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SNAIL RECORDS FROM VARIOUS SOUTHERN, EASTERN AND MIDDLE STATES

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During the last several years, various records have accumulated in my catalogs which are probably of some interest to students of molluscan distribution. Several of the species reported below are either scarce or are of limited range, and hence the whereabouts of such specimens should be recorded. The figures in parentheses represent the number of each species collected.

ARKANSAS

A. Two miles north of Cincinnati, Washington County. July 4, 1960.

Mesodon zaletus (Binney) (1). Diameter 23.0, height 16.0 mm, whorls 5 7/8.

B. Gum Springs, Mt. Nebo State Park, Yell County. October 8, 1957.

Mesomphix friabilis (Binney) (2). Diameter 21.5, height 15.0, diameter of umbilicus 2.5 mm.

C. White River, 10 miles northeast of Fayetteville. May 16, 1959.

Ferrissia rivularis (Say) (1). Length 5.2, width 3.5 mm. The form most often recorded as *F. tarda* (Say) in Arkansas and Oklahoma. -- Basch (1963) placed the name in the synonymy of *F. rivularis*.

D. Small, unnamed spring, 5.3 miles west of Rogers on the main highway. May 16, 1964.

Physa virgata Gould (2). If Taylor (1966) is correct in relegating *P. anatina* Lea to the synonymy of this species, and I believe he is, this is possibly one of the most widely ranging mollusks in North America.

Helisoma trivolvis Say (3).

Ferrissia rivularis (12). Length 4.5-6.0. width 3.0-4.0 mm.

Mudalia potosiensis (Lea) (3). There is a slight indication of banding on the body whorl, similar to the condition seen in specimens from Texas County, Missouri (Jones and Branson, 1964).

ILLINOIS

Spoon River, east of Galesburg; collector H. R. Howard, but no additional information.

Viviparus contectoides W. G. Binney (121). Height 18.0 - 34.0, diameter 15.0 - 25.0 mm, whorls 4¾ - 5 1/3.

Lioplax subcarinata (Say) (2). Height 14.0, diameter 10.5, whorls 4½.

Somatogyrus subglobosus Tryon (4). Height 6.5 - 7.1, diameter 5.8 - 6.3 mm, whorls 4 1/5 - 4¼.

Helisoma trivolvis (1).

Gastrocopta contracta (Say) (1).
Quadrula quadrula (Rafinesque) (1).
Carunculina parva (Barnes) (3).
Sphaerium transversum (Say) (1)
Mesodon clausus (Say) (1).

FLORIDA

A. Islamodora Key, 21 miles south of John Pennekamp State Park; collector Ray Schaaf. December 28, 1967.

Polygyra cereolus (Mühlfeld) (3). Diameter 7.5 - 8.6, height 3.5 - 4.0 mm., whorls 5¾ - 6.0.

Drymaeus multilineatus (Say) (1). Length 24.0, spire length 14.2, aperture length 9.8 mm, whorls nearly 7.

Subulina octona (Bruguière) (10). Length 11.5 - 14.8 mm, whorls 7½ - 9.

Chondropoma dentatum (Say) (1). Length 12.5, diameter 5.9 mm, remaining whorls 4½.

B. Ichtucknee Springs, Columbia County. August 18, 1961.

Euglandina rosea (Férussac) (1).
Pomacea paludosa (Say) (5).
Notogillia wetherbyi (Dall) (2).
Goniobasis (Oxytrema) floridensis (Reeve) (84).
Campeloma geniculum (Conrad) (3).
Helisoma duryi (Wetherby) (3).

GEORGIA

A. Benton, August 14, 1961.
Euglandina rosea (1).
Ventridens demissus (Binney) (1).

B. Twelve miles north of Clayton on Warwoman Road, Morsingill Creek crossing. August 21, 1961.
Ventridens demissus (1).
Mesodon inflectus (Say) (1).

ALABAMA

Shoal Creek, Chocolacco Wildlife Refuge, Claburn County. August 20, 1961.

Pleurocera (Oxytremw) alveare (Conrad) (191).

Ninety of these shells, collected near the point where Goodrich (1934) collected, were bandless, whereas the remaining 101 possessed bands.

OHIO

Shawnee Forest, Adams County; collector Edd Baker. July 5, 1968.

Philomycus carolinianus (Bosc) (2). Typical specimens with the double row of black dashes down the back.

LOUISIANA

Watermeter housing, Shreveport. June 12, 1963.

Deroceras laeve (Müller) (2). Contracted length 11.0 - 16.0 mm.

Limax flavus (Linné) (6). Contracted length 25.0 - 38.0 mm.

Polygyra texasiana (Moricand) (5). Diameter 8.0 - 8.9, height 3.7 - 5.0 mm, whorls 5 - 5 1/3.

TENNESSEE

A. Ten miles northwest of Ripley, near Cold Creek, base of Chisholm Bluff, Lauderdale County; collector M.E. Sisk. November 26, 1964.

Triodopsis fraudulenta (Pilsbry) (1). Diameter 13.3, height 6.5 mm, whorls 5½.

Mesodon thyroidus (Say) (1). Diameter 25.5, height 16.2 mm, whorls 5 1/3.

B. Junglebrook Nature Trail, near old Gristmill, about 2,000 feet mean sea level, Great Smoky Mountains National Park.

Pallifera wetherbyi (Binney) (1). Contracted length 49.1 mm, width of sole 7.8 mm. This specimen differs little from ones found in the vicinity of Cumberland Falls, Kentucky. The ground color is pale tan, and the margin of the foot is rusty in life fading to pale gray in alcohol; the sole is granular. A grayish, median band occurs between the anterior tentacles, and it broadens out over the mouth. Anteriorly, on the back, there is a double row of dark brown blotches which coalesce posteriorly to form a continuous single band. The lateral surface of the mantle bears a series of diagonal dashes of the same color, and the interspaces between them are profusely marbled with small brown blotches and lines. As I have indicated elsewhere (Branson and Batch, 1968), there is a rather distinct molluscan relationship between the Smokies and Pine Mountain, Kentucky, where *P. wetherbyi* is common. This find further substantiates my conclusions.

Stenotrema pilula (Pilsbry) (1).

Mesodon ferrissi (Pilsbry) (1). Diameter 16.5, height 9.0 mm, whorls 5.

Triodopsis albolabris (1).

Mesomphix vulgatus (Baker) (1).

Mesomphix andrewsae (Pilsbry) (4). Diameter 16.0 - 19.8, height 8.0 - 10.0 mm, width of spire 7.0 - 9.5 mm, width of body whorl 6.0 - 8.0 mm, whorls 4 2/3 - 5.

Ventridens acerra (3).

C. Clingman's Dome, Great Smoky Mountains National Park. April 12, 1967.

Ventridens acerra (18).

Mesomphix andrewsae (1). Diameter 14.3, height 7.5 mm, width of spire 6.3 mm, width of body whorl 6.5 mm, height of aperture 6.6 mm, width of aperture 8.5 mm, whorls 4 1/3.

Haplotrema concavum kendeighi (Webb) (1). Diameter 6.5, height 3.3 mm diameter of umbilicus 2.3 mm, whorls 3½. Hubricht (1956) considers this a distinct species, but I have found too much local variation to concur.

Stenotrema depilatum (4). Diameter 9.6 - 10.0, height 6.9 - 8.5 mm, whorls 5 2/3 - 6 1/3.

Mesodon ferrissi (2).

Triodopsis multilineata (Say) (1). Another species which Branson and Batch *(loc. cit.)* recently reported from Pine Mountain, Kentucky. The Smokies and the Pine Mountain region probably served as refugia during the glacial period, hence such mollusks represent relicts.

D. Spruce-fir self-guiding nature trail, about 6,000 feet elevation, off road to Clingman's Dome. April 12, 1967.

Vitrinizonites latissimus (Lewis) (6). Greatest diameter 7.4 - 16.5, height 4.0 - 9.0 mm whorls 2 - - 2 7/8.

Stenotrema depilatum (Pilsbry)(2). Diameter 10.5 - 10.6, height 7.5 mm, whorls 5 2/3 - 6.

Pallifera dorsalis (Binney) (1). Contracted length 20.8, width of sole 2.3 mm.

E. Powell River, near Hwrrogate, U. S. Highway 25 E crossing, Claiborne County. July 21, 1968.

Ferrissia rivularis (2).

Pleurocera unciale (Haldeman) (37).

Anculosa praerosa (Say) (117).

Io fluvialis (Say) (5). These specimens were collected from a stretch of the river which, according to Adams (1915), possesses 'spinose undetermined shells.' In the headwaters of the Powell, the form was termed *I. fluvialis lyttonensis* by Adams, whereas in the lower ends of the Holston and French Broad rivers, and in the Tennessee itself, the form is *I. f. loudonensis* Adams. The five shells reported here are more like Adams' *(loc. cit.) loudonensis*, but, since the area is a known transition zone, (Goodrich, 1937), they may be intergrades between *lyttonensis* of the Upper Powell and *I. fluvialis brevis* (Anthony) of the middle and lower Clinch River. The collecting site is not far from the point of confluence between the two streams.

Quadrula cylindrica (Say) (1).

Cyclonaias tuberculata (Rafinesque)(1).

Cyprogenia irrorata (Lea) (1).

Dysnomia brevidens (Lea) (1 female, 1 male).

Lasmigona costata (Rafinesque) (1).

Actinonaias carinata (Barnes) (1).

Lastena lata (Rafinesque) (1).

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MOLLUSCAN FAUNA AND LACUSTRINE SEDIMENTS IN SANPETE VALLEY NEAR MANTI, SANPETE COUNTY, UTAH

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INTRODUCTION

PURPOSE OF INVESTIGATION. The aim of the study is to determine, if possible, the paleoecology of a deposit west of Manti, Utah, as well as the geomorphology of the deposit.

LOCATION OF DEPOSIT. The deposit under investigation is located in Sanpete County, Utah, on Manti Quadrangle, 7.5 minute series, in Sections 23, 24, 25. 26, 27, 30, and 34, Township 17 South, Range 2 East, and Sections 3 and 4, Township 16 South, Range 2 East (Figs. 1 and 2). This deposit of lacustrine origin is referred to here as the Manti deposit. The uppermost part of the deposit that contains fossils is at 5430 feet above sea level on the west side of the valley, and the beach area above this terminates at approximately 5450 feet. On the east side of the valley fossil clay is at 5445 feet, but a beach level there could not be established. The deposit in this paper is labeled Qlb and Qlc on the map, Figure 2.

ACKNOWLEDGEMENTS. Dr. Sidney E. White suggested the investigation and Dr. Aurèle La Rocque helped in the identification of the molluscan fauna. Sincere thanks are hence owed both of these professors.

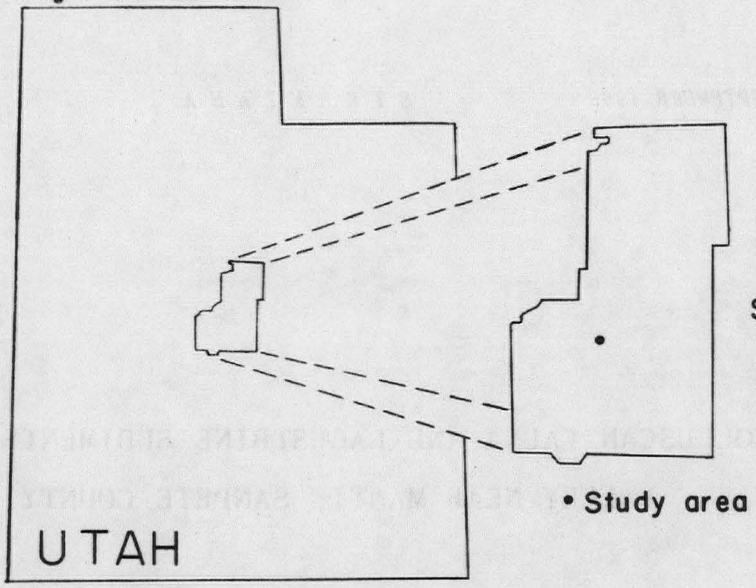
GEOLOGY OF THE STUDY AREA

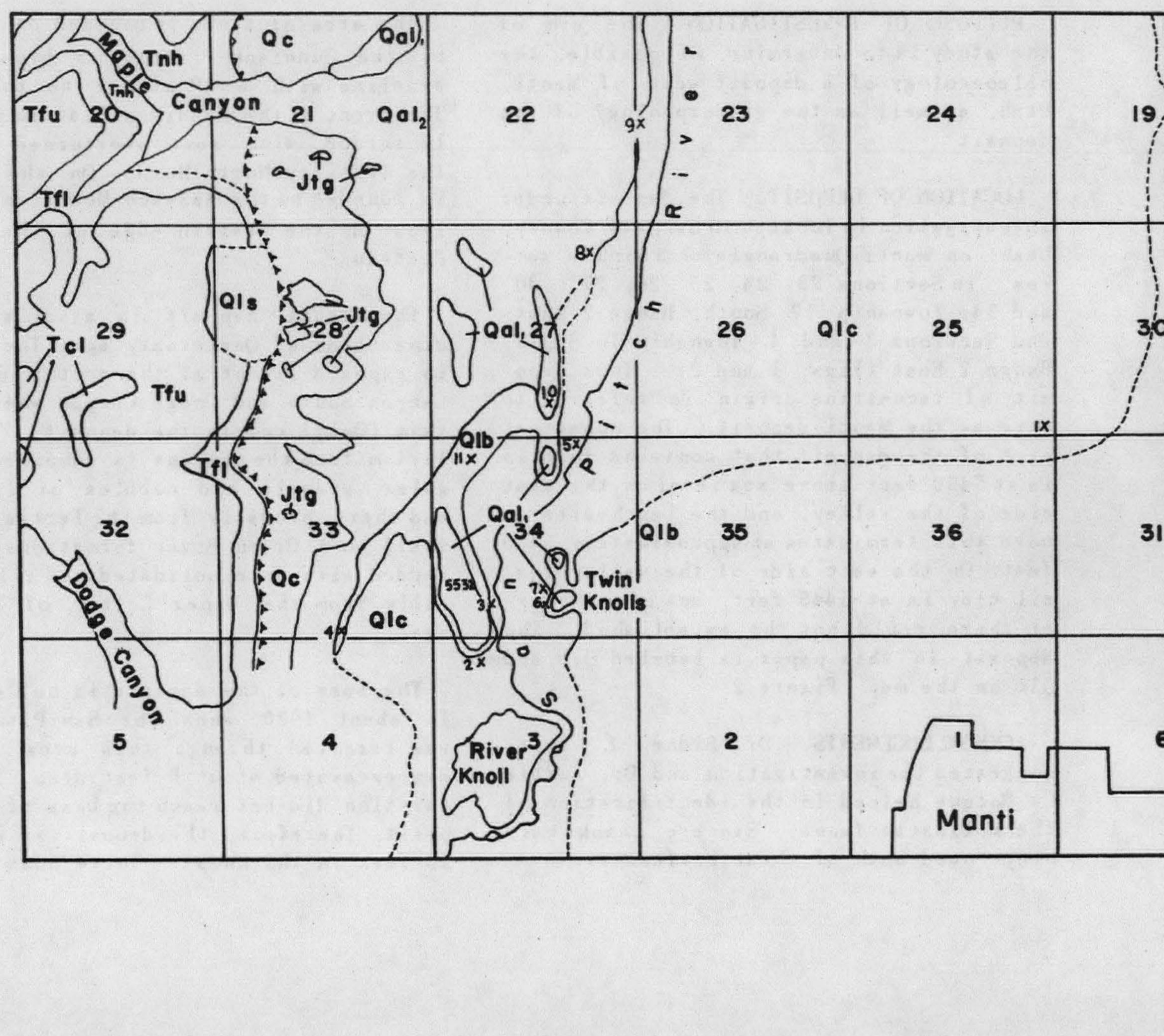
The area of study is bounded on the west by the Gunnison Plateau, a broad gentle syncline with a 4° plunge to the south. The front of the Gunnison Plateau is sharply folded, with some overturned beds in the Tertiary North Horn. On the east it is bounded by the Wasatch Monocline, which lies on the western edge of the Wasatch Plateau.

