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EDITOR
Aurèle La Rocque
Department of Geology
Ohio State University
125 S. Oval Drive
Columbus 10, Ohio

ANNOUNCEMENT

STERKIANA is named after Dr. Victor Sterki (1846-1933) of New Philadelphia, Ohio, famed for his work on the Sphaeriidae, Pupillidae, and Valloniidae. It is fitting that this serial should bear his name both because of his association with the Midwest and his work on the living and Pleistocene non-marine Mollusca of North America.

STERKIANA is a quarterly founded in 1959 by a small group of workers on living and fossil non-marine Mollusca. It is issued as separate numbers, consecutively numbered, ten of which may be bound together to form a volume. Each number consists of some 50 pages or more.

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A HAND SIEVE NET FOR SMALL AQUATIC MOLLUSKS

DAVID BICKEL

Department of Geology, Ohio State University
and The Ohio State Museum, Columbus, Ohio

During recent field work, the need became apparent for a wire sieve net suited to rapid qualitative collecting of small bottom dwelling mollusks. Needham scrapers, Cable scrapers, and food strainers with extension handles were either awkward or ineffective for gathering small forms on silt, sand, or gravel substrates at moderate depths. The scraper that was designed to meet the requirements of this type of collecting (Fig. 1) has an 11 X 10 in opening and is about 7½ in deep. In side view the basket approximates an equilateral triangle with one angle, the bottom, rounded. The basket rim and bottom support are ¾ X ¼ inch steel strips, and the two side members were bent from ½ X 3/16 in strips. The frame was welded together and a 2 X 10 in blade and detachable handle were added. When the frame rests on its forward surface, the handle stands at a 75° angle as shown in Fig. 1b. A framework constructed of lighter material should work equwlly well. Wire mesh with 10 openings per inch (maximum size of opening, 2.8 mm) was soldered to inside surfaces of the frame. One piece was bent to form the front, back, and rounded bottom, with two additional pieces enclosing the sides. This screen size will retain many smaller gastropods, adult fingernail clams, and juvenile naiades, yet samples can be thoroughly washed with a few back-and-forth movements of the partly submerged basket. This motion can be forceful enough to pass sediments through the fine mesh, because the basket keeps in contents more effectively than the shallower devices now in common use. A liner of smaller mesh can be used on silt or fine-sand bottoms to retain the minute forms of Amnicolidae and *Pisidium* without sacrificing ease of washing.

The net is stable by itself when standing with the handle upright (Fig. 1b) or resting in a horizontal position (Fig. 1d). Either way, it provides a flat and accessible area of screen from which organisms can be picked. The upright position is useful where space is limited, such as along brushy shorelines or in small boats. With a little practice, the final washing stroke can be used to distribute the contents on the front or rear surface of the basket for examination or concentrate it in the rounded bottom for removal.

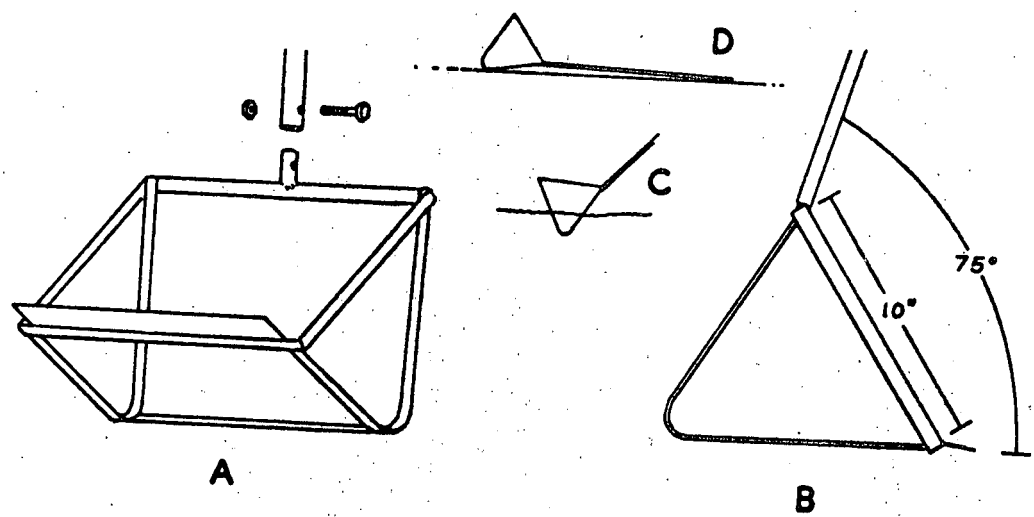

FIGURE 1. Diagrams of the sieve net, showing (A, B) framework of basket, (C) position for washing samples, and (D) the scraper resting in a horizontal position.

REPRINTS OF RARE PAPERS ON MOLLUSCA

SMITHSONIAN MISCELLANEOUS COLLECTIONS

144

LAND AND FRESH-WATER SHELLS

OF

NORTH AMERICA

PART III.

AMPULLARIIDAE, VALVATIDAE, VIVIPARIDAE, FRESH-WATER RISSOIDAE, CYCLOPHORIDAE, TRUNCATELLIDAE, FRESH-WATER NERITIDAE, HELICINIDAE.

BY

W. G. BINNEY.

WASHINGTON:

SMITHSONIAN INSTITUTION

SEPTEMBER, 1865.

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This volume, prepared at the request of the Smithsonian Institution, is devoted to all the operculated land and fresh-water mollusks of North America, excepting the family of *Melanians*. The descriptions of the *Cyclophoridae, Truncatellidae,* and *Helicinidae* have already been published in the 'Terrestrial Mollusks of the United States,' Vols. 2 and 4. It will be seen, however, that these families are now grouped according to their lingual dentition and breathing organs, and not collectively as *Pneumonopoma*. In treating the fresh-water families, it has been considered better to give the original description, or an English translation of it, and a fac-simile in outline of the original figure of each species and synonym. This work must, therefore, be considered rather as a report on the present state of our knowledge of the subject. When the large area over which the species range shall have been explored and full suites of specimens obtained of every age, variety and locality, and when this volume shall have elicited criticism and prompted research, a complete monograph may then be prepared on the decisions of which the student can fully rely as correct.

An extensive correspondence with all the living American conchologists, and opportunities of examining the original specimens from which the descriptions of almost all the species were drawn, have enabled me to eliminate from the list of species a large number of synonyms. The original description and figure of these being given, the student can judge for himself of the correctness of my conclusions.

The descriptions of families and genera of the *Viviparidae* and *Rissoidae* are adopted from Dr. Stimpson, those of the former from his manuscript, of the latter from a paper entitled 'Researches on the Hydrobiinae and Allied Forms,' lately published

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by the Smithsonian Institution. 'In the remainder of the work the descriptions of the 'Genera of Recent Mollusca have been adopted.'

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The original figures of shells and lingual dentition were drawn by Mr. E.S. Morse, of Gorham, Maine.

The subject is brought down to January, 1864.

W. G. BINNEY

Burlington, N.J., September, 1865.

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(PAGE 1)

LAND AND FRESH-WATER SHELLS

O F

NORTH AMERICA.

III.

Family AMPULLARIIDAE.

Lingual membrane with seven series of teeth (3, 1, 3), central teeth acute, lateral subulate. Rostrum divided into two long tentacular lobes in front; tentacles long and filiform; eyes on peduncles at the outer bases of the tentacles. Mantle with a more or less elongated siphon on the left side in front; left gill rudimentary; mantle cavity with a large pulmonary sac on each side. Rectum not traversing the heart. Foot simple. Operculum annular, regular. Shell spiral, turbinate, covered with an olivaceous epidermis; aperture simple in front. Jaws present.

(Figs. 1 and 2)

The *Ampullariidae* are fluviatile, and represent in the ponds and rivers of the tropics the *Viviparidae* of more temperate climates. Although distinct gills exist, the respiratory cavity is very large and partly closed, so as to enable these animals to live a long time out of water; in fact, they appear to be

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truly amphibious, and to be enabled to survive a long drought, and have been known to revive after having been kept several years out of water. The long siphonal tube appears to be formed by the left neck-lappet, which is seen in the *Viviparidae* in a rudimentary state.

But one genus of this family is represented in North America. In order, however, that the others may be understood by those not having access to the more recent works on general Conchology, I have added below the descriptions of H. & A. Adams.

Genus AMPULLARIA.--Respiratory siphon elongate. Operculum horny, with an external shelly coat. Shell globose, umbilicated; spire small, last whirl ventricose; aperture oblong, entire, peristome continuous, slightly reflexed, with an internal thickened rim or ledge.

Genus POMUS, Humphrey, characterized as below.

Genus MARISA, Gray.-- Siphon elongate. Operculum horny, dextral. Shell dextral, depressed, discoidal, deeply and widely umbilicated; spire very short, whirls rounded; aperture suborbicular, entire, peristome thin, simple.

Genus POMELLA, Gray.--Operculum horny, dextral. Shell solid, spire short, whirls transversely striated, the last very large; aperture semi-ovate, inner lip concave, broad, flattened, peritreme simple, acute.

Genus LANISTES, Montfort.--Operculum horny, sinistral, or with the nucleus on the left margin. Shell depressed, thin, sinistral, deeply and widely umbilicated; spire short; aperture oblong, entire; inner lip expanded over the last whirl, peristome simple, acute.

Genus MELADOMUS, Swainson.--Operculum horny, sinistral. Shell sinistral, thin, imperforate, covered with a dark olivaceous epidermis; spire produced, acuminated; aperture oval, reversed, contracted and acute posteriorly, entire in front, peristome thin, simple.

Genus ASOLENE, D'Orbingy.---Siphon not exposed. Operculum horny, with an internal shelly coat. Shell globose, solid; spire small, whirls rounded; aperture oval, entire; inner lip slightly thickened peritreme simple, acute.

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POMUS, Humphrey.

Siphon elongate. Operculum horny, dextral. Shell dextral, globose, widely umbilicated, last whirl very large, ventricose; spire short; aperture entire, oblong, large, expanded, peritreme simple, always thin, sometimes subreflexed. Fig. 3

The genus *Pomus* differs from *Ampullaria* in the absence of the thickened ledge within the peritreme for the operculum, which latter, moreover, is entirely horny. The species inhabit the lakes and rivers of warm countries, more especially those of South America and the West Indies. In the dry season they bury themselves deeply in the mud, where they remain in a state of torpidity, and, on account of their possessing a pulmonary cavity in addition to the gills, they are enabled sometimes to survive a considerable period after having been removed from the water. The South American Indians term them 'Idol Shells,' and are said to hold them in great veneration.

Pomus depressa, Say.--Shell ventricose, subglobular, obsoletely banded with obscure green; whirls four, slightly wrinkled;

body whirl more prominent above, somewhat flattened towards the suture, of a pale olivaceous color, which is almost concealed by numerous unequal, longitudinal and transverse greenish and brownish lines; spire very much depressed; aperture suboval, within somewhat glaucous, on the margin exhibiting the bands distinctly; labrum simple, as much rounded above as below; umbilicus small, nearly closed. Greatest width one inch and nine-twentieths, total length one inch and a half; length of the aperture one and one-fifth on an inch nearly. Fig. 4.

Inhabits East Florida.

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During an excursion to East Florida, in company with Messrs. Maclure, Ord, and T. Peale, I obtained a single dead and imperfect specimen of this interesting shell. It occurred in a small creek, tributary to St. John's River, and on the plantation of Mr. Fatio. Captain Le Conte, of the Topographical Engineers, has since presented me with a perfect specimen, with the information that he observed them in very great numbers on the shores of Lake George, a dilatation of St. John's River; that in some places the dead shells were piled up confusedly to a considerable height, and that the *Numenius longirostra* feeds upon the living animal. The spire is still less elevated than that of the *globosa* of Swainson.

Ampullaria depressa.--As the name *depressa* of the Appendix to Long's exped. p. 264 is preoccupied by Lamarck for a fossil species, it may be changed to *paludosa. (Say.)*

Ampullaria depressa, Say, Long's Ex. 264, pl. xiv, f. 2; Binney's ed. p. 130, pl. lxxiii, f. 2.--Haldeman, Mon. p. 5, pl. i, ii.--De Kay, N. Y. Moll. 124.--Hanley, Conch. Misc. pl. iii, f. 9 --Philippi, in Chemn. ed. 2, p. 52, pl. xvi, f. 4.

Ampullaria paludosa, Say, New Harm. Diss. II. 260; Desc. 22; Binney's ed. p. 147.

Ampullaria hopetonensis, Lea, Tr. Am. Phil. S. V, 115, pl. xix, f. 84; Obs. I, 227.--

Binney, p. 4

DeKay, N.Y. Moll. 124.--Reeve, Con. Icon. fig. 60.--Philippi, in Chemn. ed. 2, p. 36, pl. ix, f. 7.

Figure 5 represents the lingual dentition of a specimen of *Pomus depressa* kindly furnished me by Prof. Agassiz The Fig. 5. teeth are light brown in color, and make thirty-four rows in all; the Fig. 6. first and second laterals are notched and the third is simple. The central tooth has seven denticles, the central one quite large, the next two short and blunt, and the last rather long and blunt.

Mr. Say proposed the name *paludosa* because his first name, *depressa,* was preoccupied by Lamarck, An. s. Vert. 1822. Since, however, that *Ampullaria depressa,* Lam. has been removed to the genus *Natica,* I adopt Mr. Say's first name. Figs. 1 and 3, represent the animal and operculum of this

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species, the former, copied from Haldeman, being reduced in size. Fig. 4 is a fac-simile of the outline of Say's figure, and fig. 7 of Mr. Lea's of *A. hopetonensis.* Fig. 6 represents a specimen from Georgia. I have no doubt of the identity of this last named species with *depressa* after examining the typical specimen. No. 8986 and 8987 were labelled by Mr. Lea as *hopetonensis.* Haldeman also places it in the synonymy. The original description here follows, and an outline of the figure (7).

Ampullaria hopetonensis.--Shell subventricose, smooth, flattened above, umbilicate, yellowish brown, banded; sutures impressed; whirls 5; aperture subovate, white.

Habitat Hopeton, near Darien, Ga. Prof. Shepard. My cabinet; Fig. 7. cabinet of Prof. Shepard. Diam. 1.7 inch. I owe to the kindness of Prof. Shepard of New Haven this interesting shell. It was procured by him during his late geological investigations in our Southern States, with other shells, descriptions of which will be found in these memoirs. It resembles the *A. fasciata,* Lam., but is less globose, the whirls of our species being somewhat flattened

Binney, p. 5

on the side and top. It differs from the *A. depressa,* Say, described in Major Long's Exp. to St. Peter's River (subsequently changed to *A. paludosa* in the Disseminator) in being less globose, and in being flatter on the side and superior part of the whirls. *(Lea.)*

Inhabits Georgia and Florida.

In the preliminary Report on N. Y. Moll. 1839, 32, *A. paludosa* is included erroneously.

DeKay gives as synonyms *A. penesima,* Say, and *A. disseminata,* Say. The names do not occur in Say's writings, though the last is suggestive of the periodical in which the description of *A. paludosa* appeared. Dr. Martens (Mal. Blatt. IV, 204) refers *A. depressa* and *A. paludosa* to *A. hopetonensis,* disregarding the priority of Say's names.

Cat. No.	No. of Sp.	Locality.	From whom received.	Remarks.
8984	2	Florida.	W.G. Binney.	.....
8986	1	Silver Spring L., Fla.	O.M. Dorman.	
8987	1	" "	W.G. Binney.	
8988	1	Georgia.	J.G. Anthony.	.....
9306	..	"	L. Agassiz.	Lingual.

Fig. 5.

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SPURIOUS AND EXTRA-LIMITAL SPECIES OF AMPULLARIIDAE

This family does not appear to belong to the molluscous fauna of the United States, but rather to that of South America. I have not, therefore, included the Mexican species.

Ampullaria crassa, Deshaes. Vide *Melantho ponderosa.*

Ampullaria borealis, Valenciennes, in Humboldt and Bonpland, Rec. d'Obs. II, 260, is probably *Lunatia heros,* Say. Ferussac (**Bull. Zool.** 1835, 2d sect. p. 33), in reviewing Valencienne's work, refers it to a large marine *Natica* figured by Chemnitz. The description is as follows:--

'Shell ventricose, globose, heavy, thick, smoky, white, broadly umbilicated, with longitudinal striae but no wrinkles.

Binney, p. 6

St. Pierre and Miquelon, near Newfoundland.

This species resembles *Am. guyanensis*. Its proportions are the same; it is longitudinally striate, but its shell is at least three times as thick, so that it is quite heavy. It is also distinguished by its very large umbilicus, while *A. guyanensis* has none. The color is yellowish or light reddish on the top of the last whirl; the base is white.'--*Valenciennes*.

Ampullaria rotundata, Say.--Shell remarkably globose; length and breadth equal, dark brown, but becoming olivaceous towards the aperture; spire but little elevated; suture moderately impressed; body whirl a little undulated instead of being wrinkled; these undulations being very perceptible to the finger within the shell; aperture within on the margin thickened equally all round, and fulvous, with a slight groove for the reception of the operculum, hardly visible but palpable; within somewhat perlaceous; a little darker on the columella; umbilicus small, narrow; operculum calcareous, deeply and concentrically rugose, so as to appear stratified; nucleus on the side towards the labium submarginal. Length less than one inch and four-fifths; greatest breadth about the same.

For this interesting species we are indebted to Captain Leconte, of the Topographical Engineers, who informed me that he found it in St. John's River, in Florida.

It is most closely allied to the *A. globosa*, Swainson, a native of the rivers of India. But that shell is rather less globose, and does not appear to have the almost regular, but slightly elevated and very numerous undulations so perceptible towards the aperture on the body whirl of this species; which has also a few hardly perceptible, distant, brownish bands, particularly towards the base. It may, however, be only a variety of that species. *(Say.)*

Ampullaria rotundata, Say, N. Harmony Diss. II, 245; Discr. 27; Binney's ed. p. 147, pl. lxxv.--Philippi, in Chemn. ed. 2, p. 68.

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Ampullaria globosa, Haldeman, Mon. p. 8. --Swainson, Zool. Ill. II, 119.

I do not consider this and *Vivipara elongata* well established American species. If actually found in Florida, they were probably brought from Calcutta, where they both are found.

