

SMITHSONIAN MISCELLANEOUS COLLECTIONS

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THE NONMARINE MOLLUSKS  
OF SAN JOSÉ ISLAND, WITH NOTES ON  
THOSE OF PEDRO GONZÁLEZ ISLAND,  
PEARL ISLANDS, PANAMÁ

(WITH THREE PLATES)

BY

J. P. E. MORRISON

Assistant Curator, Division of Mollusks  
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THE NONMARINE MOLLUSKS OF SAN JOSÉ ISLAND,  
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INTRODUCTION

Under the joint auspices of the United States Army Chemical Warfare Service and the Smithsonian Institution, the writer spent the months of February to September, 1944, inclusive, on San José Island, Archipiélago de las Perlas, Republic of Panamá. During this time all types of animals were collected for the United States National Museum, but particular emphasis on the molluscan fauna was the natural outcome of the writer's primary interest.

San José Island is the farthest outlying, as well as one of the largest of the Pearl Islands, lying approximately 60 miles south of Panamá City, nearly in the middle of the Bay of Panamá. Up to the time of these collections, the island had been uninhabited for some 70-odd years, although at various times earlier it had been cleared for agriculture over extensive areas. As a direct result of this earlier land use, the virgin jungle covered about half the island's area, and the remainder was secondary in nature, with sour canebrakes and a matted "vine" or "brush" jungle almost impossible to penetrate without cutting one's way foot by foot. There is only a thin layer of leaf mold present anywhere on the island.

The soil is a red clay, residual from the weathering of the volcanic breccia which forms the underlying rock of all the island surface. With abundant rainfall, and a maximum elevation of about 350 feet, the numerous, mostly small streams are for the most part rapidly flowing, ecologically young. Since there is no limestone on the island, the land and fresh-water snails must depend for lime on the small amount leached out of the volcanic rock present.

Pedro González Island was visited very briefly on five different occasions, and mollusks were collected there also. It lies directly north of San José at about 5 miles distance, is at present inhabited, and does not exhibit the impenetrable secondary "vine" jungle habitat. On account of the limited time spent thereon, the mollusks of Pedro González Island were very incompletely collected, but are included in this report as far as known.

Three new genera, 27 new species, and one new subspecies, described herein, were found during the course of this study. This relatively high number of new forms represents a lack of previous knowledge of the fauna, rather than a high degree of endemism on the Pearl Islands. Further information on the general biology and characteristics of the Pearl Islands and San José Island in particular may be found in the other reports of this series.<sup>1</sup>

The writer wishes to express his appreciation to the authorities of the United States Army and of the Smithsonian Institution, who made possible such an extended and intensive study of this insular fauna. In particular, thanks are due to Dr. Alexander Wetmore, whom I had the honor to assist in the field for the first 6 weeks of these studies, and to Dr. Paul Bartsch and Dr. Harald A. Rehder, also of the United States National Museum, for their most helpful advice and guidance in the preparation of this report.

## MOLLUSCA

The molluscan fauna of the Pearl Islands is the fauna of the Panamic region in general. As far as known, the marine fauna is identical with that found on the Pacific shore of the Isthmus of Panamá, with the possible addition of a very few endemic species.

The nonmarine fauna, the restricted subject of this report, is a true insular fauna, showing clearly its direct relationship and derivation from that of the Panamá Isthmus. Its poverty in species may be considered likewise a direct result of the island's geographic isolation from that isthmus.

For the purposes of this report, all the land, fresh-water, and brackish-water mollusks are included. Included also are certain forms such as the littorinid snails which occupy habitats that are transitional to a true land habitat.

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<sup>1</sup> Smithsonian Misc. Coll., vol. 106, Nos. 1 to 7.

## GASTROPODA

## PROSOBRANCHIA

## Family NERITIDAE

## Genus NERITA Linné, 1758

## NERITA SCABRICOSTA Lamarck

1822. *Nerita scabricosta* LAMARCK, Hist. Nat. Anim. sans Vert., vol. 6, No. 2, p. 194.  
 1823. *Nerita ornata* SOWERBY, Gen. Shells, *Nerita*, fig. 4.

Ubiquitous, on every rocky portion of the shores of San José and Pedro González Islands, often in countless numbers. They occur on rocks in the intertidal zone at the mouths of certain streams, even on the same rocks with *Neritina latissima*, where salt concentration must vary from fresh to salt with every change of the tide. This change may not alter their activity much, however, since so much of the time they are not actually immersed in water, either salt in their normal habitat, or brackish to fresh at the transition area around the mouth of streams.

## NERITA BERNHARDI Recluz

1850. *Nerita bernhardi* RECLUZ, Journ. de Conch., vol. 1, p. 285.  
 1851. *Nerita funiculata* MENKE, Zeitschr. Malak., vol. 7, p. 169.

Not numerous, but found on both San José and Pedro González Islands. Seen on rocky shores, principally in the intertidal zone, and along the sea-water side of some of the mangrove swamps.

This species may be distinguished from the more abundant *N. scabricosta* by the lower spire and proportionately more effuse aperture.

## Genus THEODOXUS Montfort, 1810

## THEODOXUS LUTEOFASCIATUS (Miller)

1833. *Neritina picta* SOWERBY, Proc. Zool. Soc. London, 1832, p. 201 (not of Féruccac, 1825).  
 1879. *Neritina picta luteofasciata* MILLER, Malak. Blätt., n.s., vol. 1, p. 168.  
 1923. *Theodoxus luteofasciatus* H. B. BAKER, Proc. Acad. Nat. Sci. Philadelphia, vol. 75, p. 158.

The individuals of this species collected on San José Island have the same obscurely reticulated dark greenish color as the *Neritina latissima* from the island. The similarity to some young individuals of *N. l. globosa* is confusing. It may be differentiated by habitat, as far as personal experience goes; *luteofasciatus* is to be found on the

margin of mangrove swamps, on the muddy margin of lagoons or seepages of those swamps, but not in running fresh water, which is the habitat of *N. latissima*.

The proof of distinction lies in the slight difference in proportions of shell, prominence of opercular hypophyses, and the distinct microscopic beading. In contrast, the fresh epidermis of *N. latissima* shows almost regular threaded spiral sculpture, but it is not beaded, and usually shows a more velvety surface.

Genus *NERITINA* Lamarck, 1816

*NERITINA LATISSIMA* Sowerby

1833. *Neritina latissima* SOWERBY, Proc. Zool. Soc. London, 1832, p. 200.

1836. *Neritina latissima* SOWERBY, Conch. Ill., *Neritina* sp. No. 29, figs. 3, 16.

The typical (extreme) alate form of adults was abundant in several streams on the Island of San José. On the other hand, local geography or stream size or elevation above sea level seemed to have little apparent effect on the variations of this enormously widespread species.

The phase of the species (shell form and average adult size) seemed to be set for each stream in which they were found. For example, of the six streams, stream courses, or seepages in which this species was collected on Pedro González Island, only two showed any trace of the alate condition, one north- and one south-flowing stream, both in the eastern part of the island. Six stream channels examined on the north side, west of the village of Cocal, ranging from a fresh-water seepage at high-tide line containing *Littorina conspersa* also, to a permanent stream up to 50 feet elevation and up to 200 yards inland, all showed the *globosa* form exclusively.

Likewise, the globose, intermediate, and alate forms were all found in dominance on the west side of San José, but in different streams. In the Río Marina on the east side, and in the small southwest streams it was evident that the alate maximum adults were to be found at the upstream limit of their zonal occurrence in the fresh water.

In only one medium small stream on the west side did *globosa* go all the way up to the headwater pools as it did in one stream on the north side of Pedro González Island. This difference is probably due to some unmeasured local chemical or physical difference of the stream habitat.

*Neritina latissima latissima*, *N. l. intermedia*, and *N. l. globosa* were all found on the Island of San José; *latissima* and *globosa* forms are both found on Pedro González Island.



The *globosa* form was taken at the mouth of at least one small stream on San José, on the rocks in company with *Nerita scabricosta*; its habitat must here alternate between salt and fresh water with every tide!

This species as seen in the Río Juan Diaz, a little east of Panamá City, Panamá, was predominantly of the *intermedia* form.

#### Genus *NERITILIA* Martens, 1879

*Genotype*.—*N. rubida* Pease.

The distribution of this genus is most interesting. The genotype is widespread in the West Pacific; *N. succinea* and *guatemalense* are known from the West Indies and Central America in the West Atlantic. The following new species from the (Panamic) East Pacific region closes one gap in the tropical circle of its distribution.

#### *NERITILIA PANAMENSIS*, new species

Plate 1, fig. 2

Shell small, obliquely neritiform, corneous (covered with a blackish deposit in the types seen), the spire hardly projecting above the voluminous body whorl. Nuclear whorls minute, smooth; postnuclear whorls  $1\frac{1}{3}$ , rapidly expanding, regularly ornamented with fine lines of growth. The aperture is large, suborbicular, with a columellar callus as wide as the operculum; the columellar margin is not straight but sinuous (pinched-in medially), producing a subelliptic opening to be closed by the thin, translucent, pinkish horn operculum. The operculum is subelliptical, irregularly convex externally with a well-defined, humped-up ridge just at the columellar edge of the opercular nucleus. The nucleus is placed two-fifths of the distance from the base, and exactly opposite the slight ridge which continues obliquely downward on the internal face of the operculum to form the single, well-defined peg. The operculum is strengthened within with a transparent shell layer which continues at an angle as the raised "margin" of the baso-columellar region, and is glossy within except for the two distant, subtriangular, impressed muscle scars.

The type, U.S.N.M. No. 542133, has 1.5 whorls and measures: Height, 2.9 mm.; diameter, 4.4 mm.; aperture height, 2.9 mm.; aperture diameter, 3.5 mm.

It and 62 paratypes, U.S.N.M. No. 542134, were taken in company with *Neritina latissima intermedia* and thousands of *Zetekella frenata*, *Cochliopa diazensis*, and *Cochliopina zeteki* along the east bank of the Río Juan Diaz near Las Sabanas Road east of Panamá City. This is in the zone of rapid water just a little above tidewater. One

large lot of the amnicolids was screened principally from rocks in the edge of the current. A second large lot screened from roots and plants along the sandy and muddy margin of the river contained only five additional specimens, U.S.N.M. No. 542135. These specimens from the muddy margin were covered with a blackish (iron?) deposit, as were most of the amnicolids from this spot.

No special search was made here for Neritidae; this new species is apparently present in moderate numbers on the rocks along with the *Neritina*.

This species may be easily distinguished from *rubida* Pease by the lower spire, the plane or concave, not convex, columellar callus, and the more widely effuse aperture. It differs from all other known species of *Neritilia* in the position of the opercular nucleus which is subcentral, near the columellar margin, and not subbasal.

#### Family PILIDAE

Genus POMACEA Perry, 1811

#### POMACEA CUMINGII (King)

1831. *Ampullaria cumingii* KING, Zool. Journ., vol. 5, p. 344.

1856. *Ampullaria cumingii* REEVE, Conch. Icon., vol. 10, *Ampullaria* No. 81, pl. 17, fig. 81.

The Island of Taboga is given as the type locality. The National Museum collection contains one badly worn or acid-cleaned topotype, U.S.N.M. No. 4673, which measures: Height, 34 mm.; diameter, 32.5 mm.; aperture height, 24 mm.; aperture diameter, 17.5 mm.; umbilicus diameter, 3.5 mm.

A small form of this species is known from Pacheca Island, the northernmost of the Pearl Islands. A representative individual, U.S.N.M. No. 432879, one of several recently received from James Zetek, has the following measurements: Height (apex eroded), 27.5 mm.; diameter, 27 mm.; aperture height, 20 mm.; aperture diameter, 15 mm.; and umbilicus diameter, 2.7 mm.

This species is not found on the Isthmus of Panamá as far as known to the writer. All specimens in the National Museum from Panamá in the Atlantic drainage, as well as Pacific (Isthmus) streams, belong to the following species (*zeteki*).

#### POMACEA CUMINGII SANJOSENSIS, new subspecies

Plate 1, fig. 1

Shell of medium size, globose, openly umbilicated, solid. The surface dull, ornamented with numerous fine lines of growth, and

minute lines of beaded microscopic sculpture, greenish to dark greenish or blackish horn colored, with numerous (8 to 10) subequidistant spiral bands of a mahogany reddish brown color. Whorls remaining 4, well rounded, separated by moderately deep sutures, spire usually eroded, variable in height, usually comprising about one-third the shell height. Aperture large, subauriform, almost entire; the lip heavy, somewhat flaring, but not reflected. The outer lip is evenly rounded, the base well rounded; the columellar lip is rounded below, straight above across the parietal callus. The aperture is slightly flared, the lip all in one plane except for the heavy parietal callus which is carried forward slightly on the parietal wall. The aperture is hardly insected by the penultimate whorl.

The type, U.S.N.M. No. 542136, has 5 whorls remaining, and measures: Height, 44.0 mm.; diameter, 46.5 mm.; aperture height, 33.5 mm.; aperture diameter, 24.5 mm.; and umbilicus diameter, 6.0 mm.

This large, heavy subspecies was found in only three small streams (not of contiguous drainage) on the west side of San José Island.

It differs from *cumingii* by its heavier, broader shell, more completely rotund in adult examples, and by its much wider umbilicus. It is faintly remindful of the group of *glauca* L., from northern South America (Atlantic drainage), but its closest relatives are probably in the region of Río Tuyra near the Colombian border of Panamá, if one specimen of doubtful identification from the Río Sambú is any indication.

Its occurrence in these three smaller streams only, out of the dozen or more permanent streams of suitable habitat personally examined on San José Island, is entirely fortuitous, and could not have been brought about by stream capture.

The reproduction of this species is possibly somewhat continuous, as young of various sizes were seen on several occasions. Egg masses in various stages of hatching were seen along with individuals in coitus on March 5, 1944, during the dry season.

It is much larger in size than any typical *cumingii* seen and has a larger umbilicus in proportion. The spire is higher although usually eroded in adults, and the fresh young shells of about 25 mm. are covered with numerous spiral rows of epidermal tufts, giving the shell a velvety appearance.

The largest of many specimens seen measures: Height (apex eroded), 52 mm.; diameter, 53.5 mm.; umbilicus diameter, 8 mm. The smallest adult shell measures: Height (apex eroded), 37.5 mm.; diameter, 40.5 mm.; and umbilicus diameter, 4.8 mm.

## POMACEA ZETEKI, new species

Plate 1, fig. 3

1899. *Ampullaria cumingi* MARTENS, Biol. Centr.-Amer., Mollusca, p. 422, in part.