The Manti deposit is associated with other beds of Quaternary age. The deposit is exposed except at the mouths of Maple Canyon South and Dodge Canyon where alluvium (Qal_2) covers the deposit. This alluvium from the canyons is composed of angular gravels and cobbles of limestone and chert, probably from the Tertiary Flagstaff and Green River formations, interbedded with unconsolidated red silts, probably from the Upper Colton of Tertiary age.

The base of the deposit is not exposed. In about 1930, when the San Pitch River was rerouted through this area, a ditch was excavated about 8 feet deep. This excavation did not reach the base of the deposit. Therefore, the deposit is at least 20 feet in thickness. There does not ap-

Fig.1 INDEX MAP





pear to be any bedding in the lacustrine sediments. Judging from the sequence of formations in the area, the lacustrine sediments probably rest upon Jurassic Arapien Shale.

COMPOSITION OF FAUNA

The Mollusca of the Manti deposit were collected at sampling sites shown in Fig. 2. Most of the collections came from the western side of the deposit.

Of the eight species in Table 1, one was a fingernail clam, one a freshwater gill-breathing gastropod, five freshwater lung-breathing gastropods, and one a terrestrial gastropod. Two occurred in every sample that was fossiliferous and two occurred in all but one of the samples (Table 2).

TABLE 1. SPECIES OF MOLLUSCA OCCURRING IN MANTI DEPOSIT

Bivalvia:
Pisidium nitidum pauperculum Sterki

Freshwater Gill-breathing Gastropoda:
Valvata humeralis californica Pilsbry

Freshwater Lung-breathing Gastropoda:
Gyraulus parvus (Say)
Fossaria parva (Lea)
Physa gyrina Say
Promenetus exacuous (Say)
Helisoma trivolvis (Say)

Terrestrial Gastropoda:
Oxyloma retusa (Lea)

TABLE 2. HORIZONTAL DISTRIBUTION OF SPECIES

Species	*Sample collections* 1	2	3	4	5	6	7	8	9
Pisidium nitidum pauperculum Sterki	x	x	x	-	-	-	x	-	-
Valvata humeralis californica Pilsbry	x	x	x	-	x	-	x	-	x
Gyraulus parvus (Say)	x	x	x	-	x	-	x	-	x
Fossaria parva (Lea)	-	x	x	-	x	-	x	-	x
Physa gyrina Say	-	-	x	-	x	-	x	-	x
Promenetus exacuous (Say)	-	x	x	-	x	-	x	-	x
Helisoma trivolvis (Say)	-	-	x	-	x	-	x	-	-
Oxyloma retusa (Lea)	-	-	x	-	x	-	-	-	-

PALEOECOLOGY

The Manti deposit is composed of seven freshwater species and one land gastropod. The land gastropod, *Oxyloma retusa* (Lea), occurs in only collections 3 and 5 and constitutes a very small percentage in each of these collections. Its presence could be expected since the environment it lives in at present is a moist one. *Valvata humeralis californica* Pilsbry and *Gyraulus parvus* are the most numerous in all the collections. Frequency of occurrence of *V. humeralis californica* ranges from 17.3 percent in collection 5 to 48.9 percent in collection 7, and that of *G. parvus* from 10.6 percent in collection 7 to 69.5 percent in collection 5.

The ecology of each of the species has

been condensed and summarized from the following authors: Baker, 1928; Clark, 1961; Henderson, 1929; La Rocque, 1952, 1966; Leonard, 1950; Mowery, 1961; Taylor, 1960; Reynolds, 1959; and Zimmerman, 1960.

Bivalvia

Pisidium nitidum pauperculum Sterki. This species lives in ponds, small and large lakes in shallow water. The bottom may be sand, clay, mud. It usually lives in shallow water probably from 1 to 5 m. The depth would be for a more dense population. It can live in water as deep as 39.5 m. The pH for this species is 7.0 to 8.0 and the fixed carbon dioxide 9.3 to 24.73 ppm. It burrows into the bottom sediments and feeds on detritus and plankton.

Freshwater Gastropoda

Valvata humeralis californica Pilsbry. Very little information is available for this species in the literature. Henderson (1929) believes that the species found in the Grand Coulee district of Washington is of Pleistocene lacustrine origin. It also lives in lakes, ponds, and streams. *V. tricarinata* is abundant in weedy places on either sandy or muddy bottoms. It would seem likely that *V. humeralis californica* Pilsbry would inhabit environments similar to those of other Valvatidae. The environment would be shallow water with a pH of at least 7.1 with a fixed carbon dioxide of 8 ppm. minimum.

Gyraulus parvus (Say). This species inhabits quiet, shallow bodies of water 0.3 to 2.2 m deep, mainly those of small size, on mud, sandy mud, sand, gravel, or boulder bottom; also on logs and vegetation. It lives in areas of abundant vegetation which are well protected. It has a slight burrowing reaction when faced with desiccation. It can live for a time on various substrata as long as moisture is present. The pH is 7.0 to 8.16; fixed carbon dioxide 8.16 to 30.56 ppm.

Fossaria parva (Lea). This species lives in wet, marshy places, generally out of water, on sticks, stones, or muddy flats. It is more prone to leave the water than any other species of the family. For other species of the family the pH is 5.86 to 8.37; fixed carbon dioxide 10.65 to 18.87 ppm.

Physa gyrina Say. This is a shallow water species, usually 0.3 m. deep, that inhabits swampy, slow moving, and stagnant bodies of water that have sandy silt or mud bottoms. The optimum conditions for its survival are shallow water which is unshaded; few or no enemies such as fish and some birds; a minimum amount of debris; protection from waves and currents; moderate growth of pondweed; and well-aerated water. It is usually found on the upper side of pond lily leaves. They can live for a time on almost any substratum. *P. gyrina* lives upon both animal and vegetable food, either fresh or partly decayed. The pH is 7.1 to 8.37; fixed carbon dioxide 9.5 to 22.75 ppm.

Promenetus exacuous (Say). This is another quiet, shallow water species. It lives on the underside of lily pads, on sticks, and on stones along the margins of ponds just under the water. The area is more or less marshy with shallow water with a soft mud bottom. In streams it is always found on mud flats in quiet water, not in more rapid parts of the streams. The types of vegetation it lives on are varied. *P. exacuous* lives in water whose pH varies from 7.0 to 7.64 and whose carbon dioxide content ranges from 9.3 to 22.5 ppm. The most important factors in the habitat seem to be the preference for cold water and the presence of vegetation.

Helisoma trivolvis. This species is an inhabitant of quiet, shallow, stagnant eater. It flourishes in ponds and sloughs, even though they may be choked with vegetation or polluted with decaying organic materials and is invariably absent from flowing streams. It also lives behind beach barriers, in large open swamps, and at the edges of lakes and streams. The pH of the water in which it lives varies from 6.6 to 8.37 and the carbon dioxide content ranges from 7.5 to 30.56 ppm. The bottoms of the marshes, swampy shores, or stagnant pools are mud or fine sandy silt with the water depth up to 2 m. but generally less than 0.6 m. deep.

Terrestrial Gastropoda

Oxyloma retusa (Lea). This is a species of marshes and other wet places. It commonly lives on mud flats above high water level along swampy shores, caused by raising of the water level in the lake or pond. It is also found upon partly submerged sticks and on rotting weeds.

REGISTER OF COLLECTIONS

1. North of Manti, SE ¼, SE ¼ sec. 25, T. 17 S., R. 2 E., Sanpete County, Utah; depth 6 ft.; 1968; 7 specimens.

Species	*No.*	*Percent*
Gyraulus parvus	4	57.1
V. humeralis californica	2	28.6
P. nitidum pauperculum	2	14.3

2. NW ¼, NW ¼, sec. 3, T. 17 S.. R. 2 E.; depth 54 in.; 1968; 115 specimens.

V. humeralis californica	67	58.2
P. nitidum pauperculum	1	0.9
Fossaria parva	5	4.3
Promenetus exacuous	1	0.9
Gyraulus parvus	41	36.7

E. SW ¼, SW ¼ sec. 34, T. 17 S., R. 2 E.; depth 22 in.; 1968; 336 specimens.

Oxyloma retusa	4	1.2
Helisoma trivolvis	4	1.2
Fossaria parva	8	2.4
Gyraulus parvus	190	56.5
Promenetus exacuous	36	10.7
Physa gyrina	4	1.2
P. nitidum pauperculum	1	0.3
V. humeralis californica	89	26.5

4. SW ¼, SE ¼ sec. 33, T. 17 S., R. 2 E.; depth 12 in.; 1968; no fossils.

5. NW ¼, SE ¼, sec. 34, T. 17 S., R. 2 E.; depth 15 in.; 1968; 1062 specimens.

Physa gyrina	2	0.2
V. humeralis californica	184	17.3
Oxyloma retusa	2	0.2
Promenetus exacuous	58	5.4
Helisoma trivolvis	8	0.7
Fossaria parva	71	6.7
Gyraulus parvus	738	69.5

6. NW ¼, SE ¼, sec. 34, T. 17 S., R. 2 E.; depth 20 in. on side of southern knoll of Twin Knolls; 1968; no fossils.

7. NW ¼, SE ¼ sec. 34, T. 17 S., R. 2 E.; depth 20 in.; 1968; 222 specimens.

V. humeralis californica	133	58.9
Helisoma trivolvis	3	1.3
Gyraulus parvus	24	10.6
Promenetus exacuous	6	2.7
Fossaria parva	25	11.1
P. nitidum pauperculum	34	15.0
Physa gyrina	1	0.4

8. NE ¼, NE ¼ sec. 27, T. 17 S., R. 2 E.; depth 24 in.; 1968; no fossils.

9. SE ¼, SE ¼ sec. 22, T. 17 S., R. 2 E.; depth 14 in.; 1968; 312 specimens.

Valvata h. californica	86	27.6
Promenetus exacuous	42	13.5
Gyraulus parvus	87	27.9
Fossaria parva	97	31.0

HISTORY OF THE LACUSTRINE FAUNA

The species in the Manti deposit form a typical freshwater assemblage. The general environment would have been a quiet, shallow lake with a bottom that would have consisted of fine sediments, including fine.

sand, silt, clay, and mud. Near shore there were areas on the bottom that were probably covered with pebbles and granules. It was a lake of moderate to abundant vegetation. There were no waves to speak of and no strong currents. The assemblages indicate that the average depth of the lake was 2 m., for the Mollusca occur across the entire floor of the valley of the study area. The average pH ranged from 7 to 8 as indicated by the abundance of *Gyraulus parvus* and *Valvata humeralis californica*. The probable limits of the fixed carbon dioxide are between 7.5 and 30.56 ppm.

Either *Gyraulus parvus* (Say) or *Valvata humeralis californica* Pilsbry is the most abundant in all but one of the collections. *V. humeralis californica* is most abundant in collections 2 and 7, while *G. parvus* is most abundant in collections 1, 3, and 5. The reason the two species vary in their abundance is that *V. humeralis californica* can flourish at greater depth than can *G. parvus* (Table 3).

In collection 9 the writer found that *Fossaria parva* was the most dominant, consisting of 31 percent of the species, while *G. parvus* and *V. humeralis californica* com-

Table 3. Relations of Mollusca to character of bottom, depth of water, range of pH and carbon dioxide dissolved.

Character of Bottom / Species	Boulder	Gravel	Sand	Silt	Clay	Mud	Depth of Water meters 1	2	3	4	5	6	pH range	carbon dioxide ppm.
Pisidium nitidum pauperculum													7.0-8.0	9.3-24.73
Valvata humeralis californica													7.1 +	8 +
Gyraulus parvus													7.0-8.16	8.16-30.56
Fossaria parva													5.86-8.37	10.65-18.87
Physa gyrina													7.1 -8.37	9.5-22.75
Promenetus exacuous													7.0 -7.64	9.3-22.5
Helisoma trivolvis													6.6-8.37	7.5-30.56

posed 27.9 percent and 27.6 percent respectively. This is the result of the shallowing of the lake to less than 1 m, and a rise in the carbon dioxide concentration as compared with the areas of the other collections. *F. parva* is completely absent from collection 1, probably because of a low carbon dioxide concentration, under 10.65 ppm., in that area.

Oxyloma retusa (Lea) occurs the least of any of the species. Because this is a land gastropod that lives in a moist environment, for example along the swampy shores of a lake, it would be expected not to be abundant in the lake.

AGE AND CORRELATIONS

It is difficult to determine the age of the Manti deposit because little information is available on Pleistocene molluscan assemblages of Utah. Roy (1962, p. 12) describes a molluscan assemblage about one mile south of the area covered in this paper. The assemblage here reported is included in that reported by Roy. The two most abundant species in both deposits are recorded for the Pliocene. *Gyraulus parvus* is reported in Pliocene deposits by Taylor (1960, p. 58). Chamberlin and Berry (1933, p. 29) report *V. humeralis californica* for the Pliocene. Both these species as well as the others that occur in the deposit still exist in Utah today (La Rocque, manuscript records).

Roy (1962, p. 5) reports that his Gunnison deposit in Sanpete Valley is between 5400 and 5450 feet above sea level. The area covered in this paper is approximately one mile north of Roy's Gunnison deposit. It has approximately the same molluscan assemblage, and occurs at the same elevation as the Gunnison deposit. Therefore, it would seem very likely that these two are the same deposit. If this is true, and the writer believes that it is, the Manti deposit is also of Wisconsin age and probably of latest Wisconsin age (Roy, 1962, p. 12).

GEOMORPHOLOGY

EARTHFLOW. The lake formed as a result of a debris flow that came out of Six Mile Canyon and moved across Sanpete Valley damming up the San Pitch River. Wallace (1964) who made a study of mass movement in the area, reports that a bouldery deposit moved across the Sanpete Valley blocking the San Pitch River. The general drainage of the area was probably to the south as it is today. As a result, the water backed up behind the bouldery debris flow forming the lake to the north.