Ampullaria urceus, Müller *(A. rugosa*, Lam.), is found in Mexico. (Vid. Humboldt & Bonpland, Rec. d'Obs. II p. 258.) Of its presence in the Mississippi Mr. Say says: The '*Ampullaria urceus*, L. *(rugosa*, Lam.) is stated in the books to inhabit the Mississippi River; but I have never been so fortunate as to find it, or to gain any information relative to it there. Mr. O. Evans did me the favor to make inquiry at various places on that river, and to exhibit, as somewhat similar, a colored plate of the *A. globosa*, Swains., to persons from whom information might be expected, and amongst others to some Indians, who in general are known to be accurate observers; but no one has seen any similar shell in the waters of the Mississippi. I am therefore much inclined to believe that the species is a native of some of the more southern rivers, probably those of Texas. Any information in relation to it, or specimens of the shell, will be very acceptable.' (Binney's ed. p. 195). See also Haldeman, Mon. p. 11; Montfort, Conch. Syst. II, p. 244; Lamarck, An. s. Vert. &c.

Ampullaria flagellata, Say, N. H Diss. II, 260; Descr. 22: Binney's ed. p. 147.--Haldeman, Mon. p. 10.--Philippi, in Chemn. ed. 2, p. 38, pl. ix, f. 7. Near Vera Cruz (Mexico).

Ampullaria flatilis, Reeve, Con. Icon. pl. vii, fig. 31 (1856). Tobasco, Mexico.

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Ampullaria cerasum, Hanley, Conch. Misc. Mexico.

Ampullaria miltocheilus, Reeve, Con. Icon. fig. 120. Chiapa, Mexico.

Ampullaria Ghiesbreghti, Reeve, Con. Icon. fig. 123. Chiapes, Mexico.

Ampullaria fumata, Reeve, Con. Icon. 124. Chiapes, Mexico.

Ampullaria violacea, Valenciennes, Rec. d'Obs. II, 260.

Ampullaria reflexa, Swainson, Phil. Mag. LXI, 377.

Ampullaria malleata, Jonas, Moll. Beit. I 22.

Ampullaria paludinoides, Crist., and Jan in Chemn. ed. 2, p. 27.

Ampullaria scalaris, d'Orb. Mag. de Zool. 1835, p. 31. (*A. angulata,* Jay, Cat. earlier ed., not of Dunker.)

Pomacea linearis, Perry, Conchology, pl. xxxviii, fig. 2. Fig. 8 --Shell pale reddish-brown, slightly spotted with pale pink spots; mouth slightly shaded with a broad band of brown reaching round the body; the rim yellow. The shell is found on the coasts of North America, and is drawn from a specimen in the collection of Mr. Stuart. *(Perry.)*

This is the original description, and a copy of Perry's figure reduced one-half. I know nothing of the species.

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FOSSIL SPECIES.

Ampullaria ? perovata, Conrad, Proc. Acad. Nat. Sc. Philad. III, 21, pl. i, fig. iii.

FAMILY VALVATIDAE.

Lingual membrane with teeth in seven series

(3, 1, 3); the central teeth broad, with a hooked and denticulated apex,

(FIG. 9)

the lateral lanceolate, hooked and denticulated Rostrum produced; tentacles cylindrical; the eyes sessile at their external
Fig. 10. bases. Mantle simple in front; gill plumose, exposed, the lamina pinnate, spirally twisted, protected by a long, slender respiratory lobe. Foot bilobed in front. Operculum horny, orbicular, spiral, many whirled; whirls with a thin elevated edge. Shell spiral, turbinate or discoidal, covered with an epidermis; aperture with the peritreme entire.

The species of this family are distributed throughout the temperate regions of the globe, living in slow running rivers, ditches, and lakes.

I have copied Haldeman's figure of *Valvata sincera* to illustrate the animal of this family (fig. 11).

VALVATA, O. F. MÜLL.

Fig. 11. Shell turbinate or discoidal, umbilicated, thin, whirls round, simple or keeled, covered with a horny epidermis; aperture circular, peristome continuous.

The species of this small genus inhabit the ponds and ditches of Europe and North America. When the animal progresses, the delicate, retractile, branchial plume is projected over the neck. The female

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deposits her eggs in a single, coriaceous, spherical capsule, which is affixed to stones or the stems of aquatic plants. Jaws present.

Valvata tricarinata, Say.--Shell with three volutions; three revolving, carinate, prominent lines, giving to the whirls a quadrate instead of a cylindric appearance. Suture canaliculate, in consequence of the whirls revolving below the second carina and leaving an

interval. Spire convex, apex obtuse. Umbilicus large. Carinae placed, one on the upper edge of the whirl, one on the lower edge, and the third on the base beneath. Breadth one-fifth of an inch.

Inhabits the river Delaware. Rare. Found by Mr. Le Sueur, whose proposed name is here adopted. *(Say.)*

Cyclostoma tricarinata, Say, J. Acad. N. S. Phil. I, 13, 1817; Nich. Ency. ed. 3; Binney's ed. p. 68 59, 56.

Valvata tricarinata, Say, Journ. Acad. II, 173; Binney's ed. 68.--Deshayes in Lam. VIII, 507; Tr. El. de Conch. pl. lxxii, f. 4-6.--Menke, Zeit. f. Mal. 1845, p. 121.--Haldeman, Mon, III, pl. i; f. 1-4. --Gould, Invert. 225, f. 156.--DeKay, N. Y. Moll. p. 118, pl. vi, f. 130. Anonymous, Can. Nat. II, 213, fig.--Adams, Thompson, VI, 152.

Valvata carinata, Sowerby, Gen. Shells, xli, f. 2.

Valvata unicarinata, DeKay, N.Y. Moll. 118, pl. vi, f. 129.

Valvata bicarinata, Lea ? Tr. Am Phil. Soc. IX, 21; Obs. IV, 21; Proc. II, 81, 83; Arch. f. Nat. 1843, II, 129.

Tropidina carinata, Chenu, Man. de Conch. II, 312, fig. 2232.

Troschel *(Gebiss der Schnecken,* p. 96, pl. vi, f. 14) figures the lingual ribbon of this species.

(Fig. 12.)

This is a very variable species, as shown by No. 8981 of the collection. Variety *simplex* is contained in No. 8982; bicarinated forms in 8941. Mr. Say's specimens of *Valvata tricarinata* are still preserved in the collection of the Philadelphia Academy of Natural Sciences. From an examination of them and of Mr. Lea's original *Valvata bicarinata* I am convinced of the identity of the two. I have given (fig. 13) a figure of Mr. Lea's shell and

Fig. 13.

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his description below. Haldeman refers it with doubt to *tricarinata.*

I have not seen authentic specimens of the other species men-

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tioned in the synonymy. The original descriptions and fac-similes of the original figures now follow.

Valvata bicarinata, Lea.--Shell orbicular, flattened above, bicarinate, rather thick, horn-colored above, whitish below, widely umbilicate; sutures impressed; spire depressed; whirls four, convex; aperture rounded, whitish within.

Body rather short and white, head large, tapering, slightly enlarged at the anterior termination, with a black mark passing from the neck between the eyes, tapering off and reaching nearly to the end of the snout, where there are two oblique black marks bordered in front by white, and accompanied behind by several irregular white spots, the anterior ones being the larger. Branchia translucent, superior portion blackish, bordered with white spots and occasionally obtruded; eyes round and deep black, placed at the posterior base of the tentacula, surrounded by a white area; tentacula long, rather tapering, obtuse at the end; filament rather short, translucent with longitudinal white lines; foot wide and furcate anteriorly, where minute white spots may be observed. Operculum thin, semitransparent, light horn color, increment circular and rather coarse.

Fig. 14.

Schuylkill River, west side, below Permanent Bridge. H C. Lea. My cabinet. Diam. .30, length .12 inch.

In the form of the shell, this species closely resembles the *tricarinata,* Say. It differs in having but two carinae, in having a wider umbilicus, and the spire is more depressed. The animals of the two species differ in form and color more than the shells.

The head of the *tricarinata* is more cylindrical and enlarged at the termination, where it somewhat resembles the snout of the hog,

Binney, p. 10

while that of the *bicarinata* is more conical and without so sudden an enlargement at the end. The color of the *bicarinata* is lighter. In the black markings they also differ. In the *tricarinata* there is a single blotch anterior to the area between the eyes. In the *bicarinata* this extends also behind this area; and in addition may be observed two quite black marks above the mouth, which the *tricarinata* does not seem to have. The tentacula of the *bicarinata* are larger and more filiform. When in motion, the anterior portions of the lobes of the foot are pointed, and recurved or hooked.

The shell of the *bicarinata* is quite light colored beneath, and rather a dark horn color above, the change of color taking place a short distance above the periphery of the whirl, between which and the superior carina it is quite dark. The superior carina is large and erect, the inferior one is smaller. All the whirls are visible beneath. Very minute longitudinal striae cover the whole surface.

Having several living specimens of both these species, I observed them closely with a lens while under water in a glass vessel. On the 15th of May, while I had a *tricarinata* at the focus of my lens, I observed a small

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apple green, globose object, passing from under the aperture of the shell. This was shortly followed by others, and soon a transparent gelatinous mass became visible. This mass was passed slowly over the right side of the neck, under the pectiniform movable branchiae, until entirely discharged against the perpendicular side of the vessel in which it was kept, and there the mass remained attached, the parent having abandoned it immediately. The time was fifteen minutes from the first appearance of the mass until it was fairly discharged. The green globules were the ova, of which I counted thirty in the transparent, globose gelatinous mass, which was not more in diameter than one-twentieth of an inch, the transverse diameter of the shell being about four-twentieths of an inch. In other cases, I found the number of ova to differ; some masses having only ten or twelve.

Binney, p. 11

On the 23d (eight days after), the ova were so far advanced as to be changed to a dull faded green, the mass enveloping them having changed by degrees in transparency, and becoming of a slightly ferruginous color. As yet, no change of bulk or arrangement was observed.

On the 29th (fourteen days after), the mass was observed to be opened, and with a lens of considerable power I could plainly see a motion in most of the ova, the rounded form of the shell being easily discerned within.

On the 30th (fifteen days after), most of the young shells had broken their filmy bonds, only six or seven remaining: their motion was very apparent, and their minute black eyes could be plainly seen. I observed to-day, for the first time, that the *Valvata* has the power of swimming, inverted from the surface of the water, like the *Planorbes, Physae,* &c. Most of the young were in that position, and could move comparatively fast. The action of the mouth in the adult, when swimming in this way, was constant, and changed from an oval to a circular form.

From the above observations, we may conclude that the *Valvata tricarinata* requires from fourteen to fifteen days to be perfected in the ovum, from the time it is ejected and abandoned by its parent. The *bicarinata,* I have no doubt, requires the same time. Numerous globules were deposited about the glass, which globules appeared all to resemble each other, and nearly all the individuals were of the species *bicarinata. (Lea.)*

Valvata carinata, Sowb., l.c., is figured only; no description is given (fig. 15).

Fig. 15 Fig. 16.

Valvata unicarinata, DeKay.-- Shell small, apex depressed; whirls 3 or 4, impressed with minute incremental striae, all flattened above and bounded by a revolving rip or keel, which in the younger individuals ascends to the summit: aperture circular, nearly vertical, scarcely modified by the keel; opercle corneous, thin, with concentric striae; umbilicus wide, profound, exhibiting all the volutions; color

Binney, p. 11

milky bluish-white; apex often tinged with rufous. Height .1, diam. .15.

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These dimensions are from one of the largest size, obtained from Lake Champlain, where they are very abundant, and from the Erie Canal. It is allied to the preceding *(V. tricarinata)*, and forms the passage to *V. sincera*. Some eminent conchologists suppose this, and perhaps the following *(V. sincera)* to be mere varieties of *V. tricarinata*. It approaches the *V. humeralis*, Say, from Mexico; but it is smaller, not so much depressed, and has a wider umbilicus. *(DeKay.)*

I have evidence of its ranging at least from New England and Pennsylvania to Council Bluff and Methy Lake, lat. 57°.

Haldeman says the ova are deposited from the first day of March to the end of July, in transparent masses half a line in diameter, each containing a number of germs of a bright green color dotted with yellow.

Cat. No.	No. of Sp.	Locality.	From whom received.	Remarks.
8978	150+	Mohawk, N.Y.	Dr. J. Lewis.	.....
8979	1	Ann Arbor, Mich.	Prof. Winchell.	
8980	10	Milwaukee, Wis.	I.A. Lapham.	.....
8981	20+	Herkimer, N.Y.	Dr. Lewis.	vars.
8982	20+	Little Lakes, N.Y.	"	var. simplex.
8937	6	" "	" "	"
8941	5	" "	" "	*bicarinata.*
8938	5	Burlington, N.J.	W.G. Binney.	
9058	50+	Grand Rapids, Mich.	Dr. Lewis.	
9059	100+	Schuyler's Lake.	"	
9060	100+	Mohawk River.	"	
9061	20	Little Lakes, N.Y.	"	
9293	2	Otter Tail Creek, Min. R.	Kennicott.	
9292	5	Great Slave Lake.	"	

Valvata sincera, Say.--Shell subglobose-conic; whirls nearly four, accurately rounded, finely and regularly wrinkled across; aperture not interrupted by the penultimate whirl, nor appressed to it, but merely in contact with it, the labrum not diminished in thickness at the point of contact; umbilicus large, exhibiting the volutions. Breadth less than 1.5 inch. Inhabits Northwest Territory.

Fig. 17.

Binney, p. 12

For this species I am indebted to Dr. Bigsby. It is very similar to the *tricarinata*, Nobis, but it is destitute of carinated lines and the umbilicus is rather larger; it differs from the *obtusa* of Europe also, in the much greater magnitude of the umbilicus. *(Say.)*

Valvata sincera, Say, Long's Ex. 264, pl. xv, f. 11; Binney's ed. p. 130, pl. lxxiv, f. 11.--Haldeman, Mon. p. 6, pl. i, f. 5-10.--Adams, Sh. of Vt. in Thoms. Vt. p. 152; Am. Jour. Sc. [II], XL, 267.---DeKay, N.Y. Moll. 119, pl. vi, f. 127, 128.

Valvata depressa, pars, Küster in Chemn. ed. 2, p. 88 (1852).--Menke, Zeit. für Mal. II, 122, 1845 (including *tricarinata* and *simplex*).

Valvata striata, Lewis, Pr. Phil. Ac. N. Sc. 1856, p. 260.

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The outline figure published by Say and copied in my figure 16 is not very satisfactory, nor have I ever seen specimens referred to this species which can easily be distinguished from ecarinate forms of *V. tricarinata*. Fig. 11 is a view of the animal copied from Haldeman. Kirtland quotes it from Ohio.

I have also a figure of a specimen of *V. striata* furnished by Dr. Lewis. I have no doubt of its identity with *V. sincera*. The name is preoccupied by Philippi, Enum. Moll., p. 157. Dr. Lewis' description is as follows:-

Valvata striata.----Shell conical, depressed, umbilicate; aperture round; epidermis brown and very regularly striate. Has all the other features of *sincera* except color and translucency. Animal not observed. Very rarely seen. Of several hundred specimens of *Valvata* only seven were this species. *(Lewis.)*

Fig. 18.

No. 8936 of the collection was labelled *V. sincera* by Dr. R. E. Griffith.

Cat. No.	No. of Sp.	Locality.	From whom received.	Remarks.
8985	3	Madison, Wis.	I.A. Lapham.	.....
8936	..	.....	Phil. A.N.S.	Cabinet series.
9296	2	Peace River.	.....	.....
9297	7	Upper Mackenzie R.	.....	.....
9294	13	Great Slave Lake.	Kennicott.	.....

Binney, p. 13

Valvata pupoidea, Gould.--Shell small, elongate-ovate, opaque, chestnut-colored, when divested of the rough, dirty pigment which usually adheres closely to it; whirls four or five, minutely wrinkled, the posterior one small and flattened so as to form an obtuse apex; the others cylindrical, and so partially in contact as to expose about one-half of the cylinder; the last entirely disjoined from the preceding one for at least the half of a revolution; aperture circular, lip simple and sharp; on looking at the shell from below, no umbilical opening is found; operculum horny, apex central, elements concentric. Length .1, breadth 3-40 inch.

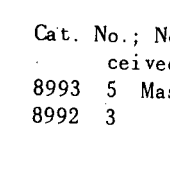

Fig. 19.

Found at Fresh Pond and other ponds, on stones and submerged sticks; and has been for many years in our cabinets marked as a *Paludina.*

Animal very active; head proboscidiform, half as long as the tentacles, bilobed in front, dark, terminated with light; tentacles rather stout, light drab-colored, with a line of silvery dots on the upper side, over the large, black eyes; foot, tongue-shaped, as long as the first whirl, dilated into two acute angles in front, light drab-color; respiratory organ occasionally protruded to half the length of a tentacle on the right side.

This species is widely distinguished from all other described ones by its minuteness, its color, its elongated form, and its want of an umbilicus; of

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which characters the last two seem to arise from the loose manner in which the whirls are united. *(Gould.)*

Valvata pupoidea, Gould, Am. Journ. Sc. 1st ser. XXXVIII, p. 196, 1840; Invert. of Mass. p. 226, f. 155; Otia, 180.--Haldeman; Mon. p. 10, pl.i, fig. 11-13.--DeKay, N. Y. Moll. 119.--Chenu, Man. de Conch. II, 311, fig. 2230.--Anonymous, Can. Nat. II, 214, fig.

Fig. 19 is an enlarged view of one of Dr. Gould's figures. Found also in Connecticut *(Linsley),* District of Columbia *(Girard),* Maine *(Mighels),* and Canada *(Can. Nat. i. c.).*

Binney, p. 14

Cat. No.	No. of Sp.	Locality.	From whom received.	Remarks.
8993	5	Massachusetts.	Dr. J. Lewis.	.....
8992	3	"	W. Stimpson.	Cabinet series.

This species is made the type of a new genus *Lyogyrus,* by Mr. Gill. (Proc. Ac. Nat. Sc. Phil. 1863.) It does not appear to me that there are sufficient grounds for believing it distinct.

Valvata humeralis, Say.--Shell subglobose, depressed; spire convex, not prominent; whirls three and a half, with the shoulder depressed, plane; wrinkled across, or rather with slightly raised lines; aperture appressed to the penultimate whirl, but not interrupted by it; umbilicus rather large. Greatest breadth, less than one-fifth of an inch.

Inhabits Mexico.

Differs from *V. sincera,* nob. of the Northwest Territory, in being more depressed, and in having a shoulder or plain surface near the suture. The umbilicus is larger than that of the *V. piscinalis,* Müll., and the spire more depressed; that species is also destitute of the depressed shoulder. *(Say.)*

Valvata humeralis, Say, New Harm. Diss. II, 244; Descr. 22. Binney's ed. p. 148.--Haldeman, Mon. p. 9.--Menke, Zeit. für Mal. II, 129.