Shell of medium size, globose, narrowly umbilicate, moderately solid. The surface is dull to shining with fine lines of growth and minute lines of beaded microscopic sculpture, corneous, with numerous subequal and subequidistant spiral bands of mahogany color within. Whorls well rounded, separated by a moderate suture. Body whorl a little more abruptly rounded above the periphery, less so below. Spire moderate, about one-third the shell height. Aperture large, ovate-semicircular, somewhat effuse below, lip heavy, thickened but not reflected. The outer lip is evenly rounded in an almost even curve from suture to base; columellar lip well rounded into the basal curve. The aperture is slightly inset by the penultimate whorl in the region of the moderately thin parietal callus.

The holotype, U.S.N.M. No. 542137, has  $4\frac{3}{4}$  whorls remaining and measures: Height, 40 mm.; diameter, 40 mm.; aperture height, 30.5 mm.; aperture diameter, 23 mm.; umbilical diameter, 3 mm.

It and numerous paratypes, U.S.N.M. No. 542138, were personally collected from the shallow margin of the Chagres River near Gatuncilla, Republic of Panamá, on October 6, 1944. It is named in honor of James Zetek, who has done so much to promote the scientific knowledge of the animals of Panamá.

Von Martens did not differentiate between the isthmian form as found in the Chagres River and the true *cumingii* from Taboga Island in the Bay of Panamá.

*P. zeteki* (*cumingii* of authors generally) is easily distinguished by the slightly shouldered appearance of the whorls and the narrow umbilicus. The numerous bright reddish-brown color bands show through the greenish horn epidermis and are a rich mahogany color within the aperture. In clean specimens the microscopic sculpture is seen as spiral bands of scars of the epidermal tufts which produce the velvety appearance of the young shells.

## Family LITTORINIDAE

The littorinid snails are usually considered as marine in habitat, while actually many of the species occupy transitional habitats. It has been actually proved by experiment that certain species of *Littorina* have an optimum environment of an occasional immersion in salt water (or regular immersion at each high tide) with long

periods out of water in the air. The consideration of the littorinid snails as occupying a marginal land habitat is further strengthened by their close morphological relationship to the members of the family Cyclophoridae, which are exclusively terrestrial in habit.

#### Genus *LITTORINA* Férussac, 1822

On San José Island the genus *Littorina* is well represented, both in species and number of individuals. In the mangrove swamps these snails are usually seen high up on the aerial mangrove roots or the tree trunks, often out of the reach of high tide. Here two larger species about an inch in length were found.

#### *LITTORINA ZEBRA* (Donovan)

1825. *Turbo zebra* DONOVAN, Nat. Repos., vol. 4, pl. 131.

1832. *Littorina pulchra* SOWERBY, Gen. Shells, pl. 37, figs. 2, 3.

This large reddish species has a shouldered body whorl and a striking design of narrow diagonal black stripes, for which it is named.

#### *LITTORINA FASCIATA* Gray

1839. *Littorina fasciata* GRAY, Zool. Capt. Beechey's Voyage, p. 139.

This large species possesses a more rounded body whorl, a little angulate at the base, and is spirally more roughly ridged than *L. zebra*. Also, the brown and gray mottling presents a much more subdued color pattern.

#### ?*LITTORINA GLABRATA* Philippi

A third species, much more strikingly conical in shape and intermediate in size, was found only in small numbers, and mostly in the young state, on the mangrove roots. It is tentatively identified as *Littorina glabrata* Philippi (Proc. Zool. Soc. London, 1845, p. 140). The few specimens seen from San José Island and elsewhere in Panamá vary in color from light lemon yellow to brown mottled characteristically with darker brown.

#### *LITTORINA DEBILIS* Philippi

1846. *Littorina debilis* PHILIPPI, Proc. Zool. Soc. London, 1845, p. 140.

1847. *Littorina debilis* PHILIPPI, Abbild. Conchylien, vol. 3, p. 11, *Littorina*, pl. 6, fig. 7.

This small species, about half an inch long, was found in extreme abundance on and under the drift in the Río Marina swamp, behind

the sand barrier at its mouth, especially on the rotting fronds of the coconut palm, along with great numbers of *Detracia* snails. It is long, conical, prettily mottled with brown, and varies considerably in the strength of color. An undetermined species of trematode worm was found in some of these snails. On the date of collection, August 2, 1944, these parasites were in the sporocyst stage in the bodies of the snails.

On the rocks, near, at, or even above the high-tide lines, there are two species in great abundance :

#### LITTORINA CONSPERSA Philippi

1847. *Littorina conspersa* PHILIPPI, Abbild. Conchylien, vol. 2, p. 200, *Littorina*, pl. 4, fig. 14.

This species is usually almost entirely whitish in color, with a minute blackish apex.

#### LITTORINA ASPERSA Philippi

1847. *Littorina aspersa* PHILIPPI, Abbild. Conchylien, vol. 2, p. 200, *Littorina*, pl. 4, fig. 13.

*Littorina aspersa*, in contrast to *conspersa*, is much darker in color, mottled with black and may have the tip of the shell eroded and white.

### Family FOSSARIDAE

#### Genus FOSSARUS Philippi, 1841

Along with the species of *Littorina* on the rocks near or at the high-tide line are two species of *Fossarus*. Their habitat may likewise be considered transitional to land or "marginal" land.

#### FOSSARUS ANGIOSTOMUS (C. B. Adams)

1852. *Littorina* (?) *angiostoma* C. B. ADAMS, Cat. Shells Panama, p. 170.

*Fossarus angiostomus* (C. B. Adams) is ovate-conic, about a quarter of an inch long, smoothish, and almost entirely white in color.

#### FOSSARUS ATRATUS (C. B. Adams)

1852. *Littorina atrata* C. B. ADAMS, Cat. Shells Panama, p. 171.

*Fossarus atratus* (C. B. Adams) is strongly spirally ridged and variable in color from white to heavily spotted with black. These

members of the genus *Fossarus* may be distinguished from the littorinid snails, with which they occur, by their small size and the presence of a small umbilicus or central opening on the base of the shell.

### Family AMNICOLIDAE

#### Subfamily HYDROBIINAE

##### Genus ZETEKELLA, new genus

*Genotype*.—*Littoridina frenata* Pilsbry = *Zetekella frenata* (Pilsbry).

Shell imperforate, elongate-conic, smooth, with shallow sutures separating the appressed whorls. Spire moderate, acute. Aperture long-elliptical, acutely angled above. Columellar lip somewhat caloused. Operculum thin, corneous, paucispiral. Verge a little flattened, functionally simple, with a rather blunt tip, and furnished with two small appendages on the left side.

The genus *Zetekella* is a well-marked group of Central American snails, known at present to be distributed from Nicaragua to Panamá and the Pearl Islands in the Bay of Panamá. As far as known, this genus is confined to streams of the Pacific drainage, above tidal influence.

In addition to the genotype, *Z. frenata* (Pilsbry), from the Río Juan Diaz, Panamá, it is known to include:

- Z. martensi* (Pilsbry), from the Río Fula, Nicaragua, Proc. Acad. Nat. Sci. Philadelphia, vol. 87, p. 5, fig. 2, 1935;
- Z. melanoides* (Martens), from the Río de los Platanales, Costa Rica, Biol. Centr.-Amer., Mollusca, p. 436, pl. 22, fig. 8, 1899;
- Z. panamensis* (Bartsch), from the Río Matasnillo, Panamá, Proc. U. S. Nat. Mus., vol. 58, p. 164, pl. 12, fig. 8, 1920;
- Z. veraguasensis* and *Z. kompi*, new species, described herewith, from Sona, Veraguas, Panamá, and San José Island, Pearl Islands, Gulf of Panamá.

Unfortunately, *Z. panamensis* (Bartsch) is apparently extinct. Its exact type locality is believed to be the Río Matasnillo, on the eastern edge of Panamá City. A search of this stream above tidewater on October 7, 1944, revealed no amnicolids; the stream's condition on this date indicated heavy sewage pollution from the encroaching city.

It may be noted here that members of the genus *Zetekella* and of the *Cochliopa* group are the closest morphological relatives, in the Panamá region, of the Asiatic genera *Oncomelania* and *Katayama*.

The extinction of some of these species of the family Amnicolidae by sewage pollution in the Panamá region is probably a condition of great medical importance. If we analyze this condition carefully, we find here biological proof that these species do not have the physiological or ecological ability to carry the trematode parasites of Asiatic human schistosomiasis (*Schistosoma japonicum* Katsurada).

These facts will also explain why the Asiatic human schistosomiasis has never been endemic in Panamá, in spite of the probability that infected human carriers have been present in the region of Panamá City for the past three centuries.

#### ZETEKELLA FRENATA (Pilsbry)

1935. *Littoridina frenata* PILSBRY, Proc. Acad. Nat. Sci. Philadelphia, vol. 87, p. 5, figs. 1, 1a.

*Z. frenata* (Pilsbry) was taken in considerable numbers from the Río Juan Díaz (type locality) east of Panamá City, in company with *Neritina latissima intermedia*, *Neritilia panamensis*, *Cochliopina zeteki*, and *Cochliopa diazensis*. It was especially abundant on the matted tree rootlets hanging in the water along the bank of the river.

#### ZETEKELLA VERAGUASENSIS, new species

Plate 2, fig. 1; plate 3, fig. 1

Shell small, elongate-conic, imperforate; the spire regularly conic (apex acute), of six flat-sided whorls. Suture linear, shallow, each whorl regularly increasing. Apex minute, apical whorl smooth, closely appressed to the preceding. The suture appears banded because of a subsutural callus filling the appressed summit of the whorl. Postnuclear whorls smoothish, ornamented with minute growth lines and microscopic spirals. Aperture two-fifths of the shell, oval, acutely angled above, narrowly rounded below. Parietal margin almost straight with a moderate callus on the lower part. Operculum thin, corneous, paucispiral, of about 3 turns; nucleus subbasal. The verge is as described for the genus, attached a little behind the right tentacle.

This species may be distinguished by the large size, more obese body whorl, and almost straight parietal lip.

The type, U.S.N.M. No. 542139, has 7 whorls and measures: Height, 6.2 mm.; diameter, 3.1 mm.; aperture height, 2.8 mm.; aperture diameter, 1.7 mm.

It and several paratypes, U.S.N.M. Nos. 218175 and 516967, were collected by James Zetek from the Río Tribiqué at Sona, Veraguas Province, Panamá.



## ZETEKELLA KOMPI, new species

Plate 2, fig. 2; plate 3, fig. 2

Shell small, imperforate, elongate-conic; spire terete-conic (apex acute), of 6 almost flat-sided whorls; suture shallow, linear, between the faintly subangulate, regularly increasing whorls. Apex smooth (eroded); postnuclear whorls, beginning with the second, ornamented with fine growth lines and prominent microscopic spiral lines. Aperture ovate, narrowed posteriorly, evenly rounded anteriorly. The parietal lip is arched somewhat to present a curve almost equal to that of the periphery. The lip is strong but thin, dark-edged, connected in adults by a moderate callus on the parietal wall. The operculum is thin, corneous, paucispiral, of about 2 turns, with subterminal nucleus.

The animal is as described for the genus, the verge with two small appendages on the left (forward) side.

The type, U.S.N.M. No. 542140, has 6 whorls remaining, and measures: Height, 5.8 mm.; diameter, 2.6 mm.; aperture height, 2.3 mm.; aperture diameter, 1.6 mm. It and numerous paratypes were personally collected from the Río Mata Puerco and its branches on the west side of San José Island, Archipiélago de las Perlas, Panamá.

This species may be distinguished by its large size and faintly shouldered whorls.

Named for Col. W. H. W. Komp, of the United States Army Sanitary Corps, whose malarial research led to its discovery.

## Genus AROAPYRGUS H. B. Baker, 1931

Shell amnicoloid, with minute spiral striae on a smooth shell. Operculum thin, corneous, paucispiral. Verge: a large simple penis, unbranched, its terminal half smaller in diameter and pigmented.

*Genotype*.—*Aroa ernesti vivens* H. B. Baker = *Aroapyrgus ernesti vivens* (H. B. Baker).

The reproductive anatomy of all Panamanian species of "*Amnicola*" available has been examined, and found to be that of this genus, now known definitely to occur from Panamá to Cayenne.

Determination as to which of the species of "*Amnicola*" known from Tampico, Mexico, to Costa Rica, belong here also must await a check of their animal characters.

*A. panamensis* Tryon agrees in shell characters; its male reproductive anatomy has not been examined. It is believed to belong here, nevertheless. In addition, there are the following new species in the Panamá region.

**AROAPYRGUS ALLEEI, new species**

Plate 2, fig. 4; plate 3, fig. 3

Shell small, ovate-conic, narrowly perforate, the spire almost regularly conic, of well-rounded, obscurely shouldered whorls, separated by a deep suture. Aperture 0.4 of the shell height, narrowed and obtusely angled above, rather evenly rounded below. Parietal lip straight in contact with the penultimate whorl, then evenly rounded to the columellar region. Umbilicus narrow, behind the narrowly thickened lip. Sculpture of microscopic spirals and more prominent, irregular, widely spaced, raised growth lines. Plane of the aperture sinuous, produced a little peripherally. Operculum thin, corneous, paucispiral, of about 3 turns, with subbasal nucleus.

Animal as described for the genus, with a large simple verge in the male, attached a little distance behind the right tentacle.

The holotype, U.S.N.M. No. 542142, has  $4\frac{1}{2}$  whorls and measures: Height, 3.1 mm.; diameter, 2.3 mm.; aperture height, 1.7 mm.; aperture diameter, 1.1 mm. It and numerous paratypes, U.S.N.M. No. 542143, were personally collected from dead leaves, sticks, etc., in a pool in the Allee Stream on Barro Colorado Island, Gatun Lake, Canal Zone, Panamá, on October 8, 1944. It is named for Dr. W. C. Allee, my former professor at the University of Chicago, in whose honor this stream is named.

U.S.N.M. No. 432880 includes many additional paratypes collected by James Zetek. U.S.N.M. No. 474053 contains additional paratypes collected by Prof. H. J. Van Cleave, of the University of Illinois.

This species may be distinguished by its obscurely shouldered whorls. It is larger than the specimen of *panamensis* Tryon (Rowell's No. 20) in the National Museum collections.

**AROAPYRGUS CHAGRESENSIS, new species**

Plate 2, fig. 3; plate 3, fig. 4

Shell small, narrowly perforate, ovate-conic, with the spire conic, of moderately well-rounded whorls, separated by a deep suture. Aperture less than 0.4 the shell height, ovate, narrowed a little above, evenly rounded below, made entire by continuation of the lip across the parietal wall. The aperture is outwardly slightly effuse. Plane of the aperture a little sinuous, the thickened lip carried forward a little peripherally and on the parietal wall. Sculpture of microscopic spiral lines and more conspicuous, distant, irregular growth lines. The lip

callus is thickest in the upper parietal region. Operculum thin, corneous, paucispiral, of about 2 turns.

