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THE MOLLUSCA COLLECTED BY THE UNIVERSITY OF MICHIGAN-WALKER EXPEDITION IN SOUTHERN VERA CRUZ, MEXICO. I

BY H. BURRINGTON BAKER

INTRODUCTION

The specimens on which this paper is based were collected by the University of Michigan-Walker Expedition, during six weeks (July 10 to August 20) in the summer of 1910. The expedition consisted of Alexander G. Ruthven and his wife, Florence H. Ruthven, who paid particular attention to the amphibians and reptiles, and the writer, who was primarily interested in mollusca.

The work of identification and description was made possible by the Academy of Natural Sciences of Philadelphia, which generously put at my disposal its extensive collections and exhaustive library. As a result, any credit that this paper may deserve is largely due to Dr. H. A. Pilsbry, whose constant advice and assistance is the reason behind its production. The writer did the detailed work and the drawing, and any inaccuracies or errors of judgment that may appear can safely be laid to him. The drawing and photography were done at the zoölogical laboratory of the University of Pennsylvania.

As a detailed study of the environment of the region has already been published,[1] it is only necessary, in this paper, to present again the location of the region and to summarize briefly the ecological habitats.

Location

All of the collection was made on or within a few miles of the Hacienda de Cuatotolapam, except one day's work at the Laguna de Catemaco, about twenty miles away. The hacienda (map in Ruthven's paper; *l. c.*) lies between the Rio San Juan and the Arroyo Hueyapam, a tributary, in the Canton of Acayucan, southern Vera Cruz. This is approximately 18° N. Latitude and 95° W. Longitude, and about 50 feet above sea-level. The country is quite typical of the tropical lowlands, and the collections were made during what is known as the wet season.

The Laguna de Catemaco is a few miles to the north in the heart of the coastal San Andreas Tuxtla range, and not far from the city of San Andreas Tuxtla. This lake also drains into the San Juan River system. The range and the lake basin appear to be of volcanic formation. The altitude of the latter is not definitely known to me, but is probably not more than 2000 feet above sea-level. From the appearance of this region, a considerable difference in the molluscan population

[1] Ruthven, A. G., 1912. The Amphibians and Reptiles Collected by the University of Michigan-Walker Expedition in Southern Vera Cruz, Mexico; *Zool. Jahrb.*, XXXII, abt. f. Syst.; pp. 295-330; pl. vi-xi.

would probably be found, but the visit was too short to ascertain the fact.

Ecology

Here is simply included a brief classification of the habitats, which is practically that of Ruthven (*l.c.*), where the details are presented and illustrated by photographs. A review of the molluscan inhabitants of the various environments will be given in another paper.

A. *Terrestrial Habitats.*

I. Lowland forests. The dense jungle of the untouched flood-plains. Two ecological strata are recognized here: (a) the ground stratum, which includes the leaf-humus, rotting logs, and other debris; and (b) the arboreal or subarboreal stratum, under which are taken up the species obtained from the trees and bushes themselves, both from the leaves and the trunks.

II. Lowland forest clearings. These may be subdivided into three classes: (a) partially cleared places along the Arroyo Hueyapam (bush and a few clumps of large trees); (b) the burnt-over ground (mainly dead shells obtained); and (c) cleared fields (the fields of sugar cane and corn and the roads and *guardas rayas* between them).

III. Savannah forests and thickets. Clumps of bush and relict jungle, usually on higher ground, and of a more xerophytic type. The yuccas and spiny palms are especially prominent, scattered in clumps through the mesophytic vegetation. The ground stratum (a), and the subarboreal stratum (b), may also be recognized here.

IV. Savannah grassland. The grazed, prairie-like portions, probably due to disturbance by man and cattle. They are practically without molluscan life.

B. *Aquatic Habitats.*

V. Lowland forest ponds. Swamps and pools, mainly temporary, in the forest itself and in the cleared regions. The two main classes studied are: (a) pool-swamps in the low jungle along La Laja; and (b) the pools in the burnt-over region and cleared land.

VI. Savannah ponds. Established ponds in the savannahs. Although the Laguna de Chacalapa is about a mile in length, it is not over a meter deep at the height of the wet season. Only one shell was obtained.

VII. Rivers and lakes. a. La Laja. This is what is known in many Spanish-American countries as a *caño* (literally, a sewer). It is a sluggish stream and black-water channel off of the Arroyo Hueyapam, and does credit to its Spanish designation.

b. Sand-bars of the Arroyo Hueyapam. At the hacienda, the Hueyapam consists of a steep-banked channel about fifty yards by twenty to thirty feet deep, which, dependent upon the weather, may contain anything from a sizable creek, with pools, little rapids and sand-bars, to a raging torrent that completely fills or overflows it. It is quite typical of the scoured, sandy creeks so common in the tropics.

c. Rio San Juan. A quite large river, which was in flood at the time visited, and in some places over-reached its banks for almost half a mile. Its bottom is probably sandy.

d. Laguna de Catemaco. A deep-basined crater (?) lake, several miles in diameter. Most of the shore is of volcanic rock and it contained several rocky islands, but near the outlet and in some other places this is covered by a deposit of humus-material. The latter developed, in some parts, a magnificent border of water-hyacinths, a hundred yards wide or more. Collecting was also done in a small, but very deep, body of water, near the town of Catemaco, and about a hundred yards from the lake, which fills the crater of a small subsidiary cone.

ACKNOWLEDGMENTS

I wish to add my thanks to those of Dr. Ruthven, already expressed, to all of the Americans at the Haciendas of Cuatotolapam and Hueyapam, for their kind hospitality and generous assistance. In addition, I wish to express the greatest indebtedness to Dr. Ruthven and wife, for help in every way.

As already mentioned, I owe the very production of the paper to the generous and patient advice and instruction of Dr. H. A. Pilsbry. Mr. Vanatta was always a ready additional help. I also express my indebtedness to Dr. Bryant Walker, whose generosity made the collection originally possible, and whose continued advice has been very helpful. Acknowledgment is also made to the many members of the staff of the zoölogical laboratory of the University of Pennsylvania, who have been of assistance in the production of the photographs.

PART I. THE UNIONIDAE OF THE SAN JUAN RIVER SYSTEM

Unfortunately, the water was high, so the only living naides obtained were a few small specimens of *A. sapotalensis* (Lea) and a number of juvenile individuals of a form near *A. umbrosa* (Lea) from the Arroyo Hueyapam (H, vii, b).[1] In addition, other shells from the Arroyo Hueyapam and La Laja (H, vii, a) were picked up on the sand-bars and in the streams themselves.

Fortunately for the collector, some of the natives of the region collected the uniones at low water, for the purpose of

[1] The Roman numerals and letters, throughout the paper, designate the habitats, as classified in the introduction. In order to distinguish them from the references to the plates, they are preceded by the letter H.

baking the shells to make the quick-lime used to soften maize in the preparation of *tortillas,* the national Mexican breadstuff. The shells from the Laguna de Catemaco (H, vii, d) were obtained, through the intervention of the Spanish gentleman whose hospitality we enjoyed, from a pile (all of one species) at the edge of the town of Catemaco. They probably came from the mucky-bottomed portion of the shore, near the outlet. All of the shells from the Rio San Juan, except the one specimen of Anodonta, were bought (for one peso) from a *peon* at the village of Cuatotolapam, on the hacienda of the same name. He informed me, through the medium of Mr. Thomas La Rue, the subgerente of the plantation, that they were obtained, during low water, from a depth of a few feet in the Rio San Juan, near the town (H, vii, c).

UNIONIDAE

Amblema (Megalonaias) nickliniana (Lea) (1834).—One small left valve, from the Rio San Juan (H, vii, c). Measurements[1]: length, 86 mm.; height-index at beaks, 75 per cent (64.5 mm.); height-index at wing, 80 per cent (69 mm.) diameter-index, 37 per cent (32 mm.).

From the specimens labeled *Q. eightsii* (Lea) in the A. N. S. P., that form, which Simpson (1914) regarded as a synonym of *Q. heros* (Say), resembles some specimens of the latter species less than it does *Q. nickliniana.* At least, it looks as if the range of variation in *Q. heros,* as used by Simpson, is

[1] The measurements of the naiades in this paper are given in the same order and with the same significance as in Simpson (1914), except that, instead of the height and diameter, the height-index and diameter-index are given. The index of the height is taken as the height divided by the length; that of the diameter, the diameter divided by the length. Both indices are expressed as percentages. Except in the case of quotations, the indices are followed (in parentheses) by the actual dimensions in millimeters.

much greater than the divergence of *Q. nickliniana* from some of its forms.

Elliptio (*Leptonaias*) *ravistellus* (Morelet) (1849).—One dead specimen along Quebrada Laja (H, vii, a). Measurements: length, 48.5 mm.; height-index, 51 per cent (25 mm,); diameter-index, 33 per cent (16 mm.).

The specimen somewhat resembles this species, although a larger set might show constant differences. In this individual, the general shape approaches that of *E. popeii* (Lea); it is somewhat compressed laterally and has a tendency to be subsinuate ventrad. The ridges are closer and finer than in typical *E. ravistella,* so that the dry shell has a grayish appearance. When wet, the golden-yellow ground-color, with rather diffuse, olive-green rays, is apparent. The posterior, dorsal region is marked by two quite deep furrows, and between these the surface is wrinkled irregularly, in a manner remotely suggestive of the Sphenonaias group. The pseudocardinals are lamellar and very oblique, especially in the right valve.

Unio ravistellus Morelet is the type of the section Leptonaias Fischer and Crosse (1894), which I use here in the sense of Nephronaias Frierson (1917). Unfortunately, Simpson (1900) chose Nephronaias Crosse and Fischer (1894) (type *U. plicatulus* Charp. in Küster, 1856) as the name of his mixed assemblage of Elliptio-like and Lampsiline species. Frierson separates these and retains the name for the unionine shells, on the supposition that *U. plicatulus* is such a species. Von Martens (1900), however, places this species in the synonomy of *A. aztecorum* (Philippi). Personally, I think it is rather *A. medellina* (Lea). It is true that the surface looks like the Elliptio-group of Southern Mexico and Central America, but all of Küster's figures look remarkably alike; also the description mentions fine, close-set wrinkles, but these are also present in *A. medellina,* to a certain degree, and a darkening of the epidermis appears to be a characteristic of many individuals of all species from the Medellin River. On the other hand, the block of teeth in the left valve (the individual teeth are indistinguishable) forms an almost equilateral triangle, and is set quite far anteriad and ventrad, as in *A. medellina,* while in Leptonaias they form an acute-angled triangle with the smallest angle posteriad, and set up more nearly under the beaks, as well represented in Lea's figure of *U. persulcatus* (Obs. VII, xl, 135). In addition, the color of the nacre is that of *A. medellina* and it comes from the same river. However, the figure also very much resembles some of the more elongate, smooth forms of *E. plexus* (Con.), and the dimensions fit either species. For this reason, the best place for *U. plicatulus,* and the section Nephronaias with it, is under the synonomy of *A. medellina* (Lea), along with *U. purpuriatus* (Say), and sharing the same question-mark! Therefore, Leptonaias Crosse and Fischer (1894), type *U. ravistellus* Morelet, is used here as a subgenus of Elliptio, to include those southern Mexican and Central American forms, with the peculiar ornamentation, included in the genus Nephronaias as used by Frierson (1917). Coenonaias (type *U. aeruginosus* Mo.) and Simononaias (type *U. tabascoensis* "Charp." Küster) are synonyms. Both owe their origin to Crosse and Fischer (1894).

Elliptio (*Sphenonaias*) *plexus* (Conrad) (1838). Plate I, figs. 4 and 5.

Unio coloratus "Charp." Küster (1856).
? *Unio plicatulus* "Charp." Küster (1856).
Unio pigerrimus (C. and F.) (1893).

Three small specimens from the Rio San Juan (H, vii, c) closely resemble the smoother forms of this species. They represent, I believe, a depauperate race of the following form.

The hinge-armature is similar to that of juvenile specimens, and the color of the nacre is that usual in medium-sized individuals—i. e., lavender with copper tints. However, the shells are solid, somewhat inflated, and much eroded at the beaks, and have every external appearance of mature individuals. One (fig. 5) is quite sinuate on the ventral margin. They measure:

	Length	Height-index	Diameter-index
Fig. 4	50 mm.	60 (30 mm.)	39 (19.5 mm.)
Fig. 5	54 mm.	61 (33 mm.)	39 (21 mm.)
Another	55.5 mm.	58 (32 mm.)	42 (23 mm.)
E. plexus	55	64	44 (Simpson, 1914)
U. pigerrimus	59	65	46 (C. and F., 1894)

Unio coloratus has every appearance of a smooth specimen of this species. The question of *U. plicatulus* has already been discussed. *U. pigerrimus* easily falls within the range of variation of this and the following form.

The section Sphenonaias C. and F. (1894) (type *U. liebmanni* Ph.) is used here to include, besides the type, the more Elliptio-like forms of Psoronaias (type *U. psoricus* Morelet). The typical forms with higher umbones have much more the appearance of some of the southern species, placed by Simpson (1914) in Quadrula, but which were also included in the section Psoronaias, as originally described. The section Barynaias C. and F. (1894) is described in Part VII of the "Moll. terr. et fluv. de Mex.," with *U. pigerrimus* as the single example, while in Part VIII that species is put under Psoronaias and *U. sallei* is listed as the sole example of the former section. Barynaias is thus a synonym of Psoronaias. Von Martens (1900) mistakenly calls *U. sallei* the type of Pachynaias C. and F. Barynaias is also a synonym of Sphenonaias, as used here. Sphenonaias should not go into the synonomy of Psoronaias, nor vice versa, until the anatomy of a typical example of either section has been studied; the group whose anatomy is unknown should be placed, at least temporarily, in the synonymy of the one studied, so as to reduce the chances of future confusion.

Elliptio (Sphenonaias) plexus, subspecies *distinctus* (C. and F.) (1893). Plate I, fig. 3; plate II; plate III, fig. 15, 11.—Thirty-nine specimens, including odd valves, from the Rio San Juan (H, vii, c). This is a very variable form; nothing about it seems constant. The sculpture varies from almost perfectly smooth to plicate (typical forms), and finally pustulate. The shape varies from quite close to that of the next species to a quadrate form which resembles *U. testudineus* Morelet. Some of the older specimens have the biangular posterior margin and the double ridge of *U. morini* Mo. It seems probable that Lea was quite right when he combined *E. plexus* with *E. crocodilarum* Mo., as some specimens of this intermediate form are indistinguishable from the latter shell. *E. plexus crocodilarum* (Mo.) may still be retained, as a subspecies, for the usually larger and more cylindrical, southern form. From the variation in *E. plexus distinctus,* it seems probable that both *U. morini* and *U. testudineus* are synonyms of *E. plexus crocodilarum,* or the second may be a subspecies. *E. semigranosus* (von dem Busch), from the Panuco River system, is a considerably more compressed form, and may be a separate species, although a series in the A. N. S. P., from the Tecomate River, are more or less intermediate between it and the present form. It is, at least, a very distinct northern subspecies. *Unio corium* Reeve appears to me to be a distinct species, more closely related to *E. psoricus* (Mo.) than to the present group.

Besides this variation in the larger specimens, this subspecies (*distinctus*) varies a great deal with age. The younger shells are much more compressed in shape and have a whitish nacre, although they quite early assume the coppery tint. Their hinge armature is quite similar to that of *E. liebmanni* (i. e., the pseudocardinals are more apt to be compressed, quite simple, and more or less oblique—fig. 15, plate III). However, the laterals are always proportionately shorter and more curved than in that species, although in this, as in other characters, the two species somewhat approach each other. As is true of all of these shells from the Rio San Juan, the early erosion of the beaks and the constant malformation (due to tropical floods?) cause many small individuals to have every appearance of an adult shell. For this reason, and because the specimens in the A. N. S. P. (among them the type) have the juvenile pseudocardinals of this species, I am inclined to believe that *P. kuxensis* Frierson (1917) is a depauperate, small stream form, closely related to *E. plexus crocodilarum* (Mo.). However, the general appearance is certainly that of completely adult shells.

In all of the specimens of this series of *E. plexus distinctus* the beaks are eroded, but the smaller specimens retain enough to lead me to believe that the beak sculpture of this species consists of very irregular, but more or less parallel wrinkles, disturbed by radial plicae and pustules, with a slight tendency to be doubly looped, rounded on the posterior slope and with an oblique V on the anterior one, so that the sculpture appears to run obliquely postero-ventrad.

Plate II, fig. 13, shows a very peculiar, compressed and slightly sinuate shell, which looks quite like a different species. The nacre and the general shape of the inside of the shell, as well as the lateral teeth, are quite typical of *distinctus*, but the pseudocardinals are of the juvenile type; that is, they are compressed, almost equal and oblique (figs. 3 and 15 are similar). The beaks are eroded, but the remainder of the shell shows no sign of ornamentation, and is almost black, smooth and shiny, with evident, fine, radiating striations. Other specimens approach it in various characters, but it combines so many peculiarities that, if found in large numbers, it would seem to require at least distinct racial recognition.

The pseudocardinals of the figure of the type of *E. plexus distinctus* (C. and F., 1894) resemble the juvenile form, but the description sounds more like those of the adult, in which the posterior pseudocardinal of the right valve is very heavy, jagged, and almost quadrate.

Variation in *E. plexus distinctus* (C. and F.)