This Mexican species, not noticed since Mr. Say found it in Mexico, has been quoted from Canada by Bell, Whiteaves, &c. They probably refer to a variety of *V. tricarinata.* Compare *V. virens.*

Valvata virens, Tryon.--Shell turbiniform, consisting of four well rounded whirls; spire elevated, apex acute, sutures deeply indented; periphery almost angulated; umbilicus very wide; aperture oval or nearly round, the peristome merely touching the body above. Surface closely striate. Color varying from brilliant to dark-green. Height .5; diam. maj. .5, min. .4; of aperture, length 2.5, breadth 2 mill.

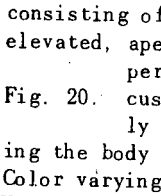

Fig. 20.

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Clear Lake, California. Wm. M. Gabb. My cabinet, and cabinet of Mr. Gabb. A number of

specimens of this species are before me, most of them being about two-thirds grown. It has no American[1] analogue. *(Tryon.)*

Valvata virens, Tryon, Proc. Phila. Acad. Nat. Sci. May, 1863, 148, pl. i, fig. 11.

I have added to the fac-similes of Mr. Tryon's figures (Fig. 20) an enlarged view of the shell and Fig. 21 operculum of this species in Fig. 21[2] The peculiar greenish color of the shell distinguishes it from the other American species. The description may be compared with that of *V. humeralis*, given above.

Cat. No.; No. of Sp.; Locality.; From whom received. Remarks.
9303 3 Clear Lake, Cal. G.W. Tryon, Jr. ... Fig. 20.

SPURIOUS SPECIES.

Valvata arenifera, Lea, Tr. Am. Phil. Soc. IV, 104, pl. xv, f. 36; Obs. I, p. 114. On p. 27 of Vol. V it is said to be the larva case of *Phrygania*. Vide the interesting remarks by Von Siebold on this and similar sacs of Phryganidous and other insects in a paper 'On a true Parthenogenesis in Moths, &c.,' translated by Dallas, London, 1857, p. 28, note. See also Conrad, N. Fr. Water Sh. p. 2.

Valvata cinerea, Say, from Western States, is mentioned by name only by Wheatly in his Cat. of Shells of U.S., p. 29; also--

Valvata buccata, Lea, Schuylkill.

Valvata lustrica, Menke, Syn. Meth. Moll. (Zeit. f. M. II, 130.)

FOSSIL SPECIES.

Valvata parvula, Mk. and Hdn., Phil. Pr. 1856, 123.

Valvata scabrida, Mk. and Hdn., Phil. Pr. 1860, 418.

Valvata subumbilicata, Mk. and Hdn. Phil. Pr. 1860, 430.

Planorbis subumbilicatus, *Mk.* and Hdn. (1856, 120).

1. Eastern North American?

2. The specimen figured was received from Mr. Tryon.

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FAMILY VIVIPARIDAE

Lingual membrane with seven series of teeth (3 1. 3), the central teeth broader; simple or denticulated at their apices.

(FIG. 22.)

Rostrum simple, moderate; tentacles short, stout, the right hand one, on the male, as large as the rostrum; eyes on peduncles at their exterior base. Foot large, simple. Operculum annular, sometimes with a spiral nucleus. Shell spiral, turbinate, covered with an olivaceous epidermis; aperture simple in front.

VIVIPARA, Lamarck.

Foot of moderate size, thick, not produced beyond the snout. Colors very dark. Head rather large. Snout of moderate

Fig. 23. Fig. 24.

size. Lingual teeth armed with large denticles at their cusps; the central tooth with from seven *(swainsonii)* to eighteen *(sub-*

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purpurea) denticles, the intermediate with from seven to twelve, the inner lateral with from five *(swainsonii)* to ten *(georgiana)*, and to sixteen *(bengalensis)*. Right tentacle as broad as the snout, and but little shorter than the left, with its extremity truncated and excavated, forming a sheath for the reception of the connate male organ, which projects a little beyond when unsheathed or unfolded. Cer-

Binney, p. 17

vical lappets of each side very large, and folded, trough-shaped, forming with the mantle distinct tubular conduits, on the right side for the ingress, and on the left for the egress, of the water for respiration. Branchial laminae very numerous, narrow, almost linear, and crowded in a single row, but variable in width at base, and diverging at their tips so as to appear to be in three or more rows. *(Stimpson.)* Operculum with the nucleus simple. Shell thin, turbinated, sometimes umbilicated; spire produced, whirls round, smooth or carinated, covered with an olivaceous epidermis; peristome thin, continuous, simple anteriorly.

Fig. 25.

Vivipara intertexta, Say.—Shell subglobose, yellowish-green or brownish, wrinkled, and with minute, very numerous, obsolete revolving, deciduous lines; spire depressed conic, obtuse, truncated, eroded at tip; volutions nearly four; suture rather deeply indented; umbilicus closed by the lateral extension of the columella.

Fig. 26.

Greatest breadth, from four-fifths to one inch; length, about the same. Inhabits Louisiana.

We collected many of the shells in the marshes near New Orleans and on the banks of the Carondelet canal. It is remarkable for its globular form and for the numerous obsolete lines which seem like equidistant deciduous corrugations of the epidermis, having no effect whatever in modifying the calcareous surface, upon which it exhibits no trace. In good specimens two or three obsolete, pale bands are visible by transmitted light. *(Say.)*

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Paludina intertexta, Say, 1829, New Harmony Diss. II, 244; Am. Conch. 3, pl. xxx, f. 3, 4, 1831; Binney's ed. p. 146, 185, pl. xxx, f. 3, 4; ed. Chenu, 42, pl. xi, f. 7-9.--Haldeman, Mon. p. 31, pl. x, f. 1-6, 1841.--DeKay, N.Y. Moll. p. 85 (1843).--Philippi, Conch. II, 8, pl. ii, f. 4 (1846).--Küster, in Chemn. ed.2, p. 16, pl. iii, f. 9, 10* (1852).

Paludina transversa, Say, N. H. Diss. II, 245, 1829; Binney's ed. p. 145.--DeKay, N.Y. Moll. p. 85 (1843).

Ampullaria (?) intertexta, Haldeman, Mon. Ampullaria, p. 11 (1844?).

Binney, p. 18

In addition to Mr. Say's localities, I have received it from Grand Coteau, St. Laundry Parish, La. *(Blanc.)* Also from South Carolina *(Ravenel)*, and from Davenport, Iowa *(Prof. Sheldon)*. Very globose specimens of *Vivipara contectoides* sometimes are readily confounded at first glance with this species. They are umbilicated.

Fig. 27.

Mr. Say's figures are copied above (fig. 26). Fig. 27 represents the front view of a more perfect specimen, No. 8863 of the collection.

Mr. Say's type of *Pal. transversa* is still preserved in the Cabinet of the Philadelphia Academy. It is evidently a young *intertexta,* as suggested by Haldeman. His description follows, with a view of his type (Fig. 28).

Paludina transversa, Say.-Shell transverse, depressed, orbicular; spire convex; whirls three and a half, with numerous minute, slightly elevated revolving lines; suture not widely indented; body whirl very convex, short; umbilicus small; operculum pale fulvous.

Fig. 28.

Greatest width, two-fifths of an inch. Inhabits Louisiana.

We obtained two specimens in the marshes near New Orleans. It is much wider in proportion to the length than any other species I have seen, exceeding in this respect even *M. subglobosa,* nob., and especially *P. intertexta,* nob., of which latter, in fact, I at first supposed it to be the young, in consequence of its rotundity and the similarity of its capillary lines; but inasmuch as the number of its whirls is nearly the same, whilst the magnitude differs so greatly, I have separated it as a different species. *(Say.)*

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FIG. 29.

Fig. 29 represents the lingual dentition of *V. intertexta*. There are forty-eight rows of seven teeth each, the first fifteen or sixteen of a smoky claret color.

The male and female of this species are respectively represented in Figs. 31 and 30.

Fig. 30. Fig. 31.

Cat. No.; No. of Sp.; Locality.; From whom received. Remarks.

8862 4 Grand Coteau, St. Laundry, La. Rev. A. Blanc.
8863 2 Grand Coteau, St. Laundry, La. " " Blanc. Figured.
8864 2 New Orleans. Acad. Nat. Sc. .....
9202 2 Illinois? Gen. Totten. .....
9305 .. Iowa-Davenport. Prof. Sheldon. Lingual ribbon - Fig. 29.
9315 1 Iowa-Davenport. Prof. Sheldon. Female.
9316 1 Iowa-Davenport. Prof. Sheldon. Male.

Vivipara subpurpurea, Say.--Shell oblong, subovate, olivaceous, with a tinge of purple more or less intense, sometimes hardly perceptible; spire rather obtuse, terminating convexly; whirls five, wrinkled, equally convex; suture impressed, but not very profoundly; aperture much widest in the middle, narrower above; within glaucous, somewhat perlaceous; labrum rectilinear from the middle upwards; umbilicus none. Length about one inch, greatest breadth four-fifths of an inch.

Fig. 32.

An inhabitant of Fox River, an arm of the Wabash. It is very distinct from any other species I have seen.

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The labrum exhibits no curvature from the middle almost to its junction with the penultimate volution.

Shell subglobular oval, nor remarkably thickened; spire longer than the aperture, entire at the tip; whirls five, slightly wrinkled across, rounded but not very convex; penultimate volution somewhat elongated; suture impressed; aperture ovate-orbicular, less than half the length of the shell; labium with calcareous deposit; animal very pale bluish, with minute yellow points, particularly on the rostrum, tentacula, and prominent respiratory tube, which is as long as the tentacula; eyes on the exterior side of the tentacula, near the middle of their length; the anterior portion of the foot is very short.

Fig. 33.

This species was first found by Mr. Lesueur and Dr. Troost, in Fox River of the Wabash. In the young state the figure is subglobose, and the aperture, although it hardly differs in form from that of the adult, is yet longer than the spire. They become proportionally more elongated as they advance in age, and the form, therefore, of the adult, is so different from that of the young or half grown, that in these states it may, very readily, be mistaken for a widely distinct species.

The color of the shell is variable. In some it is pale horn, more tinged with yellowish than with green; in others are traces of obsolete purplish bands; in many specimens the whole shell is reddish-purple, more or less obscure in different individuals.

Fig. 34.

In the autumn it is frequently found between the valves of dead Unios, in which it enters perhaps to hybernate. The species is certainly allied to the *vivipara*, but it cannot well be mistaken for it, as it is much less dilated, the volutions less convex; the penultimate volution is much longer in proportion to the length of the body whirl, and the umbilicus is obsolete. *(Say.)*

Paludina subpurpurea, Say, 1829; N.H. Diss. II, 245; Am. Conch. III, pl. xxx, f. 2, 1831; Binney's ed. p. 146, 185, pl. xxx, f. 2; ed. Chenu, 41, pl. xi, f. 6.--Haldeman, Mon. p. 28, pl. ix, 1841.-- DeKay, N. Y. Moll. p. 86 (1843).--Küster, Chemn. ed. 2, p. 12, pl. ii, fig. 10-13; pl. vii, fig. 3-5.--Reeve, Con. Icon. 47, Feb. 1863.

Vivipara texana, Tryon, Pr. Ac. Nat. Sc. (fig.), Sept. 1862, p. 451.--Reeve, Con. Icon. 24 (Feb. 1863).

Binney, p. 20

Mr. Say's original specimens of this species are still preserved in the collection of the Philadelphia Academy. Fig. 35 is taken from one of them.

The surface is often quite smooth and shining, the spire more or less elongated and slender, but generally distinguished by the penultimate whirl, which is very much larger than is usual in our

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Viviparae, and when seen from behind, appears remarkably bulging at its upper portion. The umbilicus is not always closed.
Fig. 32 is copied from one of Mr. Say's figures. No. 9301 of the collection is figured in Fig. 36.

Fig. 35.

In the description of the animal Mr. Say speaks of a tubular cylindrical organ as a respiratory syphon, but Haldeman suggests its being probably the outlet of the viscous glands.

A specimen in Mr. Anthony's cabinet measures in extreme length 33, last whirl 19, penultimate 8, antepenultimate 2½ mill., the measurements being taken on the front of the shell.

I have traced this species from Texas through Louisiana and Mississippi to Key West, Florida, and in the Western States of Indiana, Wisconsin, and Missouri.

A more elongated, slender form of the species, which is common in the southwest, from Mississippi to Texas, has been described by Mr. Tryon as a distinct species under the name of *V. texana*. A careful examination of the specimen from which his diagnosis is drawn, as well as the large series in the Smithsonian collection, leaves no doubt in my mind of its identity. The original description and figure are given below. Reeve figures a much less characterized specimen of *V. subpurpurea* as *Pal. texana*, which he considers distinct.

Fig. 36.

Vivipara texana.--Shell solid, conic, light green colored; spire elongate, suture deeply impressed, apex obtuse; whirls 6, slightly convex; aperture two-fifths the shell's length.

Fig. 37.

Binney, p. 21

Texas. Coll. Acad. Nat. Sciences; Coll. G. W. Tryon, Jr.

Shell solid, narrowly conic, consisting of six whirls, which are somewhat flattened around the upper half of their breadth; suture well marked; aperture suborbicular, equalling two-fifths of the length of the shell; umbilicus covered; epidermis light green with faint red revolving bands.

This shell resembles most the *V. subpurpurea*, Say, but

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is easily distinguished by having six whirls, which are much narrower than in that species. The spire is also almost double the length of that of *subpurpurea*, and the epidermis of a lighter color. *(Tryon.)*

Fig. 38. Operculum horny, rounded; nucleus subcentral; lines of accretion concentric.

The lingual dentition of *V. subpurpurea* is shown in Fig. 39.

(FIG. 39)

Cat. No.	No. of Sp.	Locality.	From whom received.	Remarks.
8844	9	Natchez.	Col. Wailes.	.....
8845	13	Lake Concordia.	"	.....
8846	8	Mississippi River.	"	.....
8847	4	.....	.....	Cabinet series.
9210	1	.....	.....	.....
9301	1	.....	W.G. Binney.	Fig. 36.
9314	2	.....	Agassiz.	Figured.

Vivipara multicarinata, Hald.--Shell conic, thin, subdiaphanous, green, whirls 5, longitudinally striate and transversely carinate.

Fig. 40. This *Paludina* is thinner and lighter than our species and has but 5 whirls. The length is about one-fifth more than that of the last whirl, of which the diameter is about double that of the penultimate whirl; beside the longitudinal striae, there are four carinas, of which the first and third are stronger than the second and fourth, and which cover the whole length of each of the whirls.

Binney, p. 22

The opening is almost circular, yet the vertical is greater than the transverse diameter. The lip is slightly thickened, not acute; the columella, which is hardly distinct from the lip, joins the superior termination of the aperture under a slightly acute angle.

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The columella termination of the lip partially covers a very small umbilicus. The length of fully developed shell is 14, its breadth 11 lines. *(Valenciennes.)*

Paludina carinata, Valenciennes, in Humboldt and Bonpland (1833), Rec. d'Obs II, 252, pl. lvi, f. 2, a b.--Küster, in Chemn. ed. 2, p. 28, pl. vi, f. 6, 7.--Haldeman, Mon. p. 27, pl. viii (1841).

Paludina multicarinata, Haldeman, Mon. pt. 4, p. 4 of cover (1842).

Fig. 40 is a fac-simile of that of Valenciennes, whose description is copied above. Prof. Haldeman suggests the name *multicarinata,* as the name *carinata* has also been used by Swainson. I have seen no specimens of the species.

Vivipara contectoides.--Shell umbilicated, elongately-ovate, rather thin, smooth, shining, the surface scarcely broken by the extremely delicate lines of growth; greenish horn-color, sometimes darker, varied with several longitudinal dark streaks marking the former peristome, and with four well marked brown bands revolving upon the whirl, of which two only are visible on the penultimate and antepenultimate; under the epidermis of a pale yellowish color, still plainly showing the bands; spire scalariformly turbinated, apex entire, well defined, obtuse; whirls 5, bulging, regularly and rapidly increasing in length, the last ventricose, more than one-half the shell's length, umbilicated; aperture sub-circular, oblique, about half as long as the body whirl, within white, showing plainly the four revolving bands, the lower one very near its base, none of them reaching the edge of the aperture; peristome dark, thin, acute, made continuous by the dark, thin, exserted callus which connects the terminations, somewhat reflected at the umbilicus.

Fig. 41.

Fig. 42.

Binney, p. 23

Length of axis 22, greatest breadth of last whirl 18; length of aperture 15, breadth 13 mill.

Operculum horny, concentric, thin, flexible, concave, the nucleus nearer the columellar margin (Fig. 42).

Limnaea vivipara, Say, Nich. Enc. Am. ed. II, pl. ii, f. 5 (1817) *(Paludina* of later ed.).

Paludina vivipara, Say, Am. Conch. pl. x, outer figs. (1830); Binney's ed. 49, 159, pl. lxx, f. 5; ed. Chenu, 17, pl. ii, f. 5, 5a.--Haldeman Mon. 17, pl. vi (1841). --DeKay, N. Y. Moll. 86 (1843).

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Paludina linearis, Küster, in Ch. ed. 2, 10, pl. ii, f. 6-9; p. 19, pl. iv. f. 4 (1852).

Helix vivipara, Eaton, Zool. Text-Book, 196 (1826).

Has been found in Florida, Georgia, South Carolina, Alabama, Arkansas, Missouri, Illinois, Indiana, Michigan.

The specimen (Fig. 41) from which the above description is drawn is probably a male. It is the most scalariform of all that I have seen. The species is variable, the degrees of globoseness being numerous.

Fig. 43.

Fig. 44.

The umbilicus is rarely entirely closed, even in young shells.

The number and disposition of bands is constant in all the specimens before me; the lower band sometimes is expanded so as to surround and enter the umbilicus.

The species is readily distinguished from *V. georgiana* by its perfect apex, by the greater globoseness of its whirls--they being more loosely convoluted, and by its more shining surface. Its epidermis is more delicate, and does not peel off like that of *georgiana.*

Fig. 45.

Fig. 46.

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Viviparus contectoides receives its name from its strong resemblance to the *V. contecta* of Europe. It has been by some authors considered identical with that species, and with the exception that the American form has four spiral bands upon the body whirl while the European is described as having but three, I can detect no specific differences between them. It is more upon its geographical distribution that I base my opinion of its being distinct. Our species is found over an area very much vaster than that inhabited by its European analogue. It is not one of the fluviatile species of the circumpolar or boreal regions, common to the three continents, as it is not found farther north than the great lakes. I am inclined to believe that, as with the exception of these circumpolar species the land and fresh-water

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molluscous fauna of Europe and America are entirely distinct, we are justified in considering that this *Vivipara* is not identical with the *V. contecta*.