Animal as described for the genus with a large, simple verge in the male, attached to the neck a little behind the right tentacle.

The holotype, U.S.N.M. No. 542144, has 5.5 whorls and measures: Height, 3.7 mm.; diameter, 2.5 mm.; aperture height, 1.6 mm.; aperture diameter, 1.3 mm.

The type and many paratypes, U.S.N.M. No. 542145, were screened from small beds of *Chara* and other plants in shallow water near the southeastern side of the Río Chagres, near Gatuncilla, Republic of Panamá

Another lot of specimens, U.S.N.M. No. 542146, was collected from plants in the rapids of the Río Chagres, near Madronal, Republic of Panamá.

This species is easily distinguished by its roundly ovate, slightly effuse aperture of adult specimens. The whorls are evenly rounded from suture to suture, not faintly shouldered as in *A. alleei*.

#### AROAPYRGUS JOSEANA, new species

Plate 2, fig. 5; plate 3, fig. 8

Shell small, narrowly perforate, ovate-conic to conic, the spire composed of very well-rounded whorls, separated by a deep suture. Apex smooth. Postnuclear sculpture of fine growth lines and faint microscopic spiral lines. The base is unusually well rounded, produced by the marked rotundity of the axially short whorls, suborbicular in section. Umbilicus distinct, narrow behind the unreflected columellar lip. Aperture ovate-suborbicular, about one-third the shell height, almost entire, ovate, narrowed above, almost evenly rounded below. Plane of the aperture a little sinuous, projecting slightly forward in the columellar region. Lip thickened somewhat, unreflected. The moderate lip callus is heaviest at the baso-columellar region.

The operculum is thin, corneous, paucispiral, of about 2 turns.

Animal as described for the genus. The males with a prominent simple verge attached on the right of the neck some distance behind the right tentacle. Its outer half (functional tip) is darkly pigmented and much smaller in diameter than the basal portion. It may be variously coiled in the retracted condition seen in preserved specimens.

The holotype, U.S.N.M. No. 542147, has 5 whorls and measures; Height, 3.1 mm.; diameter, 2.1 mm.; aperture height, 1.2 mm.; aperture diameter, 1.1 mm.

The type and 12 paratypes, U.S.N.M. No. 542148, were collected from a northern tributary of the Río Mata Puerco estuary, San José Island, Archipiélago de las Perlas, Panamá, about a quarter of a mile above tidewater, and near the upper limits of Amnicolidae in this small stream. In addition, this species was found in small numbers in two streams on the northwest part of San José Island, and in the Río Marina on the east side.

*Aroapyrgus joseana* may be easily distinguished from the other Panamanian species by the axially shorter whorls and the rotundity of the base. In this last character it approaches *A. ernesti* (Martens) from Venezuela, but it may be distinguished from that species by its smaller aperture and narrower conical outline.

Genus LYRODES Doering, 1884

*Genotype*.—*Lyrodes guaranitica* Doering, 1884.

The genus *Lyrodes* is widespread from southern United States (Texas) to Central America, the West Indies, and south to the Argentine in Latin America.

The absence of this genus from San José Island is noteworthy, in view of its widespread occurrence on islands of the West Indies. It may be that there are no sufficiently favorable habitats on the Island.

The following new species from the Isthmus of Panamá were located in the search for Panamanian species related to the island fauna:

LYRODES CHAGRESENSIS, new species

Plate 2, fig. 6; plate 3, fig. 6

Shell small, turreted-conic, narrowly perforate, translucent; apex acute. Nuclear whorls smooth, postnuclear whorls spirally liriate; the cord at the shoulder a little above the periphery becoming prominent to form a carina on the third whorl, often prominently nodose to form short "spines" on the fourth and fifth whorls, usually less prominent on the body whorl. The whorls are rather well rounded, separated by a deep suture and furnished with numerous equidistant spiral lirae above and below the shoulder. In the aspinose phase, the shoulder carina is discernible, but little larger than the other spiral lines, and the whorls are more evenly rounded from suture to suture. Aperture small, one-third the shell height, regularly ovate, narrowed very little above. The columellar lip is evenly arched, regularly rounded into the base. Operculum thin, corneous, paucispiral.

Animal as described for the genus; in the male with a prominent appendiculate verge on the right side of the neck. The verge has a tripartite appendage at the left side (forward) pigmented near the functional tip, and basally on the right a single row of fine short papillae; female ovoviviparous.

The holotype, U.S.N.M. No. 542149, has 6 whorls and measures: Height, 4.2 mm.; diameter, 2.1 mm.; aperture height, 1.4 mm.; aperture diameter, 1.1 mm. It and several paratypes, U.S.N.M. No. 542150, were personally collected from *Chara* beds, etc., in the shallow water near the margin of the Chagres River, near Gatuncilla, Republic of Panamá, in company with *Aroapyrgus* and *Pisidium*.

This species may be distinguished by its slender form and small aperture, with the characteristic sculpture most prominent on the fourth and fifth whorls, and reduced on the body whorl.

The male examined and drawn (Jan. 16, 1946) proved this to be a typical member of the genus, variable as the shell is, on account of the pattern of the verge. This species has the narrow (lirate) form of the genotype variable to spinose (as in *Pyrgophorus*) and probably proves that these two are just shell phases of one generic group.

#### LYRODES ZETEKI, new species

Plate 2, fig. 10

Shell small, elongate-conic, narrowly perforate, translucent, apex smooth, acute; postnuclear whorls spirally lirate and shouldered. The shoulder carina is most prominent on the fourth and fifth whorls, and often nodose to form the characteristic short "spines." Whorls well rounded, shouldered, separated by a deep suture. In the aspinose form the whorls are narrower, more flatly rounded, the sculpture is much reduced, and may be without a discernible shoulder or spiral lirations on the body whorl. Aperture moderate, about three-eighths the shell height, ovate, narrowed above. The lip is thin, simple, in some individuals with a callus across the parietal region to produce an entire aperture. Operculum thin, corneous, paucispiral. Females ovoviviparous, the embryonic young in the uterus with short amnicoloid shells of  $1\frac{1}{2}$  whorls.

The holotype, U.S.N.M. No. 542151, has  $5\frac{3}{4}$  whorls and measures: Height, 4.8 mm.; diameter, 2.6 mm.; aperture height, 2 mm.; aperture diameter, 1.4 mm.

U.S.N.M. No. 432871 includes many paratypes from the same lot collected by James Zetek at Pedro Miguel, Canal Zone, Panamá.

This species from the Pacific drainage may be distinguished from *L. chagresensis* by its large aperture and less slender shape. The nodose spines (when present) are larger and less numerous than in that species.

A critical examination of the species hitherto referred to the genus *Cochliopa* has shown that they fall into three groups, distinct from each other on the bases of shell and of anatomy.

In fact all the species previously referred to *Cochliopa*, except the genotype, are proved by the present anatomical studies to differ generically from that species. The species involved comprise three natural groups which are here separated.

#### Genus COCHLIOPINA, new genus

Shell conic-helicoid to planorboid, without umbilical keeling. The whorls are separated by moderate to deep sutures, not closely appressed; the sculpture is often composed of subequal spiral lirations, which may be distinctly colored. The aperture is oblique, subcircular to subtrapezoidal, usually almost or quite entire, sometimes a little solute in mature shells. Operculum thin, corneous, paucispiral, but almost multispiral in appearance, of 3 to 5 whorls, and has a sub-central nucleus. The radula has the formula:  $\frac{4-1-4}{3-3} : 2-1-3 :$

13:  $\infty$  (in *C. minor*). The verge is long, entirely simple, without appendages (pl. 3, fig. 7).

*Genotype*.—*Cochliopa riograndensis* Pilsbry and Ferriss, 1906 = *Cochliopina riograndensis* (Pilsbry and Ferriss).

The distribution of known members of the genus *Cochliopina* is very interesting. All the northern species, ranging from Texas through Mexico to eastern Guatemala as far as Lake Izabal and the Río Dulce, are found only in river systems draining into the Gulf of Mexico and the Caribbean. In contrast, all the species known from the southeast corner of Guatemala, southward through Nicaragua, Costa Rica, Panamá, and the Pearl Islands in the Gulf of Panamá, occur only in streams of the Pacific drainage. Undoubtedly this interesting and apparently complete switch from one side of the Continental Divide to the other has its source in the biological history of this region in past geological time.

It is extremely interesting to note that in the two known streams in which species of *Cochliopina* and *Cochliopa* are found living together, the *Cochliopina* species is much the smaller of the two.

An even more striking difference in ecological habit was observed on San José Island. The only *Cochliopa* found on the island was present from tidewater almost to the sources of the Río Mata Puerco system. On the other hand, the *Cochliopina* found in that stream, and the ones found in five other streams on the island also, were markedly limited to a narrow habitat zone of the stream a little above tidewater.

This genus probably includes, besides the genotype, the following:

- C. picta* (Pilsbry), Río Choy, San Luis Potosí, Mexico, Nautilus, vol. 23, No. 8, p. 100, pl. 9, figs. 1, 2, 1910;  
*C. compacta* (Pilsbry), Río Choy, San Luis Potosí, Mexico, Nautilus, vol. 23, No. 8, p. 99, pl. 9, figs. 4, 5, 1910;  
*C. infundibulum* (Martens), Petén, Guatemala, Biol. Centr.-Amer., Mollusca, p. 429, pl. 23, fig. 3, 1899;  
*C. francesae* (Goodrich and Van der Schalie), Río Pasión, Guatemala, Univ. Michigan Mus. Zool., Misc. Publ. No. 34, p. 38, pl. 1, fig. 3, 1937;  
*C. hinkleyi*, *C. izabal*, and *C. izabal* mut. *perstriata* (Pilsbry), all from Lake Izabal, Guatemala, Proc. Acad. Nat. Sci. Philadelphia, vol. 72, pp. 198, 200-201, figs. 4, 6, 7, 1920;  
*C. dulcensis* (Marshall), from the Río Dulce, Guatemala, Proc. U. S. Nat. Mus., vol. 58, p. 302, pl. 17, figs. 1-3, 1920;  
*C. guatemalensis* (Morelet), Río Michatoya, near Istapa, Guatemala, Test. Noviss., pt. 2, No. 138, p. 22, 1851; Fischer and Crosse, Miss. Sci. Mex. Amér. Centr., pt. 7, vol. 2, Mollusques, p. 302, pl. 48, fig. 2, and pl. 50, fig. 1, 1900.  
*C. tryoniana* (Pilsbry), western Nicaragua and southwestern Costa Rica, Nautilus, vol. 4, No. 5, p. 52, 1890; Proc. Acad. Nat. Sci. Philadelphia, 1891, p. 331, pl. 15, fig. 12, 1892;  
*C. minor* (Pilsbry), Polvon, Nicaragua, Proc. Acad. Nat. Sci. Philadelphia, vol. 72, p. 199, fig. 5, 1920;

and the following new species:

**COCHLIOPINA ZETEKI, new species**

Plate 2, fig. 7; plate 3, figs. 5, 9

Shell small, helicoid, narrowly umbilicate, peripherally subangular, of 5 regularly increasing whorls. Apex low; nuclear whorls about  $1\frac{1}{2}$ ; postnuclear whorls spirally striate or lirate; suture shallow. Sculpture variable, in most regularly spirally striate with subangular periphery, others peripherally carinate and striate above and below, in a few multicarinate, due to almost equal prominence of a few strongly developed spiral lirae. In all the base is well rounded.

Aperture subtrapezoidal, oblique, produced on the parietal wall. Lip simple, thickened within, the callus most prominent on the columella. Operculum thin, corneous, of about 5 narrow turns. Animal as described for the genus; male with simple verge on the back of the neck behind the right tentacle. The snout has two black bands across it, and the tentacles show two bands of black pigment, one at the middle and the second near the tip.

The holotype, U.S.N.M. No. 542152, has 5 whorls and measures: Height, 3.1 mm.; diameter, 3.9 mm.; aperture height, 2.1 mm.; aperture diameter, 2.1 mm. The type was personally collected from the leaves and roots along the eastern margin of the Río Juan Diaz, just below the bridge of Las Sabanas Road, east of Panamá City, on October 7, 1944.

U.S.N.M. No. 542153 includes several hundred paratypes from the same source.

James Zetek had previously collected this species here on February 20, 1932 (U.S.N.M. Nos. 432877 and 432878), and it is named in honor of its discoverer. Formerly considered *C. tryoniana* Pilsbry, this species differs from that by having the shell less high in adult specimens. The noncarinate phase of this species is markedly lower than the *tryoniana* seen.

#### COCHLIOPINA JURADOI, new species

Plate 2, fig. 8; plate 3, fig. 10

Shell small, low, conic, narrowly umbilicate, peripherally rounded to subangular, of  $5\frac{1}{2}$  regularly increasing whorls. Spire conic; nuclear whorls minute,  $1\frac{1}{2}$ , smooth; postnuclear whorls finely spirally lirate, sometimes with one subcarinate lira at the periphery. Whorls moderately flattened above the periphery, well rounded below. Suture moderately deep. Base well rounded with narrow funiculate umbilicus. Aperture subtrapezoidal, oblique, produced at the posterior angle; base line of aperture evenly rounded from columella to periphery. Lip thin, simple, markedly calloused on the columella. Operculum thin, corneous, of about 5 closely wound turns and sub-central nucleus. Animal with a prominent pigment band across the tentacles at their distal third, with simple verge attached far over on the right side of the neck a little behind the right tentacle. The verge is as described for the genus, the distal half more slender, and lightly pigmented.

The holotype, U.S.N.M. No. 542154, has  $5\frac{1}{2}$  whorls and measures: Height, 4 mm.; diameter, 4.6 mm.; aperture height, 2.1 mm.; aperture diameter, 2.3 mm.



U.S.N.M. No. 542156 includes several paratypes collected July 25, 1944.

U.S.N.M. No. 542155 includes many more paratypes collected at the same spot on August 20, 1944.

The type was personally collected from rocks in the rapids of the stream leading to the northwest mangrove swamp on San José Island, Archipiélago de las Perlas, Republic of Panamá.

The species is named for R. B. Jurado, civilian surveyor for the United States Army Engineers, whose joint resurvey of this stream with the writer led to its discovery, and whose exploratory "survey trails" opened many spots on San José Island for their first scientific scrutiny.

*C. juradoi* may be distinguished by its regular conic spire and well-rounded whorls and base with narrow umbilicus.