LAKE EVIDENCE. Twin Knolls and hill 5532 existed at the time of lake deposition. There is at least one terrace, possibly two, on the west side of Twin Knolls, and also there are two especially evident on the east side of hill 5532. A terrace may exist around the eastern, western, and southern sides of River Knoll.

There is no evidence for major movement in the study area after deposition of the lake sediments. Minor movement may have occurred on River Knoll since three faults with vertical displacements of one inch were observed in a road cut on the north end of the knoll.

The most important evidence for a lake are the freshwater Mollusca that were collected and discussed earlier.

It is difficult to establish a beach area for the lake. On the west side of Sanpete Valley the fossiliferous clay is at an elevation of 5430 feet above sea level. On the eastern side of the valley the fossiliferous clay is located at 5443 feet. It is rather unlikely that such a discrepancy of 13 feet should exist. On the west side of the valley what is thought to be a beach is located between 5430 and 5450. No beach could be located on the eastern limits of the fossiliferous clay. The difficulty arises from present day alluvial material covering the lake sediments. The discrepancy can be resolved easily by realizing that present day alluvium covers much of the shores of the lake. There is more alluvial material covering the western edge than the eastern edge of the deposit because the western edge is within a mile of the front of the Gunnison Plateau, whereas the eastern side is about 2 miles from the Wasatch Plateau.

DRAINAGE. Today the area drains to the south just as it did at the time of the

Manti lake deposit. It was forced to drain around the west side of the bouldery debris flow through the present day Gunnison Reservoir area. If it had not drained to the south, the bouldery deposit at Six Mile Canyon could not have caused a lake to the north. Furthermore, the Wasatch Mountains were blocking the way for drainage to the north. It drained very slowly, for the lake was filled with Mollusca that live in quiet water, well protected from waves and strong currents.

TABLE 4. MECHANICAL ANALYSIS OF SEDIMENTS. The sediments were analyzed as follows: above 4 mm. -- pebble; 4-2 mm. -- granule; 2 - 1 mm. --very coarse sand; 1-½ mm. -- coarse sand; ½ - ¼ mm. -- medium sand; ¼ - 1/8 mm.--fine sand; 1/8-1/16 mm. - very fine sand; less than 1/16 mm.--silt and clay. Weight is in grams.

	SAMPLE 1		SAMPLE 2		SAMPLE 3	
	WEIGHT	PERCENT	WEIGHT	PERCENT	WEIGHT	PERCENT
above 4 mm.	0.000	0.00	0.000	0.00	0.000	0.00
4-2 mm.	0.503	1.01	0.000	0.00	0.147	0.29
2-1 mm.	1.276	2.56	0.043	0.08	0.129	0.26
1-½ mm.	1.730	3.49	0.098	0.19	0.185	0.37
½-¼ mm.	2.090	4.20	1.074	2.16	1.798	3.42
¼-1/8 mm.	6.162	12.38	6.940	13.90	10.855	21.73
1/8-1/16 mm.	19.827	39.86	28.960	58.04	27.443	54.94
less than 1/16 mm.	18.158	36.50	12.788	25.63	9.489	18.99
TOTAL	49.746	100.00	49.903	100.00	49.956	100.00

	SAMPLE 4		SAMPLE 5		SAMPLE 6	
	WEIGHT	PERCENT	WEIGHT	PERCENT	WEIGHT	PERCENT
above 4 mm.	0.000	0.00	0.000	0.00	0.000	0.00
4-2 mm.	0.050	0.10	0.000	0.00	0.000	0.00
2-1 mm.	0.050	0.10	0.032	0.06	0.000	0.00
1-½ mm.	0.180	0.36	0.069	0.14	0.038	0.07
½-¼ mm.	1.050	2.11	0.690	1.40	2.900	5.83
¼-1/8 mm.	7.660	15.38	9.082	18.41	13.375	26.86
1/8-1/16 mm.	26.995	54.21	26.168	53.04	19.619	39.38
less than 1/16 mm.	13.815	27.74	13.295	26.95	13.880	27.86
TOTAL	49.800	100.00	49.336	100.00	49.813	100.00

	SAMPLE 7		SAMPLE 8		SAMPLE 9	
	WEIGHT	PERCENT	WEIGHT	PERCENT	WEIGHT	PERCENT
above 4 mm.	0.000	0.00	0.000	0.00	0.000	0.00
4-2 mm.	0.000	0.00	0.000	0.00	0.000	0.00
2-1 mm.	0.000	0.00	0.000	0.00	0.014	0.02
1-½ mm.	0.000	0.00	0.051	0.10	0.070	0.15
½-¼ mm.	0.022	0.04	0.160	0.32	0.279	0.56
¼-1/8 mm.	10.835	21.32	2.943	5.91	2.196	4.39
1/8-1/16 mm.	31.494	61.95	26.694	53.55	26.930	53.95
less than 1/16 mm	8.485	16.69	19.993	40.12	20.431	40.93
TOTAL	50.836	100.00	49.841	100.00	49.920	100.00

TABLE 4 (CONT.)

	SAMPLE 10		SAMPLE 11	
	WEIGHT	PERCENT	WEIGHT	PERCENT
above 4 mm.	0.898	1.82	1.632	3.27
4-2 mm.	1.338	2.69	7.164	14.36
2-1 mm.	0.797	1.60	6.178	12.39
1-½ mm.	0.608	1.23	6.086	12.20
½-¼ mm.	2.538	5.13	5.683	11.39
¼-1/8 mm.	8.578	17.31	7.257	14.55
1/8-1/16 mm.	27.358	55.19	5.847	11.72
less than 1/16 mm.	7.447	15.03	10.034	20.12
TOTAL	49.562	100.00	49.881	100.00

MECHANICAL ANALYSIS. Finally, a mechanical analysis was made on the eleven samples collected (Table 4). Samples 10 and 11 were omitted because of lack of fossils. Samples 1, 2, 3, 5, 7, and 9 indicate the quietness of the lake environment by the percentages of very fine sand, silt, and clay recorded. In these samples the lowest percentage of very fine sand, silt, and clay is in sample 3 where it makes up 73.9 percent of the sample. In sample 2 the material less than 1/8 mm made up 83.65 percent of the sample.

Samples 4, 6, and 11 came from areas that were thought to be beach areas. Some fossil hash was found in all three samples but nothing that could be identified. Some ostracods were found in sample 6 which would indicate a freshwater environment.

Sample 10 is possibly from either a sand bar or a spit that existed in the lake; 17.30 percent is fine sand, 55.19 percent is very fine sand, and 15.02 percent is silt and clay.

Sample 8 is from the nose of the alluvial fan coming out of Maple Canyon South. The material in it is 93.66 percent less than 1/8 mm.

SUMMARY

A quiet, shallow lake, with a bottom of fine sand, silt, clay, and mud, as determined by the environments of the molluscan fauna as well as by the mechanical analysis of the sediments, was formed as a result of a large bouldery debris flow that came out of Six Mile Canyon and dammed the San Pitch River. The lake formed behind the bouldery dam, thus depositing the 'Gunnison Reservoir Deposit' (Roy, 1962) and the Manti deposit of this report. The similarities of these deposits, similar molluscan fauna and similar elevation, indicate that they are of the same origin. Thus the name Lake Sterling is proposed for this lake.

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MANUSCRIPT RECEIVED JULY 14, 1969

LEGEND FOR MAPS ON PAGE 6

UPPER MAP: Index map of Utah, showing location of Sanpete County.

LOWER MAP: MAP OF STUDY AREA

Qls	Landslides and other mass movement	Tcl	Lower Colton
Qal_2	Younger alluvium	Tfu	Upper Flagstaff
Qal_1	Older alluvium	Tfl	Lower Flagstaff
Qb	Lake Sterling beach?	Tnh	North Horn
Qlc	Lake Sterling clay	Jtg	Twist Gulch
Qc	Colluvium	1 X	Sample localities

THE AMERICAN MALACOLOGICAL UNION
THIRTY-FIFTH ANNUAL MEETING
MARINETTE, WISCONSIN, JULY 21-25, 1969

This year's meetings were co-hosted by our Secretary, Margaret C. Teskey, and the University of Wisconsin-Green Bay, Marinette Center. Advance registration had already passed the hundred mark by the first day of the meetings and many more registered later.

REGISTRATION was in the lobby of the Auditorium, University of Wisconsin-Green Bay, Marinette Center, and the scientific sessions were held in the fine modern auditorium itself.

The meeting was called to order at 1:30 p.m. by President Joseph Rosewater who presented Mrs. Teskey for a brief word of welcome. She was followed by Mr. George S. Robbins, manager of the Marinette Area Chamber of Commerce, and Dr. William A. Schmidtke, Acting Dean of the Marinette Center and Dr. Frederick Sargent, Dean, College of Environmental Sciences, University of Wisconsin-Green Bay. The thoughtfulness and gracious welcome of our hosts indicated that the meeting would be a most agreeable one, and so it turned out to be.

President Rosewater thanked our hosts for their invitation and their warm welcome, after which the meeting proceeded to the presentation of papers.

In the list of papers that follows, an asterisk indicates that the paper was not presented. Sessions were varied with intermissions at mid-morning and mid-afternoon.

PAPERS PRESENTED MONDAY, JULY 21, 1969

The molluscan fauna in North Carolina's Neuse River estuary. *Hugh J. Porter*, The University of North Carolina, Institute of Marine Sciences, Morehead City, N. C.

Mollusca of Cedar Bog (Champaign Co., Ohio). Eugene P. Keferl, Columbus, Ohio.

Donax fossor, a summer range extension of *Donax variabilis*. *Paul Chanley*, Virginia Institute of Marine Science, Gloucester Point, Virginia.

Western Atlantic *Donax*. *J. P. E. Morrison*, U. S. National Museum, Washington, D. C.

The Pleurocerid fauna of the Tennessee River. *Ralph M. Sinclair*, U. S. Department of the Interior, Federal Water Pollution Control Administration, Cincinnati, Ohio.

Egg cases of *Nitidella ocellata* Gmelin and an *Anachis*. *Dorothy Raeihle*, Elmhurst, New York.

Scandals in Malacology. Morris K. Jacobson Rockaway, New York.

MONDAY EVENING : SLIDE SHOW

A well-attended showing of slides from former meetings, collecting trips, and topics of interest was held from 7:30 p.m. to about 9:00 p.m. in one of the University classrooms under the chairmanship of Morris K. Jacobson.

GROUP PHOTOGRAPH, TUESDAY, JULY 22, 1969

Before the presentation of papers, the group gathered on the slope below the Flying Dutchman Restaurant of the Dome Motel for a group photograph. The official photographer had a considerable amount of competition but finally managed to gather the group together and to take the official photograph which was available two days later, a record of some sort.

PAPERS PRESENTED TUESDAY JULY 22, 1969

Patterns of oxygen consumption of the freshwater pulmonate snail, *Lymnaea palustris*. *David G. S. Wright*, Department of Zoology, University of Guelph, Guelph, Ontario, Canada.

Preliminary report on the distribution of land snails in northern Missouri. *Charles D. Miles* and *Richard L. Reeder*, Department of Biology, University of Missouri-Kansas City, Missouri.

Some algae isolated from *Helisoma trivolvis* (Say). *Richard L. Reeder* and *Robert G. Anderson*, Department of Biology, University of Missouri-Kansas City, Mo.

The shells of Dioscorides of Anazarba. *Kenneth Jay Boss*, Museum of Comparative Zoology, Harvard University, Cambridge, Mass.

Philopthalmus sp. (Trematoda) in *Tarebia granifera* and *Melanoides tuberculatus* in South Texas. *Harold D. Murray* and *Deborah Haines*, Biology Department, Trinity University, San Antonio, Texas.

* Morphological-taxonomic notes on various freshwater pulmonate snails. *Harold J. Walter*, Dayton, Ohio.

Problems in snail control in Hawaii. *Henry van der Schalie*, Museum of Zoology, Ann Arbor, Michigan.

Problems and techniques in experimental work with bivalve larvae. *Ruth D. Turner*, Museum of Comparative Zoology, Harvard University, Cambridge, Mass.

Cabeza de Vaca, dealer in shells. *James X. Corgan*, Austin Peay State University, Clarksville, Tenn.

Histological studies of the nephridium and pericardial lining of *Quadrula nodulata* (Rafinesque). *Paul Robert Myers* and *Dorothea S. Franzen*, Illinois Wesleyan University, Bloomington, Illinois.

Late Pleistocene nonmarine mollusks from Lake Bretz, Lower Grand Coulee, Washington. *James J. Landye*, Washington State University, Pullman, Washington.

Some possible consequences of a sea-level Panama Canal. *Arthur H. Clarke*, National Museum of Canada, Ottawa.

SHELL CLUB NIGHT, TUESDAY EVENING

Under the capable leadership of Mr. Albert Lindar of the Chicago Shell Club, members met to hear of progress in the various shell clubs throughout the country.

EXECUTIVE COUNCIL MEETING TUESDAY EVENING

While the membership was hearing reports of the various shell clubs, the executive council was meeting in another room to hear reports of the officers of the Union and to prepare for the business meeting on Thursday.

COWRY EXHIBIT

An outstanding feature of this meeting was an exhibit prepared by Mrs. Thomas Burke and Mr. Stanley Dvorak of Chicago and Mr. and Mrs. Crawford Cate of Los Angeles.

For perhaps the first time in the history of this genus, representatives of every taxon was represented by specimens. It will be difficult to assemble such a collection again, especially to equal the fine quality of the specimens exhibited.

PAPERS PRESENTED WEDNESDAY, JULY 23, 1969

Notes on *Valvata tricarinata* from central Nebraska. *Carl W. Gugler*, University of Nebraska, Lincoln, Nebraska.

Contributions to the biology of New England Nudibranch Molluscs. *M. Patricia Morse*, Marine Science Institute, Northeastern University, Nahant, Mass.

Malacology today. D.S. Dundee Louisiana State University New Orleans, La.

* Some techniques in studies of freshwater snails. *Harold J. Walter,* Dayton, Ohio.

SYMPOSIUM ON THE NAIAD MOLLUSKS.

Introduction. Symposium Chairman *David H. Stansbery*.

Early American workers on the Naiades. *William J. Clench,* Museum of Comparative Zoology, Cambridge, Mass.

The earliest names for North American Naiades. *J.P.E. Morrison,* U. S. National Museum, Washington, D.C.

Some basic problems in Naiad taxonomy. *David H. Stansbery,* Ohio State Museum, Columbus, Ohio.

The freshwater mussels of the Canadian Interior Basin. *Arthur H. Clarke,* National Museum of Canada, Ottawa.

Where to find mollusks in creek-size streams. *Herbert Athearn,* Museum of Fluviatile Mollusca, Cleveland, Tenn.

Effects of pollution on the Naiades of the Illinois River. *William C. Starrett,* Illinois Natural History Survey, Havana, Illinois.

Some research needs and methods for protecting Naiades from extinction. *Marc J. Imlay,* National Water Quality Laboratory, Duluth, Minnesota.

