), #4908-D, Bright Angel trail. B. Holotype, *S. coloradoensis mohaveana* W.B. Miller. C. *S. hachitana peloncillensis* Pilsbry & Ferriss, #4987-A, Skull Canyon, Peloncillo Mts. D. Holotype, *S. waltoni* W.B. Miller. E. *S. caerulifluminis* Pilsbry & Ferriss, #4964-A, Tollgate Canyon, Peloncillo Mts. ec, epiphallic caecum; ep, epiphallus; fo, free oviduct; pe, penis; pr, penial retractor; ps, penial sheath; sp, spermathecal duct; va, vagina; vd, vas deferens; ve, verge. All drawings to scale indicated, from stained whole mounts.

1966, a determined assault on this slide by Munroe L. Walton, Albert R. Mead, Joseph C. Bequaert, and the author resulted in obtaining many dead shells as well as over a dozen live specimens. Dissections of the animals revealed that these specimens were significantly different from topotypes of *S. h. peloncillensis* and represented a new species, described below.

SONORELLA WALTONI new species.

Figure 1, A-C.

Description: Shell depressed-globose, heliciform, thin, glossy, light tan, with chestnut spiral band on the well-rounded shoulder; umbilicate, the umbilicus contained about 8 times in the diameter. Embryonic shell of about $1\frac{1}{4}$ whorls with sculpture of the *hachitana* type; its apex silky smooth, not glossy; the first half whorl with weak, irregular, radial wrinkles, the remainder of the embryonic shell with thin, microscopic, raised striae arranged in some ascending but mostly descending spirals, superimposed over the radial wrinkles. Post-embryonic whorls marked with light growth wrinkles and scars of worn-off periostracal projections; these scars becoming sparse to absent on the body whorl. The periostracum presents a silky, lustrous appearance. The last whorl descends slightly and abruptly to the peristome. Aperture oblique, rounded, slightly wider than high. Peristome slightly expanded, the margins converging; parietal callus very thin.

Holotype measurements: Height 11.2 mm; max. diam. 19.8 mm; umbilicus 2.6 mm; whorls $4\frac{1}{4}$.

Genitalia of holotype (Fig. 3, D): The long penis is of the *hachitana* type, with a long, thin, annulated, tapered verge; the orifice of the seminal duct at the apex of the verge. The epiphallus is about $\frac{3}{5}$ the length of the penis and bears a distinct, well-detached epiphallic caecum. Penial sheath about $\frac{1}{3}$ the length of the penis.

The vagina is about $\frac{1}{2}$ the length of the penis and is slightly swollen at the base. The free oviduct, spermathecal duct, and spermatheca have the usual proportions of such structures in the group of *hachitana*.

Type locality: West Doubtful Canyon, Peloncillo Mts., Cochise Co., Arizona, in a NE-facing rockslide along the right bank, at R 32 E, T 13 S, Sec. 9, NW $\frac{1}{4}$ (San Simon, 1950, topo. quadrangle); elevation ca. 4800 ft. (Munroe L. Walton, Albert R. Mead, Joseph C. Bequaert, and Walter B. Miller, 23 Oct. 1966). Holotype ANSP 314848. Paratypes in collections of ANSP.

(314849), Dep't. of Biological Sciences, University of Arizona (3007), Munroe L. Walton (9297), and the author (4931).

In shell characteristics, *S. waltoni* has a smaller diameter than any of its nearest, described, geographical relatives except for some forms of *S. hachitana orientis* from the Organ Mts. of New Mexico and vicinity. In the type lot of over 60 specimens, the largest has a diameter of 21.9 mm. while the smallest measures 17.3. The embryonic spiral threads show variation from closely spaced, mostly descending on the holotype to more widely spaced, equally ascending and descending on some paratypes. They are always present on fresh specimens. The chestnut-brown shoulder band varies from wide and dark on some specimens, to narrow and lighter on others; a few specimens are completely bandless.

The genitalia of *S. waltoni* are most distinctive. They have a considerably longer penis and verge than any of the known New Mexico populations of the group of *S. hachitana*, as well as its nearest geographical relatives in the Peloncillo Mts., namely *S. h. peloncillensis* (Figure 3: C) from Skull Canyon at the southern end of the range and *S. caerulifluminis* (Figure 3: E) from Tollgate Canyon at the northern end of the range. Comparative measurements of the subspecies of *S. hachitana* are listed in Pilsbry (1939, p. 275). Comparative measurements of genitalia (in mm.) of *S. waltoni*, *S. h. peloncillensis*, and *S. caerulifluminis* are listed below:

	Penis	Verge	Epiphallus	Vagina
<i>S. waltoni</i> (holotype)	17	12	10	9
<i>S. waltoni</i> (paratype A)	16	13	10	9
<i>S. waltoni</i> (paratype B)	16	13.5	9	9
<i>S. waltoni</i> (paratype C)	18	12.5	11	9
<i>S. h. peloncillensis</i> (topotype 4987-A)	9	7	8	9
<i>S. h. peloncillensis</i> (topotype 4987-B)	10	7.5	8.5	9
<i>S. caerulifluminis</i> (Blue River at Pigeon Ck, my #4964-A)	8	4.5	7	12
<i>S. caerulifluminis</i> (Tollgate Canyon, my #4941-A)	9	6	7	13

S. waltoni is known only from the type locality. Probably it exists also in other slides in West Doubtful Canyon as well as in slides in the nearby Doubtful Canyon and Little Doubtful Canyon. It probably evolved from a common ancestor of *S. h. peloncillensis* and *S. caerulifluminis* through geographical isolation and genetic drift.

It is named after Munroe L. Walton, an eminent malacologist and friend, who has searched for and collected *Sonorella* for over 20 years and who first located the type population of this species.

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- Pilsbry, H. A. 1939. Land mollusca of North America (north of Mexico). Acad. Nat. Sci. Philadelphia, Monogr. 3, v. 1, pt. 1, 573 p.
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FOUR NEW SPECIES OF LAND SNAILS

BY LESLIE HUBRICHT

GLYPHYALINIA RIMULA, new species.

Figure 1, A-C.

Shell small, strongly depressed, pale coppery (when fresh), glossy, thin and translucent, spire very low conoid. Whorls 4.5 to 5, well rounded, gradually and uniformly increasing except for more rapid expansion on last half of last whorl, sutures moderately impressed. Sculpture of rather widely spaced radial furrows (34 distinct furrows on last whorl of holotype), very faint spiral sculpture visible in places at a magnification of 30x. Aperture lunate; lip thin, sinuous, with a tongue-like callus at the columellar end which partially covers the umbilicus. Umbilicus rimate.

Height 3.4 mm., diameter 7.7 mm., aperture height 3.0 mm., aperture width 4.0 mm., 4.5 whorls. Holotype.

Animal pale gray. Penis cylindrical, moderately stout; clearly separated into an apical and basal chamber. The apical chamber about one-fourth the length of the penis. Retractor short and stout, attached a little below the end of the penis. Epiphallus about one-half as long as the penis, sessile, attached to the base of the apical chamber, very stout, enlarged towards the distal end, distal end about twice the diameter of the penis. Vagina

very short. Free oviduct about one-half as long as the penis. Spermatheca ovoid, duct about twice as long as the spermatheca and about half as wide.

Distribution: Tennessee: Clay Co.: cedar woods, 2 miles southeast of Celina. Overton Co.: river bluff, 3.7 miles east of Alpine. Cannon Co.: in Tenpenny Cave, 2 miles northwest of Woodbury (Stewart B. Peck & Alan Fiske, colls.) holotype 156937, paratypes 156938, Field Museum of Natural History, other paratypes 36847 collection of the author; in Henpeck Mill Cave, 1.7 miles northeast of Woodbury (Peck & Fiske, colls.).

Glyphyalinia rimula appears to be most closely related to *Glyphyalinia solida* (H. B. Baker). The shell differs in that the tongue-like callus does not completely cover the umbilicus. Anatomically it differs notably in the presence of a small extension of the penis beyond the retractor and in the shape of the epiphallus.

GLYPHYALINIA LATEBRICOLA, new species.

Fig. 1, D-F.

Shell small, strongly depressed, nearly transparent with a whitish wash, glossy, spire very low conoid. Whorls 5 to 5.5, well rounded, gradually and uniformly increasing, sutures moderately impressed. Sculpture of radial furrows (55 distinct furrows on last whorl of holotype), and distinct spiral striae visible under 30x magnification. Aperture lunate; lip thin, sinuous, with a tongue-like callus at the columellar end which partially covers the umbilicus. Umbilicus rimate. Base of shell deeply impressed around the umbilicus.

Height 3.1 mm., diameter 6.3 mm., aperture height 2.4 mm., aperture width 2.9 mm., 5.3 whorls. Holotype.

Animal nearly white, with some black flecking on the back. Penis claviform, stout; retractor short and stout, attached below the end of the penis. Epiphallus about one-half as long as the penis, very stout, the distal end bifurcate with the vas deferens attached to the end of one of the lobes; epiphallus attached to the penis opposite the insertion of the retractor and a little below it. Vagina short. Free oviduct about one-half as long as the penis. Spermatheca ovoid, duct a little longer than the spermatheca and the same width.

Distribution: Alabama: Madison Co.: on the undersides of stones, base of Burwell Mtn., east of Jeff, holotype 156939, paratypes 156940 F.M.N.H., other paratypes 35336 collection of the

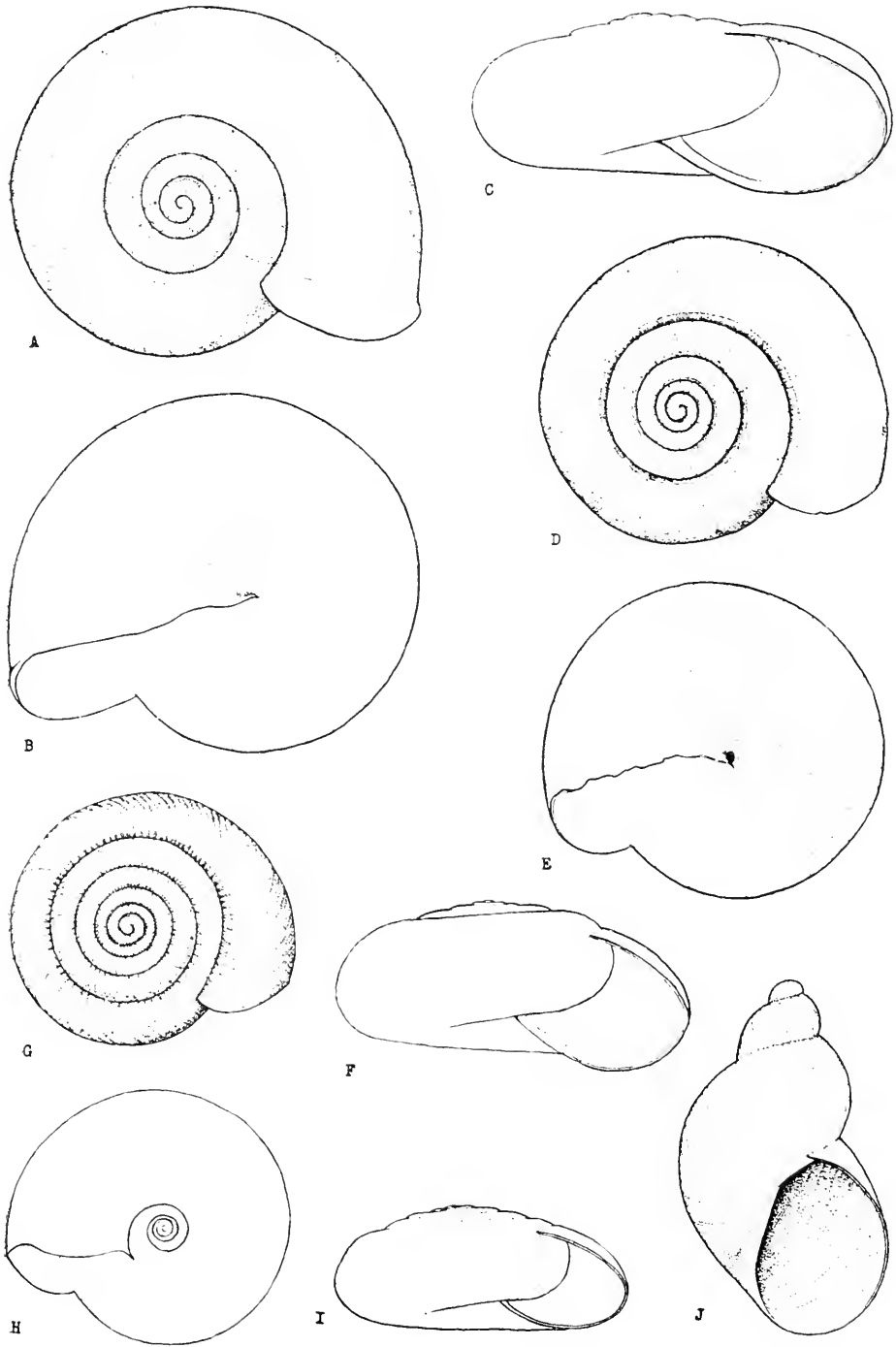


Figure 1: Holotypes. A-C, *Glyphyalinia rimula* Hubricht. D-F, *G. latebricola* Hubricht. G-I, *Paravitrea grimmi* Hubricht. J, *Catinella aprica* Hubricht. Drawings by Field Museum of Natural History.

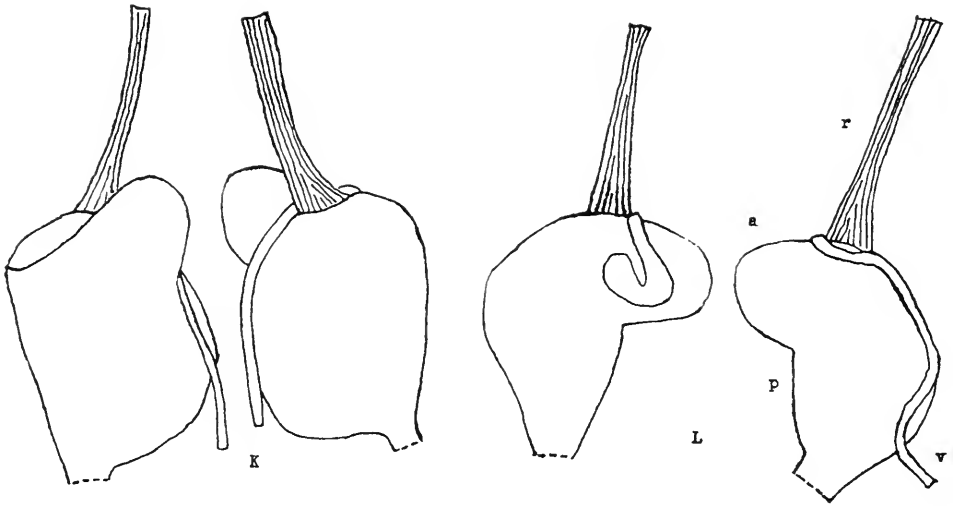


Figure 2: K-L. *Catinella aprica* Hubricht. Left and right views of two penises. p. penis. a. appendix. v. vas deferens. r. retractor.

author. Jackson Co.: in Doug Green Cave, 2 miles northwest of Swain (Stewart B. Peck, coll.).

Glyphyalinia latebricola is most closely related to *Glyphyalinia praecox* (H. B. Baker), differing in the much shorter "flagellum" of the penis; and in the stouter, distinctly bifurcated epiphallus. The shell is most likely to be confused with that of *Glyphyalinia cryptomphala* (Clapp). It has the same whitish color but the umbilicus is not completely covered.

Glyphyalinia latebricola, *G. rimula*, and *G. luticola* Hubricht represent a connecting series between *Glyphyalinia* s. s. and Section *Glyphognomon* H. B. Baker. The conspicuous differences which were present in the species known at the time *Glyphognomon* was described no longer exist, and *Glyphognomon* must be placed in the synonymy of *Glyphyalinia* s. s.

PARAVITREA GRIMMI, new species.

Fig. 1, G-I.

Shell small, pale buff, subhyaline, shining; spire low, convex, with shallow sutures. Whorls 6 to 6.5 slowly increasing, last whorl increasing more rapidly. Periphery rounded, becoming somewhat flattened above near the aperture. Umbilicus deep, well-like, occupying about 17% of the diameter of immature shells but enlarging to about 23% in the last whorl of mature shells. Aperture somewhat oblique, lunate, wider than high, somewhat flattened on the base and above. Lip thin, simple. Sculpture of numerous irregularly spaced radial grooves and

growth wrinkles, distinct above but becoming obsolete on the base. Teeth absent at all stages of growth. Base flattened around the umbilicus.

Diameter 5.2 mm., height 2.4 mm., aperture width 2.2 mm., aperture height 1.7 mm., umbilicus 1.2 mm., 6 whorls. Holotype.

Animal pale slate colored. Penis clearly separable into a basal and apical section; basal section cylindrical, short and very stout; apical section attached to the side of the basal section at the distal end, very slender, a little less than one-half as long as the basal section. Retractor slender, about as long as the apical section of the penis. Epiphallus about four times as long as the penis and attached at the distal end of the apical section; a basal section about as long as the penis very slender, the rest about the same diameter as the apical section of the penis. Vagina about as long as the penis. Free oviduct very short. Spermatheca as long as the basal section of the penis and about as wide; duct about twice as long as the penis, rather slender.

Distribution: Virginia: Alleghany Co.: under leaves on a sparsely wooded limestone hillside near an old quarry, 9 miles north-northeast of Covington, holotype 156935 paratypes 156936 F.M.N.H., other paratypes 36263 collection of the author.

Paravitrea grimmi clearly differs from all other species for which the anatomy is known in its peculiar penis and in its very long epiphallus. The shell is most likely to be confused with that of *P. petrophila* (Bland) but the base is more flattened and the umbilicus enlarges more in the last whorl. From *P. blarina* Hubricht it differs in its larger size.

This species is named for F. Wayne Grimm who first found it. *Paravitrea capsella lacteodens* (Pilsbry)

Pilsbry recorded three localities for this subspecies: the type locality, "Ramp Cove," Tuskegee Mtn., Graham Co., North Carolina; Wetumpka, Alabama; and Rock Bluff, Liberty Co., Florida. Through the courtesy of Dr. R. Tucker Abbott I was able to examine these specimens. The specimen from Florida is a slightly immature *Paravitrea conecuhensis* (Clapp). The specimens from Wetumpka are of an undescribed species similar to *P. pilsbryana* (Clapp) but with a smaller umbilicus. The specimens of the type lot do not appear to be fully mature and do not look like a form of *P. capsella*. I tried to find the type locality but was unsuccessful. According to people who have lived all of their

lives at its base there are no ramps growing on Tuskegee Mtn., hence no "Ramp Cove." I found typical *P. capsella* (Gould) at two places on Cheoah Mtn., which is the first mountain south of Tuskegee Mtn., but did not find any *Paravitrea* on Tuskegee Mtn. Until this subspecies can be found at the type locality and dissected its status will remain in doubt. It may be a form of *P. placentula* (Shuttleworth) or it may be a good species.

Helicodiscus inermis H. B. Baker

Helicodiscus singleyanus inermis H. B. Baker, 1929, *Nautilus* 42: 86.

Helicodiscus (Hebetodiscus) intermedius Morrison, 1942, *Bureau Amer. Ethnology Bull.* 129, p. 378.

I could find no difference between topotypes of *H. intermedius* supplied to me by Dr. Morrison and specimens of *H. inermis*. He reported that *H. intermedius* occurred with *H. s. inermis* and was readily separable. However, specimens of the latter which he kindly sent to me for examination proved to be a mixture of *H. singleyanus* (Pilsbry) and *H. hadenoecus* Hubricht.

I found *H. inermis* associated with *H. singleyanus* in drift of the Guadalupe and Pecos Rivers in Texas and in several Pleistocene deposits in the vicinity of St. Louis, Missouri and I could always separate them readily.

Succinea barberi (Marshall)

Lymnaea barberi Marshall, 1926, *Proc. U. S. Nat. Mus.* 68 (11): 1-4. *L. aperta* Marshall, loc. cit.

Succinea sanibelensis Rehder, 1933, *Nautilus* 47: 20.

Oxyloma sanibelensis (Rehder), Pilsbry, 1948, *Acad. Nat. Sci. Philadelphia, Mono.* 3, vol. II, p. 793.

O. barberi (Marshall), Taylor, D. W., 1966, *Malacologia* 4: 114.

This species was collected in a salt-marsh on the south side of the causeway opposite Woody's Motel, 3 miles west of Bridgehead, Baldwin Co., Alabama. Upon dissection it was found to belong in the genus *Succinea* rather than in *Oxyloma* where it would appear to belong from the shell. The penis is rather long and slender with a large terminal loop.

CATINELLA APRICA, new species.

Figs. 1 (J) & 2 (K-L).

Shell small, thin, usually bright reddish-gold, translucent, shining. Whorls 3 to 3.5, well rounded, sutures deep, sculpture of unevenly spaced growth wrinkles. Aperture ovate, occupying about 50% of the length of the shell, outer and basal margins well

rounded. There is usually a slight angle at the junction of the columella with the parietal wall.

Height 6.3 mm., diameter 3.5 mm., aperture height 3.3 mm., aperture width 2.4 mm., 3.3 whorls. Holotype.

