

















# THE NAUTILUS

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DEVOTED TO THE INTERESTS  
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## TWO NEW *SONORELLA* FROM SONORA, MEXICO, AND NOTES ON SOUTHERN LIMIT OF GENUS

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The southern limit of distribution of *Sonorella* has never been established, even vaguely. In the state of Chihuahua, Mexico, Pilsbry found *Sonorella mormonum* Pils. at Lat.  $30^{\circ} 19' N$ , and *S. pennelli* Pils. slightly farther south at Lat.  $30^{\circ} 09' N$ . In Sonora, *S. magdalenensis* (Stearns) was found ca. Lat.  $30^{\circ} 39' N$ , near Magdalena. I have found *S. nixoni* W.B. Miller as far south as Nacozari, ca. Lat.  $30^{\circ} 22' N$ .

Investigating ever farther south, I have found populations of *Sonorella* in the region of Moctezuma and Huasabas, Sonora. A population east of Huasabas, ca. Lat.  $29^{\circ} 56' N$ , is a new subspecies of *mormonum*, while a population east of Moctezuma, ca. Lat.  $29^{\circ} 53' N$ , is a new species, related to *mormonum*. Both are described below.

Still farther southwest, on the road from Moctezuma to Hermosillo, I have found a population of *S. sitiens montezuma* P.&F. (the subspecific name refers to Montezuma canyon in Arizona) just west of Moctezuma, ca. Lat.  $29^{\circ} 45' N$ ; and a population of *S. magdalenensis*, ca. Lat.  $29^{\circ} 25' N$ , some 24 road miles east of Ures. To the best of my knowledge, the latter is the most southerly known locality for *Sonorella* to date.

Collecting still farther to the south, in the vicinity of El Novillo, on the banks of the Rio Yaqui, ca. Lat.  $28^{\circ} 54' N$ , and Sahuaripa, ca. Lat.  $29^{\circ} 03' N$ , I failed to find any *Sonorella* at all. Instead, several undescribed species of *Holospira*, *Bulimulus*, and *Euglandina* characterize the area, thereby indicating a different faunal province. Also, the vegetation is primarily tropical thorn scrub, rather unlike the preferred oak-woodland and Lower Sonoran habitats of *Sonorella*. Admittedly, *magdalensis*, in the vicinity of Ures, seems to have adapted to some rock-slides in tropical thorn scrub, but these are drier and sparser than the usual thorn scrub farther south. Accordingly, based on present, incomplete evidence,

the probability of finding *Sonorella* south of a line drawn easterly from Hermosillo through Sahuaripa, ca. Lat. 29° N. would be small. Dr. Stillman Berry expressed a similar opinion to me, several years ago, before I had begun any explorations in the area.

*SONORELLA MORMONUM HUASABASENSIS* new subspecies. Plate 1, figs. A-C.

*Description:* Shell moderately depressed-globose, heliciform, thin, glossy, light brown, with chestnut-brown spiral band on the well-rounded shoulder; narrowly umbilicate, the umbilicus contained 10 times in the diameter. Embryonic shell of about 1 and  $\frac{1}{4}$  whorls; its apex, the first  $\frac{1}{4}$  of the embryonic shell, is finely, radially wrinkled; over the second  $\frac{1}{4}$ , the wrinkles break up into papillae and the radial pattern begins to descend spirally toward the suture; over the second  $\frac{1}{2}$ , the spiral papillae have united to form fine threads; those above the shoulder ascend toward the upper suture, while those below the shoulder descend toward the lower suture, forming the usual *hachitana* pattern of ascending and descending spiral threads; the space between threads is finely, radially wrinkled; over the last  $\frac{1}{4}$  of the embryonic shell, the spiral striae have diverged far apart and some begin to break up into long hyphen-like papillae; they end abruptly at the end of the embryonic shell. Remainder of shell, at first, finely, radially wrinkled, with small papillae and scars of deciduous, periostracal, hairlike processes; later, over the the body whorl, the scars are absent, the radial wrinkles are smooth, and the periostracum has a silky luster. The last whorl descends moderately in front. The aperture is rounded, the peristome narrowly expanded in the outer and basal margins; parietal callus thin.

*Holotype measurements:* Height 9.4 mm.; max. diam. 14.9 mm.; umbilicus 1.5 mm.; whorls  $4\frac{1}{4}$ .

Measurements of  
genitalia, in mm.

	Holotype	Paratype B	Paratype E
Penis	7.0	7.5	7.0
Verge	3.5	3.5	3.0
Penial sheath	4.5	3.0	4.0
Epiphallus	8.0	8.0	8.5
Epiphallic caecum	1.0	1.0	1.0
Vagina	7.0	5.5	7.0
Free oviduct	3.0	3.0	3.5

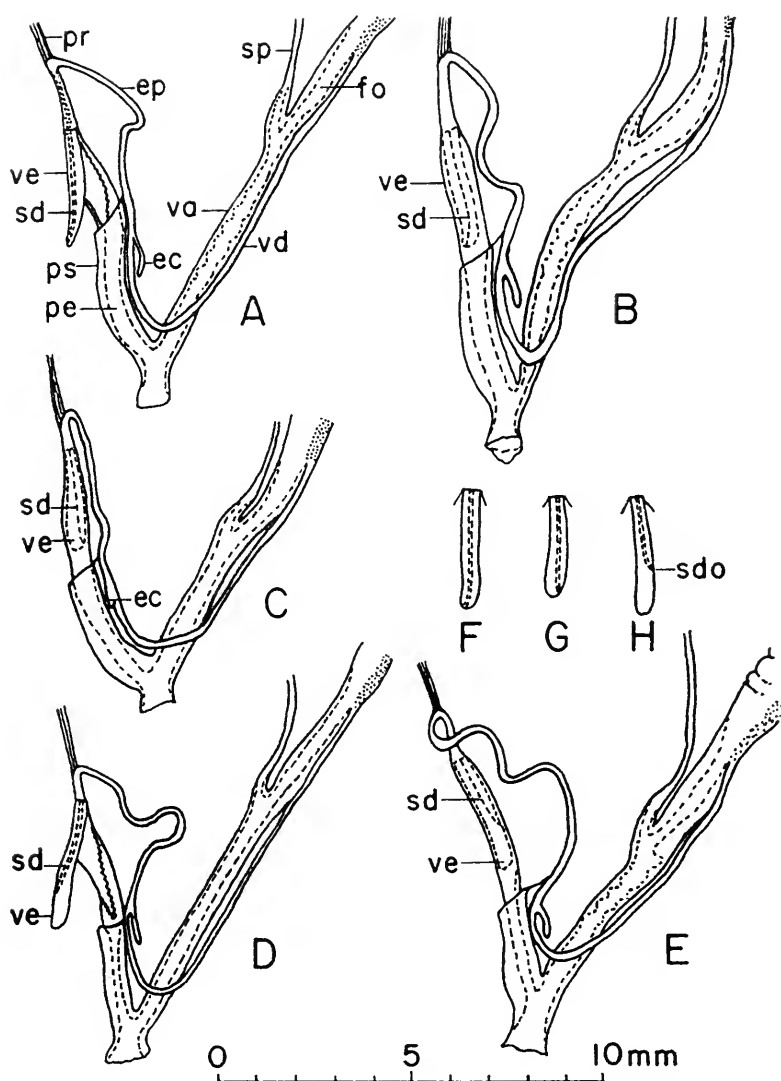
Genitalia of holotype (Page 4, figs A, B): The moderately long

penis contains a slender, cylindric verge of about  $\frac{1}{2}$  the length of the penis, blunt at the end. The seminal duct opens at the tip of the verge in a shallow depression. Penial sheath slightly longer than  $\frac{1}{2}$  the length of the penis. There is a well-developed, detached epiphalllic caecum. The vagina is about as long as the penis.

*Type locality*: Sonora, Mexico, in NW facing rockslides about 5 miles east of Huasabas along the road from Huasabas to Bavispe; elev. ca. 3600 ft. (W. N. Miller and W. B. Miller, 1 Sept. 1965). Holotype ANSP. (312763). Paratypes in collections of ANSP. (312764), Dept. of Zoology, University of Arizona (2819), and the author (4821).

This subspecies closely resembles nominate *S. mormonum* Pilsbry, in the shape and sculpture of the shell, as well as in the morphology of the genitalia. It differs from *mormonum* by the presence of a well-developed, detached epiphalllic caecum, and by the larger diameter of the shell. The epiphalllic caecum was observed in all 6 dissected specimens of *huasabasensis*; whereas it was vestigial in all 6 dissected topotypes of *mormonum* (Page 4, fig. C). The larger diameter of the shell of *huasabasensis* was determined to be significantly different from that of *mormonum* by statistical analysis. A sample of 24 adult specimens from the topotype population of *mormonum* was compared with a sample of 52 adult specimens of *huasabasensis*. Contrary to the usual high variance in shell diameter of most species of *Sonorella*, *mormonum* and *m. huasabasensis* show a high degree of homogeneity. The mean diameter of *mormonum* was 14.2 mm., with a minimum of 13.3, a maximum of 15.1 and a standard deviation of .433; the mean diameter of *huasabasensis* was 15.4 mm., with a minimum of 14.5, a maximum of 16.8 and a standard deviation of .567. Student's *t* was calculated to be 10.1, thereby indicating a significant difference in shell diameter in the two populations at a confidence level greater than 99.9%.

*S.m. huasabasensis* lives in large rock-slides on the western slope and near the top of the nameless mountain range just east of the Rio de Bavispe near Huasabas. This locality is about 65 airline miles southwest of the type locality of *mormonum*. The vegetation around the slide is lower Sonoran, consisting mainly of *Condalia*, *Lycium*, sotol, coral bean, and occasional *Quercus chihuahuana*.



Lower genitalia. A. *Sonorella mormonum huasabasensis* W.B. Miller, holotype; penis cut open to show verge. B. *S.m. huasabasensis*, paratype 4821-E. C. *S. mormonum* Pilsbry, topotype 4901-B. D. *S. perhirsuta* W.B. Miller, holotype; penis cut open to show verge. E. *S. perhirsuta*, paratype 4824-B. F. Verge of *huasabasensis* 4821-E. G. Verge of *mormonum* 4901-B. H. Verge of *perhirsuta* 4824-B. ec, epiphallic caecum; ep, epiphallus; fo, free oviduct; pe, penis; drawings to scale indicated, from stained whole mounts.

pr, penial retractor; ps, penial sheath; sd, seminal duct; sdo, seminal duct orifice; sp, spermathecal duct; va, vagina; vd, vas deferens; ve, verge. All

#### SONORELLA PERHIRSUTA new species.

Plate 1, figs. D-F.

*Description:* Shell moderately depressed-globose, heliciform, thin, hirsute, light brown, with chestnut-brown spiral band on the well-rounded shoulder; narrowly umbilicate, the umbilicus contained



9 to 10 times in the diameter. Embryonic shell of about 1 and  $\frac{1}{4}$  whorls; its apex smooth, followed by rough radial wrinkles over the first  $\frac{1}{3}$  whorl; next  $\frac{1}{3}$  whorl with well-developed, widely spaced, descending spiral threads, between which fine wrinkles lie perpendicular to the spiral threads; remainder of embryonic shell with raised papillae superimposed on fine radial wrinkles. Later whorls, including body whorl, with raised growth striae, fine radial wrinkles, and papillae from which project short, periostracal hair-like processes. The periostracal processes are worn off in places, but are mostly persistent all the way to the peristome and into the umbilicus. The last whorl descends moderately in front. The aperture is rounded, the peristome narrowly expanded; parietal callus thin.

*Holotype measurements:* Height 9.0 mm.; max. diam. 15.1 mm.; umbilicus 1.6 mm.; whorls  $4\frac{1}{4}$ .

Genitalia of holotype (Page 4, figs. D, E): The moderately long penis contains a slender, cylindric verge of about  $\frac{1}{2}$  the length of the penis, blunt at the end. The seminal duct opens at the side of the verge, at about  $\frac{2}{3}$  to  $\frac{3}{4}$  the length of the verge. Penial sheath about  $\frac{1}{2}$  the length of the penis. Epiphallus about  $1\frac{1}{2}$  times the length of the penis. There is a well-developed, detached, epiphallic caecum. The vagina is about as long as the penis.

Measurements of  
genitalia, in mm.

	Holotype	Paratype B	Paratype D
Penis	6.5	6.5	7.0
Verge	3.5	3.0	3.5
Penial sheath	3.0	3.0	3.5
Epiphallus	10.0	9.5	11.5
Epiphallic caecum	0.7	0.7	1.0
Vagina	7.0	5.5	5.0
Free oviduct	3.0	2.5	2.5

*Type locality:* Sonora, Mexico, in mountains between Moctezuma and Huasabas, about 2 miles north of the Moctezuma-Huasabas road at a point 16.8 road miles east of Moctezuma, in granite rock piles in ravine on the north-east face of the high peak; elev. ca. 4650 ft. (W. N. Miller and W. B. Miller, 2 Sept. 1965). Holotype ANSP. (312765). Paratypes in collection of Dept. of Zoology, University of Arizona (2820), and the author (4824).

*S. perhirsuta* is closely related to *S. mormonum* Pils. and *S. m. huasabasensis*, W. B. Miller. It differs from them by the anatomy

of the verge, in that the seminal duct orifice is not terminal, and by the long epiphallus. It has a well-developed epiphallic caecum, as in *huasabasensis*. In shell characteristics, it differs by the lack of ascending spiral threads on its embryonic shell and by the persistent periostracal processes on adult shells; such hirsute appearance on adult *Sonorella* shells has been reported only from *S. apache* P.&F. and *S. greggi* W. B. Miller.

*S. perhirsuta* is known only from the holotype and seven paratypes. The smallest adult paratype measures 13.4 mm. in diameter and the largest 16.1 mm. It lives in the Upper Sonoran life zone among small, granite rock-piles in ravines. Vegetation was mainly *Quercus oblongifolia*, *Q. chihuahuana*, sotol, yucca, coral bean, and a profusion of wild zinnias in bloom. Heavy humus contributed to the early decomposition of dead shells.

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### A NEW HAWAIIAN CYPRAEA

By C. M. BURGESS, M.D., Honolulu, Hawaii

It has become apparent through study of recently collected beach and living shells from the Hawaiian Islands that a distinct cowrie has been heretofore overlooked. This cowrie is superficially similar to *Cypraea globulus* Linn. 1758, and *Cypraea bistrinotata* Sch.-Sch. 1937; but it also resembles *Cypraea cicercula* Linn. 1758.

CYPRAEA MAUIENSIS Burgess, new species.

Plate 2.

The holotype is inflated and globular; the dorsum is humped posteriorly, colored tan to pale lemon-pulp yellow, and there is no dorsal sulcus. The dorsum is adorned with tiny discrete elevations, some of which are pigmented, and which are larger, darker and more prominent near the lateral margins and extremities of the shell. There are 3 paired brown dorsal blotches, one pair just above the spire, the second on the mid-dorsum, and the third above the anterior process, and 4 faint brown terminal spots. On the base, at the marginal extremities near the anterior and posterior canals, are 4 faint brown blotches. The extremities are blunt and only moderately produced. The aperture is narrow, slightly curved to the left posteriorly, and does not flare anteriorly. There is a large flat callus above the posterior canal and above this is a shallow depression. The spire is slightly elevated, even in calloused shells, but there is no blotch. The protoconch, when not covered by callus, is transparent. The teeth are fine, and in the mid-columella

are obsolete or absent. There is a distinct labial marginal callus. The anterior extremity is attenuate and pointed; tilting sharply upward but following the contour of the base.

A representative series of living specimens was collected in September, 1963, on a shallow reef at Olowalu, Island of Maui, State of Hawaii. The cowries were found deep in crevices on the under surfaces of living coral heads (*Porites lobata* Vaughn) growing on and firmly adherent to a porous reef in  $1\frac{1}{2}$  to  $1\frac{1}{2}$  meters of clear active water.

The mantle is thick, lemon-pulp yellow, and obscures the dorsal pattern of the shell. It is covered with circular gray dots except around the bases of chalk-white 0.5 to 0.75 mm. long fleshy, tapered, beaded papillae which number about 30 to the side. The mantle is also studded with minute circular lemon-yellow spots, which bear flat wart-like papillae; these papillae occupy the spaces between the gray dots and the longer white papillae, giving the tissue a cobblestone appearance.

The tentacles are long (fully 30-35 percent. of the length of the shell), tapered, slender, bright orange-yellow, this color becoming deeper at the tips, and longitudinally striped with gray. The tentacles are placed relatively far posterior on the animal and were never presented at the anterior canal in 9 animals observed for 6-8 hours. When the animal changed direction both tentacles would often be on the same side of the shell.

The eyes are jet black and set almost directly beneath the bases of the tentacles.

The ventral surface of the foot is white; the sides covered with gray spots similar to those found on the mantle but of a lighter shade.

The siphon is bell shaped, fringed completely with 16-18 elongate, tapered, blunt processes which are exactly the same shape (if reversed) as the spaces between them. The siphon extends nearly 2 mm. beyond the anterior canal. The cowrie is active and moves fast for one so small.

I named this cowrie *Cypraea mauiensis* for the Island of Maui, State of Hawaii, where in August, 1963, Mr. Joe Kern of Kahului, collected the first living specimen. The holotype, from Olowalu, Maui (Latitude  $20^{\circ} 48.5'$  North, Longitude  $156^{\circ} 37.3'$  West) has been deposited in the Bernice P. Bishop Museum, Honolulu,

Hawaii, and bears the number B.M. 8916.

Paratypes have been deposited in the Academy of Natural Sciences, Philadelphia; the United States National Museum, Washington, D. C.; the American Museum of Natural History, New York; the Museum of Comparative Zoology, Harvard; the National Museum, Manila; the Cambridge Museum of Zoology; the British Museum (Natural History); the Rijksmuseum van Geologie en Minerologie. Leiden; the Institut Océanographique, Monaco; the Universitets Zoologiske Museum, Copenhagen; the Indian Museum, Calcutta; the Western Australian Museum, Perth; the Australian Museum, Sydney; the National Museum of Victoria, Melbourne; the Auckland Institute and Museum; and the Bishop Museum, Honolulu. Additional paratypes have been given to several individuals seriously interested in the *Cypraea*.

*Cypraea mauiensis* has been previously illustrated by C. S. Weaver in "Hawaiian marine mollusks" 1964, Vol. 2, No. 25, Plate 24, Top Center. It also will appear in "The living cowries," Burgess, Plate 30, Fig. F. *Cypraea mauiensis* so far has been reported only from the Hawaiian Islands. It is found as beach worn specimens in older Hawaiian collections in the Bernice P. Bishop Museum.

The type area is the reef at Olowalu, Maui.

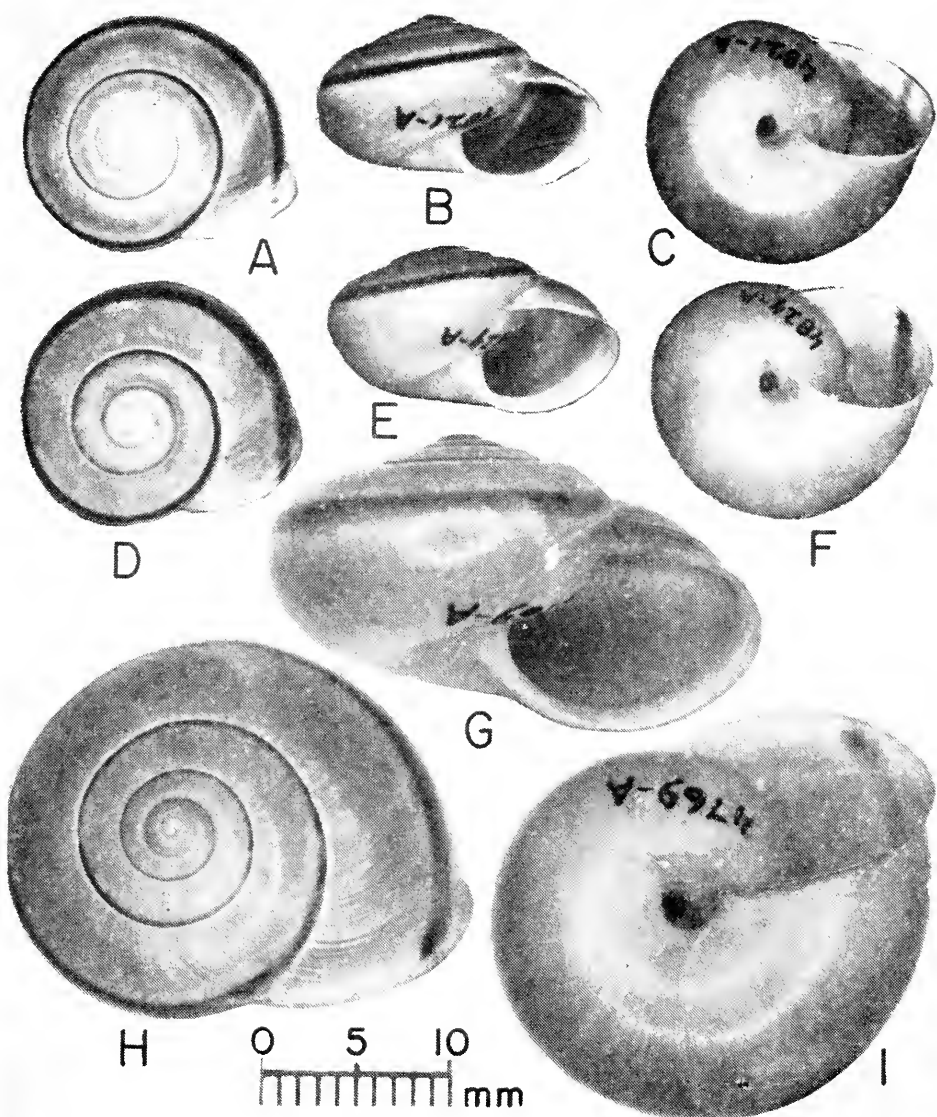
Four species of cowries are now known which are in general globular, with beaked extremities, and light fawn in color. The key below is adequate for separation of these 4 species, but certain other significant differences are usually present.

#### KEY TO SPECIES

1. Shell macroscopically smooth and glossy without dorsal line or sulcus — 2. Shell obviously pustulate — 3.
2. Sides and extremities of dorsum with elevated and or pigmented pustules visible with low power (2-3x) magnification — *Cypraea mauiensis*. Entire surface microscopically smooth — *Cypraea globulus*.
3. With spire blotch, dorsal sulcus, but without basilar spotting or 3 paired dorsal blotches — *Cypraea cicercula*.

Without spire blotch but with basilar spotting, paired dorsal blotches, and dorsal sulcus or line — *Cypraea bistrinotata*.

In general *C. mauiensis* is smaller, has a consistent pale lemon-yellow color, the extremities are less produced, the anterior proces-



Holotypes. A-C. *Sonorella mormonum huasabasensis* W. B. Miller. D-F. *S. perhirsuta* W. B. Miller. H-I. *S. bequaerti* [to be described fully in Oct. no.].

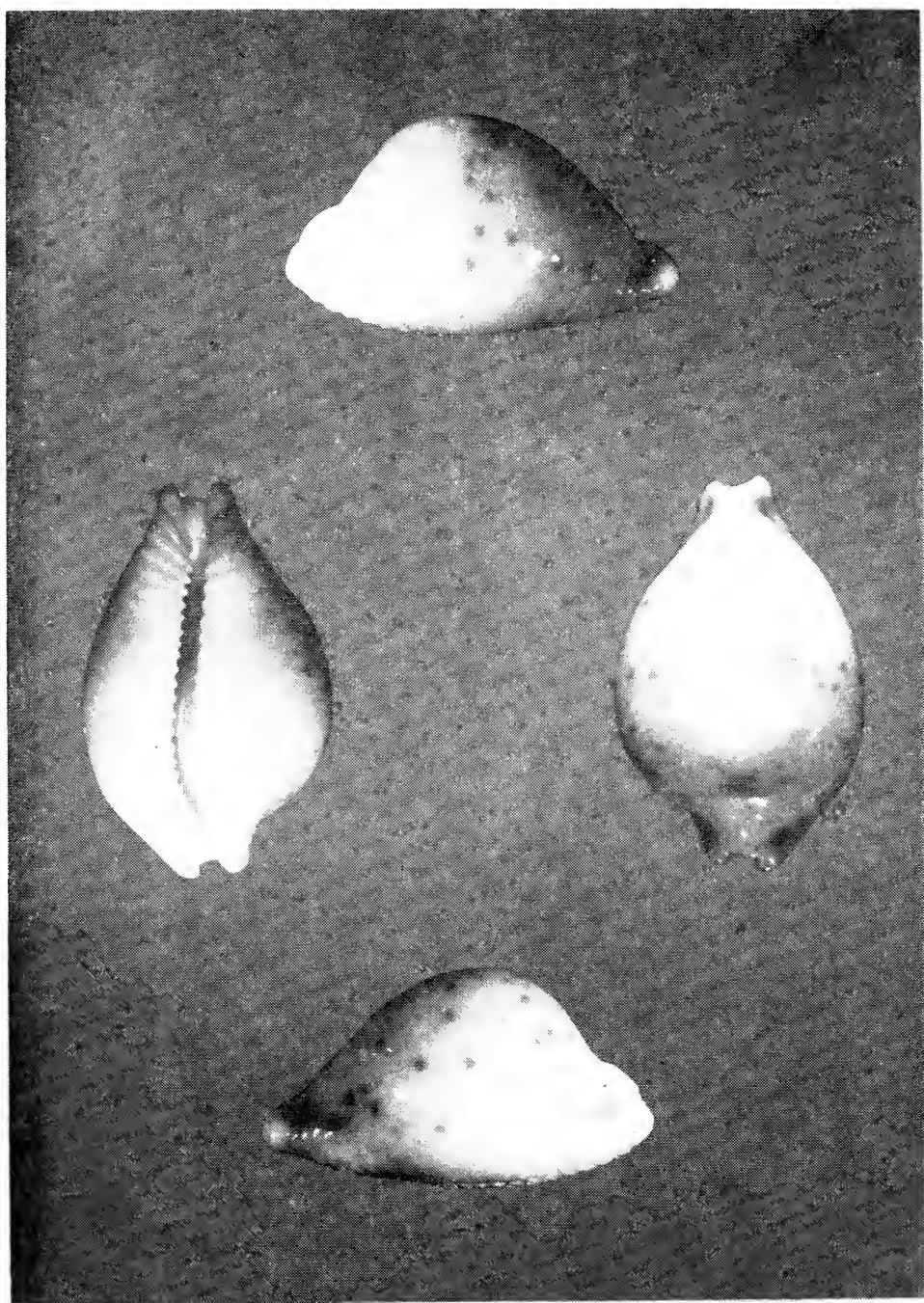


Plate 2. *Cypraea mauiensis* Burgess. Enlarged photograph showing the base, dorsum, right, and left lateral views of the holotype. Actual dimensions in mm.: Length 13.7, width 8.7, height 7.7. Photograph by Gilbert Halpern, Honolulu.

ses more attenuate, the labial marginal callus more prominent and the dorsum more humped posteriorly than in any other of the group. In the specimens measured, the dimensions were found to average in mm.; length 12.38, width 7.94, height 6.87. The largest measured 14.7 x 9.3 x 8.3 mm., and the smallest adult 9.9 x 6.7 x 5.9 mm.

*Cypraea cicercula* is easily differentiated because of its spire blotch.

*Cypraea bistrimontata* and *Cypraea mauiensis* are, in certain melanotic specimens of the latter similar on superficial examination. Both may have elevated lateral spotting, 3 paired dorsal blotches, 4 basal spots and attenuate columellar teeth. However *C. mauiensis* is smaller, is lemon-pulp yellow in color (*C. bistrimontata* is golden-brown) and has markedly less produced extremities. The basilar spotting on *C. mauiensis* is present only in about 4 percent, of specimens, and the dorsal blotching in about 75 percent. The basilar spotting on *C. mauiensis* is also placed nearer the edges and extremities of the shell. It can be separated from smooth or beach-worn specimens of *C. bistrimontata* by the character of the dorsal callus which in *C. mauiensis* is wide and flat, the top of which is concentric with the curve of the posterior canal. The callus of *C. bistrimontata* is highly arched or even pointed. The mid-columellar teeth of *C. mauiensis* are attenuate or absent. The teeth of *C. bistrimontata* are nearly always prominent across the entire base.

*Cypraea globulus* may be easily separated, in adult specimens, from *C. mauiensis* by its entirely smooth shell. The dorsal spotting may be similar, and *C. globulus* may also have the 4 basilar spots and a semblance of the dorsal blotches.

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## EROTOLOGY OF THREE SPECIES OF PRATICOLELLA, AND OF POLYGYRA PUSTULA

By GLENN R. WEBB

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[Continued from April issue]

The availability of developing young snails of both species permitted a survey of the patterns of genital development in the two species. The sequence of progressive maturation of genitalia in *P. berlandieriana* is shown in figs. 12-17, 7, 9 and 10. In *griseola*

(figs. 1-6, 8 and 11) the series is weak in lacking stages comparable to figs. 13 and 14. The essential differences in the genital development of the two taxons are in the retractor-retentor muscle system; the proportion of accessory gland to rest of penis; and the symmetrical development of paired penis-retentor-muscles which straddle the epiphallus-vas deferens and insert on each side of the basal penis. At the stage shown in fig. 7 of *berlandieriana*, a transient recapitulation of the onset to this condition is shown, but the musculature does not develop trifurcately but retrogresses (compare figs. 7, 9, and 10). Instead in *berlandieriana* the accessory gland becomes excessively engrossed and elongated so that ultimately it is larger than the penis-tip beyond the basal disk; in *griseola* the accessory gland develops moderately and the penis-tip area is hypertrophied. At one stage in the development (fig. 7) both species appear more nearly identical than either before or after. Thus anyone attempting to determine the validity of these two species by random anatomical sampling could be led to conclude that the genitalia overlap in characteristics. My study contrasts the development as seen in the Harlingen strain of *griseola* and the New Braunfels strain of *berlandieriana*. Possibly, of course intermediate populations may exist. Because the mode of semen transfer seems enough different in my samples of the two taxons as to possibly prohibit intermating, the mode of functioning of the sex organs of any supposed intermediate populations should be evaluated lest unknown allied species be confused unnecessarily with either *berlandieriana* or *griseola*. Obviously the strains I have studied also are not topotypic of the two species to which I have referred them, so that anatomical characterization of topotypes of both *griseola* and *berlandieriana* are unavoidable prerequisites of accurately delineating the relationships of these two taxons.

*Praticolella mobiliana floridana*: On June 15, 1964, I collected about 36 adult and juvenile specimens amid swampy vegetation adjacent to a cool, swift stream on U. S. route 90, west of Swannee River State Park, and 4.1 miles east of Greenville, Madison Co., Florida. The initial shells were taken adjacent to the concrete bridge. Living specimens were then found on wet soggy soil amid moss, grass, and sedge debris, often quite close to the stream. Where the vegetation was ranker away from the stream-edge fewer specimens were found. Two nests of eggs of this *Praticolella* were found.



One contained 4 eggs, the other 7 eggs. Both clutches of eggs were just below the decaying layer of brown vegetation. No other land snail was found except a succineid. June 28, 1964, encaged the specimens; and July 24, 1964, while cleaning the cage, found eggs, hatching, and hatched young. No trace of hair papillae was evident on the hatchlings.

*Courtship:* Aug. 5, 1954, a pair was observed courting about 9:40 P.M. The head-on pair clung to the underside of the cage cover-glass, and had the fore third of the body detached from the glass, and projecting downward and foreward obliquely archwise. The snails were seen to be making mouthing motions with the radula moving against the exerted jaw plate as in courting *Ashmunella rhyssa edentata* (Webb 1954). Each snail has been seen to bite the other in the head-arching exchange of blows. The snails remained at one spot and produced successive, slow, hammer-like blows of the detached forebody toward the other snail, sometimes contacting, sometimes not. If bitten, a snail withdrew its head momentarily and usually resumed its own attack. At 9:47 P.M. the pair momentarily rested head-on about 4 mm. apart and with the superior tentacles extended into close proximity distally. A minute later they resumed head-arching and one bit the other. Often they were biting at the space from which the head of the other had been uplifted. At 9:56 one pivoted counterclockwise as viewed through the cage cover-glass, rejoining head-on at 9:57. At 9:58 it pivoted clockwise. The pair were head-on again at 10:02. Only one of the two snails were seen to pivot. This snail crawled off at 10:09 P.M. and courtship ceased without having culminated in a mating.

Another partial courtship was noted on Dec. 1, 1964, when a pair of head-on snails were noted clinging to the cage cover-glass. The foreparts of the two snails were detached from the glass in an arc. Soon they began biting at each other with hammer-like strokes which seldom made contact. At such time as much as half the pedal disk was detached from the glass. A bitten snail was seen to cringe momentarily and withdraw the foreparts. After about 3 minutes of such pugnacious actions, the pair rested head-on with about  $\frac{1}{4}$  inch between them. A short time later they extended their anterior ends by creeping forward on the glass until they barely were in contact; no biting attempt was made; instead the part of the snail's body before the shell but behind the tentacles

of the lighter colored animal became swollen, and the atrial pore dilated and strongly evident.

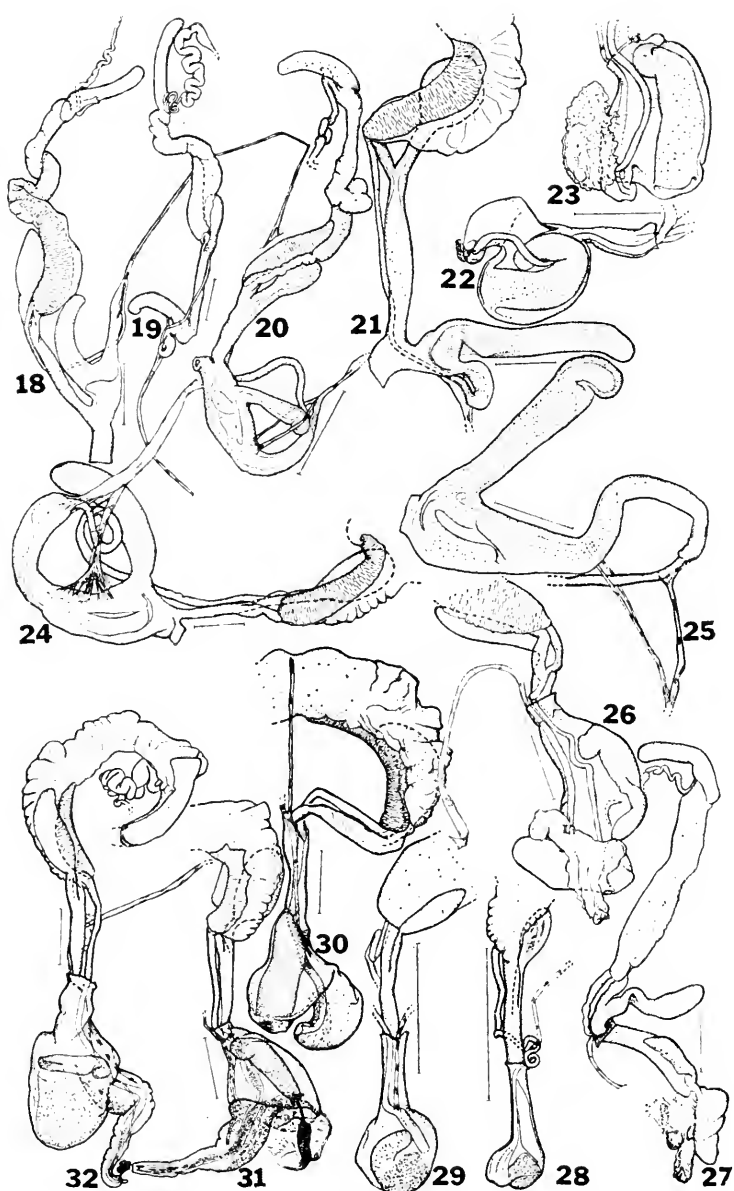
*Mating:* On Sept. 23, 1964, two pairs were seen in courtship. Minutes later one of the pairs was seen with engaged penes and killed for mating anatomies in boiling water. The other pair separated and did not resume courtship. The killed snails did not remain united by the sex organs. My instantaneous view of the process was inadequate to observe if the organs everted into contact or were entwisted. My impression tends to favor the former.

*Mating-anatomy data:* Two anatomies have been available. In each the penis bore a mass of jelly-like material as well as unexchanged semen. The total bulk of such matter was as great as that of the penis. Probably the jelly came from the gland area of the penis and may function to cement the acquired semen to the organ for engulfment.

The form of the everted penis is shown in figs. 26 and 27. The anatomy of fig. 26 seems normal, but that of fig. 27 had the proximal  $\frac{2}{3}$  sucked into the aperture of the shell so that the penis became distorted during fixation of the tissues. To avoid this happening when securing mating anatomies, one can crush the shell of at least one of the snails before plunging them into boiling water. If one does not have to hold the cage cover-glass with one hand, the shells of both mating snails possibly can be crushed before plunging them into boiling water. Additional techniques have been discussed in an earlier paper (Webb, 1947).

In the mating-anatomy of fig. 26 (shell crushed), the slight pouch just above the semen mass and to the left of the gland, had the tip of the other snail's semen mass projecting into its shallow cavity. Blunt ridges near the pouch indicate that it may be a true structure rather than a chance indentation due to the pressure of the semen mass. In *Polygyra septemvolva* (Webb, 1950) and *P. cereolus* (Webb, 1965) a pouch is present on the basal penis as an intrinsic structure and not as an adventitious indenture. The structural reality of the pouch in *P. mobiliana floridana* needs to be confirmed by more data and specimens.

As seen in fig. 26, the orifice of the vagina is present on the everted penis just below the atrium, but no everted female organ is involved. One side of the everted penis bears the elongate gland which in this species, appears as a ridge and lacks a lumen.



Figs. 18, 20, 24, 25, 31-32. *Praticolella griseola* (Pfr.). 18, 20, 24, 25, maturation of genitalia; 31, 32, mating anatomies. Figs. 19, 21, 22, 23, 30. *P. berlandieriana* (Moricand). 19, 21, mature genitalia. 22, 23, 30 mating-anatomies. Figs. 26, 27. *P. (Farragutia) mobiliana floridana* Vanatta, near Greenville, Madison Co., Florida. Mating anatomies; in fig. 26, site of ejaculatory pore is hidden from view by semen; in fig. 27, note semen in vas deferens. Figs. 28, 29. *Polygyra (Lobosculum) pustula* (Ferussac), near Panama City, Bay Co., Fla. Mating anatomies; possibly not yet at full eversion.

I interpret this structure to be a specialization of part of the clasping disk of the more primitive polygyrids. In the proceeding two species of *Praticolella*, this has evolved into a tubular gland; but in the present species the gland retains a more primitive non-tubular structure. An alternative view, that the non-tubular accessory gland of *P. (Farragutia) mobiliana* has attained its form by degeneration, is totally without confirmatory data.

The bilaterally lobed expansion of the penis tip in *P. mobiliana floridana* seems to represent a more highly evolved condition than that of *berlandieriana* or *griseola*, and to represent a different mode of functioning. A somewhat similar bilobed condition is found in some species of *Mesodon* and of *Polygyra*.

The site of the ejaculatory pore can be made out by special illumination of the inverted slide to be nearly central and sub-terminal on the bilobed penis-tip. The orifice of the ejaculatory pore in fig. 26 is concealed behind the ejected semen.

An incomplete series of development slides revealed the immature penis never to exhibit a trace of a lateral projection of a transient stage of the development of a tubular gland so that the form of the developing penis appears as in immature *Mesodon*.

*Polygyra pustula*: The specimens were collected Sept. 3, 1941, under bricks and boards on a vacant lot near Cuba-Cabins Tourist Camp, about 3-5 miles east of Panama City, Bay County, Florida. I am indebted to the late James T. Close for transportation and companionship on the field trip.

*Courtship and mating*: Oct. 8, 1941: The mating behavior is quite like *Euchemotrema* (Webb, 1947, 1948). First the specimens approach each other head-on; the superior and inferior pair of tentacles appose those of the mate, and the region between the inferior tentacles is projected, lip-like, forward and seems to touch that of the mate. The snail is very timid and the slightest vibration causes it to retract partially into the shell. After the pair rest head-on as described, the sex organs suddenly evert into contact. The appearance of the contiguous organs is distinctive. As the cage cover-glass was inverted, preparatory to securing mating anatomies if possible, the animals separated their sex organs. During the head-on stance of the snails, the extreme foreparts were detached from the cover-glass. The individuals observed had been previously kept in species solitary confinement before being placed together for

possible mating.

On Oct. 28, 1941, another courtship and mating was noted. The specimens converged head-on. The tentacles were held in apposition to those of the other, and the head was slightly detached from the cover-glass in an arc. One of them made half of a pivot counter-clockwise, then shifted direction clockwise to rejoin the other head-on. The sex organs suddenly emerged, did not entwine, and appeared somewhat as the engaging organs of *Stenotrema fraternum* (Say), Webb 1948. This pair were killed by pouring boiling water on them as soon as the sex organs appeared.

On November 5, 1941, again a pair of specimens were placed together after species solitary confinement. They began courting. When I returned to observe after starting water to boiling, they were seen to be with engaged sex-organs. The cover-glass with specimens on it was plunged into the boiling water. Courtship so far as noted was like those described above.

*Mating anatomy data:* Four specimens have been available for study; two are shown (figs. 28, 29). Two of the specimens show the everted penis incompletely distended, the other two are probably at near maximum eversion with the probable exception of the distal penis which is not everted but which from general structure would seem homologous to that in *Praticolella griseola* and could be expected to be everted somewhat as in that taxa. All the anatomies had the organs partly sucked into the aperture of the shell, so the basal part of the penis is probably abnormally narrowed and elongate. The main body of the penis is strongly sphaeroidal, and has the accessory gland opening by a pore at the tip.

In view of the anatomical (Pilsbry, 1906) and functional close similarity of *Polygyra pustula* to the *Praticolella* species, the question which needs to be explored is why this species should not be regarded as a diminutive member of the genus *Praticolella*? The organs do not function as in *Polygyra septemvolva*. Except for teeth on the outer lip of the shell, I see no feature precluding considering this species to be a true species of *Praticolella*. However, before I would make a formal decision, I would like to examine the penial retractor system of resting specimens to see if any trace of penial retentors is present. I would expect to find delicate duplicate strands to be present which straddle the epiphallus-vas deferens complex. Pilsbry (1906) did not find such but unless one were

expressly conscious of their possibly being present, they may be so small as to be almost certainly overlooked even by a careful observer. Anyone situated to check on this feature should do so.

Pilsbry in 1906 expressed the above viewpoint and seemed to view the species as a true *Praticolella*, in which he regarded a distinct subgenus under the name *Lobosculum*. In 1940, Pilsbry did not reiterate this view but treated the species as being a *Polygyra* which developed a penis gland (convergently to *Praticolella* presumably).

The shells of all material studied agree with Pilsbry's (1940) figures. Each scale equals 2 mm.

#### BIBLIOGRAPHY

- Hubricht, Leslie 1961. Eight new species of land snails from the southern United States. *Naut.* 75: 1:26-33, figs.
- Pilsbry, Henry A. 1930. Anatomy and relationships of some American Helicidae and Polygyidae. *Acad. Nat. Sci. Phila.* 82: 303-327, figs.
- 1940. Land Mollusca of North America (North of Mexico). *Acad. of Nat. Sci. Phila. Monograph #3: Vol. 1:2: see pp. 607-610.*
- Webb, Glenn R. 1947 The mating-anatomy technique as applied to polygyrid landsnails. *Amer. Nat.* 81: 134-147.
- 1947. Studies of the sex-organs of mating polygyrid landsnails. III. *Acad. Sci. Trans.* 40: 218-227, figs.
- 1948. The mating of *Stenotrema fraternum* (Say). *Naut.* 62: 1:8-12, figs.
- 1950. The sexology of *Polygyra septemvolva* Say, life-history notes, possible utility, and data on *Stenotrema* (Gastropoda, Pulmonata, Polygyridae). *Amer. Micro. Soc.* 69: 4:387-393, figs.
- 1954. The life-history and sexual anatomy data on *Ashmunella* with a revision of the *Triodopsis* snails. *Gastropodia* 1: 2:11-18, figs.
- 1965. Matings between *Polygyra cereolus carpenterianus* and *P. septemvolva*. *Naut.* 79: 1:34-35.

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### RADIODISCUS, NEW TO MOLLUSCAN FAUNA OF MONTANA

BY ROYAL BRUCE BRUNSON AND RICHARD H. RUSSELL  
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The genus *Radiodiscus* was described by Pilsbry and Ferriss in 1906. H. B. Baker originated the sub-generic name *Radiodomus* in 1930. At the same time Dr. Baker described the species *R. abie-*

*tum*, from the type locality in Adams County, Idaho.