Seasonal variation in gonad activity in Unionid clams and its systematic significance. *William H. Heard,* Florida State University, Tallahassee, Florida.

Functional bilateral symmetry of the *Lampsilis* mantle: some problems. *Louise R. Kraemer,* University of Arkansas, Fayetteville, Arkansas.

Studies on the structure and ultrastructure of the glochidial stage of the Naiad *Actinonaias ligamentina* (Lamarck, 1819). *Karen Heffelfinger,* Ohio State University, Columbus, Ohio.

Life history of *Pleurobema cordatum* (Rafinesque, 1820). *Paul Yokley,* Florence State University, Florence, Alabama.

PAPERS PRESENTED THURSDAY JULY 24, 1969

The life history of *Truncatella caribaeensis* 'Sowerby' Reeve. *Landon T. Ross,* Florida State University Tallahassee, Florida.

A dual behavioral interpretation of a single environmental stimulus with freshwater clams. *Marc J. Imlay,* National Water Quality Laboratory, Duluth, Minnesota.

Speciation and distribution of Arctic Wedge Clams in the western North Atlantic. *John D. Davis,* Smith College, Northampton, Mass.

A revision of the land snail genus *Rabdotus* in Texas. *W. L. Pratt,* Fort Worth, Texas.

Special invertebrate staining techniques. *Lucretia Buchanan,* Bureau of Commercial Fisheries Biological Laboratory, Oxford, Md.

Paramya subovata, a commensal of the echiuroid *Thalassema hartmani*. *Charles E. Jenner* and *Anne B. McCrary,* University of North Carolina, Chapel Hill, N.C.

Changes in the naiad fauna of the Cumberland River at Cumberland Falls following impoundment. *David H. Stansbery,* Ohio State Museum. Columbus, Ohio.

The University of Arizona Sciences Program. *Albert R. Mead,* University of Arizona. Tucson, Arizona.

Gonad development in the Three-ridge naiad *Amblema plicata* (Say, 1817). *Carol B. Stein,* Ohio State Museum. Columbus. O.

Methods of subfamily recognition in Pacific Island endodontid land snails. *Alan Solem,* Field Museum of Natural History, Chicago, Illinois.

The American mussel industry -- economic perspectives and ecological implications. *John M. Bates,* Eastern Michigan University, Ypsilanti, Michigan.

After a brief intermission, the business meeting was held. Details will appear in the annual report. The meeting for 1970 will be held in Key West, Florida, exact date to be announced later.

ANNUAL BANQUET, THURSDAY EVENING

The annual banquet was held at Red n' Ed's Supper Club, River Road, Marinette. Buses transported delegates from the Dome Motel to the Supper Club around 6:30 and the banquet was preceded by a highly successful social hour.

After dinner, President Rosewater introduced Dr. William J. Clench who gate the annual after-dinner address on 'Distribution of the freshwater mollusks of North America.' The audience showed its appreciation with a standing ovation for Dr. Clench.

Next, the president officially acknowledged the fine work of Mrs. Teskey and her various assistants for a well organized and successful meeting. The audience was not slow in showing its appreciation of Margaret Teskey's work by a standing ovation lasting several minutes.

President Rosewater then thanked the Union for making his work as president so agreeable and introduced the new president, Alan Solem, vice-president, David H. Stansbery, and publications editor, M. Karl Jacobson.

President Solem thanked President Rosewater and the AMU for the high honor bestowed upon him. He promised to do his best to further the interests of the Union during the coming year.

The meeting then adjourned until next year and all that remained of the 1969 meeting was the field trip.

FIELD TRIP, JULY 25 1969

Buses transported the delegates from the Dome Motel to Lake Mary and Julia, in Marinette County, where *Lymnaea haldemani* still survives. It is the snail portrayed on the cover of this year's program and on the inside front cover in fine anatomical and shell drawings by Harold J. Walter.

The list of the 112 members and guests attending the thirty-fifth annual meeting of the AMU is printed herewith thanks to Margaret Teskey who compiled it.

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A. La Rocque

BOOK REVIEW

JUAN J. PARODIZ, *The Tertiary non-marine Mollusca of South America*. Annals, Carnegie Museum, Pittsburgh, Pa., v. 40, p. 1-242, 19 pls., 7 maps. 1969

Tertiary non-marine Mollusca of any area are notoriously difficult to study. There is enough similarity between the fossil genera and living ones to require comparison with the latter if firm taxonomy is to be achieved. The temptation to erect new genera must be resisted until those of even the most remote and unlikely places have been compared with the fossil forms under study. Likewise, comparisons based on superficial resemblances must be seriously evaluated before conclusions are drawn concerning paleogeography and dispersal. Identification is further complicated by the absence of anatomical data and sometimes by lack of delicate surface sculpture or dentition, both in pelecypods and gastropods.

For South America, two further complications exist: first, the confusion in the early literature as to the geologic age of the beds in which fossils were collected and second, the location of types in the museums of three continents.

It is apparent, therefore, that any revision of the taxonomy would require a special combination of abilities on the part of the scientist bold enough to attempt it. We are fortunate in having in Juan Parodiz a malacologist-paleontologist who has the necessary qualifications and has worked for more than 20 years on this problem.

The results of his work are impressive. His paper gives new lists of non-marine Mollusca for the units of the South American Tertiary from the Paleocene to the Pliocene. For example, the genera *Lioplacodes, Neritina, Pyrgulifera, Valvata, Physa,* and *Sphaerium* are present in many areas of South America as early as the Paleocene. The same genera, or very close allies. are represented in the North American Tertiary. Parodiz has indicated (map 7, p. 190) the probable dispersal patterns involved and this will give much food for thought to paleogeographers and paleoecologists concerned with the question of dispersal by wind from one isolated area to another or by continuous ecological conditions later broken by marine invasion or other disrupting factors.

There is much more stimulating material in this authoritative revision which is highly recommended to malacologists, paleontologists, and Tertiary paleogeographers.

A. L.

Genus RHODACMEA Walker, 1917.

Shell and animal as in the subfamily.

Key to the sections of *Rhodacmea*.

Shell elevated. Radula having the base of the central tooth expanded and not overlapped by the mesocone of the first lateral .... *Rhodacmea s. s.*

Shell depressed. Base of central tooth of radula not expanded, overlapped by the mesocone of the first lateral.... *Rhodocephala.*

Section RHODACMEA s. s.

Shell elevated. Radula with a unicuspid central, which has the base triangularly expanded; laterals with the cusp of the mesocone extending but little beyond the base and not overlapping the base of the central tooth. Type: *Ancylus filosus* Con., fig. 63. Radula, fig. 64.

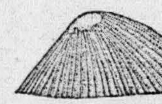

Fig. 63

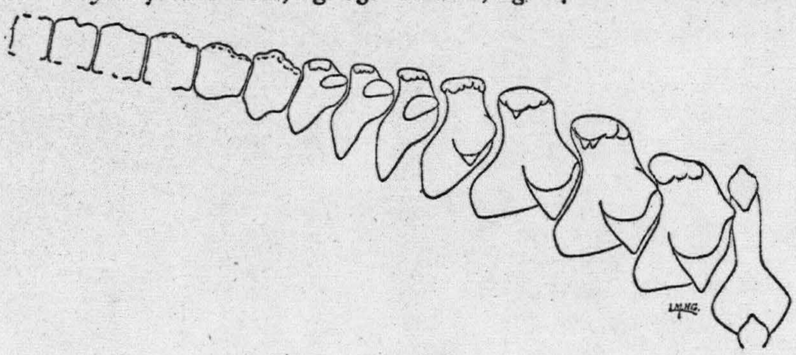

Fig. 64

Section RHODOCEPHALA Walker, 1917.

Shell depressed. Radula with a faintly bicuspid central, which has the sides of the base straight and not expanded; laterals with the cusp of the mesocone extending far beyond the base and overlapping the base of the central tooth.

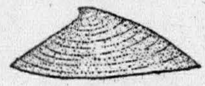

Fig. 65

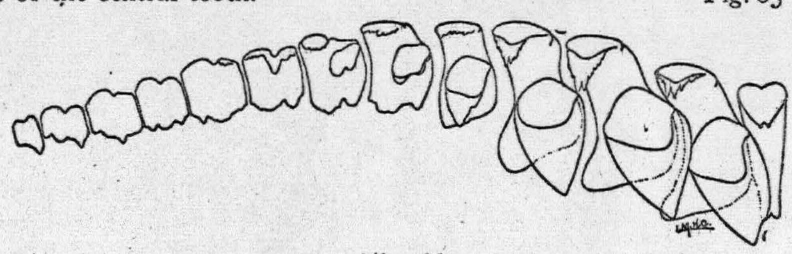

Fig. 66

Type: *Rhodacmea rhodacme* Walk., fig. 65. Radula, fig. 66.

Subfamily NEOPLANORBINÆ Hannibal, 1912.

Shell small, planorbiform or neritiform.

Key to the genera of *Neoplanorbinæ*.

Shell planorbiform .... *Neoplanorbis.*
Shell neritiform .... *Amphigyra.*

Genus NEOPLANORBIS Pilsbry, 1906.

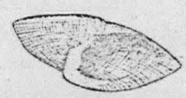

Fig. 67

Shell very minute, planorboid, dextral, subdiscoidal, nearly flat above, convex below, usually carinate at the periphery; whorls two, rapidly enlarging; aperture very oblique, wider than high, a little dilated at the base; lip thin, not continuous; columellar margin straight and broadly dilated, somewhat thickened within. Dentition and anatomy so far as known similar to *Amphigyra*.

Type: *N. tantillus* Pils., fig. 67.

Genus AMPHIGYRA Pilsbry, 1906.

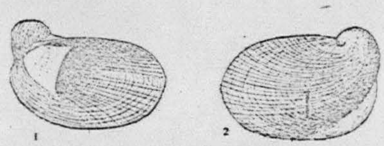

Fig. 68

Shell minute, dextral, neritoid or crepiduliform, imperforate, with a small, depressed, lateral spire; whorls about 1½, very rapidly enlarging, the last very convex dorsally; apex smooth; body-whorl spirally striate; aperture very large, transversely oval; lip continuous and full, thin; cavity of the spire very small, a thin, broad, concave, columellar plate projecting across the end next the spire.

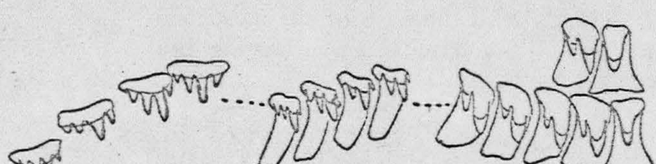

Fig. 69

Animal sinistral, externally lymnæid; tentacles short, blunt, cylindric; eyes near their inner bases; a short, false gill in the pallial cavity. Radula arranged as in *Lymnæa*, central tooth unicuspid, laterals bicuspid, marginals low, wide, with four or five cusps.

Type: *A. alabamensis* Pils., fig. 68. Radula, fig. 69.

Subclass STREPTONEURA.
Order PECTINIBRANCHIA.
Suborder TÆNIOGLOSSA.
Superfamily PLATYPODA.

Key to the families of *Platypoda*.

1.	Operculum concentric	2.
	Operculum spiral	3.
2.	Shell very large; animal with both gill and lung	*Ampullariidæ.*
	Shell smaller; animal with gill only	*Viviparidæ.*
3.	Operculum circular, multispiral	*Valvatidæ.*
	Operculum paucispiral	4.
4.	Animal with external verge, central tooth with basal denticles	*Amnicolidæ.*
	Animal without verge; no basal denticles on central tooth	*Pleuroceridæ.*

Family AMPULLARIIDÆ.

Shell large, spiral, globosely turbinate; aperture entire; operculum (in the North American species) corneus, concentric, with a sub-central nucleus.

Animal with snout divided into two long, tentacular lobes; tentacles long and filiform; eyes on peduncles on the outer bases of the tentacles; mantle with two cervical lobes, that on the left forming a more or less elongated siphon; genital orifices on the right side in the pallial cavity; the respiratory chamber divided into two parts, the one being a lung and the other containing a large gill; foot large, simple; jaws two; radula with seven rows of teeth, central large, subtrapezoidal, multicuspid, no basal denticles; the laterals and marginal narrow, uni- or bicuspid. Oviparous.

Genus AMPULLARIA Lamarck, 1799.

Shell dextral, globose, with a green or brown epidermis; spire short, last whorl rounded, inflated; umbilicate; aperture entire, angular above, rounded below, lip simple.

Fig. 71

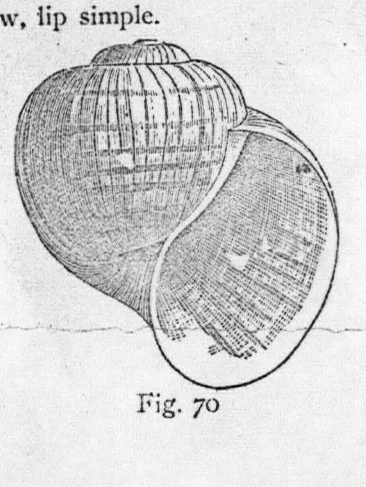

Fig. 70

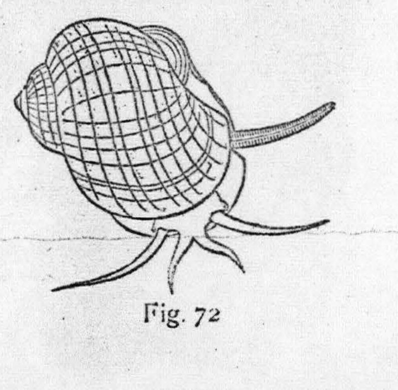

Fig. 72

Type: *Nerita urceus* Müll.

Example: *A. paludosa* Say, fig. 70. Radula, fig. 71. Animal, fig. 72.

Family VIVIPARIDÆ.

Shell moderately large, turbinate, imperforate, or subperforate; whorls convex; aperture entire, subcircular or somewhat angled above; lip simple; operculum convex, concentric, nucleus subcentral, sometimes subspiral.

Animal with a long snout, not divided into tentacular lobes; tentacles long and slender, in the male the right one is shorter, truncated and forms a sheath for the verge; eyes on peduncles on the exterior base of the tentacles; mantle with two cervical lobes, of which the right is the larger, forming with the mantle distinct tubular conduits for the ingress and egress of water for respiration; jaws two; radula with the teeth simple or denticulate, central tooth large, broad, without basal denticles, laterals large, subtrigonal, marginals narrow, elongated. Ovoviviparous.

Key to the Genera of *Viviparidæ*.

1.	Operculum wholly concentric	2.
	Operculum with subspiral nucleus	*Lioplax*.
2.	Reflected apices of the lateral teeth simple	*Campeloma*.
	Reflected apices of the lateral teeth denticulate	3.
3.	Inner margin of the operculum simple	*Viviparus*.
	Inner margin of the operculum reflected, forming an elevated marginal fold	*Tulotoma*.

Genus VIVIPARUS Montfort, 1810.