Mantle and sides of foot deep chocolate. Penis very short and broad; appendix short, about as broad as long, subapical; retractor about as long as the penis, slender, attached at the apex of the penis. Vas deferens entering the penis below the apex, inflated at point of entry, looping downward before turning upward and gradually narrowing to usually pass between the retractor and the appendix. Spermatheca large, globose, duct rather long, slender. Prostate gland large, oval but somewhat distorted by pressure of surrounding organs. Hermaphrodite duct usually well pigmented. Talon very dark, club-shaped with a terminal notch.

Distribution: Alabama: Washington Co.: cedar glade, 1.5 miles north of St. Stephens, holotype 156933 and paratypes 156934 F.M.N.H., other paratypes 34410 collection of the author. Clarke Co.: cedar glade, 2 miles south of Suggsville. Sumter Co.: cedar glade, 4.5 miles northeast of Livingston. *Mississippi:* Clay Co.: Selma Chalk, 0.6 miles west of Trebloc; Selma Chalk, 3.5 miles south of McCondy. Oktibbaha Co.: cedar glade, 1.0 mile southwest of Osborn. Kemper Co.: roadside, 3.8 miles northwest of Scooba. Jasper Co.: roadside, 2.5 miles southwest of Rose Hill.

Catinella aprica is most closely related to *Catinella oklahomarum* (Webb); differing in the smaller, more brightly colored shell with proportionately longer spire. Anatomically it differs in the usually shorter and broader appendix on the penis. The anatomical differences are not absolute, as there is some intergradation. As in some species of *Succinea*, the shell must be relied upon for specific identification. The shell of *C. oklahomarum* is larger with a shorter spire and larger aperture and the color is more greenish. The habitat of the two species is quite different. *C. oklahomarum* is a woodland species, found usually in pine or oak woods which are usually somewhat acid; and specimens are usually few in numbers. *C. aprica* is a sun-loving calciphile, which when found is usually abundant.

Most references in the literature to the habitat of Succineidae state that they are found in marshes, near bodies of water, and

in other wet places. While this may be true for *Oxyloma* it is certainly not true for some species of *Succinea* and *Catinella*. These genera contain some of the most xerophilous land snails known from the eastern United States.

THIRTY-FOURTH ANNUAL MEETING OF THE AMERICAN MALACOLOGICAL UNION

BY MARGARET C. TESKEY, AMU. Secretary

Hosted by six Texas shell clubs, the American Malacological Union held its thirty-fourth annual meeting July 15 to 19, 1968, in Corpus Christi, Texas. President Arthur H. Clarke, Jr. presided over the following papers:

Activities of *Strophocheilus oblongus*. Ozro B. Wiswell. Some physiological aspects of *Strophocheilus oblongus*. Ozro B. Wiswell. Studies on the distribution of presumed hemaglobin in bivalve Mollusca. Harold W. Harry. Small beginnings. Adlai B. Wheel, Sr. Larval development of the commensal bivalve *Montacuta percompressa*. Paul Chanley. Density and distribution of the ocean quahog. Arthur S. Merrill and John W. Ropes. Establishment of a trematode cycle in *Tarebia granifera* (Lamarck) in Texas. Harold D. Murray. Studies in the life history of the naiad *Amblema plicata* (Say, 1817). Carol B. Stein. Formation, regeneration, pigmentation and luminosity. Mrs. C. J. Siekman. Observations on western Atlantic Caecidae. Donald R. Moore. Mollusks of Project Hourglass. William G. Lyons. Notes on Periplomatidae (Pelecypoda, Anomalodesmata). Joseph Rosewater.

Symposium on rare and endangered North American mollusks. Atlantic, Caribbean and Gulf of Mexico marine mollusks. R. Tucker Abbott. [Discussant: Kenneth J. Boss.] Pacific marine mollusks. A. Myra Keen. [Discussant: William K. Emerson.] Brackish-water mollusks. J. P. E. Morrison. Eastern freshwater mollusks (1). David H. Stansbery. Eastern freshwater mollusks (2). William H. Heard. [Discussants: H. D. Athearn, A. H. Clarke.] Western freshwater mollusks. Dwight W. Taylor. Eastern land snails. William J. Clench. [Discussant: Dee S. Dundee.] Western land snails. Allyn G. Smith. [Discussant: Joseph C. Bequaert.]

Abundance, local variation and brood pouch formation in

Libera fratercula from Rarotonga, Cook Islands. Alan Solem. A "gastropod" bivalve, commensal on *Squilla emposa*. Charles E. Jenner and Anne B. McCrary. Spirogyphics: A study in species associations. Joseph P. E. Morrison. Pyrimidine catabolism by some gastropods. Stephen H. Bishop. Mollusks of El Paso County, westernmost Texas. Artie L. Metcalf. Notes on captive *Cerithium variabile* C. B. Adams and *Mitra floridana* Dall. Dorothy Raeihle. A collection of marine Mollusca from the northwestern part of the Gulf of Mexico. Helmer Odé. The marine mollusks of the Marquesas Islands. Harald A. Rehder. Heterodont affinities of the Lucinacea. Kenneth J. Boss. Literary mollusks. Morris K. Jacobson. An immunological approach to lymnaeid systematics. John B. Burch and G. K. Lindsay. More about introduced mollusks. Dee S. Dundee. Some faunal-oral-substrate interrelationships at low tide. Fay H. Wolfson. Ecology and distribution of the micro-mollusks of the Laguna de Tamiahua, Veracruz, Mexico. Antonio Garcia-Cubas. Biological studies in the Teredinidae. Ruth D. Turner and A. C. Johnson. Sexual dimorphism in erycinacean bivalves. Charles E. Jenner and Anne B. McCrary. Interesting mollusks from Brazilian fishes. William E. Old, Jr. Remarks on the Cuban genera of Vianinae, formerly *Eutrochastella*. Morris K. Jacobson. Prevention of reaggregation of disaggregated molluscan cells. Vera King Farris. Reaggregation of multiple organs from dissociated molluscan cells. Vera King Farris. Analysis of quantitative records of Mollusca in Pleistocene lakes of Ohio. Aurèle La Rocque. The systematic position of the Athoracophoridae. John B. Burch and Charlotte M. Patterson.

The following officers were elected to serve in 1968-1969: President, Joseph Rosewater. Vice-president, G. Alan Solem. Second Vice-president (Chairman, AMU. Pacific Division) Bruce G. Campbell. Secretary, Margaret C. Teskey. Treasurer, Mrs. Horace B. Baker. Publications Editor, Morris K. Jacobson. Councillors-at-large, Donald R. Moore, Robert Robertson, Donald R. Shasky, Myra Taylor.

The 1969 meeting will be held July 21-25, 1969, in Marinette, Wisconsin, and all interested persons, especially those specializing in land and fresh-water mollusks, are invited to attend.

NOTES AND NEWS

HARRY R. TURVER. January 8, 1892 - April 1, 1968.—The death of Harry R. Turver is reported with regret. He was born in Yorkshire, England. For 44 years Harry was employed as paleontologist by the Standard Oil Company. He and his wife, Mary, lived in Santa Cruz, California, for many years, and while there they collected mollusks and started a marine aquarium museum. He was the curator. In 1945 they moved to southern California, and a few years later Harry was president of the Long Beach Shell Club. Mrs. Turver was president of the Conchological Club of Southern California in 1955. They were always free with their help to others. They made many collecting trips south of the border. Their collection was world wide. After retirement they moved to Yucaipa, California, where his time was divided between shells and the painting of many beautiful pictures. Mrs. Turver has given their large collection to the Natural History Museum of San Diego.—ROSE A. BURCH

FRED R. TOBLEMAN. 1892-1968. — Fred Tobleman of Ocean Grove, New Jersey, died July 2nd, in a local medical center. He was born in Newark, N. J., retired 25 years ago as New York jeweler, and is survived by his wife Minnie. He collected mollusks most of his life, was an original member of the American Malacological Union and of the New York Shell Club, and, because of his interest in radulae, was a life member of the N. Y. Microscopical Society. His colleagues will miss him. — H. B. B.

INTERSPECIFIC COMPETITION between *Bithynia* and pleurocerids — Since my article "Replacement of pleurocerids by *Bithynia* in polluted waters of central New York" appeared in the *Nautilus* (Harman, 1968), several persons have asked about the mode of competition between these 2 groups of gastropods. This note is an attempt to explain these processes.

In all biotopes where pleurocerids occur they feed by grazing on the substrate. *Bithynia tentaculata* can acquire food in much the same manner, but it also possesses filter feeding capabilities (Jorgensen, 1966). New York State's culturally enriched waters contain high densities of suspended organic matter. Large populations of *Bithynia* congregate in these environments, strongly reminding

one of sessile, marine filter feeders. Apparently *Bithynia* is utilizing suspended organic matter for food in these situations. The clear and cold Finger Lakes contain relatively low amounts of suspended materials. *Bithynia* grazes over the substrate in these waters just as other local gastropods, because the supply of nutrients available by filter feeding apparently is not adequate for survival.

Bithynia and the pleurocerids apparently graze with about equal efficiency. This results in relatively stable populations of these 2 groups in the Finger Lakes. In Oneida Lake, the Erie Canal, and other more eutrophic waters, *Bithynia* utilizes the vast nutrient resources of the phytoplankton, multiplies, and physically occupies the range necessary to support the pleurocerids. Unable to graze effectively, these snails are then exterminated.—WILLARD N. HARMAN, Dept. of Entomology and Limnology, Cornell University, Ithaca, New York.

REFERENCES

- Harman, W. N. 1968. Replacement of Pleuroceridae by *Bithynia* in polluted waters of central New York. *Nautilus* 81 (3): 77-83.
Jorgensen, C. B. 1965. Biology of suspension feeding. Pergamon, Oxford. 357p.

INTERNATIONAL SYMPOSIUM ON MOLLUSCA.—The Marine Biological Association of India sponsored a week-long *Symposium on Mollusca* held at Cochin-Ernakulam in South India 12-16 January 1968. This was organized by Dr. S. Jones, President of the Marine Biological Association of India and Director of the Central Marine Fisheries Research Institute. Research papers numbering 105 were submitted for the program and were divided into the following sections: 1) Taxonomy and Phylogeny; 2) Distribution; 3) Morphology and Anatomy; 4) General Biology; 5) Radiation Biology; 6) Reproduction and Early Development; 7) Ecology and Behavior; 8) Physiology; 9) Cytology; 10) Boring and Fouling Mollusks; 11) Parasites and Commensalism; 12) Culture; 13) Economics and Fishery; 14) Historical Review. The meetings were held at the Central Institute of Fisheries Operatives. The symposium was inaugurated by His Excellency Shri V. Viswanathan, Governor of Kerala, who gave a brief discourse pertinent to the occasion. Dr. Jones delivered a presidential address. In addition to the technical reports, special invita-

tional lectures were given by Shri K. P. A. Menon, Secretary of the Indian Council of Agriculture Research and Shri G. N. Mitra, Joint Commissioner for Fisheries in the Ministry of Food, Agriculture, Community Development and Cooperation. In addition to social events and a film-showing scheduled in the evening, the participants visited the various oceanographic and fisheries laboratories in the area. A sight-seeing trip of general and historic interest was enjoyed by all on Sunday afternoon.

The papers have been edited for publication and will soon go to press. Hopefully, the proceedings will be available in January of 1969 when the next Symposium devoted to Corals and Coral Reefs, the fourth in the series, will be held at Mandapam Camp in South India.—RALPH W. DEXTER, (Member of the Advisory Committee), Dept. of Biological Sciences, Kent State University, Kent, Ohio.

GENITAL DIFFERENCES IN *PHILOMYCUS virginicus* Hubricht and *P. bisdosus* Branson.—The primary differences are in the lower genitalia: *P. virginicus* possesses a relatively longer, broader dart sac, a longer, more robust vagina, a considerably more slender vas deferens, a thicker penis, and a heavier penis retractor muscle. The three specimens of *P. virginicus* dissected were virtual topotypes.—BRANLEY A. BRANSON, Eastern Kentucky University, Richmond, Kentucky 40475.

N. S. F. GRANTS, FISCAL '67. Previous tabulations have listed government support in aspects of malacology from the National Science Foundation for Fiscal '65 and '66 (*Nautilus*, 80: 141-2; 81: 104-5). The amount of support has varied through these years but increased significantly in '67. Totals are, for '65, \$268,500; for '66, \$214,000; for '67, \$445,200. These do not reflect the *real* sum expended for any single fiscal year since the tenure of some grants is for a period greater than 12 months. The present data were compiled from the section on Basic Research Support, Biological and Medical Sciences Research Projects in the grants and Awards for the Fiscal Year Ended June 30, 1967, available for 75 cents from the U. S. Government Printing Office, Washington, D. C. 20402.

Arnold, John M. Influences of the egg cortex on the development of the molluscan embryo (GB5962); 12 months; \$21,000.

University of Hawaii, Honolulu, Hawaii (Developmental Biology).

Burch, John B. Cytotaxonomic studies of pulmonate snails (GB5601); 24 months; \$41,800. University of Michigan (Systematic Biology).

Clement, Anthony C. Development in *Ilyanassa* (GB5331X); 24 months; \$37,400. Emory University, Georgia (Developmental Biology).

Collier, J. R. Gene transcription in the embryo of the marine mud snail (GB5514); 24 months; \$39,300. Cuny-Brooklyn College, New York (Developmental Biology).

Furnish, W. M. and Brian F. Glenister. Permian ammonoids (GB5530); 24 months; \$44,500. University of Iowa (Systematic Biology).

Hill, Robert B. Neural control of molluscan myocardial rhythmicity (GB5598); 12 months; \$14,700. Dartmouth College, Medical School (Regulatory Biology).

Kohn, Alan J. Indo-Pacific mollusks of the family Conidae (GB5942X); 24 months; \$37,800. University of Washington, Seattle (Systematic Biology).

Kondo, Yoshio. Archaic land snail families, Achatinellidae, Partulidae, and Amastridae (GB6450); 24 months; \$57,800. Bernice P. Bishop Museum, Honolulu, Hawaii (Systematic Biology).

Loosanoff, Victor L. Development and spawning of different physiological races of *Crassostrea Virginica* (Gmelin) (GB5250-Amend. No. 1); \$3,200. University of the Pacific, Dillon Beach, California (Environmental Biology).

Lowenstam, Heinz A. Environmental influences of marine mollusk shell characteristics (GB6275); 24 months; \$8,700. California Institute of Technology (Environmental Biology).

Morrill, John G. Ooplasmic segregation and experimental analysis of development of fresh-water pulmonate Mollusca (GB5540); 12 months; \$10,000. College of William and Mary, Virginia (Developmental Biology).

Mullins, Lorin J. The sodium pump of the squid axon (GB5643); 24 months; \$32,900. University of Maryland, School of Medicine (Molecular Biology).

Struhsaker, Jeannette W. Population genetics and larval ecology of Hawaiian *Littorina* (GB6503); 24 months; \$34,000. University

of Hawaii, Honolulu, Hawaii (Environmental Biology).

Vokes, Harold E. Tertiary and Recent molluscan genera of the Western Atlantic Region (GB6048); 24 months; \$38,300. Tulane University of Louisiana (Systematic Biology).

Voss, Gilbert L. A monograph of the cephalopods of the Atlantic Ocean (GB5729X); 24 months; \$23,800. Institute of Marine Science, University of Miami (Systematic Biology).—K. J. Boss

ATTEMPTED SINISTRAL-DEXTRAL MATING — January 18, 1955, a sinistral captive *Allogona ptychophora* (Brown) was noted head-on in courtship with a normal specimen. The courtship was as usual (*Gastropodia* 1 (7):70-72) except that the sinistral snail had the atrium on the left side. It was slow to evert and protrude the basal penis and constantly failed to bring its atrium into contact with the right side located atrium of the normal snail. Ultimately the pair discontinued the effort to mate. Possibly two sinistrals could mate successfully. When the sinistral snail became feeble, it was dissected; the genitalia seemed normal except for the reversed location of the atrium. I had collected the snail 4 miles west of Superior, Montana, Sept. 29, 1954.—GLENN R. WEBB.

INTRASPECIES AGGRESSION — On March 19, 1953, an approximately half-grown juvenile *Triodopsis tridentata frisoni* (F. C. Baker) was noted on the spire of a smaller individual, which it was attacking by gnawing from above on the exerted body parts near the columella. The attacked snail thrashed its shell about which caused the aggressor to withdraw momentarily, but it soon re-exserted the forebody and resumed chewing on the other's body, causing the latter to retreat into its shell. The aggressor then began chewing on the other's mantle rim.

Now the victim re-emerged quickly and violently; and, in so doing, rammed its foot tip into the other's "face". The aggressor now retracted, while the victim began to crawl away so violently as to dislodge the aggressor. Such attacks are seemingly frequent in dense cage populations of actively growing juveniles which often show jagged, eroded aperture-rims.—GLENN R. WEBB.

PUBLICATIONS RECEIVED

Abbott, R. Tucker, Editor. July 1968. Exotic Conchology by William Swainson, xxiv + 48 pp., 48 colored pls. \$30.00. D.

Van Nostrand Co., Princeton, New Jersey 08540. Contains a biography of William Swainson by Nora F. McMillan, a modern explanation of plates by R. T. Abbott, and a facsimile reproduction in color of the original 1821-22 edition and Hanley's 1841 edition.

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Long out of print, this useful monograph series on Western Atlantic Conidae, Muricidae, Strombidae, Cardiidae, etc., is now once again available. Reproduced in its original size, original paper, and beautifully soft-bound, it may be obtained for only \$15.00 (postage and packing free) from W. AND R. McCAULEY, 1919 Sandy Hill Road, Apt. C-12, Norristown, Pa. 19401. If you also wish vols. 2, 3 and 4, write: DR. W. J. CLENCH, Museum of Comparative Zoölogy, Cambridge, Mass. 02138, U.S.A.

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Mrs. Horace B. Baker, Business Manager
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Second-Class Postage paid at Spring House, Pa.

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A Quarterly Journal devoted to the study of Mollusks, edited and published by HORACE B. BAKER, CHARLES B. WURTZ and R. TUCKER ABBOTT.

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THE NAUTILUS

Vol. 82

January, 1969

No. 3

STRUCTURAL CHARACTERISTICS OF SUCCINEID GASTROPOD *OXYLOMA SANIBELENsis*

By DOROTHEA S. FRANZEN

Biology Department, Illinois Wesleyan University

Oxyloma sanibelensis (Rehder) was originally described as *Succinea sanibelensis* Rehder (1933). Pilsbry (Pilsbry, 1948) recognized the species as being of the genus *Oxyloma*. Both designations were based solely on shell characters.

The author, while on a field expedition in Florida, February-March, 1966, searched for living snails or shells of *Oxyloma sanibelensis*. Dr. William Clench and Margaret Teskey joined the author in a search on Sanibel Island (type locality) as well as on Captiva Island. Not a living snail nor shell of that species was found. Subsequent diligent searchings by the author along the western coast of Florida, in Long Pine Key of the Everglades, and on Key Largo were, likewise, futile. This possibly may be attributed to changes of ecological conditions. At the time the localities were visited they were dry due to a drought. Also, several hurricanes of recent years washed in marine water which may have made the habitats undesirable for this species.

While examining shells of paratypes of *O. sanibelensis* (Rehder), Ac. Nat. Sci. Philadelphia Cat. No. 163082, collected by W. F. Clapp in 1911, the author noted that they contained dried bodies of which she extracted two from their shells. It was impossible to dissect the genitalia or any other soft parts but radulae and jaws were successfully removed, stained and mounted. Radulae and

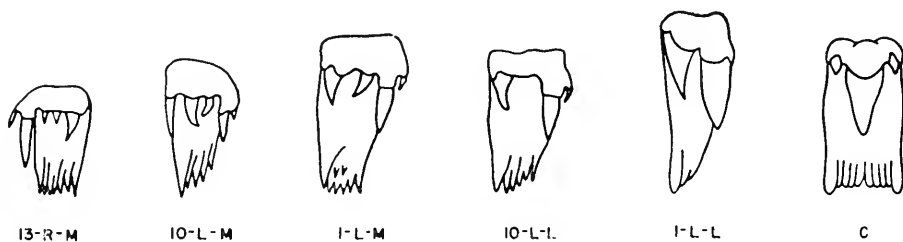


Figure 1. Representative teeth of a radula. 500x. C, Central tooth; 1-L-L, 1st left lateral; 10-L-L, 10th left lateral with an endocone; 1-L-M, 1st left marginal; 10-L-M, 10th left marginal; 13-R-M, 13th right marginal.

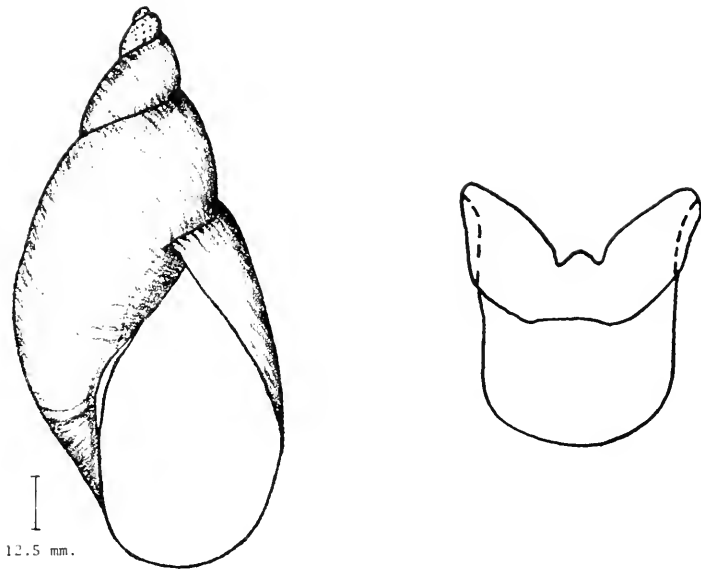


Figure 2. *Oxyloma sanibelensis* (Rehder). Jaw at right; shell of a paratype at left.

jaws were obtained also from paratypes Mus. Comp. Zoology, Harvard, Cat. No. 97928. The radulae studied bear, in general, the characteristics of the Succineidae. The central tooth has a large mesocone flanked on either side by a smaller ectocone. The laterals have a large mesocone and a smaller ectocone. Although the endocone is generally wanting in the laterals, a small one is occasionally present in some laterals which are located near the marginals. The laterals have a small endocone and a prominent mesocone. The ectocone is divided into three of which the outermost is the longest (Text Fig. 1).