	Length in mm.	Height-index in per cent	Diameter-index in per cent	
E. semigranosus	98	68	32	(type, C. and F., 1894)
E. plexus distinctus	79	63	42	(type, *l. c.*)
E. plexus crocodilarum	90	61	46	(Simpson, 1914; C. and F. same proportions, but smaller specimen)
U. testudineus Mo.	91	77	37	(C. and F., 1894)
U. morini Mo.	75	63	37	(C. and F., 1894)
P. kuxensis Frierson	50	60	34	(Frierson, 1917)
Plate I, fig. 3	38.5	61(23)	33(12.5)	(Cf. *kuxensis*)
Plate II, fig. 8	59.5	68(39.5)	39(23)	(*distinctus* sculpture)
fig. 16	62	69(43)	40(25)	(nearly smooth)
fig. 15	67	63(42)	42(28)	(practically smooth)
fig. 17	69	70(47.5)	36(25)	(plicate to pustulate)
fig. 9	69.5	72(50.5)	37(26.5)	(Cf. *testudineus*)
fig. 14	75	64(48)	35(26.5)	(*distinctus* sculpture)
fig. 10	77.5	69(53.5)	44(33.5)	(sculptured dorsal)
fig. 13	80	60(48)	35(28)	(peculiar, smooth shell)
fig. 11	82.5	67(55)	51(42)	(all sculpture eroded)
fig. 18	82	61(49.5)	43(35)	(compare *morini;* double posterior ridge)
fig. 12	84	61(51)	50(42)	(Cf. *crocodilarum;* heavy)
fig. 19	94	61(57)	42(39)	(largest specimen)
Mean of 39 specimens	75.0	64	41	
Extremes of lot	38 to 94	60 to 72	33 to 48	

Elliptio (Sphenonaias) liebmanni (Philippi) (1847), subspecies **cuatotolapamensis,** new subspecies

Plate I, figs. 6, 7; plate III, fig. 22 (type); plate IV, figs. 20-25.

Twenty specimens; including odd valves; from Rio San Juan (H, vii, c).

Shell of medium size, elongate subelliptical to subrhomboid, quite solid, convex, with posterior ridge well marked, subangular or often rounded and sometimes double; beaks well anterior, sculpture (as interpreted from remains of smallest specimen) probably somewhat similar to that of *E. plexus,* only not so oblique, and broken by the radial plications so as to give it an almost radial appearance (at least suggestive of some of the South American genera); anterior end evenly rounded or subangular just in front of lunule; posterior margin gradually curved, sometimes quite markedly biangulate behind; basal line very slightly rounded to subsinuate, postbasal point but little elevated; epidermis (in older shells) dark brown to almost black, roughened to smooth and shiny, with fine, radiating striations (in younger shells with golden-yellow ground-color, almost completely obscured by diffuse olive-green rays); surface of shell usually marked by vertical furrows (which start high on the beaks and more or less disturb the beak sculpture), most prominent on and just behind the anterior slope, usually not extending more than 30 mm. ventrad from the beaks, and rarely by radiating, dorsally curved plications as in *E. plexus;* left valve with two pseudocardinals, the anterior compressed, almost lamellar and very oblique, the posterior trigonal or compressed ventrally so as to be wedge-shaped, and two, elongate, almost straight laterals, of which the more ventral is better developed; right valve (II, 22) usually with two, subequal, compressed, almost lamellar, and very oblique pseudocardinals, although sometimes the anterior is partially suppressed and in old shells both become jagged, and usually one well-developed, slightly curved, long lateral, with sometimes an indication of another more dorsad; beak cavities rather shallow, showing or just obscuring the dorsal scars; anterior muscle scars deep and sculptured by anastamosing lamellae; posterior scars well impressed only at the anterior end; nacre white to salmon or lavender, without distinct, coppery tinge; radially striate and iridescent in the younger shells, but thickened and minutely pebbled anteriad in the older specimens.

VARIATION IN *E. liebmanni cuatotolapamensis*, n. subsp.

	Length in mm.	Height-index in per cent.	Diameter-index in per cent	
E. liebmanni	103	56	43	(Philippi, 1849)
E. sphenorhynchus	71	52	33	(C. and F., 1894)
Fig. 6 (smallest)	55	51 (28)	33 (18)	(heavily ornamented)
Fig. 7 (left valve)	62	50 (31)	34 (21)	(ornamented)
Fig. 20 (right valve)	62	58 (36)	37 (23)	(see below)
Fig. 21	65	55 (36)	34 (22)	(smooth and shiny)
Fig. 24	74	54 (40)	33 (24)	(ornamented)
Fig. 23 (left valve)	78.5	48 (38)	29 (23)	(smooth; see below)
Fig. 25 (very heavy)	79	53 (42)	42 (33)	(strongly eroded)
Fig. 22 (type subspecies)	81	53 (43)	35 (28)	(ornamented)
Mean of 20 specimens	69	54	34	
Extremes of lot	55–83	48–58	29–42	

This is a smaller form than typical *liebmanni*, with, apparently, a stronger tendency towards ornamentation. Simpson (1914) omits any mention of the ornamentation in his description of *E. liebmanni*, but Philippi (1849) says: "The beaks of my examples are very widely and strongly eroded; however, on one I still recognize vertical, shallow furrows, which are about a line apart and extend almost an inch from the beaks, which must give an individual character to the young, uninjured shell, that helps to differentiate this species from others" (translation). The locality of the species is indefinite (Mexico, legit cl. Liebmann), but it is probably a more southern form than this subspecies. *U. sphenorhynchus* C. and F. (1894) has the same dimensions as the subspecies, but is very sinuate ventrad; has a much more definitely marked posterior ridge; the beaks are placed more posteriad; and the posterior tooth in the right valve is more trigonal than compressed. C. and F. (1894) also give a figure (lxv, 4) of what they consider an aberrant shell of their *U. tehuantepecensis;* it has every appearance of my shell, plications and all.

This species is apparently quite closely related to *E. plexus* (Con.) and its identification is further confused by the very great resemblance to what I think to be the young shells of *A. walkeri* (see below). These latter are intermediate in shape between *E. plexus* and *E. liebmanni,* and their lateral teeth somewhat resemble those of the former. However, their right pseudocardinals are more trigonal and they lack the vertical furrows, typical of both species, although they possess somewhat similar, curved, posterior plications.

Two quite well-marked lines of variation are present in the lot. One is represented by figs. 20 and 21, and by two other shells not figured. These four shells are much smoother and more polished than are the rest (21 has no sign of ornamentation), have a more strongly curved, dorsal line, and shorter and more curved laterals, and tend to be somewhat higher. The last two of these characters make them approach, in appearance, the young shells of *A. walkeri* and *E. plexus*. The other aberrant type is represented by a single left valve (fig.

23). It is a considerably more elongated and compressed form than are the others, and the epidermis is golden-brown with indistinct, brownish rays. The growth-lines are well marked and give this shell a somewhat concentricly wrinkled appearance; otherwise it appears quite without ornamentation.

Anodonta globosa Lea, subsp. *nopalatensis* (Sowerby) (1867).—Plate V, fig. 26. One left valve, in good condition, from the Rio San Juan (H, vii, c); picked up on the bank by Dr. Ruthven.

The epidermis is radially striate, ½ mm. apart, while anterior to the umbones are etched very distinct, fine furrows, 4 to 6 mm. apart. The ventral margin is distinctly sinuate, but this may in part be caused by an injury about 3 cm. dorsad; but the shell is flattened to slightly concave centrally, even above this. The color of the epidermis is dark brownish-olive, to rust-colored towards the beaks.

This specimen is from within a few miles of the type locality of *nopalatensis,* as worked out by von Martens (1900); *A. globosa globosa* is from a lake near the mouth of the same river system. With its extremely high and full beaks, great inflation and sloping dorsal margins, this form appears to be more distinct from *globosa* (adult specimens in the A. N. S. P.) than is *A. tabascensis* Mo. as figured by Fischer and Crosse (1894).

MEASUREMENTS

	Index in mm.	Height-index in per cent	Diameter-index in per cent	
A. globosa Lea.	100	72	52	(type, Simpson, 1914)
A. tabascensis Mo.	178	69	59	(F. and C., 1894)
A. nopalatensis Swby.	150	73		(F. and C., 1894)
Plate V, fig. 26	150	75 (112.5)	68 (102)	

Actinonaias sapotalensis (Lea) (1841), and approaching subspecies *computata* (Crosse and Fischer) (1893).—Seven specimens from Arroyo Hueyapam (H, vii, b); 8 from Rio San Juan (H, vii, c). The former include the specimens of which the anatomy has been described and figured by Ortmann (1912).

The specimens from the Arroyo Hueyapam are near *sapotalensis,* while those from the Rio San Juan approach *computata,* which, from the proportions and the figure of the hinge armature, appears to be the description of a youngish individual of a considerably larger form, from the Goatzalcoalcos River system. One of the larger specimens is arcuate ventrad very much like some of the specimens of *P. opacata* (plate VII). In these older individuals, the wavy tendency of the rays becomes accentuated towards the ventral margin, until they are broken into very pronounced zig-zags, similar to some of the species of Plagiola.

MEASUREMENTS

	Length in mm.	Height index in per cent	Diameter-index in per cent	
A. sapotalensis	56	64	41	(Simpson, 1914)
A. s. computata	77	68	39	(C. and F., 1894)
Arroyo Hueyapam	50.5	62	34	(young male)
	53.5	65	39	(female)
Rio San Juan	70.3	67	44	
	79.5	65	44	
(largest)	81	65	49	(arcuate ventrad)
Extremes	50–81	58–67	33–49	

Actinonaias umbrosa (Lea) (1856) and approaching *explicata* ("Mo." C. and F.) (1894).

U. alienigenus C. and F. (1893). Plate VII, figs. 43-47.

Five adult shells and 15 juveniles from the Arroyo Hueyapam (H, vii, b); 12 specimens, including odd valves, from Rio San Juan (H, vii, c).

The small river form (Arroyo Hueyapam) approaches quite closely *A. umbrosa* (Lea), as it has the more wedge-shaped form (figs. 44, 45), but the specimens are quite light-colored, while most of those from the Rio Medellin, like so many species from that river, are quite dark. Some of the adult males(?) from the Rio San Juan (fig. 46), on the other hand, quite closely approximate *U. alienigenus* C. and F. or even *A. explicata.* The females(?) from the Rio San Juan (fig. 47) are not so rectangular as the males and are somewhat swollen along the posterior shoulder down to the posterior ventral margin, very much as in *A. sapotalensis,* although to a lesser degree. The young males of the last species are practically identical in shape with those of this form, but may be easily separated by the difference in the pseudocardinals. The juvenile specimens from the Arroyo Hueyapam (fig. 43) are subrhomboid, and are beautifully rayed with green. They have no sign of a dorsal "wing." The pseudocardinals of the right valve are always oblique and almost parallel, but the size of the upper tooth is variable and the development of either appears dependent on the age of the individual. In the juvenile specimens, they are lamellar, while in the older specimens, although always distinctly compressed, they are often quite heavy and jagged. The nacre of the adults is usually white, but may be tinged with either salmon or violet.

Although typical specimens of *A. umbrosa* and *A. explicata* are very dissimilar, these two lots of shells show approaches to both species, and it seems probable that *umbrosa* is a dwarfed, small-river, northern form (type apparently a female) of the same species of which *explicata* is the larger, southern, form (type apparently a male). *U. alienigenus* is an intermediate form from the Goatzcoalcos River system. Strictly speaking, *A. umbrosa* (Lea) should have the priority, as Morelet's description, like so many in the Test. Nov. (1849), was totally unrecognizable until 1894, when it was beautifully figured, from original specimens, by Fischer and Crosse. However, as the general tendency in North American uniones seems to be to accept types regardless of the recognizability of the descriptions, *A. umbrosa* will perhaps ultimately become a subspecies of *A. explicata,* as the original naming of the latter (1849) has the priority.

Mesonaias C. and F. (1894) (type *U. explicatus* Mo.) is used here as a synonym of Actionaias. Graphonaias, of the same paper, has already been placed in the synonymy of the latter by Frierson (1917), who lists the type species (*U. medellinus* Lea) as an example of that genus.

From the original comparison, *L. sapperi* von Ihering (1901) appears to resemble an old specimen of *A. explicata,* with heavier pseudocardinals and obliquely truncate anterior end, but the dimensions are those of a more elongate and compressed form. The original notes of comparison, without figure, are too brief to assure its determination.

MEASUREMENTS

	Length in mm.	Height-index in per cent	Diameter-index in per cent	
A. explicata	116	57	33	(F. and C., 1894)
U. alienigenus	82	62	37	(F. and C., 1894)
A. umbrosa	90	59	33	(Simpson, 1914)
L. sapperi	114	49	29	(von Ihering, 1901)
Arroyo Hueyapam:				
Fig. 43	21.5	56(12)	32(7)	(smallest juvenile)
Fig. 44	41	61(25)	37(15)	
Fig. 45	71	62(44)	36(25.5)	(compare *umbrosa*)
Rio San Juan:				
Fig. 46	94	63(59)	35(33)	(male? compare *explicata*)
Fig. 47	93.5	62(57.5)	40(37)	(female?)

Actinonaias (Disconaias) walkeri, new species

Plate I, figs. 1 and 2; plate IX, fig. 49, type; plate X, figs. 48-50; plate XI, figs. 48 and 49

Fifteen specimens, including odd valves, from Rio San Juan (H, vii, c).

Shell rather large; male(?) subrhomboid, elongate, compressed, often slightly sinuate below; female(?) subelliptical, rather swollen; anterior end rounded, with dorsal margin considerably lower than beaks and the ventral margin obliquely truncate; posterior end with dorsal margin equal (males?) or higher (females?) than the beaks; posterior ridge double, rounded to subangular in the males(?), while the region is considerably swollen in females(?); posterior margin moderately biangulate; beaks rather low, behind the middle, and curved posteriad, especially in the females(?); sculpture (if identification of juvenile specimens is correct) probably consisting of fine, concentric wrinkles, flattened ventrad; epidermis roughened by irregular growth-lines which are sometimes markedly sulcate, especially near the ends of the shell, radially striate throughout and sometimes with dorsally curved sulcations on the anterior slope; color brownish with very indistinct olive-green rays in adult (rays diffuse on a yellowish background in juvenile shells); left valve with two stout, trigonal, jagged pseudocardinals, and two heavy, short laterals (fig. 49, plate XI); right valve with two pseudocardinals, the anterior small to vestigial, oblique; the posterior large, stout, trigonal, almost vertical, and broken superficially by vertical, jagged lamellations; with cavity for reception of posterior left pseudocardinal, usually deep and large; followed by a small tooth; and with one very heavy, club-shaped, short lateral; hinge-plate heavy, short, occupying middle half of dorsal margin, curved below in male(?) and almost arcuate in female(?); beak cavities rather shallow, just obscuring dorsal scars; anterior muscle scars deeply impressed but quite smooth; posterior scars well marked but not impressed; pallial line deep, crenate; nacre white to reddish violet, almost scarlet, sometimes with a coppery tinge, thickened anteriad, iridescent posteriad; edge of inside of shell, due to obliquity of prismatic layer, with white to rust-colored border 2 to 4 mm. wide.

MEASUREMENTS

	Length in mm.	Height-index in per cent	Diameter-index in per cent	
A. disca (Lea)	132	63	27	(type, Lea, 1838)
	135	67	24	(Simpson, 1914)
A. disca fimbriata (Fr.)	80	59	31	(Frierson, 1907)
Fig. 1	46	52(24)	30(14)	
Fig. 2	61	56(34)	34(21)	
Fig. 48 (right valve)	97	65(63)	41(40)	(female?)
Fig. 49	105	57(60)	34(36)	(type; male?)
Fig. 50 (left valve)	102.5	57(59)	31(32)	(male?)
Extremes (11 adults)	88.5–109.5	55–65	31–45	

The larger shells of this species seem to be markedly dimorphic; those that appear to be the old males somewhat resemble *L. fimbriata* Frierson (1907), while those taken for old females have the slightly hooked beaks and the humped posterior dorsal margin of *U. discus* Lea (1838). On account of this dimorphism and the resemblance of the two sexes (?) to these two forms, I think it is probable that *Unio discus* (more normal development *U. panacoensis* von d. Busch) is largely based on old female specimens which have reached, in the quieter water of the large river near Tampico, their completely distinctive form, while *L. fimbriata* Frierson, also from the Panuco River system, is a small-stream form of the same thing, mainly described from males and from rather immature females that had not yet developed the characteristic shape of the older specimens. The epidermis, hinge armature, obliquity of the prismatic layer and nacre of the two forms are practically identical, except that typical *L. fimbriata* plainly shows its exposure to a more severe environment. A youngish shell, approaching *L.fimbriata,* in the A. N. S. P. from "near Tampico," perhaps represents the male of typical *A. disca* (Lea). Some of the young shells of *disca* in the A. N. S. P. are indistinguishable from some specimens of *L. fimbriata,* which might be regarded as females that had not yet completely developed the adult dimorphism.

Ortmann (1912) has already shown that the marsupial characters of *fimbriata* are those of the general Plagiola-Paraptera-Actinonaias type. If the hypothesis in regard to the sexual dimorphism of *A. discus* is correct, the section Disconaias C. and F. (1894) (type *U. discus* Lea) is more or less intermediate in shell-characters between Actinonaias and Plagiola, as the males are more or less Lampsilis-like in shape, while the completely developed females bear considerable resemblance to typical Plagiola. The dimorphism of *A. disca* (Lea) is more marked than that of *A. walkeri,* as the females of the latter species do not differ so much in general shape from the males, but the shape of the post-dorsal swelling and beaks in the females is peculiar, and agrees with that of *A. disca.*

The section Disconaias thus contains two species, one of which may be divided into two subspecies: *A. disca disca* (Lea), *A disca fimbriata* (Frierson), both from the Panuco River system, and *A. walkeri* from the Rio San Juan. The dimensions given in the partial description of *L. sapperi* von Ihering (1901) are similar to those of *A. walkeri,* and some of the points mentioned in the original comparison might be applied to the latter, but I cannot believe that Simpson (1900) would ever confuse a species, even a male specimen, of this group with *A. explicata.*

A. walkeri is smaller than typical *disca* and, in proportion to size, is also heavier than either *disca* or *fimbriata*. The females are more inflated than in either of the northern forms, and are usually more elongate. The laterals of *A. walkeri* are heavier and lower, in proportion to the size of the shell, and the main pseudocardinal of the right valve is more broadly trigonal, with no tendency to be compressed. This last difference is most notable in the young specimens, as the juvenile pseudocardinals of *A. disca* are both quite oblique and almost lamellar, while those of *walkeri* are quite similar to those of the adult in shape. The epidermis of *walkeri* is also thicker, and the nacre attains a much more pronounced color (although similar in shade) than in any specimens of *A. disca* that I have seen.