Pilsbry (1948) reports *R. abietum* as occurring in Oregon and Idaho. He does not show this snail to occur in Montana, although he gives records from Bonner, Kootenai, Clearwater, Nez Perce, Idaho, and Adams Counties of Idaho. All these counties, with the exception of Kootenai, Nez Perce, and Adams, border Montana. No records are given for Boundary or Shoshone Counties, both of which border western Montana.

The authors have found *Radiodiscus* in 10 localities in western Montana. These localities occur in 6 counties and 5 mountain ranges (see map).

In the list of localities that follows, the number of specimens is in parentheses after the catalogue number. Elevations are approximated from U.S. Geological Survey topographical maps and a pocket altimeter.

*Lincoln County*: Cabinet Mountains, between Leigh Lake trail and Leigh Creek, 150 yards from start of trail. T28N, R31W, Sec. 6. Elevation 3900 feet. T. E. Lee, July 27, 1960. RBB, 1560 (3).

*Sanders County*: North end of Bitterroot Range, 4 miles west of Noxon. T26N, R33W, sec. 17. Elevation 3000 feet. R. H. Russell, May 2, 1965. RHR. 775 (1). West side of Cabinet Mountains at Government Creek, Noxon. T26N, R32W, sec. 20. Elevation 2700 feet. R. B. Brunson, June 20, 1956. RBB. 11356 (2).

*Lake County*: South Crow Cirque, Mission Mountains, west end of Schwartz Lake. T20N, R19W, sec. 10. Elevation 3500 feet. R. H. Russell, July 7, 1960. CNHM. 105841 (1). McDonald Cirque, above McDonald Lake, Mission Mountains, T19N, R19W, sec. 2. Elevation 3500 feet. R. B. Brunson, June 17, 1960. RBB. 360 (8).

*Mineral County*: Crystal Lake trail in Cour d'Alene Mountains, DeBorgia, under fallen logs in cedar forest. Elevation 2800 feet. R. H. Russell, October 17, 1965. One specimen in collection of Glenn R. Webb.

*Missoula County*: Deep Creek in Bitterroot Mountains, 10 miles west of Missoula. T13N, R21W, sec. 20. Elevation 4000 feet. R. A. Taylor, May 11, 1957. RBB. 12357 (1).

*Ravalli County*: North fork Lost Horse Creek in Bitterroot Mountains, T5N, R22W, sec. 35. Elevation 5600 feet. Gary Rumley, May, 1960. RBB. 2760 (1). Lost Horse Creek, T4N, R22W,

sec. 6. Elevation 5000 feet. Gary Rumley, June 5, 1960. RBB.4960 (1). Sleeping Child Creek, below Sleeping Child Hot Springs, near Sula in southern end of Sapphire Range. 4N, R19W, sec. 7. Elevation 4550 feet. R. H. Russell, December 31, 1965. RHR. 1124 (1).

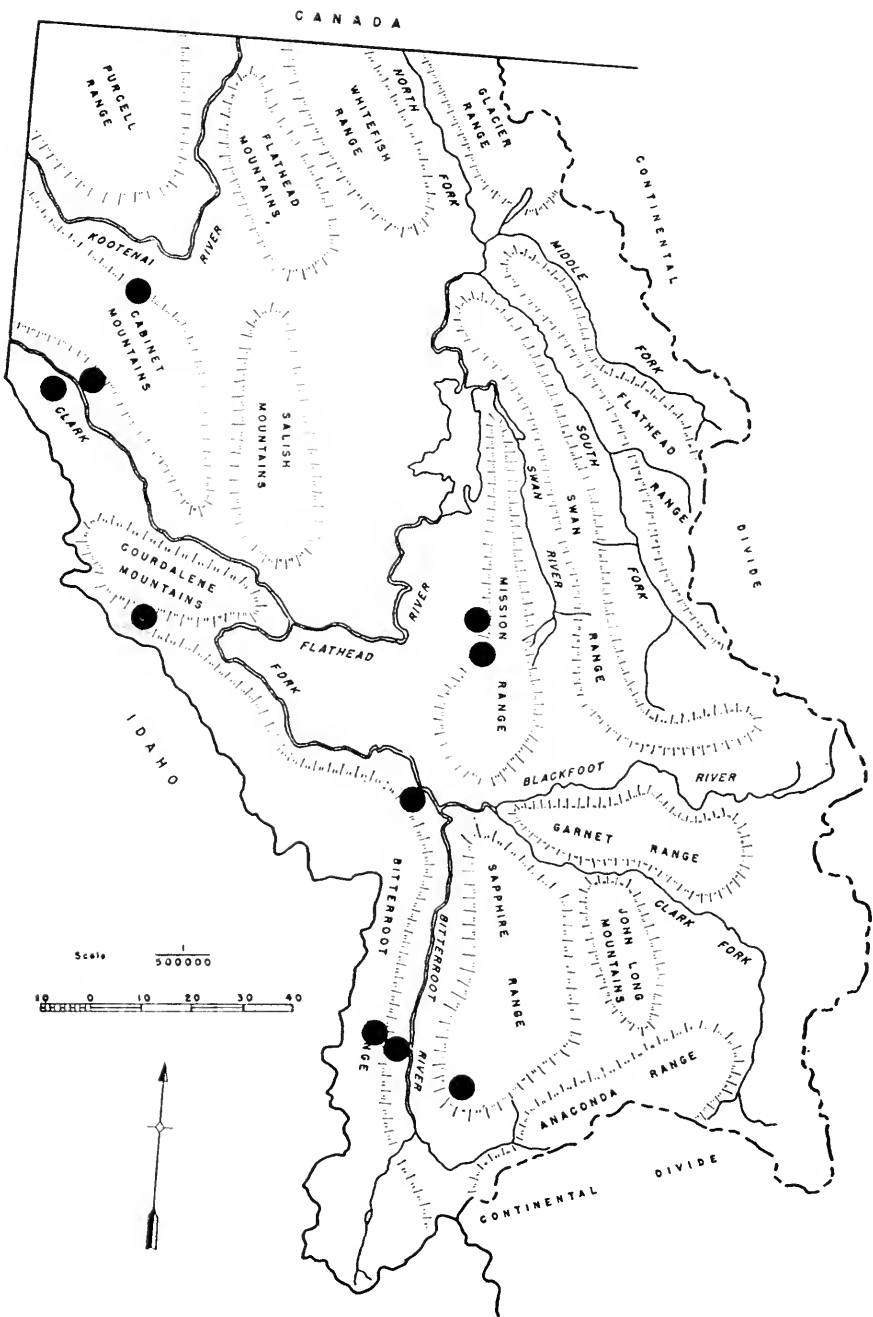
From two of the above localities, we have collected specimens which are larger than any previously recorded shells. Sizes of some representative specimens from 7 areas are given below. The measurements of H. B. Baker's type and largest paratype are included for purposes of comparison.

Greater diameter mm.	Height mm.	No. of whorls	
7.0	4.0	6.0	McDonald
7.0	3.7	5.8	McDonald
6.8	3.2	5.7	Lost Horse
6.7	3.2	5.75	Paratype
6.6	3.5	5.7	McDonald
6.0	3.4	5.4	McDonald
6.0	3.2	5.5	McDonald
5.7	3.0	5.5	Deep Creek
5.5	2.9	5.3	Noxon
4.89	2.61	5.0	Type
4.8	2.5	5.1	Government Creek
4.2	2.4	4.6	Leigh Creek
4.2	2.2	4.5	Sleeping Child
4.0	2.1	4.2	McDonald
3.8	2.0	4.1	McDonald
3.1	1.8	4.2	Leigh Creek
2.5	1.4	3.5	McDonald

Ecologically, the distribution of *Radiodiscus* in Montana is limited primarily by moisture. Furthermore, quite apparently from the collection sites, this moisture is necessarily present during most of the year. *Radiodiscus* is consistently found in a shaded seepage area in McDonald Cirque. Other collection sites have been near streams and in thick forests. Unlike Baker's experience, we have found *R. abietum* in stands of the white cedar, *Thuja plicata*, which represent, in Montana, a remnant of the coastal forest.

Part of the funds for this work have been supplied by the research council of the University of Montana.





Map of western Montana showing the distribution of *Radiodiscus abietum*.

#### REFERENCES

- Baker, H. B. 1930. New and problematic west American land snails. *Nautilus*, 43 (4) :121-128.
- Pilsbry, H. A. 1948. Land Mollusca of North America (north of

Mexico). Vol. 27, pt. 2: 654-660. Acad Nat. Sci. Phila., Mon. 3.  
Pilsbry, H. A. and J. H. Ferriss. 1906. Mollusca of the southwestern states, II. Proc. Acad. Nat. Sci. Phila., 58:123-175.

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## NEW HELICID SNAIL FROM ZACATECAS, MEXICO<sup>1</sup>

By FRED G. THOMPSON

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This is the second species of *Humboldtiana* to be described from the state of Zacatecas. The other species known from the state is *H. chrysogona* Pilsbry, which is common in the mountains above Concepcion del Oro. The new species is unusual within the genus because it lives in a dry, sparsely vegetated desert. In allusion to its habitat it is named:

*HUMBOLDTIANA* TESCOLA new species.

Page 27, figs. 1-4.

*Diagnosis.* A member of the *texana* group in which the ground color of the shell is dark tan with numerous close white streaks. Bands are absent or weakly developed. Shape conico-globose. Shell thin. Suture deeply impressed. Embryonic whorls large, protruding. Periostracum absent. Sculpture consisting of strong incremental striations and wrinkles. Granulation sparse and rudimentary, confined to upper surface of first two neanic whorls. Diagnostic features of the anatomy are listed below.

*H. tescola* differs from all other species of the *texana* group by its predominately white-streaked color pattern that lacks distinct dark spiral bands.

*Description.* Shell (page 27, figs. 1-4) conico-globose, 0.83-0.97 times as high as wide. Thin. Obliquely umbilicate. 4.0-4.5 whorls. Suture deeply impressed. Whorls regularly increasing in size; last quarter whorl descending deeply to aperture. 1.2-1.4 protruding embryonic whorls. First whorl smooth, 2.4-2.8 mm. in diameter perpendicular to initial suture; following 0.2-0.4 embryonic whorls with fine radial striations. Neanic whorls with strong incremental striations and wrinkles. First two neanic whorls with sparse low granules that are usually located within axial striations and between wrinkles. Granules confined to upper surface of early whorls and absent or very sparse on body whorl. Periostracum absent. Aperture

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<sup>1</sup> Field work in Mexico during 1966 was supported by the National Institutes of Health Research Grant GM. 12300-2.

oblique in lateral profile, lying at about  $45\text{--}52^\circ$  to axis of shell, 0.94-1.19 times as high as wide. Peristome sharp, simple. Interior of aperture frequently with a low callus behind peristome. Columella oblique, partially reflected over umbilicus. Parietal callus thin, transparent, slightly advanced.

Ground color dark tan marked with numerous white streaks that dominate color pattern. Bands generally absent. Two bands may be vaguely evident in some specimens, one just above and the other just below the periphery. Embryonic whorls grayish-tan. Interior of aperture rusty-tan. Columella grayish-white.

Measurements of type: height, 30.8 mm.; major diameter, 34.2 mm.; oblique aperture height, 24.0 mm.; aperture width, 21.5 mm.; 4.2 whorls.

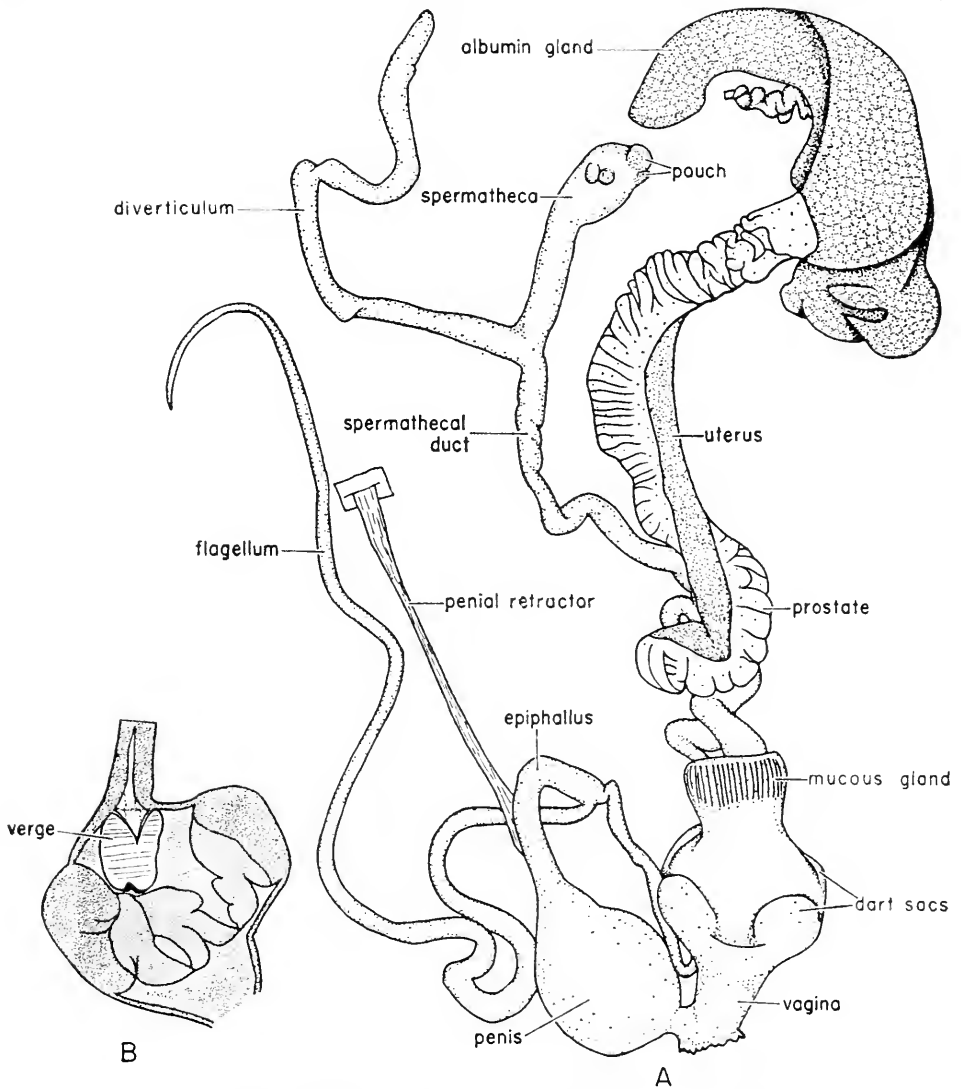
Measurements of paratypes: height, 28.2-33.1 mm.; major diameter, 32.0-38.3 mm.; aperture height, 21.1-25.0 mm.; aperture width, 20.4-25.6 mm.

*Anatomy.* Most aspects of the anatomy are typical for the genus as described by Pilsbry (1939: 395-396) and Burch and Thompson (1957). The reproductive system is illustrated in page 24, figs. A,B. Measurements of various reproductive structures for 3 specimens are:

	79 mm.	68 mm.	60 mm.
flagellum	7	11	9
epiphallus	7	9	—
penis	2.9	2.0	2.4
verge	26	32	25
vas deferens	20	—	—
penial retractor muscle	46	54	39
spermatheca and duct			
above diverticulum	14	12	10
duct below diverticulum	32	42	29
diverticulum	34	36	29

(Comparable measurements for other species in which the anatomy is known are given in Burch and Thompson, 1957).

Diagnostic features of the anatomy are: Mucous glands on vagina separated from dart sacs (as in *H. texana* Pilsbry). Verge with a vestigial chamber at base of epiphallus. Vagina with 4 equally developed and functional dart sacs. Spermatheca with 4-6 small globular pouches on surface. Diverticulum considerably longer than distal segment of spermathecal duct, and about as long as



Figs. A, B. *Humboldtiana tescola* Thompson. A. Reproductive system. B. Interior of penis.

lower segment. Flagellum long, 3.5-5.6 times length of penis and epiphallus. Epiphallus short, 1.0-1.2 times length of penis. Nape and snout very darkly pigmented, almost black. Sides of body dark gray. Lower sides of foot and tail light gray.

*Type locality.* Zacatecas, 15.7 miles southwest of San Tiburcio, 7600 feet alt. Type: University of Florida Collections (UF.) 19752; collected August 6, 1966 by Fred G. Thompson. Paratypes: UF. 19753 (20), Museo Nacional de Mexico (3); same data as the type.

The type locality lies along the highway from Zacatecas City to Saltillo, and is in a low, dry range of limestone hills that rise about 400-600 feet above the surrounding desert. Specimens were collect-

ed in limestone crevices and under dead Joshua tree trunks (*Yucca* sp.) along the southeast side of the range on a dry rocky hillside. The vegetation in the area consisted of sparse, low desert scrubs and Cholla cactus (*Opuntia*, s. g. *Cylindropuntia* sp.), and occasional scattered Joshua trees on the hill tops.

*Relationships.* This species belongs to the *texana* group (Burch and Thompson, 1957: 2) because of the separation of the mucous glands from the dart sacs on the vagina. *H. tescola* is distinguished from other species in which the anatomy is known by the diagnostic features outlined above. It is unique anatomically because of the length of the diverticulum on the spermathecal duct, and by the presence of small globular pouches on the spermatheca. It is also unusual in that it has a proportionally long flagellum, and a relatively short epiphallus. It resembles *H. fortis* Pilsbry in these latter two characters, but that species belongs in another group because of the close association of the mucous glands and dart sacs on the vagina, and in having only two well developed, functional dart sacs.

In shell features, *H. tescola* is similar to *H. hogeana* (Martens) in the weak development of its granular sculpture. It differs from that species by its coarser axial striations and wrinkles, its bandless color pattern, its deeper suture, and its more protruding embryonic whorls. It is also similar to *H. fortis* in its color pattern, but that species completely lacks granular sculpture, is more globose, and is thicker shelled.

#### REFERENCES

- Burch, John B. and Fred G. Thompson. 1957 Three new Mexican land snails of the genus *Humboldtiana*. Occ. Pap. Mus. Zool. Univ. Mich., (590) : 1-11; pls. 1-5.
- Pilsbry, Henry A. 1939. Land Mollusca of North America (North of Mexico) Monogr. 3, Acad. Nat. Sci. Phila., 1 (1) : 395-410.

## TWO NEW SPECIES OF *PACHYCHILUS* FROM NORTHEASTERN MEXICO<sup>1</sup>

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Two new species of *Pachychilus* collected during recent years are remarkable for their restricted distributions. One is confined

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<sup>1</sup> Field work in Mexico during 1965 was supported by the National Institutes of Health Research Grant GM. 12300-1.

to a small area along a spring run, and the other is restricted to a very narrow zone in a river where it emerges from a cave. These species are interesting additions to the elaborate fauna that was described earlier from northeastern Mexico by Pilsbry and Hinkley (1909) and Pilsbry (1956).

*PACHYCHILUS APHELES* new species. Page 28, upper figs. 1-5.

*Diagnosis.* A species of the subgenus *Oxymelania* characterized by its small size, its slender spire, its reduced number of whorls due to erosion, its smooth shell with very fine incremental striations, and its laterally situated aperture in which the upper-outer corner is receded. It resembles some forms of *P. pleurostriatum* (Say) in shape and color, but it differs from that species by its small size, more slender shape, smooth sculpture and decollate shell.

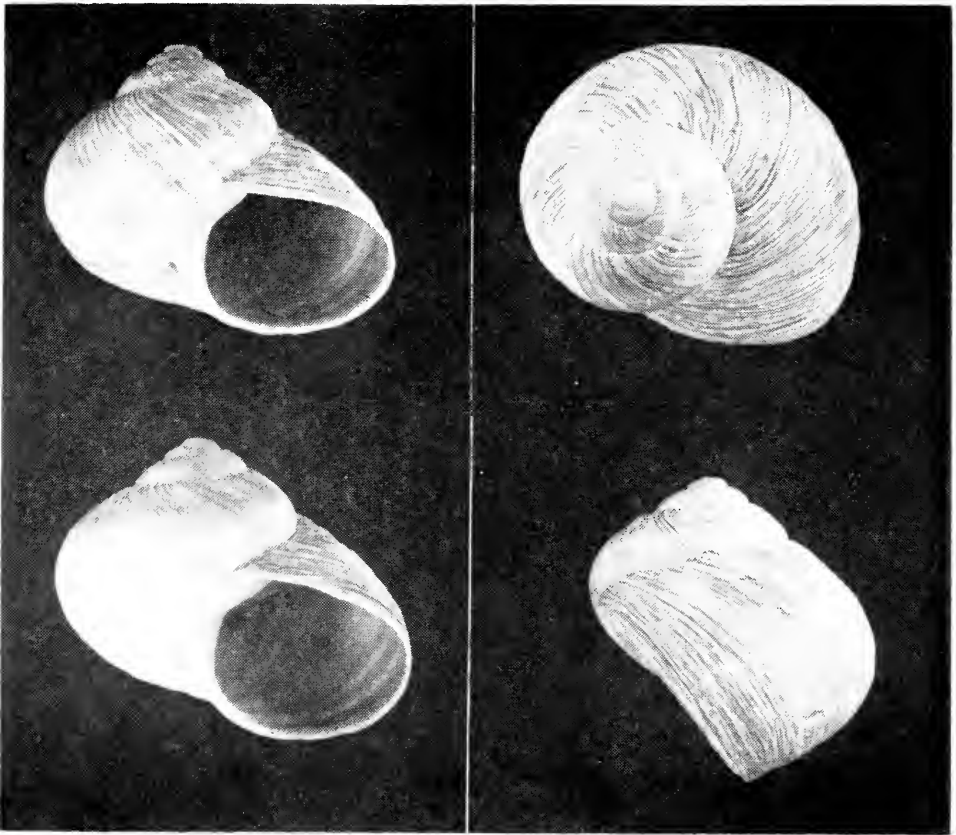
*Description.* The shell is small and black or reddish-black in color. The shape is conico-turrite with the apex eroded away leaving 2.0-3.5 whorls in adult shells. The remaining spire is longer than the height of the aperture. The sculpture of adult shells consists primarily of fine incremental striations. 4-5 low spiral chords are present on the early whorls of juvenile shells, and some chords may persist below the suture to the penultimate whorl of the adult shell. The suture is moderately impressed, and is located below the periphery of the preceding whorl. The whorls are only slightly arched between the upper suture and the periphery. The aperture is ovate, and is laterally extended due to the projection of the outer peristome. The parietal callus is moderately thick. The upper corner of the peristome is thickened and weakly receded. The interior of the aperture is bluish-black with a white tinge along the columellar margin. The operculum is paleomelanian in structure.

Measurements in mm. of 5 representative specimens are:

Length	Width	Aperture Height	Whorls
14.2	9.0	7.0	2.0
16.2	10.0	8.0	2.5
19.4	10.3	8.2	3.5 (TYPE)
20.2	11.9	8.9	3.0
20.5	10.1	8.5	3.3

*Type locality.* A spring run 14 miles west-southwest of Ciudad Valles, on the road to Rio Verde, San Luis Potosi. Type: UF.

19756; collected April 11, 1965 by Fred G. Thompson. Paratypes: UF. 19757 (35), Museo Nacional de Mexico (6); same data as the type.

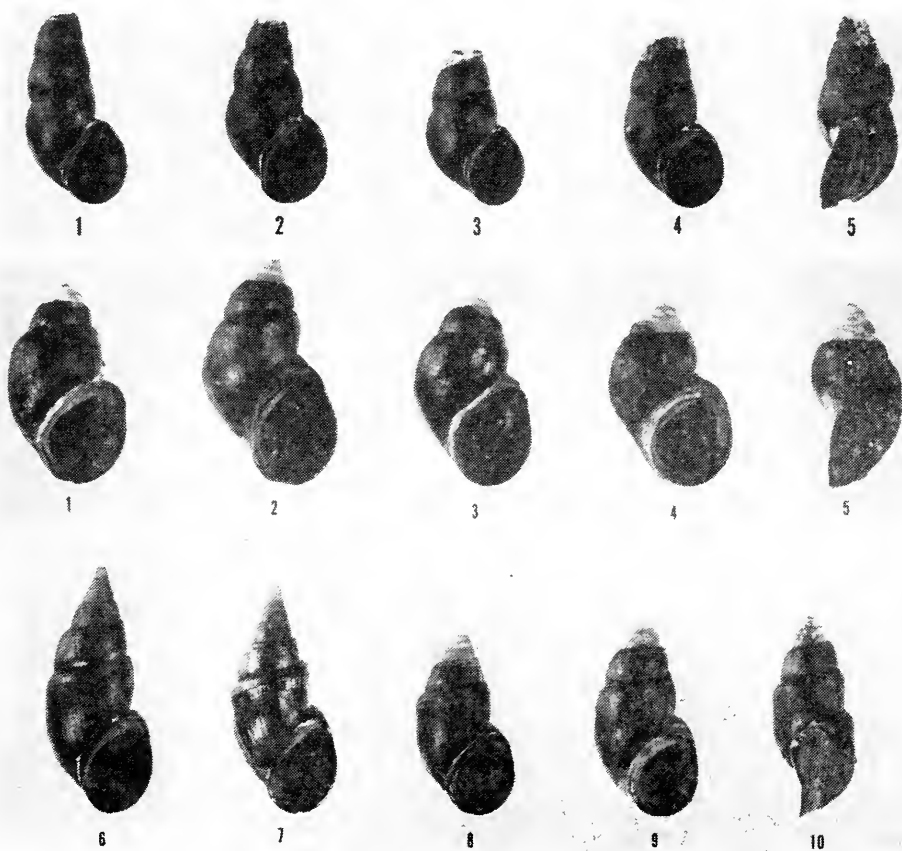


*Humboldtiana tescola* Thompson. Upper figures, type. Lower figures, paratype.

*Remarks.* The spring at the type locality issues from the ground about 200 meters above the highway, and forms a large deep run where it is crossed by the road. Near the highway the clay sides and bottom of the run are nearly barren of vegetation. *P. apheles* and *P. pleurostriatus* ssp. were sparsely distributed on the sides and bottom of the run.

*P. apheles* resembles in shape the more slender forms of *P. pleurostriatus* (Say). It differs from *P. pleurostriatus* by its smaller size, the absence of spiral chords on the lower whorls, its flatter whorls, and its eroded spire. The lateral extension of the aperture is not unique to *P. apheles*, but it is more apparent than in other forms because of the absence of strong sculpture on the preceding whorls,

and because of the narrow spire. *P. pleurostriatus* is medium sized for the genus, has strong spiral chords through the length of the shell, has moderately arched whorls, and retains the early whorls of the shell, even in habitats where other species become badly eroded.



Upper figs. 1-5 (1, type; 2-5, paratypes): *Pachychilus apheles* Thompson. Lower figs. 1-5 (1, type; 2-5, paratypes): *P. corpulentus* Thompson. Lower figs. 6-10: *P. monachus* Pilsbry & Hinkley.

**PACHYCHILUS CORPULENTUS new species.** Page 28, lower figs. 1-5.

*Diagnosis.* A species of the subgenus *Oxymelania* characterized by its obese shape, short eroded spire, deep suture, rounded whorls which are not shouldered below the suture, weak sculpture consisting of spiral and incremental striations, and its large, weakly notched aperture. This species is most closely related to *P. monachus* Pilsbry and Hinkley, because of similarities in the shape of the aperture and the shape and texture of the preceding whorls. It differs from *P. monachus* by having moderately arched whorls that



are not shouldered, by having a shorter spire, by its obese shape, and by lacking strong spiral threads below the suture.

*Description.* The shell is moderately large, ovate-conical in shape and reddish-black in color. The upper whorls are badly eroded due to symbiotic algae, leaving about 3.2-4.5 whorls in adult shells so that the snail has an obese appearance. Erosion of the shell may be so extensive that only small patches of the periostracum persist in some specimens and the shell may be roughly pitted. The remaining spire is about as long as, or is shorter than the height of the aperture. The suture is deeply impressed and the whorls are moderately arched between the sutures but are not shouldered. The sculpture consists of numerous close, fine incremental striations, and less distinct, more widely spaced spiral striations. In occasional specimens nearly obsolete spiral threads may also be present below the suture, but are so weak and infrequent as to be non-characteristic of the species. The aperture is irregular in shape, but is generally ovate or broadly elliptical. The interior of the aperture is bluish-black with a white tinge along the parietal callus and the columella. The parietal callus is very thick and extends laterally beyond the preceding whorls so that the upper corner of the aperture is off-set and thickened. The corner is retracted so that a shallow notch is formed in the peristome. The operculum is paleomelanian in structure.

Measurements in mm. of 5 representative specimens are:

Length	Width	Aperture Height	Whorls
19.8	19.7	14.0	3.3
24.6	18.1	12.2	3.5
27.2	17.8	12.9	4.0 (TYPE)
30.1	19.5	15.8	4.5
31.7	18.7	14.2	4.1

*Type locality.* Nacimiento de Rio Mante, about 5 miles west of Ciudad Mante, Tamaulipas. Type UF. 19754; collected January 26, 1964 by Fred G. Thompson. Paratypes: UF. 19755 (253), Museo Nacional de Mexico (30); same data as the type.

*Remarks.* The Rio Mante issues from a cave at the base of a limestone cliff. Large blocks of limestone occur in the river near the base of the cliff, but elsewhere the river bed is covered with sand and silt. *P. corpulentus* was found on limestone boulders immedi-

ately at the mouth of the cave, but did not occur even ten yards downstream on similar limestone blocks.

*P. corpulentus* is most similar to *P. monachus* Pilsbry and Hinkley which it resembles in characteristics of the aperture, and the color, texture, and appearance of the lower whorls. *P. monachus* differs from *P. corpulentus* by having nearly flat-sided whorls that are strongly shouldered below the suture, by having a more slender shell with a longer spire, and by having distinct spiral threads or chords below the suture through the length of the shell. Topotypic specimens of *P. monachus* are illustrated for comparative purposes (page 28, figs. 6-10).

The notched aperture is not unique to *P. corpulentus*, but occurs independently in other species of the genus. This character tends to occur in some specimens of *P. monachus*, and to much more elaborate extremes in *P. pleurotoma* Pilsbry and Hinkley, and *P. dalli* Pilsbry (1896: 269-270). These species do not have relationships in common, but are more closely related to other unnotched species of the genus. *P. pleurotoma* is similar in all other features of the shell to *P. suturalis* Pilsbry and Hinkley, with which it may be subspecifically related (Pilsbry, 1956: 37). *P. dalli* is similar in other shell features to large species of the *P. laevis* complex of southern Mexico and Central America.

Morrison (1952: 7) proposed the subgenus *Pilsbrychilus* for *P. dalli* because of its notched peristome. By definition this subgenus would also include *P. pleurotoma*, *P. corpulentus*, and possibly *P. monachus*, or would justify the recognition of another subgenus to include these species. Since the character occurs among unrelated species within the genus, and is of dubious specific value in at least one instance (*P. pleurotoma*), its use as a subgeneric criterion is unacceptable. *Pilsbrychilus* Morrison, 1952, cannot be considered distinct from *Pachychilus* Lea, 1851, s.s.

#### REFERENCES

- Morrison, J. P. E. World relationships of the melanians (an Abstract). Amer. Malac. Union New Bull. Ann. Rept., 1951: 6-9. 1952.
- Pilsbry, H. A. A remarkable central American melanian. Proc. Acad. Nat. Sci. Phila., 269-270. 1896.
- Pilsbry, H. A. Inland Mollusca of northern Mexico. III. Polygy-

ridae and Potodominiae. Proc. Acad. Nat. Sci. Phila., 108: 19-40. 1956.

Pilsbry, H. A. and A. A. Hinkley Melaniidae of the Panuco River system, Mexico. Proc. Acad. Nat. Sci. Phila., 519-531 1909.

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## HENRY G. FRAMPTON

1902-1966

Henry G. Frampton was born in Sharon, Pennsylvania on February 4, 1902. He attended grade schools in Sharon and in St. Petersburg, Florida, and later Culver Academy, Culver, Indiana, and the University of the South at Sewanee, Tennessee. He started his career as a newspaper man in Knoxville, Tennessee, and later became managing editor of the Clearwater, Florida Sun. In 1926 he moved to Miami and joined the staff of the Miami Daily News, first as a reporter and later as News Editor.

Always a naturalist at heart, his interest in mollusks, particularly the genus *Liguus*, became established about this time, largely through his association with Charles Torrey Simpson, one-time staff member of the Division of Mollusks in the United States National Museum. A little later he became acquainted with Richard Deckert, a nature artist, and Joseph Farnum, a local Miami naturalist. Both of these men were ardent students and collectors of *Liguus*.

In 1936 Mr. Frampton was named "Outstanding Newspaperman of the Year" in Florida and the quality of his work was instrumental in the awarding of the Pulitzer Prize in Journalism to the Miami Daily News in 1938. Shortly after this time he gave up newspaper work in order to establish his own business, the Tropical Biological Supply Co. in Miami.

In 1952 he became interested in Doberman Pinschers and in a very short time became an outstanding exhibitor. It was while showing a prize dog at a show in Greenville, South Carolina, on July 29, 1966, that he suffered a cerebral hemorrhage which caused his death.

Henry Frampton is survived by his wife, Theodosia Howie Frampton of Miami and one son, Major Henry G. Frampton II of Colorado Springs, Colorado.

Mrs. Frampton very kindly presented his very large collection of

*Liguus* to the Museum of Comparative Zoology, Harvard University and we are indebted to her as well for much of the data given above.

The collection of *Liguus* approximates 16,000 specimens which were collected mainly in 4 areas, namely Pinecrest, Central Everglades; Long Pine Key, south central Everglades; the coastal ridge from Fort Lauderdale to Homestead and the lower Florida Keys. Most of the specimens were collected between 1930 and 1935.

During March and April of 1931, William Schevill and I were camping on Paradise Key, less than  $\frac{1}{2}$  mile east of Long Pine Key. At that time we were making daily trips to Long Pine Key for *Liguus*. H. A. Pilsbry had joined us here for a short period of time, staying at the old lodge at night but having his meals with us. One week-end, Henry Frampton and Richard Deckert put up at the lodge and we all planned a long trip north of Long Pine Key into territory which had never been explored for *Liguus*. With two cars we drove to the north edge of the Key, then a tramp of about two miles brought us to a hammock which we called Powell Hammock after A. W. B. Powell of the Auckland Institute and Museum of New Zealand. A beautiful yellow *Liguus* (*L. lossmanicus* Pilsbry) was the only color form present on this hammock and they were exceedingly numerous. In order to cover more ground, we decided to split the party, Henry and I to explore the country to the north and east, the others to cover several hammocks near by. At that time Dr. Pilsbry was 70 years old and Deckert not much younger and a very long trip on foot for them was hardly advisable. It was still early in the morning, about 7 o'clock, when we left the others and Henry and I didn't get back to the car until about 10 P.M. This ended what was to be the longest walk either of us ever made; we estimated it to be about 30 miles! Most of the hammocks we explored were small and but few of these possessed *Liguus*. The walk back to the car gave us ample opportunity to discuss the numerous problems concerned with the distribution of *Liguus*. A warm friendship developed from this day in the 'glades which has lasted through the years. — W. J. CLENCH

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### NOTES AND NEWS

DATES OF THE NAUTILUS. — Vol. 80, no. 1, pp. 1-36, iii, was

mailed July 6, 1966. No. 2, pp. 37-72, iii, pls. 1-4, Oct. 11, 1966. No. 3, pp. 73-108, iii, including pl. 5, Jan. 24, 1967. No. 4, pp. 109-144, iii, iv, including pls. 6-9, April 24, 1967. — H. B. B.

CORRECTION FOR APRIL NO. — On plate 9, p. 124, change "Miller" to Russell, after subspecies name. Apologies are presented for this error. — H. B. B.

ACROLOXUS COLORADENSIS FROM MONTANA. — *Acrolooxus lacustris* (Linné) is a common fresh water limpet in central and western European lakes. *Ancylus hendersoni* was described by Bryant Walker in 1925 from Eldora Lake near Boulder, Colorado. It was renamed *Ancylus coloradensis* by Junius Henderson in 1930. This species is the only known representative of the genus *Acrolooxus* in North America. In addition to the type locality, it has been reported by Mozley from Jasper Park, Alberta, Canada, and by Taylor as a fossil from the Pleistocene (Dixon Local Fauna) of south-central Kansas. The authors have collected *A. coloradensis* in Lost Lake, Glacier National Park, Montana. Lost Lake is a small lake of approximately two acres and is located at an elevation of about 4700 feet. The lake drains into St. Mary's Lake, a part of the Hudsonian Drainage. *Acrolooxus coloradensis* has been found on the undersides of rocks in shallow water near shore. There was sparse vegetation in the lake, and the only other mollusks which have been collected are *Physa gyrina* (Say) and *Pisidium casertanum* (Poli). The sponge, *Spongilla lacustris* (Linné), was also abundant in the lake.

We should like to thank Dr. Bengt Hubendick, director of the Museum of Natural History in Göteborg, Sweden, for the identification of *Acrolooxus*. — RICHARD H. RUSSELL and ROYAL BRUCE BRUNSON, Department of Zoology, University of Montana, Missoula.

#### REFERENCES

- Henderson, J. 1930. *Ancylus coloradensis*, new name for *A. hendersoni* Walker, 1925, not 1908. *Nautilus*, 44:31.  
Mozley, A. 1926, Preliminary list of the Mollusca of Jasper Park, Alberta. *Nautilus*, 40:53-56.  
Taylor, D.W. 1959. Late Cenozoic molluscan faunas from the High Plains, U.S. Geol. Surv. Professional paper 337.  
Walker, B. 1925. New species of North American Ancyliidae and Lancidae. Occ. Pap. Mus. Zool., Univ. Mich. No. 165.

ECOLOGY OF *BULIMULUS DEALBATUS* at Everman, Texas — The following notes deal with the feeding habits and parts of the life-cycle of this snail in Tarrant County, Texas. Living specimens were found aestivating on leaves of Johnson grass (*Sorghastrum*) in June, 1958. On May 8, 1959 many specimens were noted, and two pairs were seen mating conjoined by the sex-organs. A spermatophore was removed artificially from one pair. The spermatophore is much as in *Helix aspersa*, being composed of a long, thread behind a slightly stouter semen-filled opaque portion, which in turn is preceded by a short, stout, transparent end of about the same length as the opaque part. The semen mass is only about 1/10 to 1/12 the total length of the spermatophore. July 2, 1959, rain and large numbers of specimens noted climbing vegetation, mostly low grass and forbs. Collected 52 living *dealbatus* of various sizes. Each was marked by India ink on the aperture and numbered on the outer whorl (ultimate) above the aperture, and the dry ink protected by a layer of clear lacquer. Twenty shells were full-sized adults, 10 smaller but seemingly reproductively mature, and 12 were half grown juveniles. The specimens were released July 14, by a wooden stake driven into a stand of prairie vegetation, mostly unmowed grass, where the species had been previously found. July 18, prolonged rain in the afternoon. A marked snail, number now illegible, noted 13 feet 3 inches from stake; 13 specimens were 7-19 feet from stake, averaging a foot apart. One marked snail was adjacent to the stake. The most far-moved snail was found alive 62 feet SSW of the release stake. The dispersal pattern was somewhat concentric. Most were moving west in slightly shorter grass. Specimen 20 was seen feeding on a dead-brown herb fragment. Observations were continued in a separate, more distant area, very gentle rain was yet falling. Two crawling not feeding; two on wilted, brown, wild-lettuce (*Lactuca*) stem and chewing dead-brown leaves. One feeding on sepals of dead composite; two fed on dead-brown forb; one chewing on dead-brown end of a grass blade; Very small specimen noted crawling, just slightly larger than newly hatched young as seen in the laboratory. Adults (2) were eating dead-green ragweed (*Ambrosia*) leaf, and stem. One was feeding on dried red-flowered composite. July 19, one was noted feeding on cut dead-brown stem of a coneflower. One was feeding on dead-brown stem of

*Lactuca*; One on dead-brown cut-leaf of small ragweed; one was on the bark of a dead-brown coneflower stem. In making the feeding observations, great care had to be used in approaching the snails as sound or foot-fall (vibration) caused them to withdraw or cease feeding, for unless the mouthing actions could be observed the snail could not be recorded as feeding. The mowing of the edges of the field by the gravel roadside seemed to cause a concentration of specimens here with a lesser population density in more central area of the fields. A slight embankment present by the roadside may also have in some way had an effect to concentrate population. July 20, an adult was noted with its head, neck, and forebody thrust into the ground. Removal of the specimen revealed a short tube to penetrate the ground. A mass of whitish, collapsible eggs cohered in a loose cluster in the earth at the end of the tube. These eggs hatched about Aug. 4, and 23 young were noted aestivating on the sides of the jar-cage. On July 20, about a dozen *dealbatus* also were noted feeding on dead-brown herbs (mostly forbs) but not one was seen eating living vegetation. If this species' habits are as noted here, it should be considered economically beneficial since it eats non-living vegetation of weeds rather than grasses. — GLENN R. WEBB.

UNITAS MALACOLOGICA EUROPAEA. — The third European Malacological Congress will be held September 3 to 6, 1968, in Vienna, Austria. It will be preceded by a symposium on "Mollusks as parasites and their transmitters" (Sept. 1-3). Applications for additional information and notices of attendance should reach me before Aug. 31, 1967. — Dr. OLIVER E. PAGOT, President, Museum of Natural History, Burgring 7, A-1014, Vienna, Austria.

MUDALIA. — Haldeman, 1840, Monogr., suppl. to no. 1: pp. 1 & 2, originally included 2 species, which he termed *Anculosa* (*Mudalia*) *turgida* and *Paludina* (*Mudalia*) *dissimilis* Say [Cf. Tryon, 1873: xxxiv.]. The first selection of its type seems to be that of Hannibal, 1912, Proc. Malac. Soc. London 10: 168, who chose *Paludina dissimilis* Say = *Bulimus carinatus* Brug. [Cf., Morrison, 1954: 361], below his statement that "types have been cited for all the group names . . ." Apparently available synonyms are: *Nitocris* Adams, 1854. *Spirodon* Tryon, 1873. *Alleghenya* Clench & Boss, 1967. — H. BURRINGTON BAKER.

JUGA AND MELASMA. — When, 1963, Naut. 77: 35, a subsequent selection of type was made for *Melania* (*Melasma*) H. & A. Adams, 1854, The genera of recent Mollusca 1: 302, and another for *Vibex* (*Juga*), op. cit.: 304, I overlooked earlier citations of “types” by Hannibal, 1912: 174. However, his choice of *Buccinum virginicum* Gmelin for *Juga* is incorrect; actually Adams, 1854, included “*Virginica*, Gmelin” in the genus *Ceriphasia* (p. 297) but listed “*Virginea*, Say” [Cf. Tryon, 1873: xv] under *Juga*. Thus my selection of Adams’s “*silicula*, Gould” appears to be the first valid subsequent designation.

On the other hand, Hannibal’s citation of “*Melania blanda*, Lea” for *Melasma* seems an acceptable designation of type, but the result is about the same, since *M. blanda* Lea, 1841 [not 1871] is a subjective synonym of Adams’s “*laqueata*, Say,” which was my later selection. — H.B.B.

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### PUBLICATIONS RECEIVED

- Clench, Wm. J. 1966. Notes and descriptions of new Urocoptidae from Cuba and Hispaniola (Mollusca: Pulmonata). *Breviora* no. 245: 14 pp. including 2 pls. N. spp. of *Archegocoptis*, *Urocoptis* & *Brachypodella*.
- Feng, S. Y. 1965. Heart rate and leucocyte circulation in *Crassostrea virginica* (Gmelin). *Biol. Bull.* 128: 198-210, figs. 1-5, tables 1-4.
- Frick, Wolfgang. 1964. Der Kalziumstoffwechsel bei *Helix pomatia* unter dem Einfluss wechselnder Kohlensäureatmosphären [Influence of CO<sub>2</sub> on calc changes.] *Mitt. Zoo. Mus. Berlin* 41: 95-120, figs. 1-4, tables 1-7, and pls. 1-7.
- Frontz, Harold O. 1966. New *Solenochilus* species from the Conemaugh series of eastern Ohio. *Ohio. J. Sci.* 66: 433-436, 3 figs.
- Frings, Hubert & Carl. 1965. Chemosensory bases of food-finding and feeding in *Aplysia juliana* (Mollusca, Opisthobranchia). *Biol. Bull.* 128: 211-217, figs. 1-3.
- Ghose, Krishna Chandra. 1962. The nervous system of *Achatina fulica* Bowdich. *Ann. Zoo. [Agra]* 4: 25-38, including fig. 1 and pl. 1.
- 1963. Morphogenesis of the pericardium and heart, kidney and ureter, and gonad and gonoduct in the giant land snail, *Achatina fulica* Bowdich. *Proc. Zoo. Soc.* 16: 201-214, figs. 1-21.