The radulae bear the characteristics of the genus *Oxyloma*. For example, one radula examined has a total of 87 rows of teeth. The tooth formulae of four rows are as shown in Table I. This reveals a ratio of laterals to marginals of approximately 1:2 except of the most anterior rows of the radula. The basal plate of all the teeth exceeds the length of the mesocone. Distinctive of the radulae of *Oxyloma* are the long and tapering basal plates of the laterals and marginals as contrasted with those of *Succinea* and *Catinella*. The basal plates of the laterals and marginals of *Oxyloma retusa* (Lea) are long and tapering as noted by Pilsbry (Pilsbry, 1948: 771, Fig. 413, A) and by Franzen (Franzen, 1963:89, Fig. 1). The basal plates of the marginals and laterals of *Succinea* are broader

and shorter. This has been noted by Quick (Quick, 1933:296, Fig. 2) to be true of *Succinea putris* (L.) and, likewise, reported by Pilsbry (1948:777, Fig. 413, B) and by Franzen (Franzen, 1959:195, Fig. 3) to be true of *Succinea ovalis* Say. The basal plates of the laterals and marginals of *Catinella* are shorter and broader than those of either *Succinea* or *Oxyloma*. The short and broad basal plates of *Catinella* (*Succinea*) *arenaria* (B.-Ch.) are illustrated by Quick (1933:296, Fig. 4) and of other species of *Catinella* by Odhner (1950:208, Fig. 6).

The jaw, as recovered from the dried bodies, is light amber color. Its form resembles that of *O. retusa*. A large median fold projects anteriorly (Fig. 2). It lacks lateral folds which are characteristic of the jaw of *S. ovalis* Say (Franzen, 1959:194, Fig. 2).

The shells of Succineidae, although lacking certain striking features such as color bands, carinae, excrescences or denticles, need to be carefully examined for certain generic and/or specific characteristics. The maximum number of whorls, features of the nuclear whorl, the color and texture of the shell as well as the several dimensions and ratios of certain dimensions are significant. The author examined shells of paratypes obtained on loan from The Academy of Natural Sciences of Philadelphia, the Museum of Comparative Zoology of Harvard University, and the United States National Museum.

The shell of *Oxyloma sanibelensis* is slender in comparison with those of other species of the genus. The nuclear and second whorls

TABLE I

TOOTH FORMULAE

Row								
17	12	-	10	-	1	-	8	- 13
35	21	-	10	-	1	-	8	- 21
65	20	-	9	-	1	-	9	- 20
76	23	-	9	-	1	-	8	- ?

Counts made of representative rows of teeth of a radula to show the number of the various teeth.

TABLE II
 DIMENSIONS and RATIOS of DIMENSIONS of SHELL of
 NINE PARATYPES of OXYLOMA SANIBELENSIS (REHDER)

No. of Whorls	Height	Width	Width/Height	Height of Aperture	Width of Aperture	H. Ap./H. Shell	W. Ap./W. Shell	W. Ap. H. Ap.
4	13.5 mm.	6.1 mm.	.452	8.2 mm.	4.4 mm.	.607	.721	.536
4	12.4	6.0	.484	7.5	4.1	.605	.683	.547
4	12.2	6.0	.492	7.4	4.1	.606	.683	.554
4	12.2	6.0	.492	7.6	4.1	.623	.683	.539
3-3/4	12.1	5.5	.454	7.3	4.1	.603	.745	.562
3-3/4	12	5.5	.458	7.7	4.0	.642	.727	.519
4	11.6	5.3	.457	7.2	4.0	.621	.755	.555
3-3/4	11.5	5.5	.478	6.7	3.7	.583	.673	.552
3-3/4	11.1	6.1	.549	7.2	4.2	.649	.688	.583

are inflated forming an acute, obtusely rounded spire. The subsequent whorls increase rapidly in size and are only slightly inflated. The sutures are not as deeply impressed as are those of, for example, *O. retusa*, *O. haydeni*, and *O. salleana*. Although the shells have been in museums for over fifty years they have retained what is supposedly their natural luster and straw-yellow to grayish-yellow color. The nuclear whorl is finely punctate and exceedingly finely striate. The second whorl, also finely punctate, is finely striate. The striae increase in size toward the aperture becoming heavier on the ultimate whorl producing a wrinkled texture (Fig. 2). Of the paratypes examined only nine shells were intact and, therefore, measurable. The measurements are to be noted in Table II. The largest shell measured is smaller than the largest reported by Pilsbry (Pilsbry, 1948:794).

Comparisons of ratios of dimensions of the shell of *O. sanibelensis* with those of *O. retusa* (Lea), *O. haydeni* (W. G. Binney), and *O. salleana* (Pfeiffer) are to be noted in Table III. The measurements of the last three species are based on previous studies made by the author as noted above. Because only nine shells of *O. sanibelensis* could be measured the comparisons must be considered accordingly. As is indicated in Table II the width of the shell of *O. sanibelensis* is proportionately narrower to its height than is characteristic of the shells of the other three species here compared.

SUMMARY

Further field studies may result in the finding of living snails of *Oxyloma sanibelensis* (Rehder). The known records of its geographic distribution are limited to southern Florida. This might indicate that this species is living in Central and/or South America. As is shown in this study, the shell of *O. sanibelensis* differs from that of other North American species of *Oxyloma* in the shape, ratios of dimensions, and indentation of the suture. The anatomy of the soft parts is not known. However, the characteristics of the jaw and radula correspond with those of the genus *Oxyloma* which verifies Pilsbry's placing this species into that genus.

Acknowledgments: The field studies which included the search for *Oxyloma sanibelensis* and the studies at The Academy of Natural Sciences of Philadelphia were made possible through financial assistance of a National Science Foundation Grant-in-

TABLE III
COMPARATIVE RATIOS OF SHELL DIMENSIONS

Width of Shell / Height of Shell

Species	No. of Shells	Range	Median
<u>Oxyloma retusa</u>	33	46.7% - 60.0%	52.0%
<u>O. haydeni</u>	41	43.1% - 58.5%	49.0%
<u>O. salleana</u>	43	50.0% - 69.5%	56.3%
<u>O. sanibelensis</u>	9	45.2% - 54.9%	47.8%

Height of Aperture / Height of Shell

Species	No. of Shells	Range	Median
<u>Oxyloma retusa</u>	33	65.9% - 84.0%	74.4%
<u>O. haydeni</u>	41	59.0% - 80.0%	73.0%
<u>O. salleana</u>	43	72.2% - 87.4%	78.6%
<u>O. sanibelensis</u>	9	58.3% - 64.9%	60.7%

Width of Aperture / Width of Shell

Species	No. of Shells	Range	Median
<u>Oxyloma retusa</u>	33	69.6% - 94.1%	80.5%
<u>O. haydeni</u>	41	73.4% - 93.0%	85.3%
<u>O. salleana</u>	43	65.6% - 95.7%	79.2%
<u>O. sanibelensis</u>	9	67.3% - 75.5%	68.8%

Width of Aperture / Height of Aperture

Species	No. of Shells	Range	Median
<u>Oxyloma retusa</u>	33	49.2% - 69.6%	57.1%
<u>O. haydeni</u>	41	47.3% - 74.2%	57.6%
<u>O. salleana</u>	43	53.3% - 63.3%	57.6%
<u>O. sanibelensis</u>	9	51.9% - 58.3%	55.2%

TABLE III (at left)

Comparative Ratios of Dimensions of Shells

The various ratios are results of previous studies of *Oxyloma retusa* Lea, (Franzen, 1963, Table I); *O. haydeni* (W. G. Binney), (Franzen, 1964, Table I); *O. salleana* (Pfeiffer), (Franzen, 1966, Table I); and of *O. sanibelensis* (Rehder), Table I of this study.

Aid. The author is indebted, also, to The Academy of Natural Sciences of Philadelphia, the Museum of Comparative Zoölogy of Harvard, and to the United States National Museum for the loans of paratypes.

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CONCERNING THE TYPE LOCALITY OF MICRARIONTA
ROWELLI HUTSONI (Clapp)

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On surveying the literature related to the history of *Micrarionta rowelli hutsoni* (Clapp), it becomes apparent that there is still some question concerning the location of the published type locality of this subspecies. The locality given by Clapp (1907) with his description of *Epiphragmophora (Micrarionta) hutsoni* was "about 8 miles from Quartzite, Yuma Co., Ariz., in the foothills, at an alt. of about 1600 ft." No direction from Quartzite

was given but, as Willett (1930) suggested, the available information would seem to place the type locality "in the Dome Rock Mountains." Later, however, George Hutson, the collector whose name Clapp gave to this snail, corrected the location (*in* Pilsbry, 1939, p. 230, footnote 1) and placed the type locality in Arizona "about 20 miles south of Quartzite, 12 miles north of Kofa, Yuma County, in foothills of the Short Horn Range, at an alt. of about 1600 feet." To this correction Pilsbry added the comment, "It is in the north end of the Eagle Tail Mountains." The purpose of this paper is to present a further correction for the attention of those who might be interested, and to attempt to identify more precisely the site at which the writer believes Hutson collected his specimens.

First of all, the distance between the towns of Quartzsite and Kofa is about 60 miles by air, and substantially greater by any means of land transport, which fact immediately leads to the conclusion that the corrected location (*in* Pilsbry, 1939) is still in error. Second, Pilsbry's comment placing the location in the Eagle Tail Mountains further compounds the error, because this group of mountains lies considerably farther eastward and northward and is separated from the Short Horn Range by the Little Horn Mountains and about 10 miles of desert. Perhaps the confusion in this regard arose from the similarity in names of the Little Horn and Short Horn Mountains, and the proximity of the Little Horn and the Eagle Tail Mountains. In any event, I conclude that the type locality in question has no relation to the Eagle Tail Mountains.

Speculation concerning the actual location of Hutson's site led the writer to attempt to deduce his probable route, either from Quartzsite or from Kofa. Having travelled by jeep over much of the area in question, one must express admiration for those earlier collectors who, like Hutson, travelled such distances over desolate terrain by far more primitive means. If one assumes, as did the writer, that the locality specified by Hutson lies somewhere in the Short Horn Mountains, Quartzsite was the point from which Hutson started. He might have travelled northward from Kofa, a station on the Southern Pacific Railroad, toward the southernmost portion of the Short Horn Mountains some 35 miles away, but a journey southward from Quartzsite seems much more likely;

he would have been near the northern portion of the Kofa Mountains after having travelled about 20 miles, whereas the trip northward from the town of Kofa would have involved a journey of twice that distance. Moreover, the Short Horn Mountains are a southeasterly extension of the Kofa Mountains, and at no point therein is one less than about 35 miles north of the town of Kofa.

The assumption having been made that the site is, in fact, in the Short Horn Range, as specified by Hutson, a reasonable and quite logical explanation for the discrepancy in distances from Quartzsite and from Kofa now becomes apparent. In citing "Kofa" as a reference point, Hutson very probably was referring to the King of Arizona Mine, often known in abbreviated form as K of A Mine, Kofa Mine, and K of A; the last designated form easily could be interpreted or even mis-read as "Kofa" by someone reading Hutson's notes. Very evidently from the distances noted earlier, Hutson was not using the Southern Pacific station (Kofa, or Kofa Station) as his map reference; and his starting point probably was Quartzsite.

Continuing to speculate, the writer searched a topographic sheet of the area in order to attempt to find a point which would agree with Hutson's description of the locality as "about 20 miles south of Quartzsite . . . in foothills of the Short Horn Range, at an alt. of about 1600 feet." By tracing the course of each recorded mining trail, a location was found which seems to fit very well with that description. Driving south from Quartzsite on U. S. Highway 95 (Arizona 95 on older maps) for about 20 miles, one encounters an unimproved road to the southeast which, if followed for about 5 miles, leads into "foothills" having 1500-1600 foot elevations. The Kofa Mountains and spectacular Palm Canyon are about 4 miles farther east, at the end of the road. The group of mountains immediately to the south of the highest peak (4852 feet) of the Kofa Mountains is the Short Horn Range. Although Hutson did not mention the high peak, the foothills are undoubtedly those to which he referred. The King of Arizona Mine is about 15 miles to the southeast of the foothills.

It is suggested here that Hutson followed essentially the route which has been described, using a trail which has been replaced in part by Highway 95, and arrived at a site which now can be located in Section 8 of Range 18 West, Township 1 South; a site

which very closely corresponds with Hutson's description, if the correction concerning the reference to "Kofa" is accepted and the reference to the Eagle Tail Mountains is deleted. The following is therefore proposed as a corrected description of the type locality:

Arizona: Yuma County, in the northeast portion of Section 8, Range 18 West, Township 1 South (USGS Map NI 11-9, Salton Sea Quadrangle); about 20 miles southeast of Quartzsite and 15 miles northwest of King of Arizona Mine; at about 1600 feet elevation in foothills of the Short Horn Range, 4 miles due west of the base of the highest peak of the Kofa Mountains; about 50 feet up the north side of a small hill which is immediately south of a prominent wash; in a rock slide area below overhanging large rock ledge; sparse ground cover of greasewood and paloverde shrubs.

The foregoing account points up the necessity for more exact reporting of data concerning collecting sites, particularly with regard to type localities. The use of USGS. map range, township and section numbers, I suggest, very likely will reduce the need for corrections such as that with which this paper has been concerned. Some mistakes in transcription of notes and labels are bound to occur, and the use of names of towns, highway route numbers and other convenient and seemingly adequate references invites error if these are the only reference points given. As Hoff (1961) and this writer have pointed out, names of towns change, as do the route numbers of highways; and, on occasion, even the location of geographic features such as mountain ranges becomes a subject of some confusion. The suggestion is made, therefore, that published records of collecting sites and/or type localities in the future include, first of all, topographic map citations as primary points of reference, in addition to the other means by which writers ordinarily identify such sites. The purpose of recording a locality is, after all, rather utilitarian: to enable another worker to find the site and verify one's work. Each of us should make the job of finding such locations more possible.

Field work related to this study has been supported, in part, by a grant from the Research Council, Eastern Illinois University. Appreciation is also due the Department of Biology of the University of New Mexico for facilities so graciously provided during the writer's sabbatical leave.

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A NEW SONORELLA FROM THE SALT RIVER MOUNTAINS OF PHOENIX, ARIZONA

By WALTER B. MILLER

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SONORELLA SUPERSTITIONIS TAYLORI new subspecies. Page 59, fig. 2.

Description: Shell depressed-globose, heliciform, small, thin, light-tan, with a dark-brown spiral band on the well-rounded shoulder; umbilicate, the umbilicus contained about 6 times in the diameter. Embryonic shell of about $1\frac{1}{2}$ whorls roughened by radial wrinkles and superimposed papillae; the papillae punctate on the first half whorl, becoming elongate, hyphen-like, and occasionally anastomosing into spirally descending threads over the remainder of the embryonic whorls. Post embryonic whorls roughened by irregular growth wrinkles and numerous punctate papillae becoming fainter and sparser on the body whorl but extending over the base and into the umbilicus. Periostracum silky-lustrous. The last whorl descends slightly and gradually to the scarcely expanded peristome; aperture oblique, rounded, slightly wider than high, with margins converging; parietal callus very thin.

Holotype measurements: Height 7.2 mm., max. diam. 14.2 mm.; umbilicus 2.3 mm.; whorls $4\frac{1}{4}$.

The body wall of the animal is dark grey anteriorly, becoming lighter posteriorly. The mucus gland papillae on the mantle collar are light brownish-white; no trace of orange mucus was noted on the mantle collar. The sole of the foot is light orange-brown and there is a tinge of orange pigment on the tail of the foot.

Genitalia of holotype (Fig. 1, A): The moderately long penis is enveloped in a long, thin penial sheath which has a short, swollen, muscular base. It contains a short, stout, annulated,

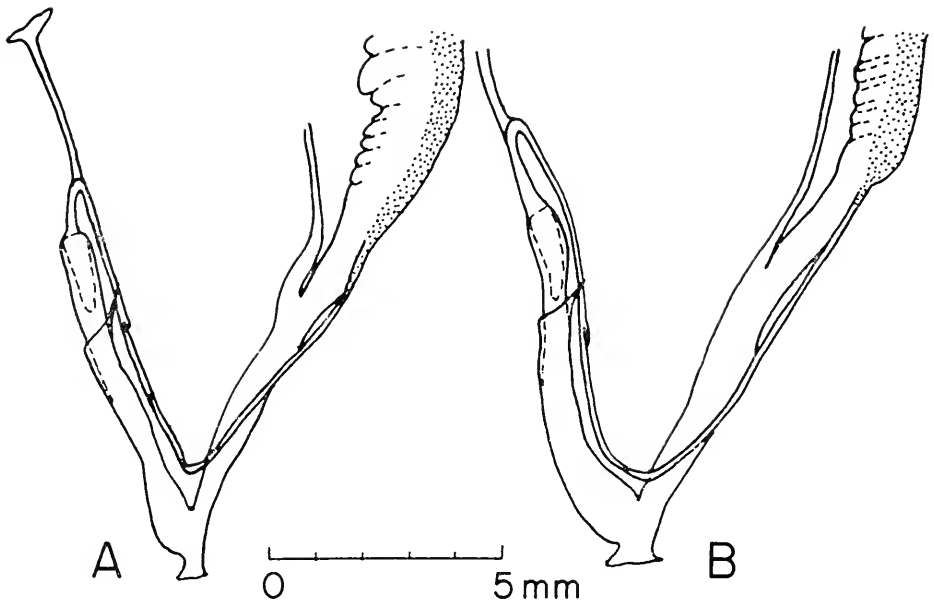


Fig. 1. Lower genitalia. A. Holotype, *Sonorella superstitionis taylori* W. B. Miller. B. *S. superstitionis superstitionis* Pilsbry, #4933-B, Boulder Canyon, Superstition Mts., Arizona. Drawings made from stained whole mounts arranged to facilitate comparison of corresponding organs. Note close similarities in size and shape of structures.

conical verge. A short epiphallus, about $\frac{2}{3}$ the length of the penis bears a very short, barely detached epiphallic caecum. The penial retractor is inserted on the epiphallus near the penis. Vagina nearly as long as the penis; free oviduct very short, less than $\frac{1}{3}$ as long as the vagina.

Type locality: Salt River Mts. (South Mountain Park), Maricopa Co., Arizona, in igneous rock piles on the south side of canyon at west end of Guadalupe Road at a point 2.6 road miles west of S. 56th St. Elev. ca. 1500 ft. (Holotype, W. B. Miller, 9 Feb., 1968. Paratypes, D. W. Taylor & Paul Gabaldon, 3 Oct., 1967; W. B. Miller, 9 Feb., 1968; J. T. Bagnara & W. B. Miller, 29 Feb., 1968). Holotype ANSP. (314851). Paratypes in collections of ANSP. (314852), Dept. of Biological Sciences, University of Arizona (3126), and the author (5009, 5043, 5047).

This subspecies [illustrated Oct. 1968, vol. 82, no. 2, p. 59, fig. 2 a-c] is very small and superficially resembles *S. allynsmithi* Gregg & Miller [see next article] which is found on the north side of Phoenix in the Phoenix Mts. Its habitat is equally hot and arid as that of *allynsmithi*. It differs conspicuously in shell sculpture, however, presenting a rough surface of growth wrinkles and super-

Measurements of Genitalia, in mm.	Holotype	Paratype 5009-A
Penis	6.8	7.0
Verge	1.5	2.0
Penial Sheath	5.0	4.5
Epiphallus	4.0	5.5
Epiphallic caecum	0.2	0.2
Vagina	5.0	5.0
Free Oviduct	1.5	1.5
Spermathecal Duct	16.0	16.0

imposed punctate papillae. In the genitalia, it differs from *allynsmithi* by having a short but prominent and stout verge. The size and shape of the verge, the lengths and proportions of penis, penial sheath, and vagina are similar to those of *S. superstitionis superstitionis*, figure 1B, some 40 miles to the east, along the Salt River, in the northern foothills of the Superstition Mts. (Boulder Canyon at Canyon Lake).

It differs from *S. superstitionis superstitionis* Pilsbry by its significantly smaller shell diameter, wider umbilicus, and somewhat rougher sculpture on the post-embryonic whorls. The embryonic sculptures are similar. In a lot of 9 *S. s. superstitionis* from Boulder Canyon, the shell diameter ranged from 16.8 to 18.7 mm.; the holotype, according to Pilsbry, measures 19.3 mm. In the type lot of 34 adult *S. s. taylori*, the shell diameter ranged from 12.5 to 14.6 mm.