Actinonaias (*Leptodea?*) *tecomatensis* (Lea) (1841).—Fourteen specimens, including odd valves, from the Rio San Juan (H, vii, c). These specimens agree quite well with typical *tecomatensis*. This species is very close to the more northern *A. tampicoensis* (Lea) (1838).

Measurements

	Length in mm.	Height-index in per cent	Diameter-index in per cent	
A. tampicoensis	80	75	35	(Simpson, 1914)
A. tecomatensis	90	67	44	(Simpson, 1914)
Mean, from Rio San Juan	88	70	45	
Extremes, ditto	66.5–96	66–76	40–49	

The group of Mexican forms with a tendency towards the production of dorsal alae, which includes these species, may be given any one of three names, all sections of Fischer and Crosse (1894): Cyrtonaias (type *U. berlandierii* Lea), Delphinonaias (type *U. delphinulus* Morelet), and Phyllonaias (type *U. paludosus* Morelet). None of these are used and they are all included as synonyms of Actinonaias for the following reasons:

1. From the shell characters, they all appear to be more or less closely related to Actinonaias, although very probably subgenerically or generically distinct.

2. Until definitely placed in the synonomy of Actinonaias, anyone who desired a little more variety in the nomenclature of the North American uniones might possibly have placed that genus in the synonymy of any of them.

3. The choice of name should be left until the anatomy of one of the types is thoroughly known. They are all prior to Paraptera Ortmann (1911).

Plagiola (*Artonaias*) *opacata* (Crosse and Fischer) (1893).—Plate VI, fig. 35; plate VII, figs. 27-38. Fifty-eight specimens from Lake Catemaco (H, vii, d), about one-half mile from the outlet in the Rio San Juan River system. Although no soft parts were obtained, the marked dimorphism of this lot of specimens presents convincing evidence that the type of *U. opacata* C. and F. is a female of a species closely related to *Plagiola* (*Artonaias*) *sallei* (C. and F.) (1893).

Checkerboard graphs, showing the variation in length and the height-index, the variation in length and diameter-index, and the variation in the two indices, were made for all 58 specimens, and gave bimodal arrangements in each case. Of the photographs presented (plate VII), the left hand column and the two central figures are plainly of the female type (figs.

27-30, 32, and 33), while those in the right hand column and the middle figure in the upper row (figs. 31, 35-38) are evidently of the male type. However, young shells are more or less inseparable and in old age the proportions again often become similar, as, for instance, the middle figure in the bottom row (fig. 34) looks like a female, but the earlier growth-lines give more the contour of a male.

The older specimens are practically black and all are discolored, but an application of oxalic acid to some of the younger ones reveals a beautiful, silky-brown epidermis, often with quite evident, olive-green rays. The beaks of all are eroded, but, in two or three of the more nearly perfect specimens, remains were observed that apparently indicate the beak sculpture to consist of low, rounded wrinkles, with a slight tendency to be doubly looped. The silky appearance is caused by the close and regular arrangement of the growth-lines, which are crossed at right angles (in many specimens) by fine, radiating striations. At the posterior end, the latter become coarser and more distinct and are often separated by quite pronounced ridgelets. This structure appears to be a characteristic of the surface of the shell-substance, and may or may not affect the epidermis. In some of the older shells, the epidermis has a similar, flaky appearance to that characteristic of the group Artonaias. As shown by the figures and measurements, the shell is extremely variable and the older, arcurate specimens bear little resemblance to the younger shells. They are all connected by intermediates, but the specimens figured are chosen for divergence rather than resemblance. Fig. 32 shows an especially aberrant form, with much higher beaks, which are very swollen. The right pseudocardinals are usually quite equal and compressed (as remarked by F. and C.), but often the upper is smaller (as pointed out by Simpson, 1914). As the type figure is that of a female specimen, a male specimen is here figured in some detail (plate VI).

U. mexicanus Philippi (1847) apparently has been confused with this species by various authors. Crosse and Fischer began the trouble by placing the two in the same section, without comparison. Von Martens (1900) remarks that *U. opacatus* is "perhaps only a shorter variety of *U. mexicanus.*" Simpson (1914) apparently considered *U. mexicanus* as practically unidentifiable, but had a shell like a young *opacatus* that he thought satisfied the description of the former. A careful examination of Philippi's somewhat blurred, but rather good figure (1849) (Küster's copy as usual is abominable), and a comparison of the description and proportions, will, I believe, convince the most skeptical that *U. mexicanus* is exactly what Philippi (one of the keenest observers of his time) intimated that it was: a rather distinct form related to *A. aztecorum* (Ph.)! He wrote, "The epidermis, the nacre, the figure agrees pretty well with *U. aztecorum* and at first I held this form (Art) for a variety of the same, yet there occur the following differences. . . ." (translation). A specimen in the Wheatley collection (A. N. S. P.), labeled *aztecorum*, approximates Philippi's description of *U. mexicanus*. The form certainly has nothing in common with *P. opacata* except a rather straight dorsal line.

MEASUREMENTS

	Length in mm.	Height-index in per cent	Diameter-index in per cent	
P. opacata	53.5	67	52	(C. and F., 1894)
A. mexicana	64	58	38	(Philippi, 1849)
Means (male type)	53	61	44	
Means (female type)	50	65	47	
Extremes (58 specimens)	43–66.5	58–75	40–54	

Plagiola (*Artonaias*) *opacata* (C. and F.), subspecies new ?.—One specimen from the Rio San Juan quite closely approximates *P. opacata,* but has only one right pseudocardinal (the posterior). With it probably belong two or three much larger valves, all badly eroded and broken, but which show a considerably heavier and more arched hinge plate. These shells perhaps represent large subspecies (river form), but the material is too scanty and poor to justify a description. In many ways this form somewhat resembles *P. sallei* (C. and F.) (which would have the priority over *opacata*), but the latter appears to have higher and fuller beaks (fig. 32, plate VII, is comparable in this regard), and a trigonal, right posterior pseudocardinal. Simpson (1914) also speaks of the absence of radial striations, but they are difficult to find, or are completely lacking, in the epidermis of some specimens of *P. opacata.* These large specimens also resemble, to a certain degree, some of the older shells of *A. sapotalensis* (Lea), but the latter may be quite easily separated by their vertical right pseudocardinals, which are trigonal in shape, and by the zig-zag rays.

Lampsilis rovirosai Pilsbry **sanjuanensis,** new subspecies

Plate VII, figs. 39-42

Fourteen specimens, including odd valves, from the Rio San Juan (H, vii, c).

Shell rather large, subrhomboid to obovate; rather elongate, subinflated; posterior ridge well rounded and with two radiate sulcations on postero-dorsal slope; hinge-line rather short and quite straight; beaks rather full and well developed (especially as compared to *A. explicata*); beak sculpture (from remains in two younger specimens) apparently consisting of five or six, rather coarse wrinkles, scarcely looped; epidermis radially striate, olive-green in younger specimens, shading to yellowish at beaks and at the edge of the shell, blackish in old specimens; growth-lines fine and regular, giving the shell a soft, dull finish; left valve with two almost horizontal pseudocardinals, lamellate to heavy and jagged, but always compressed, and with two laterals, the ventral being especially high and lamellate; right valve with two, parallel, oblique, usually lamellate pseudo-cardinals, although the upper is vestigial or sometimes almost completely lacking, while the lower in old shells tends to become almost trigonal; and with one thin lateral; beak cavities moderately deep, capacious, obscuring the dorsal pits anteriad; anterior muscle scars well marked, smoothish, separated; posterior scars larger, confluent, not impressed, concentrically striate and iridescent; pallial line well marked throughout its length; nacre white, or tinted with lavender or salmon, somewhat thickened anteriad and delicately iridescent throughout.

The male(?) shell (plate VIII, figs. 39 and 40, type) is subrhomboid, with the posterior ridge better marked and ending in a rounded point about one-half way up on the posterior margin. The female(?) shell is more elongate, subovate, and strongly inflated in the posterior half of the shell, with the very much rounded posterior point one-half or more of the height above the ventral margin (plate VIII, figs. 41 and 42).

This subspecies is apparently a smaller form of the more southern typical *rovirosai*. The adult female(?) shell also differs from the type specimen, by a tendency to be somewhat more strongly inflated and elongate.

Simpson (1900) first pointed out that *U. testudineus* Reeve differed from true *explicatus* Morelet, and named the form *L. lividus*. Although I must confess that I am unable to place some individuals to my complete satisfaction, I think that the two shells, as Simpson intimated, are not even very closely related. But, from the material on which the subspecies is based, *U. testudineus* or *L. lividus* appears to represent a rather unpronounced female type, while *rovirosai* (type in A. N. S. P.) is what I believe to be the completely developed, old female, which has a type of marsupial(?) swelling quite distinct from that of *A. explicata* (Mo.). If this arrangement is correct, *L. rovirosai* Pilsbry shows a much more marked sexual dimorphism than does the latter species, where the female is nearly the same shape as the male but is slightly more inflated along the posterior ridge and down to the ventral margin. This more marked dimorphism and the indications of the beak sculpture (even the younger specimens are somewhat eroded) are the reasons for the retention of *rovirosai* in Lampsilis, until the soft parts are known.

MEASUREMENTS

	Length in mm.	Height-index in per cent	Diameter-index in per cent	
L. rovirosai	112	64	40	(Pilsbry, 1900)
L. lividus	110	56		(Simpson, 1914)
L. r. sanjuanensis				
Fig. 39	70.5	61 (43)	36 (25)	(male?)
Fig. 40	82	65 (53)	41 (34)	(type; male?)
Fig. 41	90	64 (58)	44 (40)	(female?)
Fig. 42	98	61 (60)	43 (42)	(female?)
Extremes (14 specimens)	64–98	58–65	36–48	

Lampsilis ruthveni, new species

Plate XI, fig. 53; plate XII, fig. 53; plate XIII, figs. 51-54

Seven specimens, including odd valves (2), from the Rio San Juan (H, vii, c).

Shell rather small, elliptic to subovate, rather solid, inflated behind middle; beaks in front of middle low; beak-sculpture not observed; posterior ridge rounded or shouldered; posterior margin with rounded point at or a little below middle of height; epidermis smoothish, thrown into sulcations and low, rounded ridges at growth-lines, dull, golden-brown to dark brown, the lighter shells with distinct, wavy, greenish-black rays, limited to the posterior half ventrad but painting the entire length of the earlier growth; left valve with two pseudocardinals, the anterior almost vertical, narrow and high, with the anterior surface forming an almost equilateral triangle and overhanging the anterior muscle-scar; the posterior rather heavy, pyramidal and trigonal; and with two short laterals; right valve with two pseudocardinals, the anterior small or vestigial and trigonal, the posterior heavy and trigonal; with a deep cavity for the reception of the posterior tooth of the left valve, often followed by a low, rounded accessory tooth, and with one short, stout lateral; hinge plate moderately heavy, usually well arched, and, in these specimens, extensively invaded by a ventral proliferation of the ligamental material; beak cavities shallow, exposing or just obscuring the irregular row of deep muscle pits at their anterior ends; anterior muscle scars deep, separate, the largest almost conical with the point of the cone undermining the pseudocardinals, especially in the left valve, little but coarsely sculptured; posterior scars semiconfluent, the largest spatulate in shape, slightly impressed anteriad, concentrically striate and iridescent throughout; nacre white or tinged with buff dorsad, thickened anteriad, iridescent posteriad; pallial line well marked, crenulate.

The male(?) shell is moderately inflated, subelliptical, with the well-rounded posterior point at about the middle of the height (plate XIII, fig. 52). The female(?) shell (fig. 51 is the type) is narrowly or broadly (fig. 53) ovate, much inflated just posterior to the center, and with two quite well-marked, but rounded, radiating swellings posteriad: one extending ventrad into the posterior point of the shell which is below the middle of the height, the other reaching the ventral margin about one-third of the length from the posterior end. The ventral margin of the female(?) shell is almost straight to quite noticeably sinuate just in front of the ventral end of the anterior swelling, and the margin is also often indented between the projections formed by the ventral ends of the two swellings. Two older shells have a slight arcuate tendency at the prolonged posterior point, which gives them a peculiar, beaked appearance (fig. 54). In both of these last, the beaks are eroded to such a degree that the pseudocardinals show dorsally as a sinuation of the hinge-line.

This swollen shell is more markedly Lampsilis-like in general appearance than are any of the other southern Mexican naiades; in fact, if without definite locality, it would undoubtedly be taken for a shell from the central United States. The marsupial(?) swellings even give it a certain resemblance to the genus Truncilla. All of the specimens are heavily eroded, as if the shell-substance was softer than usual, which may be the reason for the ligamental invasion of the hinge plate. Among the Rio San Juan uniones, *Lampsilis ruthveni* is nearest *Lampsilis rovirosai sanjuanensis* in shape, although much smaller and heavier, while its color and rays give it a superficial resemblance to *A. sapotalensis*. The radiate posterior swellings and the general inflation, especially of the females(?) are very distinctive characters in a Mexican form.

MEASUREMENTS

	Length in mm.	Height-index in per cent	Diameter-index in per cent	
	53	66(35)	48(25)	
Fig. 52	55.5	64(35)	47(26)	(male?)
	56	66(37)	48(27)	
Fig. 51	59	65(38)	58(34)	(type, female?)
Fig. 53	60	72(43)	52(31)	(much higher; female?)
Fig. 54	73	62(45)	46(33.5)	
	73.5	62(45.5)	46(34)	
Means (7 specimens)	61.5	65	49	
Extremes	53–73.5	62–72	46–58	

Part II. Operculates

HELICINIDAE[1]

Oligyra (Succincta) flavida strebeli (Pfeiffer).

H. flavida Menke (1829). The usually larger, more southern, banded form.

H. trossula Morelet (1849). A synonym of the preceding.

H. brevilabris Pfeiffer (1857). From description, a still larger form.

H. strebeli Pfeiffer (1861). Usually smaller, thinner and more depressed, with 5 to 5½ whorls; used here as subspecies.

About 800 adults; from leaves of trees, shrubs and vines (H, I, b), and on the ground (H, I, a) in the lowland forest; dead shells from the burnt-over area (H, II, a); from leaves of shrubs, cacti, etc., in the savannah forests (H, III, m); and from shrubs and elephant-ears along Arroyo Hueyapam (H, II, b).

None of the specimens are banded, but the ground-color varies from vitreous white and milky white, through horn-colored and greenish horn-colored, to yellow and dark amber-brown. The last two color-forms are especially striking. The lip is always milky white. Extremes measure:

Altitude	Greatest diameter	Height aperture	Diameter aperture
6.1 mm.	93 (5.7 mm.)	48 (2.9 mm.)	52 (3.2 mm.)
4.5 mm.	102 (4.6 mm.)	53 (2.4 mm.)	58 (2.6 mm.)[2]

The spiral striations in these specimens are very variable; they may be quite well developed or almost completely absent.

[1] The radulae of the four species included here have been examined and are figured in another paper, "Notes on the Radula of the Helicinidae," which will appear in the *Proc. Acad. Nat. Sci. of Philadelphia*. As the synonymy of the North American mainland species is also treated in that paper, it is omitted here, except where it is actually discussed.

[2] Throughout this paper, the altitude is expressed in millimeters, but the other dimensions are expressed as indices. The index of each dimension is taken as that dimension divided by the altitude. The index is followed by the actual dimension in millimeters.

One specimen from the savannah forests (H, III, b) has a well-marked indentation on the basal lip of the aperture, and many specimens show an indication of the same tendency. These specimens quite closely resemble *O. fragilis* (Morelet), which Wagner (1907) places in his subgenus Leialcadia (or Leicaladia?) of the genus Alcadia.

Helicina (*Tristramia*) *zephyrina* Duclos (1833).—One hundred one adults, mainly from leaves of trees and shrubs (up to about 15 feet above ground) in the lowland jungle (H, I, b); also found on shrubs, trees and elephant-ears in the partially cleared region along Arroyo Hueyapam (H, II, a), and on the leaves of shrubs and on cacti and yucca in the patches of brush on the savannahs (H, III, b). Shells (mainly dead) were also found on the ground (where they apparently aestivate) in these places (H, I, a; H, III, a) and also in the burnt-over region (H, II, b).

This species aestivates with the operculum almost entirely closed, but leaves a little crack between its lower edge and the basal margin of the aperture (fig. 1). Many specimens have a slight depression on this portion of the aperture margin, with an adjacent callus or tooth at the base of the columella. This makes them look very much like the figures of *H. deppeana* von Martens (1863). As this series of specimens also approaches that species in sculpture (as figured), I am rather inclined to believe that the latter is little more than a subspecies of the present species. Apparently this condition of the aperture is quite common throughout the family, although best developed in Alcadia. The operculum of *H. zephyrina* has the horny, inner layer well developed and almost scarlet in color. The calcareous plate is very thin and is usually incomplete towards the parietal wall of the aperture, although the columellar edge is thicker and better developed.

The specimens show considerable variation in size; from individuals seen in copulation, it appears that the males are usually smaller and less globose than the females. Extremes measure:

Altitude	Greatest diameter	Height aperture	Diameter aperture
12.4 mm.	107 (13.3 mm.)	55 (6.8 mm.)	63 (7.8 mm.)
9.3 mm.	111 (10.3 mm.)	62 (5.8 mm.)	66 (6.1 mm.)
9.1 mm.	117 (10.7 mm.)	67 (6.1 mm.)	73 (6.6 mm.)

The color variation in this lot may be divided into the following classes, which do not appear to be related to habitat:

(a) General coloration: from milky-white and yellowish-brown to orange and wine-colored. Ten specimens out of the total number were uniformly light-colored, while 3 were uniformly wine-colored. In the former case, the colored bands are certainly absent; in the latter, they may be obscured by the dark ground-color.

(b) One broad, dark band, just above the greatest ventricosity of each whorl, and reaching almost to the suture above (42 specimens). This band is either orange or wine-colored, and may be distinct or diffuse. Some of these specimens also show the broken stripe of class (d), which forms a lower margin to the one considered here.