#### COCHLIOPINA FRATERNULA, new species

Plate 2, fig. 9; plate 3, fig. 11

Shell minute, helicoid, openly umbilicated, of  $4\frac{3}{4}$  whorls (in the type); apex low; nuclear whorls smooth; postnuclear whorls finely regularly spirally lirated, well rounded and separated by a moderately deep suture. Base rounded; umbilicus proportionately large. Aperture roundly trapezoidal, plane of aperture oblique, somewhat sinuous; lip thin, thickened within, the callus heaviest at the base. Operculum thin, corneous, of closely wound turns with subcentral nucleus. Animal (male examined) with a black pigment band at the middle and a round black spot at the tip of the tentacles. Verge whitish, the slender distal half lightly pigmented, attached a little behind the right tentacle and a little to the right of the midline, on the back of the neck.

The holotype, U.S.N.M. No. 542157, has 4 whorls and measures: Height, 1.5 mm.; diameter, 2 mm.; aperture height, 0.8 mm.; aperture diameter, 0.9 mm. It and 4 paratypes, U.S.N.M. No. 542158, and 1 specimen, U.S.N.M. No. 542159, were personally collected in the reaches just above tidewater of the Río Mata Puerco, San José Island, Archipiélago de las Perlas, Republic of Panamá.

It is named "little brother" on account of its much smaller size than *Cochliopa joseana* in whose company it was found. Unlike that species (genus) it does not occur throughout the greatest part of the stream, but only in a definite zone a short distance upstream from the mangrove swamp. In this ecological character it agrees with all the other *Cochliopina* species known from San José Island.

It is easily distinguished by its minute size and well-rounded base with proportionately large umbilicus. It is the smallest *Cochliopina* known from the Panamanian region.

A paratype of U.S.N.M. No. 542158 was dissected to check the male genitalia and furnished the sketch.

**COCHLIOPINA NAVALIS**, new species

Plate 2, fig. 12; plate 3, fig. 12

Shell small, helicoid, umbilicate, of 5 to  $5\frac{1}{2}$  well-rounded, regularly increasing whorls. Spire subconic; nuclear whorls minute,  $1\frac{1}{2}$ , smooth; postnuclear whorls regularly spirally lirate, the lirae closely spaced and equally prominent. Suture near the apex well marked, deep, increasingly less prominent between the later whorls, sometimes very shallow on the body whorl. Base well rounded, with moderately open, funiculate umbilicus. Aperture rounded, subtrapezoidal, the plane of aperture oblique; lip simple, much thickened within; the callus subequal all around. Operculum thin, corneous, of about 5 turns and with subcentral nucleus. Animal with the distal half of the tentacles darkly pigmented. The prominent verge with pigmented distal half is attached a little to the right of the midline, a short distance behind the right tentacle.

The type, U.S.N.M. No. 542160, has  $5\frac{1}{2}$  whorls and measures: Height, 3.7 mm.; diameter, 4.6 mm.; aperture height, 1.9 mm.; aperture diameter, 2.2 mm. It and numerous paratypes, U.S.N.M. Nos. 542161 and 542162, were collected from the stream flowing into the small bay on the southwest part of San José Island, at which is located the landing for the United States Naval lighthouse maintained on the southwestern part of the island.

*C. navalis* may be distinguished by its larger size, lower conic spire, and slightly shouldered whorls. The base of the body whorl may be somewhat flattened.

**COCHLIOPINA EXTREMIS**, new species

Plate 2, fig. 11; plate 3, fig. 13

Shell small, umbilicate, low-helicoid, of  $4\frac{3}{4}$  whorls. Apex low; nuclear whorls  $1\frac{1}{2}$ , smooth; postnuclear whorls finely but regularly strongly spirally lirate. The whorls are apparently a little wider than high, well rounded above, apparently somewhat flattened below, separated by a well-marked deep suture that often becomes shallower on the body whorl. The periphery is well rounded, not angulate.

Aperture roundly trapezoidal, very oblique, markedly sinuous, most recessive on the outer basal margin. Lip thin, heavily thickened within, the callus heaviest on the columellar side. Operculum thin, corneous, of about 5 turns as in the genus. Animal with the snout darkly pigmented, with two black pigment bands across it, the rear one a little obscure. The tentacles light, with a black pigment band across their middle and a black pigmented spot at their tip. The verge is proportionately large, with pigmented distal half, and attached far over on the right side, at the neck, close behind the right tentacle.

The type, U.S.N.M. No. 542163, has  $4\frac{1}{2}$  whorls and measures: Height, 2.5 mm.; diameter, 3.5 mm.; aperture height, 1.5 mm.; aperture diameter, 1.6 mm.

It and numerous paratypes, U.S.N.M. No. 542164, were personally collected from the small stream with a 100-yard lagoon just east of the southern tip of San José Island, Archipiélago de las Perlas, Panamá.

The habitat of this species is extremely limited in geographic space. The habitat zone for this species in this stream consists of only the last rapids of the stream just above the lagoon. Actually the species was found living in only 25 yards or less of the stream, at this point not even 25 feet wide.

*C. extremis* may be distinguished by the small size and the depressed appearance of whorls and shell.

#### COCHLIOPINA AUSTRALIS, new species

Plate 2, fig. 13; plate 3, fig. 14

Shell small, umbilicate, helicoid, of  $5\frac{1}{2}$  whorls. Apex low; nuclear whorls minute,  $1\frac{1}{2}$ , smooth; postnuclear whorls subangular, strongly spirally lirated; usually the lirae are of unequal strength and strong lirae are separated by several fine ones, so as to produce a sort of multicarinate appearance. Whorls of the low spire are faintly shouldered, separated by a moderate suture which becomes shallow near the aperture where the shoulder angle disappears on the body whorl of adults. Base widely reamed around the moderate umbilicus, somewhat flattened near the aperture. Aperture large, subtrapezoidal, very oblique; lip simple, thickened within with a moderate callus. Operculum as in the genus, of about 5 turns with subcentral nucleus. Animal lightly pigmented, with one prominent black band and a second fainter one across the snout. Tentacles with one prominent black pigment band across their middle. Verge whitish, lightly pigmented distally, and attached far to the right side a little distance behind and lower than the right tentacle.

The type, U.S.N.M. No. 542165, has  $5\frac{1}{4}$  whorls and measures: Height, 3.6 mm.; diameter, 5 mm.; aperture height, 2.2 mm.; aperture diameter, 2.3 mm. It and many paratypes, U.S.N.M. No. 542166, were collected in the lowermost reaches of the Musselshell Creek, just above the lagoon. This Musselshell Creek opens on a small steep sand beach near the south (east) end of the island.

*C. australis* may be known by its depressed conic shell of subangular whorls, large aperture, and lightly pigmented animal. The body whorl is apparently of much less axial height proportionately than in *C. wetmorei*.

#### COCHLIOPINA WETMOREI, new species

Plate 2, fig. 16; plate 3, fig. 15

Shell large (for the genus), umbilicate, regularly conic, of about  $5\frac{1}{2}$  whorls. Nuclear whorls minute,  $1\frac{1}{2}$ , smooth; postnuclear whorls somewhat subangular, spirally lirate, narrowly shouldered below a distinct but shallow suture. The body whorl appears higher than wide and is depressed toward the aperture, so as to touch the penultimate whorl only below the periphery over the last half whorl. The base of the body whorl is markedly flattened just in back of the aperture. The aperture is large, roundly subtrapezoidal, very oblique, usually made entire by the heavy callus within the lip which is heavy all around but thickest in the parietal region. Some adults seen have an almost solute aperture. Operculum thin, corneous, of about 5 turns as in the genus. Animal lightly pigmented, with two prominent black pigment bands across both the muzzle and the tentacles. One pigment band is about at the distal third of the tentacle, the other is almost terminal, a small white spot showing beyond at the tentacular tip. Verge large, simple and distally pigmented as in the genus, attached at a little distance directly behind the right tentacle.

The holotype, U.S.N.M. No. 542167, has 4 whorls remaining and measures: Height, 4.4 mm.; diameter, 5.3 mm.; aperture height, 2.2 mm.; aperture diameter, 2.5 mm. One of the largest paratypes seen measures: Height, 5.8 mm.; diameter, 6.1 mm.; aperture height, 2.6 mm.; aperture diameter, 2.9 mm. It and thousands of paratypes were collected from the habitat zone of the species in the Río Marina, the largest stream on San José Island. This habitat zone begins a little above the lowermost rapids of the stream and extends only about a quarter of a mile upstream, through a series of three sets of rapids and the intervening pools. This Río Marina is the large stream that opens at the middle of the long sand beach on the east side of San

José Island, Archipiélago de las Perlas, Panamá. Although the stream was personally traced to almost every branch of its headwaters, there are no *Cochliopinas* living beyond this short zone above the tidewater lagoon.

**Genus SUBCOCHLIOPA, new genus**

Shell conic to helicoid, usually peripherally keeled, and with spiral lirations which may be obsolete on the base which is somewhat flattened below the peripheral keel. Aperture oblique, subtrapezoid, produced at upper parietal region. The operculum is thin, corneous, almost multispiral in appearance, of about 4 turns, with a subcentral nucleus. Animal in the male with a simple verge, the functional tip (distal two-fifths) heavily pigmented, and at base of the pigmented area a very small appendage on the left (forward) side.

*Genotype*.—*Subcochliopa trochus*, new species, described herewith.

This new genus possesses spiral lirations similar to those of the *Cochliopina* group, accentuated in the direction of the peripheral keel and somewhat flattened base of the body whorl. On the other hand, the verge resembles that known for *Cochliopa*. While there is one small appendage in each case, the general appearance is different enough to indicate they are not identical (congeneric). The striking shell differences will make it easy to separate them from *Cochliopa*.

While it is not yet proved by anatomical study, it is thought that *Cochliopa trochulus* (Martens)<sup>2</sup> from southwestern Costa Rica belongs here.

**SUBCOCHLIOPA TROCHUS, new species**

Plate 2, fig. 17; plate 3, fig. 20

Shell large (for the genus), regularly conic, narrowly umbilicate, peripherally carinate, of about 5 regularly increasing, more or less flat-sided, whorls; apex obtuse. Nuclear whorls  $1\frac{1}{2}$ , smooth (eroded in the type); postnuclear whorls finely and regularly spirally striate, peripherally carinate, and wound so that the suture is at the carina of the preceding whorl. Base somewhat flattened. Aperture subtrapezoidal, oblique, carried far forward on the parietal wall, entire, the lip margins joined by a moderate callus on the parietal wall. Lip simple, thickened within, the callus heaviest on the columellar margin. Operculum thin, corneous, paucispiral, but apparently arctispiral, of 5 narrow turns, and with the nucleus subcentral. Animal in the male with a simple verge, the functional tip (distal two-fifths)

<sup>2</sup> Biol. Centr.-Amer., Mollusca, p. 429, pl. 23, fig. 2, 1899.

heavily pigmented, and with a very small appendage on the left (forward) side at the base of the pigmented area.

The type, U.S.N.M. No. 542168, and numerous paratypes, U.S.N.M. Nos. 217341 and 432875, were collected by James Zetek from the Río Tribique, at Sona, Veraguas Province, Panamá. The type has  $5\frac{1}{4}$  whorls and measures: Height, 5.9 mm.; diameter, 6.7 mm.; aperture height, 3.3 mm.; aperture diameter, 3.4 mm. The largest paratype seen has  $6\frac{1}{4}$  whorls and measures: Height, 7.5 mm.; diameter, 7.9 mm.; aperture height, 3.2 mm.; aperture diameter, 3.8 mm.

This species is easily distinguished by its greater size and acute peripheral keel, constantly carinate periphery and regular conic shape. The base is more flattened in this species than in *C. trochulus* (Martens).

#### SUBCOCHLIOPA COLABRENSIS, new species

Plate 2, fig. 14; plate 3, fig. 16

Shell small, helicoid, narrowly umbilicate, peripherally subangular, of  $4\frac{3}{4}$  regularly increasing whorls. Apex low. Nuclear whorls minute,  $1\frac{1}{2}$ , smooth; postnuclear whorls spirally lirate. Suture well marked, shallow between the moderately rounded spire whorls. Body whorl finely regularly lirate above the prominent peripheral subcarinate liration, flatter below the peripheral angle, where medially the lirations become much finer, almost obsolete, and subangulate around the narrow umbilicus. The lirations near the umbilicus are again prominent. Aperture ovately subtrapezoid, oblique, much produced on the parietal wall. Lip thickened within, most prominently on parietal and columellar margins. Operculum very thin, corneous, of about 4 turns. Animal with muzzle generally dark, base of tentacles dark, obscuring the eyes. Tentacles light, with an interrupted black pigment band at the basal third and a black spot at the tip. The verge, large, simple, light, with one minute light appendage and the functional tip pigmented beyond this point, is attached to the right of the midline, a little distance behind the right tentacle.

The type, U.S.N.M. No. 542169, has 5 whorls and measures: Height, 3.5 mm.; diameter, 4.6 mm.; aperture height, 2.1 mm.; aperture diameter, 2.3 mm. It and several paratypes, U.S.N.M. No. 218177, were collected by Meek and Hildebrand from the Río Colabre, of the Bayano River drainage, Panamá.

This species may be easily distinguished by the marked flattening of the base of the body whorl below the subcarinate periphery.

Genus *COCHLIOPA* Stimpson, 1865

The small (typical) group of species comprises the genus *Cochliopa*.  
*Genotype*.—*Amnicola rowelli* Tryon = *Cochliopa rowelli* (Tryon).

Unfortunately the genotype is now extinct, apparently having succumbed to sewage pollution of its type locality, the Río Matasnillo immediately east of Panamá City. At least careful search of this stream October 7, 1944, revealed no amnicolids whatsoever living in the heavily polluted stream.

Reexamination of type material of *rowelli* (U.S.N.M. No. 47855) has shown that the "bifid" condition is not a flagellate one as in the Bythinellinae, but is due to the possession of a simple verge with one small appendage, as described by Stimpson. A peculiarity of this species is the pigmentation of the tentacles, to give the appearance of false eye spots, a little distal of the midlength of the tentacles (pl. 3, fig. 17).

Shell helicoid, rimate to narrowly umbilicate, smooth to spirally liriate; aperture oblique, subrotund, angled or obtusely rounded above; whorls, especially the body whorl, closely appressed to the penultimate and depressed below the suture. Operculum thin, corneous, paucispiral, of 2 to 3 turns, with the nucleus near the columella-basal margin. Radula with the formula  $\frac{5-1-5}{2-2} : 3-1-4 : 18 : 24$ , in the genotype.