S. s. taylori is named after Dwight W. Taylor, friend and distinguished malacologist, who collected the first live adult specimen.

A NEW SONORELLA FROM PHOENIX, ARIZONA

BY WENDELL O. GREGG AND WALTER B. MILLER

In 1953 Allyn G. Smith collected shells of a small *Eremarionta*-like snail in the rocky hills just north of the Arizona Biltmore Hotel in Phoenix. Additional collections were made on 28 Jan., 1954 by Munroe L. Walton and again on 23 April, 1954 by the senior author and M. L. Walton. On 30 Oct., 1965, M. L. Walton, Joseph C. Bequaert, and the junior author collected large quantities of dead shells as well as live specimens in the same vicinity; dissection of several specimens revealed them to be a new species of *Sonorella*, described below:

SONORELLA ALLYNSMITHI new species.

Fig. 2, A-C.

Description: Shell depressed-globose, heliciform, small, moderately thin, glossy, white with a tinge of brownish-grey, with a light-brown spiral band on the well-rounded shoulder; umbilicate, the umbilicus contained about $6\frac{1}{2}$ times in the diameter. Embryonic shell of about $1\frac{1}{2}$ whorls, with a very small, silky-smooth area at the apex, followed by closely-spaced radial wrinkles over which are the faint remnants of superimposed spiral, hyphen-like papillae which occasionally anastomose into forwardly descending and ascending threads. Post-embryonic whorls with irregular, light growth wrinkles, the first part with occasional pit scars of worn-off periostracal projections; periostracum silky-lustrous. The last whorl descends steeply and abruptly to the moderately expanded peristome. Aperture oblique, rounded, wider than high, with margins converging; parietal callus thin.

Holotype measurements: Height 7.8 mm.; max. diam. 13.4 mm.; umbilicus 2.1 mm.; whorls $4\frac{1}{8}$.

The body wall of the animal is very dark grey, nearly black. The mucus gland papillae of the mantle collar are brownish-white and occasionally exude vivid orange secretions, particularly in the vicinity of the pneumostome. The sole is dark grey as is the tail of the foot.

Genitalia of holotype (fig. 2, A): The small penis is enveloped in a thick, muscular sheath in the manner of *S. rooseveltiana rooseveltiana* and *S. rooseveltiana fragilis*. It contains at its apical end a minuscule verge. The epiphallus is about twice as long as the penis and bears a prominent, detached epiphallic caecum. The

penial retractor is inserted well up on the epiphallus, about half-way between the penis and the epiphallic caecum. Vagina short, about $\frac{1}{2}$ the length of the penis; the free oviduct is relatively long, being nearly twice as long as the vagina.

Measurements of Genitalia, in mm.	Holotype	Paratype 4833-A	Paratype 5042-A
Penis	2.4	2.0	3.0
Verge	0.10	0.18	0.16
Penial sheath	2.0	1.2	2.0
Epiphallus	5.0	5.0	5.5
Epiphallic caecum	0.6	0.7	0.6
Vagina	1.3	1.2	1.0
Free oviduct	2.0	2.0	2.0
Spermathecal duct	18.0	16.0	18.0

Type locality: Phoenix Mts., Phoenix, Maricopa Co., Arizona, in igneous rock piles on east side of Squaw Peak road, about 0.3 miles from Lincoln Drive; elev. ca. 1500 ft. (A. G. Smith, M. L. Walton, W. O. Gregg, J. C. Bequaert, W. B. Miller.) Holotype ANSP. (314853). Paratypes in collections of ANSP. (314854), Dept. of Biological Sciences, University of Arizona (1630), M. L. Walton (6807, 6851, 9225), W. O. Gregg (7029), W. B. Miller (4833, 5042), and A. G. Smith (10,974). Additional paratypes to be deposited in collections of Calif. Acad. Sci. and Los Angeles Co. Museum.

This species is one of the smallest *sonorellas* known. In the large type lots examined, with over 200 adult shells, the largest specimen has a diameter of 15.7 mm. while the smallest measures 12.5 mm. The embryonic spiral threads and post-embryonic periostracal projections are prominent on fresh, immature shells but are largely or entirely worn off on older specimens. The shoulder band varies from chestnut brown to light tan and is occasionally absent on some fresh specimens.

The genitalia show a close relationship to *S. rooseveltiana rooseveltiana* and *S. rooseveltiana fragilis*. In the latter two, the penial sheath is short and muscular as in *allynsmithi*, but the verge is completely absent. The very short vagina and the relatively long free oviduct are unusual in *Sonorella*, the free oviduct normally being shorter than the vagina. The insertion of the penial retractor at a point about midlength on the epiphallus is a *Micrarionta* char-

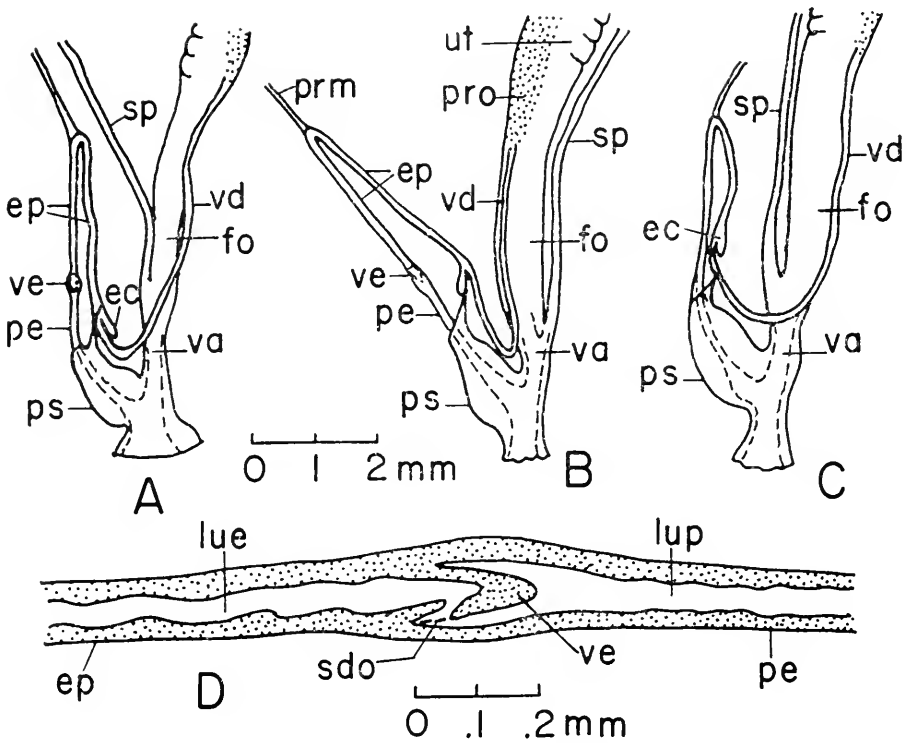


Figure 1. Lower genitalia. A. Holotype, *Sonorella allynsmithi* Gregg & Miller. B. Paratype #5042-A, *S. allynsmithi*. C. *S. rooseveltiana rooseveltiana* Berry, #4935-E, Theodore Roosevelt Dam, Arizona. D. Details of verge of *S. allynsmithi* (from photomicrograph of #5042-A). Upper scale for A-C. Lower scale for D. ec, epiphallic caecum; ep, epiphallus; fo, free oviduct; lue, lumen of epiphallus; lup, lumen of penis; pe, penis; prm, penial retractor muscle; pro, prostate; ps, penial sheath; sdo, seminal duct orifice; sp, spermathecal duct; ut, uterus; va, vagina; vd, vas deferens; ve, verge.

acteristic; the usual insertion in *Sonorella* is on the epiphallus very close to the penis. *S. allynsmithi*, therefore, forms a link between verge-less species of *Sonorella* and those with a verge. Its existence raises doubts on the validity of *Mytophallus* as a good subgenus.

The habitat of *Sonorella allynsmithi* is the most arid, hottest, and lowest of any *Sonorella* known; it is more typical of *Eremarionta* habitats. The small size and light color of the shell, the nearly black body wall of the animal, and the high insertion of the penial retractor on the epiphallus are also *Eremarionta* characteristics. This may be a case of convergent evolution or it may be a close phylogenetic link which would tend to point to *S. allynsmithi* as a relatively unchanged descendant of the ancestral *Sonorella* founder.

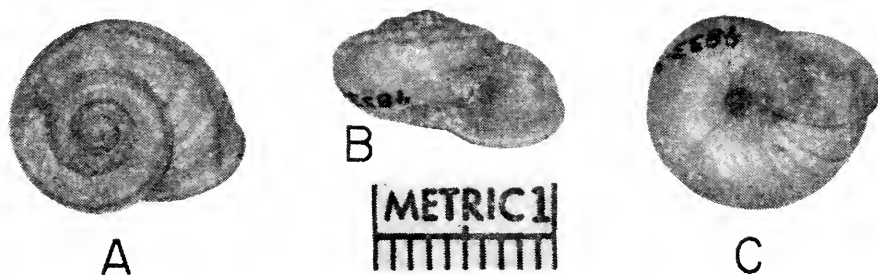


Figure 2. Holotype. A-C. *Sonorella allynsmithi* Gregg & Miller.

It is named after Allyn G. Smith, long time malacologist, friend, and colleague, and current Curator of Invertebrates at the California Academy of Sciences.

HYDROID AND SPONGE COMMENSALS OF *CANTHARUS CANCELLARIUS* WITH A "FALSE SHELL"

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The marine gastropod *Cantharus cancellarius* (Conrad), common in shallow waters of the northeastern Gulf of Mexico (Abbott, 1954), frequently is collected in the Alligator Harbor area of Florida in special symbiotic associations with a hydroid, *Podocoryne carnea* Sars, or with a sponge, *Xestospongia halichondrioides*. This report presents observations on the hydroid and sponge commensals associated with this gastropod, and the occupancy of the later's sponge-encrusted shell by a hermit crab. The occurrence of a remarkable "false shell," sometimes the product of this commensal relationship, is also recorded.

In the Alligator Harbor area, *Cantharus cancellarius* has been collected from the intertidal zone to a depth of approximately 25 feet. In the collections dredged from sand bottoms 10 to 20 feet deep off Lighthouse Point, Alligator Harbor, and Dog Island on 20 March 1965, 9 October 1965, and other dates, the shells of all live *C. cancellarius* were clothed by a white or pinkish encrustation of the hydroid *Podocoryne carnea*. This hydroid species, which has been recorded from both sides of the Atlantic Ocean (Fraser, 1944), is known primarily from gastropod shells occupied by

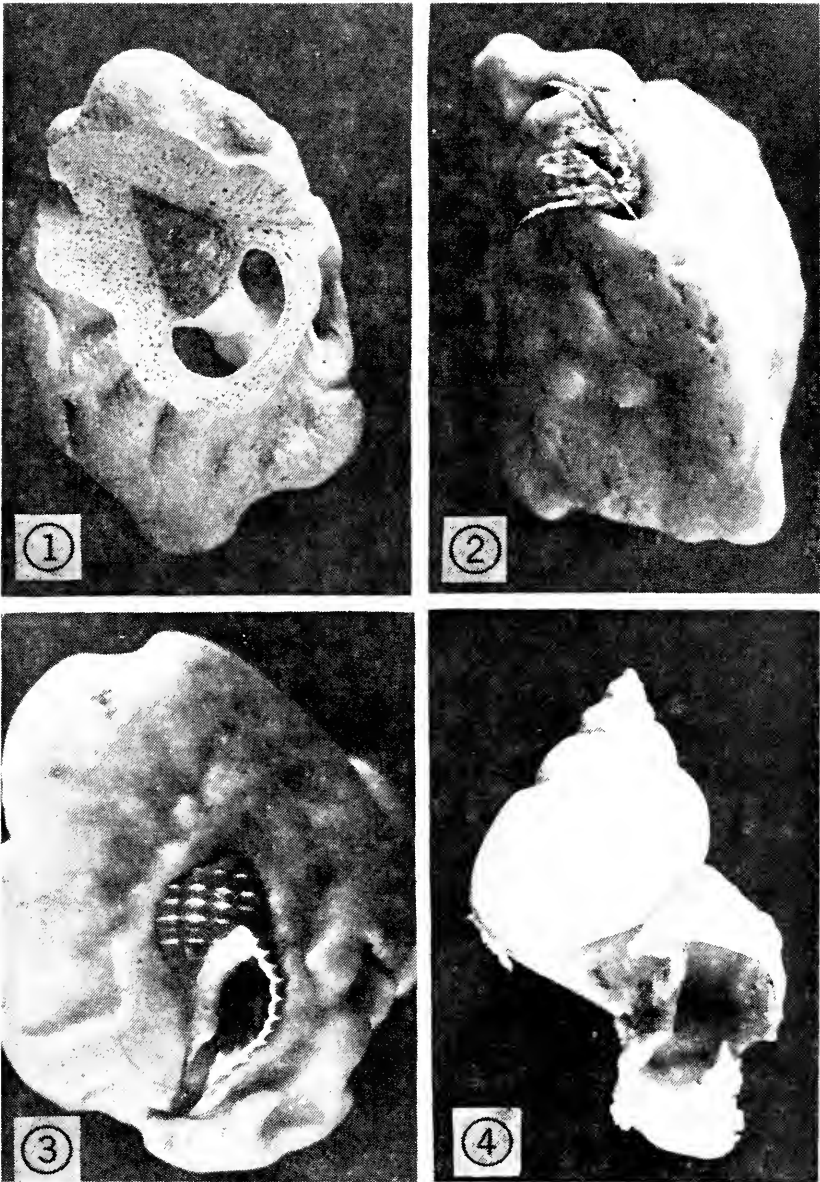


Fig. 1. Sponge *Xestospongia halichondrioides*, 50 mm. long, cut to show apical *Cantharus cancellarius* shell and spiral hermit crab chamber; Fig. 2. *X. halichondrioides*, 51 mm. long, inhabited by a hermit crab, *Paguristes hummi*; Fig. 3. *X. halichondrioides*, 45 mm. long, enclosing *Cantharus cancellarius*; Fig. 4. "False shell," 51 mm. long, formed of sponge tissue and an apical *C. cancellarius* shell.

hermit crabs. However, in these collections, colonies of *Podocoryne* covered all exposed shell surface of each living *C. cancellarius*, only the shell adjacent to the aperture remaining bare. The hydroid colonies consist of many flexible zooids extending up to 2 mm. from a fleshy, thin encrustation. Over the shell surface a colony produces a dark-brown basal layer of perisarc from which project tapering spines about 0.5 mm. long. Although the shells which were occupied by hermit crabs were often free of *Podocoryne* colonies, such bare hermit crab shells still retained some of the spinose perisarc layer formed by a previous *Podocoryne* colony. In this particular relationship, the hydroid primarily associates with the gastropod rather than with the hermit crab.

Merrill (1964) has reported a corresponding association of a similar hydroid, *Hydractinia echinata*, with several gastropods. Like *P. carnea*, *H. echinata* is known primarily from gastropod shells occupied by hermit crabs, but the latter species has also been found on live gastropods (*Buccinum undatum*) and live deep sea scallops (*Placopecten magellanicus*) off New England (Merrill, 1967). Although both *P. carnea* and *H. echinata* are commonly associated with hermit crabs in the Alligator Harbor area, *H. echinata* was not found on the live *C. cancellarius* examined.

From inshore sandy areas, numerous live specimens of *C. cancellarius* have been collected which carried large colonies of the sponge *Xestospongia halichondrioides* (Wilson). During the period from 15 to 22 May 1966, 66 *C. cancellarius* were collected whose shells were imbedded in masses of this sponge. Usually the size of the shell (6 to 22 mm. long) was surpassed by that of the mass in which it was imbedded (43 to 104 mm. long, by $\frac{2}{3}$ as wide).

These sponge masses are smooth, lobate or ovoid in form and somewhat flattened, up to 25 mm. thick. The gastropod shell is usually subterminal in position on the lower surface of the mass, with the aperture facing the substratum and with the siphonal canal directed toward the nearby margin of the sponge mass (Fig. 3). In many cases the shell is completely imbedded in sponge tissue with only the aperture and siphonal canal visible; but in others, the contours of the body whorl are exposed or are recognizable under a relatively thin sponge encrustation.

Fresh *Xestospongia* masses are bright orange, relatively compact, and firm in consistency. When exposed to unfavorable conditions,

the orange color fades and is frequently replaced by blue-green upon drying or by black after burial under sediments. The smooth sponge surface is formed of a dense cortex 200 μ thick consisting of a palisade of siliceous spicules. The interior of the sponge is much less dense, organized in a bread-like structure, with no special orientation to the abundant spicules. Adjacent to the shell, which serves as the basal attachment, the sponge forms dark hemispherical gemmules, 180 to 200 μ in diameter, which enable it to survive unfavorable conditions.

Epifaunal encrustations are frequently regarded as conveying an advantage to their possessors, usually in terms of concealment, thereby enabling them to escape the notice of would-be predators (Caullery, 1952; Aurivillius, 1889). However, by its size, the growing *Xestospongia* mass could convey a disadvantage to its host that may offset any protective or camouflage value. By its overgrowth, *Xestospongia* often restricts movement of the gastropod's foot, and often even blocks the siphonal canal. It seems likely that the weight and bulk of the sponge seriously impedes the gastropod's locomotion, and in some cases the sponge appears to have overwhelmed and smothered the host. Such a relationship in which one of the participants is inhibited while the other is not affected is termed amensal, as defined by Odum (1953). By acting upon the sponge itself, wave action sometimes deposits such encrusted *C. cancellarius* on nearby Gulf beaches, where they die of desiccation.

This association of *Xestospongia halichondrioides* with the shell of *C. cancellarius* often continues long after the death of the snail host. During the same period of collection (15-20 May 1966), 157 specimens of *Xestospongia* were found which had been inhabited by hermit crabs. In more than 70% of these cases a *Cantharus cancellarius* shell lay in the mass, completely covered by sponge tissue, even the aperture being encrusted (Fig. 2). The openings in these sponges were semicircular, 4 to 17 mm. in greatest dimension (i.e. height), although most were 7 to 13 mm. high. In sponges collected with hermit crab inhabitants, three crab species were represented: *Paguristes hummi* Wass, *Pagurus impressus* (Benedict), and *Pagurus pollicaris* Say. *Paguristes hummi*, by far the most common crab inhabitant, is characteristically associated with small sponges in this region as Wass (1956) noted in his

original description. A small species, *P. hummi* maintains a smaller opening in the host sponge, compared to the other two crab species which maintain larger openings (i.e. 15-17 mm. in greatest dimension). In each case the crab could withdraw through this opening into a spiral cavity in the sponge, just as he could into a gastropod shell.

The presence of any shell within these sponge masses inhabited by hermit crabs was rarely evident. However, in 70 crab-sponges examined in detail, a gastropod shell was located by probing and was revealed by cutting into the sponge tissue. The imbedded shell adjoined the apex of a spiral cavity which had been maintained by the hermit crab occupant. In cases in which the crab inhabitant was a relatively recent tenant, little additional sponge tissue had formed around the shell aperture. In other cases, the shell was deeply immersed in the sponge, and was attached at the apex of a spiral chamber of up to three whorls that ultimately opened to the exterior (Fig. 1). Through long association with the crab, the sponge tissue had grown around the crab, forming a continuous spiral chamber of gradually increasing diameter as the crab continued its growth. Of 70 sponges examined in detail, 55 contained shells of *Cantharus cancellarius*; the remaining specimens enclosed shells of *Terebra*, *Conus*, *Turritella*, *Crassispira*, and *Murex* species. On several *Cantharus* shells, traces of perisarc remained from a previous encrustation by *Podocoryne* colonies, now covered by sponge tissue. This perisarc is strong circumstantial evidence for a sequential relationship between these commensal species, with the *Podocoryne* preceding and perhaps preparing the shell for subsequent *Xestospongia* colonization.

Elsewhere in the northeastern Gulf, I have collected *Xestospongia halichondrioides* attached to *C. cancellarius* or to shells occupied by hermit crabs from a number of localities, and as subtidal encrustations on pilings from St. Andrews Bay, near Panama City, Bay Co., Florida. This sponge has been reported previously from North Carolina (Wells, et al., 1960) and Puerto Rico (Wilson, 1902), but in these situations, no special commensal relationship has been recorded.

However, in the Mediterranean Sea, a comparable commensal relationship has been recognized between the sponge *Suberites domunculus* and other hermit crab occupants of gastropod shells

(Lendenfeld, 1896; Caullery, 1952), and in boreal Atlantic waters the sponge *Suberites ficus* occurs in a similar association (Burton, 1953; Hartman, 1958; Müller, 1914). Müller (1914, pl. IV) shows a series of crab-sponges (*S. ficus*) sectioned to show internal spiral chambers like those reported here in *X. halichondrioides*. The existence of parallel associations of sponges with different species of hermit crabs in different parts of the world indicates a similar ecological valence of the participants and a widespread potentiality for such symbiotic relationships. Under de Laubenfels' 1936 scheme of generic placement of sponges, however, *Xestospongia* is placed in the Haliclونidae, rather distant from the placement of *Suberites*, in the Suberitidae.