(c) Two broad bands, with a light band between (3 specimens). The second band is just below the greatest ventricosity of the whorls, and varies in color with the other.

(d) A fine, broken stripe of colored dashes, at the position of the lower edge of the band in class (b) and often present at its lower border. Seventeen specimens have no other marking; it varies in color like the bands.

(e) A diffuse tint on the base which begins at the position of the lower edge of the second band in class (c), but which does not occur with it. Eight specimens have the band in class (b) and this basal coloration.

Helicina (*Tristramia*) *zephyrina elatior* "von Martens" Crosse and Fischer (1893).[1]—Eleven specimens from trees in the lowland forests (H, I, b) and the savannah forests (H, III, b); from the ground in the savannah forests (H, III, a), and from the burnt areas (H, II, b). This is a rather well-marked race of *H. zephyrina,* although it occurs with the typical form. In shape it is practically identical with the more northern *H. chrysocheila* Binney (1851), but the latter usually (not always) differs markedly in color and appears quite distinct. At least at present, it appears best to retain *elatior* as a race of *zephyrina,* which occurs with the typical form, and simply approaches, in shape, the other species. Specimens measure:

Altitude	Greatest diameter	Height aperture	Diameter aperture
12.1 mm.	103 (12.5 mm.)	49 (5.9 mm.)	53 (7.0 mm.)
11.2 mm.	94 (10.5 mm.)	47 (5.3 mm.)	55 (6.2 mm.)
10.6 mm.	100 (10.6 mm.)	52 (5.5 mm.)	57 (6.0 mm.)

Helicina (*Tenuis*) *tenuis* Pfeiffer (1849).

H. lindeni Pfeiffer (1849).

H. vernalis Morelet (1849).

Fifty-eight adults; from leaves of trees, vines and shrubs in lowland jungle (H, I, b) and on ground (H, III, a) and on leaves of shrubs and cacti (H, III, b) in the savannah forests. The specimens vary somewhat in size; extremes measure:

Altitude	Greatest diameter	Height aperture	Diameter aperture
9.7 mm.	100 (9.7 mm.)	48 (4.7 mm.)	55 (5.3 mm.)
9.5 mm.	101 (9.6 mm.)	54 (5.1 mm.)	60 (5.7 mm.)
7.7 mm.	107 (8.2 mm.)	61 (4.7 mm.)	66 (5.1 mm.)

[1] "Elatior" as used by von Martens (1890) is a one-word description and not a name. This is the reason why he puts *H. berendti* Pfr. as if it were a synonym under another of his short descriptions, "*excavatoangulata.*" When he actually wished to denote or name a subspecies, he placed the name in italics and followed it by the name of the author or the letter "n." Crosse and Fischer (1893) have since changed some of these descriptions into true names, as, for instance, in the present case.

The considerable color variation, which seems not to be correlated with the habitat, may be classified as follows:

(a) General coloration: milky-white to yellowish (variety delta of C. and F. (1893) and typical *lindeni*), greenish (most common), and chestnut-brown.

(b) One broad, brown stripe from near the greatest ventricosity up to the suture (variety epsilon of C. and F.).

(c) Two broad, brown stripes, with a light stripe between; the second below the greatest ventricosity includes varieties zeta and etta *chiapensis* (when combined with the brown body-color) of C. and F.

(d) Two dark and one light band above the greatest ventricosity; the stripe of class (b) divided through the center (variety gamma of C. and F. = typical *tenuis*).

Helicina lindeni and *H. tenuis* were described in the same paper (P. Z. S. 1848; April 25, 1849). The former name has page priority, but von Martens (1890) chose to regard the former as a form of the latter, so *tenuis* becomes the specific name. *H. vernalis* Morelet (Test. Nov. I) appears to be prior as regards date of publication of the name, as his paper bears the date Feb. 15, 1849. However, *H. vernalis,* like so many of the names in the Test. Nov., is only recognizable because later redescribed and figured, so it seems best to retain Pfeiffer's name. The same is true of *H. amoena* Pfr. and *H. purpureoflava* Morelet, and of *H. oweniana* Pfr. and *H. coccinostoma* Mo.

Lucidella (Poenia) lirata (Pfeiffer) (1847).—Eighty-one specimens in and at edge of pools, on ground, in lowland jungle (H, 1, a, or H, v, a). This species appears almost semi-aquatic, and is often found together with aestivating Pisidium, Planorbis, etc.

AMNICOLIDAE

Amnicola guatemalensis Crosse and Fischer.—Very numerous, under bits of lava and pumice, on the north shore of Lake Catemaco, and also on the opposite side of the lake, in shallow water near a sulphur spring (H, vii, d). These specimens are narrowly imperforate to almost rimate. The original description does not mention the microscopic, raised, spiral lines; these are not very evident on the adults, but are very noticeable in the young specimens. The operculum is thin, corneous, and from dark brown to almost black in color. It is three-quarters spiral, with evident, raised ridges parallel to the growth-lines. The radula is shown in figure 5. In certain lights, the outer tooth may be seen to be striated longitudinally for almost its entire length.

Potamopyrgus coronatus (Pfeiffer).—A single specimen from the Laguna de Chacalapa, a large savannah pond (H, vi).

AMPULLARIIDAE

Ampullaria flagellata Say (1827).

A. malleata Jonas (1844).
A. malleata, var. *exculpta* C. and F. (1890).
A. malleata, var. *arata* C. and F. (1890).

Twenty specimens. Some of the shells from the larger forest pools near La Laja (H, v, a) are quite typical of what is often cited as *A. malleata* Jonas. *A. flagellata* represents a shell with a slightly more flaring lip than is general, but is not, I believe, even subspecificly distinct. Two of the shells are close to the figures of *arata*—i. e., they practically lack the malleation. The term *exculpta* appears to include the more malleated forms and does not appear even racially distinct. All of the shells in this lot are rather small; the largest measure:

Altitude	Greatest diameter	Height aperture	Diameter aperture
50 mm.	87 (43.5 mm.)	71 (35.7 mm.)	52 (25.8 mm.)
47.5 mm.	88 (41.7 mm.)	76 (36.1 mm.)	57 (26.7 mm.)

The jaw-plates and the radula (fig. 6) are almost identical with those of *A. flagellata belizensis* C. and F., as figured by the authors (1890), although their figure of the jaw, in particular, appears slightly idealized. Especially noteworthy are the small size and sharpness of the cusps of the central tooth and the broad and markedly double base of the second lateral. The latter is represented from a slightly different viewpoint in C. and F.'s figure of *belizensis*. In a few of the central teeth of the three specimens examined the first of the lateral cusps was double, and in many the outer cusp was double, so that in a few cases as many as 11 cusps were found on a single tooth. A single inner lateral, in which the inner of the two small, outer cusps was divided, was also noted, while there was a quite constant tendency for a third cusp to be differentiated from the cutting edge outside of the other two.

Ampullaria flagellata, subspecies *erogata* Crosse and Fischer (1890).—Thirty specimens. Ampullaria seems to have a peculiar ability to mature at almost any size. In places where the shells are abundant, specimens two centimeters in length have been seen in copulation. This was also noted in a Venezuelan species. These small shells may or may not assume the adult characters, so that those that do have a thickened peristome and a quite different shape from those that do not. These small specimens are never markedly malleate, as the malleation is not well developed except in the older shells.

The shells from the smaller, more temporary pools, especially from those in the burnt-over areas (H, V, b), appear never to reach a large size, and thus form a quite well-marked, ecological subspecies, which appears to fit the description of *A. erogata* Crosse and Fischer very well. *A. cerasum* Hanley is not very different, and may be a similar form, perhaps of another species. Examples of *A. f. erogata* measure:

Altitude	Greatest diameter	Height aperture	Diameter aperture
32.2 mm.	91 (29.3 mm.)	72 (24.8 mm.)	53 (17.1 mm.)
24.6 mm.	91 (22.4 mm.)	78 (19.2 mm.)	52 (12.8 mm.)

Ampullaria patula Reeve (1856),[1] **catemacensis,** new subspecies

Figs. 2, 3, 4 and 7

Twenty-five specimens from Lake Catemaco (H, vii, d).

Shell thin, translucent, rimate; ground-color yellowish to olive-green or dark brown (rich amber by transmitted light), with 25 to 40 darker brown, spiral bands or lines of varying widths, sometimes with a broadish band of creamy yellow just below suture; surface marked with fine growth-wrinkles, crossed by regularly spaced, delicate, more or less beaded wrinkles, 2 to 3 mm. apart, and by microscopic, wavy ridgelets, so as to give the shell a beaded appearance under the lens; spire very low (somewhat eroded and pitted at very tip); whorls 4 or 5, rapidly expanding, more or less flattened above, each with the sutural edge sloping up over the preceding whorl so as to give, with the sharply marked, somewhat undulate suture, the impression of being flattened over it; last whorl greatly inflated, so as often to about equal in diameter, as viewed from above, all of the others combined; aperture very large; peristome slightly thickened within, but with edge

[1] Dr. Bryant Walker, to whom I sent the accompanying figures of this form, writes: "Your figure certainly looks very much like Reeve's *patula*. Curiously enough, Sowerby in his recent revision of Ampullaria (*Pr. Mal. Soc.*, VIII, p. 345) seems to have omitted any reference to it. I have four lots in the collection labelled '*patula*.' One from the Amazon has got misplaced and I have not been able to find it. The other three evidently belong to the same species, whatever it may be. One lot from 'Brazil' are dealer's specimens, and I know nothing of their history. The other two came from New Granada. They come from Rolle. The 'typical' form is banded and has the interior dark brown, but the aperture is not so expanded as in your shells, and the apex is higher than in Reeve's figure. The largest specimen measures 30.5 x 25 mm.; tip of apex eroded."

sharp, often somewhat expanded externally; columellar margin whitish to orange in color, and reflected so as to further close the umbilicus; inside of aperture infuscate with chestnut, darker towards edge, with the bands showing through, and with the upper portion lighter and often whitish near the suture. Operculum (figs. 3 and 4) horny, thin, pear-shaped, dark-brown in color (smoky amber by transmitted light), and considerably smaller than aperture; outside concave, dull and marked by growth-lines externad to the submarginal nucleus, or even laminating into thin layers at the edges; internal margin sigmoid with vertical, crescentic boss above the nucleus; inner surface with fine, radiate, subspiral striations; muscle-scar dull and of same shape as operculum, not extending internad to nucleus; extranuclear portion with smooth, shiny deposit, which often obscures the radial lines.

Shell very variable in shape; some specimens are not shouldered but globose, with the last whorl descending, so as to raise the spire considerably above the aperture, the latter not greatly expanded. Two color-forms were obtained, as indicated above. One has the ground-color light olive-green, shading to creamy yellow near the suture; the other has it chestnut-brown, shading to smoky golden near the suture. The first form was obtained from the shores of a rocky island in the main lake, the second in a small but very deep body of water in a subsidiary crater-cone, with the water surface about 100 feet in diameter. This small body of water was separated from the main lake by a rock ridge about 60 feet high and 300 feet wide. More variation in shape was apparent in the small number obtained of the first form. The type (fig. 4) belongs to the second form.

This is a very distinct shell for an Ampullaria, although it appears to belong to the *A. ghiesbrechtii* group. In the

Wheatley Collection, at the A. N. S. P., are two shells labeled *A. patula* Reeve, Mexico, which are smaller specimens of the brown color-form. The original description and figure of Reeve fits quite well the light color-form, but none of my specimens are completely imperforate, although the young specimens are more nearly imperforate than the larger ones. This subspecies appears to be a considerately larger shell than Reeve's *patula*. One young specimen is of about the same size, but is quite different in shape, as shown in the table of dimensions.

	Altitude	Greatest diameter	Height aperture	Diameter aperture	
Patula	30	98(29.5)	83(25.0)	62(18.5)[1]	
Catemacensis					
Young	36.5	88(32)	82(30)	58(21)	
Fig. 2	44.0	102(45)	89(39)	69(30.5)	(type)
	51.5	91(47)	77(39.5)	56(29)	(not shouldered)
	42	98(41)	91(38)	64(27)	
Mean	44.5	95	84	62	(24 adults)
Extremes	40–51.5	91–102	77–91	56–69	

The jaw-plates of this form are quite like those of *A. flagellata* or of *A. flagellata belizensis,* although none of my specimens were as regular nor had as well-defined cutting edges as those shown in the figure of F. and C. (1890). The radula of *A. patula catemacensis* (fig. 8) is very similar, but shows minor and apparently quite constant differences (5 radulae examined). The middle cusp of the central tooth is much larger and is not so sharp and angular; the lateral cusps are also larger and better defined, and are spatulate in shape, while those of *flagellata* are more nearly triangular. These lateral cusps do not appear to have the tendency to split up into smaller cusps, as noted under the latter species. The first

[1] The original description gives no dimensions; these taken from figure.

lateral differs in much the same manner as does the central; like *A. flagellata,* three ectoconic cusps are often present. The second lateral (or first marginal) is more slender, is ligulate in shape, and is not double at the base, although there is a thinner portion (uncalcified?) extending laterad from the main, thickened portion. The outer tooth is also more slender and the base is not so enlarged as in *flagellata.*

APEROSTOMIDAE

Aperostoma dysoni (Pfeiffer).—Eighteen specimens: from the burnt-over area (H, II, b, dead shells); and from leaf-humus in the lowland jungles (H, I, a). The largest specimen measures: altitude, 15.8 mm.; greatest diameter, 129 (19.1 mm.); height aperture, 69 (11.0 mm.); diameter aperture, 65 (10.2 mm.).

The radula and jaw-plates of this species were examined; they have been figured by Crosse and Fischer (1888, 1890). They also figure what they term "elements" in both this species and in *Tomocyclus simulacrum.* In my specimens, these "elements" look as if they were the cells, or that each one was the product of a single cell, and they are not regular in size throughout the plate. Toward the edge they are longer, and are lanceolate to long trapezoidal in shape, while toward the center they are more nearly square or, more often, polygonal. The arrangement of these elements causes the apparent striations, seen under low magnification; this loses its regularity when examined closely.

Cyrtotoma mexicanum salleanum (von Martens) (1865).—Eleven adults and 6 young shells from under leaves in humus in the lowland forests (H, I, a). These shells are quite typical of *salleanum* (fig. 9), which apparently is the more general form of the species in the favorable, damp habitats, as will be discussed more fully under the form *mexicanum.* These specimens are yellowish horn-colored, shading into amber toward the tip. The growth-wrinkles are very regularly and evenly spaced. The following extremes show the variation in size of the adults:

	Altitude	Greatest diameter	Height aperture	Diameter aperture
Fig. 9	14.5	138 (20)	72 (10.5)	66 (10.5)
Largest	16.5	152 (25)	64 (10.5)	61 (10.0)

The jaw-plates of this species are practically the same as those of *Aperostoma dysoni* (Pfr.). The radula (fig. 8) is also quite similar, but differs in several minor particulars. The central tooth in *C. mexicanum* is more elongate and the cusps tend to be somewhat more rounded than in the latter species. The outer cusp of the second lateral is almost vertical and faces inward. In the ordinary position of the tooth it appears as simply a blunt, vertical projection on the outer margin of the tooth, but when seen in profile it appears more prominent than in *A. dysoni,* and projects out almost at right angles to the remainder of the cusps. The outer tooth has three cusps, as in *A. dysoni,* but lacks the attenuate point in the lower corner. In both *A. dysoni* and the present species there is not a definite base to this last tooth, as might be judged from Crosse and Fischer's figure, but the entire tooth forms a plate with three cusps on the inner side. The inner and central cusps curve inward and down, but the large, triangular, basal cusp faces directly inward. The tooth appears to be attached to the basal membrane by its outer edge.

Cyrtotoma mexicanum mexicanum (Menke) (1830).—One adult (dead shell) from the burnt-over region (H, II, b), and 6 adults and 2 young specimens from the strip of jungle along the upper portion of La Laja. These last woods are about intermediate in type between the lowland forests (H, I, a) and the savannah forests (H, III, a).

This set of specimens presents evidence that *mexicanum* and *salleanum* are ecological growth-forms of the same thing. According to von Martens (1890), the only trustworthy distinctions between the two are the larger size of *salleanum* and the peristome. He describes the latter as follows: "lower lobe of the columellar margin beneath the deep notch is always free in *C. mexicanum* and soldered to the penultimate whorl in *C. salleanum;* this seems to be a constant character."

The newly formed peristome of this species is smooth on its outer surface and is usually regularly attached to the body whorl, although some specimens (for example, F. and C., *l. c.*, pl. xxxv, 4; also specimens in the A. N. S. P.) apparently have a slight scalariform tendency. Under the most equable conditions of the environment, this condition of the peristome is apparently retained; so that in the lowland forests all of the specimens are quite typical of *salleanum* (fig. 9). However, the size cannot be used as a specific character; although the specimens of *salleanum* tend to be somewhat larger, the smallest specimen obtained (20 mm. in diameter) belongs to this form.

The differentiation of *C. mexicanum mexicanum* from this type is apparent in the specimens from along La Laja. In these drier habitats there appears to exist a tendency to produce the reflected peristome when smaller in size (younger?). Probably on acount of the repeated periods of aestivation, additional layers of material are secreted over the outside of the peristome, as shown in the figures (figs. 10, 11 and 12). These additional layers are most extensive on the palatal and basal portions and tend to widen the peristome as well as increase its thickness (fig. 10). On the columellar margin, the added layers fail to attach themselves to the penultimate whorl (fig. 11), so that finally the typical *mexicanum* is formed (fig. 12), in which the lower lobe of the columellar margin is not adnate to the body whorl. If this process should be continued long enough, I have no doubt it would result in the complete freedom of the peristomal margin.