There exist in Europe two species of *Vivipara:* the *contecta (Cyclostoma)*, Millet, and *vivipara (Helix)*, Lin. It is to the former that our species bears so strong a resemblance, and not to the *vivipara*, as suggested by authors. I have copied Reeves' figures of both species (Figs. 45 and 46) that those not having access to foreign works may compare them with our shells. *V. contecta* is described as being composed of 5½ prominently turned whirls, convoluted so loosely as to leave a deep umbilicus in the centre; while *V. vivipara* has one whirl less, has moderately ventricose whirls, and is more constrictedly convoluted--the umbilicus being reduced to a mere chink.

I have elsewhere remarked that *V. contectoides* seems, in respect to form, to hold the same relation to *V. georgiana* as *V. contecta* does to *V. vivipara*.

I have been unable to obtain living specimens of this species, or any preserved in spirits, from which to examine the lingual membrane.

Mr. Say first mentions this species as early as 1817, describing it as identical with the

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European *V. vivipara*, as a *Limnaea*, and later as a *Paludina*. I give below a copy of his description and figures from the American edition of Nicholson's Encyclopedia (Fig. 47), and the American Conchology (Fig. 48). It will be observed that Say mentions three revolving bands instead of four. I am inclined to attribute this to his overlooking the lowest band, which is quite at the base of the shell and does not extend so far towards the edge of the aperture on the inside.

Paludina, vivipara, Say.--Shell subconic, with six rounded whirls; suture impressed, color olivaceous or pale, with three red-brown bands, of which the middle one is generally smallest, whirls of the spire with but two; aperture suborbicular, more than half the length of the shell.

It is doubtful whether or not this is the same as the *vivipara*, but it certainly approaches very near to it; we, however, refer it to that species until a specific difference can be indicated, which at present we are unable to do; the spire of this species is rather more obtuse, and the suture not so deeply impressed, as in the figures of the European specimens above mentioned.

Fig. 47.

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Donov. Brit. Shells, tab. lxxxvii, *Helix vivipara*.--Lister, Conch. tab. cxxvi, fig. 26; *Cochlea vivipara fasciata*, &c. &c.

This appears to be one of the many species that are common to North America and Europe. And though the specimens from the two continents differ a little, yet this difference is so slight as not to be specific. Cuvier remarks that 'the female produces living young, which are found in its oviducts, in the spring, in every state of development. Spallanzani assures us, that the young, taken at the moment of their birth and nourished separately, reproduce without fecundation, like those of the *Aphis*. The males are nearly as common as the females; their generative organ is exserted and retracted, as in *Helix*, by a hole pierced in the right tentaculum, which causes this tentaculum to appear larger than the other. By this character the male is easily known.'

Fig. 48.

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The *vivipara* is far less common than the *decisa,* and seems to be more usually found in the southern part of the Union. Mr. Elliott of Charleston sent me two specimens from the banks of St. John's River, Florida, and Capt. Leconte presented me with one, which he obtained at Lake George on the same river. Pl. 10.[1] the two middle figures exhibit the brownish banded var. *(Say.)*

The next notice of the species was by Eaton, in 1826, who describes it as *Helix vivipara.*

In 1841 it is again described and figured by Haldeman, as identical with the European *Paludina vivipara.* The bands are spoken of as 'several.' Prof. Haldeman quotes *Pal. lineata* in the synonymy. (See that species).

The description of DeKay (1843) gives no additional information regarding the species, which is 'extra-limital' to New York; it gives only four whirls and three bands to the shell.

In 1852, in the second edition of Chemnitz, this species is described and figured as *Paludina linearis.*

In the Proceedings of the Philadelphia Academy, 1862, p. 451, Mr. Tryon points out the fact of the American shell being invariably distinguished by the presence of four bands, yet refers it to *Pal. lineata,* Val., which derives its name from its being sometimes characterized by numerous revolving lines of green color instead of bands.

[1] One of the figures is given in my figure 48.

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In 1863 Mr. Reeve refers the American form to *Paludina vivipara,* Lin.

Believing the species to be distinct from its European analogue, and not finding the description of Valenciennes to apply to it, I have been forced to adopt a new name, suggested by the resemblance of the shell to the *V. contecta* of Europe.

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Cat. No.	No. of Sp.	Locality. ; From whom received. Remarks.
8849	1	Coosa River, Ala. Dr. E. R. Showalter.
8850	3	Lake Muxinkawka, Ind. ....
8851	4	Jacksonville, Fla. W.G. Binney. .....
8852	4	Georgia. J. Postell. Cabinet series.
8855	2	Illinois. ....
8856	2	Mississippi River. ....
8860	3	Indiana. W.G. Binney. .....
8861	4	St. Clair River. .....
9011	1	....
	1	Florida. Prof. Agassiz. .....
9202	1	Tuscumbia, Ala. Gen. Totten. .....

Vivipara georgiana, Lea.--Shell scarcely rimate, elongately ovate, rather thick, smooth, lines of growth delicate; greenish horn-color, broken with darker longitudinal streaks and a few black ones showing the former peristomes, and whitish under the epidermis; sometimes of a rich brown color, pinkish without the epidermis, and varied with four revolving darker bands upon the body whirl, two of which only are visible above, and numerous irregularly crowded, narrow lines of the same color; spire elevated, composed of one entire and one partially truncated whirl, apex entirely removed; remaining whirls 4½, regularly increasing, convex, the last bulging, more than one-half the shell's length, rarely rimate; aperture subcircular, very oblique, more than half the length of the body whirl, within uniformly white or dark horn-color, or plainly showing the revolving bands, which do not reach the edge; peristome edged with black, simple, acute, continuous, its columellar margin exserted, somewhat reflexed, leaving a narrow fissure, connected with the upper termination by a shining, dark, raised callus. Length of axis 20, greatest breadth of body whirl 21; length of aperture 15, breadth 14 mill.

Fig. 49. Fig. 50. Fig. 51.

The operculum is thin, horny, brown, concentric with sub-central nucleus.

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Paludina georgiana, Lea, Tr. Am. Phil. Soc.

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V, 116, pl. xix, fig. 85, date of title 1837; Obs. I, p. 228.--Haldeman, Mon. p. 23, pl. vii, f. 1, 2 (1841).--Küster, in Chemn. ed. 2, p. 15, pl. iii, f. 7, 8 (1852)--DeKay, N. Y. Moll. p. 86 (1843). --Chenu, Man. Conch. I, 310, fig. 2207 (Melantho); Illust. Conch. pl. i, f. 20, 21.--Philippi, Conch. iii, 4, pl. i, f. 13 (1848).

Paludina wareana, Shuttleworth in Küster, Chemn. ed. w, 21, pl. iv, f. 10-11.--Reeve, Con. Icon. 23 (1863).

Vivipara vivipara (part), W. G. Binney, proof-sheets of this work.

Inhabits Florida, Georgia, South Carolina, and Alabama.

Mr. Lea's description of this species will have to be considerably modified to cover the various forms now known to exist; it was drawn from a specimen which was uniformly dark horn-colored. Specimens in the Smithsonian collection are thus characterized, while others are of an uniform pale greenish horn-color; others (Fig. 53) have a dark-green or brownish ground, varied with four broad brownish bands revolving on the body whirl, two only of which are discernible on the penultimate whirl; in others these bands are replaced by numerous revolving, unequal brown lines (Fig. 54). Those having the revolving lines have also bands which, as in the other cases, are plainly visible in the aperture of the shell. The bands do not reach the edge of the peritreme in the aperture; they are still discernible when the shell has lost its epidermis. As the peritreme rises to meet the base of the body whirl it is expanded and reflected, sometimes leaving a chink forming a false umbilicus--the shell being imperforate.

Fig. 52.

I have not been able to trace any revolving microscopic lines upon the specimens I have examined.

Fig. 53.

Fig. 54.

No. 8854 of the collection was determined by Mr. Lea. His description is given below, and an outline of his original figure. Fig. 52 is copied from Haldeman's figure, which was drawn from the original specimen. The other figures are from specimens in the collection.

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Paludina georgiana, Lea.--Shell ventricose-conical, thin, dark horn-colored, smooth; sutures very much impressed; whirls about five; convex; aperture nearly round, white.

Fig. 55.

Hopeton, near Darien, Ga. Prof. Shepard; my cabinet; cabinet of Prof. Shepard. Diameter .7, length 1.1 inch.

This species in form resembles most, perhaps, the *P. vivipara*. It is not quite so large, nor has it bands. It is rather more elevated, and the body whirl is smaller and rounder than the *P. decisa,* Say. The aperture at the base recedes more than is usual with the genus. *(Lea.)*

Vivipara georgiana is not a variable species in form. It bears somewhat the same relations to *V. contectoides,* as the European *V. vivipara* does to *V. contecta*. It is more constrictedly coiled upon its axis, its spire is more pyramidal in shape, its whirls are more flattened, and less angularly bulging at their upper portion. It is constantly truncated at the apex.

Reeve places *Pal. georgiana,* together with *vivipara,* Say, in the synonymy of the European *vivipara,* as I did in the proof-sheets of this work. The specimens since received have caused me to change my opinion.

An examination of an authentic specimen of *Pal. wareana* leaves no doubt in my mind of its identity with *V. georgiana*. The original description and a fac-simile of one of the original figures here follows:--

Paludina wareana.--Shell rimately perforate, ventricose, rather thin, subopaque, with delicate concentric lines, olivaceous-ferrugineous, thickly streaked with smoke color; whirls 4, inflated, sutures deep; aperture oval, white, ends joined by a thin, glassy callus; peristome straight, sharp.

Fig. 56.

Shell somewhat resembling *Pal. obtusa,* but is very truncated, rimate, perforate, ventri-

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cose, rather thin and transparent, almost opaque; striae fine; color olive green blending with iron; surface broken by numerous curved streaks, sometimes linear, sometimes stronger; whirls 4, slightly increasing; first whirl entirely eroded, the second slightly so in the shell examined; whirls ventricose, sutures moderate; aperture ovate, much shorter than the spire, above modified by the penultimate whirl, reddish within, bluish towards the edge; parietal wall covered with a thin transparent callus; columellar slightly curved; peristome straight,

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acute, from below the middle to the base slightly curved. Length 9‴, breadth 7‴.

East Florida in Lake Ware (Rugel). Coll. Charpentier *(Shuttleworth).*

The lingual membrane of *Vivipara georgiana* is figured below.

(FIG. 57.)

Cat. No.	No. of Sp.	Locality.	From whom received.	Remarks.
8853	1	Georgia.	.....	.....
8854	3	"	.....	.....
8857	1	Alabama.	Acad. Nat. Sc.	.....
8958	2	Darien, Geo.	"	.....
8959	1	South Carolina.	"	.....
9012	1	.....	.....	Figured.
9022	1	Florida.	.....	"
9023	1	Georgia.	.....	"
9300	1	Florida.	L. Agassiz.	"
9304	..	.....	"	Lingual of 9300. Figured.

Vivipara lineata, Valenciennes.--This species resembles that of the Seine. It is equally ventricose, but has a thinner shell. Shell ventricose-ovate, thin, diaphanous, with delicate transverse striae; greenish horn-color, with numerous transverse greener vittae. Whirls five, last one large, ventricose, and equalling in height one-half the entire length of the shell. Besides the striae of growth, there are numerous transverse, very fine lines. The whirls are not flattened towards the moderate suture. Apex acute. Color green, sometimes

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somewhat corneous ground, on which are a large number of bands of a deeper green and variable width, sometimes merely linear. On the upper whirls the bands are obsolete. Apex not eroded in any of a large number of individuals.

Operculum brown, thin, horny, covered with numerous concentric, not spiral, lines. Found in Lake Erie by M. A. Michaud, who found one shell full of young, as in the case of our species, which proves the species to be viviparous. There is reason to believe the other species also are so, though in the most natural genera species vary in being both oviparous and viviparous. The genera of colubers and vipers among the reptiles are an example of this, while the Mollusca furnish more numerous ones.

Length 1 inch 3 lines. *(Valenciennes.)*

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Paludina lineata, Valenciennes, Rec. d'Obs. II, 256, 1833.

I have translated above the original description of Valenciennes. I have never seen any specimen to which it will apply, but have no doubt such will be found. At present it remains a doubtful species.

It is referred to *Pal. vivipara,* of Say, by several authors, but all the specimens of that species which I have seen are not characterized as *V. lineata* is described as being. (See remarks under *V. contectoides.)*

Vivipara troostiana, Lea--Shell ventricose-conical, thin, pellucid, yellowish horn-color, smooth, perforate; spire short; sutures very much impressed; whirls four, convex; aperture large, rounded, white.

Tennessee. Prof. Troost. My cabinet, and cabinet of Prof. Troost. Diam. .68, length .72 inch.

This is a subglobose species, differing from any which has come under my notice, in having the superior portion of the last whirl somewhat flattened, giving the shell a somewhat gibbous

Fig. 58.

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appearance. The operculum is rather of a light color, and the plane of the aperture is very retuse at its base. It has a strong resemblance to *P. unicolor* (Lamarck), and perhaps a stronger one to *P. Maheyana* (Grateloup). It is more depressed in the spire than either, and the perforation is smaller than in the former, while it is nearly the size of that in the latter. The aperture is larger than either. Dr. Grateloup has very properly, I think, separated the Malabar species from that which was observed by Olivier in Egypt, and called *unicolor* by Lamarck. The Egyptian shell has a larger perforation, is darker in color, and is a larger species. I call this after my friend Prof. Troost. *(Lea.)*

Paludina troostiana, Lea, Tr. Am. Phil. Soc. IX, 14 (1844). Obs. IV, p. 14. Proc. II, 34 (1841). Arch. f. Nat. 1843, II, 130.
Paludina haleiana, Lea. l.c. X, 96; pl. ix, f. 58 (1847). Obs. IV, 70. Proc. IV, 167 (1845).

I have added to Mr. Lea's description of *V. troostiana* a view of the type (Fig. 58) in his collection. It will not seem to correspond very exactly with the figure of *haleiana,* of which a fac-simile is given below (fig. 59). A comparison of all of Mr. Lea's specimens of each has convinced me, however, of their identity. Mr. Lea's description of the latter species here follows.

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Fig. 59. *Paludina haleiana,* Lea----Shell smooth, ventricosely conical, rather thin, reddish horn-color, imperforate; spire short, sutures much impressed; whirls four, nearly convex; aperture large, nearly round, bluish.

Diameter .4, length .55 inch. Alexandria, La.

This species is nearly allied to the *Pal. troostiana,* nob., but is rather smaller, of a darker color, not quite so rotund, and imperforate. These differences would distinguish it without difficulty. In the *haleiana* there is a disposition in most of the specimens to a compression below the sutures. This makes

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quite a shoulder at the sutures and prevents the mouth from being regular. *(Lea.)*

Fig. 60. *Vivipara coosaensis,* Lea.-Shell subglobose, thin, pale, rather smooth, perforate; spire short; sutures very much impressed; whirls five, round; aperture large, nearly round, within whitish.

Coosa River, Alabama. Dr. Brumby. My cabinet, and cabinets of Dr. Griffith and Dr. Foreman. Diam. .58, length .62 inch.

This species is remarkable for its round whirls, its width and large deep sutures. The superior part of the whirls is somewhat flattened. The color is remarkably pale, nearly white. The epidermis is very thin, and under the lens displays very minute, rather regular longitudinal striae crossed on the body whirl by obsolete striae. The aperture is nearly one-half the length of the shell. *(Lea.)*

Paludina coosaensis, Lea, Tr. Am. Phil. Soc., IX, p. 23 (1844). Obs. Iv, 23. Proc. II, 83 (1841).--Reeve, Con. Icon. (Feb. 1863).
Paludina magnifica, pars., Haldeman, Mon., pt. 6, p. 4 of wrapper.

Mr. Lea's type of this species bears but little resemblance to *V. magnifica,* yet Prof. Haldeman unites the two. I myself have seen no connecting links between them, though I have examined numerous young individuals of *Viv. magnifica.*

Fig. 60 is drawn from the original specimen of Mr. Lea. No. 8949 of the Smithsonian collection was labelled by Mr. Lea.

Cat. No.; No. of Sp.; Locality.; From whom received. Remarks.
8949 .. Alabama? ..... Teste *Lea.* Cab. series.

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TULOTOMA, Haldeman.

Fig. 61. Soft parts of the animal, and lingual dentition unknown. Operculum with the nucleus simple. Shell thick, pointed-conic, imperforate; whirls

flattened, nodulous, carinated, with a dark olivaceous epidermis; peristome thin, continuous.

Tulotoma magnifica, Conrad--Shell subovate, ventricose, with two spiral bands of prominent tubercles on the body whirl, and one revolving near the base of each whirl of the spire; suture profoundly impressed, margined by an obtuse, subnodulous, prominent line; lines of growth very oblique and prominent; obscure spiral striae; epidermis olive; within bluish, often with purple bands.

Fig. 62.

A beautiful species when perfect, occurring in vast abundance on the masses of calcareous rock, which have fallen from the strata above into the Alabama River at Claiborne. I found it living only in such situations, and exclusively within a range of six or eight miles. In the Tombeckbee or Black Warrier Rivers, I never observed a specimen of it, although I searched particularly for it on the rocks at St. Stephen's. *(Conrad.)*

Paludina magnifica, Conrad, N. Fr. W. Shells, 1834, p. 48, pl. viii, fig. 4; ed. Chenu, 23, pl. iv, f. 21.--DeKay, N. Y. Moll. (1843), p. 86.--Küster in Chemn., ed. 2, 1852, p. 23, pl. v, figs. 3-6.--Philippi, Conch., III, 1, pl. i, figs. 1, 2 (1848). --Müller, 1838, Syn. test. anno 1834, promulg. 39.--Reeve, Con Icon. xx, f. 54 (1863).

Paludina bimonilifera, Lea; Tr. Am. Phil. Soc., V, 58, pl. xix, fig. 71, date of title, 1837.--Ib., Obs. I, 170.-- DeKay, N. Y. Moll. 87 (1843).

Paludina angulata, Lea; Tr. Am. Phil. Soc., IX, 22 (1844).--Ib., Obs. IV, 22. Proc. II, 83 (1841).

Tulotoma, Haldeman, Mon. I, Suppl. 2.

Operculum horny, subtriangular, with a lateral nucleus and concentric striae. A continuous elevated, heavy, revolving line sometimes takes the place of the nodules. The interior of the aperture varies from pure white to a rich dark purple; it is sometimes of a salmon color; the bands are also very variable in number and width. There are also sometimes dark-green

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bands on the exterior of the shell. I have counted as many as four on the body whirl alone. It is variable in size, and is generally much eroded at the apex. One specimen which I measured was 50 mill. long.