In the classical account of the *Suberites domunculus* commensal association with hermit crabs, as described by Schmidt (1862), Thomson (1888), Caullery (1952) and Yonge (1949), the sponge is credited with eventually eroding, destroying, or resorbing the enveloped snail shell while retaining the internal contours of its spiral chamber. That boring sponges, of the family Clionidae, characteristically perforate and erode calcareous material has been demonstrated in the laboratory and is accepted without question (Hartman, 1958; Topsent, 1900). However, ability to erode shell material is not generally recognized as an attribute of the Suberitidae, which includes *Suberites*. Indeed, Celosia (1893) and Lendenfeld (1896) supported the opposite view, that the sponge *S. domunculus* does not destroy the shell but constructs additional whorls of sponge tissue around the growing crab. Sections of that sponge figured by Lendenfeld and by Müller (1914) show a very small shell associated with a large spiral crab chamber which might mistakenly be interpreted as the result of progressive destruction of a much larger shell. Continued growth of the sponge about the growing hermit crab can produce the interesting form found in *S. domunculus* as it does in *X. halichondrioides*. Most shells found in association with *X. halichondrioides* were entire, but in a few shells occupied by hermit crabs, there were perforations and galleries remaining from a former attack by boring sponges. Careful examination revealed no evidence of such erosion in most hermit crab shells, and none in shells still occupied by the gastropod. Thus, there is no evidence to indicate boring activity by *X. halichondrioides*. The question of whether *Suberites domun-*

culus can dissolve shells should be re-examined; the observations summarized here suggest other explanations for the anomalous dimensions of the shell in relation to those of the inhabiting hermit crab.

"FALSE SHELLS"

Two remarkable structures collected on beaches of the Alligator Harbor area correspond to the internal spiral formed by this crab-sponge association and consequently bear a striking resemblance to gastropod shells. These objects, best referred to as "false shells," are constructed of a thin layer of sponge tissue 0.3 to 2 mm thick molded in the form of a gastropod shell, a conic spiral with several whorls of increasing diameter. The better developed "false shell" (Fig. 4) is composed of 4 convex whorls of sponge tissue and is 51 mm. long. At its apex there is a small *Cantharus cancellarius* shell, whose cavity is continuous with the spiral cavity of the "false shell." The bucciniform contours of the sponge tissue are evenly developed and even show a deep umbilical pit between the whorls. The base of the aperture is thicker and somewhat more lobate. In this "false shell," the apical snail shell is easily overlooked because of its small size (6 mm) and because of some additional sponge encrustation. However, a second "false shell," consisting of only one broken whorl of sponge tissue, clearly shows a larger (17 mm.) *C. cancellaria* shell at its apex, and its relationship to the crab-sponges is more evident. Both "false shells" consist of *Xestospongia halichondrioides* and a *Cantharus cancellaria* shell.

Although these "false shells" harbored no hermit crabs when collected, presumably hermit crabs have participated in their formation in much the same manner as they have in the formation of the internal whorls within the more abundant, massive *Xestospongia* specimens. The "false shell" corresponds exactly to the more dense cortical layer of sponge that lines the spiral cavity in the massive sponges. Its "outer surface" has no dermis and is neither compact nor well defined as is the lining of the cavity.

The "false shells" are clearly the product of decomposition of the outer tissues of the common massive crab-sponges, the remaining inner cortical layer having been more resistant to decomposition and to the additional erosion caused by wave action. They constitute only the apical shell and the remaining inner cortical

layer that surrounded the crab's burrow. An intermediate stage in the breakdown of the sponge structure has been collected which supports this interpretation of the "false shells." In this specimen only the lost whorl of thin sponge tissue is exposed, while most of the original massive sponge, partly decomposed, remains attached to a *C. cancellarius* shell. Additional partially decomposed tissue can be removed from this specimen almost without effort.

Similar spiral constructions formed around hermit crabs by a Japanese hydroid, *Hydractinia epiconcha*, have been described (Green, 1961). Merrill (1967) indicated that this phenomenon is not unusual for *Hydractinia echinata* associated with hermit crab shells from Georges Bank. He described the shells of several gastropods as having apertures badly deformed and greatly enlarged by the interaction of hydroid and hermit crab. In 1891, Aurivillius had described this type of enlargement of the hermit crab's domicile and recognized its development as a product of their symbiotic relationship. The present observations extend this type of development to long-term crab-sponge associations. Because such objects occur on beaches where they may excite the interest of conchologists, these "false shells" and their relation to the crab-sponge symbiosis deserve recognition.

CONCLUSIONS

From its commensal relationship with *Cantharus cancellarius*, the hydroid may receive debris from its host's feeding, but the sponge seems unlikely to share in this manner in its host's feeding. Water movements produced by the gastropod in the process of respiration and in locomotion may benefit both hydroid and sponge. However, the primary advantage gained from this relationship by the hydroid and the sponge is their attachment to the firm substrate of the gastropod shell. The nematocysts of the hydroid and the spicules or a distastefulness of the sponge could give a host snail or hermit crab a degree of protection from predators. Any such advantage received from the encrusting commensals would be secondary to the shelter which the gastropod shell bestows upon its occupant.

Clearly the primary commensal relationship established between the sponge and *Cantharus cancellarius* may be replaced by a secondary commensal relationship with the hermit crab. Apparently the sponge may also attach to a variety of other shells occupied by

hermit crabs, but whether these hermit crabs contribute to the death of the gastropods whose shells they occupy is not known.

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NOTES ON EXOTIC MOLLUSKS IN KENTUCKY

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Few geographic regions in North America are less known as regards molluscan faunas than Kentucky (Bickel, 1967). There has been no concerted effort to survey the entire state; hence detailed collecting in any region proves fruitful. The purpose of this paper is to present some distribution records and notes on several species of mollusks introduced into Kentucky by man. The records for *Limax maximum* Linnaeus, *Limax (Lehmannia) valentianus* Férussac, *Milax gagates* Draparnaud, and *Lymnaea auricularia* (Linnaeus) are new, and those for *Deroceras reticulatum* (Müller) and *Limax flavus* Linnaeus are essentially so, since Pilsbry (1948) only implied their occurrence in Kentucky by general description.

ANNOTATED LIST

Cepaea nemoralis (Linnaeus). Both Blakeslee (1945) and Reed (1964) indicated the presence of this European species in Kentucky. The following are additional localities: (1) April 11, 1967. Scott Street where it crosses railroad tracks, Lexington, Fayette County, Kentucky. One specimen. (2) June 18, 1966. Also Lexington; 328 Aylesford place. Sixteen living specimens.

The 16 specimens are all similar, yellow with one to five dark-brown bands. The single band below the periphery is very wide,

and is lacking in two specimens. The Scott Street specimen is pinkish brown with a single band. Selected mensurable details are:

<i>Diameter (mm.)</i>	<i>Height (mm.)</i>	<i>Whorls</i>
17.0	14.2	4 $\frac{2}{3}$
21.5	18.1	5 $\frac{1}{2}$
23.3	19.1	5 $\frac{1}{3}$
24.7	19.5	5 $\frac{1}{3}$

Deroceras laeve (Müller). Surprisingly enough, the only published records for this species in Kentucky are the Pleistocene fossils of Browne and Bruder (1963). Our collections yielded the following: (1) May 9, 1965. Murray State University Campus, beneath vegetation, Calloway County, Kentucky; nine specimens, ranging from 11.0 to 17.6 mm in total length (contracted). (2) April 23, 1967. Camp Daniel Boone Church Camp, banks of Kentucky River, Jessamine County, Kentucky; 1 specimen. (3) April 9, 1966. Beneath a board, Zackarich, Lee County, Kentucky. Contracted length and width of sole 22.9 and 3.5 mm., respectively. (4) December, 1965. Eastern Kentucky University greenhouse; 1 specimen.

Deroceras reticulatum (Müller). Since Pilsbry (1948) provided no definite localities for this species, the following are presented: (1) October 3, 1965. On Mud bank of Silver Creek, 1 mile south, $\frac{1}{2}$ mile east of Richmond, Old Barnesmill Road, Madison County, Kentucky; 1 specimen 19.5 mm. in contracted length, sole 2.5 mm. wide. (2) September 8, 1966. Junior author's residence, flower garden beneath boards, Richmond, Kentucky; 2 specimens, very pale tan, 16.2 and 22.1 mm. in contracted length; sole width 1.8 and 1.9 mm. (3) March 24, 1967. Lulbegrud Creek at State Highway 15 crossing, 18 miles southwest of Winchester, Powell-Clark County line; 3 specimens. 16.0 to 27.5 mm. contracted length. (4) April 1, 1967. Mouth of Lulbegrud Creek, Lily Ferry Road, Clark County, Kentucky; 4 specimens beneath debris, 13.3 to 18.0 mm. in contracted length, 2.0 to 2.5 mm. in width of sole. (5) July 13, 1967. Garden, 244 South Collins Street, Richmond, Kentucky; Two specimens, 15.6 and 21.5 mm. in contracted length. (6) April 9, 1966. Zackariah, Lee Co., Kentucky.

Limax flavus (Linnaeus). Three specimens, 18.0 to 26.0 mm. in contracted length with soles measuring 2.0 to 2.6 mm., were secured from beneath a garbage can on March 16, 1967 at 429 West 4th

street, Lexington, Fayette County, Kentucky, and one specimen was collected at the first site listed for *D. laeve*.

Limax maximum Linnaeus. Specimens were secured at the following sites: (1) September 9, 1965. In a sunken water-meter housing, Eastern Kentucky University, Richmond, Madison County, Kentucky; 2 specimens, 41.0 and 41.6 mm. contracted length. (2) November 22, 1966. On a lawn, Main Street, Richmond; 1 specimen, 83.7 mm. extended length. (3) March 16, 1967. At the 4th Street site listed under *L. flavus*; 2 specimens, 59.0 and 65.7 mm. contracted length, 6.3 and 7.0 mm. sole width. (4) May 18, 1967. Near Honeybee, McCord Road, Trimble County, Kentucky; 1 specimen, 71.5 mm. contracted length, sole width 8.7 mm. (5) July 4, 1966. Gross's farm, State Highway 1277, Whitley County, Kentucky; 3 specimens, all around 50.0 mm. contracted length. (6) July 13, 1967. At the 5th site listed under *D. reticulatum*; 3 specimens, 30.5 to 62.0 mm. contracted length, 3.5 to 6.2 mm. sole width. (7) July 23, 1967. Under decaying lumber, roadside amusement stand, just west of Virginia state line, State Highway 80, Pike County, Kentucky; 10 specimens, 25.5 to 62.4 mm. contracted length, 4.5 to 8.7 mm. sole width.

All these specimens exhibited the usual color pattern of black blotches, streaks and lines on a flesh-colored to yellowish background.

Limax (Lehmannia) valentianus Férussac. Two immature specimens of this slug were secured at a road side trash heap near Pine Mountain State Park, Bell County, Kentucky, May 23, 1967. They measure 13.0 and 16.5 mm. in contracted length. The overall color is whitish or yellowish tan. The mantle is broadly oval, slightly pointed behind, and bears a pair of broad, black bands which are nearly confluent anteriorly, and which enclose an obscure, brownish blotch medially. Posteriorly, they are continuous with stripes of the same color on the body, which bears a keel on the posterior one-third.

Milax gagates Draparnaud. On 8 August 1967, the junior author secured a single specimen from a flower bed, Sunset Street, Richmond, Kentucky; 32.0 mm. in contracted length. The back is strongly keeled from the mantle to the posterior extremity of the tail. The central part of the mantle is set off by a distinct groove, and the color is glistening black.

Lymnaea auricularia (Linnaeus). Numerous adult specimens were removed from a small pond on the Eastern Kentucky University campus on October 7, 1965. This pond supports numerous imported water lilies; consequently, the source of the snails is completely problematic. Measurements for four specimens follow:

Total Length	Spire Length	Greatest Width	Aperture Length	Aperture Width	Whorles
15.5	5.5	11.2	10.5	6.9	4 $\frac{1}{3}$
20.0	6.5	14.5	14.5	9.4	4 $\frac{1}{2}$
20.5	6.5	14.5	15.4	9.5	
21.8	7.0	17.5	16.3	11.5	4 $\frac{1}{2}$

Corbicula manilensis Philippi. In preparing his checklist of Kentucky mollusks, Bickel (1967) missed some published records which should probably be incorporated. This small pelecypod is apt to reach even more important status than in the past, notwithstanding Horning's and Keup's (1964) findings that the species was declining in the Ohio River. Bickel (1966) found that such declines are seasonal, and that populations are rapidly built up with the onset of warm weather. The latter workers also reported specimens from near Warsaw, Kentucky; Stein (1962) reported several Kentucky sites for the clam in the Ohio River, and indicated that the species had not been reported from the Kentucky River.

Our records, listed below, indicate that *Corbicula* is rapidly expanding its range in Kentucky, and that it occupies many miles of the Kentucky River, and possibly some of its tributaries. (1) July 14, 1966. Kentucky River, mouth of Silver Creek, Madison County, Kentucky. The bottom of the stream was literally "paved" with living individuals. For the record, 75 specimens were secured and catalogued (BAB 9446). In greatest length, these specimens ranged from 14.8 to 33.0 mm., and in greatest depth 13.0 to 29.3 mm. Several specimens contained embryos. (2) April 21, 1967. Kentucky River at Camp Daniel Boone, Jessamine County, Kentucky; 3 live specimens, one with embryos, the largest specimen measuring 27.0 mm. in length, 25.0 in depth. (3) August 12, 1967. Mouth of Red River (tributary of Kentucky River), Estil County, Kentucky. Eleven living specimens were secured for the record, and numerous others seen.

The authors estimate that *Corbicula* has only recently invaded

the last area, since there is a commercial boat dock located at the site. The owner had never seen the clam before 1966. The only other pelecypod collected here was *Lampsilis siliquoidea*. Numerous specimens of *Campeloma* were also collected.

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NOTES AND NEWS

THE THIRTY-FIFTH ANNUAL MEETING of the American Malacological Union will be held July 21-25, 1969 at Marinette, Wisconsin. Housing will be provided by the Silver Dome Motel, a lovely resort on the shores of Green Bay (Lake Michigan) and adjoining the campus of the University of Wisconsin Extension College. All sessions will be held at the College which will act as co-host to the AMU.

Ample opportunity will be provided to collect land and freshwater species and the field trip on the final day (Friday) will be an excursion to a small lake harboring, among other things, the curious *Acella haldemani*.

Details, reservation and call-for-papers forms will be mailed to all AMU members in April; others desiring to attend should address AMU secretary Margaret C. Teskey at P.O. Box 217, Big Pine Key, Florida 33043.

BULIMUS UNICOLOR AND BULIMULUS OCRASPIRIS. — In a recent review of the land and freshwater mollusks of Campeche (1967, *Bull. Fla. State Mus.*, 11: 221-256) I discussed the geographic and

ecological variation of *B. unicolor* Sowerby and reduced to its synonymy *Bulimus umbraticus* Reeve, *Bulimus ignavus* Reeve, *Bulimus petenensis* Morelet and *Bulimulus sanmiguelensis* Richards. These forms were named on the basis of size, color and whorl convexity. In an ecological transect of the Yucatán Peninsula four size classes are represented: A. 9.0-10.0 mm. (*ignavus*), B. 10.0-12.6 mm. (unnamed), C. 12.3-16.5 mm. (*unicolor*, *petenensis*, *umbraticus*), and D. 14.8-18.7 mm. (*unicolor*, *sanmiguelensis*). Size increases ecologically from dry to wet forests, and geographically from northwest to southeast. Variation in size is clinal, and small forms recur elsewhere in dry areas within the range of the species, as in the Polochic Valley of Guatemala.

Subsequent to my paper Branley A. Branson and Clarence J. McCoy called to my attention the description of *Bulimulus ocraspiris* Branson and McCoy, from Campeche (1965, *Neotropica*, 11: 97-100). *B. ocraspiris* is the same as the size class B (10.0-12.6 mm.) of *B. unicolor* from the mesic deciduous forests of Campeche and Yucatan. The holotype is unusually large (14.0 mm.), but the mature paratypes fall within the size range of class B.

B. ocraspiris is synonymous with *B. unicolor*, being an ecological variety, and is linked to *B. unicolor* by intermediate populations. If *ocraspiris* is recognized taxonomically it should be as a subspecies of *B. unicolor*, in which case it will also be necessary on the basis of equal merit to recognize as subspecies the other forms placed in synonymy. These subspecific variations are correlated with ecological conditions; they are clinal; they broadly overlap; and they are repeated at different places within the range of *B. unicolor*. The merits of their distinctions are minor. — FRED G. THOMPSON, Florida State Museum, University of Florida, Gainesville, Florida.

REVALUATION OF *VALLONIA EXCENTRICA*. — In 1950 I published a note (*Nautilus* 64: 35.) in which I concluded that *Vallonia excentrica* Sterki was only a form of *V. pulchella* (Müller) because other species in the genus had round and eccentric forms. Recently I re-examined my non-costate vallonias and found that I could sort them readily on the character of the outer lip. — on whether it was expanded or reflected. I have therefore concluded that *V. excentrica* is a valid species. In addition to its expanded

rather than reflected outer lip, it differs from *V. pulchella* in being less striate and more hyaline. It is also more uniform in size and does not get as large as *V. pulchella*. As in all other species which I have examined, both *V. excentrica* and *V. pulchella* have round and eccentric forms, so that this character cannot be used for their separation. — LESLIE HUBRICHT.

FEEDING AND CHEMORECEPTION IN MUD-SNAIL, *NASSARIUS OBSOLETUS*. — Scheltema (1964) describes *Nassarius* (= *Ilyanassa*) *obsoletus* (Say) as primarily a non-selective sediment feeder less adapted for scavenging than others of its congeners. It seems not to prey on mollusks, but it can very quickly find dead animal matter at considerable distances (Hyman, 1967: 367); and it can be kept in the laboratory for long periods on clam or shrimp meat. In the field, however, there are so many snails relative to the scant amount of carrion, that it is not likely to be important in the diet.

Carr (1967a,b) has studied the ability of *N. obsoletus* to find dead animal matter. Using shrimp, he showed that *Nassarius* responds in a characteristic way to the chemostimulus, and he gave some of the characteristics of the substance(s) which elicits the response. Significantly, no *single* substance, of the 25 (mostly amino acids) extracted from shrimp, was so stimulatory as were *combinations* of substances. There are several implications of this:

1. As Carr suggests, there may be much receptor specificity. That is, receptors respond to an appropriate molecule and only slightly to structural analogs.

2. Chemoreceptors are therefore probably specific for a particular molecule.

3. Since the snail does not respond maximally to a *single* compound but rather to combinations, and if each receptor is specific for a particular condition, there must be several (many?) *different* chemoreceptors, no one type in much greater abundance than any other.

4. This situation is of advantage to an animal to whom carrion, of different kinds, is only occasionally available. Different kinds of carrion will produce different kinds of stimulants, and the snail should be "equipped" to be stimulated by them all. In such a situation one would not expect selection to "favor" the development of a highly specific chemosensory mechanism; and apparently

selection has not. This explains Carr's failure to find *one* compound of shrimp to which the snails responded as eagerly as they did to whole-shrimp extracts. — CARL W. SCHAEFER, Systematic & Environmental Biology Section, Biological Sciences Group, University of Conn. Storrs, Connecticut 06268.

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NEW HOST AND DISTRIBUTION RECORDS OF *ODOSTOMIA DIANTHOPHILA*. — Boss and Merrill (1965) discuss the degree of specificity in selection of hosts of ectoparasitic gastropods of the family Pyramidellidae. They noted that but one host had been recorded for the species *Odostomia dianthophila* Wells and Wells, although increasing evidence has accumulated that pyramidellid snails generally are not limited to a single host. The species in question, *O. dianthophila*, was originally described from specimens recovered from the serpulid polychaete *Eupomatus dianthus* (Verrill) in North Carolina waters (Wells and Wells, 1961). Subsequently, Roberge (1968) has reported the occurrence of *O. dianthophila* with *E. dianthus* from Buzzard's Bay, Massachusetts, and Odé (1967) has reported it (no host given) from Matagorda Bay, Texas. The present report records the association of this pyramidellid with other serpulid polychaetes examined in studies of marine epifaunal communities of the southeastern United States.

On the south Atlantic coast, *O. dianthophila* has been found with *Eupomatus microtis* (Mörch) off Core Bank, North Carolina (4/3/61), and with *Eupomatus floridanus* Bush off St. Augustine, Florida (6/26/63). On the Gulf coast of Florida, *O. dianthophila* has been found with *Hydroides crucigera* (Mörch) offshore from St. Marks Lighthouse, Wakulla Co. (12/19/63) and Alligator Harbor, Franklin Co. (5/16/63); and with *Eupomatus floridanus* near Panama City, Bay Co. (2/7/66), near Dog Island, Franklin

Co. (10/9/65), and near Cedar Key, Levy Co. (4/9/64). In addition, *O. dianthophila* has been found at Panama City (8/26/64), Alligator Harbor (7/2/65), and Cedar Key (4/9/64) with *E. dianthus*, the host from which it was described originally.

Although a variety of serpulid polychaete species have been examined, *O. dianthophila* has been recovered only from members of the *Hydroides - Eupomatus* group. Like several other pyramidellid species, *O. dianthophila* thus feeds on a range of hosts, rather than on a single species. However, its natural choice of hosts seems to be restricted to those those serpulid species which possess an opercular calyx of many horny spines.

The present records of *O. dianthophila* extend its known distribution to include a broad area from Massachusetts to northeast Florida and on the Gulf coast, from northwest Florida to Texas. Its geographic distribution extends over a wide range of temperature conditions, as well as the wide range of salinity conditions previously noted (Wells and Wells, 1961).