Verge "rather elongated, compressed, geniculated, and bifid, the inner branch being very small, less than one-fourth the size of the outer one and arising at the inner angle of the geniculation" (Stimpson).

The genus *Cochliopa*, as here restricted to species having the shell characters and male reproductive anatomy of the genotype, comprises a group of species known only from the Republic of Panamá. In addition to the genotype, only the following two new species have been definitely proved to belong to the group.

**COCHLIOPA DIAZENSIS, new species**

Plate 2, fig. 15; plate 3, fig. 18

Shell small, conic-helicoid, narrowly umbilicate, smoothish, of a few rapidly increasing whorls. Nuclear whorls minute,  $1\frac{1}{2}$ , smooth; early postnuclear whorls microscopically spirally striate, the lirae becoming obsolete on the last 2 whorls, except in the umbilical region. Suture shallow, linear at the body whorl, which is narrowly concave below the suture. Aperture subpyriform, entire; plane of aperture

oblique, a little sinuous. Lip thickened within; callus heaviest along parietal and columellar region, subangular at base of columella. Umbilicus narrow, steep-sided, margined with a blunt angularity on base of body whorl. Operculum thin, corneous, paucispiral, of about 3 turns; nucleus subcentral. Animal lightly pigmented, except for the snout which is more or less uniformly black. Tentacles light, with a black band across the middle and an irregular black spot at the tip. Verge light-colored, very little pigmented, with a small branch on the left (forward) side near the midlength (in contracted specimens).

The holotype, U.S.N.M. No. 542170, has  $4\frac{1}{2}$  whorls and measures: Height, 3.5 mm.; diameter, 4.1 mm.; aperture height, 2.3 mm.; aperture diameter, 2.1 mm. The type and hundreds of paratypes, U.S.N.M. Nos. 542171 and 542172, were personally collected from leaves, roots, etc., along the east bank of the Río Juan Diaz just below Las Sabanas Road bridge, east of Panamá City. James Zetek had previously collected this species here, but it has been hitherto considered as *rowelli*.

It differs from *rowelli* by the higher, more regularly conic spire, and an aperture that is narrower above (posteriorly).

#### COCHLIOPA JOSEANA, new species

Plate 2, fig. 18; plate 3, fig. 19

Shell large (for the genus), conic-helicoid, narrowly umbilicate, smoothish, of a few rapidly increasing whorls. Nuclear whorls minute,  $1\frac{1}{2}$ , smooth; postnuclear whorls microscopically spirally striate, the striae obscured on the body whorl by irregular growth lines. Suture shallow, becoming linear along the body whorl which is narrowly concave below the suture. Aperture subpyriform, entire, plane of aperture oblique, somewhat sinuous at the subangular base of the columella. Lip thickened within, most prominently along parietal and columellar region. Umbilicus narrow, flat-sided, margined with a blunt angularity and often irregular because of rough irregular growth lines. Base of body whorl swollen, narrowly rimate at the umbilicus. Operculum thin, corneous, paucispiral, of about 3 turns; nucleus hardly subcentral. Animal generally light-colored, with the snout black, and a black band across the middle of the tentacles and a black spot at their tips. Verge light-colored, with a pigment area along its middle on the left or incurved side in the region of the single small appendage, and with the functional tip unpigmented.



The type, U.S.N.M. No. 542173, has  $5\frac{1}{2}$  whorls and measures: Height, 5.1 mm.; diameter, 5.4 mm.; aperture height, 2.7 mm.; aperture diameter, 2.7 mm. It and numerous paratypes were collected from the Río Mata Puerco, which opens out into the Ensenada de Bodega on the southwestern part of San José Island, Archipiélago de las Perlas, Panamá.

Unlike the members of the genus *Cochliopina* found on San José, this species is not restricted to a narrow zone of the stream above the mangroves, but lives almost up to the headwaters in all the branches of the stream. It was collected in the smaller northeastern tributary of the Río Mata Puerco mangrove swamp, also indicating that it was probably living in the Río Mata Puerco system before the main southern stream and this northern tributary were isolated at their mouths by the continued erosion and encroachment of the mangrove swamp.

*C. joseana* may be distinguished by its large size, the greater height of the spire, and the narrow umbilicus.

### Family POTAMIDIDAE

#### Genus CERITHIDEA Swainson, 1840

This group of snails occupies an ecological transition zone in the mangrove swamp between brackish-water and land habitats. In the swamps studied on San José Island they occur abundantly but only in certain habitats, not too close to fresh water. Under certain conditions, as in the estuary of the Río Mata Puerco, two of the species are found on the sandy mud, out of water a greater part of the time, between times of high tide. On the other hand, the group was represented by all four species known from the Panamanian region in the Río Marina swamp. Here they may be out of contact with salt water for months at a time, when the sand barrier cuts off the lagoon from the tide during the dry season, and they may be only occasionally in the brackish water. It is interesting to note that three of the species, *C. hegewischii*, *C. valida*, and *C. pulchra*, are found largely on the mud or sandy mud. On the other hand, *C. montagnei* is found consistently a foot or more off the mud, on the roots of the mangroves, and roots and trunks of other trees, in the inactive state sealed to the trunks by mucus threads. Their shells were clean, in contrast with the other species usually confined to the sandy mud or mud of the swamp floor. There is a marked difference in size between

individuals of each species from different mangrove swamps, as much as 100 percent difference in some cases. This difference in growth is apparently the result of some unknown food differences from swamp to swamp.

#### CERITHIDEA HEGEWISCHII (Philippi)

1848. *Cerithium (Potamides) Hegewischii* PHILIPPI, Zeitschr. Malak., vol. 5, p. 19.

1849. *Cerithium Hegewischii* PHILIPPI, Abbild. Conchylien, vol. 3, p. 15 (bis)  
*Cerithium*, pl. 1, fig. 6.

This species may be distinguished by its slender shell with several varices or former lips, and a network sculpture of subequal vertical and spiral ribs, raised into rounded knobs where they cross. The lip of the adults found on San José Island is whitish as is general in those from the Panamá region.

#### CERITHIDEA VALIDA (C. B. Adams)

1852. *Cerithium validum* C. B. ADAMS, Cat. Panama Shells, p. 157.

This is the earliest valid name for the species often called *varicosa*. It was found living with *C. hegewischii* in the Río Marina swamp without intergrades, hence is specifically distinct. *C. valida* is more massive, with a proportionately broader shell than *hegewischii*, of the same type of sculpture (knobbed, reticulate), and also with white lip in mature specimens. The largest *valida* collected on San José Island exceeds the published records for size, the largest one seen measuring 2 inches long and 1 inch in diameter at the aperture.

#### CERITHIDEA PULCHRA (C. B. Adams)

1852. *Cerithium pulchrum* C. B. ADAMS, Cat. Panama Shells, p. 156.

This interesting form is specifically different from any other *Cerithidea* seen. The shell is relatively wider, composed of more finely ribbed, well-rounded whorls, not as coarsely sculptured as in the other species of the region. In addition, the epidermis of this shell is markedly different, being very prominent in life, and consisting of many spiral rows of cuticular folds, giving the fresh shells a very velvety appearance when cleaned. The lip of these shells is a rich chocolate color.

**CERITHIDEA MONTAGNEI** (Orbigny)

1837. *Cerithium Montagnei* ORBIGNY, Voy. Amér. Mérid., vol. 5, pt. 3, Mollusques, p. 443, pl. 63, figs. 3-4.

This species, as mentioned above, is normally found upon the mangrove roots and is clean-shelled. It may be recognized by the bare, coarse, vertical ribs on the turns, not especially marked by spiral sculpture. There is no duplication of former lips on the spire of these shells. The well-expanded aperture is smoky brown or dark chocolate in color within the lip of the same color.

Family **CERITHIIDAE**Genus **THERICIUM** Monterosato, 1890

The genus *Theridium* is represented on San José by two species whose inclusion in this list is justified by their apparent ecological preference for situations of transition from salt to fresh water intermittently, such as the gravelly runs at the mouth of estuary streams freely running out of mangrove swamps, and at low tide pouring out almost fresh water, and tide pools filled at low tide with fresh water from intertidal seepage springs.

**THERICIUM ADUSTUM** (Kiener)

1841. *Cerithium adustum* KIENER, Spéc. Gén. et Iconogr. Coq. Vivantes, *Cerithium*, p. 37, pl. 13, fig. 2.

One such intertidal spring, brackish and almost fresh enough to the taste to drink, on the east side of San José, was the habitat of one colony of *T. adustum* extremely variable in size. The majority of individuals collected on April 9, 1944, were not quite mature, but the adults varied in size from a length of 37 mm. and a diameter of 21 mm. to the smallest, a length of 24 mm. and a width of 13 mm. It would be interesting to determine if the extreme change from full salt water to almost fresh at each tide has any causative effect on such extreme variation in size within the species.

**THERICIUM STERCUS-MUSCARUM** (Kiener)

1841. *Cerithium stercus-muscarum* KIENER, Spéc. Gén. et Iconogr. Coq. Vivantes, *Cerithium*, p. 47, pl. 10, fig. 1.

Under estuary conditions this species was abundant. It was found on sandy or gravelly bottom in or near the channel pouring water out of the mangrove swamp with each tide at the mouths of the Río Mata Puerco, and the stream at the head of the Navy landing station bay, both on the west side of the island.

PULMONATA  
BASOMMATOPHORA

Family ELLOBIIDAE (salt-marsh snails)

These characteristic salt-marsh snails form a conspicuous group of the molluscan fauna of San José, being well represented in the salt or brackish water to land transition zones.

The small number of specimens of this family taken from Pedro González Island was due to the lack of time available for examination of the salt-marsh areas. The total of 20 hours spent personally on Pedro González was far too little to discover all the species of mollusks living there.

Genus PHYTIA Gray, 1821

PHYTIA CONCINNA (C. B. Adams)

1852. *Auricula concinna* C. B. ADAMS, Cat. Panama Shells, p. 208. (2½ miles east of Panamá City.)

1920. *Phytia brevispira* PILSBRY, Nautilus, vol. 33, p. 77, fig.

Five specimens, U.S.N.M. No. 542174, were found in company with *Ellobium stagnalis*, *Melampus piriformis*, *Detracia zeteki*, *D. joseana*, and *D. graminea*, under leaves on the flood plain of the Río Marina, just above the mangrove swamp.

The description of Adams' *concinna* calls for the presence of a callus above the most prominent parietal lamella. Some few of the adults seen from near Panamá City and from San José Island show a thin white callus in this position, irregularly ridged. The presence of intergrades, together with the known variability of strength in apertural characters in species of the Ellobiidae, leads the writer to regard Adams' *concinna* as the heavily calloused form of the species Pilsbry has described as *brevispira*. Most of the young and adult shells seen totally lack this upper parietal callus.

Genus TRALIA Gray, 1840

TRALIA PANAMENSIS (C. B. Adams)

1852. *Auricula panamensis* C. B. ADAMS, Cat. Panama Shells, p. 210.

1854. *Melampus (Tralia) panamensis* H. and A. ADAMS, Proc. Zool. Soc. London, 1854, p. 10.

1900. *Melampus panamensis* MARTENS, Biol. Centr.-Amer., Mollusca, p. 561, pl. 43, figs. 10, 10a.

C. B. Adams collected the species abundantly "under stones, at high water mark, or crawling over wet stones," at Panamá City, and also on Taboga Island.

It was found twice (in numbers only once) on San José Island, in the same ecological habitat. It was taken in numbers, although not as abundantly as *M. tabogensis*, in whose company it was, on and under cobbles and drift at high-tide line along one of the small bays on the east side of the island. It was active in the early morning out of the sun, crawling between cobbles and taking cover when the sun came up to dry off the cobbles of the beach, wet with dew.

Genus **DETRACIA** Gray, 1840

**DETRACIA ZETEKI** Pilsbry

1920. *Detracia zeteki* PILSBRY, Nautilus, vol. 33, p. 76, figs. a, b, c.

*Type locality*.—Panamá City and Paitilla nearby.

Collected in small numbers in mangrove swamp margins on both east and west sides of San José, near the mouth of the Río Mata Puerco and the Río Marina. One collection of several hundred individuals was taken near the mouth of the Río Marina, where they were abundant in and under drift, chiefly decaying coconut fronds, in company with *Littorina debilis* in great numbers, and *Detracia graminea*.

This species is very close to *D. globulus* (Orbigny) from Guayaquil, Ecuador, also reported from Tumacao Island, Colombia, but differs by the possession of the heavy parietal callosity and teeth.

The species varies considerably in the largest lot collected (several hundred specimens); the variation is principally in the degree of development of the columellar fold and occlusion of the aperture, and in shape from regularly ellipsoidal to subglobular.

**DETRACIA GLOBULUS** (Orbigny)

1837. *Melampus margarita* BECK, Index Moll., p. 107, No. 10 (*nomen nudum*).

1837. *Auricula globulus* ORBIGNY, Voy. Amér. Mérid., vol. 5, pt. 3, Mollusques, p. 327.

1854. *Melampus (Tralia) globulus* H. and A. ADAMS, Proc. Zool. Soc. London, 1854, p. 11.

1854. *Melampus globulus* PFEIFFER, Novit. Conch., vol. 1, p. 23, pl. 6, figs. 23-25.

1901. *Melampus globulus* KOBELT, Martini and Chemnitz Conch.-Cab., vol. 1, pt. 16, p. 195, pl. 22, fig. 14.

*Type locality*.—Guayaquil, Ecuador.

Close to *zeteki* Pilsbry, 1920, but without any parietal callosity of prominence.

**DETRACIA STRIGOSA (Martens)**

1900. *Melampus strigosus* MARTENS, Biol. Centr.-Amer., Mollusca, p. 560, pl. 43, fig. 9. (Tributary of Río Coto, Golfo Dulce, Costa Rica.)

Represented by topotypes, specimens from the original lot, U.S.N.M. No. 190285.

Easily distinguished by the longer stripes, light color, and larger size of the extremely globular adults.

**DETRACIA JOSEANA, new species**

Plate I, fig. 16

Shell small, obese-ovate, reddish brown, with spiral bands of lighter color. Spire banded, darkest brown, with a light band revolving a little below the upper limit of the aperture, body whorl indistinctly banded with lighter reddish brown. Spire angle of divergence about  $90^\circ$ , of closely wound whorls, separated by a linear suture. The aperture is narrow, almost three-quarters the length of the shell, sublinear above and contracted below by the moderately developed lamellae. Columellar fold is strong, regular, entering horizontally. There is a prominent callus on the columella below the lower of the parietal folds. The upper parietal fold is smaller, little developed in some of the young shells seen. The lirae within the outer lip are strong, more or less uniformly decreasing in prominence upward.