Shell dextral, spiral, subconoidal; rather thin, smooth, imperforate or slightly umbilicate; light green or olivaceous, unicolored or banded with brown or tinged with purple; whorls convex, aperture entire, subcircular; lip simple, acute; columellar and parietal margin not usually thickened; operculum concentric, inner margin simple, not reflected.

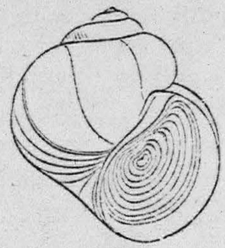

Fig. 73

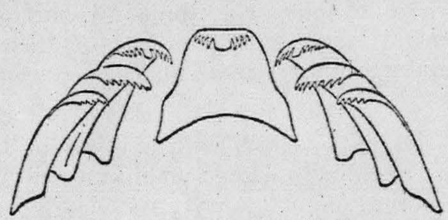

Fig. 74

Animal with foot of moderate size, not produced beyond the snout. Teeth of the radula multicuspid.

Type: *Helix vivipara* L.

Example: *V. intertextus* (Say), fig. 73. Radula, fig. 74.

Genus CAMPELOMA Rafinesque, 1819.

Shell dextral, spiral, imperforate, thick and solid; olivaceous green, unicolored, spire produced; whorls smooth, rounded or shouldered; aperture oval; lip simple, columella and parietal wall usually callously thickened. Operculum concentric, inner margin simple.

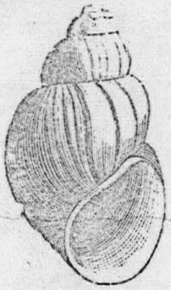
Fig. 75

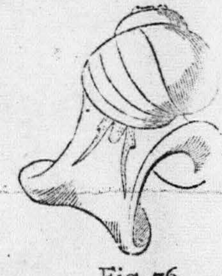
Fig. 76

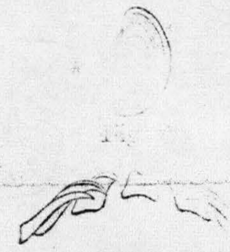
Fig 78

Animal with the foot large, rather thin, much produced beyond the snout; snout small; teeth of the radula simple or only very minutely crenulated.

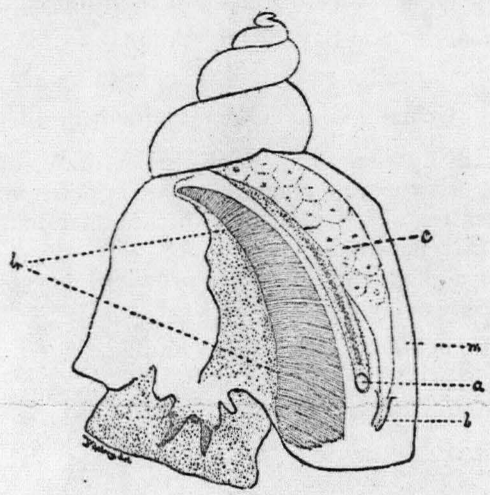

Fig 78A

a.—Anus. b-c.—Uterus.
br.—Gill. m.—Mantle.

Type: *C. crassula* Raf.

Example: *C. decisum* (Say), fig. 75. Animal, fig. 76. Operculum, fig. 77.

Radula: *C. integrum* (Say), fig. 78.

Animal: *C. subsolidum* (Anth.), fig. 78A.

Genus LIOPLAX Troschel, 1856.

Shell dextral, spiral, thin, ovate, turreted, imperforate, spire produced; whorls rounded, or carinated; olivaceous green or dark brown; aperture oval subcircular; lip thin, continuous; operculum concentric, with a subspiral nucleus.

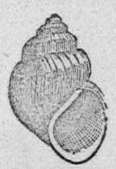

Fig. 79

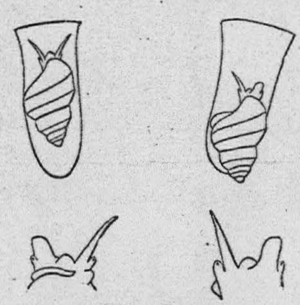

Fig. 80

Fig. 81

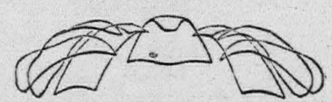

Fig. 82

Animal with the foot very large, greatly produced beyond the snout; snout very short. Lingual teeth smooth at their apices.

Type: *Limnæa subcarinata* Say, fig. 79. Animal, fig. 80. Operculum, fig. 81. Radula, fig. 82.

Genus TULOTOMA Haldeman, 1840.

Shell (typically) large, solid, thick, imperforate, obtusely conic, spire elevated; whorls flattened, nodulous, carinated; peristome thin, continuous; operculum concentric, subtriangular, with the inner margin reflected forming an elevated marginal fold.

Animal with a moderate foot, not produced beyond the snout; snout small; lingual teeth multicuspid.

Type: *Paludina magnifica* Con., fig. 83. Radula, fig. 84. Operculum, fig. 85.

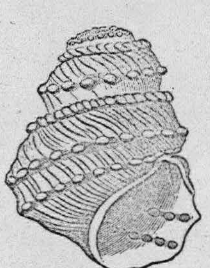

Fig. 83

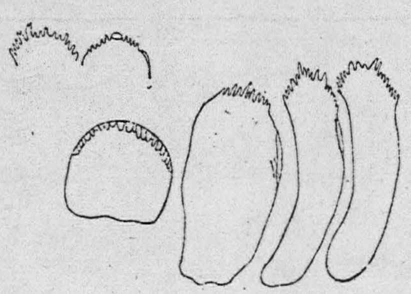

Fig. 84

Fig. 85

Family VALVATIDÆ.

Shell small, spiral, dextral, turbinate, or subdiscoidal; whorls rounded or carinated; aperture entire, circular; lip simple, sharp; operculum orbicular, multispiral, whorls with a thin elevated edge.

Animal diœcious; tentacles long, slender, cylindrical; eyes sessile on the internal bases of the tentacles; snout long; foot large, bilobed in front; gill external, plumose, protected by a long, slender pallial appendage; verge exterior, placed on the right side, at the base of and below the tentacle; jaws two; lingual teeth multicuspid, no basal denticles on the central tooth.

Genus VALVATA Müller, 1774.

The characters of the genus are those of family.

Type: *V. cristata* Müll.

Example: *V. tricarinata* (Say), fig. 86. Animal, fig. 87. Radula, fig. 88.

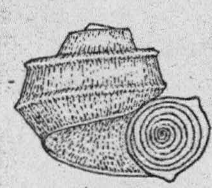

Fig. 86

Fig. 87

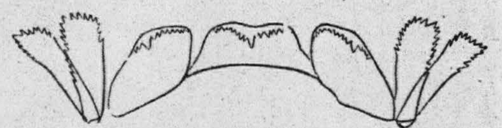

Fig. 88

Family AMNICOLIDÆ.

Shell small, spiral, dextral, conical, imperforate or umbilicated; unicolored; aperture entire, lip simple, acute; operculum concentric, spiral or subspiral.

Animal with a long snout; tentacles long, cylindrical, with the eyes at their outer bases; foot oblong, truncate before, rounded behind; gills internal; verge exserted, placed on the back, some distance behind the right tentacles; jaws two; central tooth of the radula multicuspid and with one or more basal denticles; laterals hatchet-shaped, multicuspid; marginals slender, multicuspid.

Key to subfamilies of *Amnicolidæ*.

1.	Operculum multispiral	*Lyogyrinæ.*
	Operculum concentric	*Bythininæ.*
	Operculum paucispiral	2.
2.	Foot divided	*Pomatiopsinæ.*
	Foot simple	3.
3.	Shell thin, subglobose to elongate; columella not thickened	*Amnicolinæ.*
	Shell thick, short, body-whorl very large; columella thickened	*Lithoglyphinæ.*

Subfamily BYTHININÆ Stimson, 1865.

Shell small, spiral, dextral, turbinate, spire produced; operculum calcareous, concentric.

Foot simple; central tooth of the radula with several basal denticles.

Genus BYTHINIA Leach, 1818.

Shell large for the family, spiral, elevated, subperforate; aperture oval; peristome thin, continuous; lip simple, sharp; operculum calcereous, concentric.

Type: *Helix tentaculata* L., fig. 89. Animal, fig. 90. Radula, fig. 91.


Fig. 89

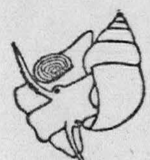
Fig. 90

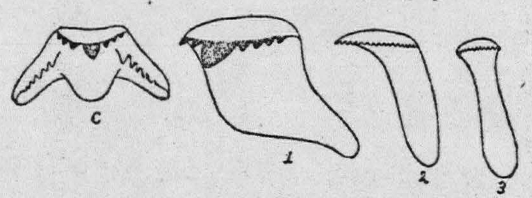

Fig. 91

Subfamily AMNICOLINÆ Gill, 1871.

Shell small, spiral, dextral, subglobose to elongate, thin; imperforate or umbilicate; columella and parietal wall not callously thickened; operculum corneous, paucispiral.

Foot simple; central tooth of the radula with several denticles.

Key to genera of *Amnicolinæ*.

1.	Shell smooth, periphery rounded	2.
	Shell smooth, periphery angulate	*Littoridina.*
	Shell strongly carinated	*Pyrgulopsis.*
	Shell spinose	*Potamopyrgus.*
	Shell longitudinally ribbed	*Tryonia.*
2.	Shell slender, spire long	*Paludestrina.*
	Shell ventricose, spire usually short	*Amnicola.*

Genus AMNICOLA Gould and Haldeman, 1841.

Shell small, oval-conic, rather short, spire subacute; whorls 4-6, convex; aperture oval; peritreme continuous; lip simple, sharp; columella not thickened. Operculum thin, corneous, paucispiral.

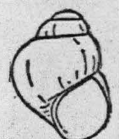
Fig. 92

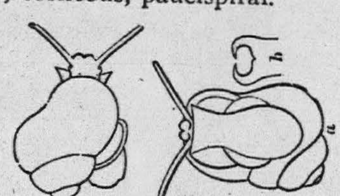
Fig. 93


Fig. 94

Animal oviparous; central tooth of the radula multicuspid, with a tooth-shaped process from the middle of the anterior surface, reaching beyond the base, and with several basal denticles; laterals and marginals multicuspid. Verge short, bifid, with a globular base.

Type: *Paludina limosa* Say, fig. 92. Animal, fig. 93. Operculum, fig. 94. Radula, fig. 95.

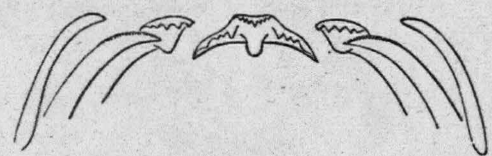

Fig. 95

Subgenus CINCINNATIA Pilsbry, 1891.

Fig. 96

Radula more minute and the denticulations of the cusps finer and sharper.

Type: *Paludina cincinnatiensis* Anth., fig. 96. Radula, fig. 97.

Fig. 97

Genus PALUDESTRINA d'Orbigny, 1840.

Shell similar to *Amnicola,* but more slender and elongated. Central tooth with but one basal denticle on each side, and without the tongue shaped process of *Amnicola*. Verge bifid.

Fig. 98

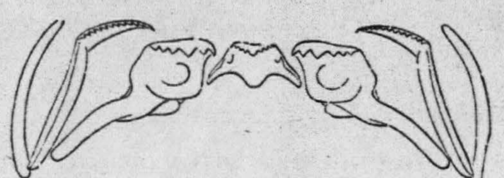

Fig. 99

Type: *Cyclostoma acutum* Drap.

Example: *P. nickliniana* (Lea), fig. 98. Radula, fig. 99.

Genus TRYONIA Stimpson, 1865.

Shell perforate, elongated, turreted, subulate; apex acute; surface longitudinally ribbed or plicated; whorls numerous, shouldered; aperture small, oblique, rhombo-ovate, lip sharp, thin and effuse at the base; peritreme continuous.

Type: *T. clathrata* Stimp., fig. 100.

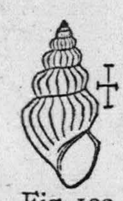

Fig. 100

Genus PYRGULOPSIS Call and Pilsbry, 1886.

Shell ovate-conical or turreted, imperforate, whorls having a single, strong carina at the periphery, which may or may not be concealed on the spire; apex acute; whorls 4½ to 6; aperture ovate, peristome continuous;

central tooth of the radula with but one basal denticle on each side; denticles of the lateral teeth large and angular, those of the laterals small and slender.

Fig. 101

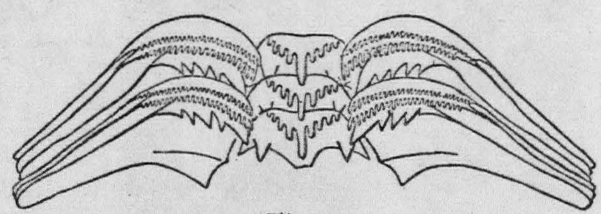

Fig. 102

Type: *Pyrgula nevadensis* Stearns, fig. 101. Radula, fig. 102.

Genus POTAMOPYRGUS Stimpson, 1865.

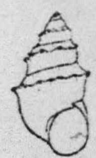

Fig. 103

Shell ovate-conic, imperforate; apex acute; whorls angulated and usually coronated with spines; body-whorl two-thirds the length of the shell; aperture ovate, lip acute.

Animal with rostrum of moderate length; tentacles very long, slender, tapering and pointed; eyes on prominent tubercles; foot rather short, strongly auriculated in front; central tooth of radula trapezoidal, inferior margin nearly straight; faintly enlobate; basal teeth minute and close to the lateral margin; denticles of the intermediate tooth numerous and of equal size.

Type: *Melania corolla* Gld.
Example: *P. coronatus* (Pfr.), fig. 103.

Genus LITTORIDINA Souleyet, 1852.

Shell narrowly perforate, subpyramidal, solid, opaque, body-whorl subangulate at the periphery; aperture pyriform, acutely angulated above; columella thickened, white; peritreme not continuous, lip sharp.

Verge very large, with five or six small, digitate appendices. Radula as in *Amnicola*.

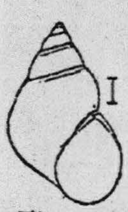

Fig. 104

Fig. 105

Type: *L. gaudichaudii* Soul.
Example: *L. monroensis* (Frfld.), fig. 104. Radula, (*L. hatcheri* Pils.) fig. 105.

Subfamily LITHOGLYPHINÆ Fischer, 1885.

Shell small, spiral, dextral, spire short, body-whorl large, forming most of the shell; columella usually callously thickened; operculum corneous subspiral.

Foot simple; central tooth of the radula with several basal denticles.

Key to the genera of *Lithoglyphinæ*.

1. { Shell imperforate or narrowly perforate .... 2.
   Shell widely umbilicate .... 3.

2. { Peritreme sinuous, lip effuse below, verge winged ...... *Fluminicola*.
   Peritreme continuous in same plane, verge simple .... *Gillia*.
   Peritreme very oblique, lip effuse above, verge bifid .... *Somatogyrus*.