Fig. 63. Fig. 64.

It inhabits Alabama and Georgia.

Fig. 62 is a fac-simile of the outline of Conrad's figure of *Paludina magnifica.* I have added below figures of Mr. Lea's *Pal. bimonilifera* and *Pal. angulata,* which are, I believe, identical with this species, Fig. 66 being a fac-simile of Mr. Lea's figure, and Fig. 67 being taken from a specimen determined by Mr. Lea. No. 8928 of the collection was labelled *Pal. angulata* by Mr. Lea. Haldeman agrees with me in considering this last identical with *T. magnifica.* I am indebted to Dr. E. R. Showalter for the other specimen figured. Haldeman adds *Pal. coosaensis* to the synonymy.

Fig. 65. Fig. 66.

Paludina bimonilifera, Lea--Shell obtusely turreted, dark horn-color; apex obtuse; whirls furnished with two rows of nodules; the nodules of the lower row of the upper whirls hidden by the suture, those of the upper row larger, and visible on all the whirls; sutures deep and irregular; outer lip sub-biangular; base subangular.

Alabama River (Judge Tait). My cabinet and those of Prof. Vanuxem, Am, Phil. Soc., Ac. Nat. Sc. Phila., P.H. Nicklin, Baron Ferussac. Diam. 1.1, length 1.8 inches.

This superb *Paludina,* which far surpasses in point of beauty any of our species yet known, I owe to the kindness of Judge Tait. Its beautiful double tuberculated cincture at once distinguishes it from all described species. Some specimens are furnished with dark purple bands which beautifully decorate the interior of the shell, and give a dark rich green color to its fine epidermis. In the others these are wanting, and the epidermis then has a clear and more yellow appearance. The sutures being

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formed immediately over the lower row of tubercles, they cause its line to be very irregular; and this row itself is hidden on the upper whirls. *(Lea.)*

Paludina angulata, Lea---Shell inflated, thin, brown, above somewhat varicose, below transversely and minutely striate, minutely perforate; spire rather short, dark at the apex; sutures impressed; whirls five, angular in the middle; aperture large, subtriangular, within subrubiginous. Fig. 67.

Coosa River, Alabama. Dr. Brumby. My cabinet, and cabinets of Dr. Griffith, Dr. Jay, Dr. Foreman, T. G. Lea, and J. Clark. Diam. .80, length 1.05 inch.

This is a very distinct species, being more angular than any I have seen. In the specimen before me, there are three irregular transverse impressions, two above the angle, and one immediately below. The striae are more distinct on the lower half of the whirl. The first three whirls are very dark. The aperture is nearly one-half the length of the shell, and quite angular at the base.

Since the above was written, I have received more mature and perfect specimens. They differ from the one described in being darker in the epidermis, and in having four purple broad bands, which are very distinct within the aperture. In these specimens, there is a series of indistinct tubercles above the periphery of the last whirl. *(Lea.)*

Cat. No.	No. of Sp.	Locality.	From whom received.	Remarks.
8927	1	Alabama.	Teste T. A. Conrad.	Cabinet series.
9017	1	"	I. Lea.	*(P. angulata)* Figured in Fig. 67.
8928	5	"		*angulata* teste Lea
9150	20+	Coosa River.		Cab. ser.
9196	2	Alabama River.	Dr. Showalter	

MELANTHO, BOWDITCH.

Fig. 68 Foot large, rather thin, broad, much produced beyond the snout, and

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slightly auricled in front. Colors rather light, in reddish spots on a palish white ground. Head of moderate size. Snout small. Lingual teeth smooth, or only very mi- Fig. 69.

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nutely crenulated at their apices. Cervical lappets of moderate size, but not forming regular tubular aquiferous ducts; the right one plicated. Branchial lamina elongate-triangular, equal in size, and arranged in a single straight row both at base and tips. *(Stimpson.)* Operculum with the nucleus simple. Fig. 70.

Shell thick, solid, ovate, imperforate, spire produced; whirls rounded, smooth, covered with an olivaceous epidermis; peristome simple, continuous.

Melantho ponderosa, Say--Shell imperforate, globosely ovate, very thick and heavy, smooth surface hardly broken by the wrinkles and delicate striae of growth, often also with delicate revolving striae; greenish horn-color, with irregularly disposed dark streaks, marking the edges of former peristomes, milky white under the epidermis; spire short, conic, apex perfect, convex; whirls 5 or 6, very rapidly increasing in length, convex, the body whirl very large, equalling four-fifths the shell's length, imperforate; aperture oval, narrowed above, slightly oblique, equalling almost one-half the shell's length, within white, shining; peristome margined externally with darker color, simple, acute, extremely sinuous, in its first half rectilinear, then produced forward and rounded, then retreating rapidly a nd curving inwards and downwards, thence upwards to the base of the aperture, its columellar portion very much thickened, sometimes exserted sufficiently to leave a narrow fissure, connected with the upper terminus by a very thick and solid callus, which enters beyond sight within the aperture, and at the upper portion is produced into a prominent Lithasia-like thickening, between which and the peristome is a deep sinus. Length of the axis 33, greatest breadth of body whirl 27; length of aperture 28, greatest breadth 19 mill. Fig. 71.

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Operculum elongate-ovate, narrow above, convex, margin thin, horny, concentric, nucleus near the columella.

Paludina ponderosa, Say, 1821, J.A.N.S. II, 173; Am. Conch. III, pl. xxx, f. 1 (1831); ed. Binney, p. 68, 184, pl. xxx, f. 1; ed. Chenu, 41, pl. xi, f. 5.--Haldeman, Mon. p. 13, pl. iv (1840.--De Kay, N. Y. Moll. p. 86 (1843) (exc. syn. *heterostropha).*--Deshayes in Lam. ed. 2, VIII, p. 516 (1838); ed. 3, III, p. 453, excl. *P. decisa.*--Küster in Chemnitz, ed. 2, p. 14, pl. iii, f. 1-4, p. 20, pl. iv, fig. 6--

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Sowerby, Gen. of Shells, f. 2.--Chenu, Man. de Conch. I. 310, fig. 2206 (Melantho); Illust. Conch. pl. i, f. 14-15; Lec. Elem. d'Hist. Nat. p. 171, f. 559, 560 (1847).--Philippi, Conch. III, 3, pl. i, f. 6 (1848).

Ampullaria crassa, Say of Deshayes, l. c.

Paludina decisa (part), Reeve, Con. Icon. f. 45 *b.*

Paludina regularis, Lea, Tr. Amer. Phil. Soc. IX, 13 (1844); Obs. IV, 13; Proc. II, 34 (1841); Arch. f. Nat. II, 130 (1843). --Reeve, Con. Icon pl. xi, f. 69 (1863).

I have received specimens from Ohio, Indiana, Illinois, Michigan near Lake Superior, Tennessee, and Alabama.

There are microscopic revolving lines upon the whirls of many specimens, and the callosity at the superior angle of the aperture is sometimes developed sufficiently to make quite a fissure between it and the lip, as in *Lithasia.* This is an important feature which serves to distinguish it from the allied species, as does also the highly developed curvature of the peristome (see Fig. 71), the extreme thickness of the shell, the heavy, deeply entering callus on the parietal wall of the aperture, the shorter spire, and more globose outline of the shell. It appears to me a distinct species, readily distinguished from *M. decisa* and *M. integra,* in early

Fig. 74

Fig. 73.

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stages of growth as well as when mature--the young shells being very much more globose than the young of those species.

From the Coosa River, in Alabama, Dr. Showalter has sent numerous specimens of this species, which were formerly noticed by Prof. Haldeman as var. a. They are extremely solid, have the callosity of the upper portion of the aperture highly developed, are constantly truncated in the early as well as later stages of growth, and when mature are very much eroded even upon the body whirl. They have the usual features of *M. ponderosa*--

Fig. 75.

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the sinuous peritreme, the revolving striae, the short spire, the heavy callus upon the parietal wall of the aperture. Some of them are figured in Fig. 72 to 75.

I give below the original description of Mr. Say, and a fac-simile of one of his figures (Fig. 76.) The shell figured as *Pal. decisa* in the American Conchology may, perhaps, be a form of *M. ponderosa* (See Fig. 84.)

Paludina ponderosa, Say.--Shell somewhat ventricose, much thickened, olivaceous or blackish; spire not much elongated, much shorter than the aperture, eroded at tip, but not truncated; whirls five, slightly wrinkled across; suture profoundly impressed; aperture subovate, more than half the length of the shell; labium with much calcareous deposit, and thickened into a callosity at the superior angle; within tinged with blue.

Inhabits Ohio River.

Greatest length, one inch and 11-20. Transverse diameter one inch and 1-10.

This shell is common at the Falls of the Ohio, and is a very remarkably thick and ponderous species. It bears a striking resemblance to *P. decisa,* and has, without doubt, been generally considered as the same; but it differs from that species in being much more incrassated and heavy; and although much decorticated and eroded upon the spire, the tip is not truncated.

Fig. 76.

Binney, p. 38

In the labrum also is a distinctive character; by comparison this part will be perceived to be less arcuated in its superior limb than the corresponding part in *decisa*.

This shell is common in many parts of the Ohio as well as its tributaries. In its full grown state it is very thick and ponderous, enlarging so much in its body whirl, as to appear very different from the young shell. In the early stages of growth it resembles *P. decisa*, Nobis, from which indeed the back view would hardly distinguish it; but a sufficiently distinctive character resides in the lower part of the labium, which in the *decisa* is not obviously produced, whereas in the present species it is considerably advanced, as in many species of *Melania*, to which genus it is closely allied. *(Say.)*

I have no doubt that a young specimen of *Melantho ponderosa* is the type of *Paludina regularis*, Lea. My figure is drawn from a specimen determined by him, and now deposited in the collection of the Smithsonian Institution (No. 9016). The spire

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is extremely short, flattened, but well defined quite to the acute apex; the sutures are impressed; the body whirl comprises more than five-sixths of the complete length of the shell; the aperture is almost as long as the body whirl, and so wide that the length and breadth of the shell are almost equal; the shell is remarkably globose, almost circular. I have often met in cabinets with immature specimens of *Viv. ponderosa* under this name. No. 8925 were also labelled *regularis* by Mr. Lea. His description here follows. The shell figured under this name by Reeve appears to me a young *M. ponderosa*.

Fig. 77.

Paludina regularis, Lea.--Shell subglobose, rather thick, greenish horn color, imperforate; spire very short; sutures impressed; whirls five, convex; aperture large, ovate, within bluish.

Ohio? T. G. Lea. My cabinet, and cabinet of T. G. Lea. Diam. .38, length .52 inch.

Binney, p. 39

A very distinct species with the body whirl about four-fifths the length of the shell. The whirls are very regular, giving the spire somewhat the appearance of a coil of rope. All the specimens before me are more or less incrusted with the oxide of iron. The aperture is inflated, and about three-fourths the length of the shell.

I am not positively sure that this species came from Ohio. By some accident the label has been misplaced, but I am under the impression it came with some other species from my brother at Cincinnati. *(Lea.)*

Ampullaria crassa, of Deshayes, is a synonym of this species, as will be seen by the translation given below of Deshayes' description. He quotes erroneously *Paludina crassa*, of Say, for the species--Mr. Swy never having published this name. An examination of the animal has, moreover, shown it to belong to the genus *Melantho*. Fig. 78 is taken from a drawing of the animal by Mrs. Say, which Prof. Haldeman furnished me.

Fig. 78.

Ampullaria crassa.--Shell ovate-elongate, acute, thick, solid, under the epidermis brownish; very white; transversely substriate; whirls 6, con-

(PAGE 40)

vex, scalariform, separated by a deep and channelled suture; aperture ovate acute, expanded at base, very white within, and with a small umbilicus.

Paludina crassa, Say.

We do not agree with Mr. Say in placing this shell among the *Paludinae:* it has not their essential characters, excepting the lengthening of the spire. In other respects it is more nearly allied to the *Ampullariae*, its form and thickness particularly approaching some of the fossil species of the environs of Paris described below.

This shell is oval, elongated, acute at the summit, rounded at base, thick, solid, heavy, covered with a brownish, sometimes greenish very thin epidermis, below which the shell is

Binney, p. 40

of an uniform milky white pureness. The spire is elongated, conic, scalariform, formed by six convex whirls, deeply separated by a canaliculated suture, and, in perfect specimens, marked with delicate transverse striae. The aperture is moderate not oblique to the shell's axis or rounded or with a continuous peritreme like *Paludina,* but oval, narrowed above where it also is angular as in most *Ampullariae,* enlarged below, where it forms a large, not deep sinus, in this point also resembling *Ampullaria,* but differing from all *Paludinae;* lastly, the right lip is slightly reflected (recouvrant), which is also characteristic of the genus in which we have placed it. Right lip acute, quickly thickening but with no rim within, sinuose, especially at base, when viewed in profile; left lip thickened, especially towards the posterior angle of the aperture, and obliquely appressed so as to blend with the columella which is rounded, thick, and reflected, with a small umbilical opening behind it. This shell comes from the Ohio and most of the North American rivers. Length from 45 to 50 mill. *(Deshayes.)*

Reeve, *l. c.,* places *Paludina ponderosa* in the synonymy of *Pal. decisa.* It is, indeed, difficult to draw the line between the two.

Cat. No.	No. of Sp.	Locality.	From whom received.	Remarks.
8841	3	Coosa River, Ala.	W.G. Binney.	.....
8842	1	"	"	.....
8843	2	.....	"	.....
8848	3	Ohio.	Acad. Nat. Sc.	Cab. series.
9152	2	Alabama.	.....	.....
9332	9	Coosa River, Ala.	Showalter.	.....
9333	12	"	"	.....
8925	6	Illinois.	.....	*regularis,* teste Lea.
8926	4	"	I. Lea.	" Cab. ser.
9016	1	.....	.....	.....

Melantho decisa, Say.--Shell imperforate, elongate, ovate, rather thick smooth, surface hardly broken by lines of growth, with microscopic revolving striae; greenish, with irregularly disposed brown streaks marking the edge of former peristomes, uniformly chalky white under the epidermis; spire truncated, one or two whirls of it alone remaining, apex entirely removed; remaining whirls 3½, convex, the last equalling two-

Fig. 79

Fig. 80.

Binney, p. 41

thirds of the shell's length, imperforate; aperture oval, oblique, more than one-half the length of the last whirl, bluish-white within; peristome externally of a darker color, simple, acute, somewhat sinuous, its terminations joined by a thin callus on the parietal wall, entering within the aperture. Length of axis 37, greatest breadth of body whirl 17; length of aperture 16, breadth 11 mill.

Fig. 81

Fig. 82.

Operculum arcuated, convex, horny, concentric, nucleus nearer the columellar margin.

Limnaea decisa, Say, Nich. En. ed. 1, 1817; ed. 2, 1818, pl. iii, f. 6.

Paludina decisa, Say, 1817, Nicholson's Encycl. pl. iii, f. 6 *(Limnaea* of earlier editions); Amer. Conch. I, pl. x (1830); ed. Binney, p. 49 159, pl. x, fig. 1 pl. lxx, fig. 6; ed. Chenu, 16 pl. ii, f. 5. --Philippi, Conch. III, 3, pl. i, f. 8 (1848).--Haldeman, Mon. p. 4, pl. i (1840). --Gould, Invert. of Mass. 227, wood-cut, p. 144 (1841).--Adams, in Thompson's Hist. of Vermont, p. 151, fig. (1842).--DeKay, N. Y. Moll. p. 84, pl. vi, f. 131; vii, 134 (1843).--Chenu, Ill. Conch. i, f. 1-5. Mrs. Gray, Fig. Moll. An. pl. cccx, f. 10. --Potiez et Michaud, Gall. des Moll. I, 247, pl. xxv, f. 13, 14.--Küster in Chemn. ed. 2, p. 13, pl. ii, fig. 14-19.--Reeve, Con. Icon. 45, *a, c, d,* excl. 45 *b (=Pal. ponderosa),* Mar. 1863.

Melania ovularis, Menke, Syn Meth. p. 134, teste Küster.

Paludina limosa, Valenciennes, Rec. d'Obs. II, p. 253, 1833, teste Küster and Haldeman.

Paludina ponderosa jun., Deshayes in Lam. VIII, 516 (1838). ed. 3, III, 455.

Paludina heterostropha, Kirtland, Ohio Rep. p. 175 (1838).--Tappan, Am. Journ. Sc. [I], XXXV, p. 269, pl. iii, p. 2, 1839.

Paludina microstoma, Kirtland, Ohio Report, p. 175 (1838).

Binney, p. 41

Paludina rufa, Haldeman, Mon. III, p. 3 of wrapper, pl. iii, f. 1 (1841).

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Paludina cornea, Valenciennes, Rec. d'Obs. II, 255, 1833.

Paludina integra, Say, 1821, Binney's ed. p. 69; Journ. A. N. Sc. II, 174 (1821).--Haldeman, Mon. p. 10, pl. iii (1840).--Adams, in Thomp. Vermont, p. 152 (1842).--DeKay, N. Y. Moll. p. 84, pl. vii, f. 132 (1943).--Küster, Chemn. ed. 2, p. 17, tab. iii, f. 11-13.--Chenu, Ill. Conch. pl. i, f. 9-13.--Philippi, Conch. III, 4, pl. i, f. 7 (1848).

Paludina genicula, Conrad, N. Fr. W. Shells, p. 48, pl. viii, fig. 3, 1834; ed. Chenu, 23, pl. iv, f. 20.--Küster in Chemn. ed. 2, p. 14, pl. iii, fig. 5, 6 (1852).--Müller, Syn. Test. in 1834 prom. p 39.--Haldeman, Mon. p. 15, pl. v (1840).--DeKay, N. Y. Moll. p. 86 (1843).--Chenu, Illust. Conch. pl. i, f. 18-19.

Paludina heros, DeKay, olim, N.Y. Prel. Rep. 1839, p. 32; Moll. p 85 (1843).

Paludina subsolida, Anthony, Proc. Ac. N. Sc. Phila. 1860, p. 71.--Tryon, Phil. Pr. 1862, 452.

Paludina decapitata, Anthony, Proc. A.N.S. Phila. 1860, p. 71.--Reeve, Con. Icon. pl. xi, f. 75 (1863).

Paludina milesii, Lea, Proc. Phila. Acad. Nat. Sc. 1863, 156.

Helix dissimilis, Wood, Ind. Suppl. pl. vii, f. 18 (1828); Hanley's ed. p. 226 (1856).

Helix decisa, Eaton, Zool. Text-Book, 196 (1826).

Lymnula ventricosa, Rafinesque, MSS.

Ambloxis (Amblostoma) major, Rafinesque MSS.