- 1963. The pedal gland of *Achatina fulica*. J. Animal Morph. and Physiol. 10: 80-82, including pl. 1.
  - 1963. The early stages of development in *Achatina fulica* Bowdich (Mollusca: Gastropoda). J. Bombay Nat. Hist. Soc. 60:228-232, pls. 1-3.
  - 1964. The kidneys of two land-snails [Mollusca: Pulmonata]. Proc. Zoo. Soc. Calcutta 17: 159-167, including 2 figs. and 1 pl.
  - 1964. The structures of the heart of *Achatina fulica* and *Macrochlamys indica* and pace-maker mechanism and refilling of the auricle in *A. fulica*, with a discussion of the same in gastropods. Philippine J. Sci. 93: 219-229, including fig. 1 and pl. 1.
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# THE NAUTILUS

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# THE NAUTILUS

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## MALACOBDELLA GROSSA IN PITAR MORRHUANA AND MERCENARIA CAMPECHIENSIS

BY JOHN W. ROPES AND ARTHUR S. MERRILL

U. S. Bureau of Commercial Fisheries Biological Laboratory, Oxford, Md.

Specimens of the morrhua venus, *Pitar morrhuana* (Linsley), containing the commensal nemertean, *Malacobdella grossa* (O. F. Müller), were collected during a May-June 1966 cruise of the Bureau of Commercial Fisheries research vessel "Delaware." *Pitar morrhuana* has been recently discovered as a fifth host for the nemertean along the western North Atlantic coast by Ropes (1966). The present account adds to the records of the initial discovery and includes observations of the nemertean in the southern quahog, *Mercenaria campechiensis* (Gmelin). More extensive distributional records of the quahog offshore of the middle Atlantic coast were reported by Merrill and Ropes (1967).

A hydraulic surf clam dredge caught 73 *P. morrhuana* at 10 of 447 locations from Montauk Point, N. Y., to Ocracoke Inlet, N. C. (Fig. 1). A total of 61 *P. morrhuana* came from three locations; 22 contained the nemertean, an incidence of 36%. None of the remaining 12 clams, from seven other locations, contained the nemertean. The shell length measurements of the clams ranged from 18 to 50 mm. and averaged 35.9 mm.; *M. grossa* occurred in specimens 27 to 47 mm. long. No multiple occurrences of the nemertean were observed.

The nemertean was found in 91 of 104 *M. campechiensis* from 13 locations (Fig. 1), an incidence of 87.5%. Porter (1962) found the nemertean nearly as often (83.3%) in southern quahogs taken off North Carolina. We found multiple occurrences in two clams; one contained 4 worms, the other 2. The quahogs were larger (length range, 80 to 127 mm.; average, 104.5 mm.) than *P. morrhuana* — providing more space for multiple occurrences of the nemertean. Generally, only one nemertean inhabits each host.

Martin L. H. Thomas, Fisheries Research Board of Canada, Biological Substation, Eglerslie, P. E. I., found *M. grossa* in *P. morrhuana* from the Gulf of St. Lawrence north to Goose Harbor,

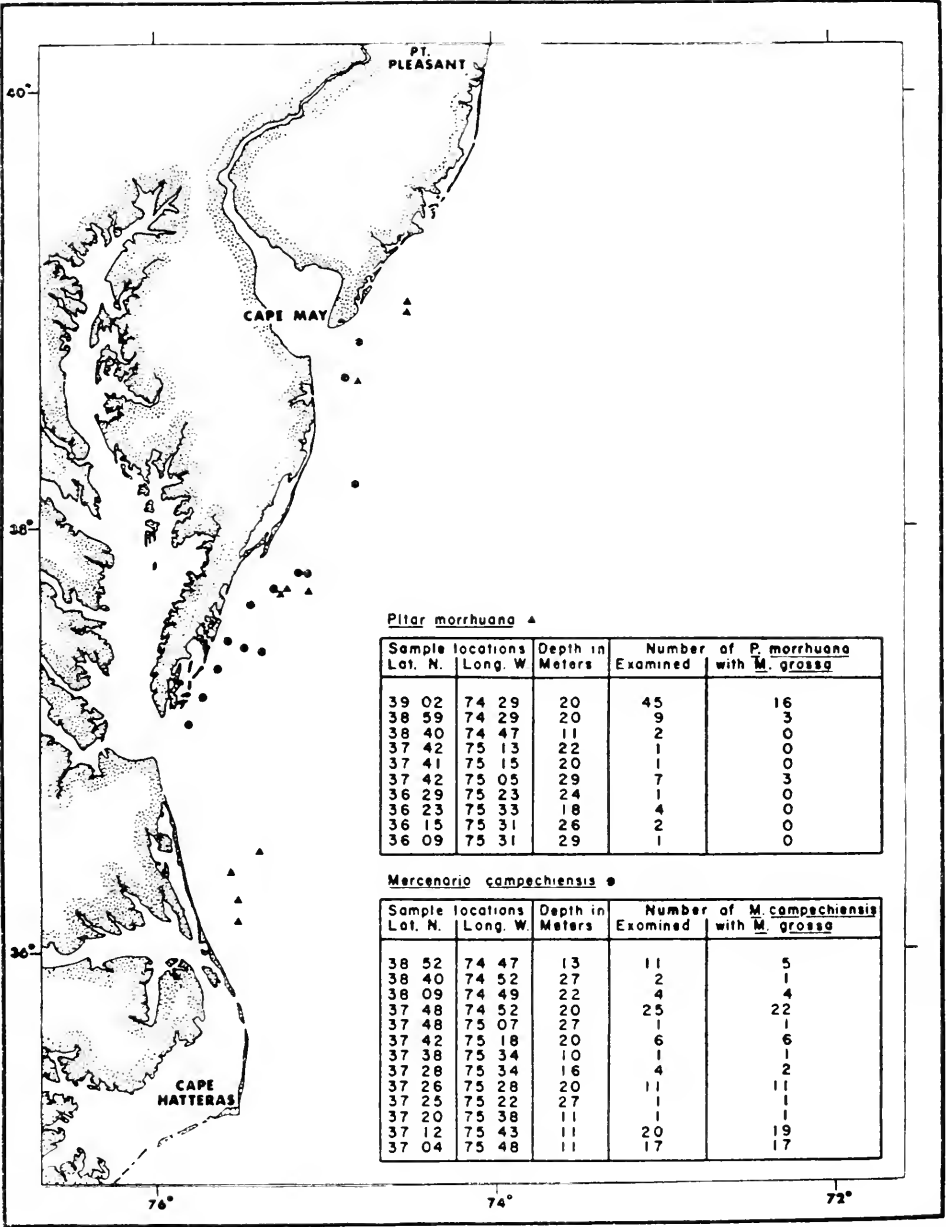


Figure 1. Sample locations for *Pitar morrhuana* and *Mercenaria campechiensis* and numbers containing *Malacobdella grossa*, middle Atlantic coast.

P. E. I., and Grand Etang, Nova Scotia (personal communication). Of 15 *P. morrhuana* collected from Malpeque Bay on 25 August 1966, 12 (35 to 50 mm. long) contained the nemertean.

Coe (1954) reported that *M. grossa* is widely distributed along the Atlantic coast from Nova Scotia to Texas. Ropes (1966) found the association of the commensal and *P. morrhuana* in offshore New Jersey waters. The above records extend the geographical

Table 1. A list of known mollusk hosts for the genus Malacobdella

Atlantic coast pelecypod hosts for <u>Malacobdella grossa</u>	Reference
<u>Mercenaria mercenaria</u>	Coe, 1943
<u>Mercenaria campechiensis</u>	Porter, 1962
<u>Crassostrea virginica</u>	Coe, 1943
<u>Mya arenaria</u>	Coe, 1943
<u>Pitar morrhuana</u>	Ropes, 1966;
	M. L. H. Thomas, 1967 (Personal Communication)
European coast pelecypod hosts for <u>Malacobdella grossa</u>	
<u>Mya arenaria</u>	Coe, 1943
<u>Mya truncata</u>	" "
<u>Cardium aculeatum</u>	" "
<u>Isocardia cor</u>	" "
<u>Venus mercenaria</u>	" "
<u>Pholas crispata</u>	" "
<u>Arctica islandica</u>	" "
<u>Macra stultorum</u>	" "
Pacific coast pelecypod hosts for <u>Malacobdella grossa</u>	
<u>Siliqua patula</u>	Guberlet, 1925
<u>Macoma secta</u>	Coe, 1943
Pacific coast pelecypod hosts for <u>Malacobdella minuta</u>	
<u>Yoldia cooperi</u>	Coe, 1945
Japanese coast pelecypod hosts for <u>Malacobdella japonica</u>	
<u>Macra sachalinensis</u>	Takakura, 1897
South American gastropod hosts for <u>Malacobdella auriculae</u>	
<u>Chilina dombeiana</u>	Guberlet, 1925

range of this association north to the Gulf of St. Lawrence and south to below Chesapeake Bay. The nemertean association with *M. campechiensis* described above extends the records of this relationship north to Cape May, N. J. Porter (1962) originally found the nemertean in southern quahogs off Cape Lookout and Beaufort, N. C. Since *M. campechiensis* occurs southward into the

Gulf of Mexico (Abbott, 1954), possibly the nemertean is present in these clams too.

Seventeen molluscan species serve as hosts for the genus *Malacobdella* (Table 1); and 14 of these are listed for *M. grossa*. Two species of the genus *Macra*, taxonomically close relatives of surf clams, *Spisula solidissima* (Dillwyn), are hosts for the nemertean—one on the European coast and one on the Japanese coast. Although the relationship between *M. grossa* and the two species of *Macra* suggests that the nemertean might occur in surf clams, none of several thousand clams opened in our studies has contained it. Numerous ocean quahogs, *Arctica islandica* (Linnaeus), a host for the commensal in Europe (Brunberg, 1964), have also been examined with negative results. Both *S. solidissima* and *A. islandica* are more abundant and widely distributed than *P. morrhuana* and *M. campechiensis* along the middle Atlantic coast. Nevertheless, apparently the nemertean is unable to associate with either of the species.

#### LITERATURE CITED

- Abbott, R. T. 1954. American Seashells. D. Van Nostrand Co., Inc., New Jersey, 541 p.
- Brunberg, L. 1964. On the nemertean fauna of Danish waters. *Ophelia* 1: 77-111.
- Coe, W. R. 1943. Biology of the nemerteans of the Atlantic coast of North America. Trans. Connecticut Acad. Arts Sci. 35: 129-328.
- Coe, W. R. 1945. *Malacobdella minuta*, a new commensal nemertean. J. Washington Acad. Sci. 35: 65-67.
- Coe, W. R. 1954. The nemertean fauna of the Gulf of Mexico. In Galtsoff, Paul S. (ed.) Gulf of Mexico—its origins, waters, and marine life. U. S. Fish and Wildlife Service, Fish. Bull. 55: 303-309.
- Guberlet, J. E. 1925. *Malacobdella grossa* from the Pacific coast of North America. Publ. Puget Sound Biol. Station, 5:1-13.
- Merrill, A. S. and J. W. Ropes. 1967. Distribution of southern quahogs off the middle Atlantic coast. U. S. Fish and Wildlife Service, Comm. Fish. Rev. 29: 62-64.
- Porter, H. J. 1962. Incidence of *Malacobdella* in *Mercenaria campechiensis* off Beaufort Inlet, North Carolina. Proc. Natl. Shellfish. Assoc. 53: 133-145.
- Ropes, J. W. 1966. *Pitar morrhuana*, new host for *Malacobdella grossa*. Nautilus 79:129-131.
- Takakura, U. 1897. On a new species of *Malacobdella* (*M. japonica*). Annot. Zool. Japan 1: 105-112.



## PLEISTOCENE MOLLUSKS FROM NEW PROVIDENCE ISLAND, BAHAMAS

By EDGAR B. HEBARD

Department of Geology, New York University

In the course of geological research on the island of New Providence in the Bahamas, the following marine fauna was collected from coastal outcrops, quarries, and excavations (Table 1).

### Gastropoda

- Fissurella angusta* (Gmelin, 1791)
- Astraea phoebia* (Röding, 1798)
- Livona pica* (Linné, 1758)
- Petalocoenchus* sp.
- Batillaria minima* (Gmelin, 1791)
- Cerithium floridanum* (Mörch)
- C. algicola* (C. B. Adams, 1845)
- Epitonium novangliae* (Couthouy, 1838)
- Strombus gigas* (Linné, 1758)
- Trivia pediculus* (Linné, 1758)
- Polinices lacteus* (Guilding, 1834)
- Natica canrena* (Linné, 1758)
- N. cayennensis* (Récluz, 1850)
- Tonna galea* (Linné, 1758)
- Fasciola tulipa* (Linné, 1758)
- Oliva reticularis* (Lamarck, 1811)
- Olivella* sp.
- Conus verrucosus* (Hwass, 1792)
- Terebra cinerea* (Born, 1778)
- Bulla striata* (Bruguière, 1792)

### Pelecypoda

- Arca zebra* (Swainson, 1833)
- A. imbricata* (Bruguière, 1789)
- Barbatia cancellaria* (Lamarck, 1819)
- Anadara notabilis* (Röding, 1798)
- Glycymeris decussata* (Linné, 1758)
- G. undata* (Linné, 1758)
- Brachiodontes exustus* (Linné, 1758)
- Plicatula gibbosa* (Lamarck, 1801)
- Aequipecten gibbus* (Linné, 1758)
- Spondylus ictericus* (Reeve)
- Ostrea frons* (Linné, 1758)
- Lucina pensylvanica* (Linné, 1758)
- Anodontia alba* (Link, 1807)
- Codakia orbicularis* (Linné, 1758)
- Divaricella quadrisulcata* (Obrigny, 1842)

*Chama macerophylla* (Gmelin, 1791)  
*C. congregata* (Conrad, 1833)  
*C. florida* (Lamarck, 1819)  
*Pseudochama radians* (Lamarck, 1819)  
*Echinochama cornuta* (Conrad)  
*Americardia media* (Linné, 1758)  
*Laevicardium laevigatum* (Linné, 1758)  
*Chione cancellata* (Linné, 1767)  
*Tellina radiata* (Linné, 1758)  
*T. listeri* (Röding, 1798)  
*T. alternata* (Say, 1822)  
*Arcopagia fausta* (Pulteney, 1799)  
*Macoma orientalis hendersoni* (Rehder, 1939)  
*Bankia* sp.

The mollusk fauna found in the lithified marine strata of New Providence Island consists of 49 species dominated by *Lucina pensylvanica*. Possibly other fossils would appear to be subdominant with more extensive collecting. Species diversity, with a small number of individuals per species, is characteristic of tropical faunas. The collected New Providence Pleistocene fauna is not as diverse as the Florida Pleistocene fauna of 222 mollusks collected by Richards (1938). Only 16 New Providence Pleistocene mollusks are identical to Richards' fauna.

The Pleistocene fauna from New Providence occurs at present throughout the tropical and subtropical west Atlantic, and most species range from North Carolina to the West Indies. No endemic Bahamian species have been found in the New Pleistocene fauna. Recent species of mollusks in the limestone cays of the Bimini area (Newell and Imbrie, 1955), and the east and west coasts of Florida (Richards, 1938), are also well represented in the Pleistocene record of Bimini and Florida.

The following non-marine fauna was collected from the New Providence Pleistocene dunes at excavations, quarries, and roadcuts (Table 1).

*Cepolis varians* (Menke)  
*C. sp.*  
*Cerion rhyssum* (Dall)  
*C. agassizii* (Dall)<sup>1</sup>  
*C. glans* (Kwester)  
*C. spp.*

The non-marine fauna is dominated by *Cerion* which is endemic to the West Indies and Florida. The adult forms are abundant in

TABLE 1

## NEW PROVIDENCE ISLAND LOCALITIES

<u>Locality*</u>	<u>Collection Elevations Above Sea Level (in feet)</u>	<u>Geographic Locations</u>	<u>Coordinates</u>
Marine:			
Coral Harbor (E)	1-3	On SW peninsula	24°29'N., 77°28'W.
W. Marine Pit (E)	4-8	S. of Lyford Cay Dune	25°01'N., 77°31'W.
Ross Pit (E)	4-8	1 Mile S. of Harold Pond	25°01'N., 77°23'W.
E. Marine Pit (E)	4-8	Near E. end of Blue Hill	25°03'N., 77°20'W.
Clifton Pier (E)	10-16	On W. end of island	25°00'N., 77°33'W.
Claridge (Q)	10-16	1 Mile E. of Blue Hill	25°02'N., 77°19'W.
E. Coral Reef (CO)	2-5	On E. end of island	25°03'N., 77°16'W.
Non-Marine:			
Lyford Cay Dune (RC)	20-50	On W. end of island	25°01'N., 77°32'W.
Nassau Dune:			
Nassau St. (Q)	40-60	On NE part of island	25°04'N., 77°20'W.
Queen's Stair (E)	50-100	On NE part of island	25°04'N., 77°20'W.
Collin's Ave. (RC)	60-90	On NE part of island	25°04'N., 77°20'W.

\* (E) = Excavation, (Q) = Quarry, (CO) = Coastal Outcrop, (RC) = Roadcut

the dune bioturbite<sup>2</sup> layers, which consist of uncemented sands. Some juveniles were noted which may indicate premature death or leaking of recent fauna. Several deformed specimens of *Cerion* were also found. During growth there may have been damage due to abrasion. Regrowth of the calcareous shell resulted in deformity of these specimens.

Limestone outcrops show the most abundant and varied snail faunas. Snails prefer this limey type of habitat which offers shelter, adequate moisture, abundant food supply, and an available source of lime (presumably for secreting of the shell) (Burch, 1962).

<sup>1</sup> Extinct Dall, (1905, p. 40).

<sup>2</sup> Bioturbite is used by Purdy and Imbrie (1964, p. 49) to describe the layers in the New Providence Island dunes containing the fossil land snail, *Cerion*.

Another ecological factor besides habitat which is important for the diverse speciation of *Cerion* is dispersion or transportation from one island to another by the sea. Hurricanes may have swept the land snails to sea where they would be carried by marine currents to another island. Bartsch (1946) found that species of *Cerion* can stand complete submergence for 41½ days in salt water and survive. Also young shells attached to dead leaves may likewise have been picked up by the hurricane's powerful winds and carried to another island.

Marine fossils although rare were found with the nonmarine fauna in the New Providence Dunes. These mollusks may have been carried to the higher dunes from lower levels by wind, waves, birds or even crabs. The following is a list of the marine fauna found in the dune bioturbite layers.

*Livona pica*  
*Cerithium sp.*  
*Natica canrena*  
*Olivella sp.*  
*Arca zebra*  
*Spondylus ictericus*  
*Ostrea sp.*

#### REFERENCES CITED

- Bartsch, P. 1946. The operculate land mollusks of the family Annulariidae of the island of Hispaniola and the Bahamian Archipelago: in Bull. 192 of the Smithsonian Institution, Washington, D.C., U.S. Government Printing Office, 263 pp.
- Burch, T. B. 1962. How to know the eastern land snails, Dubuque, Iowa, W.L. Brown Co., 214 pp.
- Dall, W.H. 1905. Fossils of the Bahama Islands: In Shattuck, G.B., The Bahama Islands: New York, pp. 23-47.
- Newell, N.P., and Imbrie, J. 1955. Biological reconnaissance in the Bimini area: Great Bahama Bank, New York Acad. Sci. Trans. (2), 18: (1): 3-14.
- Purdy, E.G., and Imbrie, J.I. 1964. Carbonate sediments, Great Bahama Bank; Field trip guidebook for field trip No. 2: Geol. Soc. America, pp. 1-58.
- Richards, H.G. 1938. Marine Pleistocene of Florida, Bull. G.S.A. 49: 1267-1296.
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## HOW TO DISTINGUISH BETWEEN LIMOPSIS AND GLYCYMERIS

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The misidentification of *Limopsis* for *Glycymeris*, or considerably less so the other way around, is much too common. Deeper dredging, because of better equipment, means that more specimens of *Limopsis* are being collected, and this is compounding the problem.

Part of the difficulty stems from the fact that in our eagerness to classify species, we pay too much attention to the variable morphologic characters that may define the species but too little attention to the much more constant or consistent morphologic characters that define the pelecypod family or genus. Obviously one must first have his specimens allocated to the correct pelecypod family and genus before he can identify the species. The remainder of this note, then, is a discussion of the consistent morphologic characters that distinguish the difference between *Limopsis* and *Glycymeris*.

*Glycymeris* has a much greater size range than does *Limopsis*. An exceedingly large limopsid will attain a height or length of at least 70 mm., but this is indeed exceptional, and most limopsid species do not attain half this size. On the other hand, several species of *Glycymeris* attain a height or length of more than 100 mm., and many species reach the maximum size of any *Limopsis*. Any large robust shell is almost certainly a glycymeridid, and so our difficulty occurs with those specimens commonly less than 40 mm. in height or length.

Do your specimens have a solid reddish-brown color or splotches or zig-zag patterns of reddish brown? If so, they are certainly *Glycymeris*. A purple color occurs uncommonly amongst the glycymeridids and some species are devoid of color. On the other hand, *Limopsis* never has a color pattern; almost all species are colorless, but an occasional species will have a purplish, lavender, or pinkish tint on the inside margins of the valves. The lack of color amongst most of the limopsids may be linked with the geographic distribution of the family, which is best represented in cold or deep water, whereas the colorful glycymeridids are most

common in warm shallow waters and are never found in the polar regions or in the abyssal zone. Thus, only the drab or colorless shells should cause much difficulty in their proper allocation.

The morphologic character most consistently pointed out in differentiating *Limopsis* from *Glycymeris* is the presence of a triangular ligamental pit under the beak in the former genus and its absence in the latter genus. This is the most reliable single criterion for separating the two genera. However, a very few large limopsids have this pit so poorly developed that it is barely apparent. Another aid in identification is that the ligament of *Glycymeris* is arranged in chevron-shaped grooves, but this is not true for all of them. *Limopsis* never has the ligament lodged in chevron-shaped grooves.

All living glycymeridid species and almost all fossil species have well developed denticulations on the interior margins of the valves. Most limopsids have smooth interior margins and when denticulations are present they are small and commonly found on only a limited part of the interior margins of the shell. However, there are a few exceptional limopsids that do have moderately well developed denticulations along the inner margins of the shell.

Nearly all glycymeridids have some form of radial ornamentation as either well developed ribs or striations or both. Relatively few limopsids have radial ribs or riblets. If your specimens have no trace of radial sculpture, you almost certainly have a species of limopsid.

Let us now summarize these observations so that one can identify his specimens quickly.

1. Shell is more than 60 mm. in height or length: Almost certainly *Glycymeris*. 2. Splotches of color or color pattern: *Glycymeris*. 3. Triangular ligamental pit under the beaks: *Limopsis*. 4. Ligament arranged in chevron-shaped grooves: *Glycymeris*. 5. Denticulations well developed along anterior, ventral, and posterior margins of the inside of the valves: Almost certainly *Glycymeris*. 6. No indication of any radial ornamentation on the outside of the valves: almost certainly *Limopsis*.

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## CASSIS MADAGASCARIENSIS AND C. M. SPINELLA OFFSHORE AT BEAUFORT, NORTH CAROLINA

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According to Abbott (1954. "American Seashells", pp. 193-194), the Caribbean species *Cassis madagascariensis* Lamarck 1822 is replaced in the Florida Keys by the form *spinella* Clench 1944, which is reported to occur also "off Beaufort, North Carolina (fossil?)." Although the helmet shell, previously called *Cassis cameo* Stimpson, has long been known in the state (see for example Dall, 1889. Bulletin of the U.S. National Museum, No. 37, p. 134), Porter (1965. Nautilus 78 (3): 106) only recently confirmed an extant population of *C. m. spinella* off the coast of North Carolina. On September 27, 1966, I collected two live helmet shells from the deck of a trawler loaded with calico scallops, which had been caught some 25 to 30 miles south of Beaufort Inlet in about 90 feet of water. The two helmet shells, catalogued in my personal collection as numbers 1070 and 1071, corresponded clearly to Abbott's descriptions of *C. m. spinella* Clench and *C. madagascariensis* Lamarck, respectively. The two forms, which are represented in my collection also by specimens obtained from the beaches near Cape Lookout, N. C., are readily distinguished. Both have 3 rows of tubercles on the body whorl, but in *C. madagascariensis* Lamarck, the spines are larger and fewer in number, and the size of the topmost spine in the first row of tubercles is exaggerated. In *C. madagascariensis*, the white teeth on the outer lip extend from one-third to one-half the width of the lip and the spaces between the teeth are colored deep brown, whereas in *spinella* Clench the teeth are more restricted to the inner edge of the outer lip and are usually only tinged with brown. The species proper has a generally more massive shell than does *spinella* Clench. Data for the two specimens reported above are shown in the following table:

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<sup>1</sup> The Radiobiological Laboratory is supported through a cooperative agreement between the U.S. Fish and Wildlife Service and the U.S. Atomic Energy Commission.

	#1070 C. m. <i>spinella</i>	#1071 C. <i>madagascariensis</i>
Length, mm.	187	137
Width, mm.	141	106
Number of whorls	9	9
Number of spines in first tubercular row of body whorl	16	10
Number of teeth on outer lip	9	11
Operculum length, mm.	50	35
Operculum width, mm.	6.4	6.7

The presence of *C. m. spinella* Clench off the North Carolina coast is hereby substantiated, and the previously reported range for *C. madagascariensis* Lamarck must be extended northward to include a probable population living offshore near Cape Lookout, N.C. These records, coupled with the report of Warmke and Abbott (1961. "Caribbean Seashells", p. 99) that *C. m. spinella* is found off Puerto Rico, suggest that the two forms of helmet shell occur together over a broad range, extending from North Carolina into the West Indies, as proposed earlier for the species by Dall.—

## RADULAE OF TWO SPECIES OF PLEUROPLOCA (FASCIOLARIIDAE) FROM THE INDO-PACIFIC<sup>1</sup>

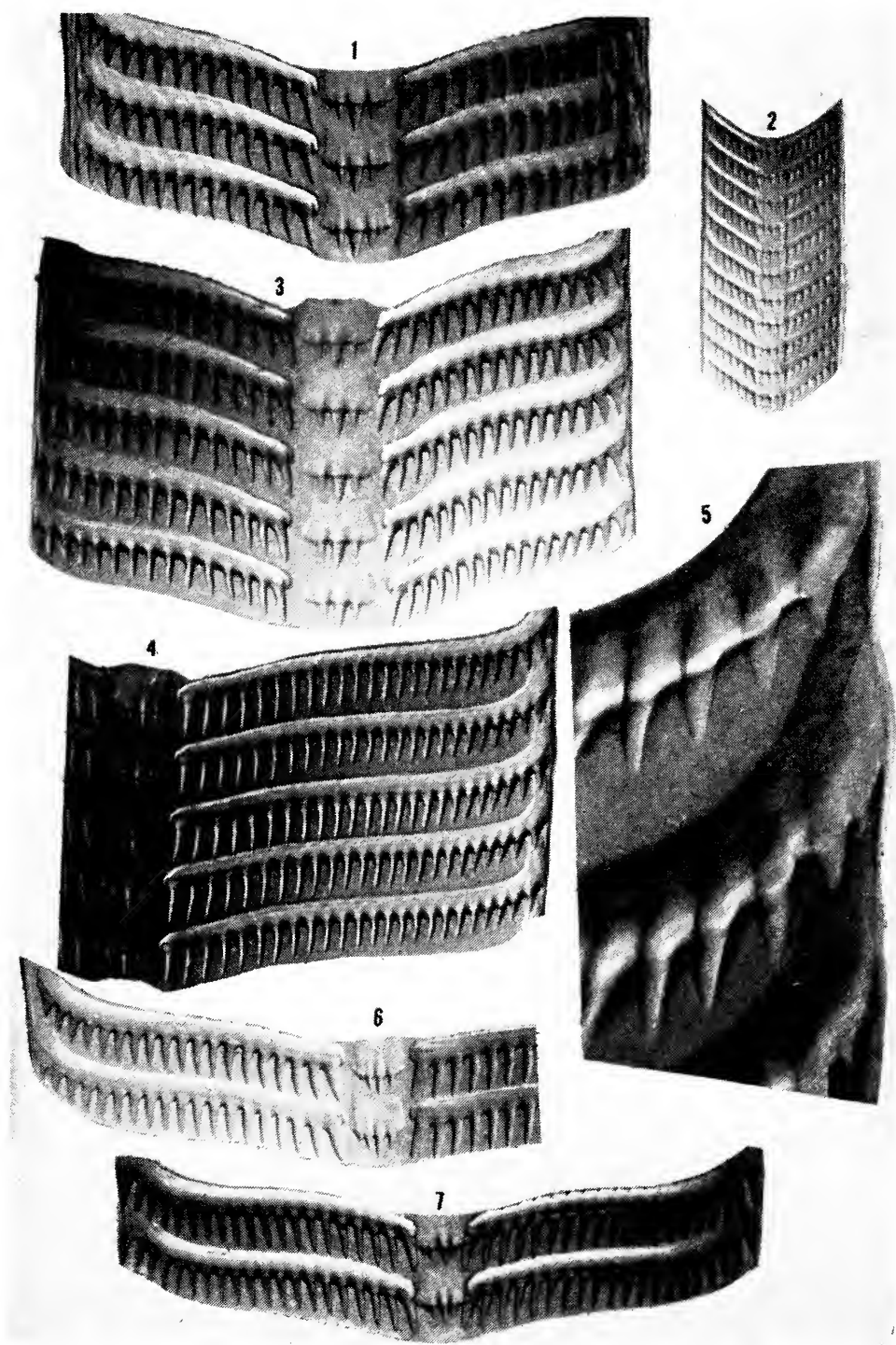
By VIRGINIA ORR MAES

Academy of Natural Sciences of Philadelphia

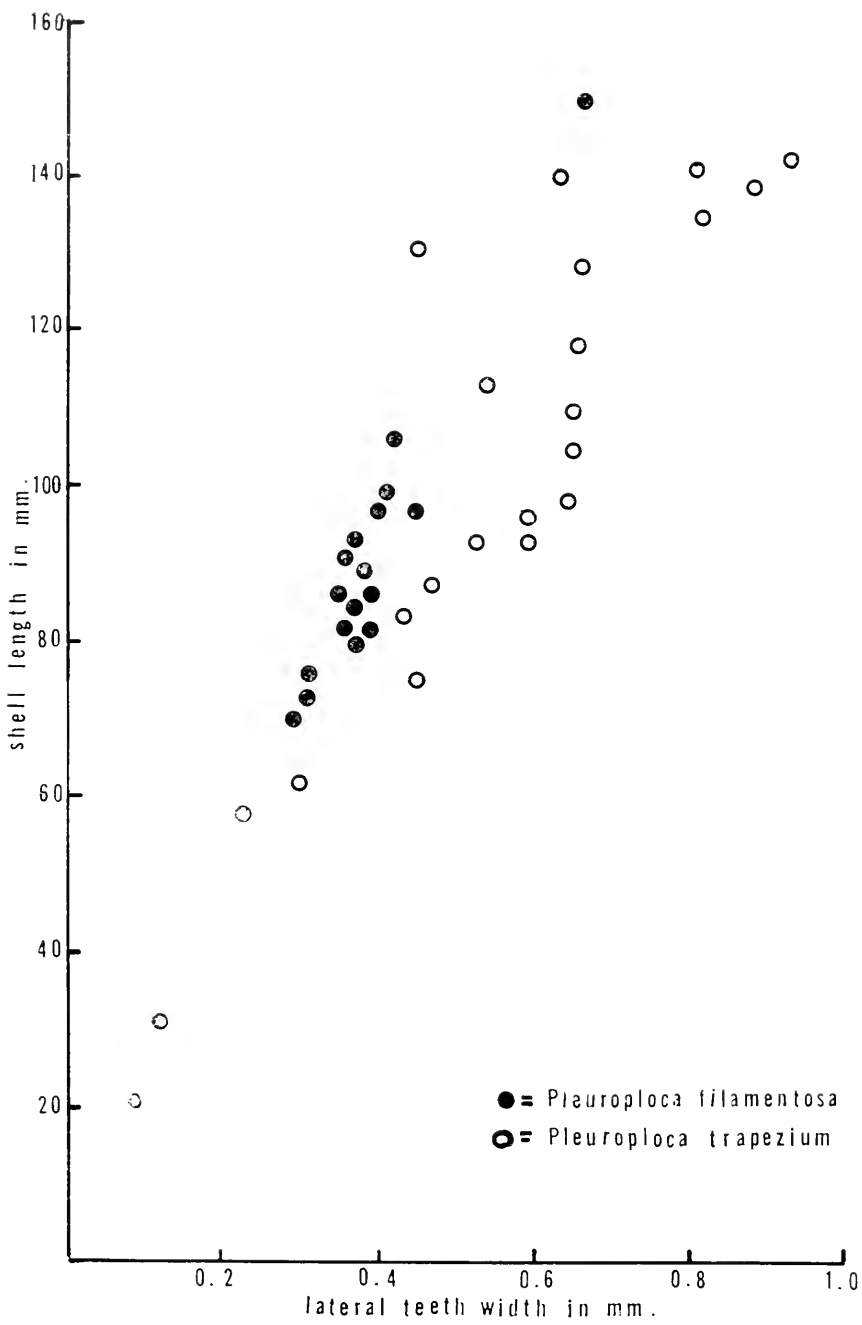
Two species of the genus *Pleuroploca* Fischer, 1884, common to many Indo-Pacific reefs are *P. trapezium* (Linné, 1758) and *P. filamentosa* (Röding, 1798). *Pleuroploca trapezium*, type of the genus (by monotypy), is found from East Africa through the Indian and Pacific Oceans to Japan, the Philippines, New Guinea,

<sup>1</sup> This study is based on material collected at Mahé, Seychelle Islands, by Mrs. R. E. M. Ostheimer and Dr. M. S. Buerk. Comparative material came from East Africa, Madagascar, and New Caledonia. It is in the collection of the Academy of Natural Sciences of Philadelphia.





Radulae of *Pleuroploca filamentosa* and *P. trapezium*; all to scale except fig. 5.



Scatter diagram of the ratio of the length of the shell to the width of the lateral radular teeth of *Pleuroploca filamentosa* and *P. trapezium*.

and the Solomon Islands. *Pleuroploca filamentosa* has a slightly wider range throughout the Indian Ocean and east through the Pacific to Samoa.

Widely sympatric, the two species are not usually found together. The larger angular—whorled *Pleuroploca trapezium*, often over 200 mm. in length, prefers a mud, sand, and weed microhabitat such as a *Thalassia* flat, while the smaller, round—whorled *P. filamentosa*, seldom over 170 mm., is found more frequently on a substrate of clean sand and coral blocks of the more open reefs. However, in New Caledonia, where *Pleuroploca trapezium* does not occur, *P. filamentosa* is found frequently on *Thalassia* flats as well as open reefs (personal observation). This suggests the habitat differences are caused by competition, not preference.

Little is known of the feeding habits of the two species. We have no feeding records of *P. trapezium* but *P. filamentosa* has fed on *Murex* and *Calliostoma* (in New Caledonia, Risbec, 1932, p. 375), and on *Drupa* (in Ceylon; Robertson, personal communication). However, both probably are similar to the Western Atlantic Fasciariidae. The latter prey primarily on fairly large gastropods but also devour worms, some clams and even carrion (Paine, 1963, p. 67). As is interesting to note, the larger western Atlantic *Fasciolaria tulipa* frequently feeds on its slightly smaller relative *F. hunteria*. Even if the larger of the Indo-Pacific species does not feed on the smaller, they probably compete for food. The present study shows that the larger, *Pleuroploca trapezium* has a proportionately wider radula which should favor it even when competing with *P. filamentosa* of equal size.

*Pleuroploca* species overpower their prey with their foot, wrenching or rasping aside opercula or wedging pelecypod valves open with their shell edge. They are incapable of boring hard shell and use their radulae only to tear or rasp relatively soft tissue which is scraped loose and transported into the mouth with an upward stroke of the ribbon (Gunter, 1936, p. 363, observing *P. gigantea*).

If the action of this radula is compared to that of a garden rake, the advantage of increasing the number of cusps as the teeth widen becomes obvious. Neither the width of the tines nor the spaces between them may be increased without impairing the rake's efficiency, but a wide rake with many tines loosens and

transports more material than a narrow one. Paine (1963 b, p. 403) calculated that the closely related Western Atlantic *Fasciolaria* consumes 3% of its own volume per day. It must, therefore, procure more food in the same amount of time as the size of the animal increases. In the fresh-water snail, *Lymnaea stagnalis*, Hubendick (1957, p. 521) found the larger individuals fed with fewer radula strokes per minute. If this applies to the Indo-Pacific *Pleuroploca*, an increase in size of the radula is imperative to offset the greater demand for food and slower rate of feeding as the snails grow.

	shell length	width of lateral	number of cusps	examples
filamentosa	21 - 40	0.09 - 0.13	7 - 9	2
	57	0.22 - 0.23	12	1
	61 - 80	0.29 - 0.32	13 - 14	3
	81 - 100	0.35 - 0.46	13 - 17	12
	106	0.42 - 0.43	17	1
	150	0.64 - 0.68	21	1
trapezium	61 - 80	0.30 - 0.45	16 - 22	3
	81 - 100	0.44 - 0.65	19 - 25	6
	101 - 120	0.54 - 0.67	18 - 25	4
	121 - 140	0.45 - 0.88	18 - 30	5
	141 - 144	0.81 - 0.84	27 - 28	2

Table 1. Comparison of shell length, size, and numbers of radula teeth in two species of *Pleuroploca*. All measurements are in mm. Radulae are measured near the posterior, formative end of the ribbon.

The radulae of *Pleuroploca filamentosa* and *P. trapezium* are rather similar, consisting of over 200 rows of narrow, peg-cusped median teeth flanked by wide, strongly-cusped laterals (Page 49). Commonly there are 3 cusps on the central teeth of both species but variants have up to 5. *Pleuroploca filamentosa* has a slightly wider and more heavily-cusped central tooth than *P. trapezium*. The number of cusps on the lateral teeth varies with the size of the individual. This is summarized in the table below. Although *P. filamentosa* has a larger median, the broad lateral teeth of *P. trapezium* give that species a much wider radula in proportion to

its size. This is illustrated by figs. 3 and 4, which shows part of the ribbon of each species from shells of approximately the same size and also by the scattered diagram (page 50).

Variation in the numbers of cusps on lateral teeth of the same width is also noted. This is due in part to the age of the animal. For example, a young male *Pleuroploca trapezium* with an undeveloped penis and a clean, thin-lipped, rapidly growing shell 85 mm. in length had lateral teeth 0.44 mm. wide with 19 cusps. Two smaller but older males with fully-developed penes and corroded, solid-lipped shells 80 and 75 mm. long had lateral teeth 0.42 and 0.45 mm. wide, respectively. Both of the latter, mature animals, have 21 cusps throughout much of the ribbon (Figs. 6 & 7).

Usually there are one or two more cusps on the laterals of the formative, posterior part of a radula than on the older, anterior portion, although new cusps may become "lost" for several rows while becoming established. Cusps are added singly to the outer edge of each lateral in intervals of from 2 to over 100 transverse rows and may or may not be added simultaneously to both laterals of a single row (Fig. 5). Some asymmetric radulae have 2 or 3 more cusps throughout one side of a ribbon (Fig. 3).

The production of additional cusps poses a physiological question. If the same odontoblasts produce the lateral teeth throughout the life of the animal, as stated by Runham (1963, p. 271) what induces them to increase the number of cusps?

Unlike their Western Atlantic relative, *Pleuroploca gigantea*, whose central tooth tends to become monocuspid with age (Hollister, 1954, p. 46) there seems to be no variation in cusping of the central tooth with either age or size of the Indo-Pacific species. Nor are there any signs of sexual dimorphism, found in some muricid genera, such as the adding of extra lateral cusps or the thickening of the bases of the teeth (Arakawa, 1958, p. 212 and Maes, 1966, p. 73). Although we found the shells of females of both species are larger than the males (mean lengths 124, 102 and 119, 88 mm. for *Pleuroploca trapezium* and *P. filamentosa* respectively) the apparently broader female radula is correlated with size not sex. The dimorphism disappeared when a ratio of shell length to tooth width was made.

It is, therefore, probably that a necessary increase in feeding capacity has been the cause of the increase in breadth and cusping

of the radula with shell size. But the mechanics of the production of the additional cusps remains an intriguing puzzle.

#### LITERATURE CITED

- Arakawa, Kohman Y., 1958. On the remarkable sexual dimorphism of the radula of *Drupella*. *Venus* 19 (3-4) : 206-216, pl. 6.
- Gunter, G., 1936. Radular movement in Gastropods. *Jour. Wash. Acad. Sci.* 26 (9) : 361-365.
- Hollister, S C., 1954. Some notes on the radula. *Nautilus* 68 (2) : 44-46.
- Hubendick, B., 1957. The eating function in *Lymnaea stagnalis* (L.). *Arkiv Zool. ser. 2*, 10 (15) : 511-521.
- Maes, V. O., 1966. Sexual dimorphism in the radula of the muricid genus *Nassa*. *Nautilus* 79 (3) : 73.
- Paine, R. T., 1963. Trophic relationships of 8 sympatric predatory gastropods. *Ecology* 44: 63-73.
- Paine, R. T., 1963b. Feeding rate of a predaceous gastropod, *Pleuroploca gigantea*. *Ecology* 44: 402-403.
- Risbec, J., 1932. Note sur les mœurs de *Ricinula chaidea* Ducl. et de *Fasciolaria filamentosa*. *Bull. Soc. Zool. Fr.* 57: 374-375.
- Runham, N. W., 1963. A study of the replacement mechanism of the pulmonate radula. *Quart. Jour. Micro. Sci.* 104 (2) : 271-277.
- Explanation of radular figures 1 to 7. 1) *Pleuroploca filamentosa*, female, from shell 91.5 mm., lateral tooth .36 mm., 14 cusps. 2) *P. filamentosa*, young, from shell 21.4 mm., lateral tooth .09 mm., 8 cusps. 3) *P. filamentosa*, male, from shell 94.0 mm., assymetric teeth both .37 mm., 14 and 16 cusps. 4) *P. trapezium*, male, from shell 93.5 mm., lateral tooth .52 mm., 24 cusps. 5) Same radula as above enlarged showing addition of cusp. 6) *P. trapezium*, juvenile male, from shell 84.9 mm., lateral tooth .44 mm., 19 cusps. 7) *P. trapezium*, adult male, from shell 80.0 mm., lateral tooth. .42 mm., 20 cusps.

## TWO NEW SONORELLA FROM RINCON MOUNTAINS OF ARIZONA

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In an attempt to obtain topotypes of *Sonorella rinconensis* Pilsbry and Ferriss, whose type locality is "Rincon Peak, above 7500 ft.", I undertook a three-day back-pack trip to Rincon Peak during the Easter holidays, April 16-18, 1965, accompanied by my son, W. Nixon Miller, and his friend, Marshall Bulle. The region above 7500 ft. is relatively small in area, narrowing down to the cone-shaped peak, whose granite summit is at 8482 ft. Snails were

found only in a gigantic rockslide on the northeast side of the peak-rock, in the fir zone; they were an *odorata*-like species, which turned out to be an interesting new species, described below. Still looking for *rinconensis*, we then investigated a promising, large canyon, about one mile north-northwest of the peak at an elevation of about 6000 ft. There, we collected several fine specimens of large shells which certainly looked like *rinconensis*. On dissection, however, they revealed an anatomy related to *sabinoensis*, with genitalia of different proportions; they belong to a new species described below. No *rinconensis* were collected on that trip; I have collected it, at other times, in Posta Quemada Canyon, on the southwest flank of Rincon Peak/Wrong Mt., at a much lower elevation of about 3700 ft.

**SONORELLA BAGNARAI new species.** Page 59, figs. A-E.

*Description:* Shell depressed, heliciform, thin, glossy, light greenish-tan, with chestnut-brown spiral band on the well-rounded shoulder; umbilicate, the umbilicus contained about 8 times in the diameter. Embryonic shell of about  $1\frac{1}{2}$  whorls; the first  $\frac{1}{4}$  whorl, including apex, with radial striae only; over the second  $\frac{1}{4}$  whorl, the radial striae break up into raised, hyphen-like papillae; over the remainder of the embryonic shell, the raised papillae anastomose into a reticulate, granular pattern on the upper portion, and into fine, nearly parallel, ascending and descending, spiral threads on the portion near the lower suture. Subsequent whorls are radially striate and microscopically wrinkle-granulose, up to the body whorl. Body whorl has growth striae only, covered by silky-lustrous periostracum; suture descending moderately to the slightly expanded peristome. Aperture oblique, oval, wider than high; parietal callus thin.