The type, U.S.N.M. No. 542175, has  $7\frac{1}{2}$  whorls and measures: Length, 6.2 mm.; width, 4 mm.; aperture height, 5.1 mm. It was collected from under fallen leaves on the flood plain of the Río Marina at the upper limits of the tidal mangrove swamp at its mouth on the east side of San José Island, Archipiélago de las Perlas, Republic of Panamá.

This species is very close to *D. strigosa* (Martens) from the Río Coto, Costa Rica, but differs in being smaller, spirally banded with a reddish brown color over all, and with heavier apertural lamellae. Specifically, the columellar callus is higher; there are 2 lamellae present on the midparietal wall, and the stronger marginal lirae regularly decrease from below upward. In *D. strigosa*, the lira just above the single parietal lamella is more prominently developed than those above and below.

This species was not found in great numbers, but was present in mangrove swamps on both east and west sides of San José Island, apparently preferring the inner landward or fresh-water edge of the swamps. It was also taken in company with *D. zeteki* and *Phytia concinna* at the margin of the Río Matasnillo mangrove swamp, just east of Panamá City, Republic of Panamá.

#### DETRACIA GRAMINEA, new species

Plate I, fig. 18

Shell small, regularly ellipsoidal, light horn color, banded with dark reddish brown. There is one broader, very dark band below the suture, a light band at the periphery, and three narrower dark bands almost equidistant below. The 10 closely wound whorls are separated by a sinuous, linear suture; the systrophic nuclear whorls are very small, projecting at the mucronate apex. Aperture narrow, approximately equaling two-thirds the shell height, linear above, wider below. The outer lip is thin, sometimes with 1 to 4 minute lirae below the periphery. The columellar plica strong, subhorizontal, with a narrow sinus above it. The parietal wall immediately above the sinus is furnished with two approximated, moderately strong lamellae with a third small lamella above.

The type, U.S.N.M. No. 542177, has 9 whorls and measures: Height, 5.3 mm.; diameter, 3.3 mm.; aperture height, 3.8 mm. The type and 7 additional specimens, U.S.N.M. No. 542178, were personally collected August 2, 1944, in and under drift (chiefly decaying coconut fronds) on the mangrove-swamp side of the sand barrier near the mouth of the Río Marina, Isla de San José, Archipiélago de las Perlas, Republic of Panamá. They were taken in company with innumerable specimens of *D. zeteki* and *Littorina debilis*.

This species had been found previously under fallen leaves at the inner or landward edge of this mangrove swamp on the east side of the island, and of another smaller mangrove swamp on the west side. This species has also been collected on the Isthmus of Panamá, U.S.N.M. No. 216282, in a tidal swamp near Corozal, Canal Zone, Panamá, by James Zetek.

This species is the smallest *Detracia* encountered on San José; it is about the height of *D. joseana* but much more slender. The coloration resembles that of light-colored young individuals of *D. zeteki*, but the apertural appearance is distinct.

## Genus MELAMPUS Montfort, 1810

## MELAMPUS PIRIFORMIS (Petit)

1843. *Auricula piriformis* PETIT, Proc. Zool. Soc. London, 1842, p. 202. (Tumaco Island, western Colombia.)  
 1852. *Auricula trilineata* C. B. ADAMS, Cat. Panama Shells, p. 212. (Panamá City.)  
 1900. *Melampus bocoronicus* MARTENS, Biol. Centr.-Amer., Mollusca, p. 560 (in part) (not Mörch, 1860). (Punta Arenas, Costa Rica.)

This species is extremely variable as to size from swamp to swamp. It was taken in moderate numbers from mangrove swamps on both east and west sides of San José Island.

## MELAMPUS TABOGENSIS C. B. Adams

1852. *Melampus tabogensis* C. B. ADAMS, Cat. Panama Shells, p. 211. (Taboga Island and Panamá City.)  
 1856. *Melampus bridgesii* CARPENTER, Proc. Zool. Soc. London, 1856, p. 161. (At mouth of the Bay of Panamá.)  
 1896. *Melampus panamensis* DALL, Proc. Acad. Nat. Sci. Philadelphia, vol. 48, p. 452 (not C. B. Adams, 1892). (Cocos Island.)

Seen from: San Lucas Island, Costa Rica (Valerio) (U.S.N.M. No. 381416); Taboga Island, Panamá (Zetek) (U.S.N.M. No. 331820); Panamá (U.S.N.M. No. 3807); Galápagos Islands (Dall) (U.S.N.M. No. 122016); Cocos Island (U. S. Fish Comm.) (U.S.N.M. No. 122853).

The *Melampus panamensis* of Dall reported from Galápagos Islands, U.S.N.M. No. 122016, and from Cocos Island, U.S.N.M. No. 122853, are not *Tralia panamensis* (C. B. Adams), but the large form of *Melampus tabogensis* (C. B. Adams) reported by Hanna and Hertlein.<sup>3</sup>

Their remarks<sup>4</sup> on the comparative size of *tabogensis* and *trilineatus* refer only to the small form of *trilineatus*. The large *trilineatus* seen from Punta Paitilla and Panamá City (collected by Zetek) and from San José Island, reach a maximum length of 20+ mm. (?)

As they imply, *Tralia* has not been seen from Cocos or the Galápagos Islands.

*M. tabogensis* was most abundant on cobble beaches and was seen (and taken) in great numbers on and under the cobbles and drift at high-tide line. It was raked by the handfuls off the bottom of drift logs on such a cobble beach on the west side of San José. Like *Tralia*

<sup>3</sup> Allan Hancock Pacific Exp., vol. 2, No. 8, p. 133, 1938.

<sup>4</sup> Idem, p. 134.



*panamensis*, which was found present less numerously, it was active in the early morning out of the sun; in early afternoon it was under the drift logs and cobbles.

#### MELAMPUS BOCORONICUS Mörch

1860. *Melampus bocoronicus* MÖRCH, Malak. Blätt., vol. 6, p. 118.

Originally described from Los Bocorones near Punta Arenas, Costa Rica, "under stones near the beach." The National Museum collections contain specimens (U.S.N.M. No. 380678) from Flamenco Island, Panamá, collected by C. D. Alleman.

Very close to *M. tabogensis* in general appearance, the shells of this species may be distinguished by the heavy white callus next above the columellar fold.

#### Genus ELLOBIUM Roeding, 1798

#### ELLOBIUM STAGNALIS (Orbigny)

1835. *Auricula stagnalis* ORBIGNY, Guérin's Mag. Zool., vol. 5, cl. 5, No. 62, p. 23.

1837. *Auricula stagnalis* ORBIGNY, Voy. Amér. Mérid., vol. 5, pt. 3, Mollusques, p. 325, pl. 42, figs. 7-8. (Guayaquil, Ecuador.)

1844. *Auricula papillifera* KÜSTER, Martini and Chemnitz Conch.-Cab., ed. 2, vol. 1, pt. 16, p. 25, pl. 3, figs. 9-10. (Western Colombia.)

1852. *Auricula stagnalis* C. B. ADAMS, Cat. Panama Shells, p. 210. (Panamá City.)

1860. *Ellobium papilliferum* MÖRCH, Malak. Blätt., vol. 6, p. 116. (Sonsonate, El Salvador.)

The National Museum collections include numerous specimens from the Pacific coast of Salvador (Biolley) (U.S.N.M. No. 163063), the Republic of Panamá, Cocos, and Galápagos Islands, and Tumaco Island, Colombia (Cuming) (U.S.N.M. No. 119545).

This species' optimum habitat on San José Island seems to be in the decaying wood of logs and stumps about at the high-tide line in mangrove swamps. They were seen in greatest abundance on San José in a small mangrove swamp on the west side of the island, in rotting logs subject to partial inundation at the highest tides. More than a hundred specimens were collected here in about an hour, mostly from one large log. They were found burrowing in the rotten "wood floor" in almost every gallery or crevice in the more solid wood.

Variation in size is very great in this species, as is the degree of surface sculpturing of the body whorl. Variation in size apparently

is controlled at least in part by food conditions affecting growth in general in the locale. Surface ornamentation varies from almost smooth to a completely decussated body whorl in different individuals from the same colony. Variation in comparative height of the spire is likewise individual. The size of adult individuals within a population does not vary nearly as much as their average size may vary from the average for another colony living less than a mile distant. It would be interesting to determine the effect on size of these snails of feeding on the rotting wood of different species of trees. This species was found drifted on the rocky shore near a large mangrove swamp on the north side of Pedro González Island, indicating its presence there also.

#### Family PLANORBIDAE

Certain members of the genus *Australorbis* Pilsbry (1934, Proc. Acad. Nat. Sci. Philadelphia, vol. 86, p. 55) are known to be intermediate hosts of the parasite of African schistosomiasis (*Schistosoma mansoni* Sambon). In none of the collections made to date nor in any published record is there any indication that this genus of snails occurs in, or has been introduced in, the Panamá region. Just as in the case of Asiatic human schistosomiasis, there has been an unscheduled but natural and large-scale human experiment in the Canal Zone for a number of years. The fact is unquestioned that among United States troops of Puerto Rican origin, stationed in the Panamá region during both World Wars I and II, there were numbers of human carriers of the parasite *Schistosoma mansoni*. In the absence of suitable intermediate host species of planorbid snails, this disease has simply not been able to become endemic either on the Isthmus of Panamá or on San José Island.

Although certain members of the genus *Tropicorbis* Brown and Pilsbry (1914, Proc. Acad. Nat. Sci. Philadelphia, vol. 66, p. 212) are under suspicion as possible intermediate hosts of *S. mansoni*, this same natural experiment offers conclusive proof that the native Panamá species *Tropicorbis isthmicus* Pilsbry is not an effective intermediate host.

The Island of San José is particularly free at the present time from such disease. In all the search for fresh-water mollusks in every body of water examined, only one specimen of planorbid snail was discovered. Apparently the ecology of stream habitats on the island is not favorable for the existence of this group of snails.

Genus **DREPANOTREMA** Crosse and Fischer, 1880

**DREPANOTREMA ANATINUM** (Orbigny)

1835. *Planorbis anatinus* ORBIGNY, Guérin's Mag. Zool., vol. 5, cl. 5, No. 62, p. 28.

1933. *Drepanotrema anatinum* AGUAYO, Nautilus, vol. 47, pp. 64-68.

One specimen only of this species was found in a small stream in the southeastern part of San José Island.

Family ANCYLIDAE

Genus **FERRISSIA** Walker, 1903

Subgenus **LAEVAPEX** Walker, 1903

**FERRISSIA (LAEVAPEX) JOSEANA**, new species

Plate 1, figs. 5, 6

Shell small, elliptic, about three-fourths as wide as long, low, about one-fourth as high as long, pale corneous, thin, transparent. Nucleus large, without sculpture, remainder of shell finely radially striate. The anterior and posterior slopes are subequal in angle, the anterior rounding into the blunt apical curve, the posterior distinctly rectilinear. The apex is situated at the posterior third of the length, and approximately one-third of the width from the right margin. Lines of growth fine, inconspicuous.

The type, U.S.N.M. No. 542179, measures: Length, 4.2 mm.; width, 3.2 mm.; height, 1.2 mm.

It and several paratypes, U.S.N.M. No. 542180, were collected from flood-plain pools along the middle reaches of the stream opening into the northwest mangrove swamp on San José Island, Archipiélago de las Perlas, Republic of Panamá.

This species may be easily distinguished from the widespread *F. excentrica* by the distinct radial sculpture. It does not have the sharp hooked beak of the described species of *Uncancylus*.

The species is rather widespread on the island, being found also in the Río Mata Puerco and Río Marina drainage systems. It is the only fresh-water snail except *Pomacea* that is not restricted to a narrow supra-tidewater zone, but occurs in the middle and upper reaches of the streams, wherever the habitat is suitable.

## STYLOMMATOPHORA

## Family VERONICELLIDAE

## Genus VAGINULUS Férussac, 1822

## VAGINULUS (LATIPES) OCCIDENTALIS (Guilting)

1925. *Vaginulus (Latipes) occidentalis* H. B. BAKER, Proc. Acad. Nat. Sci. Philadelphia, vol. 77, p. 174, pl. 5, figs. 18-20.

This moderately large land slug (2 inches long) is of uncommon occurrence in the virgin jungle areas on San José Island. In the rainy season it may be found active in the daytime on overcast days or after a rain; otherwise, it is active only at night.

## Family COCHLICOPIDAE

## Genus CECILIOIDES Férussac, 1814

## CECILIOIDES CONSOBRINA PRIMA (de Folin)

1930. *Ceciloides consobrina prima* (de Folin), PILSBRY, Proc. Acad. Nat. Sci. Philadelphia, vol. 82, p. 351.

Only a single specimen was found on San José Island. The species may be present in greater abundance, but no special search was made for this minute subterranean form.

## Family SUBULINIDAE

## Genus SUBULINA Beck, 1837

## SUBULINA OCTONA (Bruguière)

1926. *Subulina octona* PILSBRY, Proc. Acad. Nat. Sci. Philadelphia, vol. 78, p. 89.

This rather widespread land snail, which has evidently been carried by man's agency over most of the American Tropics, was found in small numbers on San José Island. It was usually to be found in spots of second-growth "scrub" jungle, representing the formerly extensive cultivated areas of the island. In all probability it was introduced during some earlier period of occupancy of the island.

## Genus LEPTINARIA Beck, 1837

## LEPTINARIA LAMELLATA CONCENTRICA (Reeve)

1926. *Leptinaria lamellata concentrica* PILSBRY, Proc. Acad. Nat. Sci. Philadelphia, vol. 78, p. 89, text figs.

This, the largest (and widest) species of *Leptinaria* living on San José, may be easily distinguished by the presence of the revolving lamella upon the parietal wall.

**LEPTINARIA PANAMENSIS** Pilsbry

1910. *Leptinaria panamensis* PILSBRY, Proc. Acad. Nat. Sci. Philadelphia, vol. 62, p. 508, fig. 4.  
 1926. *Leptinaria panamensis* PILSBRY, Proc. Acad. Nat. Sci. Philadelphia, vol. 78, p. 91, text figs.

This species is narrower and relatively smooth, without distinct riblets on the shell. On San José Island it seems to be more abundant than *L. l. concentrica*.

**LEPTINARIA FILICOSTATA** (Strebel)

1882. *Lamellaxis filicostata* STREBEL, Beitr. Kenntn. Fauna Mex. Land- und Süssw.-Conch., vol. 5, p. 113, pl. 17, fig. 10.  
 1926. *Leptinaria filicostata* PILSBRY, Proc. Acad. Nat. Sci. Philadelphia, vol. 78, p. 90, text figs.