Cochlea Virginiana, &c., Lister, Conch. t. cxxvii, f. 27 (1770).

Petiver, Gazophyl. t. cxvi, f. 18.

Binney, p. 42

Found in all eastern North America, from the Rio Grande to Nova Scotia and the Canadas.

The first point to be decided in considering this species is what shell Mr. Say had before him in drawing up the description of *Limnaea decisa,* which name was subsequently changed to *Paludina decisa.* It is from the original description and figure alone that this point can be decided. They are both copied below, as given in the American edition of Nicholson's Encyclopedia.

Limnaea decisa, Say.--Shell subconic, olivaceous, truncated at the apex; whirls four, wrinkled across and banded with minute distant striae; terminal whirl very short; suture impressed and conspicuous; aperture subovate, more than half of the length of the shell, entire; within bluish-white. Operculum coriaceous, elevated on the disk and concentrically striated. Length one inch, breadth three-fourths.

Fig. 83.

Cochlea virginia e flava viridescens, non fasciata. Lister, Conch. tab. cxxvii, fig. 27.

The young shell resembles *P. subcarinata* but the whirls

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are destitute of an elevated line, the suture is not so deeply impressed, and the aperture is narrower above.

Animal with the foot larger, suddenly a little dilated each side before and truncate in front, widely; foot livid, thickly maculated with irregular orange spots, which are much smaller beneath; head and tentacula spotted with orange; eyes on a prominent angle, at the external base of the tentacula.

I found the animal viviparous in October; the young shell had then three complete whirls, which were spirally striated. *(Say.)*

In the above description no locality is given, but there can be no doubt that the shell described is the form common in the Delaware River. I have, therefore, taken this form to be the type of the species. From one of these my description and figures 79 and 81 are drawn.

PLEISTOCENE MOLLUSCA OF THE BOX MARSH DEPOSIT, ADMASTON TOWNSHIP, RENFREW COUNTY, ONTARIO, CANADA

STANLEY R. CLOWERS

Department of Geology, Ohio State University, Columbus, Ohio 43210

CONTENTS

ILLUSTRATIONS

INTRODUCTION

Purpose of Investigation

This investigation was initiated to study the Pleistocene Mollusca in the Box Marsh deposit, Admaston Township, Renfrew County, Ontario, Canada. The objective was to determine the paleoenvironment through a quantitative study of the molluscan fauna and a critical examination of the marl obtained from a systematically collected stratigraphic section. The paleoecological interpretations presented are based on variations observed in the abundance and vertical distribution of the most abundant species in the collections.

An attempt is made to relate the fossil record in Box Marsh deposit to that in other marl deposits in Ontario, and in quantitatively studied, late Wisconsin marl deposits reported from other glaciated regions. By this means, it may be possible to establish the relationship of the non-marine Mollusca and their distribution patterns to events in the late Wisconsin history of southern Canada and northern United States.

Location of Deposit

The Box Marsh deposit is in the southwest corner of lot 19 in the seventh concession, Admaston Township, Renfrew County, Ontario, Canada (Fig. 3).

Method of Investigation

The marl deposit was located and collected during July, 1965. The extent of the deposit was determined by use of a 1-inch soil auger and a collecting site which would yield a suitable section of marl was selected. A pit was dug at this locality from the top through the base of the deposit. The full thickness of the marl was sampled from a stratigraphic column. Each sample was 1 foot by 1 foot by 2 inches thick. The marl was placed in plastic bags to retain the moisture and prevent lithification of the sediment.

In the laboratory, 2 000 milliliters of sediment was removed from each sample. This volume was washed through sieves of 10, 20, and 30 mesh and allowed to dry. The residues obtained from the 10 and 20 mesh screens were combined, and the debris that remained with the shells was removed by hand picking. The residues that were excessively large were reduced by use of a sample cutter into one-half and one-quarter portions. One thousand shells were taken at random from the selected portion of the residue, and identified to species. The data obtained were graphically displayed to facilitate interpretation of the results (figures 4-11). The approximate number of specimens per unit volume of sample was also determined and is shown as the number of shells per 1.000 milliliters of sediment (table 1).

Acknowledgements

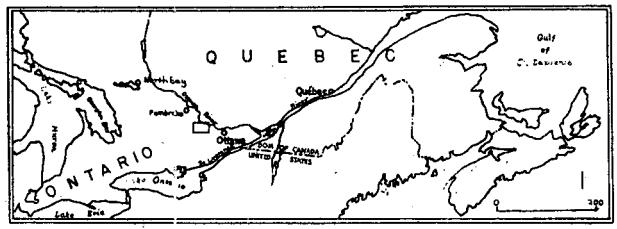
I wish to express my appreciation for the kind support and encouragement given me by my adviser, Professor A. La Rocque, during the field work, laboratory investigation, and writing of this report. The privilege of consulting the manuscript of *Pleistocene Mollusca of*

EXPLANATION OF FIGURES 1 - 3, OPPOSITE PAGE.

Fig. 1. Sketch map of southeastern Canada and the northeastern United States with a box indicating the approximate position of Figure 2.

Fig. 2. Map of eastern Renfrew County, Ontario, showing the location of Colton Lake and its relationship to the Ottawa River drainage.

Fig. 3. Sketch map of the vicinity of Colton Lake showing the location of the Box Marsh deposit and indicating the position of the sites from which marl samples were obtained.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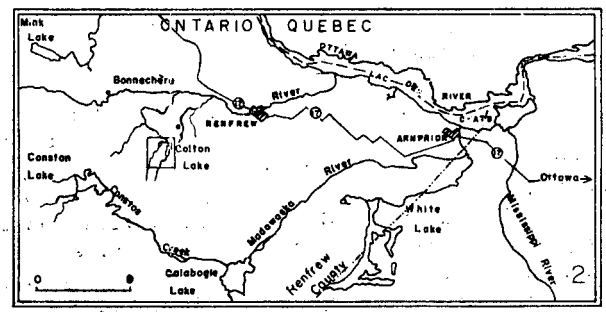
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Ottawa River
ARNPRIOR
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White Lake
Mississippi River
Madawaska River
Calabogie Lake
Renfrew County
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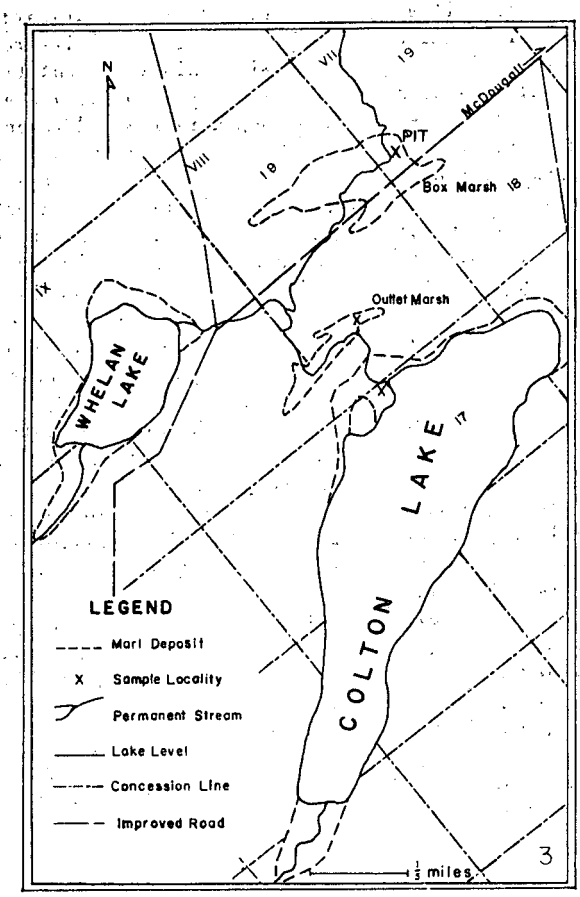
N
VII
19
McDougall
PIT
VIII
18
Box Marsh
IX
Outlet Marsh
WHELAN LAKE
COLTON LAKE
17
LEGEND
Marl Deposit
Sample Locality
Permanent Stream
Lake Level
Concession Line
Improved Road
1/3 miles
3

Ohio (La Rocque, in press) which is currently being published by the Ohio Geological Survey, is gratefully acknowledged. I thank my wife, Rebecca, for her help in preparation of the manuscript. The kindness and co-operation which I received from the residents of the community around Colton Lake were very much appreciated. Thanks are also due to my colleagues in Orton Hall, who helped me in various ways in completing the project.

I gratefully acknowledge the financial aid received through National Science Foundation Grant No. GB-318, Ohio State University Research Foundation Project No. 1642, in support of the field studies, laboratory investigation, and preparation of the report.

REGIONAL GEOLOGY

The Box Marsh deposit is located on the southern edge of the Canadian Shield in the southwestern portion of the Laurentian Highlands, a part of the shield that Bostock (1964, p. 14) placed in the Grenville physiographic province. Quinn (1956, Descriptive Notes), states that the complex Precambrian rocks in the area are mostly Archaean in age. Local topography is controlled to a large extent by the structure of these rocks. Colton Lake and Box Marsh are underlain by coarse-grained crystalline carbonate rocks of the Grenville series. In adjacent areas the bedrock consists of mixed crystalline rocks (hybrid gneisses, migmatites, and granites) accompanied by nepheline-albite gneiss. The outlet of Box Marsh which is surrounded by Grenville carbonates flows across an exposure of albite gneiss. In the same description, Quinn states that the region is cut by several nearly vertical faults associated with the Ottawa-Bonnechère graben. North of Colton Lake the valley of the Bonnechère River is structurally a graben, and encloses an outlier of Ordovician sedimentary rocks. The down-faulted strata are considered by Quinn (1956, Descriptive Notes) to be Beekmantown and Chazy (?) to Trenton, in age. In the Bonnechère graben, they consist mainly of limestone, interbedded with small amounts of shale and sandstone.

The Pleistocene geology is not as clearly described. Quinn (1956, Legend) mapped the surficial deposits in the area, distinguishing Champlain marine deposits and glacial drift, in which he included Recent deposits; however, the only age designation given is Pleistocene, without assigning the sediments to any particular part of the epoch. The exact age of the glaciation and the sequence of post-glacial events has been determined in recent studies in other areas. Gadd (1963, Legend) states that the surficial deposits in the Chalk River area, northwest of Colton Lake are Wisconsin and younger. In this region, Gadd (1963, Descriptive Notes) found evidence for only one glacial event. Glacial striae, which apparently formed after the ice had thinned and was diverted into the Ottawa Valley, found near Chalk River record a southeastward direction for the last ice movements. Gadd stated that evidence from an adjacent area to the west indicates the main movement of late Wisconsin ice was to the southwest. In the Ottawa map-area, east of Colton Lake, Gadd (1963, p. 1) found evidence of only one southward-moving glaciation with surficial deposits recording events from late Wisconsin to Recent (1963, Legend). Karrow (1961, p. 100, 101) states that after partial deglaciation had taken place, the Ottawa-St. Lawrence lowlands were invaded by the Champlain Sea, and that subsequent retreat of the late Wisconsin ice was accompanied by marine inundation. The greatest inland extension of the sea is indicated by marine sand deposits and reworked *Macoma* shells found by Gadd (1963, Descriptive Notes) in the Chalk River area, north of Pembroke, Ontario. When the ice had receded far enough to the north to expose the North Bay-Mattawa and Fossmill outlets, the Great Lakes drained into the Champlain Sea through the Ottawa River. Terasmae and Hughes (1960, p. 1444-45) suggest the opening of the outlet occurred around 10,000 C_{14} years B.P. and Gadd (1963B, Descriptive Notes) indicates that this was, at least in part, contemporaneous with the marine stage at Chalk River. The influx of fresh water progressively displaced marine conditions, and uplift of the land caused recession of the sea, which drained the embayment and exposed the area. The beginning of the marine episode is placed at 11,000 to 12,000 C_{14} years ago (marine shells) by Karrow (1961, p. 101), and Terasmae (1965, p. 36) in-

dicates that it ended about 9 500 C_{14} years B.P. or earlier (post-marine bog), at which time the early St. Lawrence River came into existence. The river occupied its present course 7 000 to 8 000 C_{14} years ago (Terasmae, 1965, p. 38).

The late Wisconsin age and sequence of post-glacial events reported in the studies considered in the preceding text indicates the age of the surficial deposits near Colton Lake and provides a basic historical framework into which the development of the Box Marsh may be placed. In the Colton Lake area, only one period of glaciation is evident The glacial striae noted by Quinn (1956, Legend) indicate that the last movement of local ice was toward the south and southeast, probably into the Ottawa River valley. The southward movement of the ice is reflected in the composition of pebbles in the till and the glacial erratics observed near Box Marsh Pebble counts made by the writer revealed that 40 to 60 percent of the rocks are limestone, 10 to 15 percent are sandstone, and the remainder are crystalline metamorphic rocks. The sedimentary rocks were probably derived from the Ordovician outlier immediately north of the area, and deposited by ice moving from that direction. Following the retreat of ice from the vicinity, the Champlain Sea covered the area, depositing the marine clays that Quinn (1956, Legend) found in the Bonnechère River Valley to the north, and in the Madawaska River drainage to the south of Colton Lake. Apparently, any marine deposits that might have existed in Box Marsh were removed after the highland area emerged from the water. The lake occupied a permanent basin in the Colton Lake drainage, which is underlain by Grenville carbonate rocks. The marl deposit rests in sharp contact on a thin layer of till and reworked material from the till which consists of clay, with sand pebbles, and cobbles up to 4 inches in diameter. The coarse clastics are angular and some of the cobbles are faceted, indicating their glacial origin. The marl is relatively pure, compact, and fairly homogeneous throughout. Slight variations in clay content and amount of plant matter in the samples are indicated by color and texture changes in the marl. The units in the stratigraphic section are based mainly on lithologic breaks; however, some consideration was given to distinct faunal changes that occurred in intervals where changes in lithology were gradual. The marl section terminates abruptly with the appearance of clay, muck, and plant matter that was deposited in the marsh presently occupying the site.

SYSTEMATIC PALEONTOLOGY

General Statement

This chapter provides a summary of data pertaining to the species found in the Box Marsh deposit. The account includes a short synonymy, important Canadian references, and a brief description of the shell, general ecology, distribution, and geologic range of each species. Particular attention has been focused upon important associations and variations in distribution patterns observed in other late Pleistocene and Recent deposits.

Information contributed through the efforts of previous workers in Pleistocene non-marine Mollusca at Ohio State University was useful in compiling this chapter. These quantitative studies provide a sound basis for comparing faunas from different areas. Important references that were consulted include: Baker (1928), Pilsbry (1946, 1948), Herrington (1962), La Rocque (1963-64), and La Rocque (in press).

Class Pelecypoda

Order Teleodesmacea

Family Sphaeriidae

Sphaerium nitidum Clessin 1876

Sphaerium nitidum Clessin 1876, in Westerlund. Neue Binnenmoll. Sibir. p. 102.

Sphaerium tenue La Rocque 1953, Cat. Rec. Moll. Canada, p. 116.

Sphaerium walkeri La Rocque 1953, *Ibid.*, p. 117.

Sphaerium nitidum Herrington 1962, Rev. Sphaeriidae N. Amer., p. 21, pl. 1, fig. 6.

TYPE LOCALITY. Siberia.

DIAGNOSIS. Shell small, less than 8 mm. long, considerably inflated; beaks about central, low; striae moderately fine, uniformly spaced and maintaining their size right up over the beaks; posterior end and dorsal margin rounded or forming an obtuse angle. (Condensed from Herrington, 1962, p. 21).

ECOLOGY. 'Requires cold water hence found only in deep water, at considerable altitudes, or quite far north.' (Herrington, 1962, p. 21). This point brought out clearly by Herrington, provides a revealing criterion in reconstructing the habitat of extinct lakes. Ewrlier records, listed below, confirm this point, as does the association listed in the next paragraph. Dall (1905, p. 139) notes it for several large northern rivers; Baker (1920, p. 69) for St. Anne Lake, Alaska, and Baker and Cahn (1931, p. 46) for Bamaji Lake, Ontario; Kindle (1925), Humber Bay, Lake Ontario.

GENERAL DISTRIBUTION. Canada: Newfoundland, Quebec, Ontario (Lakes Ontario, Superior and Nipigon), Saskatchewan (northern lakes), Alberta (Amethyst Lake), British Columbia and Northwest Territories (to Great Bear Lake). United States: Maine (Androscoggin River), New York (Lake Champlain and Cayuga Lake), Michigan (Lake Michigan), Washington, Idaho, Utah, and Alaska. Eurasia.

GEOLOGIC RANGE. No previous known fossil record.

REMARKS. This species occurs in small numbers in all but the lower four samples in the section Its presence in the deposit indicates a cooler climate than exists at present in the region and links the assemblage to northern faunas. The persistence of the form throughout the deposit was probably facilitated by the immediate proximity of the extinct lake to Colton Lake, which is much larger and deeper.

This is the first fossil record of the species in deposits examined in previous work at Ohio State University, and in other studies consulted by the writer.

Sphaerium lacustre (Müller) 1774

Tellina lacustris Müller 1774, Verm. Terr. et Fluv., v. 2, p. 204.

Cyclas jayensis Prime 1851, Proc. Boston Soc. Nat. Hist., 4, p. 68.

Musculium rosaceum Baker 1 928 F.W. Moll. Wis., pt. 2, p 358 pl. 99, figs. 19, 20.

Musculium ryckholti Baker 1928 *Ibid.*, pt. 2, p. 359, pl. 99 figs. 6-9.

Musculium lacustre La Rocque 1953 Cat. Rec. Moll. Canada, p. 100.

Sphaerium lacustre Herrington 1962. Rev. Sphaeriidae N. Amer., p. 19, pl. 2, fig. 1.

TYPE LOCALITY. Europe probably Denmark.

DIAGNOSIS. Shell small to medium, walls thin, anterior end not so high as posterior; beaks somewhat toward anterior end; striae moderately fine to fine; anterior end rounded. posterior end almost straight; hinge very long; lateral teeth slim but distinct, cardinal teeth weak. (Condensed from Herrington, 1962, p. 19, 20).

DIMENSIONS. Herrington (1962 p. 19) listed the following measurements for selected specimens of form *jayense* from Lake Ontario.

LENGTH	HEIGHT	DIAMETER
9.0 mm.	7.2 mm.	5.4 mm.
7.0	5.7	4.5
5.5	4.5	3.0

ECOLOGY. *S. lacustre* is most plentiful in small lakes and ponds, but is also found in large lakes, rivers and creeks. It seems to prefer a muddy bottom (Herrington, 1962, p. 20). Mowery (1961 p. 7) summarized previous North American statements on this species. It occurs in swamps, ponds, lakes, or streams on a firm bottom of fine deep or hard packed mud, fine gravel, and hard clay, in water up to 0.6 m. deep. It has been collected in water with pH 6.4 to 7.64, fixed carbon dioxide ratio 9.3 to 18.87 p.p.m.