The shells of the form *mexicanum* are more variable in appearance than are those of *salleanum*. The growth-wrinkles of the former are quite irregular, and the epidermis is usually eroded toward the tip, which may be somewhat chalky in appearance. Specimens measure:

	Altitude	Greatest diameter	Height aperture	Diameter aperture
Smallest	14.5	145 (21)	66 (9.5)	69 (10)
Fig. 10	17.0	135 (23)	65 (11)	65 (11)
Fig. 11	15.0	149 (23)	65 (10)	68 (10.5)
Fig. 12	15.0	150 (22.5)	67 (10)	70 (10.5)

Part III. Zonitidae and Helicidae

ZONITIDAE

Guppya gundlachi (Pfeiffer) (1840).—One hundred three specimens; on ground among humus and decaying leaves in the lowland forests (H, I, a); and a few feet above ground, on young palms in the lowland forests (H, I, b); on elephant-ears along Arroyo Hueyapam (H, II, a), and on cacti in the savannah brush (H, III, b). Apparently, it is a ground species, which moves up into the lower vegetation in the wet season.

As the dried animals were still in some of the shells, two preparations of the jaw and radula were made and examined. The jaw (fig. 3) is quite similar in structure to that of Euconulus, but has a more nearly semicircular outline. The formula of the radula (fig. 1) may be expressed:

$$C\frac{1}{3};\ L\frac{5}{3};\ M\frac{24}{3}+\frac{2}{4}+\frac{1}{1};\ \text{or } 27\text{-}5\text{-}1\text{-}5\text{-}27.$$

The central has broader and shorter cusps than Euconulus. The first four laterals are practically the same shape as the central; in fact, I could not determine which was the central until after counting the laterals. The fifth lateral is turned considerably inward, and is almost completely hidden by the distal end of the first marginal. The break to the marginals is a sharp one, and shows as a raised edge, even under low magnification. The well-developed marginals are all tricuspid and point obliquely inward, and the transverse row itself also slopes obliquely backward (i. e., in the direction towards which the cusps point). As the inner cusp of each marginal overlaps, to a certain extent, the outer one of the preceding tooth, it is sometimes difficult to make out more than 2 cusps, which probably accounts for Binney's statement that only a portion of the marginals are tricuspid. The lenses in his time were considerably inferior to the modern oil-immersion objective. Amongst the outer reduced teeth, the thirtieth and thirty-first have four cusps each, while the outermost is a mere denticle, and is lacking in some of the transverse rows.

For comparison, the jaw and radula (fig. 2) of *Guppya sterkii* (Dall)[1] was also examined. This species, as Vanatta (1920) has already pointed out, has a similar dentition to that of *G. gundlachi,* only the radular ribbon is so minute as not to fill the field of the oil-immersion objective. The central tooth, for instance, is only about 4 microns (.004 mm.) in width. The formula is approximately: $C\frac{1}{3}; L\frac{5}{3}; M\frac{13\text{–}15}{3}$. The number of cusps out to the ninth marginal was determined, but their shape on this tooth could not be made out very accurately, as the ends of the cusps are smaller than the limit of possible microscopic vision, and so could only be detected as

[1] Dried animals; A. N. S. P. No. 46177; collected at the Clydesdale Brick and Stone Company Farm, Beaver County, near Elwood City, Pa., by J. B. Clark.

points of light. For the same reason, the number of cusps on the outermost marginals, and perhaps the exact number of the teeth themselves, is indeterminable without resort to ultra-microscopic methods. On the first radula, in which the basal membrane disintegrated while under examination, so that the teeth spread out quite evenly in all directions, I thought I could count 15 marginals, in the other but 13. All of the inner teeth are quite of the same shape as those of *G. gundlachi.* The jaw is also very similar in the two species, but that of *G. sterkii* is even more nearly semicircular in outline.

Guppya gundlachi, subspecies *orosciana* von Martens (1892).—Two specimens, found in humus among rocks near Laguna de Catemaco. This mountain subspecies agrees with typical *gundlachi* in the prominence of the spiral lines and in general shape, but differs in the marked carination of the last whorl. However, specimens with a distinct angulation were also found in the lowlands (H, I, a) among those with more rounded whorls.

Guppya (Habroconus) trochulina (Mo.) (1851).

Helix selenkai Pfeiffer (1866).

Thirty-four specimens; adults on leaves of palms and trees, in lowland forests (H, I, b) and in savannah forests (H, III, b); juvenile specimens from elephant-ears along Arroyo Hueyapam (H, II, a); and one dead specimen from humus amongst rocks near Laguna de Catemaco. An arboreal species found with Helicina, Drymaeus, and Oxystyla.

The jaw (fig. 5) and radula of this form were also examined from two dried animals. The jaw is very similar to that of the general group. The formula of the radula (fig. 4) is:

$$C\frac{1}{3};\ L\frac{11}{3};\ M\frac{18}{2}+\frac{19}{3}+\frac{8\text{–}9}{4}+\frac{0\text{–}2}{1};$$

or (48, 45)–11–1–11–(48, 45). The proximal portion of the reflected edge of the central is particularly elongate, and the mesocone is also slender and lanceolate. The first lateral is turned slightly inward and the entocone has moved up on the outside of the mesocone. Both of these characters increase in prominence through the series of laterals, until in the eleventh tooth the entocone is very small and is high up on the outside of the mesocone. This tooth is shaped very much like what may be termed the first marginal, only the latter is bicuspid. The first 18 marginals are bicuspid, and arranged in an almost horizontal row. The individual teeth (No. 21 is typical) are not so obliquely placed as are the tricuspids of *G. gundlachi,* or those of this species. The thirtieth tooth shows a minute, additional cusp outside of the others, and is the first of 19 tricuspids. With these, the transverse row begins to curve obliquely backward. These tricuspid teeth are even larger and better developed than are the bicuspids. With the reduction in size of the outermost teeth comes an additional cusp on the forty-ninth, which is the first of 8 or 9 quadricuspids of rapidly reducing size. The two outer denticles, which are often absent (even in adjacent rows in the body of the radula this much variation was noticed), are practically cuspless.

Euconulus (?) *pittieri* (von Martens) (1892).—One dead specimen from humus among rocks, near the Laguna de Catemaco. This specimen agrees very well with the original description. It differs from *E. elegantulus* by the marked carination of the whorls, the more conical shape, the greater prominence of its radial wrinkles, which extend to within one whorl of the apex and which, in regularity and prominence, are somewhat reminiscent of Strobilops, and the coincident relative obscurity of the spiral striations, which, however, are quite noticeable on the lower side. It differs from *G. gundlachi* *orosciana* by its greater altitude and by the character of the sculpture, as just described.

Euconulus elegantulus (Pilsbry) (1919).—Two hundred twenty-eight specimens; on ground in lowland forests (H, I, a) and savannah brush (H, III, a); the most abundant species on the elephant-ears along Arroyo Hueyapam (H, II, a); and on leaves of low vegetation in the lowland forests (H, I, b). Apparently a ground species, which moves up into the lower vegetation, somewhat more so than does *Guppya gundlachi*, but not truly arboreal in habits, as is *G. trochulina*.

The jaw and radula (fig. 6) of two dried specimens of this species were also examined. The jaw is very similar to that of *E. fulvus*. The formula of the radula is:

$$C\frac{1}{3};\ L\frac{9}{3};\ M\frac{26}{2}+\frac{2}{3}+\frac{3\text{–}4}{4}+\frac{0\text{–}1}{1};$$

or (31, 33)–9–1–9–(31, 33). The central has the reflected plate shorter distally than in *G. trochulina*, but the cusps are longer, so that the whole tooth appears equally elongate. The laterals differ in the same manner, but go through similar changes to those in the latter species, and the break between the last tricuspid tooth and the first bicuspid is but little more marked. The main difference between the two species lies in the fact that all of the well-developed marginals are bicuspid in *E. elegantulus*, and the rows are more nearly horizontal than in *G. trochulina*. Two tricuspids and 3 or 4 quadricuspids occur among the reduced teeth at the outer end.

For comparison with this species, the radula of *Euconulus fulvus* (Müller) was re-examined.[1] The shape of the teeth, as very well shown in Taylor's reproduction (1908) of Schep-

[1] Two large specimens; A. N. S. P. No. 87302; collected at Buckfield, Oxford County, Me., by J. A. Allen.

mann's figure, are practically identical with those of *E. elegantulus*. The maximum formula is:

$$C\frac{1}{3};\ L\frac{10}{3};\ M\frac{20}{2}+\frac{4}{3}+\frac{3}{4}+\frac{1}{1};\ \text{or } 28\text{–}10\text{–}1\text{–}10\text{–}28.$$

The count for the laterals was the same for the two specimens examined, but the marginals were determined in only one, as the other curled under at the edges. The divergence between the descriptions of various writers depend probably in part on the inconspicuousness of the entocone on the laterals (in the tenth it appears as simply a point of light high up on the mesocone) and the difficulty in counting the extreme marginals, especially as the edges have a tendency to curl under. The outer denticles also vary in numbers; I have found differences of two teeth in adjacent rows. All of the well-developed marginals are bicuspid as in *E. elegantulus*.

Among others that need not be discussed here, the following group names have been applied to our American species of this general group:

Stenopus Guilding (1828), not of Latreille (1825).

Conulus Fitzinger (1833), not of Rafinesque (1814).

Guppya Moerch (1867). Type *Conulus vaccus* "Guppy" Moerch (1867), obviously a misprint for *Conulus vacans* Guppy (1866).

Habroconus Crosse and Fischer (1872). Type *Helix selenkai* Pfr. (1866).

Euconulus Reinhard (1883). Type *Helix fulva* Müller (1774).

Discoconulus Reinhard (1883). No type given, but *H. gundlachi* Prf. is mentioned as an example.

Ernstia Jousseaume (1889). Type *Ernstia ernsti* Jouss. (1889).

Spiroconulus von Martens (1892). Type *H. gundlachi* Pfr. (1840).

Conulus vacans Guppy, from Trinidad, is thus the type of the first usable name, Guppya. It is a form which is apparently closely related to *Guppya gundlachi,* but is somewhat larger. Young (?) specimens from Venezuela (Tate, collector) in the A. N. S. P., labeled as *vacans,* are very close to *gundlachi,* but have somewhat coarser whorls. These specimens have 3½ whorls with practically the same diameter as adult *G. gundlachi* with 5 whorls. Guppy (1866) describes the caudal projection, the marked spiral striation, and the radula.

The description of the last is: "Lingual teeth about 30.5.0. 5.30, broad, subequal, central obsolete; first five laterals symmetrical with a large rounded cusp having a smaller cusp of similar shape on each side; outer laterals bicuspid, resembling the teeth of Testacellus." His supposition that the central is obsolete is doubtless due to the difficulty of its identification. The description of the laterals agrees with those of *G. gundlachi.* Due to the overlapping of the marginals, as already pointed out, these would appear bicuspid under the microscope available in 1866.

Spiroconulus von Martens, type *G. gundlachi,* thus becomes a synonym of Guppya, which is not Guppya s. s. of von Martens (1892). According to Pilsbry (1910), Ernstia is also a synonym. From the shell characters of the specimens I have seen, I think it likely that *G. biolleyi* von Martens (1892) will also be found to belong in Guppya.

Helix selenkai is a synonym of *Helix trochulina* Morelet (1851), so the species of which the radula has just been described may be considered as typical of Habroconus, which is used here as a subgenus of Guppya. From the shell characters, *Guppya championi* von Martens, *G. browni* Pilsbry, and *G. costaricana* Pilsbry, with the variety *elatior* Pilsbry, appear to belong in this group. All of these species are large shells with weak spiral and radial striation and rather rapidly increasing whorls.

On the basis of the radula alone, Euconulus would certainly become a subgenus of Habroconus, and the latter would be separated genericly from Guppya. However, Crosse and Fischer (1872) remark: "After M. Bland (in letter), it follows from a verbal communication made to him by Dr. Berendt, who had occasion to examine in living state *Helix selenkai,* that that mollusc possesses, at the posterior extremity, a mucous pore quite (*tout á fait*) close to that of Stenopus" (translation). This appears to indicate a closer affinity with Guppya, although Euconulus also has a mucous pore.

In addition, Euconulus is a Holarctic genus, and in general the American forms decrease in size towards the south. (From the shell characters, I think it probable that *G. micans* Pilsbry and *G. jalisco* Pilsbry also will be found to belong in Euconulus.) Guppya, on the other hand, is a neotropical genus, whose forms (for example, *G. vacans, G. gundlachi* and *G. sterkii*) tend to decrease in size toward the north—that is, in the opposite direction. This appears to indicate a northern center of origin for Euconulus and a southern one for Guppya. *Habroconus* only has, as far as known, neotropical species, which are larger than any of the American forms of Euconulus.

For these reasons, Habroconus is tentatively used here as a subgenus of Guppya, while the more familiar Euconulus is retained as a genus to include the conical forms with better developed radial striations, and with all of the well-developed marginals bicuspid. From the shell-characters, I rather doubt if the acutely carinate species with practically no spiral striations (example *G. calverti* Pilsbry) will be found to belong to any of these groups in its strict sense.

In the radulae examined of these three groups, Guppya, Habroconus, and Euconulus, three more or less distinct tendencies or trends seem to be present.

1. A tendency for all of the teeth to become elongate and for the outer teeth to turn inward and to lose the ectones. The marginals of all three groups have lost the ectones, but the central and laterals of Guppya s. s. have not been affected to any great extent. Both the centrals and the laterals of the other two groups are elongated, although in Habroconus this is accomplished by the increase in size of the distal portion of the reflected edge, while in Euconulus the cusps themselves have been lengthened to a greater degree. The laterals of both of the last two groups show a progressive tendency, from the center out, for the ectocones to move up on the outside of the mesocones and finally to diminish in size.

2. A tendency for the ectocones to be reduced in numbers. This has not affected Guppya s. s. as much as the others, as all of the marginals have at least two ectocones. Half of the well-developed marginals of Habroconus still retain two ectocones, while none of the large marginals of Euconulus have more than one. The bicuspid teeth tend to move back into a less oblique position than that of the tricuspid. This tendency towards reduction of the number of cusps on the marginals is carried still further in such genera as Zonitoides, where the definitive marginals are mostly unicuspid.

3. A separate tendency, at least somewhat coincident with size, to reduce the number of teeth in the transverse rows. Thus, the largest species, *G. trochulina,* has about 119, *E. fulvus* about 77, *E. elegantulus* about 85, *G. gundlachi* 65, and *G. sterkii* 41. Up to a certain point, this appears to go on more

or less equably throughout the radula, and probably accounts, in part, for the lack of transitional teeth between the laterals and marginals in both species of Guppya s. s.

Zonitoides (*Pseudohyalina*) *minuscula* (Binney).—Eight specimens from humus, and on the underside of leaves and bits of bark on the ground, in the lowland (H, I, a) and the savannah (H, III, a) forests.

HELICIDAE

Thysanophora plagioptycha (Shuttleworth).—Eight specimens from leaves and humus in the lowland forests (H, I, a).

Thysanophora pilsbryi, new species

Figs. 11, 12, 13, 14

One specimen from humus in the lowland forest along La Laja (H, I, a).

Shell minute, depressed, whitish horn-colored; whorls 3¼, gradually increasing in size; last whorl descending slightly, so that the upper edge of the aperture is at about one-half the height of the preceding whorl; margin of aperture simple, thin, and almost circular in outline as far as complete; suture well marked, impressed; greatest diameter of whorls considerably above middle; umbilicus large, almost one-third the diameter of the shell, and showing all of the whorls; sculpture of shell consisting of equally spaced, quite regular, delicate riblets, which run parallel with the growth-lines, extend to within one-quarter of a whorl from the apex, and are highest on the upper side of the shell; entire surface of the shell, as far as could be made out, also covered with delicate striatulations, which cross each other at right angles, but cross the growth-lines at oblique angles, and form minute but extremely regular squares 4 microns (.004 mm.) across. This minute sculpture is regular and uniform in spacing from near the apex to the edge of the last whorl (fig. 11). Measurements: altitude, .71 mm.;

greatest diameter, 1.30 mm.; lesser diameter, 1.19 mm.; height aperture, .47 mm.; width of aperture, .47 mm.; greatest diameter of umbilicus, .43 mm.

This minute species appears from its shell characters to be most closely related to *Thysanophora tatei* Pilsbry, and so belongs within the limits of the genus as at present constituted. It differs from that species by its much smaller size, by the gradually increasing whorls, and by its fine and regular striatulations. Under high magnification (700 diameters) all shells show some structure, which is perhaps caused by the edges of the crystals of which it is composed, but these are the most regular that I have ever examined. They are very much more regular and delicate than those of the Striatura-group of the Zonitidae.

In order to differentiate this species more exactly, and to show its relations to the other Mexican and Central American forms, the following key is presented, which includes all of the species usually placed in Thysanophora, which have been listed from that district. I have examined under rather high magnification (at least 250 diameters) all of the forms included, with the exception of *H. guatemalensis* C. and F. and *T. turbinella* (Mo.). The position of these two forms in this key is doubtful, as their descriptions do not accurately describe the shell sculpture.

A. Apical whorls spirally striate, without definite markings (Radiodiscus?). 1.84; 63; 3½.[1] *coloba* Pilsbry

AA. Apical whorls with irregular punctations, somewhat radially arranged. Lower whorls also with irregular punctations, with

[1] The numbers for each species indicate in the order given: first, the greatest diameter in millimeters; second, the height-index in percentages, which is taken as the height divided by the greatest diameter; and last the number of whorls. The greatest diameter is taken as a basis for the index, as this dimension is usually most accurately determined in small species.

tendency to be arranged in diamond-shaped patterns; and with regularly spaced, much larger, papilla-like bosses, arranged in a definite pattern so as to form rows more oblique than the growth-lines and also rows less oblique. Large shell with concave apex. 19: 48; 4. *sigmoides* (Mo.) (*vitrinoides* Trm.)

AAA. Apical whorls with cuticular riblets, more oblique than, and crossing, the growth-lines.

B. Oblique, cuticular riblets over entire shell.

C. Whorls rounded.

D. Most elevated forms; cuticular riblets tend to die out on body whorl. 2.5; 112; 5. *rhoadsi* Pilsbry

DD. Not quite so elevated; about as high as wide.

E. Umbilicus minute, rimate; suture less deeply impressed. 3; 100; 4.
caecoides (Tate) (*granum* Strebel, *guatemalensis* C. and F.)