Collections which yielded specimens reported herein were supported by National Science Foundation grants GB-128 and GB-819 which are gratefully acknowledged. — HARRY W. WELLS, The Marine Laboratories, Department of Biological Sciences, University of Delaware; and MARY JANE WELLS, Newark, Delaware 19711.

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ON *LYMNAEA PSEUDOPINGUIS* (F. C. BAKER). — The late Frank Collins Baker described *Lymnaea pseudopinguis* in 1907 from brackish water at Crystal Brook, Long Island, New York, the type locality, and he cited additional specimens from Mount Sinai, Long Island (Nautilus, 21: 54). In 1911, under the name *Galba*

pseudopinguis (Lymnaeidae of North America, Chicago, p. 395, pl. 41, figs. 6, 7, pl. 42, figs. 9-13) Baker redescribed and figured the species and added Canarsie, King [sic] Co., New York to the localities where it occurred.

I could find no Crystal Brook on any Long Island maps available to me, but on the U. S. Geodetic Survey map of the Mount Sinai quadrangle, printed in 1904 and reprinted in 1944, there is shown a long, narrow tidal extension southward of Mount Sinai Harbor. This is the waterway known locally as Crystal Brook and is undoubtedly the place where Baker's specimens were taken. It is today a pond, separated by a low dam and spillway from a meandering tidal stream. On the geodetic map of 1904 the dam is not shown.

In October, 1967, I collected some *Lymnaea*, associated with *Physa heterostropha* (Say) and *Sphaerium* sp., living on the underside of submerged leaves in the spillway in fresh water. The *Lymnaea* are indistinguishable from *L. palustris* (Müller) and look quite different from the figures of *L. pseudopinguis*. The shells are slender, the body whorl is not inflated and the characteristic spiral lines of *catascopium*, to which *pseudopinguis* was thought to be allied, are missing.

Although Baker's type specimens were taken "in salt or brackish water at low tide in shore of bay fed by springs." (*op. cit.*, 1911: 396), the upper part of what is now a pond, has been separated from the tidal water by the dam which must have been constructed some time after 1907, the date when Baker received his specimens. Hence the water of the upper part of Crystal Brook is now completely fresh, while the lower part, where the springs mentioned by Baker can still be seen, has become more saline. I found fresh water species only in the upper part of Crystal Brook; in the lower, more saline part I found only *Melampus bidentatus* Say and a few dead shells of *Littorina saxatilis* (Olivi).

It is easy to realize what has happened. The lymnaeas, before the time the dam was built, were living in water that was more or less strongly affected by the diurnal tides and hence they had to adapt to a brackish water situation. After the dam was built, the tides no longer affected the brook, and consequently the water turned completely fresh. In the fresh water environment the shells of the lymnaeas returned "naturally" to the form represented by

the wide ranging *L. palustris*. I must conclude therefore that the type specimens of the taxon, *L. pseudopinguis* (Baker) were based merely on ecotypes, *i.e.*, local populations with environmentally induced variations of the shells.

Baker suspected that the shells were no more than phenotypes for he wrote: "It is probably a variation of the *catascopium* stock, produced by changing conditions of the environment which have dwarfed the shell. It is a significant fact that the icy cold spring at Mount Sinai has produced the same shell characteristics as the brackish water of Crystal Brook." (*op. cit.*, p. 396)

Shells discussed in this article have been deposited in the collections of the American Museum of Natural History, the United States National Museum, and the Museum of Comparative Zoölogy of Harvard University.

I wish to express my gratitude to the administration of the Chicago Academy of Sciences for readily making the type material available to me; to Dr. Joseph P. E. Morrison of the United States National Museum for permitting me to examine the material in the collection and for discussing the matter thoroughly with me; and to Dr. William K. Emerson of the American Museum of Natural History for reading the manuscript. — MORRIS K. JACOBSON, Associate, American Museum of Natural History.

FEEDING BEHAVIOR OF SOME NEW ENGLAND MARINE GASTROPODS. — A single specimen of *Velutina laevigata* (L.) was observed feeding upon a *Halocynthia pyriformis* Rathke at Robbinston, Maine in May 1968. The predator had a shell-aperture diameter of 16 mm. and was firmly attached at the base of the tunicate. The prey was shrivelled and withered to a length of slightly under 3 inches and a diameter of $\frac{3}{4}$ of an inch. The *Velutina* had to be pried free, but the proboscis was parallel to the surface of the prey and did not retract immediately so that it had to be worked free in order to remove the gastropod. The faecal string of the predator was a brilliant orange color for the following 24 hours. Considering the size of the *Halocynthia*, the snail must have been feeding for a long period of time. The impression left on the tunic of the prey by the snail's shell was almost like a scar.

Ankel (1936) reported *Velutina velutina* (Müller) feeding on solitary ascidians and *V. plicatilis* (Müller) feeding on an hydro-

zoan. Diehl (1956) expanded on the relationship of *V. velutina* to its prey, *Styela coriacea*.

Large numbers of *Colus stimpsoni* (Mörch) were found moving over the mud surface of an eel grass bed at Cobscook State Park, Edmunds, Maine; also in May, 1968. Several were feeding on *Littorina littorea* (L.). The periwinkle was enveloped by the foot of the *Colus*, foot to foot, with the shells of prey and predator oriented in the same direction. The predator was on its side with its exposed foot projecting upward and slightly laterad. When the littorines were removed in the field and later in feeding studies at the Marine Science Institute, the head of the *Colus* could not be seen, and the parts involved in the feeding process were retracted too rapidly to be seen. The initial part of the feeding process could be observed in the laboratory. The aperture of the shell of the prey was drawn toward the head of the predator and the latter probed the surface of the operculum with its proboscis. In all observed feedings, the proboscis was inserted between the operculum and columella, and all living parts of the prey were ingested.

The *Colus* were associated with *Buccinum undatum* L. and *Neptunea decemcostata* (Say) but were not observed feeding on either of them nor would they feed on them in the laboratory.

Some *Acmaea testudinalis* (Müller) were placed in an aquarium with *Buccinum undatum* for safe storage since *Buccinum* is a scavenger; however, they rapidly attacked the limpets. The attacks were made at the front end of the limpet with the proboscis of the whelk extending over the limpet's head. Only the visceral mass was ingested. The limpet was left still attached by its foot to the aquarium wall after each predation.

This failure to ingest the foot is similar to the situation of *Busycon canaliculatum* (L.) feeding on large *Buccinum undatum*. However, *B. canaliculatum* ingests all living parts of *Polinices heros* (Say), leaving only a well-cleaned shell and operculum. — NATHAN W. RISER, Marine Science Institute, Northeastern University, Nahant, Mass. 01908.

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Mrs. Horace B. Baker, Business Manager
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THE NAUTILUS

Vol. 82

April 1969

No. 4

MEIOCARDIA FLORIDANA, AN OVERLOOKED EOCENE PELECYPOD

By DAVID NICOL

Department of Geology, University of Florida, Gainesville, Florida.

Druid Wilson of the U. S. Geological Survey noticed the similarity of *Isocardia floridana* Dall (1900, p. 1,066) and a species I recently described in the Nautilus as *Meiocardia palmerae* (1968, pp. 89-93). The latter species was collected from the Upper Eocene Crystal River Formation. In his original description of *Isocardia floridana*, Dall erroneously recorded the age of the strata from which his specimen came as Vicksburgian Oligocene. The locality was stated as Arredondo, Florida, which is about six miles southwest of Gainesville. The description of the U. S. Geological Survey locality (#367) where *Isocardia floridana* was collected also included the words "at a blue sink," but this spot has apparently been lost in antiquity because there is no blue sink shown on any of the maps of the Arredondo region. There are, however, some long-abandoned limestone quarries at Arredondo, and the Crystal River Formation is either at the surface or only a foot or two below it. There is no other younger limestone stratum above the Crystal River in the immediate area. Furthermore, Puri's *Lepidocyclina-Pseudophragmina* faunizone crops out at the top of the quarries at Arredondo, and that is the faunizone in which *Meiocardia palmerae* was collected.

In a list of Ocala fossils (p. 1,557), of which the Crystal River Formation is a part, Dall listed this species in the following manner: "?*Isocardia floridana* Dall, Arredondo." Does the question mark indicate that Dall doubted that this species came from Ocala strata? It is not so surprising, then, that this species has been overlooked by later workers.

Dall had only an internal limestone cast of a right valve (U.S.N.M. 115773) of a true *Meiocardia*. In the measurement of the length, he gave three different figures: in the original description on page 1,066, 30.0 mm.; on plate 46, figure 21, 25.0 mm.; and on the same plate, figure 26, 36.0 mm. I have measured the

specimen and find that the length is 29.2 mm. and the height is 28.0 mm. This is a large specimen, but I have found one larger which measures 30.6 mm. long and 29.7 mm. high (U.S.N.M. 646026). The measurements of the holotype of *Meiocardia floridana* (Dall) agree well with the larger specimens of *Meiocardia palmerae* Nicol. The smaller specimens are commonly slightly higher than long, but the larger specimens (more than 25.0 mm. in height) are all slightly longer than high. Other morphological features on Dall's specimen are like those of *Meiocardia palmerae*, and it seems certain that Dall's specimen came from the same strata and within the same geographic area as *Meiocardia palmerae*. Therefore, I am convinced that *Meiocardia palmerae* Nicol, 1968, is a synonym of *Meiocardia floridana* (Dall), 1900. There are only 13 specimens of this rare species known at the present time.

Unfortunately, Palmer and Brann (1965) also overlooked *Isocardia floridana* Dall when they compiled their *Catalogue of the Paleocene and Eocene Mollusca of the southern and eastern United States*. Another probable Eocene Ocala species these authors did not include in their catalogue is *Fistulana ocalana* Dall, 1898, p. 826, which appears to be the cast or internal filling of the tube of a gastrochaenid pelecypod. The sole specimen and holotype is U.S.N.M. 112510.

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MOLLUSKS NEW TO SOUTH CAROLINA: II

BY ARTHUR S. MERRILL¹ AND RICHARD E. PETIT²

This paper is a second report of molluscan range extensions to South Carolina. An earlier paper (Merrill and Petit, 1965) gave the method and extent of our collecting, the references used in determining the distribution of mollusks, and the intended deposition of the material.

We have identified about 300 species of an estimated 450 in our collection. Twenty-six new range records were reported in the first paper, 19 in this one—a total of 45 extensions to South Carolina. In addition, five other species have been tentatively identified. If the identifications are confirmed, the total new range extensions will be over 50 from the first 300 species studied—a ratio of about one to six.

Several additional range records originally placed in this report were withdrawn when Cerase-Vivas and Gray (1966) recently reported extensions for the same species to North Carolina. Records for two other species, *Haliotis pourtalesii* Dall and *Cypraecassis testiculus* (Linnaeus), have been withdrawn at the request of Dr. Tucker Abbott, who had occasion to review this manuscript. Dr. Abbott called our attention to the fact that Dr. J. H. Ferguson had reported *Haliotis pourtalesii* Dall in his manuscript check list of North Carolina mollusks (also Abbott, 1968, p. 54), and that there is a North Carolina record of *Cypraecassis testiculus* in a 1966 North Carolina Shell Club Bulletin. The high frequency of range extensions points to the need for further study of the fauna of this area.

Pelecypoda

Anadara (Larkinia) notabilis (Röding)

Arca notabilis Röding 1798, Mus. Boltenianum, p. 173.

Several large fresh valves, dredged off McClellanville, S. C. (N. Lat. 32°31.2'; W. Long. 78°51.0'), in 46 meters, on July 3, 1963. Previous northernmost record, "northern Florida" (Abbott, 1954, p. 344).

Chlamys benedicti Verrill & Bush

Chlamys benedicti Verrill & Bush 1897, Trans. Connecticut

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Acad., 10: 74.

Many live adult specimens and fresh valves dredged off McClellanville, S. C. (N. Lat. $32^{\circ}31.2'$; W. Long. $78^{\circ}51.0'$), in 46 meters, on July 3, 1963. Verrill & Bush (*loc. cit.*) recorded this species from off Martha's Vineyard, Mass., in 1356 fathoms, but Clarke (1962) did not include *C. benedicti* in his deep-water list. Abbott (1954, p. 364) gave the northernmost range as "southeast Florida."

Lima (Ctenoides) scabra (Born)

Ostrea scabra Born 1778, Index Mus. Vindobonensis, p. 96.

Two fresh valves, largest 53.6 mm. long, dredged off Cape Romain, S. C. (N. Lat. $32^{\circ}49.4'$; W. Long. $78^{\circ}16.7'$), in 55 meters, on November 27, 1963. Our specimens from Cape Romain are the smooth form called *L. tenera* Sowerby 1843, *non* Turton 1822. Johnson (1934, p. 26), listed *L. scabra* as ranging northward to North Carolina, but restricted *L. tenera* to southeast Florida. Abbott (1954) referred to *L. tenera* as a form of *L. scabra*, the range of which he mentioned as "southeast Florida."

Pododesmus rudis (Broderip)

Placunanomia rudis Broderip 1834, Proc. Zool. Soc. London, pt. 2, p. 2.

Several live adult specimens, dredged off McClellanville, S. C. (N. Lat. $32^{\circ}31.2'$; W. Long. $78^{\circ}51.0'$), in 46 meters, on July 3, 1963. Mazyck (1913, p. 21) questioned a report of this species from Charleston Harbor, S. C. Later works, therefore, did not include *P. rudis* north of Florida (Warmke and Abbott, 1961, p. 172). Merrill (1963, p. 69), recently reported this species from a buoy off Georgia. Our findings definitely establish the range to South Carolina and confirm Mazyck's listing. Moreover, while checking Museum of Comparative Zoölogy collections, we located the following lots of *P. rudis*: from buoy off Port Royal, S. C., collected by R. C. Spencer, 1947, MCZ. No. 165400; from buoy off Cape Romain, S. C., collected by A. S. Merrill, May, 1949, MCZ. No. 213285.

Pycnodonte hyotis (Linnaeus)

Mytilus hyotis Linnaeus 1758, Syst. Nat., ed. 10, p. 704.

Numerous large fresh valves, to 80 mm. in greatest dimension, dredged off McClellanville, S. C. (N. Lat. $32^{\circ}28.7'$; W. Long. $78^{\circ}47.1'$), in 64 meters, on July 3, 1963. Previous northernmost range "off Palm Beach, Fla." (McLean, 1941, p. 7, for *P.*

thomasi [= *P. hyotis*]).

Diplodonta verrilli Dall

Diplodonta verrilli Dall 1899, Journ. Conch., 9 (8) : 245.

One large single fresh valve dredged off McClellanville, S. C. (N. Lat. 32°28.7'; W. Long. 78°47.1'), in 64 meters, on July 3, 1963. Dall (1889, p. 52) recorded this species (*D. turgida* = *D. verrilli*) from Rhode Island to Grenada. Johnson (1934), however, restricted the range from south of Martha's Vineyard, Mass., to North Carolina and later workers have not reported *D. verrilli* farther south.

Antigona strigillina (Dall)

Cytherea (Ventricola) strigillina Dall 1902, Proc. U. S. Nat. Mus., 26 (1312) : 381, pl. 12, fig. 5.

Several fresh valves dredged off McClellanville, S. C. (N. Lat. 32°28.7'; W. Long. 78°47.1'), in 64 meters, on July 3, 1963. Previously reported only as far north as "South Carolina." (Abbott, 1968, p. 230).

Thracia morrisoni Petit

Thracia morrisoni Petit 1964, Proc. Biol. Soc. Washington, 77: 157, figs. 1-6.

Three live specimens, the largest (holotype) 17.7 mm. long found in beach drift at low tide at Ocean Drive Beach, S. C., in January 1958. This species was described recently by Petit (*loc. cit.*), and is included here as a species new to South Carolina.

Gastropoda

Puncturella (Cranopsis) antillana Farfante

Puncturella (Cranopsis) antillana Farfante 1947, Johnsonia, 2 (24) : 120.

One fresh dead specimen, 9 mm. long, dredged off Cape Romain, S. C. (N. Lat. 32°35.0'; W. Long. 78°01.2'), in 265 meters, on November 27, 1963. Previous northernmost range, "along the West Indies" (Farfante, *loc. cit.*, p. 121).

Aorotrema cistronium (Dall)

Cyclostrema cistronium Dall 1889, Bull. Mus. Comp. Zool., 18 (2) : 394.

One adult specimen dredged off Cape Romain, S. C. (N. Lat. 32°49.1'; W. Long. 78°16.3'), in 65-80 meters, on November 27, 1963. The known range of this species was limited to North Carolina. Its geographic range is possibly extensive, but small size (ca. 2 mm.) and sparse collecting in southeastern waters

limit our knowledge of distribution. Pilsbry and McGinty (1945, p. 11) reported the range, Cape Hatteras to Cape Fear, N. C., in 22-63 fathoms (ca. 40-113 meters). Our finding extends the range southward to South Carolina waters.

Astraea caelata (Gmelin)

Trochus caelatus Gmelin 1791, Syst. Nat., ed. 13, p. 3581.

One moderately worn medium-sized specimen dredged off McClellanville, S. C. (N. Lat. 32°28.7'; W. Long. 78°47.1'), in 64 meters, on July 3, 1963. Previous northernmost range, "southeast Florida" (Warmke and Abbott, 1961, p. 47).

Modulus modulus (Linnaeus)

Trochus modulus Linnaeus 1758, Syst. Nat., ed. 10, p. 757.

One very fresh specimen, 8.4 mm. long, dredged off Cape Romain, S. C. (N. Lat. 32°50.2'; W. Long. 78°18.8'), in 36 meters, on November 27, 1963. Abbott (1944, p. 4) gave the range, "Bermuda, Florida, the Gulf of Mexico, and south through the West Indies to Brazil." He noted that Dall's (1892, p. 295) record of this species from 25 miles off Hatteras, N. C., is possibly an accidental specimen transported by migrating fish or other mechanical means, as it was not known to occur between Hatteras and east Florida. In view of the Bermuda record of *M. modulus*, which is of similar latitude as North Carolina, and of our finding it in South Carolina, we feel that Dall's range record is correct.

Cerithium semiferrugineum Lamarck

Cerithium semiferrugineum Lamarck 1822, Anim. s. Vert., VII, p. 74.

One large rather worn shell dredged off McClellanville, S. C. (N. Lat. 32°28.7'; W. Long. 78°47.1'), in 46 meters, on July 3, 1963. Mentioned respectively as a subspecies, a variety, and a form of *C. literatum* Born 1870 by Johnson (1934, p. 110), Dall (1889, p. 140), and Warmke and Abbott (1961, p. 72). The most northern record is Dall's (1889, p. 140) specific designation of St. Augustine, Florida.

Primovula carnea (Poiret)

Bulla carnea Poiret 1789, Voy. Barbarie, pt. 2, p. 21.

One fresh dead adult specimen dredged off Cape Romain, S. C. (N. Lat. 32°49.1'; W. Long. 78°16.3'), in 65-80 meters, on November 27, 1963. Previously reported as far north as southeast Florida by Abbott (1954, p. 181).

Charonia variegata (Lamarck)

Triton variegatum Lamarck 1816, Tableau Encyclopédique et Méthodique, Liste, p. 5, Atlas 3, pl. 421, fig. 2 a-b.

One very fresh fragment (35 mm.) of juvenile. Estimated size of entire shell about 65 mm. Dredged off Cape Romain, S. C. (N. Lat. $32^{\circ}49.1'$; W. Long. $78^{\circ}16.3'$), in 65-80 meters, on November 27, 1963. Another moderately worn fragment taken at a nearby station. Previous northernmost range in Western Atlantic: U. S. Coast, lower Florida Keys; Bermuda (Clench and Turner, 1957, p. 197).

Latirus brevicaudatus (Reeve)

Turbinella brevicaudata Reeve 1847, Conchologia Iconica 4, *Turbinella*, pl. 10, fig. 50.

One live medium-sized specimen, 30 mm. long, dredged off Cape Romain, S. C. (N. Lat. $32^{\circ}49.4'$; W. Long. $78^{\circ}16.7'$), in 54 meters, on November 27, 1963. Previous northernmost range, "lower Florida Keys and West Indies" (Warmke and Abbott, 1961, p. 120).

Oliva reticularis Lamarck

Oliva reticularis Lamarck 1811, Ann. Mus. d'Hist. Nat., 16: 314.

One live specimen, 33 mm. long, dredged off McClellanville, S. C. (N. Lat. $32^{\circ}31.2'$; W. Long. $78^{\circ}51.0'$), in 46 meters, on July 3, 1963; also taken commonly live, fresh dead, and moderately worn in other nearby dredgings. Reported as far north as southeast Florida (Abbott, 1954, p. 245).

Marginella haematita Kiener

Marginella haematita Kiener 1834, Icon. Coquilles (*Marginella*), p. 11.

One adult, length 10.7 mm., dredged off Cape Romain, S. C. (N. Lat. $32^{\circ}49.4'$; W. Long. $78^{\circ}16.7'$), in 54 meters, on November 27, 1963. Another specimen, 10.2 mm. long, taken at a nearby station. Previous northernmost range, "southeast Florida" (Abbott, 1954, p. 254).

Ancistrosyrinx radiata Dall

Ancistrosyrinx radiata Dall 1889, Bull. Mus. Comp. Zool., 18(2): 78.

One moderately worn specimen, 14 mm. long, dredged off Cape Romain, S. C. (N. Lat. $32^{\circ}49.1'$; W. Long. $78^{\circ}16.3'$), in 65-80 meters, on November 27, 1963. Previous northernmost record,

"south Florida" (Abbott, 1954, p. 268).