3. { Shell spirally striate, depressed, turbinate, widely umbilicate .... *Cochliopa*.
   Shell smooth, globose-turbinate, umbilicus narrower, but deep. *Clappia*.

Genus COCHLIOPA Stimpson, 1865.

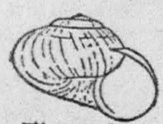

Fig. 106

Shell depressed-conic; base concave, umbilicus large and deep; aperture oblique; operculum corneous, subspiral.

Rostrum of moderate size; tentacles rather long and tapering. Teeth of the radula multicuspid, basal denticles on central tooth 2 or 3 on each side. Verge rather elongated, compressed, geniculated and bifid.

Type: *Amnicola rowellii* Tryon.
Example: *C. riograndensis* P. and F., fig. 106.

Genus CLAPPIA Walker, 1909.

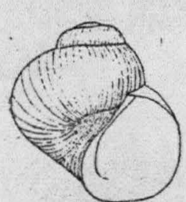

Fig. 107

Shell minute, spiral, dextral, globose-turbinate, narrowly but deeply umbilicate. Spire short; body whorl large; whorls round; aperture large; lip simple; columellar lip thin, appressed to the body-whorl only at the upper end; operculum paucispiral, nuclear whorls large, slowly and regularly increasing.

Fig. 108

Rachidian tooth as in *Somatogyrus*, intermediate tooth with a long peduncle and a strong tooth projecting from the infero-anterior angle, laterals multicuspid.

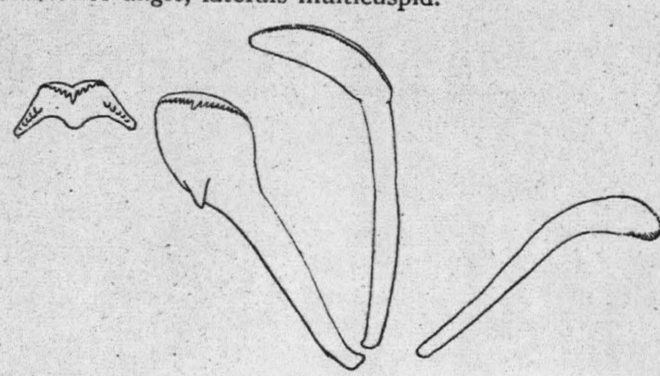

Fig. 109

Type: *C. clappii* Walker, fig. 107. Operculum, fig. 108. Radula, fig. 109.

Genus FLUMINICOLA Stimpson, 1865.

Fig. 110

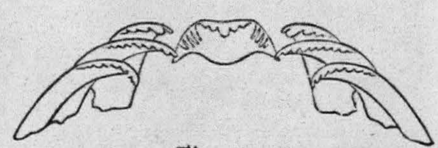

Fig. 111

Shell spiral, dextral, obliquely ovate, thick, solid, smooth, imperforate; spire moderate, obtuse; aperture ovate; columella flattened, calloused; lip effuse and projecting anteriorly so that the peritreme is not continuously in the same plane; operculum corneous, subspiral.

Rostrum rather large; tentacles tapering, foot broad; central tooth of the radula with several basal denticles on each side; outer lateral teeth with a smaller number of denticles than the inner. Verge large, compressed, with a broad semicircular wing on the left side.

Type: *Paludina nuttalliana* Lea, fig. 110. Radula, fig. 111.

Genus SOMATOGYRUS Gill, 1863.

Shell dextral, spiral, usually rather thick and solid, smooth, imperforate or narrowly perforate; spire usually short; apical whorl spirally punctate or lirate; body-whorl large, more or less inflated; aperture very oblique; lip sharp, projecting above; columella callously thickened. Operculum corneous, subspiral, nuclear whorls small, rapidly increasing.

Fig. 112

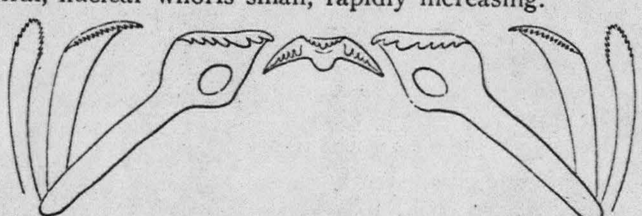

Fig. 113

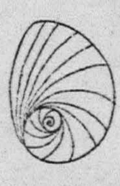

Fig. 114

Rostrum rather broad, flat and square-cut; tentacles rather short and flattened; teeth of the radula multicuspid, basal denticles on the central tooth 3-4 on each side. Verge broad, compressed and bifid.

Type: *Amnicola depressa* Tryon, fig. 112. Radula, fig. 113. Operculum, fig. 114.

Genus GILLIA Stimpson, 1865.

Fig. 115

Fig. 116

Shell spiral, dextral, not very thick, smooth, imperforate; spire short, obtuse, body whorl large, inflated; aperture large, oblique; peritreme continuous on the same plane, lip thin, sharp; columella very slightly thickened; operculum corneous, subspiral.

Rostrum broad, subtruncate, foot oblong, rounded behind and auriculate in front; tentacles long, slender and pointed; teeth of the radula multicuspid; central tooth with two basal denticles on each side. Verge small, simple, lunate.

Type: *Melania altilis* Lea, fig. 115. Radula, fig. 116.

Subfamily LYOGYRINÆ Pilsbry, 1916.

Shell minute, conical or subdepressed. Operculum circular, multispiral.

Key to the genera of *Lyogyrinæ*.

Shell amnicoliform .... *Lyogyrus*.
Shell valvatæform .... (s. g.) *Hauffenia*.

Genus LYOGYRUS Gill, 1863.


Fig. 117

Shell very small, spiral, dextral, smooth, umbilicate; globose-turbinate or elongate-ovate; aperture nearly circular; peritreme continuous, frequently quite separated from the body-whorl. Operculum corneous, circular, multispiral.

Rostrum bilobed in front, half as long as the tentacles, which are rather stout; foot auriculated in front; gill external. Dentition as in *Paludestrina*, basal denticles on rachidian tooth two on each side.

Type: *Valvata pupoidea* Gld., fig. 117.

Genus HORATIA Bourguignat, 1887.

Shell very small, amnicoliform, thick-shelled, umbilicate, almost smooth; whorls only 3-4, convex, rapidly increasing, the last large, rounded; suture impressed; aperture very oblique, rounded; lip adherent, straight, sharp; columella thickened, incurved. Operculum corneous, transparent, purple-red, with 3-4 slowly increasing spirals and an almost central nucleus.

Type: (first species) *Horatia klecakiana* Bgt.

Subgenus HAUFFENIA Pollonera, 1898.

Shell minute, rather thin, valvatæform, widely umbilicate.

Type: (first species) *Horatia tellini* Poll.

Example: *Horatia micra* (P. and F.), fig. 118.


Fig. 118

Subfamily POMATIOPSINÆ Stimpson, 1865.

Foot divided by a transverse sulcus at about its anterior third. Verge simple. Rachidian tooth with one basal denticle on each side, denticles of the lateral and marginal teeth fewer and proportionately larger than in the other subfamilies. Only one genus.

Genus POMATIOPSIS Tryon, 1862.

Shell dextral, spiral, thin, smooth, long, turreted, umbilicated; aperture somewhat expanded; lip simple or slightly reflected; operculum corneous, subspiral.


Fig. 119

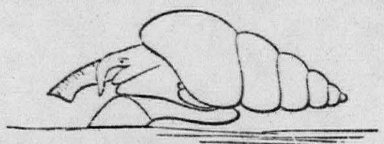
Fig. 120

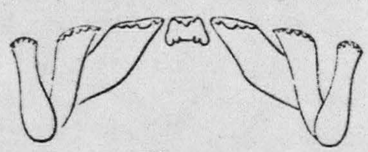
Fig. 121

Animal not as long as the shell, rostrum large, longer than the tentacles, which are short and subulate. Verge very large, simple, convoluted, outer margin rounded and smooth, inner margin sharp and wrinkled.
Type: *Cyclostoma lapidaria* Say, fig. 119. Animal, fig. 120. Radula, fig. 121.

Family PLEUROCERIDÆ.

Animal oviparous, edge of mantle smooth; eyes on the external bases of the tentacles; no verge. Rachidian tooth large, broader than long, rounded below, multicuspid; laterals subrhomboidal, multicuspid; marginals narrow, multicuspid.

Shell dextral, spiral, thick and solid, globose or elongated; aperture entire or more or less canaliculated below, operculum corneous, subspiral.

Key to the genera of *Pleuroceridæ*.

1.	Aperture canaliculate below	2.
	Aperture angulated below, not canaliculate	4.
	Aperture entire, rounded below	*Anculosa.*
2.	Shell fusiform, canal long	*Io.*
	Shell conical, canal short	3.
3.	Spire elongated; no callus thickening on parietal wall	*Pleurocera.*
	Spire short; parietal wall callously thickened above and below	*Lithasia.*
	Spire short; parietal wall callously thickened above	*Eurycœlon.*
4.	Aperture entire above	*Goniobasis.*
	Aperture with a sutural slit	*Gyrotoma.*

Genus IO Lea, 1831.


Fig. 122

Shell large, spiral, dextral, imperforate, fusiform, smooth, tuberculate or spinose; spire elevated, base of aperture prolonged in a long canal; columella round, smooth and concave; lip thin; operculum corneous, subspiral. Animal as in the family.

Type: *Fusus fluvialis* Say.

Example: *I. spinosa* Lea, fig. 122. Radula, fig. 123.

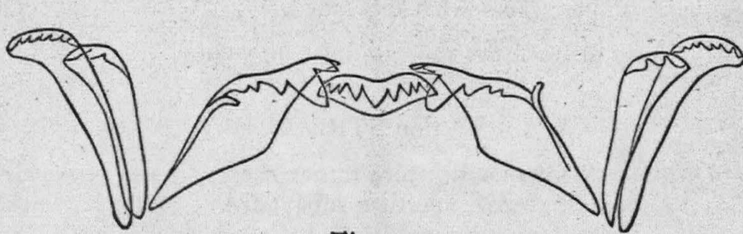
Fig. 123

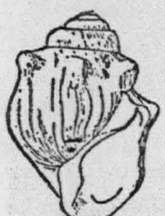
Fig. 124

Genus LITHASIA Haldeman, 1840.

Shell of medium size, spire dextral, imperforate, globose conic, smooth or tuberculate; thick and solid, spire elevated, obtusely conic; aperture large, rhomboidal; columella smooth, callously thickened above and below; base of the aperture shortly channelled below. Animal as in the family.


Fig. 125

Type: *L. geniculata* Hald., fig. 124.

Operculum, *L. obovata* (Say), fig. 125.

Section ANGITREMA Haldeman, 1841.


Fig. 126

Shell similar to *Lithasia* but with the basal canal more produced.

Type: *Melania armigera* Say, fig. 126.

Genus EURYCÆLON Lea, 1864.


Fig. 127

Shell large, obovate, thick, solid; spire short; body-whorl large; columella callously thickened above, incurved below and subtruncate.

Type: *Anculosa anthonyi* Budd, fig. 127.

Genus PLEUROCERA Rafinesque, 1818.


Fig. 128

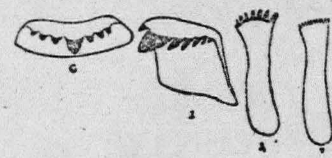
Fig. 129

Shell usually lengthened, conic or cerithiform, spiral, dextral, imperforate; smooth, tuberculate, spirally striate or carinate; aperture moderate, subrhomboidal, prolonged into a short canal below; columella smooth, twisted, not callously thickened; lip simple, sharp, sinuous, somewhat expanded.

Type: *P. acuta* Raf., fig. 128. Radula, fig. 129.

Section STREPHOBASIS Lea, 1861.


Fig. 130

Shell smooth, spire rather short, obtusely conical, body-whorl subcylindrical; aperture subquadrate; columella thickened below, twisted and drawn back, base subcanaliculate; lip acute, very sinuous.

Type: *Melania plena* Anth., fig. 130.

Genus GONIOBASIS Lea, 1862.


Fig. 131

Shell medium size, dextral, spiral, imperforate; smooth, longitudinally plicate, transversely striate or tuberculate; thick, solid, ovate-conic to elongate turreted; aperture subrhomboidal, subangular at the base but not canaliculate; columella smooth, not twisted; lip simple, acute.

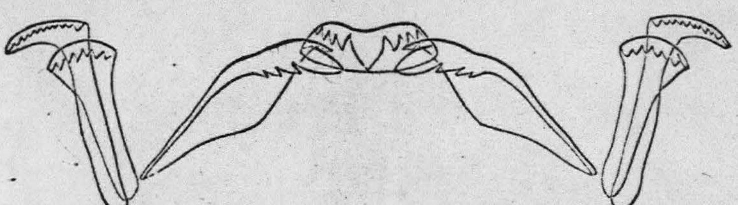
Fig. 132

Type: *G. osculata* Lea, fig. 131. Radula, *G. depygis* (Say), fig. 132.

Genus GYROTOMA Shuttleworth, 1845.

Shell of moderate size, spiral, dextral, imperforate, smooth or spirally striate, rather thick and solid, conical or globosely ovate; aperture oval or elliptical, with a sutural slit or fissure above, entire below; lip thin and sharp.

Fig. 133 Type: *G. ovoidea* Shutt., fig. 133. Radula, fig. 134.

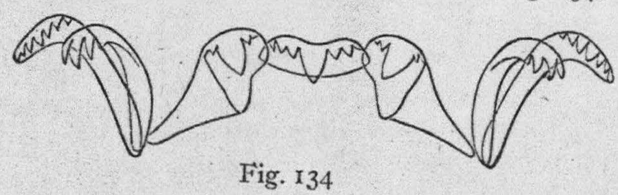

Fig. 134

Genus ANCULOSA Say, 1821.

Shell of moderate size, dextral, imperforate (except in one species), smooth, tuberculate, spirally striate, sulcate or carinate, thick, solid, subglobose with a very short spire or thinner and conical; aperture oval or subcircular, entire, rounded below; columella callously thickened; lip simple, acute.

Type: *Melania prærosa* Say, fig. 135. Radula, fig. 136.

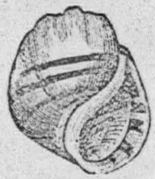

Fig. 135

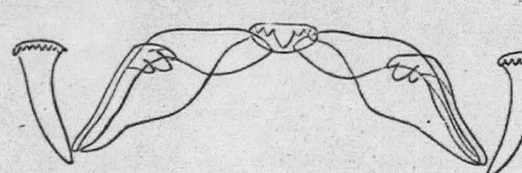

Fig. 136

Order ASPIDOBRANCHIA.

Suborder RHIPIDOGLOSSA.

The Rhipidoglossæ differ radically from the Tænioglossæ in the character of the lingual dentition. The radula has many rows of teeth, consisting of a central, 2-5 laterals and numerous marginals arranged like the sticks of a fan.

Family NERITIDÆ.