EE. Umbilicus larger (10-11 in diameter); suture more deeply impressed. 2.8; 100; 4½. *plagioptycha* (Shuttleworth)

DDD. More depressed species; umbilicus larger (less than 7 times in diameter.

F. Smallest species: 2.55; 84; 4.
fuscula (C. B. A.) (*fischeri* Pils.)

FF. Larger: 3.7; 76; 4½. *proxima* Pilsbry

FFF. Largest: 4.6; 83; 4¾. *canalis* Pilsbry

CC. Conical shell; last whorl subangulate.

G. Larger: 5; 80; 5. *turbinella* (Morelet) ??

GG. Smaller: 4.5; 78; 5 *paleosa* (Strebel)

BB. Oblique riblets represented on last whorls by oblique rows of crescentic projections; shell discoid.
(*Thysanophora* s. s.) *conspurcatella* (Morelet)

AAAA. Apical whorls with wrinkles or riblets parallel to growth-lines.

H. Apical whorls also with rather indistinct spiral striations, which tend to give the radial wrinkles a beaded appearance.

I. Lower whorls with rather distant, long, hair-like processes, arranged so as to form a diamond-pattern with oblique rows crossing the growth-lines, both more and less obliquely.

K. Smaller and more elevated: 2; 90; 6. *intonsa* Pilsbry

KK. Larger and discoid: 4; 62; 4 *hornii* (Gabb)

II. Without hair-like processes, as far as observed.

L. Entire shell with fine, close-set and irregular, anastamosing, radial wrinkles or minute riblets; spiral striation less well marked.

M. Almost discoid in shape: 4; 62; 4. *hornii* (Gabb)

MM. More elevated spire: 4.5; 78; 5. *impura* (Pfr.)

LL. Entire shell with beaded appearance, a few of the radial folds may be developed into higher riblets.

N. Shell larger and more depressed.

O. 3; 83; 4 (type Microconus). *wilhelmi* (Pfr.)

OO. 3.4; 70; 4½. *cockerellae* Pilsbry

NN. Shell small; Pupisoma-like; texture like "fine woven material." 1.95; 100; 4¼. *textilis* Pilsbry

HH. Apical whorls without definite spiral striations, but with regularly spaced, smooth, well-developed riblets, parallel to growth-lines.

P. Larger species; slight tendency towards spiral striations. 3; 60; 3½. *tatei* Pilsbry (*blakeana* Tate)

PP. Small species; minute striations between ribs, which form oblique squares, 4 microns across. 1.3; 48; 3¼. *pilsbryi* n. sp.

Averellia (*Trichodiscina*) *coactiliata* (Ferussac) (1838).—Seven specimens; from leaves and bark of trees in lowland jungle (H, I, b). One of these specimens contained the dried remains of the animal, and from it the jaw and radula were obtained.

The arcuate jaw (fig. 9) bears 13 broad, low ribs, but is also striate so that the ribs appear rather irregular and indistinct. The radular formula (fig. 7) is:

$$C\frac{1}{1-3}; L\frac{9}{1}; M\frac{17}{3}+\frac{4}{4-5}+\frac{1}{1}; \text{or } 31-1-31.$$

The central and the inner nine laterals are functionally unicuspid, but the rather long and slender mesocone bears lateral expansions or wings on both sides, below the level of its cutting edge. In some of the centrals, each of these expansions has a rather blunt and very indistinct cusp, which is only visible under the oil-immersion objective. (On other centrals I was unable to detect these, and suspect that they are not always developed.) The expansions of the laterals are entire, except that in one or two cases the outer wing was apparently slightly angulate. A definite ectocone is developed on the tenth tooth, but the entocone remains vestigial out to about the twelfth. The teeth just beyond the tenth are more elongate and have shorter bases than any of the others. The remainder of the definitive teeth are tricuspid, but the outer ones are variable, and may have as high as 5 cusps. The thirty-first is a mere denticle.

Averellia (*Trichodiscina*) *suturalis* (Pfr.) (1846).—Two young specimens appear to be this species; one from the ground in the lowland jungles (H, I, a), the other under chips of bark on the ground in the savannah forests (H, III, a).

Averellia (**Miraverellia,** new subgenus) *sumichrasti* (Crosse and Fischer) (1872).—Five specimens: 1 adult, bleached shell from the burnt-over area (H, II, a); 1 specimen (almost adult) and a juvenile from under logs on the ground (H, II, a), and 2 juveniles from the bark of a tree (H, II, b) in the lowland jungle.

This is a flattened, subangulate species, with the last whorl sharply descending near the aperture, as in most species of this genus. As Crosse and Fischer have pointed out, the whole surface of the fresh specimens has low, but prominent, crescentic to lanceolate excrescences, which extend parallel to the growth-lines. These are interspersed with more numerous, minute, conical projections, so that the entire shell appears setose under the lens. This sculpture reaches to the apex, but is more minute on the apical whorls, so that they appear smooth, by contrast, to the naked eye. These projections superficially break the regularity of the growth-lines, so that the epidermis appears marked with anastamosing wrinkles, which give the shell much the appearance of some species of Thysanophora. In the bleached specimen the epidermis is gone and the growth-lines appear quite regularly parallel, but, under a lens, the larger excrescences can be made out as comparatively slight, local developments of the growth-wrinkles. My specimens appear to be slightly more flattened above the subangulate periphery than in those figured by Fischer and Crosse (1902). The largest specimen measures: altitude, 8.8 mm.; greater diameter, 200 (17.7 mm.); lesser diameter, 170 (14.9 mm.).

In the specimen that was almost adult the remains of the dried animal were found, and the jaw and radula were obtained. The jaw (fig. 10) is broadly arcuate, has a central superior angulation, and bears 11 low, broad, striate ribs. The cutting edge has a transparent border, which is apparently much thinner than the basal portion.

The radular formula (fig. 8) is:

$$C\frac{1}{3};\ L\frac{7}{3};\ M\frac{26}{3\text{–}5}+\frac{3}{4};\ \text{or } 36\text{–}1\text{–}36.$$

The central tooth is comparatively broader than in *A. coactiliata*, and is definitely tricuspid. The ectocone and entocone are borne rather near the tip of the mesocone, but are on the same level or slightly above it. The first 7 laterals are also definitely tricuspid. Beyond this, the teeth become more elongate, and the entocone is often bifid. Beyond the twenty-eighth tooth, the ectocone also is often double. The outermost teeth seen are short, very variable, and multicuspid. There may be a denticle or so beyond the outermost tooth detected, as the outer portion of the basal membrane was lost, due to trouble in mounting. Nevertheless, the vestigial character of the last teeth present show that they are very near the outer edge of the radula.

These differences in the sculpture of the shell and in the radula seem to warrant the separation of *H. sumichrasti* Crosse and Fischer (1872) as the monotype of a new subgenus, Miraverellia. The descriptions of the shell-sculpture and of the radula, given above, separate this group from Trichodiscina von Martens (1892), of which *H. coactiliata* Ferussac (1838) is the type. The radula of Averellia Ancey (1887), in the strict sense (type *H. macneili* Crosse, 1873), has not been examined, but this typical subgenus is separated distinctly from either of the others by the peculiar, lamella-like infoldings of the last whorl; the shell-sculpture is closer to that of Trichodiscina.

PLATES

The numbers of the figures are the same as used in the dimension tables in the text. The scale of each plate is shown on it, by means of a hair-line, which represents, in plates I–XIII, an actual length of one centimeter. In the other plates, the scale is indicated above each hair-line. All drawings were made with the aid of a camera lucida.

PLATE I

Elliptio and Actinonaias. Young and depauperate specimens.
Figures 1 and 2. *A. walkeri.* Young specimens.
Figure 3. *E. plexus distinctus;* juvenile.
Figures 4 and 5. *E. plexus;* depauperate race.
Figures 6 and 7. *E. liebmanni cuatotolapamensis;* young.

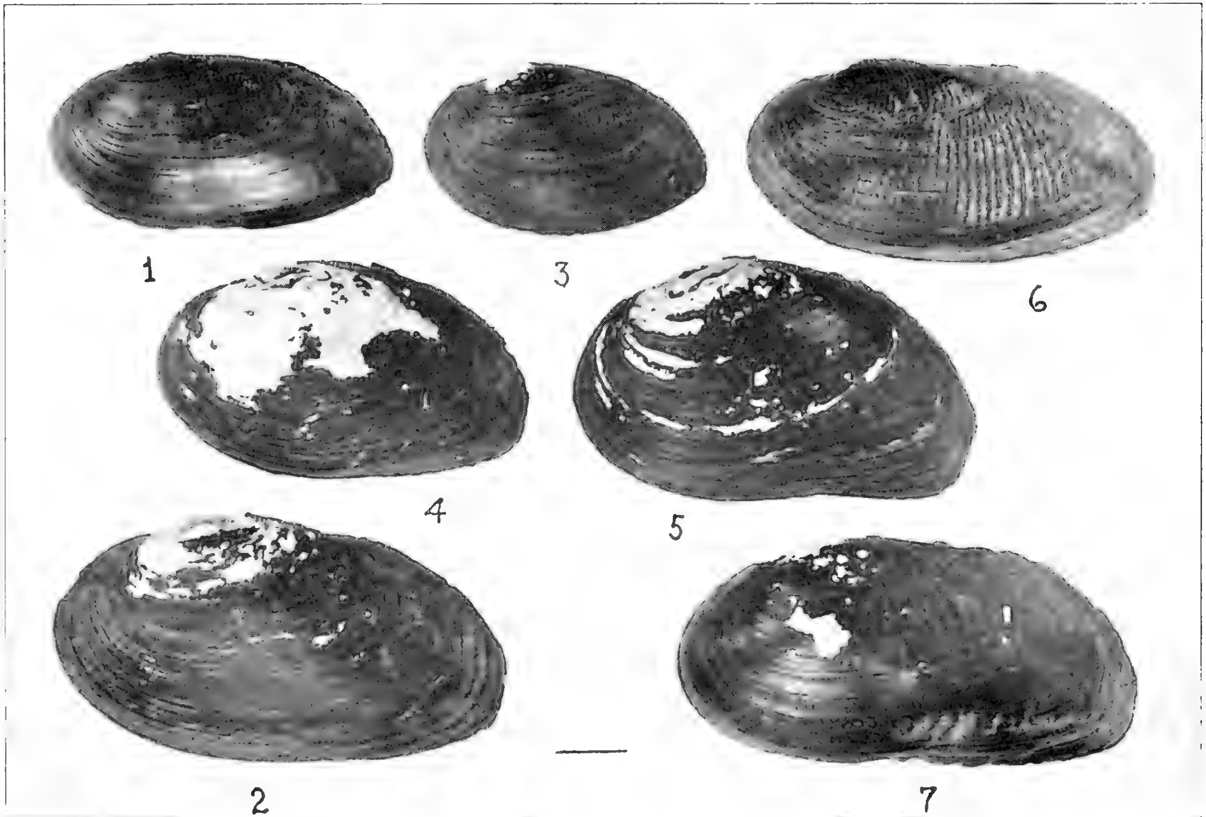
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PLATE II

Elliptio plexus distinctus. Variation

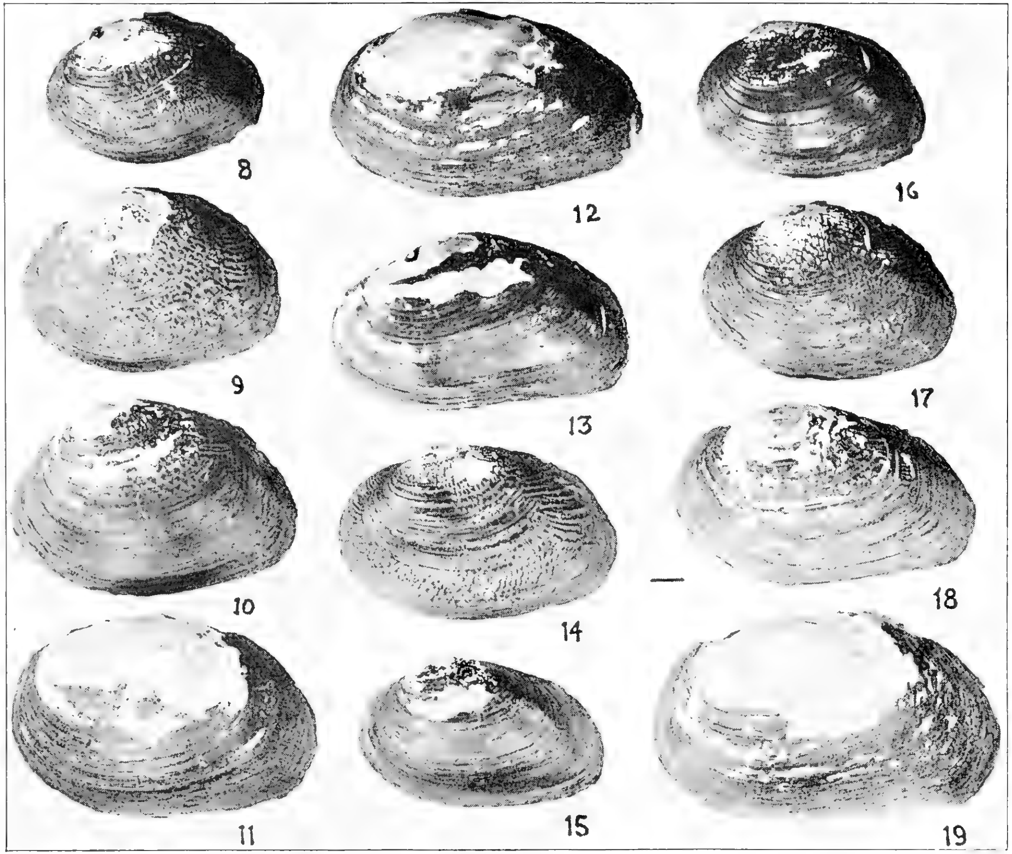
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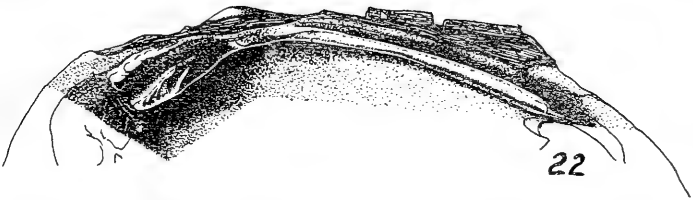
PLATE III

Elliptio. Hinge armature.

Figure 22. *E. liebmanni cuatotolapamensis.* Hinge armature of right valve of type (figure 22, plate IV).

Figure 15. *E. plexus distinctus.* Hinge armature of right valve of figure 15, plate II. Young shell.

Figure 11. *E. plexus distinctus.* Hinge armature of right valve of figure 11, plate II. Old shell.



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10 MM.

PLATE IV

E. liebmanni cuatotolapamensis. Variation.
Figure 22. Type specimen.

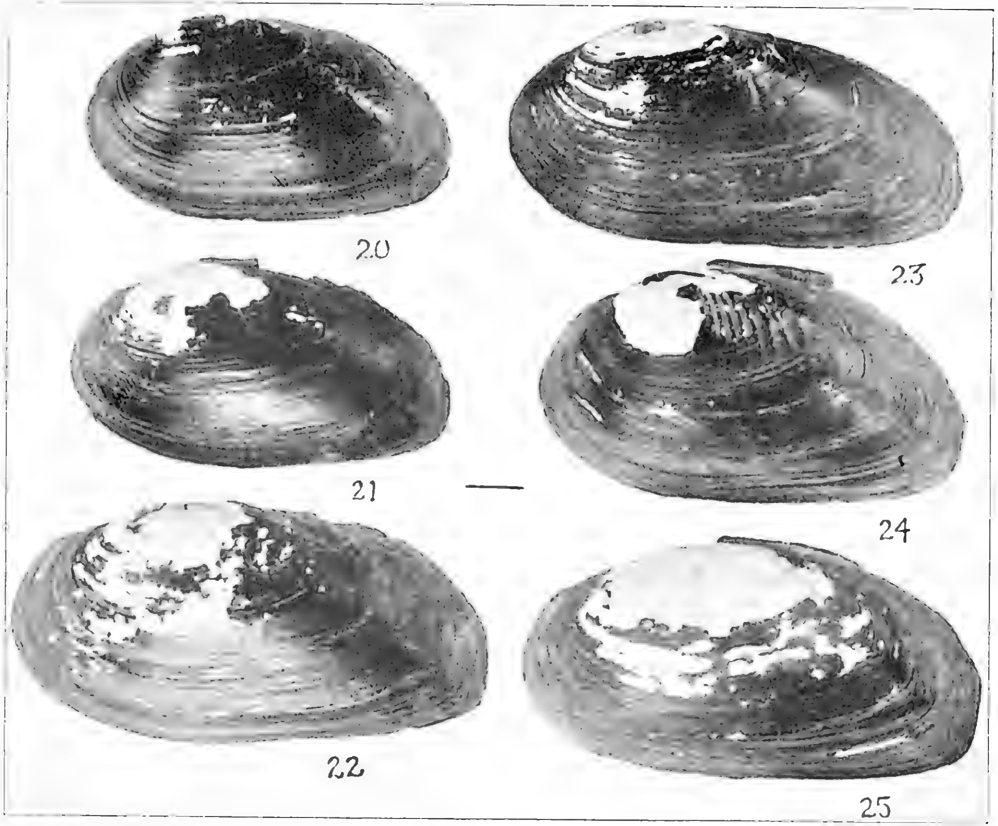
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PLATE V

Anodonta globosa nopalatensis.
Figure 26.