GENERAL DISTRIBUTION. Northwest Territories east to Nova Scotia; and south to Louisiana, Alabama, Georgia, Florida.

GEOLOGIC RANGE. Taylor and Hibbard (1955, p. 12) recorded this species from the Illinoian of Oklahoma. It is a common species in Late Pleistocene and Recent assemblages. The earliest record is for the form *ryckholtii*, from Early and Middle Pliocene deposits of Kansas and Oklahoma.

REMARKS. *S. lacustre* is absent in the lower third of the deposit and reaches a maximum

of 1.9 percent in sample number 5. This is also the level at which the only specimen with associated valves was obtained.

The species has been found in similar marl deposits in about the same numbers and distribution. Zimmerman (1960, p. 20, 22) reported it in Ohio from the Newell Lake deposit, and it was recorded by Roy (1964) in Wisconsin. However, it was absent from the Lac Blanc deposit, and other deposits in the Gaspé region (Shallom, 1965).

Sphaerium sulcatum (Lamarck) 1318

Cyclas sulcata Lamarck 1818, Anim. sans vert., 5, p. 560.
Sphaerium simile Baker 1928 F. W. Moll. Wis., pt. 2 p. 315 pl. 96, figs. 4-7.
Sphaerium sulcatum La Rocque 1953, Cat. Rec. Moll. Canada p. 116.
---- ---- Herrington 1962, Rev. Sphaeriidae N. Amer., p. 28 pl. 1, fig. 1.

TYPE LOCALITY. Lake George, New York.

DIAGNOSIS. Shell large, transversely oval, inflated, almost equipartite, rather solid; striae unevenly spaced; hinge long, lateral teeth short to medium in length, cardinals nearer anterior. (Herrington, 1962, p. 28 29).

DIMENSIONS. Herrington (1962, p. 28) gives the following measurements for specimens from Scott Graham Creek, Carleton County, Ontario Canada.

LENGTH	HEIGHT	DIAMETER
20.0 mm	14.4 mm.	11.0 mm.
14.5	10.8	7.6
10.0	7.6	5.5
7.2	5.5	3.1

ECOLOGY. 'Small lakes, also eddies in rivers and creeks. It has a preference for soft sand with vegetation; never found in swamps or ponds.' (Herrington, 1962, p. 29). Taylor (1960, p. 46) states that, *S. sulcatum* '.... has a preference for a soft bottom in fairly still waters, in eddies of a creek or river, along shore in lakes, and even in lakes filling up with marl. Herrington has found it associated with *Pisidium compressum* in all habitats.'

GENERAL DISTRIBUTION. Alberta east to the Gaspé Peninsula; south to Wyoming, Iowa. South Dakota, Minnesota. Illinois, Indiana, Ohio, Pennsylvania. and Virginia. It probably does not extend south of the area covered by the glaciers. (Herrington, 1962, p. 29).

GEOLOGIC RANGE. The species ranges from Early Pleistocene (Nebraskan) to Recent.

REMARKS. *S. sulcatum* occurs in varying minor percentages throughout the deposit. increasing slightly toward the top. Adult specimens are most common in the upper half of the deposit, but are present in two lower intervals: samples 19-20 and sample 26.

Herrington has found *S. sulcatum* in association with *P. compressum* in several different habitats. In this deposit the association is apparently due to an overlap of their respective environmental preferences. *P. compressum* is most abundant in the lower and *S. sulcatum* in the upper part of the deposit. The species has been reported in most deposits that have been examined within its area of distribution.

Pisidium compressum Prime 1851

Pisidium compressum Prime 1851, Proc. Boston Soc. Nat. Hist., 4, p. 164.
---- ---- Baker 1928 F. W. Moll. Wis., pt. 2, p. 370 pl. 100, figs. 9-13.
---- ---- La Rocque 1953, Cat. Rec. Moll. Canada p. 103.
---- ---- Herrington 1962, Rev. Sphaeriidae N. Am., p. 35, pl. V, fig. 2; pl. VII, fig. 14.

TYPE LOCALITY. Fresh Pond near Cambridge, Massachusetts.

DIAGNOSIS. Shell medium size, heavy, varying from short and high to moderately long; beaks rather prominent, far back, narrow and usually with ridges; striae, medium coarse to moderately fine. (Condensed from Herrington, 1962, p. 35). Anterior cusp of left valve not twisted, but parallel to the dorsal margin; shell tapering ventrally in end view; hinge long (more than ¾ shell length); anterior end rounded; shell without heavy ridges or, if present, only on the beaks; cardinals central or subcentral; anterior and posterior ends

sloped at different angles, i.e. not parallel; shell dull; shell with ridges on the beaks; ridges straight or slightly curved, but not U-shaped. (La Rocque, in press).

DIMENSIONS. Herrington gives (1962, p. 35) the following for specimens from Rice Lake, Birdsall Beach, Peterborough County, Ontario:

LENGTH	HEIGHT	DIAMETER
3.8 mm.	3.8 mm.	2.7 mm.
3.1	2.8	2.0
2.4	2.1	2.7
1.8	1.6	1.0

ECOLOGY. The following summary is by Herrington (1962, p. 34). 'Creeks, rivers, and lakes. It has a preference for sandy bottoms with vegetation and shallow water, but Kenneth G. Wood collected it at 16 meters in the western end of Lake Erie, and I brought it up from a depth of 20 meters in Mazinaw Lake Lennox and Addington Co., Ontario. Sterki 11916 p. 447) states: 'the river and creek form is regarded as typical.'. Next to *P. casertanum* it is the most common *Pisidium* in North America.

The following recent summaries describe the environmental preferences of this species. 'This species inhabits only perennial water bodies with some current action, such as lakes, rivers and creeks; it is never found in ponds, swamps, lagoons, or bogs.' (Taylor, 1960, p. 47). Reynolds (1959, p. 47) adds that it is a burrowing form and feeds on detritus and plankton, found in a variety of habitats, all of which have relatively firm bottoms. It has been collected in water with pH 7.0 to 8.37, fixed carbon dioxide 9.3 to 30.56 p.p.m.

GENERAL DISTRIBUTION. North America: Northwest Territories (Great Slave Lake); Canada (British Columbia to Quebec and Prince Edward Island); United States: Northeast(Maine, Vermont, New York, Mwssachusetts), Midwest (Ohio, Michigan, Iowa) to West and Southwest (Montana, California, Colorado, Texas, New Mexico); and Mexico.

GEOLOGIC RANGE. *P. compressum* is known from Middle Pliocene to Recent.

REMARKS. *P. compressum* is the most abundant species of the Sphaeriidae present in the deposit. It is most abundant in the lower portion of the deposit, gradually decreasing in abundance toward the upper part of the deposit. This change in relative abundance is probably the result of decreasing water depth, reduction in the amount of current action, and possibly reaction to increased plant growth.

The abundance of *P. compressum* in the Sphaeriid population is unusual because it has not been typically considered a lake species in other studies. Zimmerman (1960, p. 33) and Reynolds (1959, p. 47) reported the species in small numbers, but did not consider the species part of the lake fauna. However, Baker and Cahn (1931, p. 47) assigned the *P. ccmpressum* that they found in Ontario to a variety of the species that Baker considered to be a lake form.

Pisidium casertanum (Poli) 1791

Cardium casertanum Poli 1791, Test. utr. Sicil., v. 1, p. 65, pl: 16, fig. 1.
Pisidium abditum Baker 1928, F.W. Moll. Wis., pt. 2, p. 407 pl. 103, figs. 1-5.
Pisidium neglectum Baker 1928 *Ibid.*, p. 390, pl. 105, figs. 7, 8.
Pisidium politum Baker 1928, *Ibid.*, p, 404, pl. 102 fig. 19.
Pisidium roperi Baker 1928, *Ibid.*, p. 400, pl. 102. figs. 23-25.
Pisidium superius Baker 1928, *Ibid.*, p. 397.
Pisidium casertanum Herrington 1962, Rev. Sphaeriidae N. Am., p. 33, 34, pl. 4, fig. 1, pl. 7. fig. 7.

TYPE LOCALITY. Sicily.

DIAGNOSIS. Shell rather long, of moderate weight; beak generally subcentral, not high; striae rather fine; periostracum moderately dull to slightly glossy; anterior end moderately long, laterals distinct, cardinals near anterior cusps. (Condensed from Herrington, 1962, p. 33).

DIMENSIONS. Herrington (1962 p. 33) gives the following measurements for specimens from a small roadside creek near Keene, Ontario.

LENGTH	HEIGHT	DIAMETER
4.1 mm.	3.4 mm.	2.8 mm.
3.3	2.8	2.0
2.7	2.1	1.6
1.7	1.3	0.7

ECOLOGY. '*P. casertanum* has suceeded in

adapting itself to a wide variety of habitats. One finds it in big ponds, ponds, swamps that dry up for several months of the year, swamp, creeks, creeks with considerable current, rivers, and lakes, including the Great Lakes. This is by far the most common *Pisidium*.' (Herrington, 1962, p. 34). Taylor (1960, p. 47) states that, 'It lives where any other species of *Pisidium* can live, except for deep water.' Additional detail is added by Zimmerman (1960, p. 62), '. . . inhabits a sand or mud bottom in shallow water, from 0.5 m. to 3.0 m. in depth. . . . .'

GENERAL DISTRIBUTION. Almost cosmopolitan; Eurasia; New Zealand and Australia; in the Western Hemisphere from Patagonia to Alaska. (Herrington and Taylor, 1958, p. 14).

GEOLOGIC RANGE. The species ranges from Pliocene to Recent and is a common fossil in deposits of Wisconsin age.

REMARKS. *P. casertanum* is present throughout the Box Marsh deposit, varying in abundance from 1 to 6 percent, and showing an overall increase in numbers toward the top.

The species has been found in several late Pleistocene deposits, often in fair abundance. (Roy 1964 and Shallom, 1965). It has not been reported in abundance in deposits from which abundant *P. compressum* were reported.

Pisidium ferrugineum Prime 1851

Pisidium ferrugineum Prime 1851, Proc. Boston Soc. Nat. Hist., 4, p. 162.

---- ---- Baker 1928, F. W. Moll. Wis., pt. 2, p. 426, pl. 104, figs. 3-5.

---- ---- La Rocque 1953, Cat. Rec. Moll. Canada, p. 105.

---- ---- Herrington 1962, Rev. Sphaeriidae N. Amer., p. 39, pl. 4, 7.

DIAGNOSIS. Shell small, usually much inflated, walls thin; beaks subcentral, tubercular, plain, or even low and broad; anterior cusp of left valve not twisted, but parallel to the dorswl margin; shell tapering ventrally in end view; hinge long (more than ¾ shell length); anterior end rounded; shell without heavy ridges or if present only on the beaks; cardinals near anterior cusps; cusps of A II shaped like a toothpick i e , with nearly vertical and parallel sides. (Condensed from Herrington, 1962, p. 39).

DIMENSIONS. Herrington (1962, p. 39) gives measurements for specimens from Camden Lake, Camden Twp., Lennox and Addington County, Ontario, Canada.

LENGTH	HEIGHT	DIAMETER
2.8 mm.	2.5 mm.	2.2 mm.
2.0	1.6	1.6
2.4	2.1	1.9
1.3	1.1	0.9

ECOLOGY. '*P. ferrugineum* has a preference for cool climates. When found on a sandy bottom the striae are prominent and the beaks more or less tubercular. Those specimens obtained from lakes that are filling up with marl or developing a mucky bottom are smoother, have a greater diameter, and the beaks do not have the tubercular appearance. The varieties are much more common than the typical form with its strange tubercular beaks. Found in lakes, creeks, and rivers.' (Herrington, 1962, p. 40). Additional information is provided by Zimmerman (1960, p. 23) and Mowery (1961, p. 7). Mowery states that *P. ferrugineum* '. . . inhabits the mud, sand, or marly clay bottoms of ponds, lakes and some rivers in water 1 to 3 m. deep . . . is usually found among vegetation and algae. . . . in water with pH 7.23 to 8.14. fixed carbon dioxide 10.8 to 22.5 p.p.m.'

In Ontario, the record for this species is mainly for lakes, both large and small.

GENERAL DISTRIBUTION. Northern North America: Northwest Territories and British Columbia to Newfoundland and New Brunswick, south to California Utah, Illinois, Ohio, New York, and New Jersey. Europe.

GEOLOGIC RANGE. This species is known from the Wisconsin and Recent. It was recorded by Taylor and Hibbard (1955, p. 12) from the Jones Local Fauna, of Wisconsin age, from southwestern Kansas.

REMARKS. The species is very rare in the lower third of the deposit, and represents 1 percent or less in the remaining samples, disappearing in the last two samples.

P. ferrugineum was not reported by either Roy (1964) or Shallom (1965), but was recorded

for the late Pleistocene of Ohio by Zimmerman (1960) and Baker (1920).

Class Gastropoda

Order Ctenobranchiata

Family Valvatidae

Valvata sincera Say 1824

Valvata sincera Say 1824, Rept. Long's Exped., v. 2, p. 264, pl. 15, fig. 11.
---- ---- Baker 1928, F. W. Moll. Wis., pt. 1, pl. 23, pl. 1, figs. 19-22.
---- ---- *sincera* La Rocque 1953, Cat. Rec. Moll. Canada, p. 264.
---- ---- La Rocque 1962, Sterkiana, No. 7, p. 35.

TYPE LOCALITY. 'Northwest Territory' (Say).

DIAGNOSIS. Shell subglobose-conic, rather solid, 4 whorls, evenly rounded, regularly increasing in diameter; sculpture of fine and regular striae; sutures well impressed; aperture circular, continuous touching but not appressed to the whorl above; umbilicus open, round and deep. (Condensed from Baker, 1928, p. 23).

ECOLOGY. This species is generally regarded as a lake species. It has been found in deep water in Lake Michigan and Lake Superior and also in cold shaded brooks.

GENERAL DISTRIBUTION. The species is found in Newfoundland, Quebec, and Maine; west to Western Ontario and Mwnitoba; south to Wisconsin, Michigan, and northern New York.

GEOLOGIC RANGE. This species has been found in many deposits of Wisconsin age. Its range is Wisconsin to Recent.

REMARKS. *V. sincera* is present only in the lower third of the deposit. It appears in small numbers, increases, and then quickly disappears. This pattern of occurrence is common in quantitatively studied deposits in which *V. sincera* is present.

Valvata tricarinata (Say) 1817

Cyclostoma tricarinata Say 1817, Jour. Acad. Nat. Sci. Phila., v. 1 p. 13.
Valvata tricarinata Baker 1928, F.W. Moll. Wis., pt. 1, p. 11, pl. 1, figs. 1-3.
---- ---- *tricarinata* LaRocque 1953. Cat. Rec. Moll. Canada, p. 264.
---- ---- La Rocque 1956, Naut., v. 70, p. 13-14.
---- ---- Hibbard and Taylor 1960, Mus. Pal. Univ. Michigan, v. 16, p. 79 pl. V, figs. 14-15.

TYPE LOCALITY. Delaware River.

DIAGNOSIS. Shell turbinate, thin, translucent shining; horn colored or pale green; whorls about 4 rapidly enlarging, flattened between the carinae, sloping upward from the carina to the suture on the upper surface; spire elevated but depressed at the apex; sculpture of coarse growth lines more or less equally spaced; sutures distinct, well impressed; body whorl large with three distinct, sharp carinae, one on the shoulder, one on the periphery, and one on the base, which encircles the round, deep, funnel-shaped umbilicus; aperture circular, somewhat angulated at the carinae. (Condensed from Baker 1928 p. 11-12).

ECOLOGY. In Wisconsin, Baker (1928 p. 14) found *V. tricarinata* in shallow water to depths exceeding 9 meters although most of the living records averaged from 1 to 5 meters. It has been observed on mud, clay, sand, gravel, and bare-rock bottoms, with or without vegetation, in both streams and lakes.

GENERAL DISTRIBUTION. Great Slave Lake and the Mackenzie River south and east to New England and Virginia; west to Iowa.

GEOLOGIC DISTRIBUTION. *V. tricarinata* is a common fossil in deposits of Wisconsin to Recent age and has been recorded by Taylor (1960, p. 32) in Nebraskan deposits.

REMARKS. *V. tricarinata* is abundant throughout the deposit, especially in the lower portion. The (111) form with strongly developed carinae is the most abundant in the deposit, particularly in the lower portion; (100) and

(101) forms become common later in the sequence. The species is widespread and is wbundant in many lake faunas. Whittaker (1921, p. 73, 74) noted *V. tricarinata* as one of the most abundant species in marl deposits of the Ottawa River Valley.

In most deposits, it appears to be best represented in intervals not characterixed by thick vegetation, although it may persist into shallow water sediments containing a moderate amount of plant matter.

Family Amnicolidae

Amnicola limosa (Say) 1817

Paludina limosa Say 1817, Jour. Acad. Nat. Sc. Phila., v. 1, p. 125.
Amnicola limosa Baker 1928, F.W. Moll. Wis., pt. 1, p. 93, pl. 6, figs. 1-6.
----- ----- *porata* Baker 1928, *Ibid.*, p. 98, pl. 6, figs. 7-8, 18; pl. 8, figs. 1-3.
---- ----- *porata* LaRocque 1953, Cat. Rec. Moll. Canada, p. 297.
---- ----. *limosa* LaRocque 1953, *Ibid.*, p. 267.

TYPE LOCALITY. Delaware and Schuylkill rivers, Pennsylvania.

DIAGNOSIS. Broadly conic in shape, about 4.5 mm. high, 3 mm. wide, 4.5 whorls; apex blunt; later whorls round and somewhat shouldered, increasing gradually in size; body whorl round; aperture subrotund, mostly basal; umbilicus deeply perforate. (Condensed from Berry, 1943, p. 23).

ECOLOGY. This species has a wide range in distribution, occurring in creeks, rivers, and fresh and brackish-water lakes. It generally is found in thick beds of *Chara, Potamogeton, Vallisneria,* and *Elodea*. These plants are not used for food, but they harbor rich colonies of diatoms on which the snail feeds. (Berry, 1943, p. 26).

GENERAL DISTRIBUTION. *A. limosa* is found in New England and New Jersey, west to Utah, Manitoba, and south to Texas.

GEOLOGIC RANGE. This species has been found in many deposits of Wisconsin age and should probably be regarded as ranging from Late Pleistocene to Recent.