This species is about the size of *L. panamensis* but is easily distinguished by the regularly spaced vertical riblets upon all the whorls. It seems to be moderately abundant on San José Island.

**Genus OPEAS** Albers, 1850**OPEAS PUMILUM** (Pfeiffer)

1906. *Opeas pumilum* PILSBRY, Man. Conch., ser. 2, vol. 18, p. 200.  
 1926. *Opeas pumilum* PILSBRY, Proc. Acad. Nat. Sci. Philadelphia, vol. 78, p. 92, text figs.

Found only once on San José island.

**OPEAS GRACILE** (Hutton)

1906. *Opeas gracile* PILSBRY, Man. Conch., ser. 2, vol. 18, p. 198.  
 1926. *Opeas gracile* PILSBRY, Proc. Acad. Nat. Sci. Philadelphia, vol. 78, p. 92, text figs.

Found in moderate abundance, mostly in newly cleared areas on San José Island.

Family **OLEACINIDAE****Genus EUGLANDINA** Crosse and Fischer, 1870**EUGLANDINA CUMINGI** (Beck)

1926. *Euglandina cumingi* PILSBRY, Proc. Acad. Nat. Sci. Philadelphia, vol. 78, p. 95, pl. 10, figs. 3, 4.

This fine, large carnivorous snail was found only in small numbers. Its more common occurrence in the areas of secondary jungle or brushy areas on San José points to its possible accidental introduction on the island.

## Family ENDODONTIDAE

Genus PUNCTUM Morse, 1864

## PUNCTUM (?) COLOBA (Pilsbry)

1893. *Thysanophora coloba* PILSBRY, Proc. Acad. Nat. Sci. Philadelphia, vol. 45, p. 403.  
 1930. *Punctum* (?) *coloba* PILSBRY, Proc. Acad. Nat. Sci. Philadelphia, vol. 82, p. 346, pl. 29, figs. 2-2b.

This exceedingly minute land snail was found only once on San José Island, from the deeper leaf mold around the base of a large tree in a virgin jungle area near the eastern side of the island.

## Family ZONITIDAE

Genus HABROCONUS Fischer and Crosse, 1872

Subgenus ERNSTIA Jousseau, 1889

## HABROCONUS (ERNSTIA) ZETEKI Pilsbry

1930. *Habroconus* (*Ernstia*) *zeteki* PILSBRY, Proc. Acad. Nat. Sci. Philadelphia, vol. 82, p. 350, pl. 29, figs. 5, 6.

Found in small numbers in second-growth jungle, in places where there was sufficient moisture, such as in deeper ravines.

## Family BULIMULIDAE

Genus DRYMAEUS Albers, 1850

## DRYMAEUS TRANSLUCENS (Sowerby)

1926. *Drymaeus translucens* PILSBRY, Proc. Acad. Nat. Sci. Philadelphia, vol. 78, p. 83, text figs.  
 1930. *Drymaeus translucens* PILSBRY, Proc. Acad. Nat. Sci. Philadelphia, vol. 82, p. 340.

These smaller tree snails may be recognized by their pale yellow color and extremely thin shells. It is almost impossible to collect the San José individuals without crushing the shells between one's fingers. They are found in the jungle areas of San José that have not been too disturbed by former plantation clearings, and overrun by vine brush. Unseen for the greater part of the year, they may be easily collected in April and May, when they are coming out of hibernation at the end of the dry season. The adults or nearly adult individuals pass the dry season in the leaf mold of the jungle floor, and a few

weeks after the onset of the rains, start climbing the tree trunks. At this time they are easily discovered, and easily collected in numbers from 2 to 20 feet off the ground on the trunks of certain small smooth-barked trees, which they seem to prefer. None of these arboreal snails were found on trees whose bark was excessively rough in character. In the series taken on San José Island there was considerable variation in the height of the spire.

#### DRYMAEUS SEMIMACULATUS Pilsbry

1898. *Drymaeus semimaculatus* PILSBRY, Man. Conch., ser. 2, vol. 11, p. 297.  
1899. *Drymaeus semimaculatus* PILSBRY, Man. Conch., ser. 2, vol. 12, pl. 5, figs. 8, 9.

One specimen (a broken shell of an adult) was collected on San José Island. More material is needed to determine its exact habitat on the island.

#### Genus ORTHALICUS Beck, 1836

(not of Thiele)

(= OXYSTYLA auct.)

#### ORTHALICUS PRINCEPS DECEPTOR (Pilsbry)

1899. *Oxystyla princeps deceptor* PILSBRY, Man. Conch., ser. 2, vol. 12, p. 116, pl. 24, figs. 19-25.

This large tree snail may be easily distinguished by its size and prominent zigzag color pattern. Dead and bleached shells may be found on the jungle floor at any time of year, but collection of living individuals is much more difficult on San José Island.

The eggs are laid in the leaf mold at the bases of trees, apparently at the beginning of the dry season (November-December). They are spherical, about 3 mm. in diameter, and covered with a thin white calcareous shell. At the beginning of the rainy season (April and May) they contain young with shells of 2 whorls, ready to hatch. Upon the onset of the rains in April and May they hatch, and the young start their arboreal existence. Half-grown young may be found singly upon the lower part of the tree trunks or upon the lower leaves of trees in midsummer (July and August). Unfortunately, no living adults were personally collected on San José, so it is not certain whether one or two seasons are required to reach maturity. It is also not known whether adults reascend the trees after laying their eggs in the leaf mold.

## Family FRUTICICOLIDAE

## Subfamily EPIPHRAGMOPHORINAE

Genus *AVERELIA* Ancey, 1887Subgenus *TRICHODISCINA* Martens, 1892*AVERELIA (TRICHODISCINA) COACTILIATA* (Deshayes)

1838. *Helix coactiliata* DESHAYES, Hist. Nat. Gén. et Part. Moll. Terr. et Fluv., vol. 1, p. 18, pl. 72, figs 1-5.

This small discoidal species, neatly marked with brownish spiral stripes of color, was found in areas of virgin jungle on San José Island, but nowhere in abundance. Perhaps the presence of feral pigs on the island makes existence hazardous for these snails which live in the thin layer of leaf mold or under fallen logs.

## PELECYPODA

## Family CORBICULIDAE

Genus *POLYMESODA* Rafinesque, 1820*POLYMESODA JOSEANA*, new species

Plate 1, figs. 12-14.

Shell large, equilateral, subtriangular, inflated, the ventral margin evenly rounded, anteriorly light colored, posteriorly violaceous under a moderately thick pale greenish-horn epidermis. Lines of growth fine, somewhat irregular, and interspersed by several ill-defined rest marks. Umbones uneroded, high, prominent, pale violaceous. Posterior ridge low, ending at the posterior angulation a little above the base. Secondary posterior ridges above this inconspicuous. Lunule broad, shallow, indistinctly defined. Ligament short, corneous. Cardinal teeth well developed, laterals high, thin in proportion to the light shell.

The unique holotype, U.S.N.M. No. 542181, measures: Length, 42 mm.; height, 38.5 mm.; diameter, 30.5 mm. It was found in the drift of the Río Marina mangrove swamp on the east side of San José Island, Archipiélago de las Perlas, Republic of Panamá.

This large, thin species has no close relatives except *P. maritima* (C. B. Adams) described from Panamá. It may be distinguished from that species by being smaller and proportionately somewhat higher; although possessing the approximate size and shape of species from the Atlantic drainage in Nicaragua and Lake Maracaibo, it is at once recognized by its very thin shell.



## Family CYRENOIDIDAE

Genus CYRENOIDA Joannis, 1835

## CYRENOIDA INSULA, new species

Plate I, figs. 8-11

Shell small, lenticular, suborbicular, vitreous, blue-white, under a pale corneous epidermis. Umbones smooth, little prominent, scarcely projecting above the general outline. Sculpture of minute, crowded concentric striae. Hinge well developed, lightly arcuate, wider anteriorly. Anterior and ventral margins evenly rounded as one curve. Posterior margin almost evenly rounded, a trifle more abruptly rounded into the dorsal and ventral margins.

The holotype, U.S.N.M. No. 542182, measures: Length, 6.7 mm.; height, 6.2 mm.; diameter, 3.8 mm. It was collected from pools in the mud of a small mangrove swamp on the west side of San José Island. This species was found only in small numbers and did not seem to be abundant in any of the mangrove swamps on the island. It greatly resembles *C. guatemalensis* Pilsbry, 1920, from the Atlantic drainage in Guatemala, but may be easily distinguished by its much straighter hinge line.

## Family SPHAERIIDAE

Subfamily PISIDIINAE F. C. Baker, emend.

The principal anatomical character upon which the late F. C. Baker<sup>5</sup> based this subfamily of "pill-clams" has up to this time not been correctly stated. Odhner, in 1921, briefly reported on the anatomy of *Pisidium*, stating that the genotype, *P. amnicum* (Müller) has two siphons, branchial and anal. He erected the subgenus *Neopisidium* with *P. torquatum* Stelfox as subgenotype, for those species possessing only the anal siphon.

Examination of the animal of *P. dubium* (Say) 1816<sup>6</sup> from the Rappahannock River, Virginia, shows that it agrees with the type of *Pisidium*, possessing both siphons, although the branchial siphon appears much smaller than the anal. Most of our American species undoubtedly belong to the *Neopisidium* group; all of several species personally examined alive or in preserved condition, except *dubium*,

<sup>5</sup> Amer. Midl. Nat., vol. 10, p. 220, 1927, and Fresh Water Moll. Wisconsin, vol. 2, p. 363, 1928.

<sup>6</sup> Pilsbry, Nautilus, vol. 59, p. 86, 1946.

and obviously all species examined by Baker possess only the anal siphon. Therefore, the subfamily Pisidiinae must be amended to include *Pisidium* "with an obsolete or without any branchial siphon." We may thus avoid the absurdity of splitting the subfamilies in the middle of the genus.

Genus **PISIDIUM** Pfeiffer, 1821

Subgenus **NEOPISIDIUM** Odhner, 1921

**PISIDIUM (NEOPISIDUM) sp.?**

A species of *Neopisidium* was found in most of the streams visited on San José Island, but only in small numbers. The animal of this *Neopisidium* possesses only the anal siphon, and only one pair of gills. The marsupium is on the inner face of the outer lamina of the gill, in those animals examined, which were collected in a tributary of the Río Mata Puerco. On account of the lack of adequate material for specific comparison with others from the Panamá region, it is thought best not to describe it at this time. In a group difficult to identify specifically, even under the best of conditions, another obscure species name would not be particularly advantageous. The study of complete seasonal series from different localities is desirable in this genus, in order fully to recognize the true specific characters. This is especially true in the tropical regions, where under accelerated life-history conditions adults may perhaps be found only at certain seasons of the year.

Family **DREISSENSIIDAE**

Genus **MYTILOPSIS** Conrad, 1837

**MYTILOPSIS ADAMSI**, new species

Plate 1, figs. 4, 7

Shell small, mytiliform, dorsal and posterior margins rounded into one regular curve; ventral margin straight to incurved, abruptly rounded into the posterior margin at the posterior base. Ridge delimiting the ventral flattening of the shell well rounded. Umbones smooth, terminal, usually eroded except in very young individuals. Septum narrow, furnished with a small, sharp triangular process in each valve. Substance of shell whitish to clear, vitreous, under a thin corneous epidermis which is irregularly pinched up into cuticular fringing folds along the lines of growth. These cuticular folds in some individuals are accentuated into triangular processes along two

distinct rows, one a little above the ventral ridge, the second midway between that and the dorsal margin.

Animal as described for the genus, with a well-developed byssus, rufous in color.

The holotype, U.S.N.M. No. 542183, measures: Length, 12.5 mm.; height, 6 mm.; diameter, 5.6 mm. It and numerous paratypes of all ages, U.S.N.M. No. 542185, were personally collected in the upper end of the lagoon at the mouth of Musselshell Creek, which is the largest of the streams in the southeastern part of San José Island. They were principally found attached by the byssus to the underside of rocks in the uppermost end of this (fresh-water) lagoon and in the lowermost part of the stream proper, in situations where there was plenty of stream current remaining.

Reminiscent of *M. leucophaeatus* (Conrad) of eastern North America, this species can be distinguished by its greater proportionate diameter and regularly rounded postero-dorsal margin. Some individuals, heavily eroded and malformed in the umbonal region, are truly boxlike in appearance. This species is named in honor of Prof. C. B. Adams, who did so much to make known the Panamic molluscan fauna.

### Family CORBULIDAE

#### Genus PANAMICORBULA Pilsbry, 1932

1852. *Potamomya* C. B. ADAMS, Cat. Shells Panama, p. 296 (not of Sowerby, 1839).

1932. *Panamicorbula* PILSBRY, Nautilus, vol. 45, p. 105.

1945. *Panamicorbula* VOKES, Bull. Amer. Mus. Nat. Hist., vol. 86, pp. 11-12, pl. 2, figs. 1-4.

*Genotype*.—*Potamomya inflata* C. B. Adams = *Panamicorbula inflata* (C. B. Adams).

It is very interesting to find this group of brackish-water corbulid clams living in the mangrove swamps of San José Island. The genus, according to Pilsbry, is confined to the Panamic Province and constitutes another proof of the true picture of the San José Island fauna as a reduced Panamic fauna, changed somewhat by its isolation.

#### PANAMICORBULA CYLINDRICA, new species

Plate I, figs 15, 17

Shell ovate-cylindric; the umbones small, projecting little above the general shell outline, subequilateral; the umbones flattened with

a low but well-defined posterior ridge ending in the subangular mid-posterior region. Shell sculptured with fine concentric ridges which are somewhat irregular over the seasonal rest marks, and especially prominent above the posterior ridge on young shells. Hinge as described by Vokes for the genus. The right valve with one small cardinal tooth immediately under the umbo, and anterior to the well-defined resilial pit on the ventral face of the hinge; the left valve with a small, broad chondrophore, apparently tripartite on its dorsal face. The anterior part is a rounded radial rib, margined with a groove anteriorly and posteriorly; the central and posterior parts are both radially concave. Muscle scars moderate; the pallial line simple, the pallial sinus represented by a broadening of the pallial scar.

The holotype, U.S.N.M. No. 542186, measures: Length, 13.3 mm.; height, 9.3 mm.; diameter, 6.3 mm.; right valve, 3.2 mm.; left valve, 3.4 mm. It and a few broken valves of older individuals, were found in the drift of the Río Marina mangrove swamp on February 19, 1944. Its exact habitat in the mangrove swamps was never determined.