Head large, rostrum divided and lobed in front; tentacles long and slender; eyes carried on peduncles placed at the external base of the tentacles; foot large, truncate before and obtuse behind, sides simple; gill large, triangular, pointed, free at its extremity; branchial and excretory orifices on the right side. Radula with a very small central tooth, 2 to 5 lateral teeth of varying size and shape and numerous spatulate marginals.

Shell imperforate, globose, spire short; internal divisions of the shell absorbed; aperture semi-ovate, entire, columellar region expanded and flattened, usually thickened; lip acute; operculum subspiral.

Key to the genera of *Neritidæ*.

1. Operculum calcareous, edge with projecting processes (apophyses) articulating with the columella..........*Neritina*.
2. Operculum corneous, without apophyses...............*Lepyrium*.

Genus NERITINA Lamarck, 1809.

Shell dextral, spiral, thick and solid, subglobose; spire short; surface smooth (in American species); aperture semi-circular, columella flattened, straight, smooth or finely denticulate; lip acute, inner surface smooth; operculum calcareous, semi-circular, paucispiral, nucleus excentric; with two apophyses, the upper shorter, sometimes dilated and crested; the lateral in the form of an arched rib.

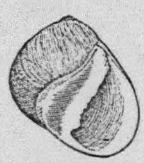

Fig. 137

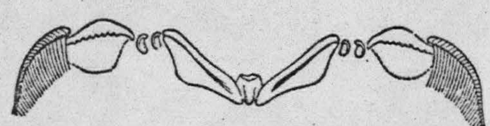

Fig. 138

Animal as in the family. Radula with the central tooth small, subquadrangular, cusp smooth; first lateral large, second and third small, fourth very large, prolonged below and with the cusp semicircular and denticulate, laterals numerous, spatulate.

Type: *N. perversa* Gmel.

Example: *N. reclivata* Say, fig. 137. Radula, fig. 138.

Fig. 139

Genus LEPYRIUM Dall, 1896.

Shell small, dextral, spiral, corneous, thin, semi-transparent; spire very small and depressed, body-whorl large; aperture large, semi-circular; columella concavely flattened, calloused, straight, smooth; lip thin, acute operculum thin, corneous, paucispiral without apophyses.

Radula with a wide rachidian tooth with a finely denticulated cusp; laterals two, the inner small and oblique, the other large with the cusp finely denticulate; laterals spatulate, numerous. Animal otherwise unknown.

Type: *Neritina showalteri* Lea, fig. 139.

Class LAMELLIBRANCHIA.

Order EULAMELLIBRANCHIA.

Suborder SUBMYTILACEA.

Key to the families of *Submytilacea*.

1.	Ligament external	2.
	Ligament internal	5.
2.	Hinge with cardinal, anterior and posterior lateral teeth	4.
	Hinge with cardinal teeth only	*Cyrenellidæ.*
	Hinge with lateral teeth only (no true cardinals) or edentate	3.
3.	Gills with distinct, interlamellar septa, parallel with the gill filaments	*Unionidæ.*
	Gills either without distinct, interlamellar septa or, when present, oblique to the gill-filaments	*Margaritanidæ.*
4.	Pallial line simple	*Sphæriidæ.*
	Pallial line sinuate	*Cyrenidæ.*
5.	Hinge with cardinal and lateral teeth	*Rangiidæ.*
	Hinge without distinct teeth	*Dreissensiidæ.*

Family MARGARITANIDÆ.

"Diaphragm incomplete, formed by the gills; posteriorly the outer lamina of the outer gills not connected with the mantle for a considerable distance; anterior end of the inner gills separated from the palpi by a gap; branchial and anal openings ill-defined, and the latter not closed above; no super-anal developed; gills without water-tubes and with scattered interlamellar connections, which in certain places form irregular rows or with continuous septa which run obliquely forwards; marsupium formed by all four gills; larva a small semicircular glochidium, without distinct hooks; shell elongated; sculpture of the beak concentric; hinge-teeth imperfect; epidermis blackish." (Ortmann.)

Genus MARGARITANA Schumacher, 1817.

Shell elongated, usually arcuate, rounded in front, almost lacking a posterior ridge; beaks rather low, sculpture consisting of a few coarse, parallel ridges which follow the growth lines; epidermis concentrically striate, brownish or blackish; hinge-teeth generally imperfect or not fully developed, two more or less perfect pseudocardinals in the left valve and one in the right, often reduced to mere tubercles; laterals short, usually imperfect or wholly wanting; cavity of the beaks rather shallow.

Key to the subgenera of *Margaritana.*

Gills with scattered interlamellar connections forming irregular rows running obliquely forwards..............*Margaritana s. s.*
Gills with continuous septa running obliquely forwards..*Cumberlandia.*

Subgenus MARGARITANA s. s.

Shell as in the genus.

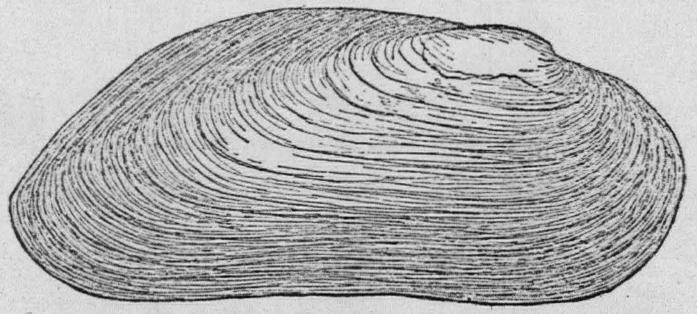

Fig. 140

Animal as in the family, but having the gills without water-tubes and with scattered interlamellar connections which in certain places form irregular rows, running obliquely forwards.

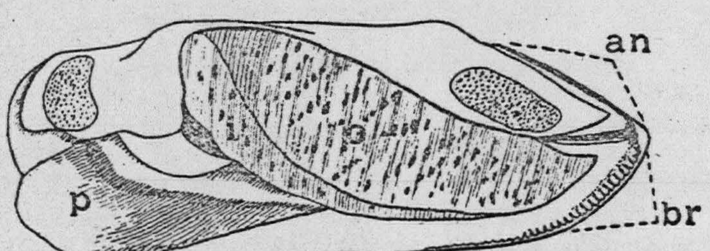

Fig. 141*

Type: *Mya margaritifera* L., fig. 140. Animal, fig. 141.

* The following lettering applies to all the figures of the animals of the Margaritanidæ and Unionidæ except as otherwise stated:

an.—anal opening.
br.—branchial opening.
f.—flaps of margin of mantle.
i.—inner gill.
o.—outer gill.
p.—foot.
pp.—papillæ on margin of mantle.
sa.—supra-anal opening.
mp.—marsupium.

Subgenus CUMBERLANDIA Ortmann, 1912.

Shell as in the genus.

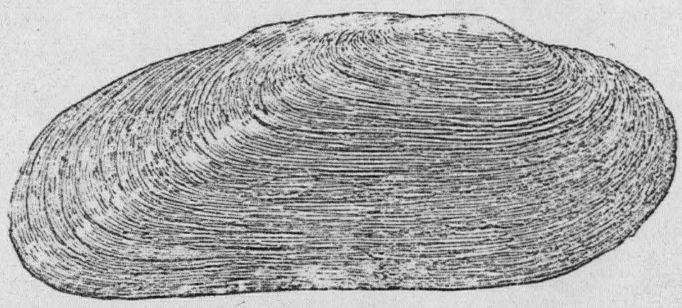

Fig. 142

Animal as in the family, but having the gills with incomplete water-tubes and with continuous septa, which run obliquely forwards.

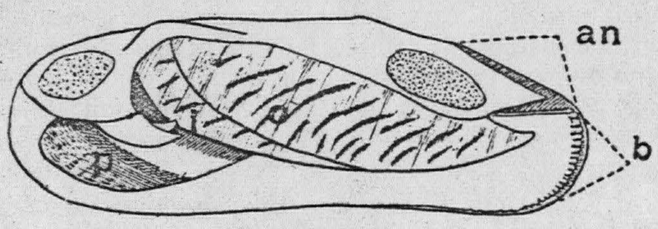

Fig. 143

Type: *Unio monodonta* Say, fig. 142. Animal, fig. 143.

Family UNIONIDÆ.

"Diaphragm complete, formed by the gills; posteriorly the outer lamina of the outer gill connected with the mantle to its posterior end; anterior end of the inner gills separated from the palpi by a gap; branchial and anal openings sharply separated from one another by the diaphragm; anal openings very rarely not closed above and without supra-anal, generally closed and with a supra-anal opening (which very rarely may be obliterated); gills with water-tubes and distinct, interlamellar septa, running parallel to the filaments. Marsupium in all four gills or only in the outer gills; larva a glochidium. Shell of very variable shape; sculpture of the beak more or less reduced, of various types, but originally of the concentric or zig-zag pattern; hinge teeth perfect or imperfect; epidermis plain or with color-markings." (Ortmann.)

Key to the subfamilies of *Unionidæ*.

1. Water-tubes simple in the gravid female.................... 2.
   Water-tubes in the gravid female divided into three tubes, of which only the centre one is used as an ovisac.....*Anodontinæ*.

2. Male and female shells usually alike; edge of the gravid marsupium always sharp and not distending...........*Unioninæ*.
   Male and female shells usually different; edge of the gravid marsupium distending and bulging out beyond the original edge of the gill ....*Lampsilinæ*.

Subfamily UNIONINÆ (Swainson, 1840) Ortmann, 1910.

"Inner lamina of the inner gills generally free from the abdominal sac (sometimes, in extralimital forms, connected); supra-anal opening sometimes not separated from the anal, normally present, the closed part rather short; branchial opening well-defined; no papillae nor flaps on the edge of mantle in front; marsupium formed by all four gills or by the outer gills only; edge of marsupium always sharp and not distending; water-tubes not divided in the gravid female; glochidium semielliptic or semicircular, without spines; shell generally heavy and solid, rounded to elongated, mostly with dull-colored epidermis; sculpture of the beak generally rather indistinct, concentric or pustulous or with indications of double loops or zig-zag bars; hinge always complete, with rather strong teeth; generally no difference of sex shown in the shell." (Ortmann.)

Key to the genera of *Unioninæ*.

1. All four gills serving as marsupia........................... 2.
   Outer gills only serving as marsupia.......................... 6.

2. Male and female shells alike................................ 3.
   Male and female shells different.......................*Tritogonia*.

3. Hinge with perfect pseudocardinals and laterals................ 4.
   Hinge teeth rudimentary or wanting....................*Gonidea*.

4. Surface plicate .... 5.
   Surface pustulose ....*Quadrula*.
   Surface smooth ....*Fusconaia*.

5. Beaks sculptured with coarse, concentric or somewhat double-looped ridges, which do not extend over the surface.*Amblema*.
   Beaks sculptured with strong, zig-zag ridges extending over the upper surface ....*Megalonaias*.

6. Surface tuberculous 7
   Surface smooth or spiny .... 8.

7. Nacre deep purple .... *Rotundaria.*
   Nacre white or tinged with pink.......................... *Plethobasus.*

8. Hinge with perfect pseudocardinals and laterals................ 9.
   Hinge teeth imperfect, vestigial.......................... *Lastena.*

9. Shell short, rounded, quadrate or oblique.......................... 10.
   Shell (usually) elongate and straight.......................... 11.

10. Beak sculpture distinct, subconcentric, rounded upon the posterior slope .... *Lexingtonia.*
    Beak sculpture coarser, inclined to be more or less double-looped .... *Pleurobema.*

11. Beak sculpture running parallel with the growth-lines and angled on the posterior slope.......................... *Elliptio.*
    Beak sculpture concentric, rounded behind.............. *Uniomerus.*

Genus QUADRULA (Rafinesque, 1820) Agassiz.

Shell triangular, quadrate or rhomboid; solid, inflated with rather coarse prominent beaks, which are generally sculptured with a few coarse, irregular, subparallel ridges that are inflated where they cross the posterior ridge; posterior ridge ordinarily well developed; disk sculptured or smooth; epidermis usually dull-colored, dark and rayless or feebly rayed; hinge plate heavy, wide, flattened; pseudocardinals solid, direct, ragged; laterals double in the left and single in the right valve; cavity of the beaks deep and compressed. Marsupium occupying all four of the gills throughout, the whole smooth and pad-like.

Key to the sections of *Quadrula*.

Posterior slope with a radial furrow above the posterior ridge .... *Quadrula s. s.*

No radial furrow above posterior ridge.................. *Theliderma.*

Section QUADRULA s. s.

Shell quadrate or rhomboid; surface pustulous, with a high, rounded or sharp posterior ridge, above which on the posterior slope is a decided radial furrow; umbonal region high; epidermis shining, usually painted with a beautiful pattern of triangular spots or chevron-shaped lines.

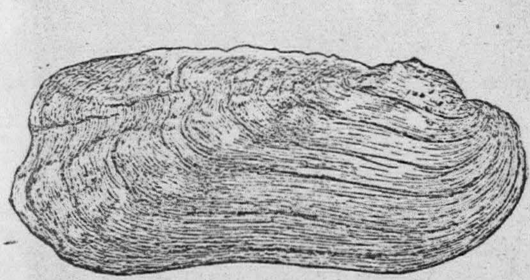

Fig. 144

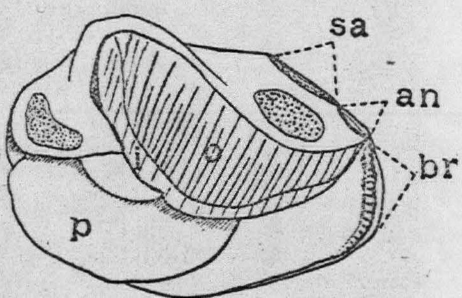

Fig. 145

Type: *Unio cylindricus* Say, fig. 144. Animal, *Q. metanevra* Raf., fig. 145.

Section THELIDERMA (Swainson, 1840) Simpson.

Fig. 146

Shell rounded, quadrate to rhomboid, solid, pustulous; beaks rather prominent, sculpture consisting of a few, rather coarse, subparallel ridges; anterior end rounded, base often arcuate, posterior end truncate, high and angled behind the ligament, epidermis rarely rayed, never as in *Quadrula s. s.*

Type: *Unio lachrymosus* Lea, fig. 146.

Genus TRITOGONIA Agassiz, 1852.