*Holotype measurements:* Height 11.0 mm.; max. diam. 20.8 mm.; umbilicus 2.6 mm.; whorls  $4\frac{1}{4}$ .

Genitalia of holotype (Page 60, figs. A, C): The short, muscular penis contains a very short, cylindrical verge of about  $\frac{1}{2}$  the length of the penis; the penial sheath encloses the entire penis and overlaps part of the proximal epiphallus. Epiphallus nearly twice as long as the penis, thin; epiphallic caecum vestigial, not detached from epiphallus; vas deferens thicker than epiphallus. The vagina is about  $1\frac{1}{2}$  times as long as the penis; free oviduct

about as long as vagina. Base of penis and vagina unusually wide and muscular.

Measurement of genitalia, in mm.	Holotype	Paratype A
Penis	3.0	2.5
Verge	1.5	1.5
Penial sheath	4.0	3.5
Epiphallus	5.0	6.0
Vagina	4.5	4.5
Free oviduct	5.0	4.0

*Type locality*: Rincon Peak, Rincon Mts., Pima Co., Arizona, in large, granite rockslide on NE side and immediately below summit of the peak at 8000 to 8200 ft. elevation. (W.N. Miller, Marshall Bulle, and W.B. Miller, 17 April 1965). Holotype ANSP. (312760). Paratypes in collection of ANSP. (312761), Dept. of Biological Sciences, University of Arizona (2821), and the author (4768).

The shells are remarkably uniform in size, shape, and color, the smallest paratype measuring 19.5 mm. and the largest 21.1 mm. in diameter. Some paratypes show a few spiral grooves on the body whorl next to the suture. By shell characteristics, *S. bagnarai* appears to belong to the group of *S. clappi* P. & F., being most closely related to *S. odorata* P. & F. Its ecology is similar to that of *odorata* in that it lives at high elevation, in the Canadian Life Zone, among rocks heavily strewn with humus and fallen logs of Douglas fir. It can be separated from *odorata* in that the body whorl has no granulose sculpture, the spiral grooves, if present at all, are very few, and the aperture is more elongate-oval. It is in the anatomy of the animal, however, that *bagnarai* is most unique. The mantle is strongly pigmented with large spots of dark-grey to black pigment (Page 59, figs. D, E); this characteristic has been observed in only one other *Sonorella*, *S. greggi* W.B. Miller, which lives in Sonora. The mucus on the mantle collar and along the sole is orange. The genitalia are most closely similar to those of *S. fragilis* Pils., which was placed by Pilsbry in a special subgenus, *Myotophallus*, characterized by a short, muscular, verge-less penis. *S. bagnarai*, however, does possess a distinct, thick, albeit very short, verge. Page 60, figs. A, B, C, and D are comparative drawings of the lower genitalia of *S. bagnarai* and *S. odorata*.



Ferriss collected a form of *S. odorata* from Spud Rock on Mica Mt. and from the "Northern slopes of the Rincons," which Pilsbry described as the form *populna*. Pilsbry indicates that the genitalia dimensions and proportions are much as in *odorata* s.s. and differentiates *populna* by the thinner shell, color differences, and wider body whorl. Mica Mt. and Rincon Peak are separated by a long, low saddle, Happy Valley Saddle, which is barely high enough to enter the lower levels of the Transition Zone. The presence of *odorata* in the Rincon Mts., along with the similarity of its shell characters with *bagnarai*, strongly suggest that *bagnarai* originated as an isolated population of *odorata* which became separated from the larger *odorata* gene pool on Mica Mt. when Happy Valley Saddle became drier, some time after the last Ice Age, and conditions changed there from Canadian to Transition. The population probably underwent rapid differentiation by genetic drift brought about by its relatively small size. In cases where a population is already kept small by the confines of the habitat, any occasional natural catastrophe, such as prolonged drought, might bring the level of the population to near extinction. This, in turn, would favor genetic homozygosity which probably would further reinforce the process of genetic drift. Convergence in the genitalia toward the morphology of *Myotophallus* is considered to be only a phenotypic expression of the segregated genes which were probably present, but masked, in the ancestral *Sonorella*. Gene expression for a thickened penis base also occurs, somewhat less extremely, in *S. walkeri* P.&F., *S. huachucana* Pils. and its subspecies, *S. sabinoensis dispar* Pils., and *S. sabinoensis tucsonica* P.&F.

This species is named after Dr. J. T. Bagnara, eminent zoologist at the University of Arizona, who has given me considerable assistance and encouragement, and with whom I have enjoyed numerous collecting trips.

**SONORELLA BEQUAERTI new species.** Page 9, figs. G-1.

*Description:* Shell depressed-globose, heliciform, thin, glossy, light brown, with chestnut-brown spiral band on the well-rounded shoulder; umbilicate, the umbilicus contained about 9 to 10 times in the diameter, partially covered by the reflected columellar lip. Embryonic shell of about 1 1/2 whorls; its apex silky-wrinkled, followed by radial striae only, for the first half-whorl; remainder

of embryonic shell with hyphen-like papillae which anastomose into a reticulate pattern over the upper part of the whorl and into the *hachitana* pattern of nearly parallel, descending and ascending, spiral striae on the region near the lower suture. Post-embryonic whorls with raised papillae superimposed over growth striae, the papillae numerous at first, sparse later, and absent on body whorl. Body whorl has growth striae and fine, spiral, incised lines along entire whorl, most prominent along the suture; suture descends sharply to the well-expanded peristome; periostracum with silky luster. Aperture large, oblique, rounded, about as wide as high; parietal callus thin.

*Holotype measurements*: Height 15.3 mm.; max. diam. 26.2 mm.; umbilicus 2.8 mm.; whorls 5.

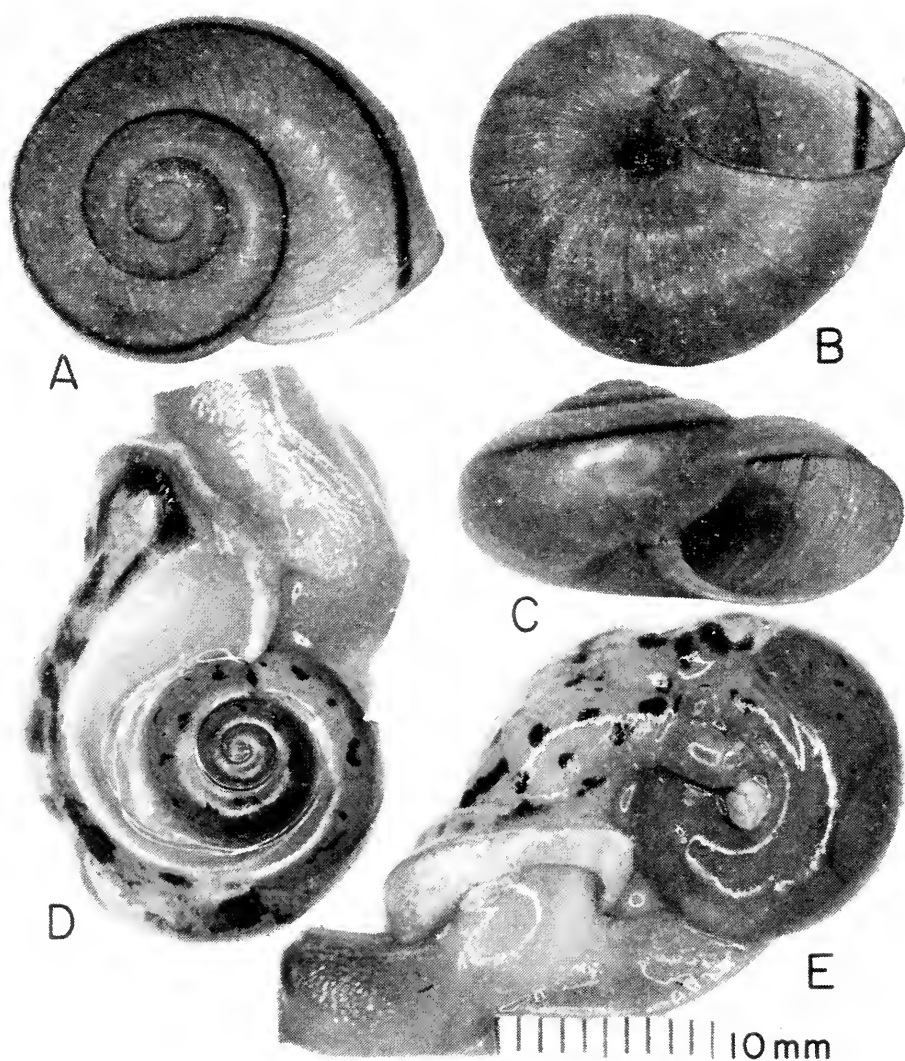
Genitalia of holotype (Page 60, figs. E, F): The short, narrow penis contains a thin, slightly annulated verge, measuring about  $\frac{2}{3}$  the length of the penis, and tapering gradually to a thin point; seminal duct opens subterminally; penial sheath short, about  $\frac{1}{3}$  the length of the penis. Epiphallus about as long as the penis; epiphallic caecum small. Vas deferens thicker than epiphallus. The vagina is twice as long as the penis; free oviduct about  $\frac{1}{3}$  the length of the vagina.

Measurements of  
genitalia, in mm.

	Holotype	Paratype B	Chimenea Can.
Penis	6.0	6.5	6.0
Verge	4.5	4.5	3.5
Penial sheath	2.5	2.5	2.5
Epiphallus	6.0	6.0	6.0
Epiphallic caecum	0.7	0.5	0.5
Vagina	13.0	11.5	12.0
Free oviduct	4.5	3.5	3.5

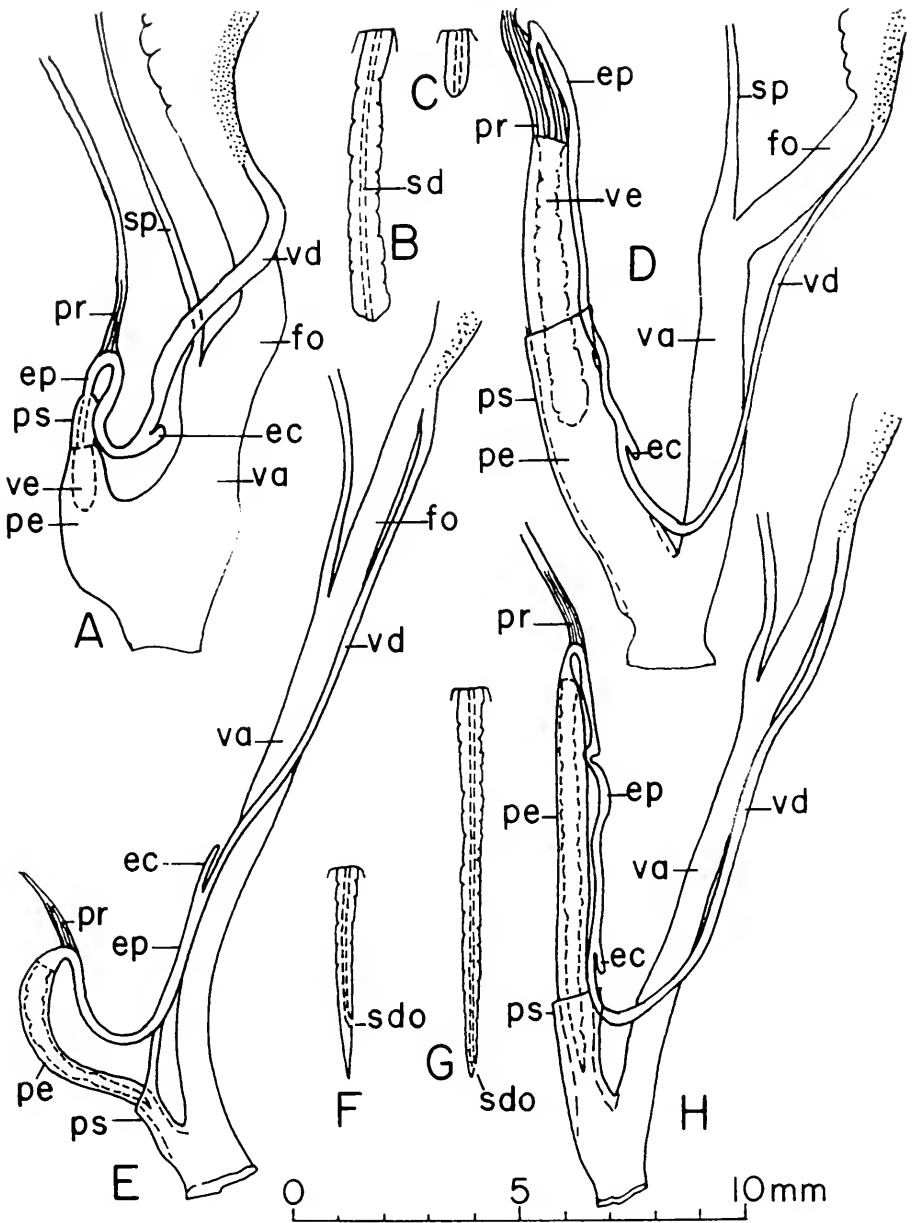
*Type locality*: Rincon Peak, Rincon Mts., Pima Co., Arizona, in granite rocks along cliffs in canyon which runs NW. from Rincon Peak and just W of the Rincon Peak, Happy Valley Saddle trail, at elev., ca. 6000 to 6100 ft. (W.N. Miller, Marshall Bulle, and W.B. Miller, 18 April 1965). Holotype ANSP. (312762). Paratypes in the collections of the Dept of Biological Sciences, University of Arizona (2818), and the author (4769).

Other localities: Chimenea Canyon, Tanque Verde Mts., Pima Co., Arizona, about  $\frac{1}{2}$  mi. above Madrona Ranger Station; elev. ca. 4000 ft. (M.L. Walton and J.C. Bequaert, 3 April 1965).



Holotype, *Sonorella bagnarai* W.B. Miller. A-C, shell; D-E, animal, showing pigment spots on mantle.

The type lot consists of 8 adult shells, of which 4 were alive and dissected. The largest shells are the holotype and 2 others, with a maximum diameter of 26.2 mm.; the smallest paratype measures 22.6 mm. The single live adult from Chimenea Canyon measures 23.6 mm. By shell characteristics, *S. bequaerti* is not distinguishable from *S. sabinoensis* P.&F., *S. marmorarius* P.&F., or *S. rinconensis* P.&F. The large variability, in shell size and shape, of the *sabinoensis* complex easily encompasses the variations *marmorarius*, *rinconensis*, and *bequaerti*. The apical sculpture is



Lower genitalia. A. *S. bagnarai* W.B. Miller, holotype. B. Verge of *S. odorata* P.&F. C. Verge of *S. bagnarai*. D. *S. odorata*. E. *S. bequaerti* W.B. Miller, holotype. F. Verge of *S. bequaerti*, holotype. G. Verge of *S. sabinoensis* P.&F., topotype 4847. H. *S. sabinoensis*, topotype 4847. Legend as after figs. on page 4. (Correction: 3rd line from bottom should be last.)

similar for all, being of the *hachitana* type. It is in the morphology of the genitalia that *bequaerti* can easily be distinguished. Its penis is much shorter and thinner than that of *sabinoensis* and *marmorarius*; in typical *sabinoensis* and *marmorarius* the penis meas-

ures from 10.0 mm. to 15.0 mm. whereas in *bequaerti* the penis varies from 6.0 mm. to 7.5 mm. Also, in *bequaerti*, the vagina is twice as long as the penis, whereas in *sabinoensis* and *marmorarius*, it is as long or shorter than the penis.

*S. bequaerti* inhabits the middle and lower slopes of the south-east side of the Tanque Verde Mts. and the west side of the Rincon Mts.; the other slopes of these mountains have not been explored for *bequaerti*. It is apparently sympatric with *S. rinconensis* P.&F., whose enormously large genitalia easily separate it from *bequaerti*, but the two have not been found in the same rockslides. It is not sympatric with *S. bagnarai* W.B. Miller, which inhabits the highest Douglas fir forest on Rincon Peak.

In phylogeny, it is probable that *bequaerti* evolved from a common ancestor with *sabinoensis*, *marmorarius*, *galiurensis*, and *tortillita*, all of them in close geographical proximity. It evolved in the direction of a small, thin penis and verge, while all other species of this group maintained or developed a relatively long penis and verge, being longest in *tortillita*.

This species is named after Dr. Joseph C. Bequaert, life-long malacologist and entomologist, who has provided inspiration and encouragement in the search for *Sonorella*, and with whom I have enjoyed numerous collecting trips.

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## MOLLUSKS OF THE OUTER BANKS, N. C.

BY DOROTHY E. BEETLE

Peninsula Junior Nature Museum & Planetarium, Newport News, Va.

The Outer Banks of North Carolina are a chain of lenticular sand bars and islands which protect the coast and stretch seaward in a great V as far as 30 miles off shore. An idealized profile of the islands from the Atlantic Ocean to the Sound shows beach, the first barrier dune, an interval and the secondary dune. Interior sand flats, some with small fresh water ponds and creeks, a wooded dune facing the Sound and marsh land reaching beyond it to the water complete the profile. High sand dunes add some elevation to the islands, which are otherwise but a few feet above sea level. Jockey Hill on Nag's Head is the highest dune and has an elevation of 138 feet.

Three major habitats are found throughout the area: the dunes, the sand flats and the marshes. Live dunes, still moving with the

wind, have plant communities pioneered by sparse stands of salt-meadow cordgrass and sandbur. More stable dunes are noted for their covering of sea oats, a distinctive and handsome grass, as well as other grasses and herbs.

The wooded dunes occupy the only high land on the islands. Common trees in this maritime forest are live oak, red cedar, wax myrtle, yaupon, American holly, red bay, lollolly pine, water and willow oaks. Palmetto reaches its northernmost distribution on Baldhead Island. Wooded areas are not extensive in any locality. Of interest around Nag's Head are some trees characteristic of upland forests much farther inland.

Between the barrier and secondary dunes the sand is nearly devoid of plants. The sand flats have a mixed shrub, grass and herb association. Yaupon, wax myrtle, saltmeadow cordgrass, sedges, rushes, composites and cactus are to be found here.

Salt marshes are of two kinds. The regularly flooded or low salt marsh is distributed mainly along the Outer Banks north to Oregon Inlet and along the coast from the South Carolina line to Beaufort. Smooth cordgrass is the dominant plant, occurring in vast pure stands. Differences in the height of the plant seem to be related to internal drainage and salinity rather than to genetic differences. A rise in elevation of a foot or more permits black needlerush, glasswort and sea lavender to enter the association.

The irregularly flooded salt marsh, reached by the spring and storm tides, is the most extensive coastal type. Saltmeadow cordgrass, salt grass and sea oxeye are typical of the area. Large stands occur on Roanoke Island, the sound side of the Outer Banks and on the mainland shore of Pamlico Sound. The water which floods them is usually of lower salinity than that of the regularly flooded marshes.

Small fresh-water marshes and ponds are scattered along the Outer Banks. Surprisingly fresh water wells up from the sands on tiny islands in the ocean, because extensive sand beds underlying the Sound carry fresh water. These beds were laid down, in the area now called the Atlantic Coastal Plain, during Cretaceous and Cenozoic time. The sand beds are flat, dipping gently seaward, and are probably thickest offshore. A well drilled at Cape Hatteras in 1946 went through 3,000 feet of Cenozoic and 6,800 feet of Cretaceous sands and clays.

Mollusks were found in fresh-water ponds near the Bodie Island and Cape Hatteras Lighthouses, Nag's Head and Ocracoke. They also occurred in the short creeks that rise just behind the barrier dunes and flow into the Sound.

In contrast to the varied and abundant fresh-water molluscan assemblage living on the coastal plain only one clam, *Sphaerium partumeium*, and two gastropods, *Lymnaea humilis* and *Gyraulus parvus*, appear to be present on the Outer Banks. Slightly brackish ponds have *Hydrobia minuta* and *Melampus bidentatus* present.

The large fresh-water pond at Bodie Island Lighthouse dries partially each summer, but is kept in existence by a dam. It is being filled by plant invasion and sand. The considerable amount of organic debris has resulted in a soft mucky bottom, a rarity on the Banks. A similar pond exists on Pawley's Island, S.C. and in the latter was found a population of *Helisoma duryi eudiscus* as well as *Melampus* and *Hydrobia*. *Euglandina rosea*, the carnivorous land snail of subtropical regions, has established itself on sand dunes in the vicinity of this pond.

Examination of the decaying vegetation lining the margins of fresh-water channels and ponds on the Outer Banks showed *Polygyra postelliana espiloca*, *Deroceras laeve*, *Succinea ovalis*, and *Vertigo ovata* occupying this habitat.

In the leaf litter under the shrubs and trees of the wooded dunes at Nag's Head, Buxton Woods at Cape Hatteras and areas on Ocracoke and Baldhead Island, the following snails were found: *Mesodon thyroides*, *Triodopsis albolabris*, *T. fallax*, *T. hopetonensis*, *Retinella* cf. *indentata*, *Ventridens cerinoideus*, *Anguispira alternata fergusonii*, *Philomycus caroliniensis*, *Succinea campestris*, *S. ovalis*, *S. wilsoni*, *Gastrocopta pellucida hordeacea* and *Pupoides albilabris*. Three species which are able to maintain themselves on the sand dunes in spite of the limited plant cover are *Triodopsis hopetonensis*, *Succinea campestris* and *Catinella pugilator*. Of interest is the establishment of the introduced species, *Helicella variabilis*, in lawns on Roanoke Island and around Morehead City.

A total of 17 land mollusks and 3 fresh-water mollusks was found on the Outer Banks. By comparison 39 land snails and 73 fresh-water species of snails and clams have been collected on the North Carolina Coastal Plain. Very probably the molluscan fauna

now living on the Banks, like the fauna and flora present, is a remnant of the previous total. This remnant represents a past distributional pattern as well as a survival ability to withstand the severe conditions of salt spray, drought, wind and sand.

During Miocene time the Atlantic Coastal Plain was submerged and the North Carolina coast ended at what is now called the Piedmont where the land rises several hundred feet in elevation. A gradual withdrawal of the sea and exposure of the coast occurred as the great ice sheets of the Pleistocene tied up water and lowered the sea level. Mollusks, in addition to other forms of life, advanced into the exposed land at this time. Later the range became discontinuous with the melting of the ice and subsequent rise in sea level.

The Outer Banks are unstable. At the present time their form is changing gradually as the result of longshore currents moving great quantities of sand from farther north and waves pounding on what were formerly shoals to the east. Currently the Banks are being moved closer to the coastline. Observation of the sand dunes shows that they invade and cover living forest in some places, while uncovering long buried trees, ancient forest graveyards, in others. This movement of the sand dunes and the changing land areas on the islands have had a limiting effect on their occupation by animal and plant species.

An examination of the ranges of mollusks found on the islands shows that two of the fresh-water species, *Sphaerium partumeium* and *Gyraulus parvus* are widely spread over the North American continent, as are 4 of the land gastropods, *Deroceras laeve*, *Succinea ovalis*, *Pupoides albilabris* and *Vertigo ovata*. The introduced species, *Helicella variabilis*, and the *Retinella* species, which was not positively identified, are not included in this total.

*Mesodon thyroides*, *Triodopsis albolabris* and *T. fallax* are widely found east of the Rocky Mountains. *Lymnaea humilis* appears to be confined to the southeastern United States east of the Appalachians.

Species restricted to the coastal plain are: *Polygyra postelliana espiloca*, *Triodopsis hopetonensis*, *Ventridens cerinoideus*, *Anguispira alternata fergusoni*, *Philomycus caroliniensis*, *Succinea campestris*, *S. wilsoni*, *Catinella pugilator* and *Gastrocopta pellucida hordeacea*.



Of the land and fresh-water species of the Outer Banks, 31.5% are widely spread over North America, 21% occur only east of the Rocky Mountains and 47.3% are restricted to the Atlantic Coastal Plain. None are endemic to the islands. Territorial limits of the 35 land species of the entire North Carolina coastal region are divided into almost identical percentages. Three species have been found, however, only on the coast of North Carolina.

#### LITERATURE CITED

- Brown, C. A. 1959. Vegetation of the Outer Banks of North Carolina. La. State University Press. Baton Rouge, pp. 179.  
Dawley, C. W. 1965. Checklist of fresh-water mollusks of North Carolina. *Sterkiana* 19: 35-39.  
Dunbar, C. O. 1964. Historical geology. John Wiley & Sons, Inc. 7th printing. pp. 319, 326 - 327, 353.  
Hubricht, L. 1961. Eight new species of land snails from the southern United States. *Nautilus* 75 (2): 60-64.  
Pilsbry, H. A. 1939 - 1948. Land Mollusca of North America (north of Mexico). Acad. Nat. Sci. Philadelphia. Monographs No. 3.  
Rehder, H. A. 1949. Some land and freshwater mollusks from the coastal region of Virginia and North and South Carolina. *Nautilus* 62 (4): 121-126.

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### SOME LAND SNAIL RECORDS FROM OKLAHOMA AND ARKANSAS

BY LESLIE HUBRICHT

During the spring of 1966 the author spent two weeks collecting land snails in eastern Oklahoma and western Arkansas. Some of the more important new records are listed here.

*Stenotrema labrosum* (Bland).

*Stenotrema abaddon* Branson, 1964, *Nautilus* 77: 103-104, fig. 1a-c.

*Stenotrema abaddon* is based on slightly immature specimens of *Stenotrema labrosum*, in which the lip is formed but the shell is thin and the umbilicus is covered but not filled in.

*Triodopsis lioderma* (Pilsbry).

*Polygyra indianorum lioderma* Pilsbry, 1902, *Proc. Acad. Nat. Sci. Philadelphia* p. 511.

*Mesodon*. It is most closely related to *Triodopsis divesta* (Gould). Philadelphia, Monographs 3, vol. 1, p. 741.

Specimens of this species collected on the Arkansas River bluff,

opposite Sand Springs, Tulsa Co., Oklahoma were dissected; and it was found to belong in the genus *Triodopsis* rather than in *Mesodon*. It is most closely related to *Triodopsis divesta* (Gould). Back in 1935 I collected this species on the bluffs along the Verdigris River, between Verdigris and Catoosa, Rogers Co., Oklahoma. I was not able to find it there on my recent trip.

*Haplotrema concavum* (Say).

Oklahoma: Mayes Co.: bluff below dam, Langley.

*Glyphyalinia wheatleyi* (Bland).

*Retinella zikmundi* Branson, 1964, Proc. Okla. Acad. Sci. 44: 27-29, Pl. 1, fig. 1-3.

Oklahoma: Cherokee County. Arkansas: Benton, Carroll, and Washington Counties.

*Glyphyalinia solida* (H.B.Baker).

Arkansas: Logan and Montgomery Counties.

*Paravitrea multidentata* (Binney).

Arkansas: Benton Co.: Sugar Creek bluff, 1 mile north of Avoca.

*Paravitrea petrophila* (Bland).

Oklahoma: Le Flore Co.: Rich Mtn., near base, 1.7 miles southeast of Page.

*Ventridens ligerus* (Say).

Oklahoma: Le Flore Co.: base of Short Mtn., below Kerr Dam.

*Helicodiscus notius notius* Hubricht.

Oklahoma: Creek, Delaware, Payne, and Tulsa Counties. Arkansas: Franklin County.

*Helicodiscus jacksoni* Hubricht.

Oklahoma: Le Flore and Tulsa Counties.

*Succinea indiana* Pilsbry.

Oklahoma: Muskogee and Sequoyah Counties.

*Succinea witteri* Shimek.

Oklahoma: Craig, Ottawa, Sequoyah, and Wagoner Counties.

Arkansas: Franklin, Sebastian, and Yell Counties.

*Catinella vermeta* (Say).

Oklahoma: Cherokee, Delaware, Le Flore, Muskogee, Ottawa, Sequoyah, and Wagoner Counties. Arkansas: Franklin, Madison, Washington, and Yell Counties.

In many of the specimens dissected the penial appendix was greatly reduced, and in some cases, completely wanting. Such specimens were found to contain numerous small nematode worms.

*Catinella wandae* Webb.

Arkansas: Polk Co.: Rich Mtn., Rich Mtn. Station.

*Strobilops aenea* Pilsbry.

Arkansas: Franklin, Madison, Washington, and Yell Counties.

*Carychium exile* H. C. Lea.

Oklahoma: Adair, Cherokee, Delaware, Le Flore, Mayes, and Sequoyah Counties. Arkansas: Benton, Conway, Polk, and Sharp Counties.

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### NOTES AND NEWS

UNIONID FAUNA OF CANNADAIGUA LAKE OUTLET, NEW YORK. —

While collecting mollusks in the Oswego River drainage system in central New York State, I discovered an area comparatively rich in fresh-water mussels (Unionidae) in the Canandaigua Lake outlet at Alloway, in Wayne County.

Unfortunately the waters of the stream are becoming increasingly polluted, and I would like to report the species found there before they become eradicated.

The species are listed in order of their abundance, from the commonest to the rarest, for the three major habitats encountered in the stream. *Ligumia recta* (Lamarck) and *Lasmigona compressa* (Lea) are represented by dead valves only.

I. On cobble and gravel bars in a current of 20-30 cm./sec.: *Elliptio complanata* (Solander), *Lasmigona costata* (Rafinesque), *Alasmidonta marginata* (Say), *Villosa iris* (Lea), *Strophitus undulatus* (Say), *Lampsilis radiata siliquoidea* (Barnes), *L. radiata radiata* (Gmelin), *Fusconaia flava* (Rafinesque).

II. Along banks on silty bottom in a current of 0-20 cm./sec.: *Lampsilis ovata ventricosa* (Barnes), *Fusconaia flava* (Rafinesque), *Elliptio complanata* (Solander), *Anodonta grandis* (Say), *Lampsilis radiata siliquoidea* (Barnes), *L. radiata radiata* (Gmelin), *Strophitus undulatus* (Say).

III. In quiet pools: *Anodonta grandis* (Say), *Elliptio complanata* (Solander), *Lasmigona costata* (Rafinesque), *Strophitus undulatus* (Say), —WILLARD N. HARMAN, Cornell University, Dept. Entomology and Limnology, Ithaca, New York.

### REFERENCES

Clarke, Arthur H., and Clifford O. Berg. 1959. The freshwater mussels of central New York with an illustrated key to the

species of northeastern North America. Cornell Univ. Agr. Exp. Sta. Memoir 367:1-79

Robertson, Imogene C. S., and Clifford L. Blakeslee. 1948. The Mollusca of the Niagara frontier region. Bull. Buffalo Soc. Nat. Sci. 19 (3) :1-191.

HEILPRIN, ANGELO, Explorations on the west Coast of Florida and in the Okeechobee wilderness. 1887, Wagner Free Institute of Science, Philadelphia, pp.7 - 134, plates 2 - 21. Through a curious error, 75 species of mollusks described in 1887 were listed as new in the Zoological Record 101: pt. 9, Mollusca, pp. 1-187 for 1964 (1966).

In 1964 the Paleontological Research Institution, Ithaca, New York, republished this rare volume of Heilprin in their Palaeontographica Americana 4:365-506, plates 54-74. The compiler for the Zoological Record simply overlooked this fact though it is clearly indicated on the title page of the republication as "Reprint" and by the date of "1887". The next page is the reprinted title page of Heilprin and the following page, a "Preface" by Katherine V.W. Palmer, Director of the Paleontological Research Institute, in which she gives thanks to the authorities of the Wagner Free Institute of Science for allowing the republication of this rare and important paper on the late Tertiary molluscan fauna of the Florida peninsula.—W. J. CLENCH.

RANGE OF THE ASIATIC CLAM IN FLORIDA.—The Asiatic clam, *Corbicula fluminea* (Müller), was first observed in the United States in 1938. The rapid spread of this mollusk from the Columbia River in Washington, southeasterly across the United States, to the Gulf Coast streams of Louisiana, Mississippi, and Alabama is well documented (Dundee and Dundee, 1958; Sinclair and Ingram, 1961; Dundee and Harman, 1963; Hubricht, 1963, 1964). Records from the Florida State Board of Health biological surveys indicate the initial entrance and dispersal of *Corbicula fluminea* in Florida.

In 1960 the Florida State Board of Health conducted a biological survey of the Escambia River. Among the organisms reported was the Asiatic clam (Schneider, 1964). Specimens ranged from 2-4 mm. long (anterior-posterior length). Based on size-class

distribution as discussed by Keup, Horning and Ingram (1963) apparently the clam invaded this area about 1959. This appears to be the first record for Florida.

The following year an extensive water quality survey of the Apalachicola River was conducted (Schneider, 1961). *Corbicula fluminea* was collected from two areas of the river, near Blountstown, Florida and near Apalachicola, Florida. The specimens were approximately the same size as those found a year earlier in the Escambia River, indicating a recent invasion into the Apalachicola watershed.

In 1963 an abundance of *Corbicula fluminea* was reported from the Apalachicola River near Chattahoochee, Florida (Heard). There is good evidence that the clam entered this portion of the river from downstream. Heard states, "*Corbicula fluminea* was found to be absent above the (Jim Woodruff) dam, but present below it at both stations". Perhaps it was transported by waterfowl as suggested by Dr. William J. Clench, Curator of Mollusks, Harvard University. Dredging operations, barge traffic, or fishermen also could have been responsible for its upstream transportation.

The range of *Corbicula fluminea* in Florida is presently from the Escambia River near Century, Hwy. 4, Escambia County (Schneider, 1964) to the Withlacoochee River at the south edge of Inglis, U. S. Hwy. 19 and 98, Levy County (Heard, 1964). The eventual extent of its range in Florida is unknown.—ROBERT F. SCHNEIDER, Biologist, Bureau of Sanitary Engineering, Fla. State Board of Health, Pensacola, Fla.

#### LITERATURE CITED

- Dundee, D. S. and H. A. Dundee. 1958. Extensions of known ranges of four mollusks. Naut. 72 (2): 51-54.
- Dundee, D. S. and W. J. Harman. 1963. *Corbicula fluminea* (Müller) in Louisiana. Naut. 77 (1): 30.
- Heard, William H. 1964. *Corbicula fluminea* in Florida. Naut. 77 (3): 105-107.
- Hubricht, Leslie. 1963. *Corbicula fluminea* in the Mobile River. Naut. 77 (1): 31.
- . 1964. *Corbicula fluminea* at Vicksburg, Mississippi. Naut. 77 (4): 143.
- Keup, L., W. B. Horning and W. M. Ingram. 1963. Extension of range of Asiatic clam to Cincinnati reach of the Ohio River. Naut. 77 (1): 16-18.

- Schneider, Robert F. 1961. A biological report of the Apalachicola River. Florida State Board of Health, pp. 1-32.
- . 1964. An ecological survey of the Escambia River, Florida. Unpub. thesis Illinois State University, pp. 1-229.
- Sinclair, R. M. and W. M. Ingram. 1961. A new record for the Asiatic clam in the United States, the Tennessee River. *Naut.* 74 (3): 114-118.

THE AMERICAN MALACOLOGICAL UNION held a most successful annual meeting, the thirty-third, July 31st to August 6th at Ottawa, Canada. As guests of the National Museum of Canada and Carleton University over 160 A.M.U. members, their families and friends enjoyed the hospitality of our neighbor to the north. Housing, meals and meeting rooms were provided by the University while the Museum not only arranged that one day's session be held at the Museum itself but provided the annual dinner at Ottawa's finest restaurant. On the final day two chartered buses transported delegates to Montreal for a brief visit to Expo 67.

A.M.U. President Leo G. Hertlein presided over a record number of papers of which abstracts will be printed in the 1967 Annual Report Bulletin:

Growth and longevity of naiads from Fishery Bay in Western Lake Erie, David H. Stansbery. Small beginnings, Adlai B. Wheel. The mollusks of Sable Island, Nova Scotia, Arthur H. Clarke, Jr. Hosts, spermatophores, and the systematics of some eastern *Odos-tomia* (Pyramidellidae), Robert Robertson. Notes on captive *Leucozonia nassa*, *Chaetopleura apiculata* and *Ischnochiton floridanus*, Dorothy Raeihle. Mexican pearly freshwater mussels, Joseph P. E. Morrison. Bivalve larval development types, Paul Chanley. Seasonal reproduction in the Lampsilinae (Pelecypoda: Unionidae), William H. Heard. Notes on the evolution of *Spengleria* (Gastrochaenidae: Bivalvia), Kenneth J. Boss. Distribution and growth rates of the edible mussel, *Mytilus edulis* in the Canadian Arctic, Irene Lubinsky. A Correlation of Postglacial molluscan succession and radiocarbon-dated pollen sequence from Atkins Lake, Ontario, Marcel Ouellet. Distribution of Arctic marine gastropods, Mrs. A. H. Macpherson. Zoogeographic and evolutionary patterns in northern Lymnaeidae and Planorbidae, Arthur H. Clarke, Jr. Notes on the taxonomy and zoogeography of the Columbelloidea, George E. Radwin. Notes on the molluscan fauna off the coast of

North Carolina, Hugh J. Porter and Charles E. Jenner. The San Juan Expedition to the Gulf of Tehuantepec, Donald R. Shasky. *Architeuthis*, the giant squid, Fredrick A. Aldrich. Dissociation and reorganization of molluscan tissues, Vera King Farris. The freshwater Mollusca of Taiwan (Formosa), Henry van der Schalie and Gary L. Pace. On the evolution of torsion in the Limidae (Mollusca: Bivalvia), Thomas J. Gilmour. A proposal to register with the A.M.U. all antiquarian shell books, Mart Hulswit. Malacologia—Five years of publication, John B. Burch. Studies on succinidae, C. M. Patterson. The habits and distribution of *Carinifex* and *Parapholys*, Gary L. Pace. Endodontid land snails of Rapa Island, pattern and problems in speciation, Alan Solem. Polyembryony in buline snails, Chin-Tsong Lo (read by Gary Pace). A taxonomic study of some species of the freshwater snail genus *Semisulcospira* in Japan, John B. Burch and George M. Davis. Ecology and distribution of the marine Mollusca of Barbados, Vincent Conde. Electrophoretic analysis of esterases in *Bulinus*, John B. Burch and G. K. Lindsay. Commensal bivalves from the North Carolina coast, Charles E. Jenner and Anne E. McCrary. Distribution of the posterior pallial nerves in *Lampsilis ventricosa*, Louise R. Kraemer. Postglacial dispersal patterns of littoral marine mollusks and crustaceans in eastern Canada, E. L. Bousfield. A Plea to list rare molluscan species endangered by pollution or other causes, Herbert D. Athearn. Locomotion in *Aporrhais* and *Haliotis*, Alan Solem. Radular studies of Taiwan muricid gastropods, Shi-Kuei Wu. Systematics of *Xylophaga* versus the teredinids, a study in contrasts, Ruth D. Turner. Tree snails of Cuba, Hispanola and Florida, William J. Clench. Western Atlantic *Hastula*, Joseph P. E. Morrison.

Officers elected for 1967-68 are: President, Arthur H. Clarke, Jr. Vice-president, Joseph Rosewater. 2nd Vice-president, Fay Wolfson. Secretary, Margaret C. Teskey. Treasurer, Mrs. Horace B. Baker. Publications Editor, M. Karl Jacobson. Councillors-at-large, Mrs. Dorothy Beetle, Harold D. Murray, David H. Stansbury, Dan Steger. The 1968 annual meeting will be held in July at Corpus Christi, Texas; 7 Texas shell clubs will co-host the event. — MARGARET C. TESKEY, *Secretary*, American Malacological Union.

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## PUBLICATIONS RECEIVED

- Habe, Tadashige. 1964. Freshwater molluscan fauna of Thailand. Nature and Life in Southeast Asia 3: 45-66, & pls. 1, 2. N. spp. of *Sinotaia* (*Filopaludina n. subg.*) & *Unio*.
- 1964. Notes on the strange ark shell *Trisides* Röding. Bull. Nat. Sci. Museum 7: 255-257, & pl. 1.
- 1964. Notes on the genus *Cucullaea* Lamarck (Mollusca) Bull. cit.: 259-261, figs. 1 & 2.
- 1965. The arcid subfamily Anadarinae in Japan and its adjacent areas. Bull. cit. 8: 71-85, & pls. 1-3.
- 1965. Notes on the ivory shell genus *Babylonia* Schlüter (Mollusca). Bull. cit.: 115-124, & pl. 1.
- Heard, William H. 1962. The Sphaeriidae (Mollusca: Pelecypoda) of the North American Great Lakes. Amer. Midland Nat. 67: 194-198.
- Survey of the Sphaeriidae (Mollusca; Pelecypoda) of the southeastern United States. Proc. La. Acad. Sci. 26: 102-120, 6 figs.
- The biology of *Pisidium* (*Neopisidium*) *conventus* Clessin (Pelecypoda; Sphaeriidae). Mich. Acad. Sci., Arts & Letters 48: 77-86, 2 figs., 2 tables.
- 1966. Recent *Eupera* (Pelecypoda; Sphaeriidae) in the United States. Amer. Midland Nat. 74: 309-317, 3 figs. Euperinae new. *E. cubensis* + *E.ingleyi*.
- & J. B. Burch. 1966. Key to the genera of freshwater pelecypods (mussels and clams) of Michigan Mus. Zoo. Univ. Mich., circular no. 4: 48 pp., 48 figs.
- Horiuchi, Shiro & Charles E. Lane. 1965. Digestive enzymes of the crystalline style of *Strombus gigas* Linné. 1, Cellulase and some other carbohydrases, Biol. Bull. 129: 273-281, 6 figs. & 4 tables.
- Humes, Ralph H. 1965. A short history of *Liguus* collecting. J. Hist. Assoc. S. Fla. no. 25: 67-82.
- Jaeckel, S. H. 1963. Landmollusken der Insel Djerba (Tunesien). Abhandl. & Ber. Staatl. Mus. Tierk. Dresden: 26: 257-261.
- & H. P. Plate. 1964. Beiträge zur Kenntnis der Molluskenfauna der Insel Mallorca. Malak. Abhandl. ditto. 1: 53-87.
- & Plate. 1965. Nachtrag [to preceding] Abhandl. cit. 2: 159-164, 1 map, 6 figs.



- Langlois, Thomas H. 1965. The conjugal behavior of the introduced European giant garden slug, *Limax maximus* L., as observed on South Bass Island, Lake Erie. Ohio J. Sci. 65: 298-304, 17 figs.
- Loosanoff, Victor L. 1965. Gonad development and discharge of spawn in oysters of Long Island Sound. Biol. Bull. 129: 546-561, 6 figs.
- 1966. Time and intensity of setting of the oyster *Crassostrea virginica* in Long Island Sound. Biol. Bull. 130: 211-227, 7 figs., 4 tables.
- Loosjes, F. E. & A.C.W. Loosjes-van Bemmelen. 1966. Some anatomical, systematical and geographical data on Neniinae (Gastropoda, Clausiliidae). Zoo. Verhandl. [Leiden] no. 77: 59 pp. + 1 pl. & 1 table. Genitalia and radulae.
- Lopes, Hugo de Souza, Arnaldo C. Dos Santos Coelho & Paulo de Sá Cardoso. 1966. Contribuicoes de conhecimento dos gastropodes marinhos do Brasil. I, Familia Rissoidae. Bol. Mus. Nac. Rio de Janeiro, Zoologia. no. 254: 11 pp. + 3 pls.
- 1965. Uma nova especie brasileira do género "*Mitrella*" Risso, 1826 (Gastropoda, Columbellidae). Rev. Brasil. Biol. 25: 21-24, 2 figs.
- Magalhaes, Luiz A. 1964. Moluscos planorbídeos do Estado da Guanabara. Rev. Brasil. Biol. 24: 277-288, 1 table.
- 1965. Afalia em "*Drepanotrema anatimum*" (Orbigny, 1835) (Pulmonata, Planorbidae). Rev. cit. 25: 93-96, figs. 1, 2.
- Medcof, J. C., Arthur H. Clarke, Jr. & John S. Erskine. 1965. Ancient Canadian east-coast oyster and quahaug shells. J. Fish. Res. Board Canada 22: 631-634.
- Paraense, W. Lobato, Pierre Fauran & Edouardo Cormes. 1964. Observations sur la morphologie, la taxonomie, la répartition géographique et les gites d' *Australorbis schrammi*. Bull. Soc. Pathologie exotique 57: 1236-1254, figs. 1-17, & pls. 6, 7.
- Paraense & Nicanor Ibanez H. 1964. "*Australorbis helophilus*" (Pulmonata, Planorbidae). Rev. Brasil. Biol. 24: 249-258, figs. 1-38.
- Paraense. 1965. The Brazilian species of "*Drepanotrema*," VIII: "*D. heloicum*" (Orbigny, 1835). Rev. cit. 25: 25-34, figs. 1-13.
- Parodiz, Juan J. & Lise Hennings. 1965. The *Neocorbicula* (Mollusca, Pelecypoda) of the Parana-Uruguay basin, South America.