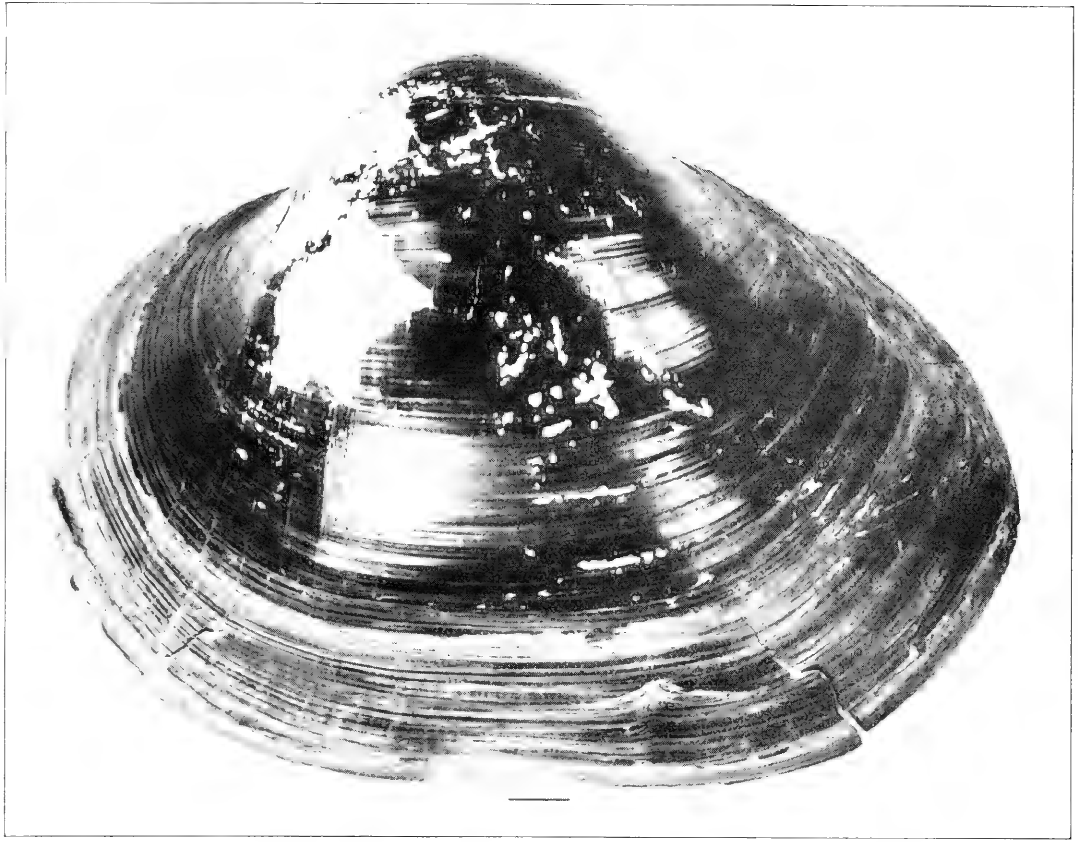

PLATE VI

Plagiola opacata. Male? (natural size).

Figure 35. Inner view of right valve, outer view of left valve, dorsal view, and hinge armature of left valve.

Plate VI

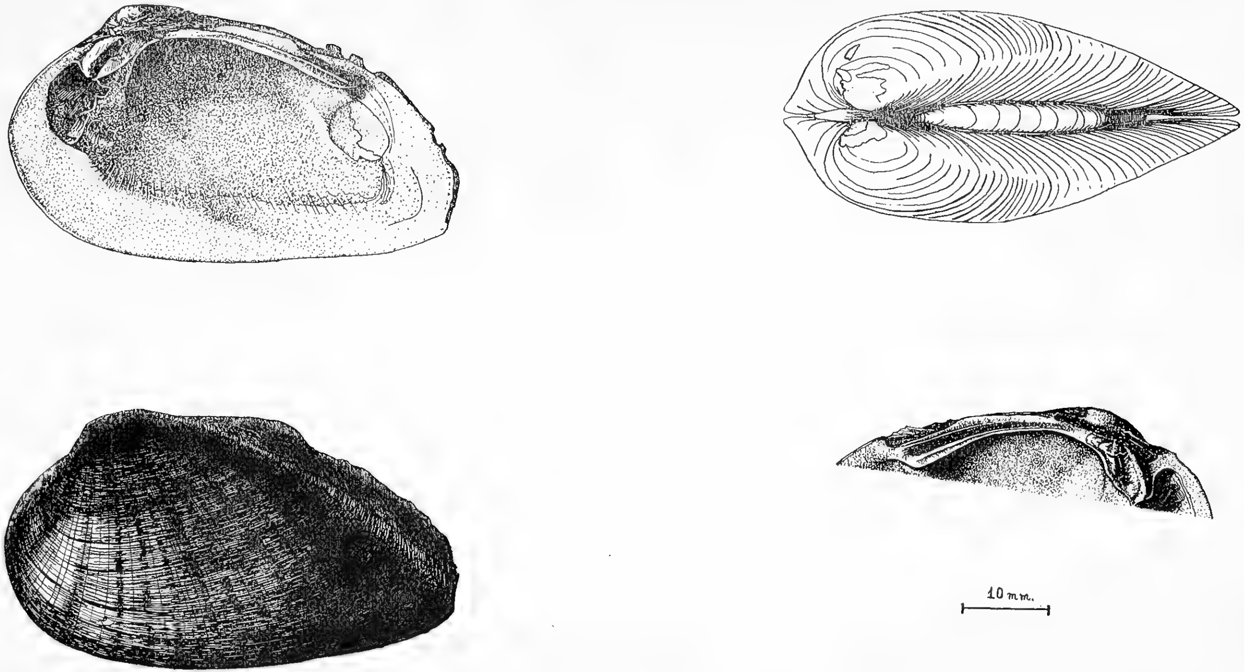

PLATE VII

Plagiola opacata. Variation.

PLATE VII

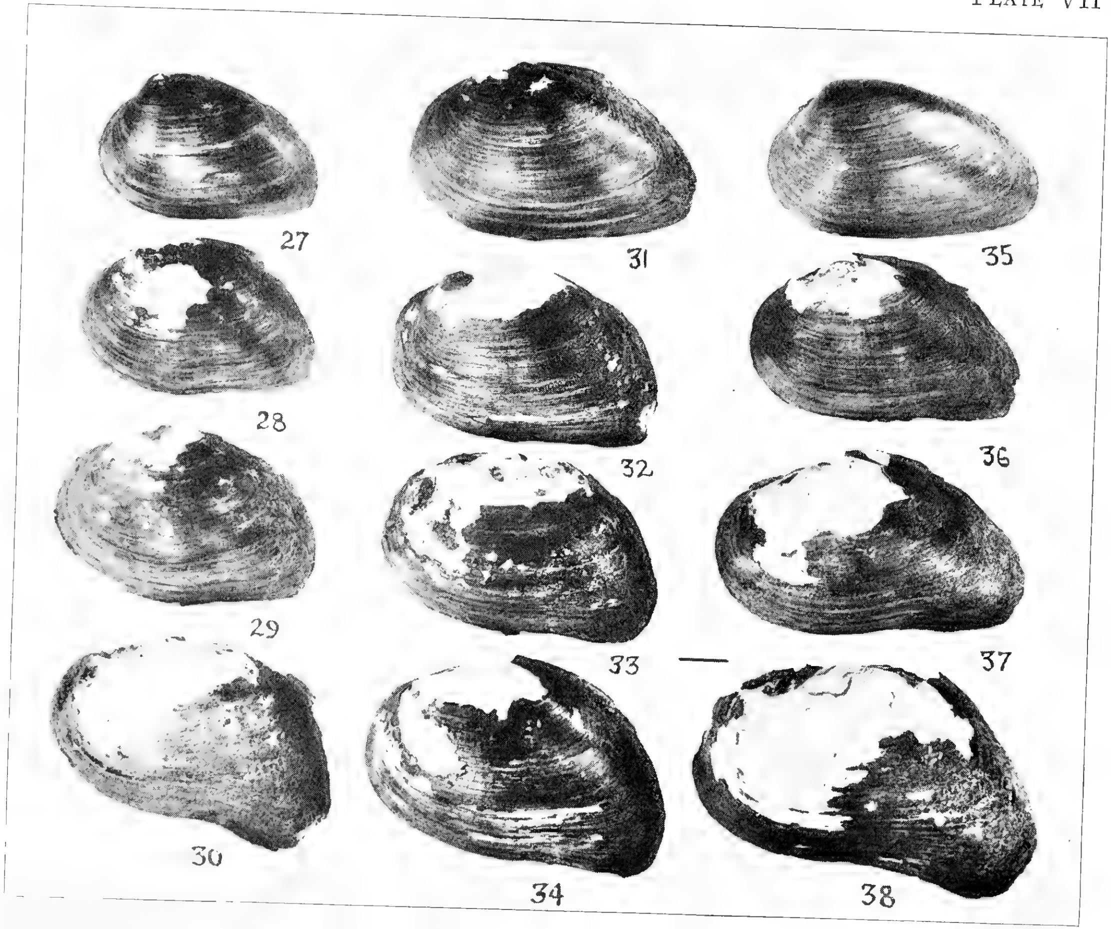

PLATE VIII

Lampsilis and Actinonaias.
Figures 39-42. *L. rovirosai sanjuanensis.* (Figure 40 is type).
Figures 43-45. Arroyo Hueyapam shells, like *A. umbrosa.*
Figures 46, 47. San Juan River shells, like *A. explicata.*

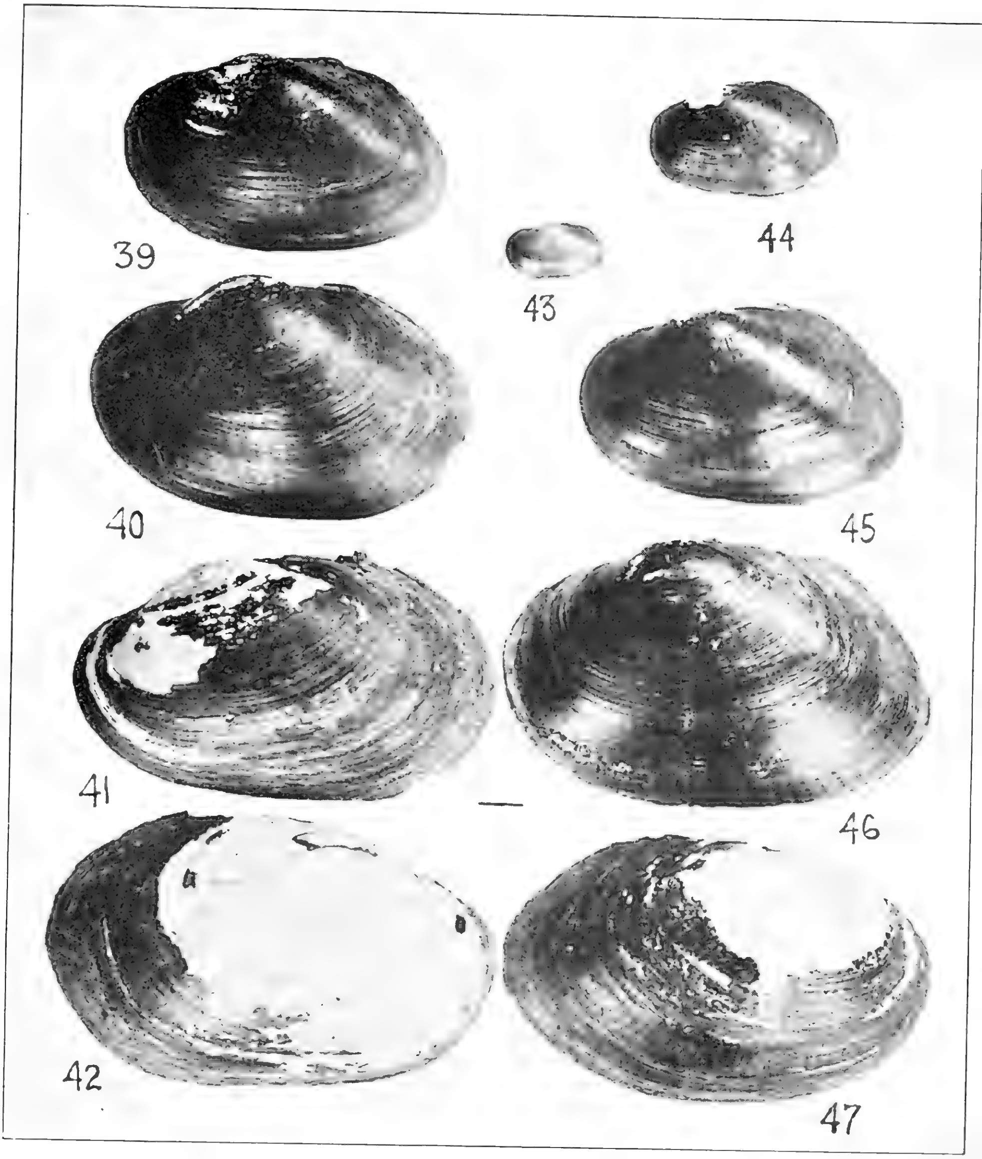
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PLATE IX

Actinonaias walkeri. Type (natural size).
Figure 49. Dorsal and left views of male(?) shell.

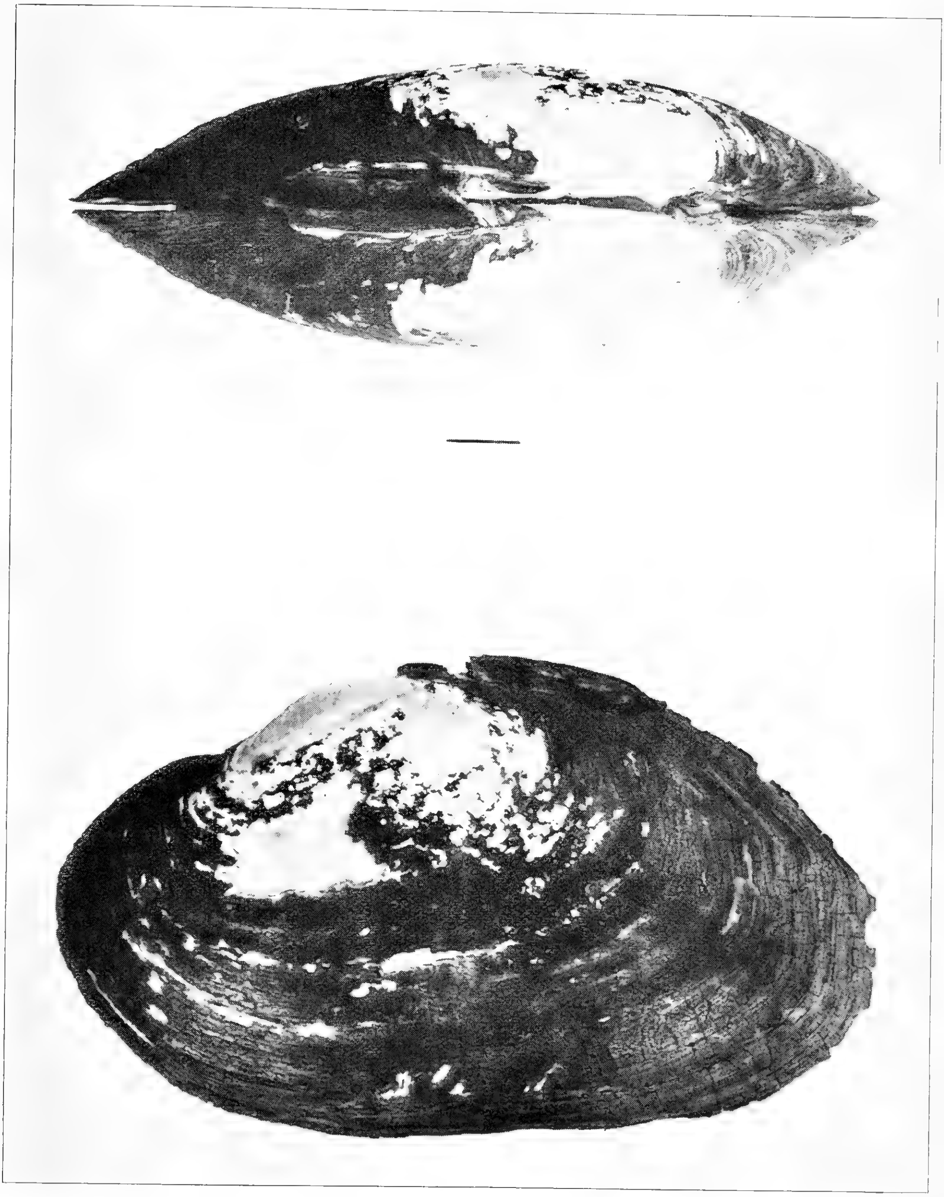

PLATE X

Actinonaias walkeri. Sexes (?).
Figure 48. Female (?) shell.
Figure 49. Type (male?) shell.
Figure 50. Male (?) shell.