Conus floridanus Gabb

Conus floridanus Gabb 1868, American Journ. Conch., 4: 195.

Two specimens, one fresh, one moderately worn, dredged off McClellanville, S. C. (N. Lat. 32°34.9'; W. Long. 78°51.3'), in 36 meters, on July 2, 1963. This is the form *C. floridensis* of Clench (1942, p. 28). Previous northernmost range off Ft. Walton, Florida (Clench, 1942, p. 29).

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OCCURRENCE OF *CYMBULIA PERONI* DE BLAINVILLE,
A PSEUDOTHECOSOMATOUS PTEROPOD,
IN THE BAY OF BENGAL

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Although the pseudothecosomatous pteropod *Cymbulia peroni* de Blainville is known to occur in the Indian Ocean (Tesch, 1904; Meisenheimer, 1905; Stubbings, 1938), there has been no report on its distribution in the Bay of Bengal. During March, 1962, six live *Cymbulia peroni* were collected from Lawson's Bay, Waltair (17°44'N and 83°23'E). Four specimens were collected on the 19th and two on the 26th of March. The surface water with the animals was gently drawn into a bucket from a catamaran. Only those animals collected on the 26th possessed the characteristic fleshy slipper-like pseudoconchae. The pseudoconchae were 15-20mm long (Fig. 1). The anterior extremity was sharply pointed and slightly curved to the right. The posterior end of the pseudoconcha resembled a fin and was drawn into two long lateral spines. The margin of the pseudoconcha had two rows of denticles. The animals possessed two wings which together measured 8-13mm across. 'Fenestrae' were absent. The muscle fibers showed a reticulate appearance. The animals possessed a flat tail drawn into a pink tentacle.

Earlier accounts on the distribution of *Cymbulia* (Tesch, 1904, 1946, 1948; Meisenheimer, 1905; Massy, 1932; Stubbings, 1938; Morton, 1954) indicate that these pteropods are mainly oceanic and apparently deep water forms in the Mediterranean Sea, Atlantic, Indian and Pacific Oceans. The sharply pointed pseudoconchae and the smaller size of the animals, which are characteristic of oceanic specimens (Tesch, 1946), suggest that the specimens in the Lawson's Bay could have originated from the open ocean. According to Tesch (1948), the Indo-Pacific and Atlantic *Cymbulia* also do not grow to such a large size as the Mediterranean forms.

During March, a northerly clockwise current skirting the east coast of India sets in and brings into the Bay of Bengal large volumes of central equatorial Indian Ocean water (Sewell, 1932).

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During the same period, upwelling of subsurface slope waters also takes place off Waltair coast (Ganapati and Subba Rao, 1957, 1958; LaFond, 1957). During the northerly current, transportation of a few holopelagic animals like *Physalia physalis* (Linnaeus) and *Velella* sp. into Lawson's Bay along with oceanic waters has been reported (Ganapati and Subba Rao, 1962). It is possible that *Cymbulia peroni* are transported from the open ocean into the bay by the prevailing water movements. The occurrence of *Cymbulia peroni* in the bay could be considered sporadic as they were absent in the townet collections made during 1952-1961 twice a week in Lawson's Bay and at about 700 oceanographic stations in the Bay of Bengal. The present report thus extends the distribution of *C. peroni* northwards and shorewards into the Bay of Bengal.

Acknowledgments

I am grateful to Prof. P. N. Ganapati under whose guidance this work was done. My grateful thanks are due to Dr. C. M. Lalli, Zoology Department, McGill University, Montreal and to Dr. D. J. Tranter, C.S.I.R.O., Division of Fish, Oceanography, Cronulla, New South Wales for constructive criticism of the manuscript. This research was supported by National Institute of Sciences of India, New Delhi.

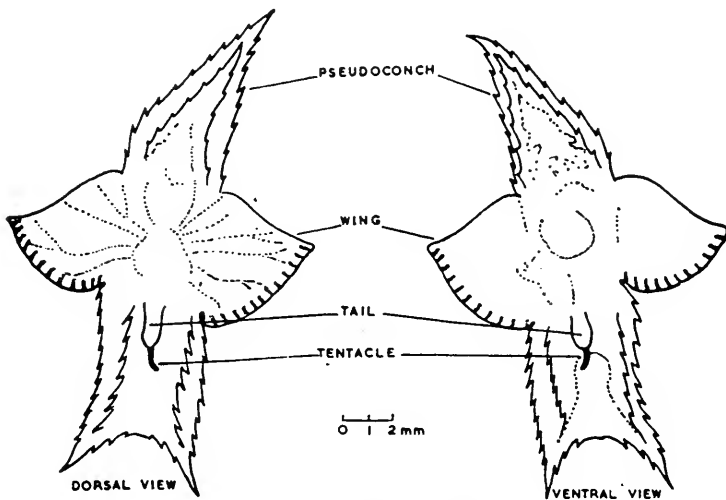


Fig. 1. *Cymbulia peroni*

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A DOUBLE TENTACLE IN *VIANA REGINA* (MORELET)¹
(Mollusca : Prosobranchia : Helicinidae)

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Viana regina is a beautiful terrestrial prosobranch which inhabits the Province of Pinar del Río in Cuba. This report deals with a specimen which possesses an abnormal tentacle.

The animal has a double right tentacle, the right eye being absent. The tentacle in the usual position is like a normal tentacle; the extra tentacle occupies the spot where the eye is usually found.

This teratological specimen was taken in Sumidero, Viñales, Pinar del Río. The shell measures: major diameter 28 mm, minor diameter 22 mm., altitude 26 mm. The presence of the extra tentacle and the absence of the right eye did not appear to interfere with the locomotion or other movements of the mollusk.

The shell is yellow in the earlier whorls and has a reddish subsutural line with more or less broken bands; the base color is greenish when the animal is present, yellow after it has been extracted. The animal is a female since the shell lacks the labial notch which is found only in the male. The three tentacles are lustrous black in color and contrast with the pale gray color of



Figure 1. *Viana regina* (Morelet) from Cuba showing a double right tentacle. X 2.5.

¹ Published by permission of the Director of Instituto de Biología, Academia de Ciencias de la Republica de Cuba.

the rest of the animal. The animal remained alive for about six weeks in the laboratory and was photographed by J. Danilo Cortés of the Instituto.

I am grateful to Vicente Carrión who collected the abnormal specimen and graciously presented it to me together with several other land shells taken at the same locality.

Abnormalities in the organs of mollusks are thought to be rare. The following cases of tentacular monstrosities have been reported:

1853, Forbes E. and S. Hanley, *Hist. British Moll.*, 4:288. *Limax agrestis* L. (= *Deroceras reticulatum* Müller) "upper tentacles united into one."

1856, Fischer, P., *Jour. de Conchyl.*, 5:230, pl. 11, fig. 4. *Submarginula* Gray 1847 (= *Hemitoma* Swainson 1840), two bifid tentacles, two eyes to each.

1864, Fischer, P., *ibid.*, 12:89, pl. 8, fig. 8. *Patella vulgata* L., left tentacle bifid with two eyes, right tentacle normal. (See also Fischer, 1880, *Manuel de Conchyl.*, p. 108, fig. 103).

1884, Baudon, A., *Jour. de Conchyl.*, 32:209, *Limax laevis* Müller (= *Deroceras laeve*), tentacles wanting.

1888, Fischer, P., *ibid.*, 36:131. *Triopa clavigera* Lovén (= *Euphurus claviger*), right rhinophore with three branches "deux antérieures lamelleuses, portées sur un pédoncle commun, lisse, et une postérieure simple, de forme régulière et représentant probablement le rhinophore normal droit."

1955, Kishimoto, H., *Venus*, 18:282, text fig. 1. *Euhadra herklotsi hesperia* Pilsbry, figure shows an aborted right tentacle, smaller and thinner than the left.

1967, Sarasúa, H., *Trabajo de Divulgación 53*, Museo Felipe Poey, La Habana, *Chondropoma poeyanum* (d'Orbigny), possessing a branched tentacle like the horn of a deer.

The cited last record plus the present one involving *Viana regina* seem to be the only cases of tentacular anomalies reported for land prosobranchs.

LUCINACEA AND THEIR HETERODONT AFFINITIES (BIVALVIA)

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It has recently been hypothesized that the Lucinacea, as a group, be elevated to the highest categorical rank short of the class level in the Bivalvia (McAlester, 1966). The evidence marshalled for such a taxonomic overhaul rests in the probable phylogenetic relationship between the Ordovician clam, *Babinka*, and all modern lucinaceans and in McAlester's belief that *Babinka* is related to the Monoplacophora. The historical facts which bear on the phylogeny of Mesozoic and Cenozoic lucinoids cannot be doubted. The fossil record and recent anatomical evidence (Boss, in press) support the contention that the Lucinidae and the Fimbriidae are more closely related to each other than are the Thyasiridae and Diplodontidae, a lineage which appeared in the Mesozoic and diverged by the Cretaceous. Most probably a basic lucinoid stock gave rise to the distinct fimbriids which paralleled the lucinids themselves for millions of years while a thyasirid-diplodontid line was derived from the lucinoid ancestors early in the Mesozoic.

In bivalves evolution usually has proceeded slowly. While one sees the vast radiation of mammals in the short time of the Cenozoic, the bivalves have diverged relatively slowly, appearing already rather highly diversified in the early Paleozoic (Pojeta, in press).

If we concede that *Babinka* is indeed a lucinoid, the origin of this group is placed back in the Ordovician. If not, we find a true lucinoid in the Silurian, with Dall's *Prolucina* from Gotland, Sweden (*i.e.* *Ilionia prisca* (Hisinger)) and in the Devonian with *Paracyclas* Hall. Thus at least sometime in the early Paleozoic we have a lucinoid. Of its anatomical characteristics we cannot be certain — save the distinctly elongate, subsemilunate form of the anterior adductor muscle, a conchologically preserved feature, suggested in *Babinka*, indisputably present in *Ilionia* [*Prolucina*] and known for a fact to be of functional significance in modern lucinids.

Allen (1958) has dwelt long and well on the functional morphology of modern lucinoids. From his work we learn: 1) the

remarkable adaptive features of numerous species of lucinoids; 2) the generally conservative features which allows us to recognize this superfamily's relation with its confrere's and its phylogenetic relationships of very long standing.

Both of these aspects of Allen's work are of special interest. On the adaptively distinctive side, we see that lucinoids utilize an anterior inhalant current, facilitated largely by an enlargement of the ciliated ventral surface of the anterior adductor muscle and, frequently, by a pedunculate foot which constructs an accessory, extraneous inhalant siphon out of mucoid pastes, benthic detritus, and sand grains.

In certain of the families (lucinids and fimbriids), the outer demibranches have been lost, the labial palps astonishingly reduced, and mantle or secondary respiratory flaps elaborated. It even appears that the Diplodontidae and Thyasiridae have secondarily evolved an external demibranch, although I cannot always be certain of paleontological reconstructions based on evidence derived from external forms.

Although the special adaptations of the Lucinacea are of intrinsic interest, their heterodont features constitute noteworthy traits which must not be mislaid amongst a plethora of minutiae. From Allen's work, we see that the nervous system with its constituent cerebral, pleuropedal and visceral ganglia plus concomitant commissures, and that the circulatory system with its paired, thinly-walled auricles and median, thickly walled ventricle, transversed by the alimentary canal, are but fundamental traits.

Heterodonta was introduced by Neumayr (1884) and formally named by Steinmann (1888). Through the years, it has been chopped, pared, reduced, enlarged, pummelled and universally criticised; nevertheless, it has endured, though somewhat modified. Notwithstanding Neumayr's provocative elucidation, Bernard (1895) brought forth the requisite data which undeniably characterized certain bivalve taxa and their hinges. Thus, it was recognized that some bivalves have both anterior/posterior and cardinal dental features in their early ontogeny, and species belonging to such groups were characterized as being "heterodonts" (Newell, 1957).

Dall (1895), who was a contemporary of Bernard, established the Teleodesmacea, an order roughly tantamount to Neumayr's heterodonts, and it included the Lucinacea.

McAlester's thesis is that the Lucinacea are so distinct and separate that "the entire group should be assigned to a separate bivalve taxon of the highest rank." That the Lucinacea possess a fossile lineage traceable at least to the Middle Silurian cannot be denied but that they should be elevated to the rank of subclass, and thus be separated from other bivalves, particularly the Heterodonta as delimited by Newell (1965), can be refuted with meaningful and compelling zoological evidence.

Other than the nervous and circulatory systems previously mentioned, the Lucinacea share important common inheritances with other heterodonts: 1) they are bilaterally equivalved, with subequal anterior and posterior adductor muscles; their pedal musculature is divided into bifurcated anterior and posterior retractors which insert into the shell dorsad of the adductor muscles; 2) their excretory system is distinctly of an advanced complexity (Odhner, 1914) where the nephroprocts or ciliated funnels connect directly with the pericardial cavity and where the distal portion of the kidney is medially and broadly coextensive; the nephric ducts debouch laterally and separately into the suprabranchial chamber, or at least a dorsal division of the mantle cavity; the distal portion of the kidney envelopes the posterodorsally traversing posterior pedal retractors; 3) the gills or ctenidia are eulamellibranch and reticulate with tissue-grade fusions between filaments; and the relation between the labial palps, if present, and the ctenidia is of Stasek's (1963) type three (III); 4) the alimentary canal of lucinoids conforms to the "Stomach Type IV" of Purchon (1958); 5) The ventral gape of lucinoids is broad and extensive, and notwithstanding the anterior inhalant current, both inhalant and exhalant apertures are present posteriorly.

Conchologically, the Lucinacea are endowed with what may be considered basic heterodont characteristics: ontogenetically they possess anterior/posterior lamellar dental structures as well as central, subumbonal or cardinal denticles, even though in adult stages, represented by such genera as *Anodontia*, both lateral and cardinal dentitions are lacking. The shell microstructure is complex cross lamellar (Böggild, 1930; Oberling, 1964). The ligament is opisthodontic and parivincular (Pojeta does not consider an opisthodontic, parivincular ligament to be a heterodont feature, *in litt.*).

Thus there is little doubt that the Lucinacea are intimately related to other bivalves of the heterodont lineage. Anatomical and conchological data attest to their relationship with such similar groups, albeit presently distinct, as the Carditacea, Crassatellacea, Isocardiacea, Tellinacea and Veneracea.

In summary, I have shown that the Lucinacea, old and persevering, are distinctly and obviously heterodont.

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THE UNIONACEA OF WILLIAM IRVIN UTTERBACK

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William Irvin Utterback is remembered for his work on the Unionacea of Missouri but almost nothing is known about him. He was born in 1872 and graduated from Wabash College, Crawfordsville, Indiana, in 1901. In 1915 he received a degree of Master of Arts from the University of Missouri, Columbia, Missouri, for his study, "The Naiades of Missouri." Utterback published on the Missouri fauna from 1914 until 1917 and then dropped from view. He spent many years teaching biology at Marshall University, Huntington, West Virginia. He died in 1949.

The Utterback collection did not find its way into any of the major museums. It was not located at Wabash College or at the University of Missouri. It appears that Utterback kept it with him.

Through the kindness of Dr. Harold E. Ward of Marshall University, all that remained of the collection was recently presented to the Museum of Comparative Zoölogy (MCZ). This consists of 30 single valves of specimens figured or mentioned in, "The Naiades of Missouri" and one valve of the holotype of *Pleurobema utterbackii* Frierson. The remaining shells in the collection were without data and of no scientific interest. Unfortunately, none of Utterback's types have survived.

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- Megalonaias* Utterback: 1915, Amer. Mid. Nat., 4: 123 (41). Type species, *Unio heros* Say, original designation.
- lefevrei* Utterback, *Truncilla*: 1916, Amer. Mid. Nat., 4: 455 (192), pl. 6, figs. 13 a-d, pl. 28, figs. 108 A-D. (Black River, Williamsville [Wayne Co.], Missouri, type lost).
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- Specimens figured in, "The Naiades of Missouri." The brackets indicate data from label on shell or from modern atlases.
1. Plate 2, Fig. 5a. *Plagiola securis* (Lea).
[Meramec R., Meramec Highlands, St. Louis [St. Louis Co.], Missouri]. MCZ 271418
 2. Plate 15, Fig. 29A. *Fusconaia undata* (Barnes).
Miss. R. [La Grange, Lewis Co.], Missouri. MCZ 271419
 3. Plate 15, Fig. 34A. *Fusconaia ebena* (Lea).
Miss. R., La Grange [Lewis Co.], Missouri. MCZ 271420
 4. Plate 16, Fig. 35A. *Amblema peruviana* (Lamarck).
Osage R., Osceola [St. Clair Co.], Missouri. MCZ 271421
 5. Plate 16, Fig. 36C. *Amblema rariplicata* (Deshayes).
Tarkio R., Craig [Holt Co.], Missouri. MCZ 271422

6. Plate 16, Fig. 37A. *Amblema perplicata* (Conrad).
St. Francis R., Greenville [Wayne Co.], Missouri. MCZ 271423
7. Plate 16, Fig. 38C. *Amblema perplicata quintardi* (Cragin).
Osage R., Proctor [Morgan Co.], Missouri. MCZ 271424
8. Plate 17, Fig. 40C. *Megalonaias heros* (Say).
Osage R., Monegaw Springs [St. Clair Co.], Missouri. MCZ 271425
9. Plate 18, Fig. 45C. *Quadrula quadrula* (Rafinesque).
Lake Contrary, St. Joseph [Buchanan Co.], Missouri. MCZ 271426
10. Plate 19, Fig. 50A. *Quadrula verrucosa* (Rafinesque).
Grand R., Darlington [Gentry Co.], Missouri. MCZ 271427
11. Plate 19, Fig. 51A. *Quadrula nobilis* (Conrad).
Marais des Cygnes R., Richhill [Bates Co.], Missouri. MCZ 271428
12. Plate 19, Fig. 52A. *Quadrula cylindrica* (Say).
Black R., Williamsville [Wayne Co.], Missouri. MCZ 271429
13. Plate 20, Fig. 56A. *Plethobasus aesopus* (Green).
Des Moines R., Dumas [Clark Co.], Missouri. MCZ 271430
14. Plate 20, Fig. 59A. *Pleurobema catillus* (Conrad).
Black R., Williamsville [Wayne Co.], Missouri. MCZ 271431
15. Plate 21, Fig. 66A. *Elliptio dilatata* (Rafinesque).
Osage R., Osceola [St. Clair Co.], Missouri. MCZ 271433
16. Plate 21, Fig. 68A. *Elliptio dilatata subgibbosa* (Lea).
Black R., Williamsville [Wayne Co.], Missouri. MCZ 271434
17. Plate 22, Fig. 70A. *Symphynota complanata* (Barnes).
Big Mud Lake, Kenmoor [but on shell, Halls, both Buchanan Co.], Missouri. MCZ 271432
18. Plate 22, Fig. 71C. *Symphynota costata* (Rafinesque).
Gasconade R., Gascondy [Osage Co.], Missouri. MCZ 271435
19. Plate 24, Fig. 78A. *Alasmidonta marginata* (Say).
Gasconade R., Gascondy [Osage Co.], Missouri. MCZ 271436
20. Plate 24, Fig. 80C. *Strophitus edentulus* (Say).
White R., Hollister [Taney Co.], Missouri. MCZ 271437
21. Plate 25, Fig. 85A. *Nephronaias ligamentina* (Lamarck).
Meremec R., Fern Glen [Meremec Highlands, St. Louis, St. Louis Co.], Missouri. MCZ 271438
22. Plate 25, Fig. 87C. *Nephronaias pleasii* (Marsh).
White R., Branson [Taney Co.], Missouri. MCZ 271439

23. Plate 26, Fig. 91A. *Lasmonos simpsoni* (Ferris).
White R., Branson [Hollister, both Taney Co.], Missouri. MCZ 271440
24. Plate 27, Fig. 98D. *Eurynia (Micromya) brevicula* (Call).
Jack's Fork [of] Current R., [Shannon Co.], Missouri. MCZ 271441
25. Plate 27, Fig. 100A. *Eurynia (Eurynia) recta* (Lamarck).
Osage R., Osceola [St. Clair Co.], Missouri. MCZ 271442
26. Plate 27, Fig. 100C. *Eurynia (Eurynia) recta* (Lamarck).
Meramec R., Meramec Highlands, St. Louis [St. Louis Co.], Missouri. MCZ 271443
27. Plate 28, Fig. 103A. *Lampsilis luteola* (Lamarck).
Black R., Williamsville [Wayne Co.], Missouri. MCZ 271444
28. Plate 28, Fig. 103C. *Lampsilis luteola* (Lamarck).
Black R., Williamsville [Wayne Co.], Missouri. MCZ 271445
29. Plate 28, Fig. 104A. *Lampsilis luteola rosacea* (DeKay).
Black R., Williamsville [Wayne Co., but on shell, White River, Branson, Taney Co.], Missouri. MCZ 271446
30. *Quadrula metancora wardii* (Lea).
Des Moines R., Dumas [Clark Co.], Missouri. Bush Colln., mentioned on p. 147 (65), but not figured. MCZ 271447

NOTES ON A LIGHT-COLORED SPECIMEN OF *PHILOMYCUS CAROLINIANUS* (BOSC)

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Pilsbry (1948) describes alcoholic albino specimens of *Philomycus carolinianus* (Bosc) having a light ochraceous buff tint, without markings. All occurred singly in lots of variously pigmented individuals from Florida, New Jersey, Pennsylvania, New York, and Maine.