- Ann. Carnegie Museum 38: 69-96, figs. 1-9.
- Plasar, Ivo. 1964. Malakofauna brehynského a Novozómeckého rybníka na Ceskolipsku. Sborník Národního Muzea v Praze 20: 257-287, figs. 1-16.
- Reigle, Norman J., Jr. 1964. The distribution of the genus *Ventridens* (Mollusca, Gastropoda) in Michigan. Amer. Midland Nat. 72: 507-508.
- Ropes, John W. & Alden P. Stickney. 1965. Reproductive cycle of *Mya arenaria* in New England. Biol. Bull. 128: 315-327, figs. 1-14.
- Sastry, A. N. 1966. Temperature effects in reproduction of the bay scallop, *Aequipecten irradians* Lamarck. Biol. Bull. 130: 118-134, 4 figs., 7 tables.
- Saurin, E. 1958. Pyramidellidae de Pho-Hai (Sud Viêt-Nam). Inst. Oceanogr. Nhatrang, contribution no. 35: 63-86, & pls. 1-4.
- N. spp. in *Cossmannia*, *Odostomia*, *Pyrgulina*, *Chrysallida*, *Egilina*, *Babella*, *Miralda*, *Turbonilla*, *Pyrgiscus*, *Careliopsis* & *Cingulina*.
- Schalie, Henry van der. 1965. Observations on the sex of *Campeloma* (Gastropoda: Viviparidae). occ. Papers Mus. Zoo. Univ. Mich. no. 641: 1-15, including 1 fig. & pls. 1-5.
- Scheltema, Rudolf S. 1965. The relationship of salinity to larval survival and development in *Nassarius obsoletus* (Gastropoda). Biol. Bull. 129: 340-354, 5 figs. 4 tables.
- Tebble, Norman. 1966. British bivalve seashells. Handbook, British Museum (Natural History), 212 pp., 110 text figs., 12 pls. (8 in color). An excellent, accurate, well-illustrated, useful guide to all the known British bivalves. \$4.00, bound, write: Sales Section, British Information Service, 845 Third Avenue, New York, N. Y. 10022.

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## PARTULIDAE: PREVIEW OF ANATOMICAL REVISION

BY YOSHIO KONDO

Dissections of the genitalia of 109 forms of Partulidae (Orthurethra) from a total of about 126 within the family leads to the following summarization:

Genus *Eua*, 4 species; *Samoana*, 22 species; *Partula*: about 100 species plus subspecies.

Hypothesis of partulid evolution: Genus *Eua* is the most primitive; *Samoana* evolved from *Eua*; *Partula* evolved from *Samoana*. *Eua* evolved from its ancestral stock in the Samoa-Tonga region. *Samoana* evolved from *Eua* in Samoa-Tonga. Co-existence of *Eua* and *Samoana* in Tonga-Samoa to the exclusion of *Partula* supports this hypothesis. Place of origin of *Partula* from *Samoana* cannot be hypothesized now.

Distribution of the 126 kinds of Partulidae is given in Table I. The table, and the list to follow, includes all the forms dissected; those not dissected, due to lack of animals; and species whose existence is doubtful.

Range: Partulidae range from Palau to Marquesas, a distance of 5,300 nautical miles. *Samoana* is distributed for 4,700 miles, from Guam to Marquesas. *Partula* is also distributed for 4,700 miles, from Palau to the Society Islands. *Eua* has only a 480-mile range, from Tonga to Samoa.

Within its expectable range, Partulidae is absent on Yap, Truk, Mangareva, and Pitcairn.

High specific number of *Partula* in the Society Islands provides evidence that the genus may be experiencing a rejuvenation there. A curious instance of a species having 3 distinct forms of genitalia occurs in Tahiti. Five of the 8 varieties (or subspecies) of *P. otaheitana* dissected show that two of them vary in anatomy according to valleys.

*Samoana* of Marquesas also shows evidence of rejuvenation. To the 6 known species can be added 7 new undescribed forms.

In recent times the Melanesian partulid species have been reduced from 39 names to about 19. Further reduction is antici-

pated in the Solomon Islands after material collected in 1966 through National Science Foundation assistance (GB-3974) is studied. One or two new species or subspecies may be added from Santa Cruz.

Table I

## DISTRIBUTION OF PARTULIDAE

(Updated to 1959)

Region	<u>Eua</u>	<u>Samoana</u>	<u>Partula</u>
Talaud			1 ? **
Micronesia			
Palau			3
Mariana		1	4 ***
Ponape			2
Kusaie			1
Melanesia			
Bismarck, Admiralty			2
N. Guinea, satellites*			3
Solomon			8
N. Hebrides			5
Santa Cruz			1
Polynesia			
Hoorn			1
Rotuma			1
Fiji		1	2
Tonga	1	1	
Samoa	3	5	
Cook			1 (1) ****
Society		4	65 (1)
Austral		3	(1)
Rapa		1	
Marquesas		6	
Totals	4	22	100

\* Louisiade, D'Entrecasteaux, Trobriand, Woodlark.

\*\* Existence doubtful.

\*\*\* One new species.

\*\*\*\* Partula hyalina (1), common to all these islands.

In the ensuing list of genera and species, undissected species are preceded by an X, doubtful species are preceded by a ? mark.

## PARTULIDAE

## Genus EUA

Tonga	Eua
globosa Pilsbry and Cooke	
Samoa	
expansa (Pease)	Savaii, Upolu
montana (Cooke and Crampton)	Upolu
zebrina (Gould)	Tutuila

## Genus SAMOANA

Tonga	Eua
cramptoni Pilsbry and Cooke	
Samoa	
stevensoniana (Pilsbry)	Savaii, Upolu
canalis (Mousson)	Savaii, Upolu
conica (Gould)	Upolu, Tutuila
abbreviata (Mousson)	Tutuila
thurstoni (Cooke and Crampton)	Ofu
Fiji	
alabastrina (Pfeiffer)	Moala
Austral	
dryas (Crampton and Cooke)	Raivavae
hamadryas (Crampton and Cooke)	Raivavae
oreas (Crampton and Cooke)	Raivavae
margaritae (Crampton and Cooke)	Rapa
Society	
attenuata (Pease)	Tahiti, Raiatea, Tahaa, Borabora
annectens (Pease)	Huahine
diaphana (Crampton and Cooke)	Moorea
X solitaria (Crampton)	Moorea
Marquesas	
strigata (Pease)	Nukuhiva, Uahuka
bellula (Hartman)	Upou
ganymedes (Pfeiffer)	Hivaoa
inflata (Reeve)	Hivaoa, Tahuata
decussatula (Pfeiffer)	Hivaoa, Tahuata
magdalinae (Hartman)	Fatuhiva
Mariana	
fragilis (Ferussac)	Guam

## Genus PARTULA

Society: Borabora	bilineata Pease
lutea Lesson	sagitta Crampton and Cooke
Tahaa	umbilicata Pease
fabia subangulata Pease	eremita Crampton and Cooke
planilabrum Pease	Raiatea

<i>fabā</i> (Gmelin)	<i>taeniata elongata</i> Pease
<i>fusca</i> Pease	Tahiti
<i>navigatoria</i> (Pfeiffer)	<i>otaheitana otaheitana</i> (Bruguère)
<i>vittata</i> Pease	o. <i>amabilis</i> (Pfeiffer)
<i>radiata</i> Garrett	o. <i>sinistrorsa</i> Garrett
<i>citrina</i> Pease	o. <i>rubescens</i> Reeve
<i>imperfōrata</i> Garrett	o. <i>affinis</i> Pease
<i>formosa</i> Garrett	<i>cytherea</i> Cooke and Crampton
<i>candida</i> Crampton	<i>producta</i> Pease
<i>dentifera</i> Pfeiffer	<i>nodosa</i> Pfeiffer
X <i>callifera</i> Pfeiffer	<i>filosa</i> Pfeiffer
X <i>cedista</i> Crampton	<i>clara</i> Pease
<i>auriculata</i> Broderip	<i>hyalina</i> Broderip
<i>robusta</i> Pease	Austral
X <i>dolichostoma</i> Crampton	<i>hyalina</i> Broderip
X <i>protracta</i> Crampton	Cook
<i>leptochila</i> Crampton	<i>hyalina</i> Broderip
<i>labrusca</i> Crampton and Cooke	<i>assimilis</i> Pease
<i>dolorosa</i> Crampton and Cooke	Fiji
<i>lugubris</i> Pease	<i>lirata</i> Mousson
<i>ovalis</i> Pease	<i>lanceolata</i> Cooke and Crampton
<i>levilineata</i> Crampton	Rotuma
<i>turgida</i> (Pease)	<i>leefei</i> E.A. Smith
<i>remota</i> Crampton	Hoorn
<i>atilis</i> Crampton	<i>subgonochila</i> Mousson
<i>tristis</i> Crampton and Cooke	New Guinea, satellites
<i>thalia</i> Garrett	<i>similaris</i> Hartman
<i>garretti</i> Pease	? <i>occidentalis</i> Hedley
<i>rustica</i> Pease	? <i>grisea</i> Lesson
X <i>levistriata</i> Crampton	? <i>bulimoides</i> Lesson
X <i>cuneata</i> Crampton	Admiralty, Bismarck
<i>crassilabris</i> Pease	<i>carteriensis</i> (Quoy et Gaimard)
<i>hebe</i> (Pfeiffer)	<i>dorseyi</i> (Dall)
Huahine	Solomon
<i>rosea</i> Broderip	<i>micans</i> Pfeiffer
<i>varia</i> Broderip	<i>coxi</i> Hartman
<i>arguta</i> (Pease)	<i>regularis</i> Hartman
Moorea	X <i>incurva</i> Hartman
<i>exigua</i> Crampton	X <i>flexuosa</i> Hartman
<i>tohiveana</i> Crampton	X <i>pellucida</i> Pease
<i>olympia</i> Crampton	X <i>hastula</i> Hartman
<i>dendroica</i> Crampton	<i>cramptoni</i> Clench
<i>aurantia</i> Crampton	Santa Cruz
<i>mirabilis</i> Crampton	<i>vanicorensis</i> (Quoy et Gaimard)
<i>mooreana</i> Hartman	New Hebrides
<i>suturalis vexillum</i> Pease	<i>turneri</i> Pfeiffer
<i>suturalis strigosa</i> Pfeiffer	<i>pyramis</i> Hartman



X auraniana Hartman	radiolata Pfeiffer
X minor Hartman	new species
X milleri Solem	Ponape
Palau	guamensis (Pfeiffer)
calypso Semper	emersoni Pilsbry
thetis Semper	Kusaie
leucothoe Semper	martensiana Pilsbry
Mariana	Talaud
gibba Férussac	? newcombiana Hartman
salifana Crampton	

## SELECTED REFERENCES

- Clench, W.J. 1941. Land mollusca from the Solomon Islands. *Am. Mus. Novitates* 1129.
- Cooke, Jr., C.M. and H.E. Crampton. 1930. New species of *Partula*. *Bishop Mus. Occasional Papers IX* (11) ; 3-9.
- Crampton, H.E. 1916. Studies on the variation, distribution, and evolution of the genus *Partula*. The species inhabiting Tahiti. *Carnegie Institution of Washington Pub. No. 228*.
- , 1925. Studies, etc. Guam and Saipan. *Ibid.* *Pub. No. 228A*.
- , 1932. Studies, etc. Moorea. *Ibid.* *Pub. No. 410*.
- , 1956. New species of land snails of the genus *Partula* from Raiatea. *Am. Mus. Novitates No. 1761*.
- Pilsbry, H.A. 1900. On the zoological position of *Partula* and *Achatinella*. *Proc. Acad. Nat. Sci., Philadelphia*: 561-567.
- , 1900. The genesis of Mid-Pacific faunas. *Ibid.* 568-581.
- , 1909. Partulidae. *Manual of Conchology 20*: 155-336.
- , 1916. Mid-Pacific land snail faunas. *Proc. Nat. Acad. Sci. 2*: 429-433.
- Pilsbry, H. A. and C. M. Cooke, Jr., 1934. Partulidae of Tonga and related forms. *Bishop Mus. O. P. 10* (14) :3-21.
- Rensch, I. 1937. Untersuchungen über die Landschneckenfauna des Bismarck- Archipels II. *Archiv für Naturgeschichte, N. F. 6* (4) :526-644.
- Solem, A. 1959. Systematics and zoogeography of the land and fresh water Mollusca of the New Hebrides. *Fieldiana: Zoology 43* (1) .

## REPLACEMENT OF PLEUROCERIDS BY BITHYNIA IN POLLUTED WATERS OF CENTRAL NEW YORK

BY WILLARD N. HARMAN

In the Oswego River drainage basin members of pleurocerids are able to withstand moderately polluted conditions, but in these environments they are unable to compete successfully with a recently introduced species from Europe.



Figure 1. Distribution of *Pleurocera acuta* in 1966 in the Oswego watershed. ● Living population. ○ Dead specimens only. 1. Oswego River. 2. Oneida River. 3. Onondaga River. 4. Seneca River. 5. Oneida Lake. 6. Onondaga Lake. 7. Otisco Lake. 8. Skaneateles Lake. 9. Owasco Lake. 10. Cayuga Lake. 11. Seneca Lake. 12. Keuka Lake. 13. Canandaigua Lake.

After the ice sheet retreated, pleurocerid fauna invaded the St. Lawrence watershed (Goodrich, 1939). *Goniobasis virginica* (Gmelin), and *Goniobasis livescens* (Menke), were found alive in the Oswego River watershed before the turn of the century (DeKay, 1843; Beauchamp, 1888). Apparently they entered from Lake Ontario via the Oswego River and its tributaries, the Seneca, Oneida, and Onondaga Rivers, and eventually reached Oneida Lake and the larger Finger Lakes. In 1825 the Erie Canal was opened from Buffalo to Albany creating a route for immigrating aquatic fauna from the west (Clarke and Berg, 1959). *Pleurocera acuta* Rafinesque may have entered the drainage basin through this canal (Dazo, 1965). F. C. Baker's classic studies on Oneida Lake (1916)

showed that *G. livescens* was present at 15 stations, and he considered the species to be "... very common in New York State."

During the summer of 1966 I collected aquatic gastropods at more than 200 localities in the Oswego River basin. *Pleurocera acuta* was found living at only one place (Fig. 1). *Goniobasis virginica* was not found alive (Fig. 2). *Goniobasis livescens* was found living at 13 localities, all isolated from the major rivers (Fig. 3). As can be seen in Figures 1, 2, and 3, dead specimens of the above species were found in the larger rivers. The empty shells were greatly eroded and the snails apparently had been dead for some time. In Oneida Lake, where Baker had found *G. livescens* so commonly, not a single shell of that species was seen. From the distribution maps, it appears that *P. acuta* and *G. virginica* never entered the smaller streams in the watershed. *Goniobasis livescens*, however, invaded these areas. It also found refuge in 4 of the Finger Lakes, Fayetteville Green Lake south of Oneida Lake, and De-Ruyter Reservoir still farther to the south.

The pleurocerids are well known to be clean water organisms (Dazo, 1965). Unfortunately, in most areas, central New York's major rivers are polluted. However, other prosobranch gastropods are still living in them. They are:

- Valvata tricarinata* (Say)
- Campeloma decisum* (Say)
- Viviparus georgianus* (Lea)
- Amnicola integra* (Say)
- Amnicola limosa* (Say)
- Amnicola lustrica* Pilsbry
- Bithynia tentaculata* (Linnaeus)

The last species listed, *B. tentaculata*, is abundant. In areas of rock bottom practically every stone supports a large colony, and in sandy areas much of the vegetation is covered with them. This species is in fact dominating many habitats in the drainage system (Fig. 4). Blank areas appearing on the map along the rivers are environments with soft, shifting bottoms and are so turbid as to prevent the growth of rooted aquatic plants. Only pulmonate snails were found in these situations.

*Bithynia tentaculata* is an introduced species (Berry, 1943). It was first recorded in Lake Michigan in 1871 (Robertson and Blakelee, 1948), probably being introduced from Europe into the St.

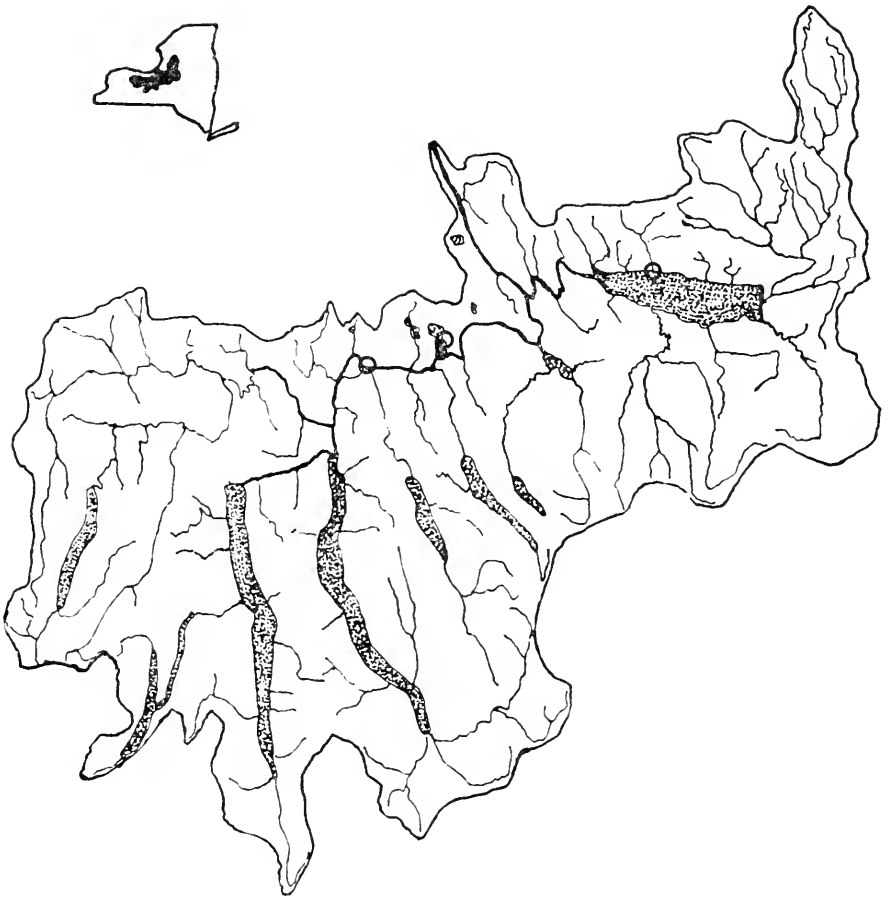


Figure 2. Distribution of *Goniobasis virginica* in 1966 in the Oswego watershed. ● Living population. ○ Dead specimens only.

Lawrence watershed via ballast in ships (Bryant Walker in Baker, 1916). William Beauchamp discovered the species at the mouth of the Oswego River in 1876 (Baker, 1916). In 1888 he reported it in the Erie Canal in Syracuse and at West Troy. He felt that it had "... become the most abundant shell in the canal . . ." and thought that it had been responsible for the eradication of *G. virginica* and *G. livescens*, of which he found only dead specimens. In 1943 Berry stated that *B. tentaculata* was one of the most abundant mollusks in the Great Lakes.

It appears that *B. tentaculata* cannot traverse streams with areas of turbulent water. In central New York, it has reached only Oneida, Onondaga, Cayuga, and Seneca Lakes. These are the only bodies of water in the Oswego watershed that are joined to Lake Ontario by deep, slow rivers (Fig. 4). *Bithynia tentaculata* has not



Figure 3. Distribution of *Goniobasis livescens* in 1966 in the Oswego watershed. ● Living populations. ○ Dead specimens only.

reached Canandaigua, Keuka, Owasco, Skaneateles, or Otisco Lakes, which are all separated from the major rivers by shallow rapids.

The richly eutrophic and somewhat polluted Oneida Lake supports a high population of *B. tentaculata*. Seneca and Cayuga Lakes, on the contrary, support relatively low populations. They are considerably more oligotrophic than Oneida Lake and the major rivers of the drainage basin. Apparently stable populations of *B. tentaculata* and *G. livescens* occur together in Seneca and Cayuga Lakes, showing that *G. livescens* can successfully compete with *B. tentaculata* in clean water. In Oneida Lake the pleurocerid fauna has been exterminated

It may appear that pollution *per se* eliminates the pleurocerids, but one can infer otherwise from observations at Chittenango Creek. This stream empties into Oneida Lake on its south shore. There

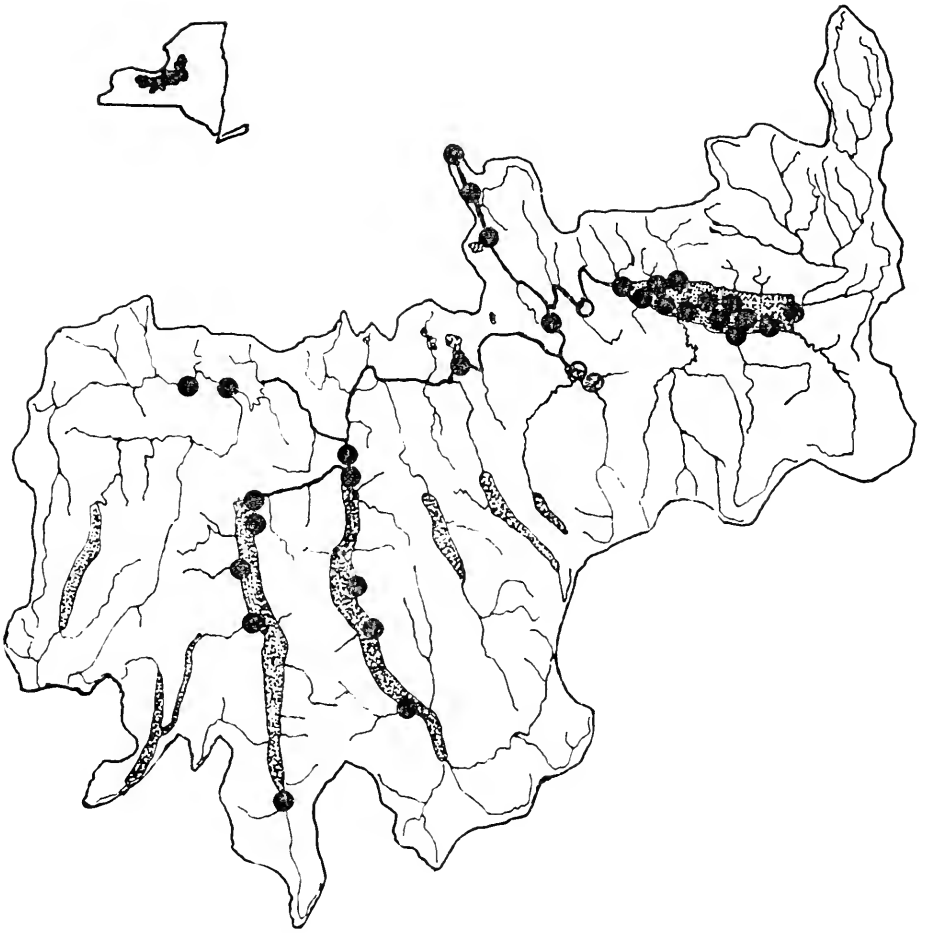


Figure 4. Distribution of *Bithynia tentaculata* in 1966 in the Oswego watershed. ● Living populations. ○ Dead specimens only.

are rapids between this collection area and Oneida Lake, and *B. tentaculata* is not present. If my contention that *B. tentaculata* will not traverse white water is true, then that is sufficient reason for its absence. During 1956 and 1957, Clarke and Berg (1959) collected several species of unionids living there. When I sampled the stream during the summer of 1966, it appeared polluted and no living mussels were found. However, *P. acuta* was abundant and associated with *Amnicola limosa* and two pulmonates. *Goniobasis virginica* is found in the polluted rivers of the Susquehanna watershed in southern New York (collected by the author in 1966). *Bithynia tentaculata* is not present there either. This shows that without added stress of competition from *B. tentaculata*, *P. acuta* and *G. virginica* are able to exist in moderately polluted environments.

I think that the elimination of pleurocerids from the major rivers and Oneida Lake is due directly to competition with *B. tentaculata*. Competition has been defined as the interaction between organisms that are both utilizing an essential resource which is in short supply. If competition were involved in the elimination of pleurocerids, species competing with them would benefit from their extinction in direct proportion to the intensity of their competition. The populations of *B. tentaculata* have increased markedly compared to those of the other associated gastropods. Seemingly, therefore the members of pleurocerids and *B. tentaculata* are severe competitors, and the pleurocerids have been eliminated because of their inability to compete vigorously in polluted situations.

This appears to be another case where an introduced species, this time with the help of man's enrichment of the waters, has invaded and dominated an environment at the expense of the native fauna. But if pollution becomes more intense, *B. tentaculata* will be eliminated also. In Onondaga Lake, a veritable open cesspool for the city of Syracuse, only empty shells of *B. tentaculata* are found, along with those of 9 other species of aquatic gastropods.

#### REFERENCES

- Baker, Frank Collins, 1916. The relation of mollusks to fish in Oneida Lake, New York. N. Y. State Coll. Forestry Tech. Pub. 4:1-366.
- Beauchamp, William M., 1888. Notes on American shells. Conch. Exchange. 2:114-115.
- Berry, Elmer G., 1943. The Amnicolidae of Michigan: Distribution, ecology, and taxonomy. Misc. Pub. Mus. Zool., Univ. Michigan. 57:1-68.
- Clarke, Arthur H., and Clifford O. Berg. 1959. The freshwater mussels of central New York with an illustrated key to the species of northeastern North America. Cornell Univ. Agr. Exp. Sta. Memoir. 367:1-79.
- Dazo, Bonifacio Capili. 1965. The morphology and natural history of *Pleurocera acuta* and *Goniobasis livescens* (Gastropoda: Cerithiacea: Pleuroceridae). Malacologia. 2 (1):1-80.
- DeKay, James E. 1843. Zoology of New York. Part 5. Mollusca. Albany. 271p. Pl. 1-40.
- Goodrich, Calvin. 1939. Pleuroceridae of the St. Lawrence River basin. Occas. Pap. Mus. Zool., Univ. Michigan. 404:1-4.
- Robertson, Imogene C. S., and Clifford L. Blakeslee. 1948. The Mollusca of the Niagara frontier region. Bull. Buffalo Soc. Nat. Sci. 19 (3):1-191.
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## A NOTE ON CATINELLA OKLAHOMARUM

By F. WAYNE GRIMM

Since the publication of their descriptions, several scattered records have been reported for *Catinella oklahomarum* (Webb, 1953a) and *C. pinicola* Grimm, 1960 (see references). Examination of specimens from many localities, including type material, has revealed that the two are conspecific, and *C. pinicola* becomes a synonym of *C. oklahomarum*. To date, no specimens have been seen which connect *C. oklahomarum loculosa* (Webb, 1954) with typical *oklahomarum*, and *loculosa* may be a good species.

*Catinella oklahomarum* ranges over most of the unglaciated land in the eastern and south-central United States, and has been collected in most of the physiographic provinces within this large area. Although widely distributed, it is infrequently found and usually occurs in small numbers. It prefers shady upland habitats, although it is found occasionally in culverts, on wasteland, and near the margins of bodies of fresh water. I have found it most often in cutover woods in hilly country and in the coastal pinewoods. Becoming sexually mature in late autumn, it increases in size until late Spring or early Summer of the following year.

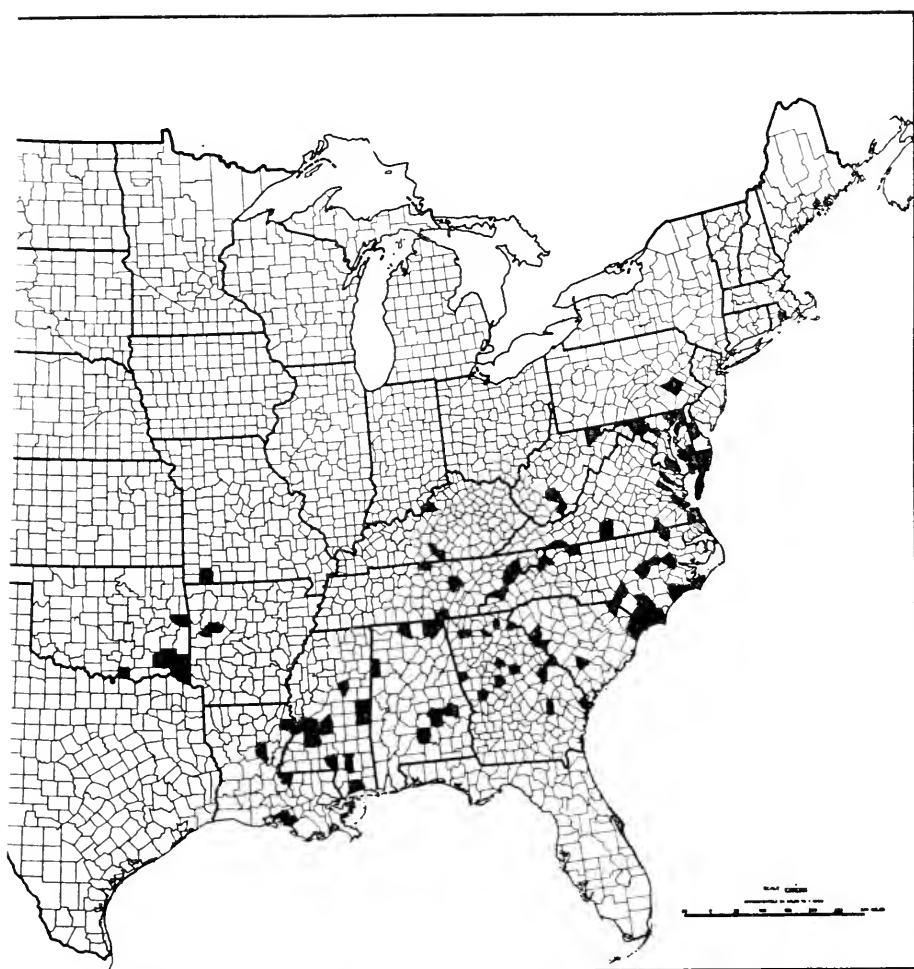
The genitalia of this species are quite variable, for the penis ranges in shape from that described and illustrated by Webb (1953a, 1954) for *C. oklahomarum* to that of *C. pinicola* Grimm (1960). This variation is neither geographic nor seasonal, for it appears in most samples in which several specimens are examined. Some of this variation may be due to the position of the penis during preservation. Often, the appendix is bent or shoved into the penis when the binding tissues contract in alcohol. After the penis matures, the female organs increase and the hermaphrodite duct decreases in size.

I am indebted to Glenn R. Webb for the loan of specimens and slides from his collection, and to Leslie Hubricht for permission to use locality records from his collection.

## REFERENCES

- Grimm, F. Wayne 1960. Two new succineids from Maryland, with notes on *Catinella vermeta*. *Nautilus* 74 (1):9-15.  
—, 1961. Landsnails from the upper Patuxent estuary margin (Maryland). *Nautilus* 74 (3):106-109.





JULY 1, 1940

The distribution of *Catinella oklahomarum* as represented in the collections of Leslie Hubricht, Glenn R. Webb, and the author.

- Hubricht, Leslie 1963. Some landsnail records from Louisiana. *Sterkiana* 10: 1-3.
- , 1964. The landsnails of Georgia. *Sterkiana* 16: 5-9.
- , 1965. The landsnails of Alabama. *Sterkiana* 17: 1-4.
- , 1966. Some landsnail records from Arkansas and Oklahoma. *Nautilus* 79 (4): 117-118.
- Webb, Glenn R. 1953a. Anatomical studies on some midwestern Succineidae and two new species. *Jour. Tenn. Acad. Sci.* 28 (3): 213-220.
- , 1953b. Additions to the pulmonate landsnails of Oklahoma (with notes on anatomical techniques). *Proc. Okla. Acad. Sci.* 34: 81-84.
- , 1954. *Quickella (Mediappendix) oklahomarum loculosa* n. subsp. *Gastropodia* 1 (2): 20.

## PORTUGUESE MARINE MOLLUSKS IN BERMUDA

BY R. TUCKER ABBOTT AND RUSSELL H. JENSEN

Foreign marine mollusks occasionally appear in Bermuda waters, but rarely survive. Most of these, like *Mytilus edulis* Linné and *Crassostrea virginica* (Gmelin), arrive on the bottoms of small, wooden sailing vessels. Verrill (1902) records a 1901 unsuccessful attempt to introduce the herbivorous trochid, *Cittarium pica* (Linné), from the Bahamas to Hamilton Harbour, Bermuda.

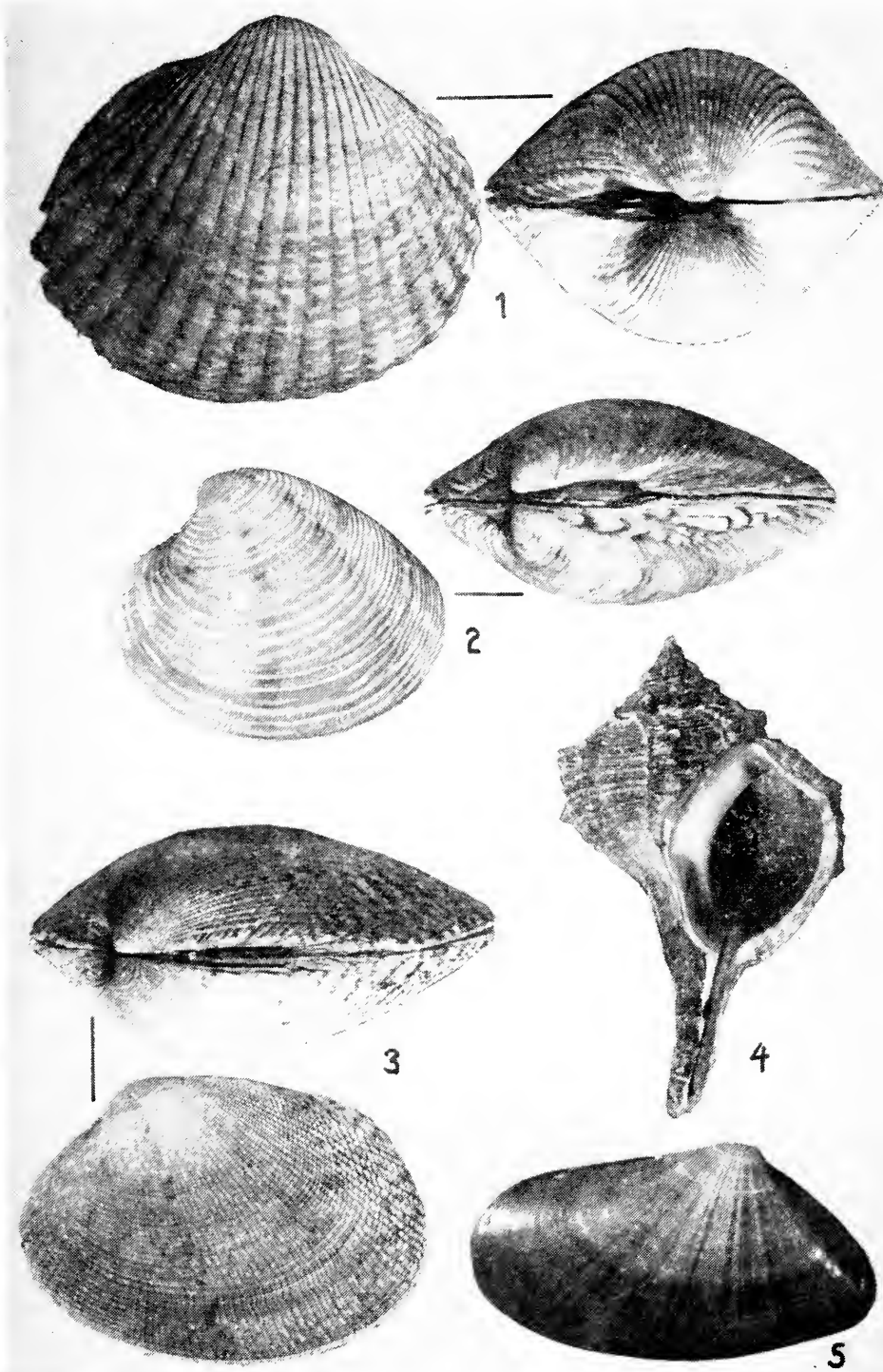
Recently, several species of edible European marine mollusks have been found living in Harrington Sound. Attempts to introduce foreign species can sometimes lead to disruptive effects to the local fauna. Sometimes, undesirable invertebrates are accidentally introduced with edible oysters. Additionally, shells new to a fauna can lead to the description of unnecessary new taxa.

Evidently, the introductions have been going on since 1965, when a commercial airline pilot living at Shelly Bay began bringing in pailsful of live mollusks packed in ice, from Lisbon, Portugal. Live specimens have been dumped, from time to time, into the western end of Harrington Sound. Living specimens were collected from June to August, 1967, by Mrs. Gwyn Outerbridge, Mrs. Jane Adriance, Mr. Arthur Guest, and the junior author. The presence of small specimens of *Venus striatula* da Costa suggests that at least one species has produced a new generation in Bermuda.

Two American cold-water bivalves have been taken alive or in freshly dead condition—*Mya arenaria* Linné and *Mercenaria mercenaria* (Linné)—but their establishment as permanent residents has not been demonstrated. The following species have been brought in from Portugal:

*Cerastoderma edule* (Linné). Numerous live and dead specimens taken in Harrington Sound. Specimens ranged in length from 26 to 43.5 mm. The obese shell is equivalve, beaks slightly in front of the midline, and with 24 to 29 radiating, weakly scaled ribs. Color yellowish white, some specimens stained with light rusty-brown. This species has a normal distribution from the Barents Sea and the Baltic to the Black and Caspian Seas, and south to Senegal, West Africa.

*Venerupis decussata* (Linné). Numerous live and dead speci-



Portuguese mollusks in Bermuda. Fig. 1, *Cerastoderma edule* (Linn.). Fig. 2, *Venus (Chamelea) striatula* (da Costa). Fig. 3, *Venerupis decussata* (Linn.). Fig. 4, *Murex brandaris* Linn. Fig. 5, *Donax variegatus* (Gmelin). All about natural size

mens taken in Harrington Sound. Specimens ranged in length from 31 to 36 mm. The strong but light-weight shell is equivalve, beaks at the anterior third, and the outer surface is finely decussated by numerous fine radial and concentric threads. Color cream to tan with sparse mottlings and broken, narrow radial rays of bluish purple. The pallial sinus is deep and U-shaped. The interior, posterior hinge plate is stained dark-purple. Its normal distribution is from southern England and France into the Mediterranean and south to Senegal, West Africa.

*Venus (Chamelea) striatula* (da Costa). A few live and freshly dead specimens taken in Harrington Sound. Specimens ranged in length from 19 to 30 mm. The thick, flattish, equivalve shell has numerous small, raised concentric ridges which are sometimes intertwined. Lunule short, heart-shaped. Escutcheon long, zebra-striped and with microscopic radial lines. Pallial sinus small, V-shaped. Exterior tan to cream with 2 or 3 narrow rays of mauve-brown. Its normal distribution is from Scandinavia to the Black Sea and to Morocco and the Canary Islands.

*Donax variegatus* (Gmelin). Only dead, matched valves found. Probably does not survive long. Specimens ranged in length from 22 to 38 mm. Shell solid, brittle, wedge-shaped, equivalve, and covered with a greenish tan, glossy periostracum. Interior whitish with blue or brownish yellow staining. Pallial sinus very large and rounded. Its normal distribution is from the English Channel to the western shores of the Mediterranean.

*Murex brandaris* Linné. Occasional live specimens taken, but no eggs or young have been found as yet. Adults from 55 to 61 mm. in length. If established, this Mediterranean (and Portugal to Senegal) carnivorous species could become a nuisance to bathers because of its spiny shells. It could also affect the bivalve populations of Bermuda.

Since our report on the sudden appearance of *Macrocallista maculata* (Linné) (Abbott and Jensen, 1967), that species has now spread from Harrington Sound to the mouth of Flatts Inlet, Shelly Bay, Bailey's Bay, Spanish Point, and Castle Harbour Sound, as of the summer of 1967.

#### REFERENCES

- Abbott, R. T. and R. Jensen. 1967. Molluscan faunal changes around Bermuda. *Science* 155: 3763: 687-688.  
Nobra, Augusto. 1932. Moluscos marinhos de Portugal. *Inst. Zool.*

- Univ. Pôrto. 466 pp., 80 pls.  
Tebble, Norman. 1967. British bivalve seashells. Handbook, Brit. Mus. (Nat. Hist.). 212 pp., illus.  
Verrill, A.H. Zoology Bermuda Islands. Trans. Connecticut Acad., vol. 11, p. 708.
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## A NEW MEIOCARDIA (PELECYPODA, GLOSSIDAE) FROM THE EOCENE OF FLORIDA

By DAVID NICOL Department of Geology, University of Florida

The Crystal River Formation (Ocala Group) of Late Eocene age is well exposed in limestone quarries to the northwest, west, south, and southeast of Gainesville, Florida. Although most of the mollusks are represented by poorly preserved casts and molds, the fauna is exceedingly diverse. Besides the many different kinds of marine mollusks, there is also a great diversity of Foraminifera, Bryozoa, Crustacea, and Echinoidea. However, both colonial and solitary corals are rare and represented by few species. Probably because of the relatively poor preservation of most of the mollusks, this part of the invertebrate fauna is still largely undescribed. However, Dr. Katherine V. W. Palmer of the Paleontological Research Institution has nearly completed a monograph of the entire molluscan fauna of the Ocala Group.

The Crystal River Formation is a pure limestone that consists of nearly 100 per cent, calcium carbonate, and in most places more than 50 per cent of the rock is composed of the calcareous shells or skeletons of marine invertebrates. In some places the limestone has been replaced by chert, and at a few localities some of the fossils have been silicified.

An undescribed species of *Meiocardia* is an uncommon fossil in the *Lepidocyclina-Pseudophragmina* faunizone (Puri, 1957, p. 48) of the Crystal River Formation. Some other associated invertebrates in this faunizone are *Crassatella* sp., *Glycymeris* sp., *Cardium* sp., *Plicatula* sp., *Tapes* sp., *Clavagella* (*Clavagella*) sp., *Clavagella* (*Stirpulina*) sp., several species of gastropods, many miliolids and other Foraminifera, small echinoids, and fragments of bryozoans and crustaceans. As far as I am aware, this is the first report of clavagellids occurring in Cenozoic strata in the western hemisphere, and both *Clavagella* (*Clavagella*) sp. and *Clavagella* (*Stirpulina*) sp. are much like species described from the Paris Basin

Eocene. When the mollusks are better known, some of them can be used as zone fossils, and they have the added advantage of being identified by the stratigrapher and field geologist with greater ease than the bryozoans, Foraminifera, and ostracods.

This species of *Meiocardia* is only the second reported from Eocene strata along the Atlantic and Gulf Coasts (Palmer and Brann, 1965, p. 192). *Meiocardia carolinae* Harris, 1919, (Harris is Van Winkle and Harris) has been found in Middle and Upper Eocene strata in North and South Carolina.

The present distribution of *Meiocardia* is interesting because it is disjunct, a rare phenomenon amongst pelecypod genera and families. There is one species, *Meiocardia agassizi* Dall, living in a small area in the southeastern Caribbean Sea—Trinidad, Barbados, and off the north coast of Venezuela. This region has not been thoroughly collected in the deeper waters, and so the exact geographic range of this species is not known, but it appears to be uncommon and confined to this restricted area. The remaining living representatives of the genus are found in Hawaii westward to southern Japan, the Philippines, the East Indies, Queensland, and westward at least as far as the Persian Gulf. Although *Meiocardia* is not confined to the Indo-Pacific today, its main development is in this region. Several other genera of mollusks found in Ocala strata are now either confined to the Indo-Pacific region or nearly so. One of the puzzling questions is why so many of these present-day Indo-Pacific genera disappeared from the Atlantic and Gulf Coastal regions during Middle and Late Eocene times.

#### Family Glossidae

##### *Meiocardia* H. and A. Adams, 1857

Type species: subsequent designation, von Martens, 1870, *Chama moltkiana* Spengler, 1783.

MEIOCARDIA PALMERAE Nicol, new species. Figs. 1-5.