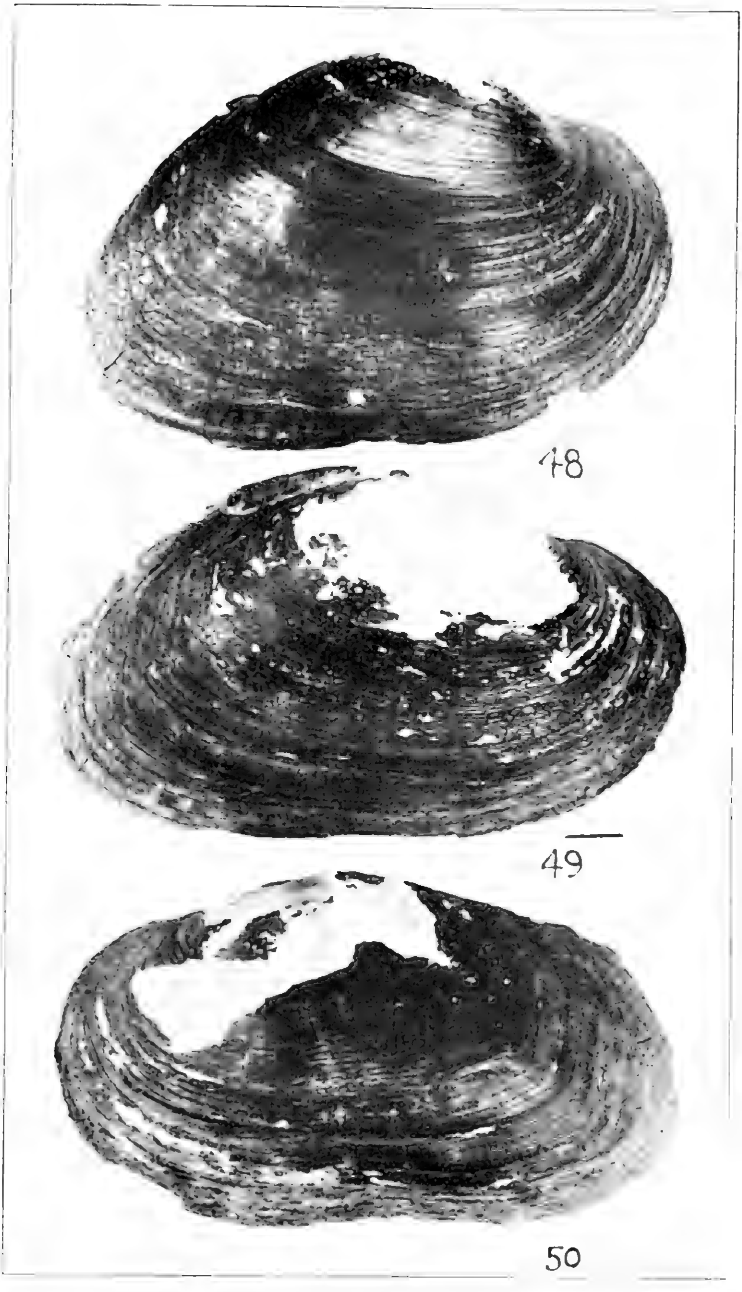

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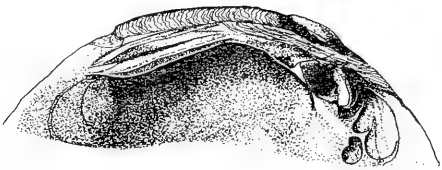
PLATE XI

Lampsilis and Actinonaias. Hinge armature.

Figure 53. *Lampsilis ruthveni.* Left valve of figure 53, plate XIII.

Figure 48. *Actinonaias walkeri.* Right valve of figure 48, plate X.

Figure 49. *Actinonaias walkeri.* Left valve of figure 49, plates IX and X.



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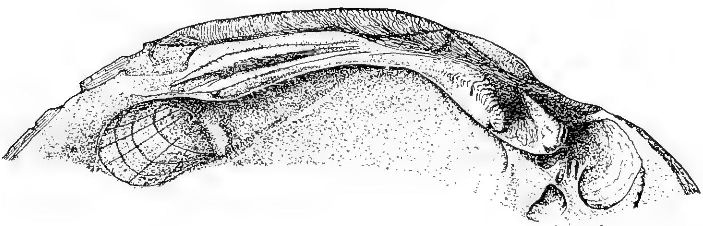

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PLATE XII

Lampsilis ruthveni (natural size).

Figure 53. Exterior view of left valve and hinge armature of right; dorsal view of entire shell. Same as figure 53, plate XIII.

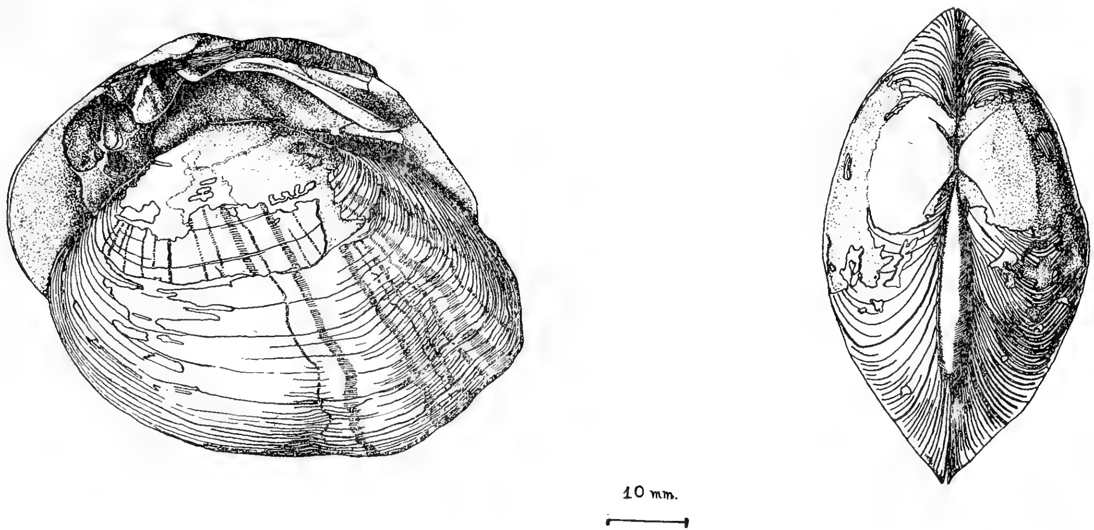
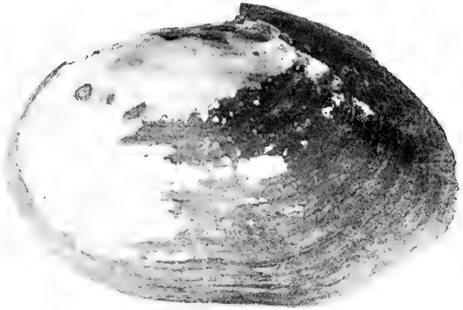

10 mm.

PLATE XIII

Lampsilis ruthveni (natural size).
Figure 52. Male (?) shell.
Figure 51. Type (female?) shell.
Figures 53, 54. Female (?) shells.

PLATE XIII



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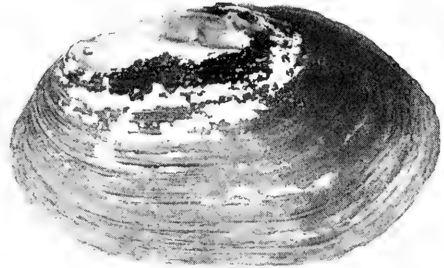

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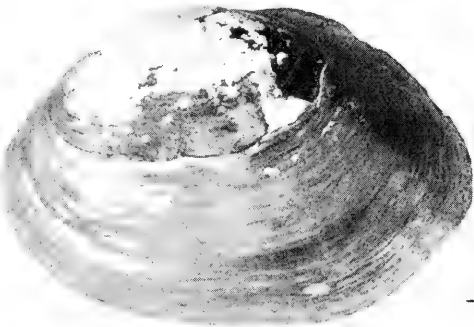

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PLATE XIV

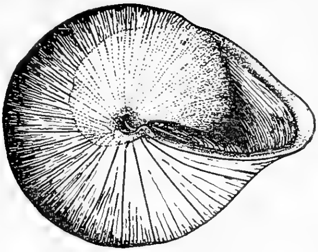
Helicina and Ampullaria.

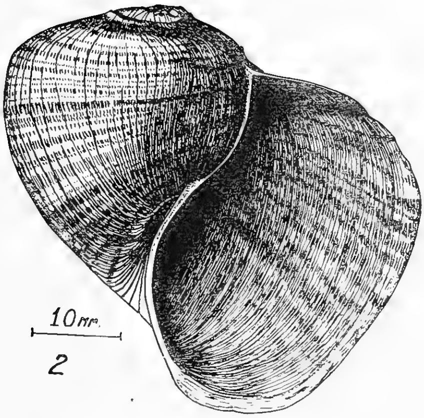
Figure 1. *Helicina zephyrina.* Basal view with operculum in place, as in aestivating individuals, to show the sinuation of the basal lip and the crack left between the operculum and the lip.

Figure 2. *Ampullaria patula catemacensis.* Type specimen.

Figure 3. *A. p. catemacensis.* Exterior view of operculum.

Figure 4. *A. p. catemacensis.* Interior view of operculum.





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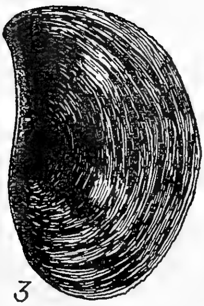

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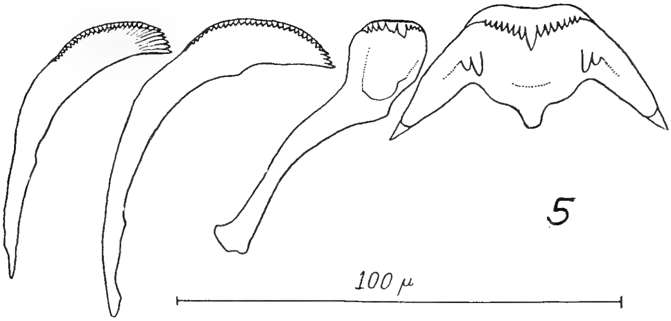
PLATE XV

Amnicola and Ampullaria. Radulae.
Figure 5. *Amnicola guatemalensis.*
Figure 6. *Ampullaria flagellata.*
Figure 7. *Ampullaria patula catemacensis.*



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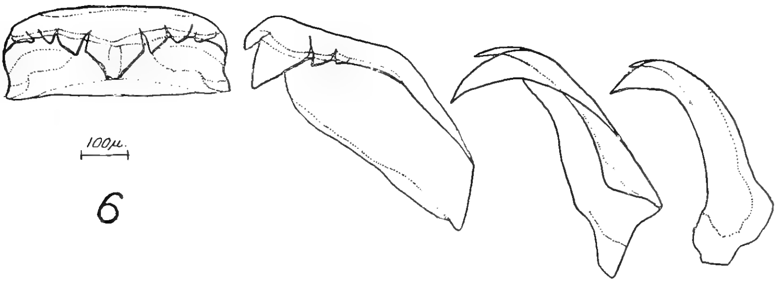
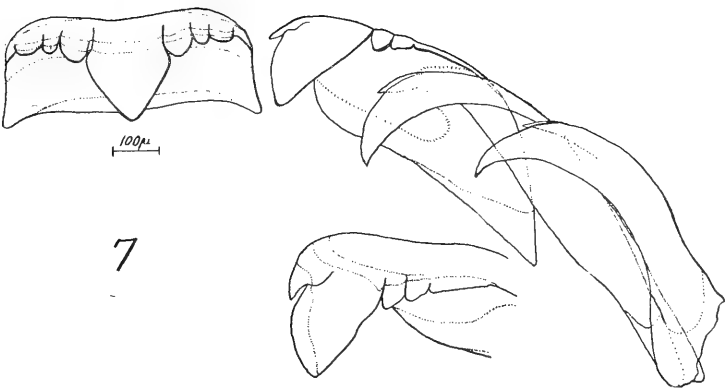


6



7

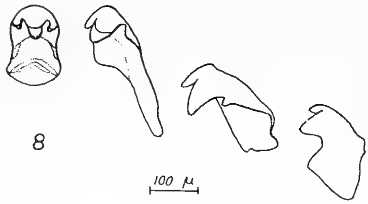
PLATE XVI

Cyrtotoma.

Figure 8. *C. mexicanum salleanum.* Radula.

Figure 9. *C. m. salleanum.* Aperture.

Figures 10, 11, 12. *C. m. mexicanum.* Apparent stages in development of aperture; drawn from different specimens.


8
100 µ

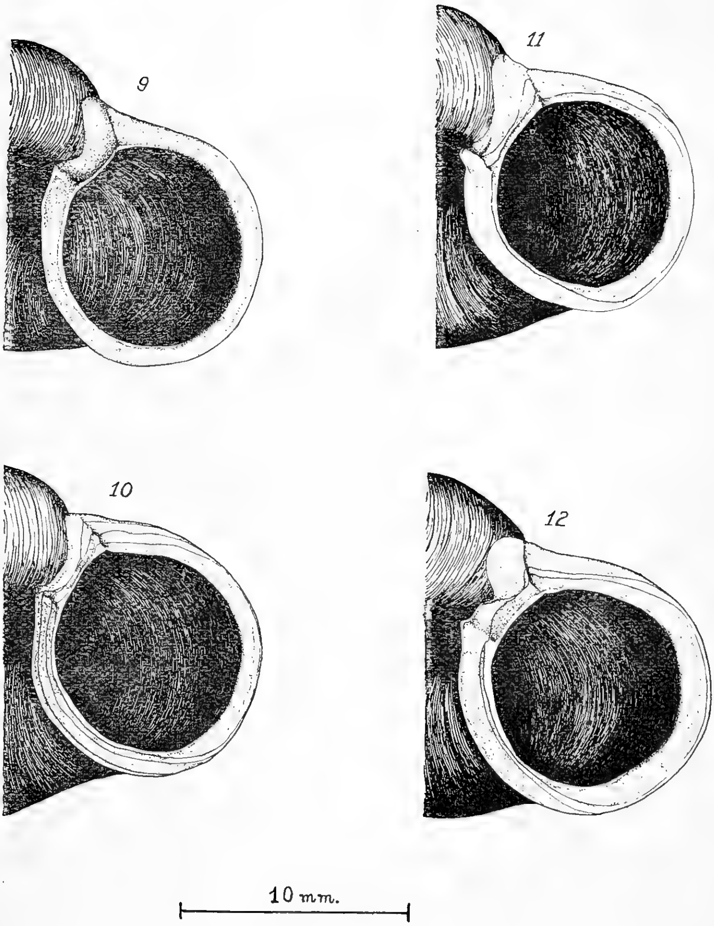
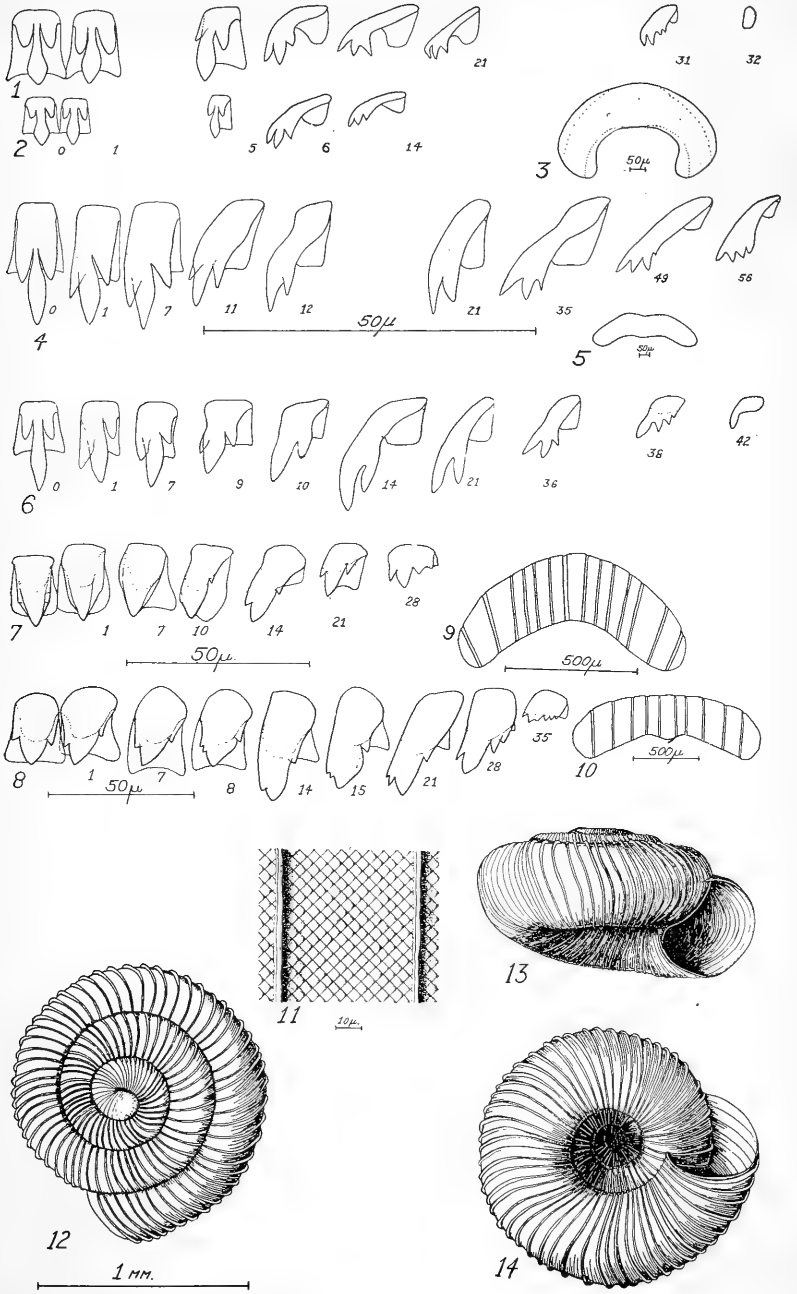

9
11
10
12
10 mm.

PLATE XVII

All drawings are made with the aid of the camera lucida. The scale of figures 1, 2, 4, and 6 is given under figure 4, while that of figures 12, 13, and 14 is under figure 12. Each of the other figures has its own scale. The laterals and marginals are numbered as a continuous series, from the center out.

Figure 1. *Guppya gundiachi;* radula.
Figure 2. *Guppya sterkii;* radula.
Figure 3. *Guppya gundlachi;* jaw.
Figure 4. *Guppya trochulina;* radula.
Figure 5. *Guppya trochulina;* jaw.
Figure 6. *Euconulus elegantulus;* radula.
Figure 7. *Averellia coactiliata;* radula.
Figure 8. *Averellia sumichrasti;* radula.
Figure 9. *Averellia coactiliata;* jaw.
Figure 10. *Averellia sumichrasti;* jaw.
Figure 11. *Thysanophora pilsbryi;* detail of sculpture.
Figure 12. *Thysanophora pilsbryi;* top view.
Figure 13. *T. pilsbryi;* front view.
Figure 14. *T. pilsbryi;* under side.


1
21
31
32
2
0
1
5
6
14
3
50μ
4
0
1
7
11
12
50μ
21
35
49
56
5
50μ
6
0
1
7
9
10
14
21
36
38
42
7
1
7
10
14
21
28
50μ.
9
500μ
8
1
7
8
14
15
21
28
35
50μ
10
500μ
11
10μ.
13
12
1 MM.
14