Shell solid, elongate, rhomboid, having a strong, irregular posterior ridge, obliquely truncated behind in the male, in the female this region is somewhat compressed and expanded into a broad wing; base curved; whole surface, except the rounded wing of the females, covered with pustules;

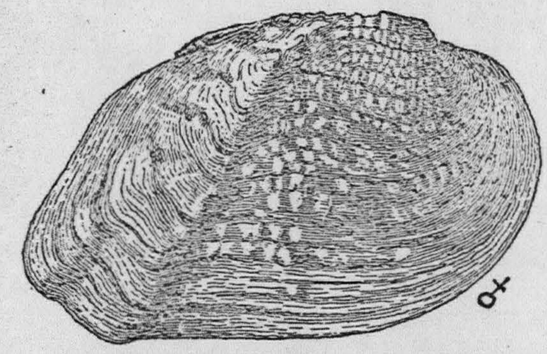

Fig. 147

beaks rather low, incurved and turned forward over the well developed lunule; beak sculpture strong, consisting of irregular, subparallel ridges which are curved upwards behind and fine radiating ridges in front of and behind them; epidermis dark olive; hinge plate rather narrow; pseudo-

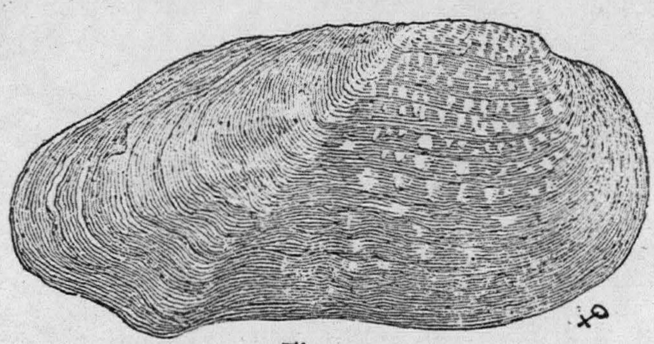

Fig. 147

cardinals strong, ragged; laterals long and straight, near to the pseudocardinals; cavity of beaks rather deep and compressed; female shell more compressed than that of the male. Marsupium occupying all four gills.

Type: *Unio tuberculatus* Bar., fig. 147.

Genus MEGALONAIAS Utterback, 1915.

Shell large, heavy, obovate or rhomboid, alate post-dorsally, disk obliquely folded; beaks sculptured with coarse, double-looped corrugations, which extend over the upper surface of the disk as nodulous plications; epidermis

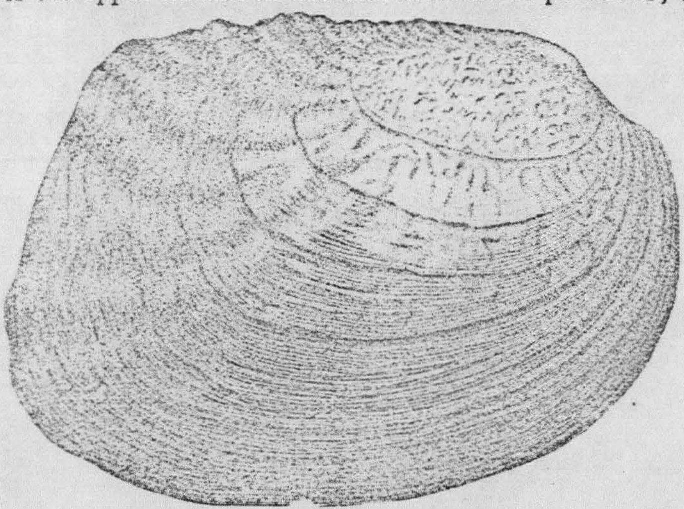

Fig. 148

dark-brown or blackish; beak cavities narrow and deep; anterior muscle scars deep and filled with a nacreous deposit, posterior scars large and indistinct.

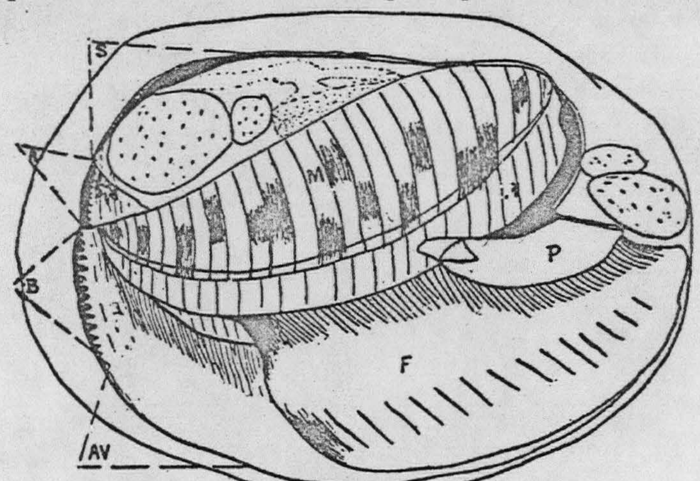

Fig. 149*

Type: *Unio heros* Say, fig. 148. Animal, fig. 149.

* The following lettering applies to figs. 149, 165 and 201:

A.—Anal opening. F.—Foot. P.—Palp.
Av.—Antero-ventral margin. I.—Inner gill. S.—Supra-anal opening.
B.—Branchial opening. M.—Marsupium.

Genus AMBLEMA Rafinesque, 1819.

Shell more or less alate; beaks prominent, sculptured with coarse, concentric or somewhat double-looped ridges which do not extend over the surface of the shell; surface of the valves usually sculptured with oblique folds; posterior slope generally having small radial plications, which curve

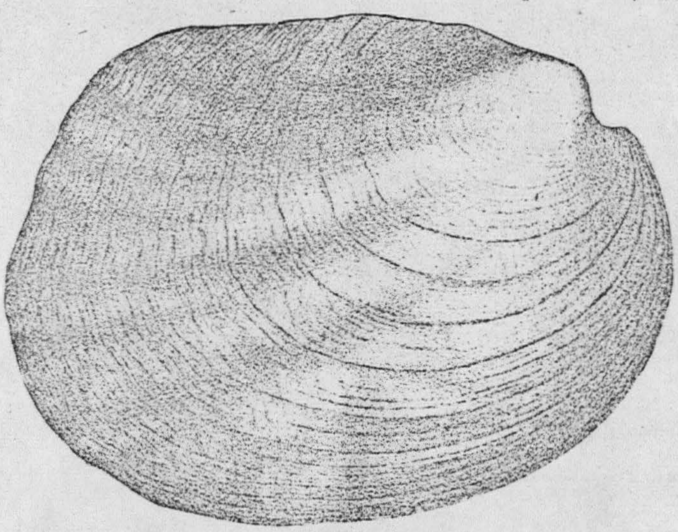

Fig. 150

upwards behind; epidermis brownish or blackish; anterior muscle scars large, distinct, very shallow, the anterior edge smooth, the rest apparently filled with roughened shelly matter; posterior scars large, shallow, indistinct; escutcheon large and dark.

Marsupium occupying all four gills.

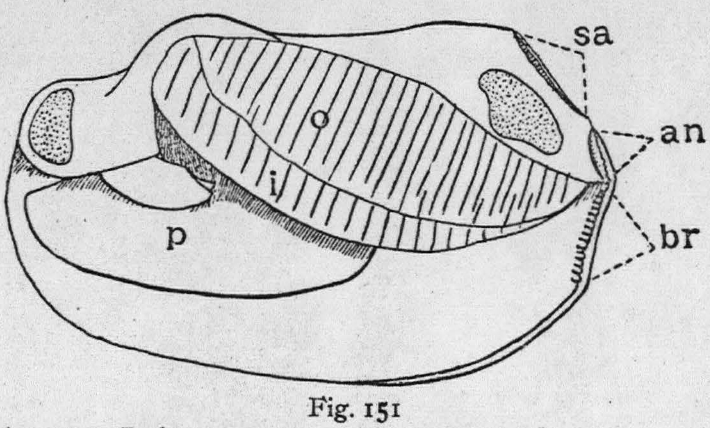

Fig. 151

Type: *A. costata* Raf.

Example: *A. undulata* (Bar.), fig. 150. Animal, *A. trapezoides* (Lea), fig. 151.

Genus FUSCONAIA Simpson, 1900.

Shell round, rhomboid, triangular or short elliptical, with a moderate posterior ridge; beaks high and full, curved inward and forward, sculptured with a few coarse, parallel ridges, which curve upward behind; epi-

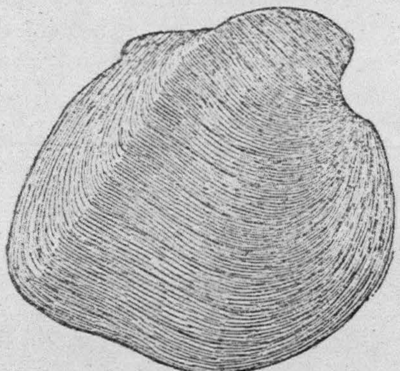
Fig. 152

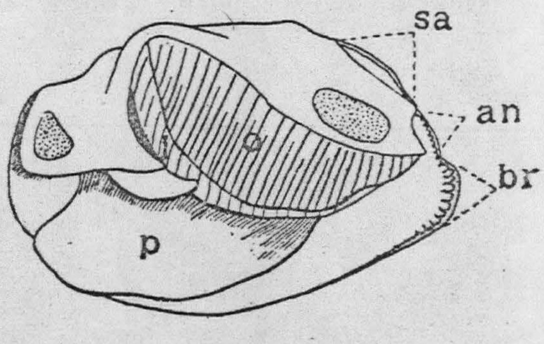

Fig. 153

dermis dark; surface not sculptured; hinge plate of moderate width; pseudocardinals strong; nacre white, salmon or purple.

All four gills marsupial.

Type: *Unio trigonus* Lea, fig. 152. Animal, (*F. rubiginosa* (Lea)), fig. 153.

Genus ROTUNDARIA (Rafinesque, 1820) Simpson.

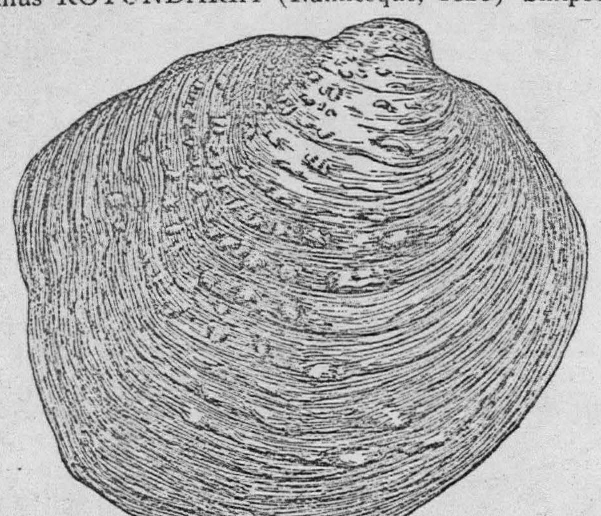
Fig. 154

Shell rounded; slightly truncated above in front; posterior ridge low beaks prominent, curved inward and forward over a strongly marked ha ule; beak sculpture consisting of numerous, fine, irregular, broken, somewhat concentric corrugations; posterior three-fifths of the shell tuberculate; epidermis brown; nacre purple.

Only the outer gills serving as marsupium.

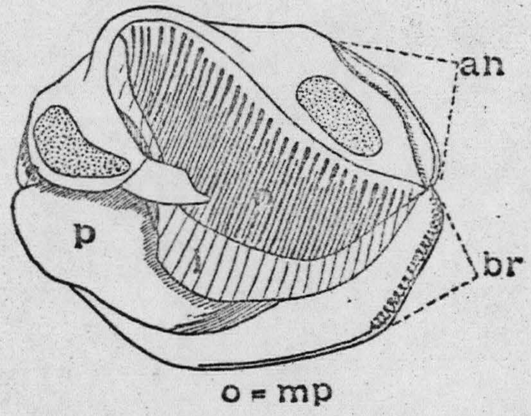

Fig. 155

Type: *Obliquaria* (*Rotundaria*) *tuberculata* Raf., fig. 154. Animal, fig. 155.

Genus PLETHOBASUS Simpson, 1900.

Shell large, irregularly oval, inflated, solid, somewhat suddenly swollen at the posterior base; posterior ridge low and rounded; beaks rather high, near the anterior end, having a few strong ridges, which are curved up-

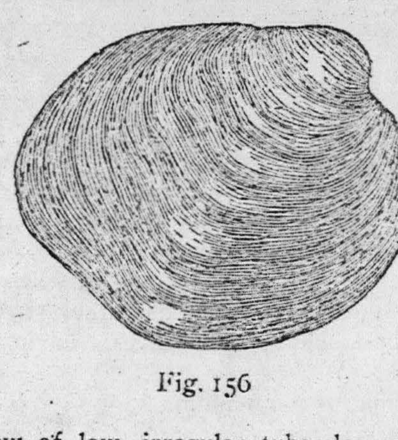

Fig. 156

wards behind; a row of low, irregular tubercles extends from near the beaks to post-basal part of the valves; epidermis tawny yellow to dark brown; hinge plate solid, not flattened; pseudo-cardinals triangular, rough;

cavity of the beaks not deep; front part of the shell very heavy, thinner behind.

Outer gills only serving as marsupium.

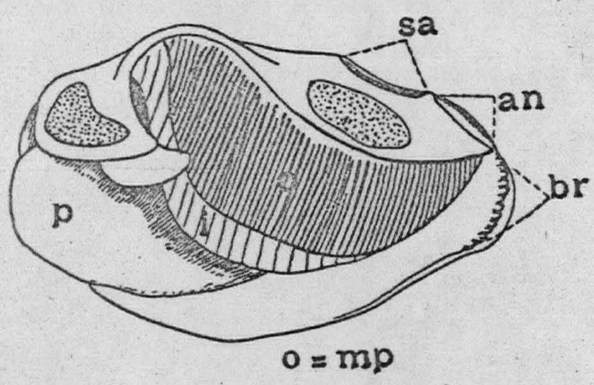

Fig. 157

Type: *Unio æsopus* Green, fig. 156. Animal, fig. 157.

Genus PLEUROBEMA (Rafinesque, 1820) Agassiz.

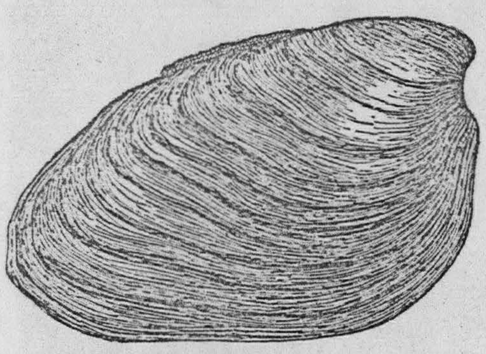

Fig. 158

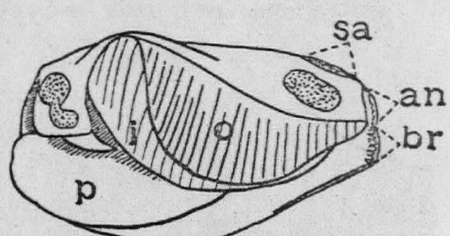

Fig. 159

Shell solid, triangular to rhomboid, usually with a prominent umbonal region; beaks at or near the anterior end of the shell, incurved and pointed forward over a small, but well developed lunule; beak sculpture coarse, consisting of a few, often broken, ridges, which curve upward posteriorly; posterior ridge present, but low and rounded; epidermis showing the rest periods plainly, tawny to olive, often ornamented with rays which show a tendency to break into square spots; hinge rather strong, plate generally narrow; pseudocardinals double in both valves. Cavity of the beaks shallow.

Outer gills only serving as marsupium.

Type: *Unio clava* Lam., fig. 158. Animal, fig. 159.