*Description:* Shell small; holotype 12.1 mm. high, 11.8 mm. long; largest specimen 25.7 mm. high, 26.8 mm. long; smallest specimen 11.8 mm. high, 10.2 mm. long; average for 10 specimens is 15.2 mm. high, 14.2 mm. long; ratio of length to height for the 10 specimens 0.93; most specimens are higher than long but two are longer than high; valve outline subtrapezoidal, anterior side arcuate, ventral margin gently rounded and sloping post-

eriorly, posterior side subtruncate, dorsal margin posterior to the beaks gently rounded, dorsal margin anterior to the beaks rounded; anterior adductor muscle scar large and nearly round, located at the antero-dorsal margin; pallial line not visible; posterior adductor muscle scar larger than anterior, indistinct, located midway on the posterior border of the valve; 7 of the casts smooth or nearly so; 3 casts have concentric rounded ribs well marked, as many as 7 concentric ribs easily seen, ribs not seen on anterior margin nor posterior to a prominent keel which runs from the posterior side of the beak to the postero-ventral margin in a broad arc; a second and shorter keel seen in a few specimens which runs from under the beak along the posterior part of the dorsal margin; interior margins of the valves apparently smooth; beaks high, well enrolled, strongly prosogyrate, located at the anterior  $\frac{1}{4}$  of the dorsal margin; only portions of the hinge teeth seen on some of the specimens; they appear to be typical for the genus *Meiocardia*.

*Comparison:* *Meiocardia palmerae* is clearly distinct from *M. carolinae* Harris, 1919, by being proportionately higher, by having higher beaks, by having a larger posterior keel or ridge, and by being smaller than *M. carolinae*.

*Meiocardia palmerae* is named in honor of Dr. Katherine V. W. Palmer, Director of the Paleontological Research Institution at Ithaca, New York. Dr. Palmer is particularly noted for her research on Eocene mollusks of the Gulf and Atlantic Coasts.

*Localities:* Locality #1. The type locality for *Meiocardia palmerae* is just east of old U. S. Highway 441 at Zuber, Marion County, Florida. This is Puri's (1957, p. 70) PM-2, and in the same publication Puri designated this place as the cotype locality for the Ocala Group. This is also Puri and Vernon's (1964, p. 81) Stop 11; SE  $\frac{1}{4}$  SW  $\frac{1}{4}$  Sec. 11, T. 14 S., R. 21 E. Besides the holotype, 4 of the paratypes were collected at this locality.

Locality #2. One paratype was collected by G. H. Espenshade of the U. S. Geological Survey in 1955 at U. S. G. S. locality #20154 (106). This is an abandoned phosphate mine with solution-pitted limestone well exposed; "French Phosphate Mines,"  $1\frac{1}{2}$  miles northeast of Anthony, Marion County, Florida; Sec. 3, T. 14 S., R. 22 E.

Locality #3. One paratype was collected at an abandoned lime-

stone quarry one mile west of Interstate 75 and two miles south of State Highway 26, Alachua County, Florida; SE $\frac{1}{4}$  Sec 9, T. 10 S., R. 18 E.

Locality #4. Two paratypes were collected at the Haile Quarries, Newberry Corporation pits, five miles northeast of Newberry, Alachua County, Florida on State Highway 235; SW $\frac{1}{4}$  SE $\frac{1}{4}$  Sec. 13, T. 9 S., R. 17 E. This is Puri and Vernon's (1964, p. 82) Stop 12.

Locality #5 The largest specimen is a paratype collected approximately two miles northeast of High Springs, Alachua County, Florida; N $\frac{1}{2}$  Sec 30, T. 7 S., R. 18 E.

Type specimens and repositories: The holotype and 4 paratypes are deposited in the collection at the Paleontological Research Institution—P.R.I.

Holotype P.R.I. 27543, right valve, figured, locality #1.

Paratype P.R.I. 27544, right valve, figured, locality #1.

Paratype P.R.I. 27545, left valve, locality #1.

Paratype P.R.I. 27546, left valve, locality #4.

Paratype P.R.I. 27547, right valve, locality #3.

Five of the paratypes are deposited in the collection at the U. S. National Museum—U.S.N.M.

Paratype U.S.N.M. 645660, right valve, figured, locality #5.

Paratype U.S.N.M. 645656, left valve, locality #1.

Paratype U.S.N.M. 645657, right valve, locality #1.

Paratype U.S.N.M. 645658, left valve, locality #2.

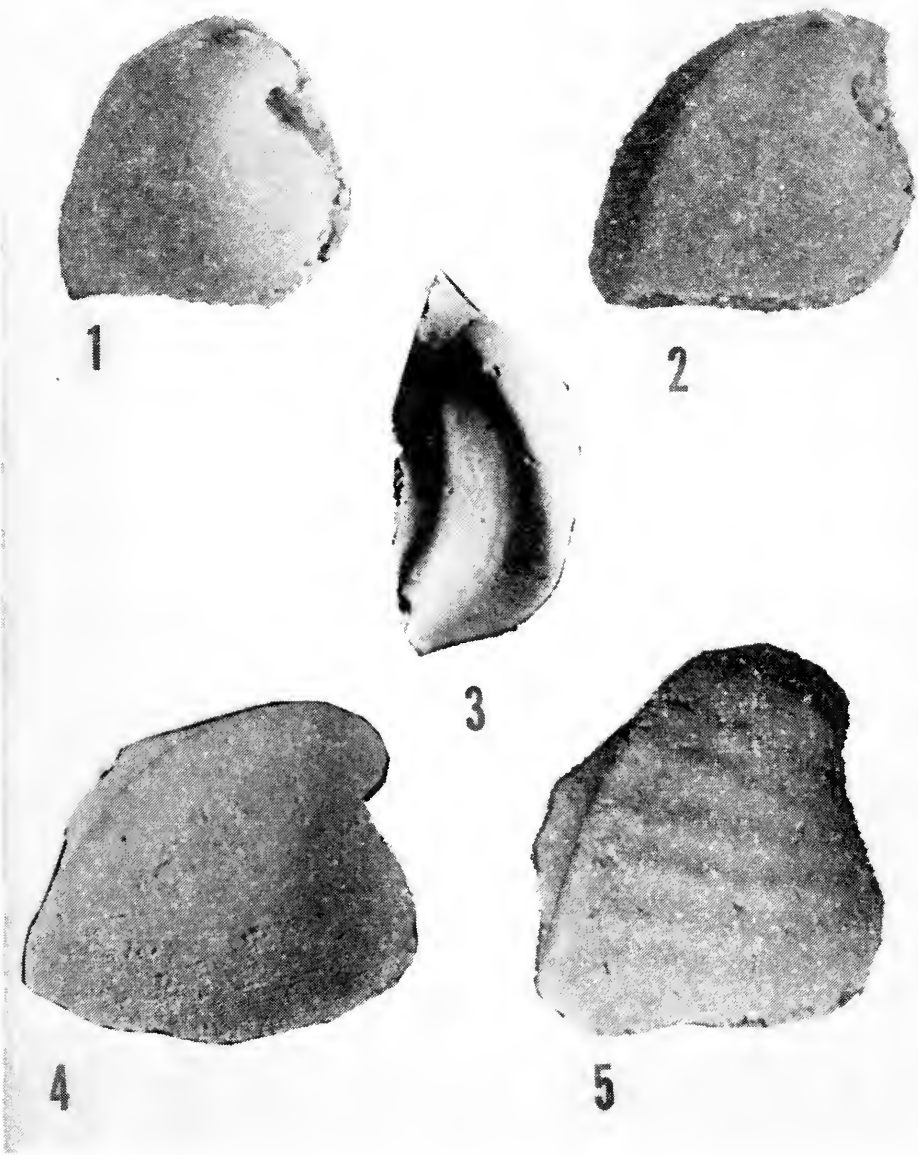
Paratype U.S.N.M. 645659, right valve, locality #4.

I am greatly indebted to Dr. David W. Ehrenfeld and Dr. Frank G. Nordlie of the Zoology Department at the University of Florida for taking and developing the photographs of *Meiocardia palmerae*.

#### LITERATURE CITED

- Adams, H., and A. Adams, 1854-1858, The genera of recent Mollusca, London, vol. 2, 661 pp.
- Palmer, Katherine V. W., and D. C. Brann, 1965, Catalogue of the Paleocene and Eocene Mollusca of the southern and eastern United States. Part I. Pelecypoda, Amphineura, Pteropoda, Scaphopoda, and Cephalopoda: Bull. Am. Paleo. 48 (218): 466 pp.
- Puri, H. S., 1957, Stratigraphy and zonation of the Ocala Group: Fla. Geol. Survey, Geol. Bull. 38, 248 pp.
- Puri, H. S., and R. O. Vernon, 1964, Summary of the geology of Florida and a guidebook to the classic exposures: Fla. Geol.





Figs. 1, 2. Holotype P.R.I. 27543. Right Valve, exterior; 1. showing beak, 2. showing posterior keel. Specimen 12.1 mm. high. Figs. 3, 4. Paratype U.S.N.M. 645660. Right valve; 3. posterior dorsal view showing both keels, 4. exterior. Specimen 25.7 mm. high. Fig. 5. Paratype P.R.I. 27544. Right valve, exterior showing concentric ribs. Specimen 17.0 mm. high.

Survey, Special Pub. 5 (Revised), 312 pp.  
Van Winkle, Katherine E. H., and G. D. Harris, 1919, New or otherwise interesting molluscan species from the east coast of America: Bull. Am. Paleo. 8 (33) : 5-32.

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## ZOOGEOGRAPHY OF THECOSOMATOUS PTEROPODS IN THE WEST ANTARCTIC OCEAN\*

BY CHIN CHEN

Lamont Geological Observatory of Columbia University Palisades, New York

Thecosomatous pteropods are the major group of holoplanktonic gastropods in the Antarctic Ocean. They have a world-wide distribution in the open ocean, mainly inhabiting the upper 500 meters, but a few species live in deeper water. About 50 species of thecosomatous pteropods have been described. Less than one-tenth of these have their main distribution in the polar and sub-polar regions.

The shells of thecosomatous pteropods are usually composed of aragonite, but a few are cartilaginous. Pteropod shells in the modern pelagic sediments are usually encountered at depths from 200 m. to 4000 m. They are rare in the shallow-water deposits of less than 200 m. Pteropod shells constitute a major portion of calcareous pelagic sediments at a depth of about 2200 m. in the subtropical and tropical areas. They diminish gradually to 4000 m. as the solution rate of  $\text{CaCO}_3$  increases with depth. Pteropod ooze was defined by Murray and Renard (1891) as deep-sea sediment in which a very large part of the calcareous organisms consists of shells of pteropods and other pelagic gastropods.

Two hundred eighty-one plankton samples from 189 *Eltanin* stations in the Scotia Sea, Weddell Sea, Drake Passage, and the Pacific sector of the Antarctic Ocean were available for this study. Usually the entire sample was studied. If there were more than 500 pteropods in a sample, a half or one-eighth aliquot was examined. The abundance of each species (specimens per 1000 m<sup>3</sup> water) in the upper 300 m. is shown on the distribution maps. The taxonomy of thecosomatous pteropods used here follows Tesch (1946, 1948).

The distribution of pteropods has been reported from several expeditions in the West Antarctic Ocean: Terra Nova Expedition (Massy, 1920), National Antarctic Expedition (Eliot, 1907), and Discovery Expedition (Massy, 1932; Hardy and Gunther, 1935; and Mackintosh, 1934). However, very little quantitative data are available.

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\* Contribution from Lamont Geological Observatory. No. 1134.

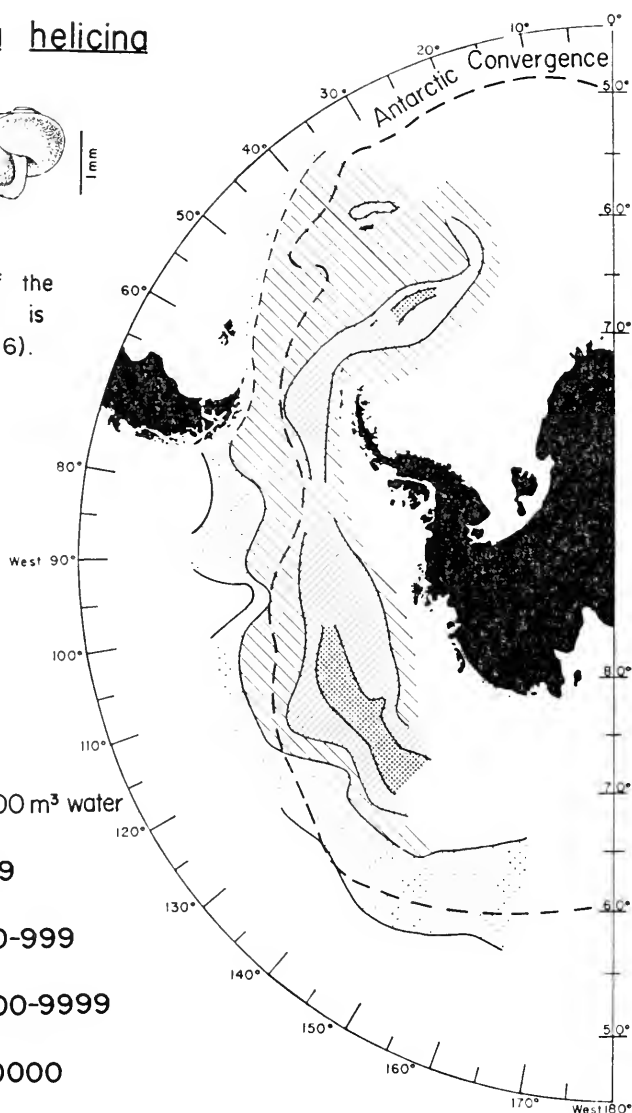
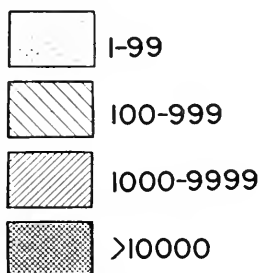
## MAP I

Limacina helicina

The mean position of the Antarctic Convergence is after Mackintosh (1946).

The legends in maps 2-4 refer to the legend in this map.

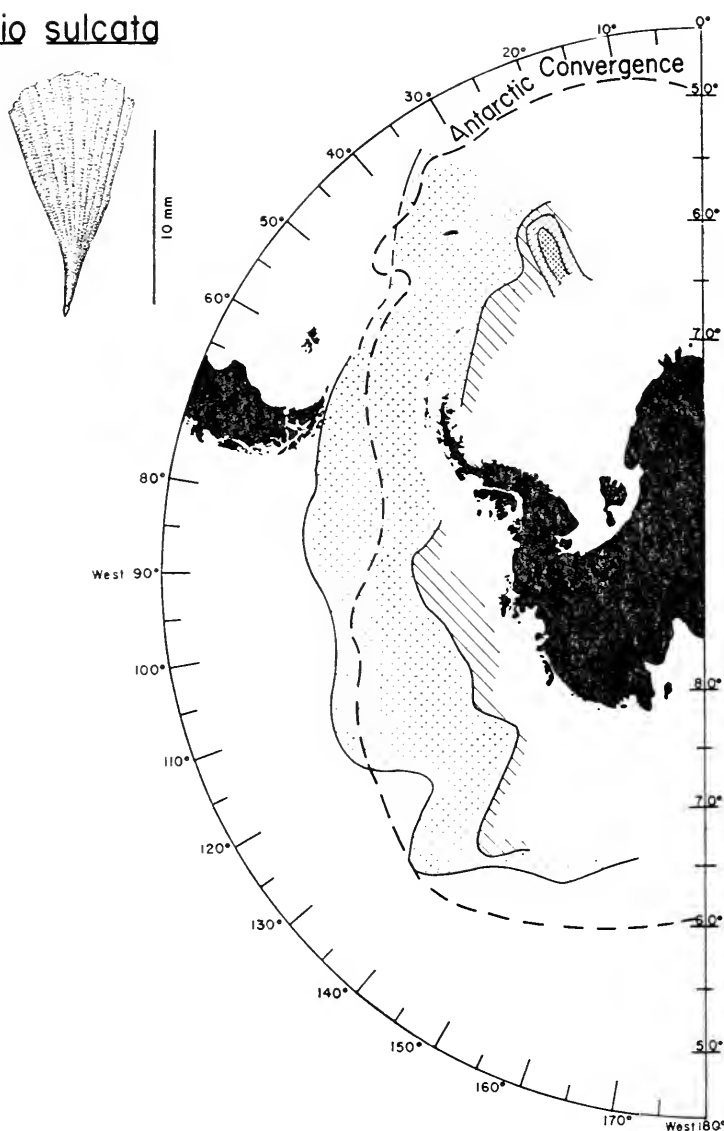
Specimens/1000 m<sup>3</sup> water



Map 1. Zoogeography of *Limacina helicina* in the upper 300 meters.

Eight species are found in the region mapped and four of these are frequently encountered. These 4 major species can be grouped into two faunal categories on the basis of their maximum concentration in relation to the Antarctic Convergence. Category 1, those mainly found south of the Convergence, consists of *Limacina helicina* (Phipps) and *Clio sulcata* (Pfeffer). Category 2, those mainly found north of the Convergence, is composed of *Limacina*

## MAP 2

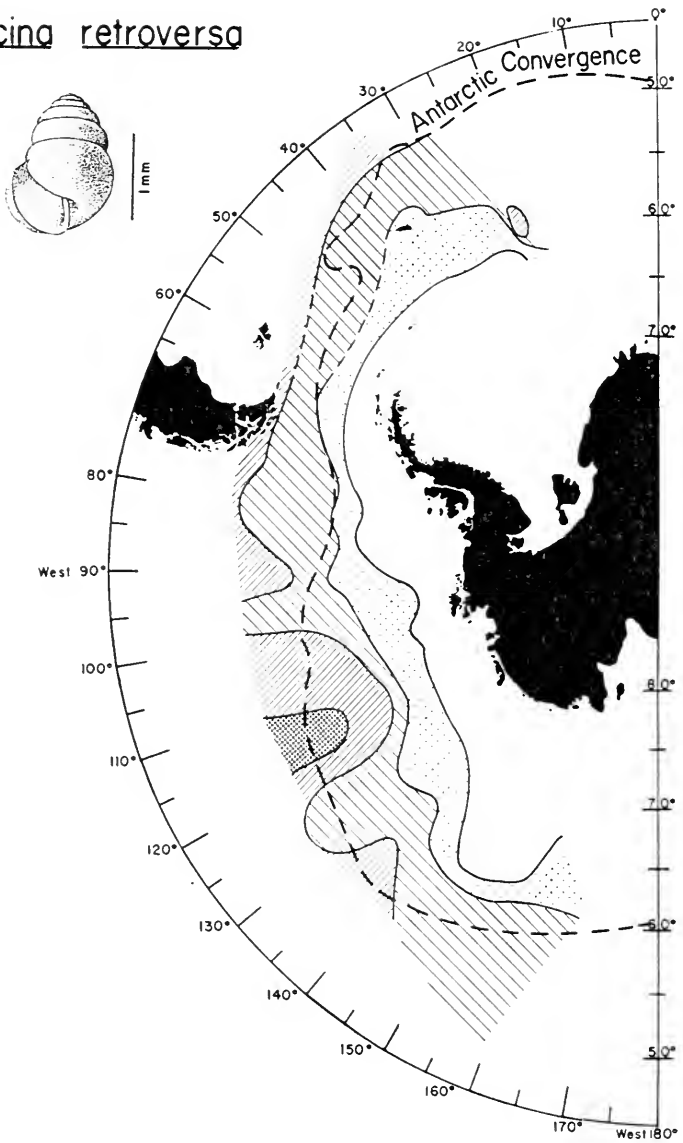
Clio sulcata

Map 2. Zoogeography of *Clio sulcata* in the upper 300 meters.

*retroversa* (Fleming) and *Clio antarctica* Dall. Four other species, *Clio polita* Pelsencer, *Clio chaptali* (Souleyet), *Limacina helicoides* Jeffreys, and *Peraclis reticulata* (d'Orbigny), are very infrequently recorded in this study. The former 3 rare species have so far been found in the Pacific sector of the Southern Ocean, and the latter species is found in the South Atlantic and west Drake Passage.

Comparison of the distribution of thecosomatous pteropod

## MAP 3

Limacina retroversa

Map 3. Zoogeography of *Limacina retroversa* in the upper 300 meters.

species in the two polar regions shows different pattern. The 4 common species, *Limacina helicina*, *L. retroversa*, *Clio sulcata*, and *C. antarctica* are circumpolar in the Southern Ocean. There is a notable difference in the northern polar region because of the absence of *Clio sulcata* and *C. antarctica*. *Limacina helicina* is present in the Pacific- and Atlantic-Arctic regions, while *L. retro-*

*versa* is limited to the North Atlantic. *Limacina retroversa* has been reported (Chen and Be, 1964) to be a dominant species in the Labrador Sea, yet it is notably absent in the North Pacific (McGowan, 1960).

*Limacina helicina* is more abundant and is larger in size south of the Antarctic Convergence. Its maximum concentration ( $>10,000$  specimens per  $1000\text{ m}^3$  water) is found approximately 5 degrees south of the mean position of the Antarctic Convergence. The largest specimens are about 8 mm. in width.

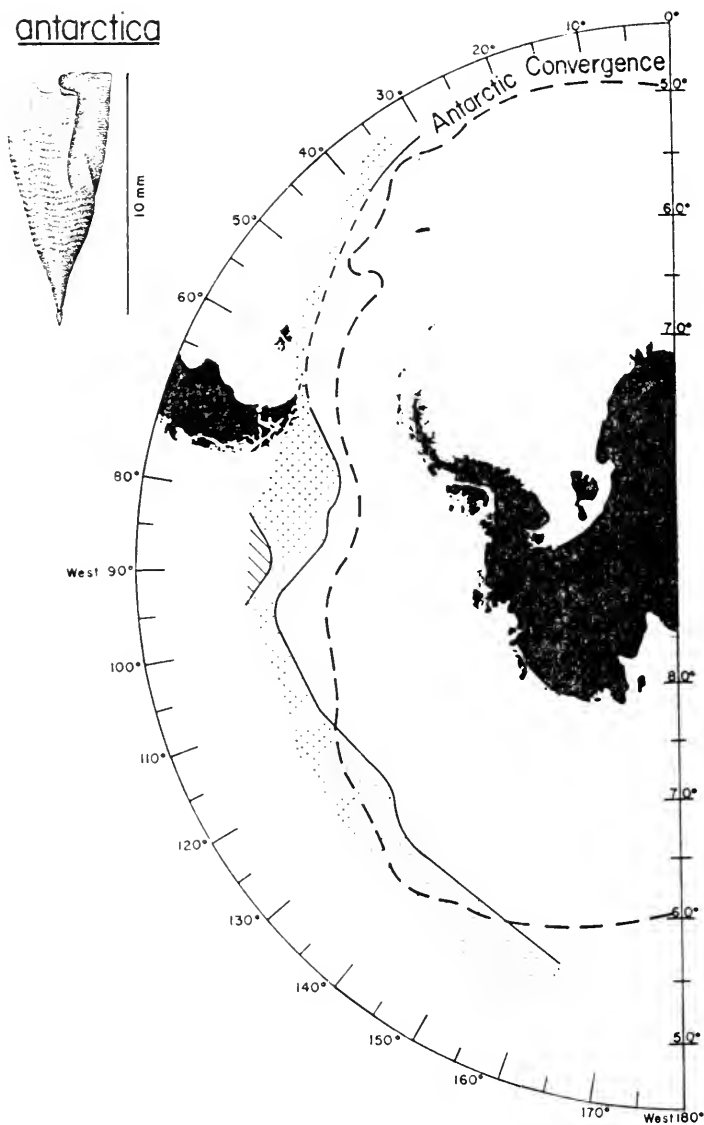
*Limacina helicina* has been reported in the Southern Ocean by Meisenheimer (1905, 1906), Massy (1920, 1932), Mackintosh (1934), and Hardy and Gunther (1935). The most northern record of this species in the Southern Ocean is at  $31^\circ\text{S}$ ,  $8^\circ\text{E}$  where 8 specimens were found by the *Valdivia* Expedition (Meisenheimer, 1905).

*Clio sulcata* is characteristic of the Antarctic water. A dense patchy distribution ( $>10,000$  specimens per  $1000\text{ m}^3$  water) was observed in the upper 300 m. in the South Sandwich Trench south of the Convergence in May of 1963. A narrow patchy area extends in a north-south direction, parallel to the direction of the trench.

*Clio sulcata* was first described by Pfeffer (1879) from two stations,  $50^\circ34'\text{S}$ ,  $83^\circ44'\text{W}$  and  $45^\circ35'\text{S}$ ,  $122^\circ1'\text{W}$ . The latter is so far the most northern record. This species has been reported in the Antarctic by Pelsener (1888, 1903), Meisenheimer (1905, 1906), Eliot (1907), Massy (1920, 1932), Mackintosh (1934), Hardy and Gunther (1935), Spoel (1962), and Taki Okutani (1963). Massy (1932) stated that over 2000 specimens were caught in hauls made at 34 stations at the South Sandwich Islands at soundings of 0-250 m.

*Limacina retroversa* is more abundant in the Subantarctic than in the Antarctic waters. It is found throughout a region extending for at least three to ten degrees of latitude south from the mean position of the Antarctic Convergence. *Limacina retroversa* is absent or very rare in the Weddell Sea whose waters are a mixture of a major portion of Antarctic continental shelf water and a minor portion of warmer water. According to Mackintosh (1934), this species shows patchy distribution and has a tendency to form shoals.

## MAP 4

Clio antarctica

Map 4. Zoogeography of *Clio antarctica* in the upper 300 meters.

*Clio antarctica* is widely distributed throughout the Subantarctic waters, but is not abundant (<100 specimens per 1000 m<sup>3</sup> water). It occurred in fairly large numbers (about 200 specimens per 1000 m<sup>3</sup> water) from a station at 55°S, 89°49'W. This species is very rare or absent in the surface waters of the region mapped.

*Clio antarctica* was observed in the southern regions of the

three great oceans around the South Pole (Pelseneer, 1888) and in an intermediate belt of temperate waters (Tesch, 1948). According to the distribution maps of Meisenheimer (1905) and Tesch (1948) the majority of this species occurred in the area between 40° and 60° S latitudes, but it was recorded from a station as far north as 20° S latitude (Meisenheimer, 1905, map 4).

*Acknowledgements.* I am deeply grateful to Drs. A. Crary and G. Llano of National Science Foundation under whose auspices the biological program on *Eltanin* has been carried out and to Dr. A.W.H. Bé who was in charge of Lamont's Antarctic plankton sampling program. I thank J. Hays, A McIntyre, T Ericson and N Hillman for constructive criticism. Gratitude is expressed to the Smithsonian Oceanographic Sorting Center for sorted pteropod specimens. This research was supported by the U. S. Antarctic Research Programs of the National Science Foundation (Grants GA-276 and GA-766).

#### REFERENCES

- Chen, C., and Bé, A.W.H. 1964. Seasonal distribution of euthecosomatous pteropods in the surface waters of five stations in the western North Atlantic, Bull. of Marine Science of the Gulf and Caribbean, 14: 185-220, 12 text-figures, 5 tables.
- Eliot, C. 1907. Mollusca, VI. Pteropoda, Nat. Antarctic Exped. Nat. Hist., 3: 1-15, 2 plates.
- Hardy, A.C., and Gunther, E.R. 1935. The plankton of the South Georgia whaling grounds and adjacent waters 1926-27, Discovery Repts., 11: 1-456, 193 text-figures, 77 tables and 5 appendix tables.
- Mackintosh, N.A. 1934. Distribution of the macroplankton in the Atlantic sector of the Antarctic, Discovery Repts., 9: 65-160, 48 text-figures, 18 tables.
- , 1946. The Antarctic Convergence and the distribution of surface temperatures in the Antarctic waters, Discovery Repts., 23: 117-212, 11 text-figures, 14 plates, 9 tables.
- Massy, A.L. 1920. Mollusca, part III. - Eupteropoda (Pteropoda Thecosomata) and Pterota (Pteropoda Gymnosomata), British Antarctic ("Terra Nova") Exped., Zoology 2: 203-231, 9 text-figures.
- , 1932. Mollusca: Gastropoda Thecosomata and Gymnosomata, Discovery Repts., 3: 267-296, 1 text-figure, 1 plate.
- McGowan, J. 1960. The systematics, distribution and abundance of Euthecosomata of the North Pacific, Ph.D. dissertation of University of California at San Diego, 1-212, 54 figures, 18 tables.
- Meisenheimer, J. 1905. Pteropoda, Wiss. Ergebn. 'Valdivia', 9:



- 1-314, 35 text-figures, 9 maps, 27 plates.
- , 1906. Die Pteropoden der Deutschen Südpolar-Exped., Dtsch. Südpolar-Exped., 9: 96-153, 10 text-figures, 1 map, 2 plates.
- Murray, J. and Renard, A. 1891. Reports on the deep-sea deposits, Rept. Sci. Res. Challenger 1872-1876. 1-525, 29 plates, 43 charts, 22 diagrams.
- Pelseneer, P. 1888. Report on Pteropoda collected by H.M.S. *Challenger* during the year 1873-76, II. Thecosomata, Rept. Voy. 'Challenger'. *Zool.*, 23: 1-132, 3 text-figures, 2 plates.
- , 1903. Mollusques (Amphineures, gastropodes et lamelli-branches), résultats du voyage du S.Y. Belgica en 1897-1899, 27-83, 2 plates.
- Pfeffer, G. 1879. Uebersicht der während der Reise um die Erde in den Jahren 1874-1876 auf S.M.S. Gazelle und von Herrn Dr. Jagor auf seiner Reise nach den Philippinen in den Jahren 1857-1861 gesammelten Pteropoden, Monastber. Kgl Preuss. Akad. Wissensch., 230-247, 1 plate.
- Spoel, S.V.D. 1962. Aberrant forms of the genus *Clio* Linnaeus, 1767, with a review of the genus *Proclio* Hubendick, 1951, (Gastropoda, Pteropoda), *Beaufortia* 9: 173-200, 10 text-figures, 2 diagrams.
- Taki, I. and Okutani, T. 1963. Reports on the biology of the "Umitaka-Maru" Expedition, Part 3. Journal of the Faculty of Fisheries and Animal Husbandry, Hiroshima University 5: 95-102, 1 text-figure, 2 tables, 1 plate.
- Tesch, J.J. 1946. The thecosomatous pteropods I. the Atlantic. Dana Report., 28: 1-82, 34 text-figures, 8 plates.
- , 1948. The thecosomatous pteropods, II. The Indo-Pacific, Dana Rept., 30: 1-44, 34 text-figures, 3 plates.

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## NOTES AND NEWS

MARGARET M. TEARE.—Mrs. Teare, who was a member of the American Malacological Union for over 20 years, and who attended many of its meetings, passed away after a brief illness, in Buffalo, New York, on June 13, 1967. She will be missed by her many friends.

CORRECTION.—Change 81 (2): 65, third line from bottom, to: *Mesodon indianorum lioderma* (Pilsbry), 1940, Acad. Nat. Sci. My apologies to author.—H. B. B.

FIELD METHOD FOR FOLLOWING LOCOMOTORY ACTIVITIES OF SAND-BURROWING GASTROPODS.—Many species of sand-dwelling marine gastropods crawl about over the sand surface at night, and remain buried in the sand during the day. In conjunction with studies on the ecology of terebrid species from Eniwetok Atoll, several unsuccessful attempts to follow the locomotory patterns of animals in the field were made, utilizing skin-diving techniques in water from three to seven meters deep. The large Indo-Pacific species of *Terebra* (*crenulata*, *guttata*, *maculata*, and *subulata*) lie buried with the apex of the shell just below the sand surface, and actively crawl over the sand with the apex dragging on the surface, thus producing a distinctive trail in the substratum. Under optimal field conditions, locomotory activities of the animals could be followed from day to day, but any disturbance of the sand obliterated the trails, thus limiting extended studies on individual specimens.

To solve this problem the animals were tagged by using two methods, both of which proved to be effective. For small specimens, a ten-centimeter length of thin nylon thread was securely tied between the first and second whorls, with the knot and free end directed dorsally. In large specimens a small hole (one millimeter diameter) was drilled through the solid apex of the shell, and the ten centimeter length of nylon was tied through this opening. In both cases a thin section of cork was firmly attached to the free end of the thread. Each cork section was painted fluorescent orange for easy location under water and was numbered with India ink. The animals were then easily located by the floating tag, whether they were crawling or buried. The tag had no apparent hindering effect on locomotion, and recovery of tagged animals in the field was highly successful.

Daily patterns of locomotion over a two-month period were followed by placing a plastic rod upright in the sand behind the apex of each buried animal. A numbered metal tag was attached to the rod to correspond with the numbered cork attached to the animal. Following each locomotory period the trail could be followed from the metal tag to the cork marking the location of the animal.

This tagging method should be applicable to field studies on other species of sand-dwelling gastropods, particularly when

studies on migratory activity require extended periods of daily observation.

Research at the Eniwetok Marine Biological Laboratory was sponsored by U.S. Atomic Energy Commission funds allotted to the University of Hawaii, and was carried out in partial fulfillment of the requirements of the M.S. degree at the University of Hawaii.—BRUCE A. MILLER (NDEA. Fellow), Department of Zoology, University of New Hampshire, Durham 03824.

FRESH-WATER MOLLUSKS EATEN BY TROUT AND OTHER FISH.—Several years ago, I received the stomach contents of 3 medium sized trout taken in a small lake in Snohomish County, Washington, on May, 1935. This small collection proves that fresh-water mollusks form an important diet for trout. In 1904-1910 I often caught yellow perch in Lake Union that had their bellies crammed with *Pisidium casertanum* or *abditum*. Pisidia are doubtless the most important food item for some bottom fish, especially in winter. Pisidia are usually the only mollusks in high mountain lakes and some species have a high northern and Antarctic distribution. I have often found them in abundance in lakes of N.E. Siberia, Kamchatka, Aleutian Is., Alaska and in the lakes of Antarctic S. Chile and Patagonia, as well as on Mt. Rainier and mountain lakes in the Cascades.

I have a series of most of the North American species of *Pisidium* and they are especially abundant in the Canadian lakes up to and beyond the Arctic Circle. Some specialists have spent nearly a life time in collecting and studying these tiny fresh-water clams. Dr. Sterki collected and described over 100 "new species" of *Pisidium* from slight shell variations. With more careful and conservative study, Rev. Herrington has reduced a large percentage of these to synonymy.

*Gyraulus*, *Physa*, *Lymnaea* and *Ferrissia* are also important molluscan food for shallow water fishes especially in small lakes, where there is an abundance of muddy water plants.

The most abundant shells in the stomachs of these fish were *Gyraulus*, *Menetus*, *Valvata* and *Ferrissia fragilis* which are mostly in shallow muddy water.

The following species of shells were taken from the stomach contents of the 3 trout. This list constitutes a census of most of

the species of fresh-water shells found in the small lakes of western Washington.

*Gyraulus vermicularis* (Gould).

*Menetus cooperi* F. C. Baker

*Helisoma anceps* (Menke).

*Physa gabbi* Tryon.

*Valvata virens* Tryon.

*Ferrissia fragilis* (Tryon).

*Pisidium randolphii* Roper.

*Pisidium casertanum* (Poli).

*Pisidium compressum* Prime.

Identifications were verified by Dr. Henry Pilsbry of Philadelphia Academy of Sciences. — WALTER J. EYERDAM.

N. S. F. GRANTS, FISCAL '66.—In keeping with the recent tabulation (Boss. 1967. *Nautilus*, 80: 141-2). I have again compiled a list of those scientists working in the various aspects of malacology who were awarded stipends from the National Science Foundation. These data were taken from the section on Biological and Medical Sciences Research Projects of NSF's grants and awards for the fiscal year ended June 30, 1966, available for one dollar from the U. S. Gov't Printing Office, Washington, D. C. 20402.

Bitterman, M. E. Learning in "*Octopus*" (GB4501); 24 months; \$13,100. Bryn Mawr College, Pennsylvania (Psychobiology).

Franzen, Dorothea S. Recent Succineidae of central North America (GB2715-Amdt. Nos. 1 and 2); \$6,900. Illinois Wesleyan University (Systematic biology).

Heard, William H. The Sphaeriidae of North America (GB-4626); 24 months; \$18,400. Florida State University (Systematic biology).

Kay, E. Alison. Littoral marine Gastropoda of the Hawaiian Islands (GB1346-Amdt. No. 1); 12 months; \$1,800. University of Hawaii (Systematic biology).

Kondo, Yoshio Archaic land snail families, Achatinellidae, Partulidae, and Amastridae (GB3974); 24 months; \$53,400. Bernice P. Bishop Museum, Honolulu, Hawaii (Systematic biology).

Little, Colin. Ionic regulation in "*Strombus gigas*" Linnaeus (GB4160); 24 months; \$10,300. University of Miami, Florida (Regulatory biology).

Loosanoff, Victor L. Development and spawning of different physiological races of "*Crassostrea virginica*" (Gmelin) (GB5250); 24 months; \$11,300. University of the Pacific, Dillon Beach, California (Environmental biology).

Margolin, Abraham S. Predator-prey relationships between echinoderms and molluscs (GB5157); 24 months; \$9,700. Phoenix College, Arizona (Psychobiology).

Menzel, R. W. Cytotaxonomy of species of related pelecypod mollusks (GB5034); 24 months; \$33,300. Florida State University, (Systematic biology).

Moore, Donald R. Systematics and zoogeography of western Atlantic Caecidae (GB5055); 24 months; \$20,000. University of Miami, Florida (Systematic biology).

Morrill, John B. Development of fresh water pulmonate molluscs (GB4393); 8 months; \$7,700. College of William and Mary, Virginia (Developmental biology).

Murray, J. James, Jr. Population genetics of the genus "Partula" (Gastropoda) (GB4188); 36 months; \$26,700. University of Virginia (Genetic biology).

Newell, Norman D. Late Permian mass extinctions of pelecypods in Japan (GB4003); 12 months; \$1,400. American Museum of Natural History, New York (Systematic biology).—K. J. Boss.

TWO NOTEWORTHY ACHATINIDS FROM PANAMA—During a recent short trip to southeastern Panama (Jan., 1967) the author collected two species of achatinid snails that previously had not been known from specific localities, *Opeas adamsi* Pilsbry and *Neosubulina (Ischnocion) triptyx* (Pilsbry). *O. adamsi* was described from "Panama" and *N. triptyx* was described from "Colombia" (1906, Man Conch., 11, Vol. 18: 216, 354). Neither species has been reported in the literature since its original description. I collected both species in a rain forest 2.5 mi. SW El Real, Tarien Prov., Panama, where they were found in small numbers among debris and leaf mulch.—FRED G. THOMPSON.

NEW LOCALITY FOR LIMAX MARGINATUS—Three specimens of *L. marginatus* Müller were collected at 526 East Huisache Street. San Antonio, Bexar County, Texas on May 29, 1967 by Sally Wiley. The specimens were found in early evening under wet leaves beneath a Pomegranate (*Punica*) bush after a rain. Additional specimen of *L. marginatus* have since been obtained from this locality. Although the maximum length of the largest specimen (approximately 40 mm.) is less than the length cited by Pilsbry (1948, Land Mollusca of North America, II (2):530), all specimens conform to the description of the species. *L. marginatus* is introduced to the United States from Europe and is herein

reported as the first record for Texas. We wish to thank Dr. Dee Dundee for verification of the specimens.—HAROLD T. MURRAY and SALLY WILEY, Trinity University, San Antonio, Texas.

PERMANENT WHOLE-MOUNTS OF SNAIL GENITALIA<sup>1</sup>.—Differences in the genitalia serve as major criteria for delimiting gastropod species, particularly in the Pulmonata. The potential value of a method of preserving dissected genitalia, in a near-natural state, is obvious. Although several techniques have been described for the preparation of whole mounts (Gregg, *Ann. Rept. Amer. Malac. Union*, p. 39, 1958; Michelson, *Nautilus*, 74:32-33, 1960), they have been found either to be time consuming, to require a high degree of technical skill, or to be inadequate for the large, bulky genitalia of many species. A technique has now been devised which is simple, rapid, inexpensive, and adequate for specimens of any size. Distortion is minimal and preparations retain their natural color. The technique combines methods proposed by Fan (*Turtox News*, 42:54-57, 1964) for mounting stages of helminth life-histories, and that of Waller and Eschmeyer (*Bioscience*, 15:361, 1965) for preserving color in biological specimens.

Mounts of genitalia are prepared in the following manner. The snail is removed from its shell and the genitalia are dissected in 50% alcohol. The genitalia are oriented in a drop of alcohol on a microscope slide, excess alcohol is removed, and the specimen is attached to the slide by adding a gelatin solution. (This solution is prepared by adding 4 gm of purified gelatin to 24 ml. of distilled water and boiling the mixture until the gelatin has completely dissolved; the solution is cooled to 45°C before use). Best results are obtained when a few drops of gelatin are allowed to flow over the entire specimen as a thin film. This film is permitted to solidify for 1-2 minutes, and then the preparation is carefully immersed in 10% formalin containing Ionol CP-40® (Shell Chemical Co.) at a concentration of 1:500. Ionol CP-40, a 40% emulsion of butylated hydroxytoluene, is an antioxidant that has been found effective in conserving the color of biological specimens.

Slide preparations may be stored indefinitely in Coplin jars

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<sup>1</sup> The investigation was supported in part by Grants AI-00513 and 5TI A-I 46 from the U.S. Public Health Service, Bethesda, Maryland.

containing the formalin-antioxidant mixture. When it is desired to examine the preparation the slide is rinsed for 30 seconds in running tap-water and then placed in a McJunkin dish or other suitable container and covered with 1% formalin. Slides may be returned to the formalin-antioxidant mixture for future storage.

In our experience, specimens remain free of distortion and retain their natural color for periods in excess of 8 months. The preparations are excellent for microscopic examination, camera lucida drawings, and photography.—E. H. MICHELSON, Dept. Tropical Public Health, Harvard School Public Health, Boston.

LAEVAPEX FRAGILIS ON THE OUTER BANKS OF NORTH CAROLINA.—The widely distributed fresh water limpet, *Laevapex fragilis* (Tryon), was found on Ocracoke Island during a brief visit July 4, 1967. It occurred at the head of a fresh water creek near the Ocracoke campground. The animals were fairly numerous on the submerged stem portions of *Typha* and *Juncus*. The water was clear and cool, the bottom sandy with very little decaying vegetation. Of 40 shells examined, one was septate.—DOROTHY E. BEETLE, Peninsula Nature Museum, Newport News, Va.

FICUS CAROLAE AND F. FLORIDENSIS. — A recent sending, by Mrs. Leon E. Chambers, of fossil shells from the Caloosahatchee Pliocene at LaBelle, Florida, included a specimen of *Ficus* which was recently described as *Ficus floridensis* Olsson and Harbison. A comparison with the Recent species, *F. carolae* Clench, indicates that both names apply to the same species.

*Ficus carolae* Clench.

*Ficus carolae* Clench, 1945, *Johnsonia* 1: no. 18, p. 3, pl. 2, fig. 1-3 (5-1½ miles SE. of the Elbow, Key Largo, Florida, in 92-100 fathoms). Holotype, MCZ. 157501.

*Ficus floridensis* Olsson and Harbison, 1953, *Acad. of Nat. Sci., Philadelphia*, Monographs no. 8, p. 258, pl. 41, fig. 3-3a (Pliocene, Willcox Collection, Caloosahatchee River, Florida.) Holotype, ANSB. 572.

In addition to the type locality, I have specimens of *Ficus carolae* from 5 miles E. of Carysfort Light, Florida (fragment) and from the Campeche Banks, Mexico. — WILLIAM J. CLENCH.