The largest paratype (adult) valve seen, U.S.N.M. No. 542187, measures: Length, 22 mm.; height, 16.3 mm.; diameter, 8 mm. (i.e., 16 mm. for both valves).

This species may be distinguished by the extreme inflation of adults, and the scarcely projecting umbones. With the extreme inflation of *inflata*, this island species has the prominence of the beaks much reduced to produce an apparent cylindrical shape.

#### EXPLANATION OF PLATES

(All enlargements are given in approximate figures.)

##### PLATE I

- FIG. 1. *Pomacea cumingii sanjosensis*, holotype,  $\times \frac{3}{4}$ .  
 2. *Neritilia panamensis*, holotype,  $\times 8$ .  
 3. *Pomacea zeteki*, holotype,  $\times \frac{3}{4}$ .  
 4. *Mytilopsis adamsi*, interior of right valve of holotype,  $\times 2\frac{1}{2}$ .  
 5. *Ferrissia (Laevapex) joseana*, right profile of paratype,  $\times 8$ .  
 6. *Ferrissia (Laevapex) joseana*, holotype,  $\times 8$ .  
 7. *Mytilopsis adamsi*, exterior of left valve of holotype,  $\times 2\frac{1}{2}$ .  
 8-11. *Cyrenoïda insula*, holotype,  $\times 2\frac{1}{2}$ .  
 12-14. *Polymesoda joseana*, holotype,  $\times \frac{3}{4}$ .  
 15. *Panamicorbula cylindrica*, holotype, interior of right valve,  $\times 2\frac{1}{2}$ .  
 16. *Detracia joseana*, holotype,  $\times 8$ .  
 17. *Panamicorbula cylindrica*, holotype, exterior of left valve,  $\times 2\frac{1}{2}$ .  
 18. *Detracia graminia*, holotype,  $\times 8$ .

## PLATE 2

(All figures  $\times$  approximately  $6\frac{2}{3}$ .)

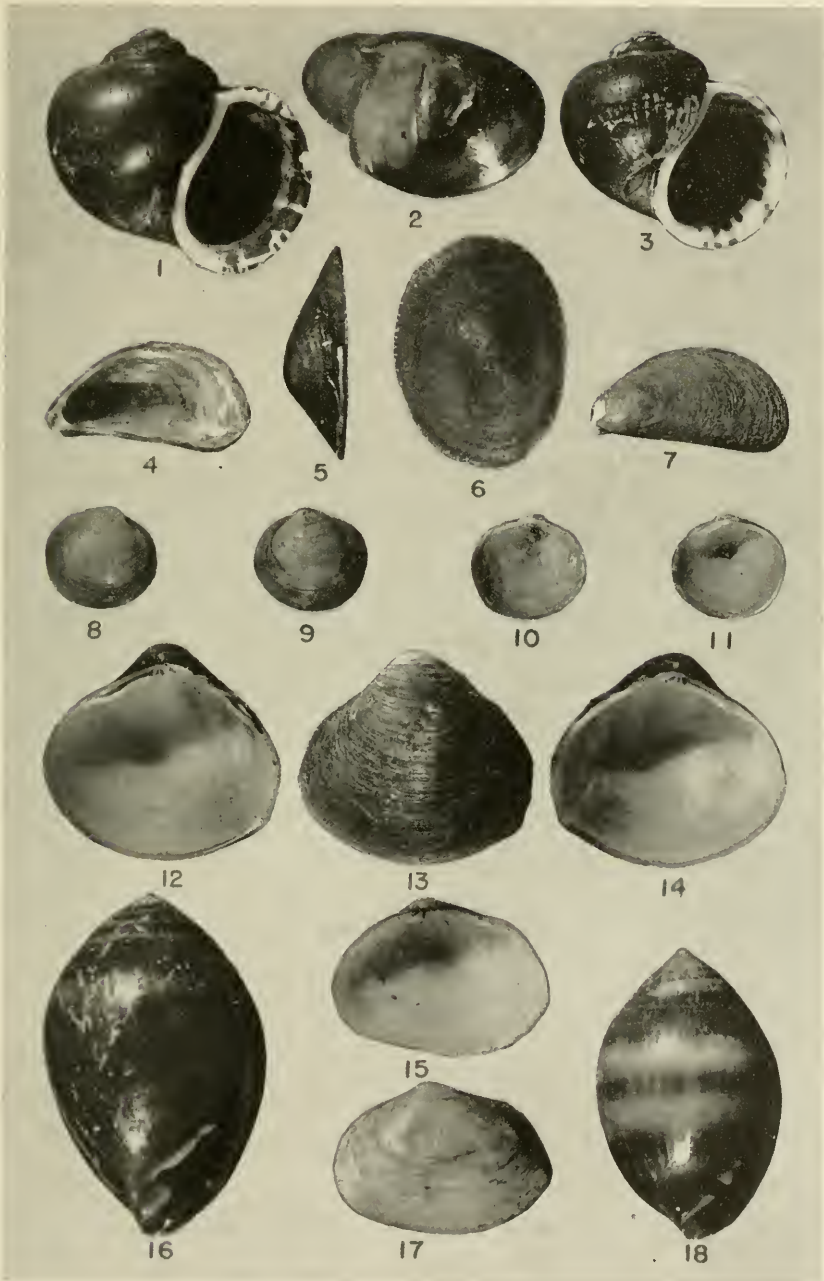
- FIG. 1. *Zetekella veraguasensis*, holotype.  
 2. " *kompi*, holotype.  
 3. *Aroapyrgus chagresensis*, holotype.  
 4. " *alleci*, holotype.  
 5. " *joseana*, holotype.  
 6. *Lyrodes chagresensis*, holotype.  
 7. *Cochliopina zeteki*, holotype.  
 8. " *juradoi*, holotype.  
 9. " *fraternula*, holotype.  
 10. *Lyrodes zeteki*, holotype.  
 11. *Cochliopina extremis*, holotype.  
 12. " *navalis*, holotype.  
 13. " *australis*, holotype.  
 14. *Subcochliopa colabrensis*, holotype.  
 15. *Cochliopa diazensis*, holotype.  
 16. *Cochliopina wetmorei*, holotype.  
 17. *Subcochliopa trochus*, holotype.  
 18. *Cochliopa joseana*, holotype.

## PLATE 3

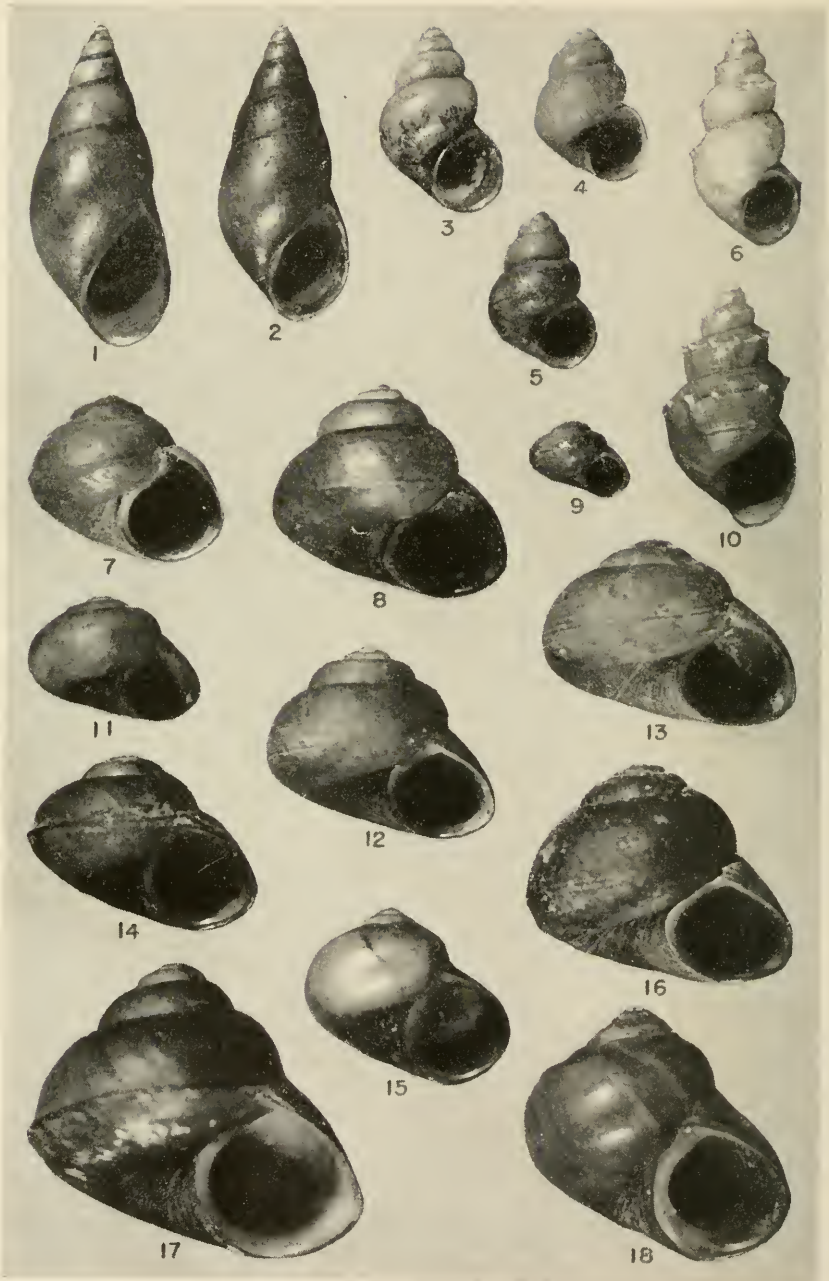
(Diagrammatic sketches of the external male reproductive characters greatly enlarged, but not to an exact scale.)

- FIG. 1. *Zetekella veraguasensis*, paratype.  
 2. " *kompi*, paratype.  
 3. *Aroapyrgus alleci*, topotype.  
 4. " *chagresensis*, paratype.  
 5. *Cochliopina zeteki*, paratype.  
 6. *Lyrodes chagresensis*, paratype.  
 7. *Cochliopina riograndensis*.  
 8. *Aroapyrgus joseana*, paratype.  
 9. *Cochliopina zeteki*, paratype.  
 10. " *juradoi*, paratype.  
 11. " *fraternula*, paratype.  
 12. " *navalis*, paratype.  
 13. " *extremis*, paratype.  
 14. " *australis*, paratype.  
 15. " *wetmorei*, paratype.  
 16. *Subcochliopa colabrensis*, paratype.  
 17. *Cochliopa rowelli*.  
 18. " *diazensis*, paratype.  
 19. " *joseana*, paratype.  
 20. *Subcochliopa trochus*, paratype.



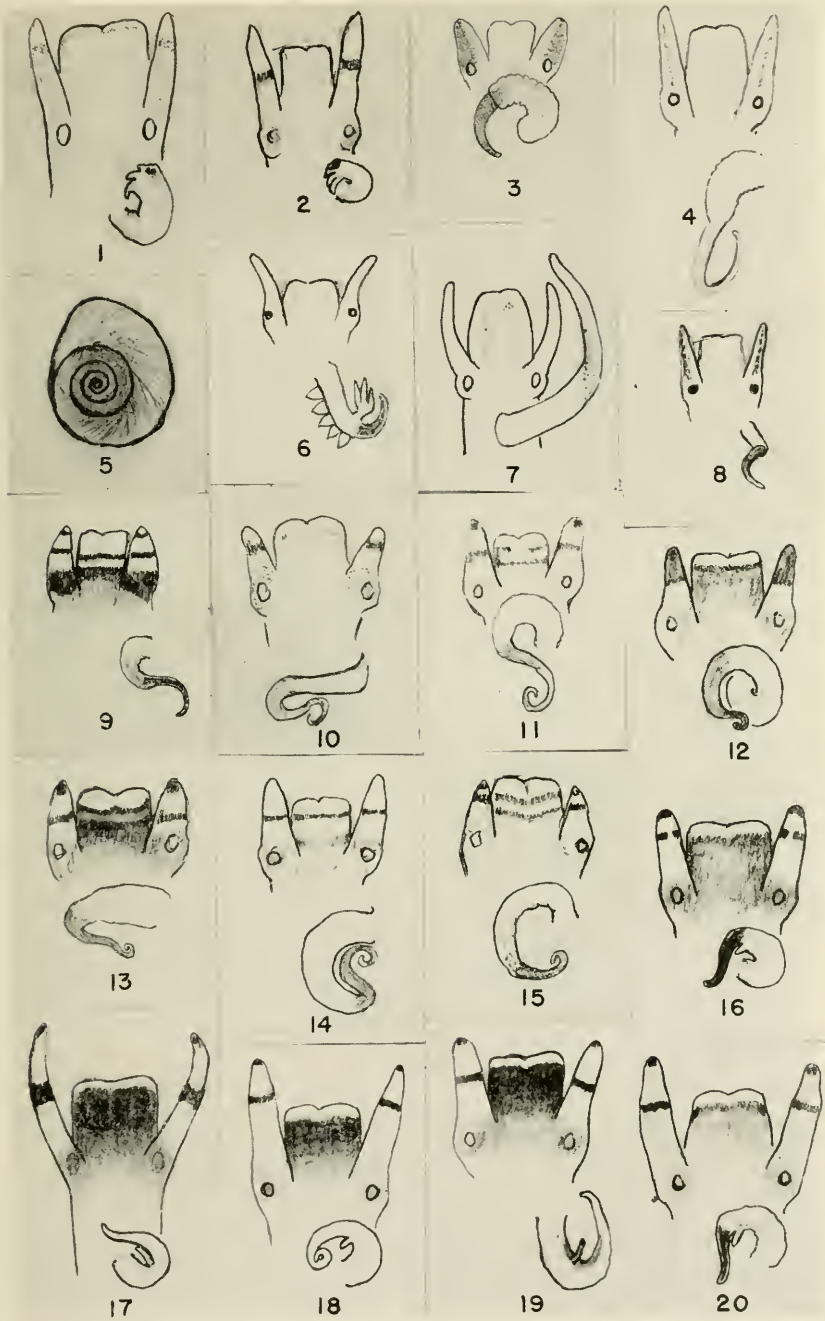


MOLLUSKS OF SAN JOSÉ AND PEDRO GONZÁLEZ ISLANDS.  
PEARL ISLANDS, PANAMÁ  
(For explanation, see p. 48.)



MOLLUSKS OF SAN JOSÉ AND PEDRO GONZÁLEZ ISLANDS.  
PEARL ISLANDS, PANAMÁ  
(For explanation, see p. 49.)





MOLLUSKS OF SAN JOSÉ AND PEDRO GONZÁLEZ ISLANDS,  
PEARL ISLANDS, PANAMÁ  
(For explanation, see p. 49.)