A single specimen of *P. carolinianus* approaching the above description was collected by the senior author from the "Big Cypress Swamp" along Florida Highway 29 near Immokalee, Collier Co., Florida on September 11, 1968. It was found in a bromeliad, *Tillandsia* sp., which was attached to a cypress tree about four feet above the water level. No other slugs were located in this area so it cannot presently be ascertained whether this was

the only light-colored specimen occurring in a normally pigmented population.

The slug was of a uniform light cinnamon buff color both above and below (Fig. 1a) except for a slight intensification of the pigment at the extreme anterior and posterior ends of the mantle. The head and lower tentacles were of a light tan color while the upper tentacles appeared whitish except for their tips which were light cinnamon. When fully extended the slug measured 57mm in length and 10mm in width.

The specimen, in the laboratory, deposited 15 eggs on November 1, 1968 (Fig. 1b) each of which ranged in size from 2.8-3.0 mm wide and 3.5-4.0 mm long. The clutch was deposited as a two-layer roughly circular mass. On November 17, 1968 one of the eggs hatched revealing a young slug with same coloration as the parent (may indicate true albinism). The other eggs did not develop properly nor hatch, probably because of contamination of the culture with decaying lettuce and free-living nematodes. The latter were seen moving about within and on the eggs presumably feeding on this egg material. The adult is being maintained in the hope that it will deposit more clutches that can be reared and examined.

While albinism is not new in slugs, it is of interest each time



Fig. 1. (a) Adult albino specimen of *Philomycus carolinianus* (Bosc) collected in Collier Co., Florida. (b) Egg clutch deposited by albino *P. carolinianus*.

it is found since it must be of non-adaptive value. A slug as light-colored as this surely stands out starkly against the background when compared with those of normal color which blend well. As pointed out by Livezey (1968) adult albinos are rarely encountered since they are more readily seen by predators and devoured before they can mature — Pat W. Hermann and Dee S. Dundee, University of Georgia and Louisiana State University, respectively.

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HINGE TOOTH REVERSALS IN SPHAERIID CLAMS¹

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Introduction. The transposition of hinge teeth in marine bivalves has been investigated by Popenoe and Findlay (1933), and van der Schalie (1936) reviewed this phenomenon in members of the freshwater mussel family Unionidae. In addition, partial or complete reversal of the hinge teeth of another large group of freshwater pelecypods, the family Sphaeriidae (fingernail and pill clams), has been noted by Walker (1896), Sterki (1899, 1922), Kuiper (1943), Eggleton and Davis (1961), and Herrington (1962).

Sphaeriids possess heterodont dentition, and the typical (i.e., most frequently encountered) arrangement of teeth in the shell of *Sphaerium* s.s., *Musculium*, *Pisidium*, and *Pseudocorbicula* is: 2 anterior laterals (AL) — 1 cardinal (C) — 2 posterior laterals (PL) in the right valve, and 1 anterior lateral — 2 cardinals — 1 posterior lateral in the left valve (see Herrington, 1962, Fig. 2; Heard, 1965a). Seven types of "reversals" are possible (Table 1, this paper), and other anomalies may also occur. The genus *Eupera* has a typical hinge tooth formula of 1 — 1 (C-2?) — 1 in the left valve, and 2 — 1 (C-3) — 2 in the right valve, and at present no data exists concerning deviations from this arrange-

¹This investigation was supported, in part, by grant GB-4626 from the National Science Foundation.

ment. *Byssanodonta*, considered edentulous by Klappenbach (1960) and Heard (1965a), has been noted by Bonetto and Ezcurra (1964) to possess a system of slight, rudimentary ridges similar to the formula in *Eupera*: 1 — (“eminencia mamelonácea”) — 1 (“relieves articulares”) in the left valve, and 2 — 1 — 2 in the right valve (although one of the posterior laterals may be absent).

Detailed frequencies of the various types of reversals are largely lacking. Walker (1896) and Kuiper (1943) merely listed numbers of individuals displaying deviations, while Sterki (1899, 1922) indicated that “20 to 30 per cent of all specimens from some localities” may be reversed. Eggleton and Davis (1961), however, presented values for specific reversals in *Sphaerium striatinum*: 40.5% for PL, 41.0% for ALC, and 18.4% for ALCPL (complete reversal).

Generic Differences. Without providing more detailed information, Sterki stated (1) in 1899 that “In *Sphaeria rhomboideum*, *occidentale*, *corneum*, etc., reversion seems to be rare; and so in *Calyculina*” (= *Musculium*), and (2) in 1922 that “With *Pisidium* they are less frequent, though noticed in many species, and with *Musculium* they are apparently scarce.” Although more information is desirable, it is clear that reversal percentages are indeed higher in species of *Sphaerium* s.s. than in members of *Pisidium* (see Table 1). While overlooked as a possible generic difference, this variation prompted Kuiper (1943) to conclude that reversals (“Inversodontie”) in Dutch sphaeriids were rare compared to those occurrences in North America. It should be pointed out, however, that until now the Nearctic data concerned *Sphaerium* s.s., while Kuiper’s (1943) observations dealt primarily with Palearctic *Pisidium*. Regretably, few studies have been made of reversals of hinge teeth in *Musculium* (= *M. lacustre*, *M. partumeium*, *M. securis*, and *M. transversum*; frequently, *Musculium* is considered a subgenus of *Sphaerium* rather than a valid genus).

Walker (1896) listed 4 kinds of reversals: AL, PL, ALC and ALCPL, while Sterki (1899, 1922), Kuiper (1943), and Eggleton and Davis (1961) recorded only the last 3 groups. Herrington (1962) specifically mentioned the reversal of AL (“more common”) and ALCPL, indicating in addition that “Other irregularities are also known to occur.” In the original data presented

here (Table 1) several new types of reversals are reported: C and ALPL in *Sphaerium* s.s., PL in *Musculium*, and AL in *Pisidium*. This leaves only the CPL reversal in *Sphaerium* s.s., and C, ALC, CPL and ALPL reversals in *Pisidium*, and the remaining six reversals in *Musculium* as never having been observed. Thus, there is seen greater variation among the types of reversals, as well as greater proportions, in *Sphaerium* s.s. as compared to these phenomena in *Pisidium* (and *Musculium*?). This conclusion is upheld despite intragenic and intraspecific variation in both *Sphaerium* s.s. and *Pisidium*.

Population Variation. Eggleton and Davis (1961) reported variation in the "rate" of reversal in *Sphaerium striatinum* from two different populations in the same drainage. Similar variations occur in *Sphaerium fabale*, *Pisidium casertanum*, *P. compressum* and *P. dubium* (Table 1). This prevalence of one or another kind of reversal in different populations of the same species is considered to represent a reflection of the reproductive habits of sphaeriids: all species are hermaphroditic and ovoviviparous. While the occurrence (let alone the extent) of self-fertilization in nature is unknown, this phenomenon has been demonstrated in *Musculium partumeium* (Thomas, 1959) and in *Pisidium conventus* (Odhner, 1951; Heard, 1963) in the laboratory. However, as with most monoecious animals, self-fertilization is at least theoretically possible (mature ova and spermatozoa may occur simultaneously; Heard, 1965b), although cross-fertilization is thought to be prevalent in nature. In either case, a sphaeriid population with insignificant emigration and immigration can be considered to comprise a comparatively closed breeding association with little if any genic exchange with other populations. Thus, in populations practicing a degree of inbreeding, a feature with genetic basis may vary in frequency of occurrence from one population to another.

Hereditary Relationships. Kuiper (1943) suggested a genetic relationship between reversals of the cardinal teeth and the anterior laterals because the cardinals never were reversed alone (refuted in this paper; see *Sphaerium fabale* and *S. rhomboideum* in Table 1) but were reversed with the anterior laterals (viz., ALC and ALCPL). Sterki (1922), however, stated that hinge tooth reversals in sphaeriids ". . . are not hereditary, or at any rate not regularly or even prevalently so: nepionic mussels with

SPECIES	LOCALITY	AL	C	PL	ALC
Sphaerium s.s.					
S. fabale	--			X	X
S. fabale	CRS*	3	1	32	2
S. rhomboideum	ML*	2	2	5	3
S. simile	--			X	X
S. simile	--			X	X
S. striatinum	--	X		X	X
S. striatinum	--			X	X
S. striatinum	Ohio			X	X
S. striatinum	RR*	4		14	18
Musculium					
M. partumeium	Florida			3	
Pisidium s.l.					
sg. Pisidium s.s.					
P. amnicum	Holland			X	X
P. dubium	--				X
P. dubium	OC*	1		8	
P. dubium	Florida			4	
sg. Rivulina					
P. adamsi	SPBP*			1	
P. casertanum	--				
P. casertanum	Holland			X	X
P. casertanum	FC*				
P. casertanum	HR*				
P. casertanum	MC*			4	
P. casertanum	NC*			1	
P. casertanum	PR*				
P. casertanum	Florida	1	1	5	1
P. compressum	FC*				
P. compressum	LC*			1	
P. compressum	NC*				
P. compressum	OL*				
P. compressum	SPBP*				
P. fallax	RR*			4	
P. henslowanum	Holland			X	
P. nitidum	Holland			X	
P. nitidum	OL*			3	
P. obtusale	Holland			X	X
P. subtruncatum	Holland			X	
P. supinum	Holland				X
P. variabile	FC*				
P. variabile	SPBP*				

Table 1. Hinge tooth reversals in sphaeriid

Numbers: numbers of individuals; *: different

ALPL	ALCPL	TYPICAL	REFERENCE
	X	X	Sterki (1899)
1	5	456	this paper
	2	542	this paper
	X	X	Walker (1896)
	X	X	Sterki (1899)
	X	X	Walker (1896)
	X	X	Sterki (1899)
	X	X	Eggleton & Davis (1961)
	6	670	this paper
		154	this paper
	X	X	Kuiper (1943)
			Sterki (1899)
	2	132	this paper
		242	this paper
		87	this paper
	X	X	Sterki (1899)
	X	X	Kuiper (1943)
		162	this paper
		55	this paper
	1	531	this paper
		71	this paper
		72	this paper
		384	this paper
		483	this paper
		34	this paper
		54	this paper
		264	this paper
		12	this paper
		1534	this paper
		X	Kuiper (1943)
		X	Kuiper (1943)
		342	this paper
	X	X	Kuiper (1943)
		X	Kuiper (1943)
		X	Kuiper (1943)
		99	this paper
		36	this paper

clams. X: presence only was noted;
populations in Michigan.

reversed hinges have been taken from normally hinged parents, and *vice versa*; also, young with normal and others with reversed hinges may be found in one parent."

The latter problem is receiving the attention of Professor Frank E. Eggleton of the University of Michigan who has been gathering extensive data on the relationships of hinge tooth reversals between P_1 and F_1 generations in *Sphaerium crassum* (= *S. simile*?) and *S. simile*.

Anomalies. Other atypical dentition, apart from the 7 possible (6 observed) reversals, may also appear on the hinge of sphaeriid clams: (1) *Duplication or absence of teeth* can occur either without or with any normally-encountered reversals (Table 2). The data, though small, suggest that duplications are more common in the left valve and deletions more common in the right valve. (2) *Small denticles* may occur in addition to the typical number of teeth. In one specimen of *P. adamsi* two small one denticle was found between the cardinal (s) and posterior lateral and cardinal teeth, and in one specimen of *P. compressum* on denticle was found between the cardinal (s) and posterior lateral (s) in each valve. However, in neither instance did the opposite valve contain corresponding depressions to receive the projections which were much smaller than the cusps of the ordinary hinge teeth.

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SPECIES	LEFT VALVE	RIGHT VALVE	CONDITIONS
<i>P. casertanum</i> (1)	2 ^a -2-2 ^a	2-1-2	2 duplications, no reversals.
<i>P. fallax</i> (1)	2 ^a -2-1	2-1-2	1 duplication, no reversals.
<i>P. fallax</i> (1)	1-2-2 ^a	2-1-2	1 duplication, no reversals.
<i>P. casertanum</i> (1)	2 ^a -2-1	2-1-1 ^b	1 duplication, 1 deletion, no reversals.
<i>P. fallax</i> (3)	1-2-1	2-1-1 ^b	1 deletion, no reversals.
<i>P. casertanum</i> (1)	2 ^a -2-2 ^c	2-1-1 ^c	1 duplication, 1 reversal.
<i>P. nitidum</i> (1)	1-1 ^c -1	1 ^b -2 ^c -2	1 depletion, 1 reversal.
<i>S. fabale</i>	2 ^c -2-2 ^c	1 ^c -2 ^a -1 ^c	1 duplication, 2 reversals.

Typical hinge tooth formula: 1-2-1 2-1-2

Table 2. Hinge tooth duplications and deletions, with and without reversals, in sphaeriid clams. a: duplication; b: deletion; c: reversal; numbers in parentheses indicate the number of specimens.

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NOTES AND NEWS

SECOND ANNUAL MEETING of the Western Society of Malacologists will be held at the conference grounds at Asilomar State Park, Pacific Grove, California, June 18 to 21, 1969. Scientific papers, symposia on related problems, and exhibits will be presented in various fields related to the study of malacology and invertebrate zoology.

Officers for the coming year who were elected at the 1968 conference are as follows: President, Dr. William K. Emerson, American Museum of Natural History; First Vice President, Dr. A. Myra Keen, Stanford University; Second Vice President, Dr. Eugene V. Coan, Stanford University; Secretary, Mrs. Paul O. Hughes, Los Alamitos; Treasurer, Mrs. Leroy Poorman, Pasadena; Members-at-Large, Dr. Judith Terry, Palo Alto, California and Miss Betsy Harrison, Honolulu, Hawaii.

All persons interested in malacology and conchology are cordially invited to attend and participate in the coming conference. Excellent accommodations in varying price ranges (American Plan) will be available for those making their reservations early.

For information on the conference or on membership in the Society please address the Secretary, Mrs. Paul O. Hughes, 12871 Foster Road, Los Alamitos, California 90720.

— WILLIAM K. EMERSON.

LAND SHELLS OF JOST VAN DYKE. VIRGIN ISLANDS. — I am most grateful to Mr. George A. Seaman of the Pittman-Robertson Wildlife Restoration Program and to Mr. Earle B. Nelthropp, Administrator of St. John, U. S. Virgin Islands, for the specimens listed below from the small island of Jost Van Dyke. This island is located about 7 km. north of St. John. It is nearly 5 km. in length and about 2.5 km. in width, with a height of 326 m. Great Harbor is the main port. About two hundred people live on the island.

As far as I have been able to determine, there are no published

records from this island. Because of dryness no live shells were obtained.

Chondropoma tortolense Pfeiffer.

Subulina octona (Bruguière).

Lamellaxis micra (Orbigny).

Lacteoluna selenina (Gould).

Drymaeus elongatus (Röding).

Plagioptycha nemoralina (Petit).

— WILLIAM J. CLENCH.

DISPERSAL OF *HELIX ASPERSA* WITH CONTAINER GROWN NURSERY STOCK. — Dundee, Hermann, and Hermann (1968) observed that mollusks appear to be spreading to new localities and that commercial plants shipped in soil are highly likely means for their dispersal.

During the spring and summer of 1968 *Helix aspersa* Müller was intercepted by plant inspectors of the Michigan Department of Agriculture at nursery sales grounds in Ingham, Oakland, Saginaw, and Wayne counties of Michigan on container grown *Euonymus* and *Pyracantha* plants produced in Los Angeles county, California. Plants originating in California were shipped directly to Michigan, or were first routed to Mississippi, wintered, and then shipped to Michigan. The snails occurred on foliage, in soil, or attached to sides of containers. Adult and subadult stages were encountered, but never in large numbers. The egg stage of *H. aspersa* was observed September 18, 1968 at a nursery outlet in Saginaw, Michigan. The clutch was partially concealed by the soil in which a container grown *Euonymus* plant had been shipped from California. It was not possible to determine whether the eggs were deposited before, during, or after shipment.

Fine cooperation by nursery firms in Michigan has apparently prevented infested material from leaving retail markets. *H. aspersa* is of regulatory concern, but established colonies are not known to occur in Michigan.—MURRAY HANNA, Mich. Dept. of Agriculture.

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CORBICULA MANILENSIS PHILIPPI IN THE NOLICHUCKY RIVER, TENNESSEE — During a collecting trip in September of 1968 to the upper reaches of the Tennessee River system we found this Asiatic species occurring in great abundance in the Nolichucky River, 3.5 miles southeast of Warrensburg, Greene Co., Tennessee. It did not occur at two stations made about twenty miles upstream. This present station was a shoals where the river bottom consisted of beds of angular limestone, loose limestone rocks, and with gravel, sand and sandy mud.

— W. J. CLENCH and D. H. STANSBERY.

LITTORINA NEBULOSA IN FLORIDA — On October 19, 1968, twenty living specimens of *Littorina nebulosa* Lamarck 1822, were collected by the writer on the west rock jetty at the entrance of St. Andrews Bay, near Panama City, Bay County, Florida, in conjunction with a study of the distribution and biology of *Littorina* along the northern coast of the Gulf of Mexico. (The author is grateful to R. Tucker Abbott for species identification.) Subsequent collecting has shown the species to be common in St. Andrews Bay. Shells of specimens found thus far vary from 5 to 23 mm. in length.

Bequaert (1943, p. 12) listed the range of *L. nebulosa* as "Greater and Lesser Antilles, Gulf of Mexico (from Tampico southward) and Caribbean coasts of Central and South America to Trinidad and the Guianas."

Specimens of this species from several localities in Texas are now in the U. S. National Museum (personal communication with Dr. Joseph Rosewater). The easternmost of these localities is "near Sabine Pass," Jefferson County, Texas.

Hedgpeth (1953, p. 197) used *L. nebulosa* to illustrate sporadic occurrence of a tropical species along the northern Gulf Coast and did not believe that the species was well-established in Texas.

The colony of *L. nebulosa* in St. Andrews Bay extends the known range of the species about 430 miles eastward and about 30 miles northward along the U. S. Gulf Coast. It is not known whether the St. Andrews Bay colony is a recruited or reproducing population. — FRASIER O. BINGHAM, Department of Biological Sciences, Florida State University, Tallahassee.

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MICROFICHE EDITIONS OF IMPORTANT MALACOLOGICAL WORKS —

A microfiche is a sturdy transparent sheet of film, 9 x 12 cm. in size, on which as many as 70 pages may be reproduced in reduction. The film may be read with a special enlarger, and copies of texts and illustrations can be made. Among the scientific papers available on microfiche is a substantial collection of malacological items. The important, large, and nearly impossible to obtain, monographs of Reeve's *Conchologia Iconica*, Martini-Chemnitz's *Systematisches Conchylien-Cabinet*, Sowerby's *Thesaurus Conchyliorum* are all available. Additionally, various oceanographic reports (*Samarang, Sulphur, Voeltzkow's* and *Semper's Reisen*) and basic taxonomic texts (Linnaeus, Adams & Adams, Adanson, Born, Costa, Dillwyn, Forskäl, Hanley, Lister, Menke, Müller, Philippi, Pulteney, and Wood) may be purchased. The prices, readers, and catalog of available microfiches of Basic Collections in microeditions of zoological works may be obtained from the Inter Documentation Company, Poststrasse 9, Zug, Switzerland.—K. J. Boss.

PUBLICATIONS RECEIVED

- Nowell-Usticke, G. W. 1968. Caribbean Cones from St. Croix and the Lesser Antilles. 31 pp., 4 pls. Livingston Publ. Co., Narberth, Pa. \$3.35.

The author of this booklet is a kindly gentleman known to many visitors to St. Croix for his cheerful helpfulness and his ardent interest in Caribbean seashells. His pursuit of specimens and new facts is admired by many conchologists.

Unfortunately, this 31-page booklet is so filled with errors, misstatements, mis-spellings, ignorance of the fundamentals of the international rules of zoological nomenclature, confusion of closely resembling names, and lack of scientific methods, that it presents a serious problem to the scientific community. Twelve new names,

both on the trivial and infra-subspecific level are proposed, some perhaps illegally. No types are identified, nor accounted for. Homonyms are created. A question arises as to whether or not the International Commission on Zoological Nomenclature should declare the names invalid. The booklet is copyrighted, so that none of the descriptions of new species may be quoted or used in scientific literature without obtaining the written permission of the author.

Amateurs who approach the hobby of conchology in the fashion of coin and stamp collectors will find the booklet interesting. The photographs by John Holeman are excellent. The Livingston Publishing Company of Narberth has shown a degree of irresponsibility in printing or publishing an over-priced booklet of considerable disservice to science and a bad example of neglectful editing. — R. T. ABBOTT.

McAlester, A. Lee. 1968. Type species of Paleozoic nuculoid bivalve genera. Memoir 105. The Geological Society of America. 143 pp., 36 pls. \$7.25, hardback.

JOHNSONIA: VOLUME 1

Long out of print, this useful monograph series on Western Atlantic Conidae, Muricidae, Strombidae, Cardiidae, etc., is now once again available. Reproduced in its original size, original paper, and beautifully soft-bound, it may be obtained for only \$15.00 (postage and packing free) from W. AND R. McCAULEY, 1919 Sandy Hill Road, Apt. C-12, Norristown, Pa. 19401. If you also wish vols. 2, 3 and 4, write: DR. W. J. CLENCH, Museum of Comparative Zoölogy, Cambridge, Mass. 02138, U.S.A.

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