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## PUBLICATIONS RECEIVED

- Maes, Virginia Orr. 1967. The littoral marine mollusks of Cocos-Keeling Islands (Indian Ocean). *Proc. Acad. Nat. Sci. Philadelphia* 119: 93-217, 4 text figs & 26 pls.
- Roper, C. F. E. and R. E. Young. 1967, A review of the Valbyteuthidae and an evaluation of its relationship with the Chiroteuthidae (Cephalopoda: Oegopsida). *Proc. U. S. Nat. Mus.* 123, no. 3612: 1-9, map & 4 pls.
- Powell, A. W. B. 1967. Mollusca of the Kermadec Islands. Pt. 2. *Rec. Auck. Inst. Mus.* 6: 3: 197-199, 1 pl. New spp. of *Fusinus*, *Baryspira* and *Lutraria*.
- . 1967. New Zealand molluscan systematics with descriptions of new species; part 6. *Ibid.*, 6: 3: 185-196, 2 pls. New spp. of *Proxicharonia*, *Morula* and *Semele*.
- Fleming, C. A. 1966. Marwick's illustrations of New Zealand shells, with a checklist of New Zealand Cenozoic Mollusca. *Bull.* 173, Dept. Sci. Industrial Research, 456 pp., 145 pls.
- Wagner, R. J. L. and R. T. Abbott (editors). 1967, Van Nostrand's Standard Catalog of Shells. Princeton, N. J. Second edition, 303 pp., illus.
- Solem, Alan. 1964. New records of New Caledonian nonmarine mollusks and an analysis of the introduced mollusks. *Pacific Sci.* 18: 130-136.
- , 1965. Land snails of the genus *Amphidromus* from Thailand (Mollusca: Pulmonata: Camaenidae). *Proc. U. S. Nat. Mus.* 117 (3519): 615-628, & 2 pls.
- Turner, Ruth T. 1962. James H. Orton. His contributions to the field of fossil and recent mollusks. *Rev. Argention Cienc. Nat.* 8: 89-99, portrait.
- , 1965. Mussel. *Encycl. Brit.*: 2 pp., 2 figs.
- Tuthill, S. J., Wilson M. Laird & Ronald J. Kresl. 1964. Fossiliferous marl beneath Lower Campbell (Glacial Lake Agassiz) beach sediments. *Proc. N. D. Acad. Sci.* 18: 135-140, figs. 1-3, table 1.
- Tuthill, Laird & C. I. Frye. 1964. Fossil molluscan fauna from the upper terrace of the Cannonball River, Grant County, North Dakota. *Proc. cit.*: 140-156, 5 figs., 4 tables.
- Wear, Robert G. 1966. Physiological and ecological studies on the bivalve mollusk *Arthritica bifurca* (Webster, 1908) living commensally with the tubicolous polychaete *Pectinaria australis* Ehlers, 1905. 1966. *Biol. Bull.* 130: 141-149, 7 figs., 1 table.
- Weber, William A. 1965. Theodore Dru Alison Cockerell, 1866-1948. *Univ. Colo. Studies Bibliography* no. 1: 124 pp., portrait.



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# THE NAUTILUS

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No. 4

## DEATH FROM DESICCATION IN THE MUD-SNAIL, *NASSARIUS OBSOLETUS*: EFFECT OF TEMPERATURE

By CARL W. SCHAEFER, PETER MILCH, AND NORMAN L. LEVIN  
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Brooklyn, New York; and Haskins Laboratories, Inc., New York City.

*Introduction.* The mud-flat snail, *Nassarius obsoletus* (Say)<sup>1</sup>, may be exposed to a wide range of temperatures over both the daily and the yearly cycles. The extremes of temperature are considerably lessened by the snails' habit of burrowing into wet mud, or retreating into the littoral zone. Nevertheless, the snails at Jamaica Bay, New York, may experience a yearly range of 1-31°C (water-temperatures, Levin and Fennel, unpubl.); the tissue temperature of the snails probably does not vary more than a few degrees from that of the water (data of Lewis, 1963). Even on hot days *Nassarius* may be found exposed on the mud, which suggests a considerable ability to withstand heat.

Several observations have been published on the abilities of various snail species to withstand exposure to high temperatures and/or desiccation (e.g., Cawston, 1929; Fischer, 1939; Evans, 1948; Mattox, 1949; Fraenkel, 1961; Segal and Dehnell, 1962; and Hunter and Meadows, 1965). Few of these have described experiments which controlled temperatures; however (Brown's papers (1960, 1961) are an exception), and there is very little work of this kind on *Nassarius*.

As a preliminary and as a stimulus to more work on *Nassarius*, we present here some data on the mortalities of *Nassarius* desiccated at two temperatures (11° and 25°C) commonly experienced by the snails. A companion paper (Schaefer, Milch, and Levin, in press (abstract, 1967)) considers the effect of trematode parasitism on desiccatory water-loss in *Nassarius*. Much more work is needed on the interrelated effects on *Nassarius* of temperature, desiccation, salinity, and trematode parasitism.

*Methods and materials.* Snails were collected weekly from the mud-flats at Jamaica Bay, New York. They were kept in fresh

<sup>1</sup> Placed in the genus *Ilyanassa* by some workers.

TABLE 1

Mortality and Weight-loss of Nassarius Desiccated at 11°C

Hours of desiccation	No. snails	No. (%) dead	Average weight-loss (%)
0.6-0.9g			
96	24	7 (29%)	18.6%
120	24	18 (75%)	21.4%
144	24	22 (92%)	20.7%
168	24	24 (100%)	23.0%
192	20	20 (100%)	24.4%
1.0-1.39g			
96	28	7 (25%)	19.3%
120	36	27 (75%)	21.7%
144	36	21 (58%)	20.1%
168	36	35 (97%)	21.9%
192	40	40 (100%)	23.9%
>1.4g			
96	7	1 (14%)	18.5%
120	7	5 (72%)	20.2%
144	7	6 (86.6%)	19.8%
168	7	7 (100%)	19.0%
192	7	7 (100%)	22.8%
<u>combined</u> (all snails)			
96	64	16 (25%)	18.8%
120	67	50 (75%)	21.1%
144	67	49 (73%)	20.2%
168	67	66 (98.5%)	21.3%
192	67	67 (100%)	23.7%

sea-water at 11°C and used within 24 hours after collection. Four arbitrary weight-classes were set up (less than 0.6g., 0.6-0.9g., 1.0-1.39g., greater than 1.4g.) to make the data easier to interpret.

Desiccation was over anhydrous  $\text{CaSO}_4$ , changed or dried after each experiment. One to 10 snails were put in small porcelain

TABLE 2

Mortality and Weight-loss of Nassarius Desiccated at 25°C

Hours of desiccation	No. snails	No. (%) dead	Average weight-loss (%)
<0.6g			
39	5	1 (20%)	16.6%
45	4	4 (100%)	27.6%
0.6-0.9g			
48	20	9 (45%)	17.3%
60	24	14 (58.5%)	17.4%
72	24	20 (83.5%)	20.4%
84	24	23 (96%)	20.7%
96	24	24 (100%)	23.2%
1.0-1.39g			
48	40	3 (7.5%)	13.7%
60	40	5 (12.5%)	15.1%
72	40	15 (37.5%)	17.2%
84	40	25 (62.5%)	18.5%
96	40	38 (95%)	21.0%
>1.4g			
48	11	0 (0%)	12.1%
60	11	2 (18%)	12.8%
72	11	6 (54.5%)	17.2%
84	11	10 (91%)	17.0%
96	12	12 (100%)	18.3%
<u>combined</u> (snails > 0.6g)			
48	71	12 (17%)	14.3%
60	75	21 (28%)	15.1%
72	75	41 (55%)	18.2%
84	75	58 (77.5%)	18.7%
96	76	74 (97.5%)	20.8%

crucibles; our data showed that up to 10 snails per crucible could be studied at once without influencing mortality or weight-loss.

Viability was tested by removing snails from the desiccators at stated times and putting them individually in vials of fresh sea-water. Snails were considered dead if they did not respond to touch after 12 hours in sea-water. In earlier experiments (not

reported here), snails were tested for only 2 hours. This indicated an apparent rate of mortality that subsequent experiments showed to be too high. The 12-hour test gave the most reproducible results.

Weight-loss was calculated (initial minus final weights) and is given in the Tables as the percentage lost from the initial weight. It is assumed that all weight decrease represents the loss of water.

#### RESULTS AND DISCUSSION

The results are presented in Tables 1 and 2. As one would expect, the higher the temperature, the sooner death occurs from desiccation: after 96 hours, the death-rate was 25% at 11°C, and 97.5% at 25°C. Other (unpublished) data indicate that, at 37°C, all snails die after 30-34 hours.

There is some suggestion in these figures that death is caused not only by the amount of water lost but also by the length of time over which it is lost. Thus at 25°C, nearly 100% mortality occurred when 20.8% weight had been lost (96 hours). At 11°C, all snails were dead with the greater average loss of 23.7% (172 hours). Conversely, when 25°C snails had lost 18.7% water (84 hours), 77.5% were dead; of 11°C snails that had lost that much (at 96 hours), only 25% were dead. Apparently then, if water is lost slowly (at low temperatures), more of it can be lost before death results. Since desiccation is slower at lower temperatures, snails at 11°C can withstand it better than those at 25°C (25°C is of course a temperature to which snails are commonly exposed).

Smaller snails are in general more susceptible than intermediate ones, as is the case in the moisture-needing aquatic snails. *Oncomelania nosophora* (Robson) (Komiya and Hashimoto, 1958) and *Pomatiopsis cincinnatiensis* (Lea) (van der Schalie and Getz, 1961). Smaller specimens of the marine snail, *Thais floridana*, also are the first to succumb to osmotic shock (Schechter, 1943). In all these cases this increased susceptibility of the young is probably due to the increased surface relative to volume. This suggests that some water may be lost from the surface through the shell (which is thinner in smaller snails), as well as through the opercular opening. Our results for intermediate snails (1.0-1.39 grams) at 144 hours at 11°C appear anomalous.

This inverse relation of size to mortality holds only for snails of the same species. Smaller species may be *more* resistant than



larger related ones. Data recalculated from Brown (1961) show that all *Bullia digitalis* Meuschen [now *Bullia achatina* Lamarck], desiccated at 19°C, die when they have lost 21.1% of their total body weight. The much larger *B. laevissima* (Gmelin) shows 100% mortality after a loss of only 5.5%. Moreover, the shell of the more resistant but smaller *B. digitalis* is a much lower percentage of the total weight, and therefore thinner than that of *B. laevissima*.

Larger *Nassarius* (greater than 1.4g.) have a greater mortality than intermediate ones, at 25°C. The larger snails are old (probably more than 2 years) and perhaps somewhat weakened by age. This would render them more susceptible to the effects of the rapid water-loss at 25°C, and mortality in this size-class is higher than in the intermediate class. At 11°C water is lost more slowly, and the relatively less surface area of larger snails is sufficient to compensate for the weakness of age. Thus at this temperature large and intermediate snails have nearly the same mortalities.

*Nassarius* in sea-water die quickly at high temperatures. Orr (1955) found death occurring in less than an hour at 42-46°C. Vernberg and Vernberg (1963) found that these snails had a high mortality at 37°C in 9 hours; complete mortality at 39°C in 5 hours, and at 41°C in 2 hours. Since our unpublished data suggest that snails live for 30-34 hours when desiccated at 37°C, it may be that desiccation in some way ameliorates the lethal effect of high temperatures.

In conclusion these preliminary results indicate that mortality from desiccation is a function of size, age, and temperature (as influencing rate of water-loss and, perhaps, other phenomena). Further study is needed to confirm these suggestions, to examine more closely their interrelationships, and to consider just how the loss of water kills.

*Acknowledgements.* We are grateful to the Graduate Division of the City University of New York, which supported part of this work.

#### REFERENCES CITED

- Brown, A. C. 1960. Desiccation as a factor influencing the vertical distribution of some South African Gastropoda from intertidal rocky shores. Portug. Acta Biol. (B) 7: 11-23.  
———. 1961. Physiological-ecological studies on two sandy-beach Gastropoda from South Africa: *Bullia digitalis* Meuschen and

- Bullia laevissima* (Gmelin). Z. Morph. Oekol. Tiere 49: 629-657.
- Cawston, F. G. 1929. The resistance of Limnaeidae to desiccation. Trans. Roy. Soc. Trop. Med. Hyg. 22: 335-338.
- Evans, R. G. 1948. The lethal temperatures of some common British littoral molluscs. J. Anim. Ecol. 17: 165-173.
- Fischer, P. H. 1939. Resistance a l'exondation chez quelques mollusques marins. J. Conchyliologie 83: 35-38.
- Fraenkel, G. 1961. Resistance to high temperatures in a Mediterranean snail. *Littorina neritoides*. Ecology 42: 604-606.
- Hunter, R. W. and R. T. Meadows. 1965. Aspects of water physiology in the salt-marsh pulmonate snail, *Melanpus bidentatus*. Biol. Bull. 129: 409.
- Komiya, Y. and I. Hashimoto. 1958. The survey of *Oncomelania nosophora*, the vector snail of *Schistosoma japonicum* under the dried condition and their water loss. Jap. J. Med. Sci. & Biol. 11: 339-346.
- Lewis, J. B. 1963. Environmental and tissue temperatures of some tropical intertidal marine animals. Biol. Bull. 124: 277-284.
- Mattox, N. T. 1949. Effects of drying on certain marine snails from Puerto Rico. Ecology 30: 242-244.
- Orr, P. R. 1955. Heat death I. Time-temperature relationships in marine animals. Physiol. Zool. 28: 290-294.
- Schaefer, C. W., P. Milch, and N. L. Levin. (in press). Effects of trematode infection on resistance to desiccation in the mud snail *Nassarius obsoletus* (Say). Mar. Biol. Assoc. India, Symp. Series 3. (abstract, 1967, Adv. Abstr. Contrib. Fish. Aquat. Sci. India 1: 66-67.)
- Schalie, H., van der, and L. L. Getz. 1961. Comparisons of adult and young *Pomatiopsis cincinnatiensis* (Lea) in respect to moisture requirements. Trans. Amer. Micr. Soc. 80: 211-220.
- Schechter, V. 1943. Tolerance of the snail *Thais floridana* to waters of low salinity and the effect of size. Ecology 24: 493-502.
- Segal, E. and P. A. Dehnel. 1962. Osmotic behavior in an intertidal limpet, *Acmaea limatula*. Biol. Bull. 122: 417-430.
- Vernberg, Winona and F. J. Vernberg. 1963. Influence of parasitism on thermal resistance of the mud-flat snail, *Nassarius obsoleta* Say. Exptl. Parasitol. 14: 330-332.

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## ON A COLLECTION OF TERRESTRIAL MOLLUSKS FROM NICARAGUA

BY MORRIS K. JACOBSON, ASSOCIATE  
American Museum of Natural History, New York

Approximately 70 species and subspecies of land mollusks are known to occur in Nicaragua, many parts of which have yet to be intensively collected (Jacobson, 1965). To this apparently

impoverished fauna, an additional 4 species may be added as a result of the present study.

This paper records the mollusks obtained on a brief collecting trip made by the author in the company of Mr. Walter Smit to the district of Bonanza, a mining town in the north central part of the country in the Department of Zelaya (approximately 14° 2' N, 84° 55' W), in February - March, 1965. Collections were also made at Managua, Federal District. Added to this account are notes on specimens collected by Mr. Vance Greene while in Asang, 7 miles west of San Carlos, on the Cocos River, and in Quemiguas, Cerro del Tigre Negro, Department of Zelaya.

The country at Bonanza is hilly, with a well-forested cover, which locally has the appearance of a rain forest. At the time of our visit, rainfall was sufficient to keep the ground cover of the forest moist. However, the soil is not calcareous, and land shells were not easily found. At Asang, a heavily wooded region, live specimens were found under leaf mold and among rocks or boulders. The collecting area at Quemiguas was described previously (Jacobson, 1966: 102). At Managua, the capital city, all species were taken dead, since this was the dry season for this area.

Most of the specimens recorded here were deposited in the American Museum of Natural History; duplicates were contributed to the Museum of Comparative Zoology, Harvard, and the U. S. National Museum. A series of the cyclophorids were presented to the Field Museum of Natural History.

This account includes also the description of a new species of Nicaraguan *Streptostyla* which was first cited as a nude name by Fluck (1906: 4).

The writer wishes to express his thanks for the hospitality extended to him by Messrs. James R. Stringham, Walter Smit and others of the local management of the Neptune Mining Company during his stay at Bonanza. Dr. William K. Emerson kindly read the manuscript.

Abbreviations used for institutions:

AMNH. — American Museum of Natural History

ANSP. — Academy of Natural Sciences of Philadelphia

USNM. — U. S. National Museum

*Helicina (Oxyrhombus) amoena* Pfeiffer 1849. Constancia Mine, Bonanza: several dead specimens, one live on leaves of a low bush.

*Helicina (Tristramia) rostrata* Morelet 1851. Quemiguas, Cerro del Tigre Negro: 4 dead specimens, one live. The specimens vary in diameter from 13.2 to 10.1 mm. It is possible that the extremes of differences in size represent sexual dimorphism.

*Helicina (Oligyra) oweniana* Pfeiffer 1849. Quemiguas, Cerro del Tigre Negro: 2 specimens. This is the first record of this species from Nicaragua. One of the specimens has the orange peristome of *H. coccinostoma* Morelet (1849), a synonym; in the other the peristome is white.

*Neocyclotus dysoni dysoni* (Pfeiffer) 1851. Constanca Mine, Bonanza: 2 live specimens; Bonanza: 1 dead. These almost gerontic specimens have the basal notch on the outer lip which is characteristic of *Cyclotus bisinuatus* von Martens 1864. However, it seems advisable to follow Solem (1956, p. 54) and personal communication (September 7, 1965) in considering this a synonym. Solem feels that the "development of a basal notch appears to be a gerontic character of no value in separating races." (1956) The fact that the taxon of von Martens has two apparent notches is also of little importance, for, as von Martens himself writes (1890, p. 3) "The margin of the aperture can be injured, probably by the animal grazing . . . to satisfy a demand for lime." Von Martens thought *N. bisinuatus* might be synonymous with *irregularis* Pfeiffer from Costa Rica.

*Mexcyclotus chrysacme* (Bartsch & Morrison) 1942. Asang, Cocos River: 11 dead, 13 live specimens. This species was originally described from Wani as *Aperostoma (Neocyclotus) chrysacme*. The present lot was forwarded to Solem who stated *in litteris*, "After seeing your shells, I think *chrysacme* is a valid species, but in *Mexcyclotus*, not in *Neocyclotus*. Previously the operculum was unknown." The type lots of *chrysacme* (2 specimens each in USNM, ANSP) are dead, whitened shells, with the first 1.5 whorls straw colored or pinkish. In the series taken at Asang the earlier whorls of young shells are shining and brownish in color which becomes straw shade as the shell matures. Moreover, the protoconch is not entirely smooth, but especially in young shells it is very thickly and finely covered with minute granulations that tend to disappear as the shell reaches maturity. The freshly taken shell has a uniformly light brown periostracum which is lost when the shell is dead, giving place to the "golden" color

and "hydrophanous zones" referred to in the original description.

*Chondropoma callipeplum* Solem 1961. Asang; Río Cocos: numerous specimens. This species was originally described from near Wani, in north central Nicaragua. The large lot taken at Asang, almost 120 km north of Wani and on the Honduran border, connects the present species, the only one of its genus in Nicaragua, with its congeners in the richer chondropomid fauna to the north. Its presence in Nicaragua contradicts Tate's views on this fauna (1870, p. 162) and extends the West Indian influence on the Central American shell fauna more to the south.

*Vaginulus (Latipes) occidentalis* (Guilding) 1825. Constanica Mine, Bonanza: 2 live specimens. H. B. Baker (1926, p. 29) believes *occidentalis* to be the predominant species of *Latipes* and writes, ". . . (it) has invaded most cultivated areas around the Caribbean." It will probably be found to be widely spread in Nicaragua and elsewhere in Central America.

*Succinea recisa* Morelet 1851. Parque de los Piedrecitas, Managua: several dead specimens near flower beds. As far as could be learned, this species is known from the shell only. Anatomical investigation will be needed to establish its true taxonomic position. There is some confusion regarding the shell differences between this species and *S. guatemalensis* Morelet 1849. According to figures in Fischer & Crosse (1878, pl. 26, fig. 13, 13a), *recisa* has a higher spire than *guatemalensis*, yet these authors write of it (p. 655), "This species (i.e. *recisa*) is remarkable because of the extreme brevity of the spire compared to the last whorl, which forms by itself almost the entire shell." (Translated)

*Deroceras laeve* (Mueller) 1774. Along road to Concha Urrutia, Bonanza, under wet leaves: 6 specimens. This widely spread immigrant from Europe has appeared under many synonyms in America (see Pilsbry 1948, 546 ff.)

*Subulina octona* (Bruguière) 1792. Along road to Concha Urrutia, Bonanza: numerous live and dead specimens.

*Lamellaxis (Allopeas) gracilis* (Hutton) 1834. Mercedes Airport, Managua; Parque de las Piedrecitas, Managua; cemetery at Tindirí, Masaya: numerous dead specimens.

*Lamellaxis (Allopeas) micrus* (d'Orbigny) 1835. Parque de las Piedrecitas, Managua: several dead specimens.

*Euglandina cumingi* (Beck) 1837. In banana plantation and

on grounds of Moravian Mission, Bonanza: 5 live specimens.

*Salasiella pulchella* (Pfeiffer) 1857. Asang, Cocos River: 9 specimens. This is the first record of this species in Nicaragua. It has been reported from Chiapas, Mexico, and Costa Rica.

*Lacteoluna selenina* (Gould) 1848. Parque de las Piedras, Managua: 1 specimen. The dead and worn specimen is provisionally determined. This species has not been reported previously from Nicaragua.

**STREPTOSTYLA (CHERSOMITRA) WANI new species.**

Page 120, upper 2 figs.

*Streptostyla flucki* Bartsch, Fluck, 1906, p. 4 (nude name).

Shell thin, elongate-ovate, almost turritid, glossy, sculptured only by fine, uneven growth lines. Whorls 8, weakly rounded, gradually descending. Protoconch glassy, faintly punctate, sharply elevated over the first post-nuclear whorl. Body whorl large, about twice the height of the spire, hardly inflated, peristome scarcely convex. Base evenly rounded. Suture shallow, simple, with a narrow secondary line on the last 3 whorls, widest at the body whorl near the aperture. Aperture narrow, about one-half the length of the shell, columella slightly twisted, edged with a rather strong callus cord.

Length 32 mm., Diameter 13 mm., Length of aperture 17 mm.

Length 21.5 mm., Diameter 9 mm., Length of aperture 14 mm. (juvenile)

Type locality: near Wani (Huani), Nicaragua, Rev. W. H. Fluck leg.

The new species resembles *S. vancegreenei* Jacobson 1966 in the nature of the columellar cord and especially in the elevated protoconch. It differs chiefly in having a decidedly more slender shell. The holotype is a dead shell divested of periostracum except for tiny fragments. The paratype is an immature shell, freshly taken, which shows a glossy, light orange-yellow periostracum.

Type depository: USNM. No. 426028, Holotype. ANSP. No. 97592, Paratype.

I wish to express my gratitude to Drs. Joseph Rosewater and J.P.E. Morrison of the USNM. and to Dr. R. Tucker Abbott of the ANSP. for the loan of the specimens involved. Photographs courtesy of AMNH.

*Streptostyla* (*Chersomitra*) *vancegreenae* Jacobson 1966. See Nautilus, 79: 101-103, fig. 1.

*Bulimulus* (*Bulimulus*) *corneus* Sowerby 1833. Along the sides of Rosita Road under wet leaves, Constancia Mine, Bonanza; in banana plantation, Bonanza; Parque de las Piedrecitas, Managua, along the edge of flower beds: many dead and live specimens. This proved to be one of the commonest larger species in the limestone-free area of Bonanza.

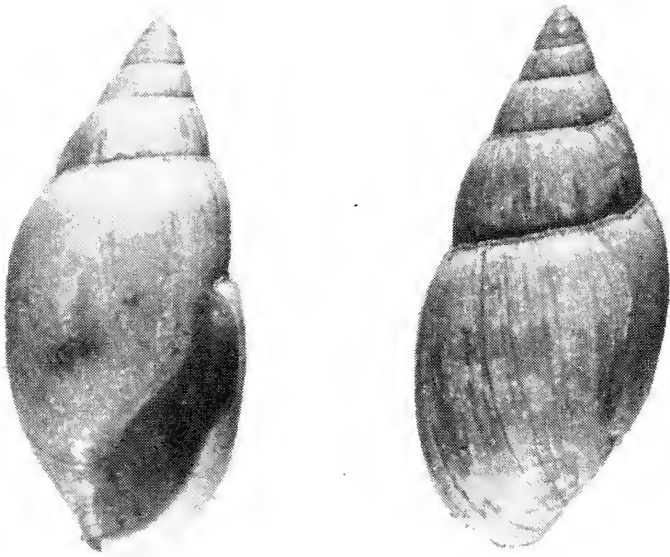
*Orthalicus princeps* (Broderip) 1833. Constancia Mine, Bonanza on road to Rositas: 4 dead specimens; Quemiguas, Cerro del Tigre Negro: 3 dead specimens.

*Praticolella griseola* (Pfeiffer) 1841. Cemetery at Tindirí, Masaya; Parque de las Piedrecitas, Managua: numerous dead specimens.

*Averellia* (*Trichodiscina*) *coactiliata* (Férussac) 1838. Bonanza: 1 dead specimen.

#### LITERATURE CITED

- Baker, H. Burrington, 1925, Proc. Acad. Nat. Sci. Philadelphia, 77: 157-184.  
——— 1926, *ibid.* 78: 29-34, pl. 4.  
Fischer, P. & H. Crosse, 1878, Mission Scientifique au Mexique et dans l'Amérique Centrale, Paris, Succineidae, pp. 643-671, pls. 26, 27.  
Fluck, W. H., 1906, Naut., 20: 1-4.  
Jacobson, Morris K., 1965, Annual Reports, American Malacological Union, p. 3.  
——— 1966, Naut., 79: 101-103, fig. 1.  
Martens, Eduard von, 1890, Biologia Centrali-Americana, London, Cyclophoridae, p. 1-11, pl. 1.  
Pilsbry, Henry A., 1948, Land Mollusca of North America, Limacidae, 2: 521-565, fig. 282-301.  
Solem, Alan, 1956, Proc. Acad. Nat. Sci. Philadelphia, 108: 41-59, pl. 5, 6.  
Tate, Ralph, 1870, American Jour. Conchology, 5: part 3, 151-162, pl. 16, fig. 2-5.
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*Streptostyla wani* Jacobson. About 1.6 x.

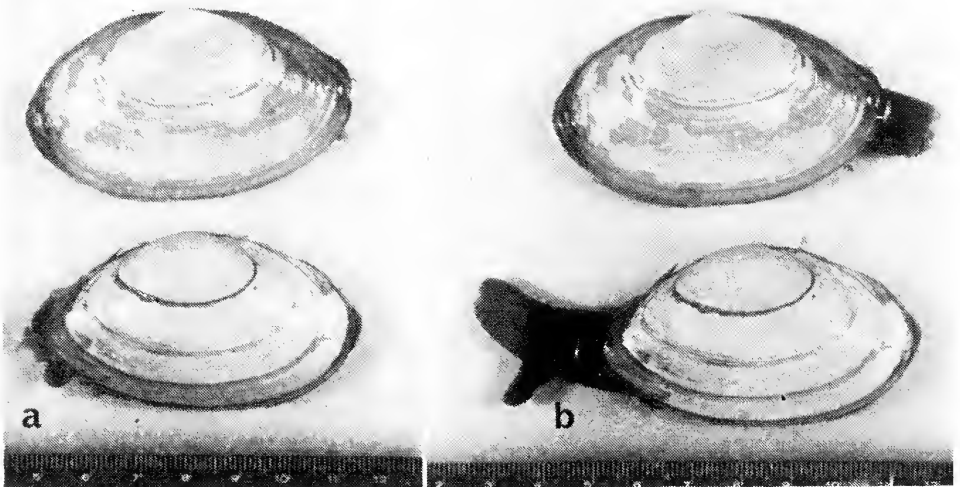


Figure 1. Soft-shell clam with a nonfunctional supernumerary appendage on the incurrent siphon: a) siphons retracted, normal clam above and clam with anomalous siphonal condition below; b) same specimens, showing semi-extended siphons and the lack of tentacles on the distal end of the appendage.



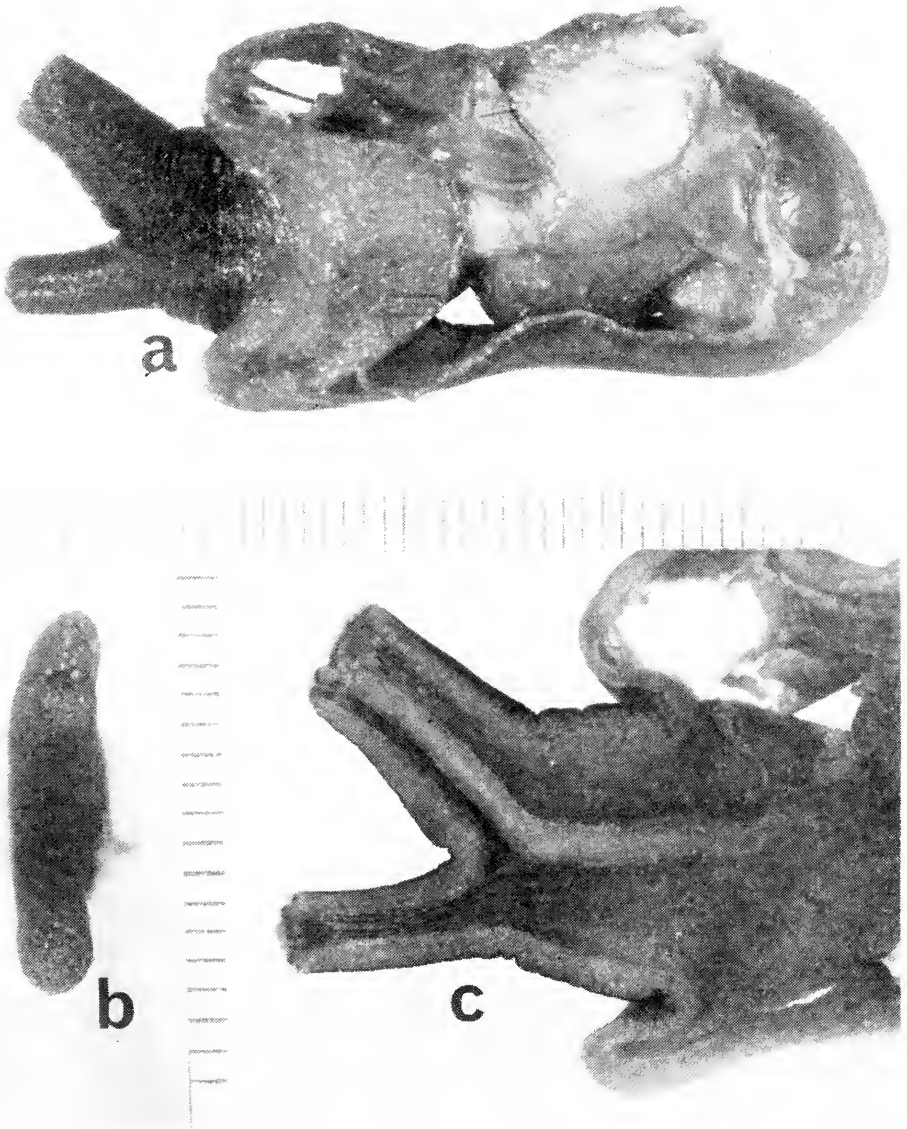


Figure 2. Soft-shell clam with a bifurcated incurrent siphon: a) the shucked, preserved specimen; b) view of the distal portions of the siphons; and c) a freehand sagittal section showing the pigmentation and the continuity of the siphonal lumina. The three illustrations are oriented in relation to each other; the scale is in millimeters.

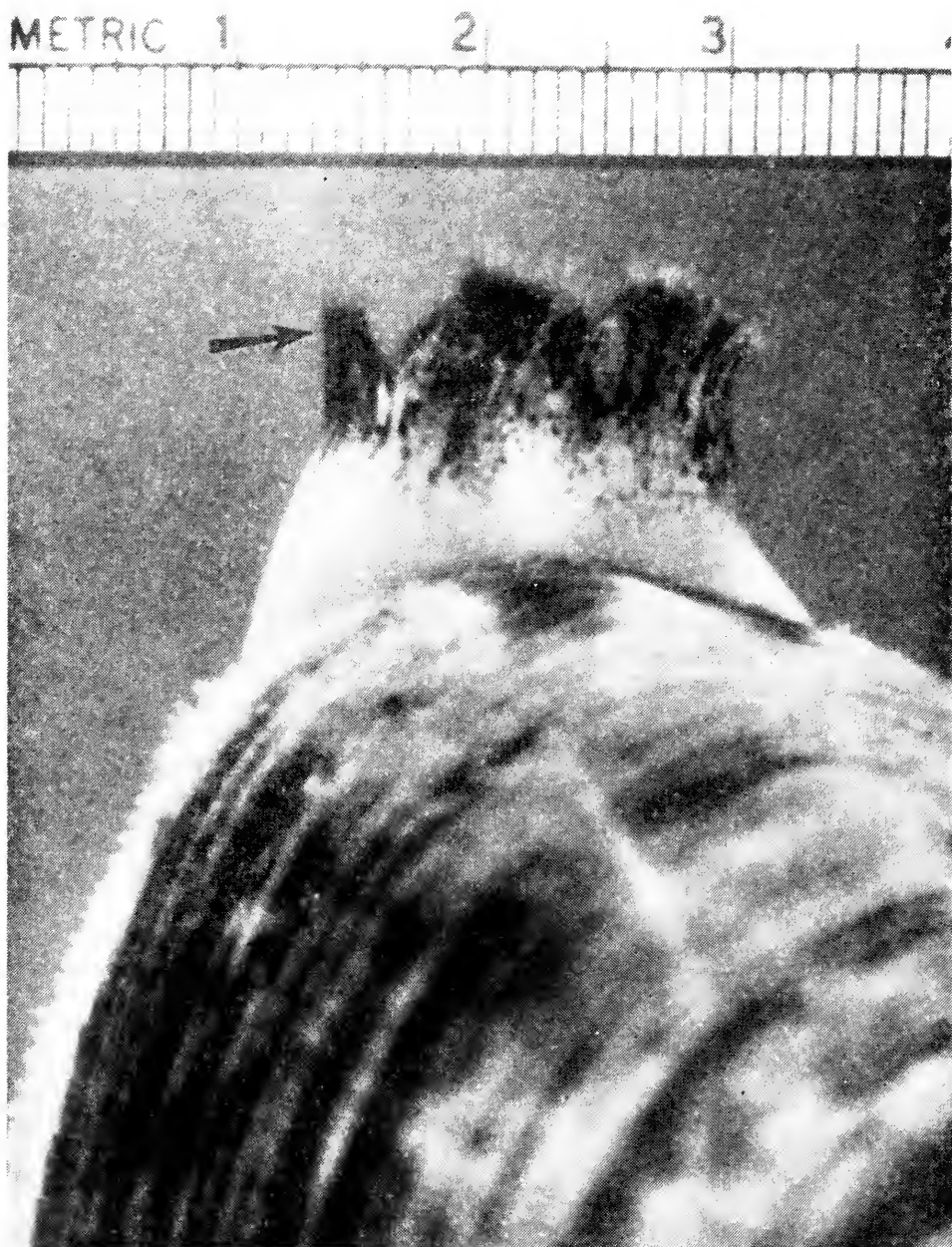


Figure 3. Northern quahaug with a nonfunctional supernumerary appendage (arrow) on the incurrent siphon; tentacles are apparent on the appendage.

## ANOMALOUS SIPHONS IN TWO SPECIES OF BIVALVE MOLLUSKS

BY HASKELL S. TUBIASH<sup>1</sup>, CARL N. SHUSTER, JR.<sup>2</sup>  
AND JOHN A. COUCH<sup>1</sup>

This report concerns anomalous siphonal structures of the soft-shell clam, *Mya arenaria*, and the northern quahaug, *Mercenaria mercenaria*. Unusual shell configurations of these two species have been reported (Morse, 1928; Blake, 1929; Fisher, 1932; Parker, 1932; Clench, 1948; and Shuster, 1966). None of these shell malformations appear to be related to the siphonal aberrations considered here and to our knowledge these anomalies have not been described previously. Three specimens formed the basis for this report; specimens 1 and 2 were soft-shell clams and specimen 3 was a quahaug.

*Specimen 1* (Page 120, fig. 1) was discovered among a group of clams collected in Chesapeake Bay and maintained at the Oxford Biological Laboratory for experimental use. Except for the supernumerary portion of the incurrent siphon, specimen 1 appeared normal in all respects. The tip of the supernumerary process was clearly apparent, even when the siphons were fully retracted (fig. 1a). When the siphons were extended, this process projected about midway along the ventral aspect. In the living, relaxed animal, the anomalous process was about 12 mm. long and had proximal and distal diameters of approximately 7 and 5 mm., respectively (fig. 1b). This supernumerary process could contract and expand, but not as much as the primary siphons. Terminal tentacles similar to those surrounding the lumina of normal siphons were absent.

The accessory siphon was dissected along its longitudinal axis and across the axis of the normal siphons. The interior of the accessory process was a short blind sac anastomosed to the adjacent incurrent siphon, but the lumen did not extend to the distal end. Histological examination revealed a predominance of longitudinal muscle fibers at the proximal end of the process, and a mixture of circular and longitudinal fibers at the distal

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end. There was no evidence of previous injury, of active cellular proliferation, or of neoplastic activity to account for the anomaly.

*Specimen 2* (fig. 2a) was collected in New Hampshire and donated to the Northeast Marine Health Sciences Laboratory. It was received shucked and preserved in rubbing alcohol. This specimen had 3 normal-appearing siphonal orifices with surrounding tentacles (fig. 2b). A freehand sagittal section of the siphons showed that the incurrent siphon was bifurcate with connecting lumina and normal pigmentation (fig. 2c).

*Specimen 3* was discovered among locally harvested quahaugs at the Northeast Marine Health Sciences Laboratory, where staff members observed its siphonal activity. The incurrent siphon (fig. 3) had a supernumerary structure on the ventral wall. This anemone-like projection terminated in a distal whorl of tentacles, not unlike normal siphons, but a functional opening seemed to be lacking. Several observations, with and without the use of dyes, failed to demonstrate passage of water into or out of the projection, whereas the normal portion of the siphons showed the usual water circulation. Pigmentation of the projection was continuous with that of the incurrent siphon. Activity of the siphons, particularly during extension and retraction, indicated that the musculature of the accessory projection was closely associated with that of the siphon proper. The specimen died and decomposed before additional information could be obtained.

These three examples show that similar siphonal anomalies may occur among two nonrelated species of bivalve mollusks. The causes of the anomalies are unknown to us, but they may be the result of genetic or developmental aberrations or predator injury. Crabs and fish are known to prey on siphon ends of clams (Morse, 1919; Turner, Ayers and Wheeler, 1948; Medcof and MacPhail, 1952), but *Mya* can survive siphonal injury and often regenerates normal tentacles (Belding, 1930; Medcof and MacPhail, 1952). Whether an incision or the loss of a small portion of siphonal tissue could lead to the formation of a supernumerary siphon or accessory process is a matter of speculation.

*Acknowledgements.* We thank Judith Young, Dover, New Hampshire, for donating Specimen 2. Paul W. Heffernan discovered Specimen 3 and Frances C. Garb assisted in observations of its siphonal activity.

## LITERATURE CITED

- Belding, D. L. 1930. The soft-shelled clam fishery of Massachusetts. Mass. Marine Fisheries Ser., No. 1: 1-65.
- Blake, J. H. 1929. An abnormal clam. *Nautilus*, 38 (3): 89-90.
- Clench, W. J. 1948. A remarkable malformed specimen of *Venus compechiensis* Gmelin. *Revista Soc. Malacol.*, 6 (1): 10.
- Fisher, N. 1932. Malformation in *Mya arenaria* L. *J. Conchol.*, 19 (8): 270.
- Medcof, J. C. and J. S. MacPhail. 1952. The winter flounder — a clam enemy. *In: Fish. Res. Bd. of Can., Prog. Rept. No. 52*: 3-8.
- Morse, E. S. 1919. Observations on living lamellibranchs of New England. *Proc. Boston Soc. Nat. Hist.*, 35 (5): 139-196.
- Morse, E. S. 1923. An abnormal shell of *Mya arenaria*. *Nautilus*, 36 (1): 28-30.
- Parker, G. H. 1932. An unusual living inclusion in the shell of a clam. *Ecology*, 8 (1): 102-103.
- Shuster, C. N., Jr. 1966. A uniquely shaped quahog. *Maritimes*, 10: 14.
- Turner, H. J., Jr., J. C. Ayres, and C. L. Wheeler. 1948. Further observations on predators of the soft-shell clam. *In: Report on Investigations of the Propagation of the Soft-Shell Clam, Mya arenaria*. Mass. Dept. Conservation, Div. Marine Fisheries. Woods Hole Oceanographic Institute Contribution No. 462: 47-49.
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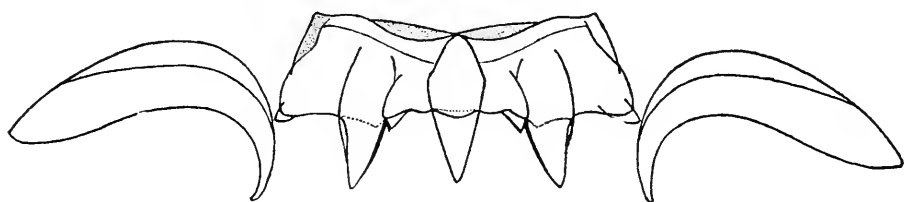
**AZUMAMORULA, NEW NAME FOR MORULINA DALL,  
1923, NOT BOERNER, 1906. (GASTROPODA: MURICACEA)**

BY WILLIAM K. EMERSON

American Museum of Natural History

Dall (1923, p. 303) proposed the generic name *Morulina* for small, *Morula*-like shells lacking a columellar plait, and he designated *Ricinula mutica* Lamarck (1816, pl. 395, figs. 2a, 2b; Liste p. 1) the type species. Thiele (1931, p. 294) and Wenz (1941, p. 1112) subsequently placed *Morulina* in the genus *Drupa* (*sensu lato*) Röding, 1798, near the "subgenus" *Cronia* H. and A. Adams, 1853. Largely on the basis of Cooke's (1919, p. 106) brief description of the radular characters of "*Morula mutica*, Lam[arck]" from Umkomaas, South Africa, Arakawa (1965, pp. 121-123) assigned several *Morula*-like species from Japanese waters to Dall's *Morulina*. Arakawa concluded that the rachidian teeth of these species: *anaxares* Kiener, *cavernosa* Reeve, *fusca* Küster, *musiva* Kiener, and *paucimaculata* Sowerby, are similar to those

possessed by the genus *Cronia* H. and A. Adams (1853, p. 128), with *Purpura amygdala* Kiener (1836, p. 39) the type species by monotypy. But unlike the rachidian teeth of *Cronia*, Arakawa found in these species, “. . . the inner denticle tends to locate adhering more closely to the lateral cusps than to the central, and the base is rather narrow.” In the genus *Morula* Schumacher (1817, p. 227), type species by monotypy: *Morula papillosa* Schumacher, 1817 [= *Drupa uva* Röding, 1798], the margins of the rachidian teeth possess denticle-like wrinkles which indent the surface and may terminate marginally as small serrations.



Rachidian tooth and lateral teeth of *Ricinula mutica* Lamarck, the type species of *Azumamorula* Emerson; anterior views,  $\times 300$ . (Drawing courtesy of M. Azuma and A. D'Attilio).

At my request, Mr. Masao Azuma of Nishinomiya, Japan recently extracted the radulae from specimens of *Ricinula mutica* Lamarck that were collected near Black River Bay, Mauritius by Ruth Ostheimer and Virginia Orr Maes, in 1960 (AMNH. 108374). An illustration of the rachidian and lateral teeth of this taxon presented herein (text figure 1) was prepared by Mr. Anthony D'Attilio from a drawing kindly provided me by Mr. Azuma. The rachidian teeth of Lamarck's taxon, the type species of *Morulina* Dall, possess characteristics intermediate between typical muricid and thaisid radulae, and it seemingly represents a valid generic group, which, largely on conchological characters, I tentatively place near the genus *Morula*.

Dall's *Morulina*, however, is not an available name, because it is a junior homonym of the insect *Morulina* Börner (1906). A new name, *Azumamorula*, is proposed here to replace *Morulina* Dall, 1923, not *Morulina* Börner, 1906. It is my pleasure to rename this taxon in honor of Mr. Masao Azuma, who is a keen student of mollusks.

The group of *Morula*-like shells that were previously referred to *Morulina* by Arakawa (1965, p. 121-123) and Wu (1965, p. 97)

would appear to be without a subgeneric name. I hesitate, however, to propose a new name for this group until the radular characters of *Purpura muricina* Blainville (1832, p. 218) are known, as this is the type species of *Semiricinula* von Martens (1903, p. 95), by monotypy.

## LITERATURE CITED

- Adams, H. and A. 1853-[1854]. The genera of recent Mollusca. London 1: 1-484.
- Arakawa, K. Y. 1965. Venus 24: 113-126, pls. 13, 14.
- Blainville, H. M. D. de. 1832. Nouv. Ann. Mus. Hist., Paris 1: 189-263.
- Börner, C. 1906. Mitt. naturh. Mus. Hamburg, 23: 147-186.
- Cooke, A. H. 1919. Proc. Malac. Soc. London 13: 91-110, 37 figs.
- Dall, W. A. 1923. Proc. Acad. Nat. Sci. Philadelphia 75: 303-306.
- Kiener, L. C. 1836. Spécies général et iconographie des coquilles vivantes. Genre Pourpre. Paris 8: 1-151, pls. 1-46.
- Lamarck, J. B. P. A. de. 1816. Tableau encyclopédique et méthodique des trois règnes de la nature. Paris 3: 1-6, pls. 391-488.
- Martens, E. von. 1903. Wiss. Ergeb. Deutschen Tief-See Exped. Systematisch-geographischer 7 (I-V): 1-146, pls. 1-5.
- Röding, P. F. 1798. Museum Boltenianum, pars secunda continens conchylia. Hamburg.
- Schumacher, C. F. 1817. Essai d'une nouveau système des habitations des vers testacés. Copenhagen.
- Thiele, J. 1931. Handbuch der systematischen Weichtierkunde, Jena, vol. 1, 778 pp., 783 figs.
- Wenz, W., in O. H. Schindewolf. 1941. Handbuch der Paläozoologie. Berlin, 6 (1). Gastropoda, pt. 5, pp. 961-1200, figs. 2788-3416.
- Wu, Shi-Kuei. 1965. Bull. Inst. Acad. Sinica 4: 95-106, 29 figs.

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## TWO NEW SLUGS (PULMONATA: PHILOMYCIDAE: PHILOMYCUS) FROM KENTUCKY AND VIRGINIA

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**PHILOMYCUS BISDOSUS** new species. Pages 132, 131.

Description of holotype (University of Michigan, UMMZ. 23065): foot nearly smooth, white except for a very short black area at extreme posterior end; head white, except blue-black tentacles; ground color of mantle (Fig. 1) pale tan marked mid-dorsally by a pair of closely approximated, longitudinal, brown wavy bands, and on each side (about  $\frac{1}{2}$  way up from ventral

edge of mantle) by a thinner, wavy band of the same color. Posteriorly, the dorsal bands fuse into a single one; anteriorly all 4 bands break-up into small, brown spots; the lower sides of the anterior three-fourths of the mantle is without spots. The lower bands are connected across the mantle at the posterior end, where the body is somewhat depressed. No cheverons or crossbars. Edge of foot pale gray. Pneumatopore slit-like, connected with margin of mantle by a strongly diagonal slit; genital opening on side of head a short distance above level of pneumatopore. Total length contracted 35.5 mm., crawling (Fig. 1) 85.5 mm.; width 8.5 mm; width of sole 7.0 mm.

*Corroborative Description:* The genitalia (Page 131, Fig. 2a) and jaw (Fig. 2b) were dissected from a paratype (UMMZ. 230636) 47.3 mm. in contracted length, secured from the Kentucky locality listed below. The jaw, though relatively strongly arched, has practically no anterior projection, and it is only faintly striate. The vagina is quite short and not much inflated. The duct of the seminal receptacle is enlarged and swollen. The dart sac is small, whereas the vas deferens is long, robust. The elongated penis is moderately slender, its retractor muscle also being slender.

Some representative measurements (all in mm.) taken from a series of 6 paratypes (BAB 9511) taken at the Kentucky site are:

<i>Total contracted Length</i>	<i>Width</i>	<i>Width of Sole</i>
15.8	6.0	4.5
23.7	6.5	5.0
35.3	9.0	7.0
35.0	9.5	8.0

The young, somewhat similar to *Philomycus virginicus* Hubricht, are darker brown and more spotted than mature specimens. In all specimens, the pneumatopore slit is set at a definite angle. In the 23.7 mm. specimen, the dorsal bands are very obscure, and in the 35.3 mm. and 35.0 mm. specimens, the flattened tail beneath the mantle is very black. In the largest paratype listed above, there are two very obscure, brownish, diagonal streaks at the anterior end of the mantle. The slime is white, tenaceous.

The name is from French: *bis*, brown: *dos*, back.

Type Locality: the Breaks Interstate Park, Buchanan County, Virginia. The holotype was secured from beneath a moist, de-



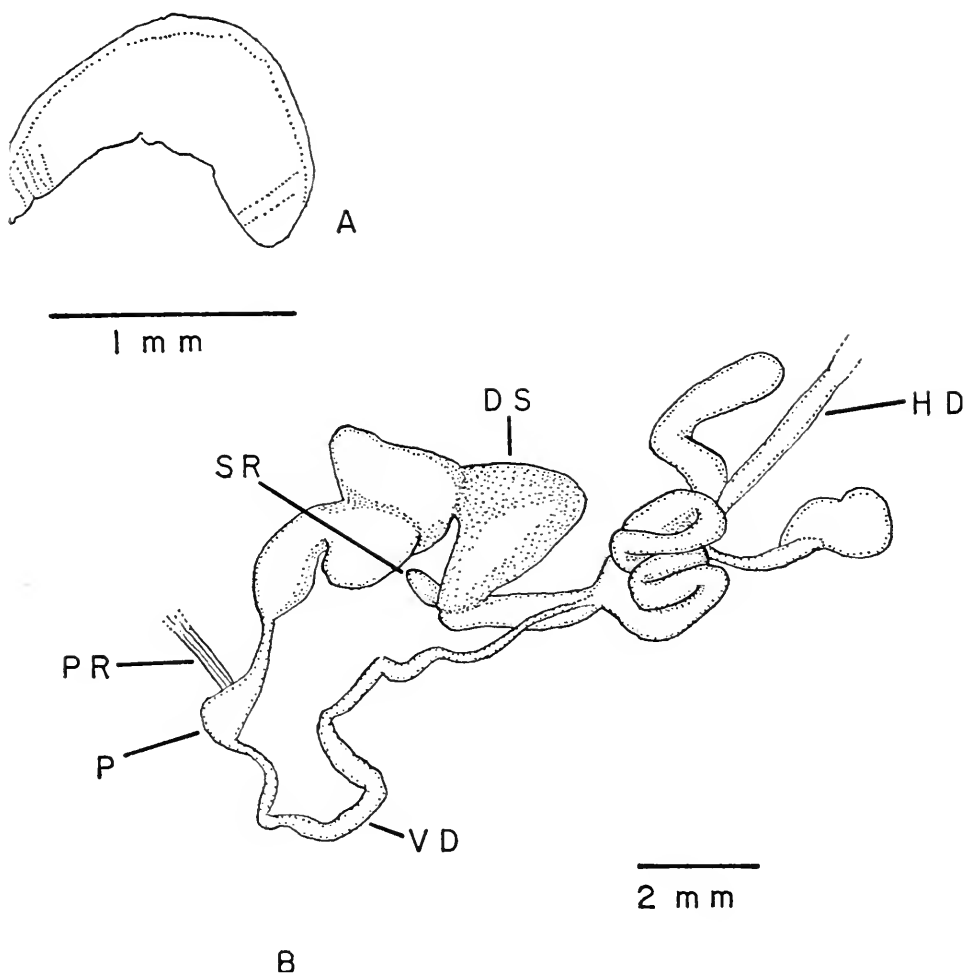


Fig. 4. Paratype of *Philomycus batchi*. A, jaw; B, anterior genitalia; DS, dart sac; HD, hermaphroditic duct; P, penis; PS, penis retractor muscle; SR, seminal receptacle; VD, vas deferens.

caying log on July 23, 1967.

The paratypes discussed above were secured from similar habitats on a hillside overlooking the Russel Branch of the Big Sandy River, just off Highway 80, Pike County, Kentucky on July 23, 1967.

*Philomycus bisdosus* seems to be most nearly related to *P. virginicus*, which is much darker and in which the color pattern attains the edge of the mantle ventrally. In *P. virginicus*, the slit of the pneumatopore is nearly in line with the opening. The genitalia of the two species also differ.

**PHILOMYCUS BATCHI** new species.

Pages 132, 129

Description of holotype (Field Museum of Natural History,

FMNH. 155478): mantle glistening black with numerous indistinct black punctae above; black grading to sooty gray mottled with small white blotches laterally, and the lower edges are white anteriorly; sides of foot and sole dead-white; pneumatopore surrounded by a white, irregular halo with a faint streak of gray below it; tail below mantle yellowish, marked on either side by 3 rows of black dashes (not visible in Fig. 3); contracted length 33.2 mm. (Fig. 3), extended length 50.3 mm.; greatest width extended 8.0 mm.

*Corroborative Description:* The anterior genitalia (Page 129, Fig. 4B) and jaw (Fig. 4A) were dissected from a paratype (BAB 9505) 32.2 mm. in contracted length, collected near Honey Bee, McCreary County, Kentucky. The dart sac is large, triangular, and the penis, which is rather conspicuously inflated near the point of attachment of the vas deferens. Following this, the penis narrows, only to enlarge before contacting the vaginal area. The jaw is weakly ribbed, more strongly medially, and is weakly notched at either corner and bears a very slight anterior projection. In radula, the central denticle is unicuspid and a little broader than those on either side. The 8th lateral develops a small second cusp; the second cusp becomes progressively larger outwardly to about denticle number 30, after which it decreases in size as the main cusp elongates.

Additional paratypes (BAB. 9513) secured with the paratypes of *P. bisdosus* at the Pike County locality. In two of these specimens there is a barely discernible thin, black longitudinal line about one-third the way up from the ventral edge of the mantle. Anteriorly, the mantle is rather profusely spotted with minute black punctae. In one of them, the posterior edges of the foot is tinged with light gray. The contracted measurements of these specimens are:

<i>Length</i>	<i>Width</i>	<i>Width of Sole</i>
29.3	4.3	3.5
28.6	8.7	5.5
40.5	7.5	5.0
40.8	8.0	6.3

Two paratypes (BAB. 9507) taken with 9505 resemble the holotype closely, but mid-dorsally the mantle is dark gray rather than black, and the scattered black spots are slightly larger. These

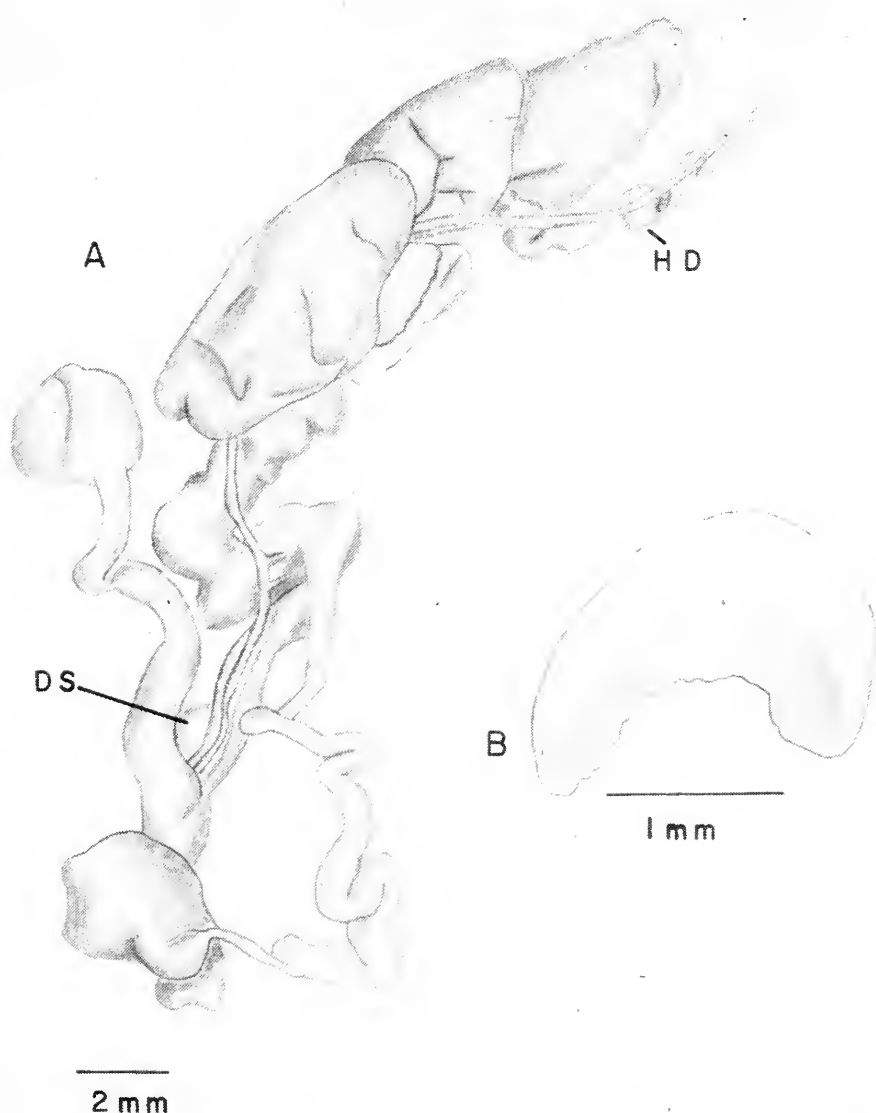


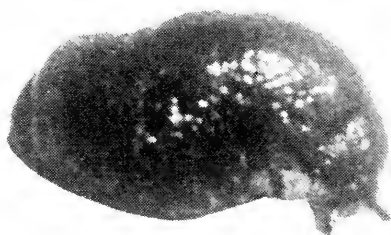
Fig. 2. Paratype of *Philomycus bisdosus*. A. anterior genitalia; B. jaw; DS, dart sac; HD, hermaphroditic duct.

specimens measure (contracted) 33.0 and 40.5 mm. in length, and 8.2 and 10.5 mm. in width, respectively.

Two additional paratypes (BAB. 9627) were collected on May 7, 1967 from the lower slopes of Black Mountain, Fugate Creek ("Slope Hollow"), near Louellan, Harlan County, Kentucky. They are mostly similar to the holotype, differing only in possessing a series of very small, intensely black streaks and punctae



4 mm



7 mm

Figs. 1, 5. Holotypes. Upper fig. *Philomycus bisdosus* Branson. Lower fig. *P. batchi* Branson.

along the sides of the mantle. They measure (contracted) 33.0 and 37.5 mm. in length, 7.0 and 6.6 mm. in sole width, respectively.

The species is named for my good friend and collector of the holotype, Dr. Donald Batch.

Type locality: east flood plain of the Kentucky River, opposite Boonesborough State Park, Madison-Clark County line, Kentucky. Found beneath a decaying log with one specimen of *Pallifera ragsdalei* Webb, June 16, 1967.

*Philomycus batchi* appears to be most closely related to *P. flexuolaris* Rafinesque, which it resembles slightly in color pattern, differing in being nearly solid black rather than brown and in lacking longitudinal stripes. It also differs from *P. carolinianus* (Bosc) in lacking a double row of large, black spots. Internally, the jaw differs slightly from these two species in being very weakly

striate, and in possessing only a very slight anterior projection. In the genitalia, the possession of an apically inflated penis and different arrangement in position of the penis retractor muscle account for additional differences.

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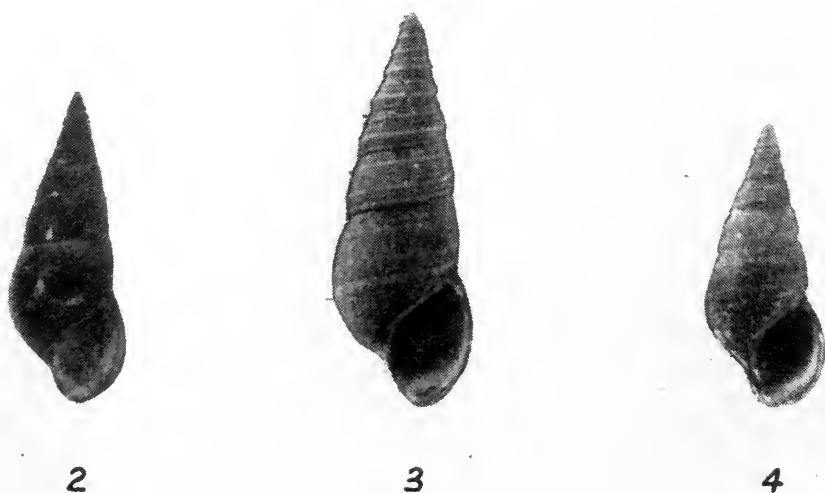


Fig. 2. Typical *G. semicarinata* from Harrison Spring. Fig. 3. Heavily sculptured shell from Harrison Spring. Fig. 4. A topotype of *G. indianensis*. All 2 $\times$ .

## GONIOBASIS SEMICARINATA AND *G. INDIANENSIS* IN BLUE RIVER, INDIANA

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*Goniobasis semicarinata* (Say) inhabits streams of the Ohio River system in the area from Scioto River, Ohio, southwest to Salt River, Kentucky. It is the only species of *Goniobasis* in this area except for possible outlying populations of *G. livescens* (Menke) in southern Ohio. However, *Goniobasis indianensis*, a shell quite similar to *G. semicarinata* was described by Pilsbry (1903) from Blue River at Wyandotte, Indiana. *Goniobasis indianensis* was discussed by Goodrich (1935) and Goodrich and van der Schalie (1944) but these observations indicate some uncertainty about the taxonomic status of the form. Goodrich (1940) failed to include it either as a distinct species or as a synonym for *G. semicarinata* in a revisionary checklist of pleu-

rocerids of the Ohio River system. The present study was undertaken to review the distribution of *G. indianensis* and to clarify its status.

There are no large northern tributary streams emptying into the Ohio River west of the Miami River, Ohio and east of the Wabash River in Indiana. Most drainage from areas immediately north of the Ohio River is carried westward across Indiana by the Wabash River system. A low divide separates this drainage from the smaller streams that flow directly southward to the Ohio River. These Ohio River tributaries are generally less than 30 mi. long. Blue River and Laughery Creek in Indiana are two exceptions that have lengths of over 50 mi. Blue River is located in southern Indiana between Louisville, Kentucky and Evansville, Indiana. The region east of Anderson River including the drainage basin of Blue River (Fig. 1) contains two prominent physiographic features. A broad plain with numerous sinkholes, Mitchell Plain, occupies the eastern part of this area and is bordered on the west by the Crawford Upland. The Crawford Upland, known locally as the Knobs, includes the lower reaches of Blue River and is characterized by high rolling limestone plains and uplands. Here most streams have high gradients and flow year around, although karst or sinkhole valleys with intermittent streams are common on its eastern edge.

*Results:* Populations of *Goniobasis semicarinata* (Say) occur in Little Indian Creek, Big Indian Creek, Little Blue River, and Buck Creek all in the vicinity of Blue River. They are similar to other populations of this species found in southern Indiana and Ohio. Specimens have spires that are 1.5 to 2 times aperture height, with slightly convex whorls. Apertures are elliptical to subrhomboidal shaped. The first 4 whorls of most specimens have a carina on the lower third of the whorl surface. The first two whorls are usually eroded away. The periostracum is light olive-green to dark buff colored, with a wide brown spiral band covering much of the center of whorl surfaces. The lighter color shows clearly only on the upper fourth of the whorl surface immediately below the suture, producing a bicolored effect. Unbanded specimens are common. *Goniobasis semicarinata* was not abundant at the Buck Creek localities and where it did occur, its spire height and banding pattern was variable.

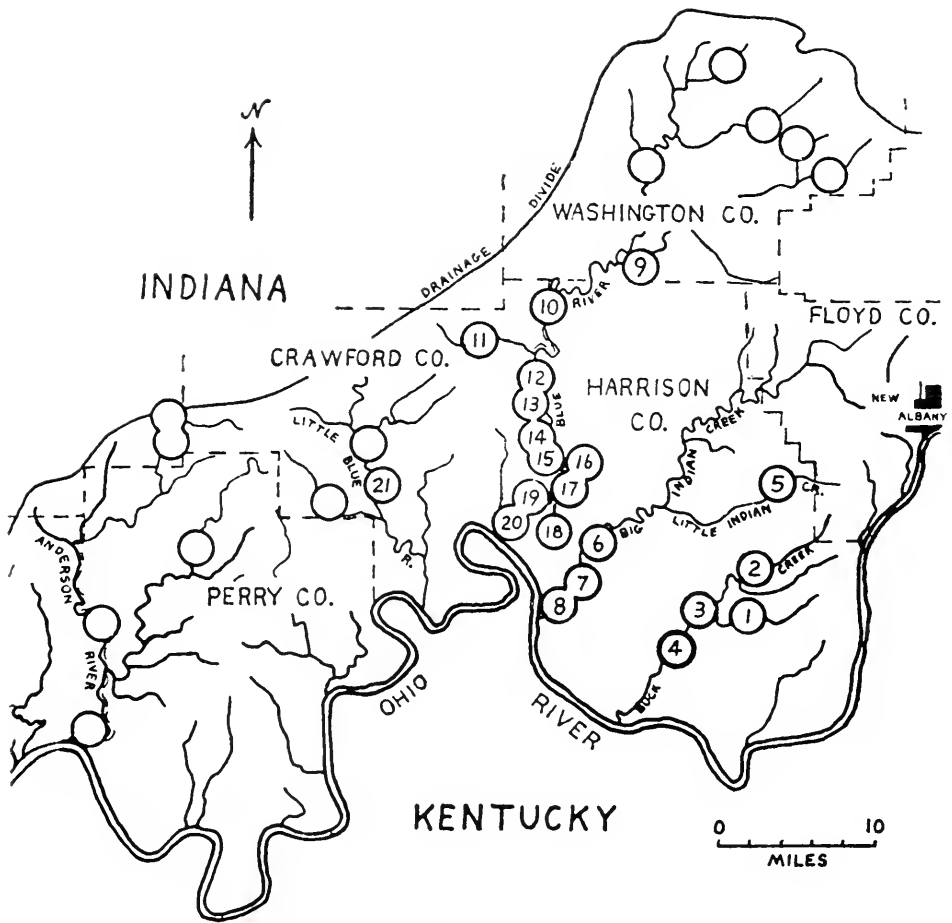


Fig. 1. Localities of *G. semicarinata* in the Blue River region, Indiana. Buck Creek: (1) 5 mi. W. of Elisabeth, (2) 1.2 mi. SE. of Middletown, (3) 1 mi. N. of Dogwood, (4) 2.3 mi. SW. of Dogwood, Little Indian Creek: (5) 1.5 mi. SW. of Lanesville. Big Indian Creek: (6) 4.2 mi. SW. of Corydon, (7) 3.8 NE. of New Amsterdam, (8) 1 mi. SW. of Sta. 7. Blue River: (9) E. of Fredericksburg, (10) 4.3 mi. E. of Hancock Chapel, (11) Marengo Creek, (12) 0.7 mi. S. of Milltown, (13) 1.6 mi. S. of Milltown, (14) 4 mi. NW. of White Cloud, (15) 2.2 mi. NW. of White Cloud, (16) and (17) Harrison Spring 1 mi. N. of White Cloud, (18) 1 mi. E. of Wyandotte, (19) at Wyandotte, (20) 2 mi. SW. of Wyandotte. Little Blue River: (21) 0.6 mi. S. of Grantsburg.

The species occurs in Blue River from the southern part of Washington County to the river mouth. *Goniobasis semicarinata* usually ranges farthest upstream of any pleurocerid in the region, but the headwaters of Blue River and Little Blue River are without pleurocerid populations, since much of the drainage in this area is subterranean and even the larger headwater streams are dry in summer.

At upstream stations (9, 10, and 11) and the tributary, Marengo

Creek, shell morphology and color pattern is similar to that of *G. semicarinata* populations in the neighboring streams. However, a stria is present on the upper part of juvenile whorl surfaces (Page 133, fig. 2c) and adult whorls are often crossed by irregular raised lines that give the shells a wrinkled appearance. Apices tend to be darker than succeeding whorls, which are light green to light brown colored. A wide color band occurs on 39 percent of the specimens, and is slightly wider than the bands on specimens of *G. semicarinata* from nearby streams. Between Milltown and White Cloud (Stations 12 to 15) specimens are much the same as those upstream, but only 18 to 20 percent are banded. These downstream bands are lighter and tend to merge with the surrounding light color.

Harrison Spring (Stations 16 and 17), a tributary of Blue River, is the farthest upstream station inhabited by the heavily sculptured *G. indianensis* form. The spring has a pool about 12 m. in diameter and the spring stream is about 9 m. wide at its mouth. The discharge once provided power for both a sawmill and a gristmill (Leverett, 1897). Here *Goniobasis semicarinata* has slightly convexed, dark adult whorls. All specimens have a wide brown band with light olive-green color showing through above it. Apertures are rounded below with slightly projected bases. There is a complete gradation of ornamentation, from that of typical *G. semicarinata* (Page 133, fig. 2) which has one or two carinae confined to juvenile whorls, to specimens with two carinae or numerous striae on adult and body whorls (Fig. 3). The multistriate shells often have up to 12 additional spiral lines.

Individuals of the *G. indianensis* form at the lower Blue River localities are smaller and have short spires that are about 1.5 times aperture height (Fig. 4). Most downstream shells have heavily eroded apices, so any meaningful information on the relative abundance of typical *G. semicarinata*, and the ornamented shells below Harrison Spring was obscured in my collections. Some distinction could be made between the two since individuals with sculptured adult and body whorls have sharp carinae that produce V-shaped suture grooves and flat whorl surfaces, while typical specimens have plain, convex whorls.

Usually, shells of *Goniobasis semicarinata* either lack ornamentation or have a carina on the lower third of juvenile whorl sur-



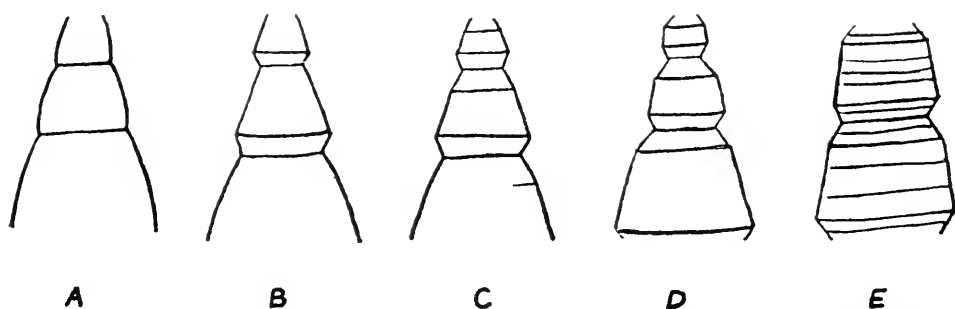


Fig. 5. Diagrammatic views of shell sculpture on *Goniobasis semicarinata*. A-C, typical *G. semicarinata*, D-E, the *G. indianensis* pattern.

faces (Fig. 2, a-b). Occasionally the upper third of the juvenile whorl is crossed by a stria and infrequently by a sharp shoulder or second carina (Fig. 2, b-d). About 80 percent of the Blue River specimens have this double carinae pattern on their juvenile whorls (12 lots ranged from 64 to 97 percent.) as do 91 percent. of the Little Indian Creek specimens, while in Big Indian Creek and Buck Creek only 11 and 19 percent. are so ornamented. This pattern when present in other *G. semicarinata* populations in Indiana, Kentucky, and Ohio usually occurs on less than 30 percent. of the specimens. The sculpture extends onto adult whorls only in Blue River populations.

#### CONCLUSION

As Goodrich and van der Schalie (1944) suspected, *Goniobasis indianensis* Pilsbry is a synonym for *Goniobasis semicarinata* (Say) that was based on an extreme form of shell sculpture. Apparently it occurs only on the populations of that species in Blue River, Indiana. The *indianensis* ornamentation pattern is the same basic pattern common to *G. semicarinata* populations elsewhere and differs from them only by extending onto adult whorls. The relationship between *G. semicarinata* and *G. indianensis* in Blue River is one of variation within a population rather than geographical variation, even in the sense of a headwaters to downstream sequence. Heavily ornamented individuals are common only in the populations of Harrison Spring and in Blue River proper downstream from this tributary.

*Acknowledgements:* Dr. David H. Stansbery generously provided facilities in the Natural History Department of the Ohio State Museum. Recognition is due Mr. Edwin H. Bickel, my father, who skillfully and enthusiastically collected much of the material.

## LITERATURE CITED

- Goodrich, C. 1935. Studies of the gastropod family Pleuroceridae — V. Occas. Pap. Mus. Zool. Univ. Mich. 318: 1-12.
- Goodrich, C. 1940. The Pleuroceridae of the Ohio River drainage system. Occas. Pap. Mus. Zool. Univ. Mich. 417: 1-21.
- Goodrich, C. and H. van der Schalie. 1944. A revision of the Mollusca of Indiana. Am. Midl. Nat. 32 (2): 257-326.
- Leverett, F. 1897. The water resources of Indiana and Ohio. Ann. Rept. U. S. Geol. Surv. 18, Part IV — hydrography. p. 419-559.
- Pilsbry, H. A. 1903. [*Goniobasis indianensis* Pilsbry, MS.] p. 606-607. In. Blatchley, W. S. and L. E. Daniels. On some Mollusca known to occur in Indiana. Ann. Rept. Indiana Dept. Geol. Nat. Resources 26: 577-680.

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## RESISTANCE OF FRESH-WATER OPERCULATE SNAILS TO DESICCATION

BY MARC J. IMLAY<sup>1</sup>

Department of Biological Sciences, Northwestern University, Evanston, Illinois.

Abstract. The fresh-water operculate snail, *Viviparus malleatus*, survived three months of starvation followed by three months of desiccation. The survival rate was as high as that reported for typical pulmonate species. Thus, uricotelic metabolism need not indicate terrestrial ancestry.

A specimen of *Viviparus malleatus* (Reeve) was inadvertently left in a dry finger bowl over the summer of 1965. Within hours after it was replaced in water it was moving about actively. This discovery was interesting because the prosobranchs, which include the live bearing Viviparidae, evidently evolved into fresh-water species directly from marine ancestry unlike the other North American subclass of fresh-water snails, the Pulmonata, which arose from air-dwelling progenitors.

However, Needham (1935) found that the fresh-water prosobranchs, *Viviparus fasciatus* and *Bithynia tentaculata*, "contained amounts of uric acid corresponding to the fresh-water pulmonates." Since at that time Needham noted "the evidence regarding the capabilities of modern fresh-water operculate gastropods is that they possess very poor powers of withstanding periods of complete dryness," he was forced to consider the possibility "that the fresh-

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<sup>1</sup> This report is included in a dissertation submitted to Northwestern University in partial fulfillment of the requirements for the degree of Doctor of Philosophy. The study was performed while the author was a Public Health Service predoctoral fellow.

water operculates originated not from the sea direct but by way of a period of terrestrial or semi-terrestrial life." This belief would be supported by the fact that Viviparidae are not found in brackish water (Prashad, 1926).

Thus, it clearly appeared important to examine more carefully the resistance of *Viviparus* to prolonged desiccation. I am grateful to Dr. Frank A. Brown, Jr., Northwestern University, for his suggestions and reading of the manuscript.

Materials and methods. At the end of the summer of 1966, 51 specimens of *Viviparus malleatus* were available from previous studies. On October 16 these were left in individual dry finger bowls in the laboratory at Evanston, Illinois. On January 16, 1967, water was added to all the finger bowls and the number of snails surviving this 3-month period of desiccation was determined. It is significant to note that, in addition, the snails had been immersed in tap water (20°C) without food from July 13 to October 16 in the studies preceding the desiccation.

Results. On the morning following the addition of water on January 16, 17 snails were moving about. A few days later 3 more snails were also active and several of the 20 survivors had given birth to active young. At this time a wet — and dry-bulb hygrometer was used for an indication of the severity of desiccation the specimens had been subjected to. The relative humidity was only 55% in the experimental room while the outdoor relative humidity was 90% and the outdoor temperature was 53°F.

Discussion. An important seasonal phenomenon in some geographic areas would be desiccation. Christy (1881) exposed a specimen of *Viviparus viviparus* for more than 3 weeks on dry ground. The snail appeared unharmed. In the present work, of the 51 specimens of *Viviparus malleatus* that were starved for 3 months followed directly by 3 months of desiccation, twenty recovered. Although only 39% of the snails survived it must be realized that not all the snails need to survive to carry the species through such an ordeal. In fact, with the 9 pulmonate species obtained from a lake and marsh, Cheatum (1934) found that only about 25% of the specimens of each species survived 62 days of desiccation, except for *Lymnaea palustris* of which half survived. This last species is ordinarily subjected to desiccation in nature.

This ability of *Viviparus* to survive desiccation as well as do the pulmonates is noteworthy since respiration is entirely aquatic in Viviparidae (Prashad, 1926). Thus, uricotelic metabolism in fresh-water operculates need not indicate terrestrial ancestry since it could be valuable during periods of drought.

The ability to retain water in the shell would be useful during desiccation. Although Annandale and Sewell (1921) found that *Viviparus bengalensis* moves to the surface of foul water and exposes the branchial chamber to the air, *Viviparus dissimilis* was found to close its operculum tightly and sink to the bottom.

#### LITERATURE CITED

- Annandale, N., and R. B. Seymour Sewell, 1921. The banded pond snail of India (*Viviparus bengalensis*). Records of the Indian Museum 22: 215-295.
- Cheatum, E. P., 1934. Limnological investigations of respiration, annual migratory cycle, and other related phenomena in fresh-water pulmonate snails Transactions of the American Microscopical Society 53: 348-407.
- Christy, R. M., 1881. The land and fresh-water shells of the neighbourhood of York. The Zoologist third series 5: 175-185.
- Needham, Joseph, 1935. Problems of nitrogen catabolism in invertebrates II, Correlation between uricotelic metabolism and habitat in the phylum Mollusca. Biochemical Journal 29: 238-251.
- Prashad, B., 1926. Recent and fossil Viviparidae. A study in distribution, evolution, and palaeogeography. Memoirs of the Indian Museum 8: 153-252.

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#### NOTES AND NEWS

CHROMODORIS CALIFORNIENSIS AND C. CALENSIS — In Journ. Mus. Godeffroy 5 (14): 3, 1879, Bergh mentions *Chromodoris calensis* Bergh n. sp. Oc. Pacific and in an accompanying footnote states that this last species will be published in my "Nudibranchiate Gastropoda of the North Pacific" which appears in one of the next following parts of the scientific results of the exploration of Alaska of W. H. Dall.

*Chromodoris californiensis* Bergh n. sp. Pl. XII, figs. 5-15 Oc. Pacific septemtr. (Coast of California, Santa Barbara Islands) appears on p. 168 of Bergh's article 1879 (b). The caption to Plate XII, figs. 5-15 which were published in 1880 is *Acanthodoris pilosa* (M.) var. not *Chromodoris californiensis*.

The second part of Bergh's article 1880 (a) in the same publication appeared in Jan. 1880 as Article 6. The name *Chromodoris californiensis*, Bergh appears on p. 272 as a caption to plate 14, figs. 5-15. These figures on the plate itself, however, are labelled as "*Chr. calensis* B." These are either hinder part of the body, upper median part of the true mouth or radular teeth and are unrecognizable as concerns specific determination.

Duplicate articles by title and author were published in the Proceedings of the Academy of Natural Sciences of Philadelphia for 1879 and 1880 with the same confusion in names, text and plate references. The pagination in the two sets of articles is different, but their content and the plates' numbers and their captions are the same.

Because of the above mixed and unrecognizable text names, plates and captions, the following conclusions are to be reached.

1. *Chromodoris calensis* Bergh. Journ. Mus. Godeffroy 5 (14): 3, 1879 is a nude name.

2. *Chromodoris calensis* Bergh in part 2 of his articles, 1880 (a) and 1880 (b) are unrecognizable for species determination. The name *Chr. calensis* Bergh therefore becomes a nomen dubium.

3. The name *Chromodoris californiensis* Bergh, while the plate designations are in error is valid, because of a recognizable text description. — HENRY D. RUSSELL.

#### REFERENCES

- Bergh, R. 1879 (a). Neue Nacktschnecken der Südsee. Journ. Mus. Godeffroy 5 (14): 1-50, pls. 1-5.  
——. 1879 (b). On the Nudibranchiate Gastropod Mollusca of the North Pacific Ocean, with special references to those of Alaska. Sci. Results Explor. Alaska 1 (1): 127-188, pls. 1-8.  
——. 1879 (c) (same title) Proc. Acad. Nat. Sci. Philadelphia 31: 71-132, pls. 1-8.  
——. 1880 (a) (same title pt. 2) Sci. Results Explor. Alaska 1: 189-276, pls. 9-16.  
——. 1880 (b) (same title pt. 2) Proc. Acad. Nat. Sci. Philadelphia 32: 40-127, pls. 9-16.

OTALA LACTEA IN SAN ANTONIO, TEXAS — Strecker (1935, Trans. Texas Acad. Sci., 17: 6) reported the occurrence of *Otala lactea* (Müller) in Waco, McLennan County, Texas. More recently, Grimm (1964, Nautilus 77 (3): 108) reported *O. lactea* in Port Arthur, Jefferson County, Texas, and Pratt (1964, Nauti-

lus 78(1): 32) reported *O. lactea* from the following Texas counties: Galveston, Brazos, and Tarrant. This is the first record of *O. lactea* in San Antonio, Bexar County, Texas.

I have traced the origin of one of three populations known to occur in San Antonio. In July, 1964, I was called to observe some large snails (*O. lactea*) in a yard at 235 Hoover Street. A larger population of several hundred snails was discovered to the north and immediately behind the Hoover Street residence. This second home, 1134 West Winnipeg Street, was occupied by the Galanos family who had moved to the United States from Greece in the early 1900's. Because of the occurrence of a similar snail in Greece and to remind her parents of their homeland, a daughter brought a few live specimens of *O. lactea* with her when she returned from the Mediterranean area after World War II (1946). The family kept the snails in a container in the house for several years and would, on occasion, eat some. A few years later (date unknown), the family moved the snails to the back yard and housed the snails in a large, wire basket approximately three feet high and two feet in diameter. In addition to the cage being ineffective in retaining the snails, the family put some of the snails in their garden area which by July, 1964, had numerous *O. lactea* on the ground, in the soil, on the trees, and on fence posts. I could observe no significant damage caused by the snails; however, the Galanos family placed lettuce and other greens in the garden for the snails.

The yards of the residences in the immediate area were examined for *O. lactea*; however, the population centered in the Galanos yard. A few specimens were found in the yard immediately to the east of the Galanos property plus the snails mentioned at the Hoover Street residence. The Galanos property was on the corner and areas across the streets to the north and west yielded no specimens.

A second population of *O. lactea* was observed in August, 1964, at 202 West Petaluma Street which is approximately 3.5 miles south of the Galanos property. The origin of the second population is unknown. One of several specimens observed at this location was adhering to a Mesquite (*Prosopis*) tree. This specimen had a hole in the shell, 15 mm. from the aperture, on the last whorl. The hole was about 10 mm. in diameter with a small arm

(4 mm. in width and 10 mm. in length) extending across the body whorls near the apex of the shell. The animal was fresh but parts of the mantle, foot, and anterior end had been removed. The damage may have been the result of a bird; however, no other specimens in San Antonio showed similar damage. A third population occurs at 110 Calumet Street which is at least 6 miles north from the preceding populations.

I wish to thank Dr. Dee Dundee for identification of the specimens and to thank Mrs. Myra Taylor and Mrs. Bessie Goethel for the Petaluma and Calumet locality records. — HAROLD D. MURRAY, Trinity University, San Antonio, Texas.

MARINE TECHNOLOGY SOCIETY. — Dr. James H. Wakelin, President of the Marine Technology Society, announced today that the 1968 Annual Conference and Exhibit will be held at the Sheraton Park Hotel, Washington, D. C. on July 8, 9 and 10, 1968. He went on to say that the 1968 Conference and Exhibit would be cast around the theme: "A critical look at marine technology — 1968," with invited speakers following the theme closely within the guidelines set up by the Program Chairman, Willard Bascom, President of Ocean Science and Engineering.

One of the highlights of the Conference will be the educational and technical exhibits, the world's largest display of oceanographic equipment! Those interested in exhibiting contact Frank Masters, Trade Associates, 5151 Wisconsin Avenue, N.W., Washington, D.C. 20016 (202-362-2794).

VALVATA PISCINALIS IN CAYUGA LAKE, N. Y. — In the summer of 1967 the writer collected 2 living specimens of *V. piscinalis* (Müller) while diving in the south end of Cayuga Lake at Ithaca, N. Y. They were taken from a silty bottom with a household sieve in 20 ft. of water.

This gastropod, a Eurasian species, was first discovered in the Great Lakes by F. C. Baker (recorded as *V. obtusa* in Trans. Acad. Sci., St. Louis, 8: 94. 1898). Oughton summarized the known range of the species in North America in 1938 [Nautilus 52, (1):30-32; (2):60-62]. Apparently *V. piscinalis* had spread throughout Lake Ontario and was invading Lake Erie via the Welland Canal at that time.

It is likely that *V. piscinalis* arrived in Cayuga Lake by way of the Oswego and Seneca Rivers from Lake Ontario. Therefore it probably is present throughout the entire Finger Lakes Drainage Basin. That means that in the last 30 years *V. piscinalis* has increased its range over 1800 sq. mi. (land and water area) in central New York alone. The synecological actions and reactions will be interesting to observe as this invading species enters into competition with our local *V. lewisi*, *V. sincera*, and the various morphs of *V. tricarinata*. — WILLARD N. HARMAN, Dept. of Entomology and Limnology, Cornell University, Ithaca, N. Y.

ADDITIONAL PACIFIC COAST MALACOBDELLA GROSSA. — To the recent review of mollusks known to serve as hosts for the commensal nemertean *Malacobdella* (Ropes and Merrill, 1967) should be added the shallow water northeastern Pacific Ocean pelecypod *Macoma nasuta* (Conrad). Investigation of the infestation of species of *Macoma* by this nemertean and a pinnotherid crab was made by the writer a number of years ago (Addicott, 1952) on material collected from the intertidal zone at Elkhorn Slough, Monterey County, California (lat. 36.8° N). *Malacobdella grossa* (Müller) was found in 3 of 50 specimens of *Macoma nasuta* (Conrad), an incidence of 6 percent. A much larger percentage of specimens of *M. secta*, 12 out of 78 specimens examined, were infested with this nemertean. None of 25 specimens of a third species, *M. inquinata* (Deshayes), contained *M. grossa*. Although most of the specimens of *M. grossa* were relatively small and of a whitish color, a few large, orange colored specimens reaching as much as 10-12 mm in length were found in the mantle cavity of *M. secta*. Male specimens of a small pinnotherid crab identified as *Pinnotheres* sp. were detected in all three species of *Macoma*. — W. O. ADDICOTT, U. S. Geological Survey, 345 Middlefield Rd., Menlo Park, California 94025.

#### REFERENCES

- Addicott, W. O., 1952, Ecological and natural history studies of the pelecypod genus *Macoma* in Elkhorn Slough, California: Stanford Calif., Stanford Univ. M.A. thesis, 89 pp.  
Ropes, J. W., and Merrill, A. S., 1967, *Malacobdella grossa* in *Pitar morrhuana* and *Mercenaria campechiensis*: Nautilus 81: 37-40.



ODOSTOMIA DIANTHOPHILA (Gastropoda, Pyramidellidae) from Buzzard's Bay, Mass., a Northern Range Extension. — *Odostomia dianthophila* Wells & Wells was described in 1961 (*Nautilus*, 74: 149-157) as parasitic on the serpulid polychaete worm, *Eupomatus* (= *Hydroides*) *dianthus* Verrill in the Beaufort, North Carolina, region. This minute snail has been found subsequently by myself and other investigators on subtidal rocks on the eastern shore of Buzzard's Bay, similarly in close association with *Hydroides dianthus*. Close examination in the laboratory shows that *O. dianthophila* definitely feeds on the serpulid in much the same manner as assumed by the authors, chiefly on the extended tentacular crown of the worm. Further work is currently being done to determine the specificity and manner of host selection.

I wish to thank Dr. R. Robertson, of the Philadelphia Academy of Natural Sciences for his confirmation of the identity and habits of this snail.

This study was aided by Contract No. 3070 (03) between the Office of Naval Research, Dept. of the Navy, and the Systematics-Ecology Program, Marine Biological Laboratory. Systematics-Ecology Program Contribution No. 147. — ARMAND G. ROBERGE, Systematics-Ecology Program, Marine Biological Laboratory, Woods Hole, Mass.

THE AMERICAN MALACOLOGICAL UNION will hold its 34th Annual Meeting at Corpus Christi, Texas, July 15-19. Driscoll Hotel is meeting headquarters, and six shell clubs of Texas will play host for the occasion. For further information, contact Anne B. Speers, Box 71, Conroe, Texas 77301.

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#### PUBLICATIONS RECEIVED

Bayer, Frederick M. and Harding B. Owre. May 1, 1967. The free-living lower invertebrates. [Sponges, coelenterates, ctenophores, flat-worms and nemerteans.] 229 + viii pp., 271 text-figures. \$11.95. The Macmillan Co., 866 Third Avenue, New York 10022.

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