REMARKS. *A. limosa* is absent in the lower third of the deposit, but becomes abundant in the upper half. When it is combined with the associated species, *A. lustrica*, the two comprise almost 40 percent of the assemblage in the upper part of the deposit. Whittaker (1921, p. 73) noted that *A. limosa*, with *V. tricarinata*, was by far the most common species in the marl deposits he examined in the Ottawa Valley. This is probably accurate for the upper portion of the deposits, where Whittaker most likely obtained his samples. Quantitative sampling of complete sections might have modified his estimates on species abundance and distribution, by placing them in a stratigraphic framework. This becomes apparent when the vertical distribution of species in the Box Marsh deposit is examined in detail. This same sort of occurrence was reported by Roy (1964, p. 40, 46) in the Spur Lake and Waupaca deposits in Wisconsin.

Amnicola lustrica Pilsbry 1890

Amnicola lustrica Pilsbry 1890, Nautilus, v. 4, p. 53.
---- ---- Baker 1928, F. W. Moll. Wis., pt. 1, p. 104, pl. 6. figs. 16-17, 26-27, text fig. 45.
---- ---- La Rocque 1953, Cat. Rec. Moll. Canada p. 268.

TYPE LOCALITY. Not specifically given: 'New York to Illinois and Minnesota.' (Pilsbry).

DIAGNOSIS. Shell small, about 4 mm., 5 whorls increasing gradually in size; apex elevated acute, sutures deeply impressed, whorls shouldered and rounded; aperture ovate umbilicus narrow, perforate. (Condensed from Berry 1943, p. 30).

ECOLOGY. It occurs on stones in rivers and lakes and often on vegetation such as *Vallisneria, Potamegoten,* and *Chara*. It is often associated with *A. limosa* and generally inhabits the same type of environment. (Berry, 1943, p. 32).

GENERAL DISTRIBUTION. New York to Minneso-

ta, and southern Ontario. Authentically reported from Indiana, Illinois, New York, Minnesota, Wisconsin, Michigan, Ohio, Pennsylvania, and southern Ontario.

GEOLOGIC RANGE. *A. lustrica* has been reported from deposits of Wisconsin age and in general ranges from Late Pleistocene to Recent.

REMARKS. *A. lustrica* appears slightly after *A. limosa* and never becomes quite as abundant; however, its vertical distribution roughly parallels that of *A. limosa*. These are common associates in many marl deposits. In some cases, *A. lustrica* is the most abundant.

Family Lymnaeidae

Lymnaea stagnalis (Linnaeus) 1758

Helix stagnalis Linnaeus 1758, System. Nat., ed. 10, p. 774.
Lymnaea stagnalis Baker 1911, Lymn. N. and M. Am., p. 136: synonymy.

TYPE LOCALITY. Europe.

DIAGNOSIS. Elongate or oval, ventricose at anterior end thin; apex smooth; whorls 6 to 7, rapidly increasing, last whorl very large; spire long pointed, acute, about one-half the length of the entire shell; suture distinct; aperture large, broadly ovate.

ECOLOGY. This species is usually found in more or less stagnant, but permanent, parts of ponds or lakes and rivers, around vegetation. It has been recorded by Baker (1928, p. 203) on mud bottoms in less than 1.5 meters of water.

GENERAL DISTRIBUTION. The species and its varieties may be described as circumboreal; in North America, south to about the 40th parallel of latitude.

GEOLOGIC RANGE. *L. stagnalis* has been recorded in Late Pleistocene deposits as well as Recent.

REMARKS. *L. stagnalis* occurred in only one sample in the deposit, and only as a shell fragment which could not be identified to subspecies.

This species and *H. trivolvis* are very abundant in the marsh and creek that occupy the present site of the Box Marsh deposit. This situation is analogous to Wisconsin, where Roy (1964, p. 71) reported these forms as living, but rare or absent as fossils. This important aspect of molluscan migration seems to be characteristic in late and post-Wisconsin deposits in the glaciated areas.

Pseudosuccinea columella (Say) 1817

Lymnaea columella Say 1817 Jour. Acad. Nat. Sci., Phila., v. 1, p. 14.
Pseudosuccinea columella Baker 1911, Lymn. N. and M. Am., p. 163, pl. 23, figs. 8-20; pl. 24, figs. 1-4.
---- ---- Baker 1928, F. W. Moll. Wis., pt. 1, p. 272, pl. 10, figs. 9-12, 20.
---- ---- La Rocque 1953, Cat. Rec. Moll. Canada, p. 283.

TYPE LOCALITY. Probably near Philadelphia.

DIAGNOSIS. Shell thin, shaped much like the larger species of *Succinea;* longitudinal growth lines appear rather coarse under magnification, crossed by spiral lines which are commonly discontinuous; whorls 4 to 5, the last one very broad at the base; aperture large, flaring; columella reflected over the umbilicus; L. 12, D. 7.5 mm. (Condensed from La Rocque, in press).

ECOLOGY. Baker (1928, p. 276) states that *P. columella* is an inhabitant of ponds and streams where the water is more or less stagnant, especially among lily pads; also along the shore in shallow water near cattails and reeds. It prefers shallow bogs and small ponds or creeks where it may browse on pond scum and on rotting water plant debris. Baker collected the species in association with *L. stagnalis jugularis, Fossaria obrussa,* and *Stagnicola palustris elodes*.

GENERAL DISTRIBUTION. Manitoba to New England and Nova Scotia; south to New Mexico, Texas and Georgia.

GEOLOGIC RANGE. The species occurs in deposits of Pleistocene (Yarmouth, Peorian, and Wabash) to Recent age.

REMARKS. *P. columella* is very rare and occurs sporadically in the deposit in 4 samples (4, 8, 15, 23), mostly as broken shells. The samples are in intervals in which *Fossaria obrussa decampi* and *Physa gyrina* are well represented.

Fossaria obrussa (Say) 1825

Lymneus obrussus Say 1825, Jour. Acad. Nat. Sci. Phila., v. 5, p. 123.

Fossaria obrussa Baker 1928, F.W. Moll. Wis. pt. 1, p. 293, pl. 15, fig. 14, pl. 18, figs. 14-24.

---- *obrussa* La Rocque 1953, Cat. Rec. Moll., Canada, p. 285.

---- Taylor 1960, U.S.G.S. Prof. Paper 337, p. 54.

TYPE LOCALITY. Harrowgate, Philadelphia County, Pennsylvania.

DIAGNOSIS. Shell subconic, pointed, oblong, thin, whorls 5½, rounded, somewhat shouldered, the last whorl is large; spire acute, sharply conical; suture deeply indented; aperture very elongate-ovate. (Condensed from Baker, 1928, p. 293-294).

ECOLOGY. This species generally occurs in small bodies of wwter, such as creeks, ponds, sloughs, bays, and marshy spots along river banks. It is commonly found on sticks, stones, and other debris that may be in the water or along its edge. (Baker 1928 p. 296).

GENERAL DISTRIBUTION. From the Atlantic to the Pacific Oceans, and from Mackenzie Valley, Canada, south to Arizona and northern Mexico.

GEOLOGIC RANGE. Baker (1911, p. 280, 281) has recorded *F. obrussa* from the Pliocene of California and from numerous deposits of Pleistocene age. Hibbard and Taylor (1960, p. 94) give the range as early Pliocene to Recent.

REMARKS. *F. obrussa* appears in the deposit later than *F. obrussa decampi*. It does not become as abundant as *F. obrussa decampi*, but it seems to respond similarly to changes in the environment.

Fossaria obrussa decampi (Streng) 1905

Limnaea desidiosa var. *decampi* Streng 1906. Nautilus v. 9, p. 123.

Galba obrussa decampi Baker 1911. Lymn. N. and M. Am., p. 289, pl. 32, figs. 15-22.

Fossaria obrussa decampi Baker 1928. F.W. Moll. Wis. pt. 1, p. 229, pl. 18, figs. 30-33, pl. 16, fig. 12.

---- ---- ---- La Rocque 1953, Cat. Rec. Moll. Canada, p. 285.

TYPE LOCALITY. Brooks Lake, Newaygo County, Michigan.

DIAGNOSIS. Shell small, oblong, somewhat inflated, subconic, rather solid; whorls 5, spire whorls convex, distinctly shouldered near the suture, body whorl much flattened in the middle; spire short, broadly conic, turreted, about as long as aperture; sutures deeply impressed; aperture long and narrow, somewhat elliptical, rounded below and forming a prominent shoulder above. (Condensed from Baker, 1928, p. 300)

ECOLOGY. Baker (1928, p. 300) states that the ecology of *F. obrussa decampi* is probably the same as that of *F. obrussa* which lives on the margins of small bodies of water, and on mud flats and debris.

GENERAL DISTRIBUTION. Maine, west to Wisconsin; northern Michigan south to northern Illinois.

GEOLOGIC RANGE. This species has been recorded from numerous deposits of Wisconsin age, post-glacial marl deposits in Ontario (Whittaker, 1921, p. 62), and from living assemblages in Manitoba Minnesota, and Wisconsin.

REMARKS. Although *F. obrussa decampi* is present throughout the deposit, it is generally more common in the upper half. Its occurrence in this deposit is similar to that in the Spur Lake and Waupaca deposits described by Roy (1964) in Wisconsin. The Lac Blanc deposit from Quebec (Shallom, 1965) and Whittaker's (1921) account of the Colton Lake marl are different. In the latter deposits *F. obrussa decampi* is reported as the most abundant species.

The species is more than 60 percent of the assemblage in most of the Lac Blanc deposit; however, it still shows variation in vertical distribution similar to that in the other deposits. The vertical distribution of the species in a marl deposit is probably controlled in large part by the nearness to shore of the locality and the bottom profile of the lake. The species is very abundant in many beach accumulations.

Family Planorbidae

Gyraulus parvus (Say) 1817

Planorbis parvus Say 1817. Nicholson's Encycl., ed. 1, v. 2, pl. 1, fig. 5.
Gyraulus parvus Baker 1928, F. W. Moll. Wis., pt. 1, p. 374, pl. 23, figs. 27-31, 29.
---- ---- Morrison 1932, Trans. Wis. Acad. Sci., Arts, and Letters, v. 27, p. 375.
---- ---- Baker 1945, Moll. Fam. Planorbidae, p. 74, 270, 330, 336.
---- ---- La Rocque 1953. Cat. Rec. Moll. Canada, p. 294.
---- ---- Taylor 1960, U.S.G.S. Prof. Paper 337, p. 53.

TYPE LOCALITY. Delaware River, near Philadelphia, Pennsylvania.

DIAGNOSIS. Shell ultra-dextral, depressed, with a rounded periphery; growth lines oblique, crowded, fine; whorls about 3½, rapidly enlarging, rounded below the periphery and somewhat flattened above on the body whorl and all the spire whorls; spire flat, first two whorls sunken below the body whorl; sutures deeply impressed; base slightly concave, umbilical region wide and shallow; aperture long-ovate, nearly in the same plane as the body whorl. (Condensed from Baker, 1928, p 375).

ECOLOGY. Usually found in quiet bodies of water of small size, on mud, sandy mud, sand, gravel, or boulder bottoms; on logs and vegetation, in shallow water, 1 to 4 feet deep. Its most suitable habitat seems to be in vegetation, in protected places.

GENERAL DISTRIBUTION. Eastern North America east of the Rocky Mountains from Florida to Alaska and northern Canada

GEOLOGIC RANGE. This species was given a range of Middle Pliocene to Recent by Hibbard and Taylor (1960, p. 100). It is a common Pleistocene species that has been recorded for the Nebraskan, Aftonian, Sangamon, and Wisconsin.

REMARKS. *G. parvus* is the most abundant species in the lower third of the deposit, but its numbers are much reduced toward the top.

Most of the mature specimens of this species exhibit an angulation of the body whorl similar to that of *G. altissimus*. A complete transition was observed from the rounded *G. parvus* characteristic in the immature specimens, to an angulated body whorl in the majority of the mature shells. However, in the mature portion, there was also a complete gradation between shells with a well angulated body whorl and shells with a well rounded body whorl. Apparently this angulation of the body whorl is a genetic variation which is strongly developed in this particular population of *G. parvus*. The situation is similar to that described by Roy (1964, p. 28), except that in Wisconsin the angulation of the body whorl in the mature specimens was not as common. All specimens were identified as *G. parvus*.

The species is widely distributed and occurs in many deposits throughout its range and area of distribution. In favorable habitats it seems to be very prolific.

Helisoma anceps striatum (F.C. Baker) 1902

Planorbis bicarinatus striatus Baker 1902. Nautilus, v. 15, p. 120.
Helisoma antrosa striata Baker 1928. F.W. Moll. Wis., pt. 1, p. 328, pl. 19, figs. 28-31.
Helisoma anceps striatum Baker 1945. Moll. Fam. Planorbidae. p. 400.
---- ---- ---- La Rocque 1953, Cat. Rec. Moll. Canada, p. 288.

TYPE LOCALITY. Coldspring Park, Milwaukee, Wisconsin; Pleistocene.

DIAGNOSIS. Shell small, 3½ whorls, dorsal and ventral carinae distinctly marked, cord-like, elevated; dorsal carina on center of upper side of body whorl; body whorl well rounded; umbilicus small, deep; surface sculpture of heavy spiral lines which become distinct ridges in many specimens; aperture higher than wide. (Condensed from Baker, 1928, p. 328).

ECOLOGY. Found in lake deposits, in marl, silts, and peaty marl; a number of deposits studied indicate that this variety lived in shallow freshwater lakes with abundant vegetation. The water in these lakes was probably colder than that of present-day lakes in the same area.

GENERAL DISTRIBUTION. Pleistocene deposits from Wisconsin and Illinois east to Quebec and south to Ohio and Indiana.

GEOLOGIC RANGE. This variety is recorded for the Pleistocene but its exact range within it is not known. Several living occurrences have been recorded for northern Minnesota and Wisconsin.

REMARKS. All of the specimens of *H. anceps* had some indication of striations. Many of the shells had very well-developed striations which became distinct ridges.

The species is present in the lower part of the deposit, becomes most abundant in the middle half, and is slightly reduced in numbers in the upper fourth of the section. This pattern of occurrence is common for *H. anceps striatum*. It is considered a cold climate indicator because it is extinct in areas where it was abundant in the late Wisconsin and is found living only in northern areas.

Helisoma campanulatum (Say) 1921

Planorbis campanulatus Say 1821, Jour. Acad. Nat. Sci. Philadelphia, v. 2, p. 166.
Helisoma campanulata Baker 1928, F.W. Moll. Wis., pt. 1, p. 345, pl. 21, figs. 1, 2, 4, 5, 8, 9, 13, 14.
---- *campanulatum* La Rocque 1953, Cat. Rec. Moll. Canada, p. 288.

TYPE LOCALITY. Cayuga Lake, New York.

DIAGNOSIS. Shell ultra-sinistral, discoidal, more or less rounded; whorls 4½, rounded below and subcarinate above; spire flat; sutures deeply impressed; base of shell rounded, exhibiting 2½ volutions with a deep umbilicus in the middle; aperture lunate. (Condensed from Baker, 1928, p. 346).

ECOLOGY. This species is characteristic of lakes, in shallow water with rock, sand, or mud bottom, with or without vegetation. It is also found in quiet parts of rivers and small streams.

GENERAL DISTRIBUTION. Vermont west to North Dakota, south to Ohio and Illinois, north to the Mackenzie drainage.

GEOLOGIC RANGE. *H. campanulatum* ranges from Late Wisconsin to Recent.

REMARKS. *H. campanulatum* occurs in minor numbers in most of the collections, and generally shows a negative correlation with the variations in abundance of *H. anceps striatum*.

Promenetus exacuous (Say) 1821

Planorbis exacuous Say 1821 Jour Acad. Nat. Sci. Phila., v. 2, p. 163.
Menetus exacuous Baker 1928, F.W. Moll. Wis., pt. 1, p. 361, pl. 23, figs. 1-5.
Promenetus exacuous exacuous Baker 1945, Moll. Fam. Planorbidae, p. 24, 181, 218, 328, 336.
---- ---- ---- La Rocque 1953, Cat. Rec. Moll. Canada, p. 292.

TYPE LOCALITY. Lake Champlain, New York Vermont, and Quebec.

DIAGNOSIS. Shell ultra-dextral, very much depressed, with an acute periphery; whorls 4, rapidly increasing in diameter; spire very flat; sutures well impressed; umbilicus rather narrow, deep; aperture ovate. (Condensed from Baker, 1928, p. 361.

ECOLOGY. In quiet, more or less marshy places, in shallow water with soft mud bottom; in streams always on mud flats in quiet water.

GENERAL DISTRIBUTION. Northern United States east of the Rockies; Canada south to New Mexico.

GEOLOGIC RANGE. Hibbard and Taylor (1960, p. 107) give Sangamon to Recent. It is commonly found in deposits of Wisconsin age.

REMARKS. *P. exacuous* is rare, occurring sporadically in a few samples.

In Ohio, the species has been reported as being much more common in late Wisconsin marl deposits. Baker (1920), Zimmerman (1960), and

Cornejo (1961). all found the species to be fairly common. By contrast Roy (1964) recorded the species in much the same frequency in 5 Wisconsin lakes as it appears in the Box Marsh deposit, and it was absent in the deposit studied by Shallom (1965) in Quebec. *P. exacuous* is present in the living molluscan faunas of these areas; therefore it probably can be considered one of the slow migrating late arrivals. The preference of the species for swampy or mud flat conditions may be an influencing factor.

Family Ancylidae

Ferrissia parallela (Haldeman) 1841

Ancylus parallelus Haldeman 1841, Monogr., pt. 2, p. 3.
Ferrissia parallela Baker 1928, F. W. Moll. Wis., pt. 1, p. 395, pl. 29, figs. 1-5.
---- ---- La Rocque 1953 Cat. Rec. Moll. Canada, p. 296.

TYPE LOCALITY. New England.

DIAGNOSIS. Shell narrow, elongate, lateral margins nearly straight, widening more or less anteriorly, ends well rounded; anterior slope rather long, slightly convex; posterior slope shorter than anterior, straight or slightly concave; apex sub-acute, slightly anterior of the shell. (Condensed from Baker, 1928, p. 396).

ECOLOGY. It is found on plants in quiet water one to six feet deep, usually in ponds or lakes.

GENERAL DISTRIBUTION. Nova Scotia and New England west to Minnesota, Manitoba south to Rhode Island, central New York, northern Ohio, and Indiana.

GEOLOGIC RANGE. The general range for this species is Pliocene (Taylor, 1960, p. 61) to Recent. It is commonly found in deposits of Wisconsin age.

REMARKS. This species is rare, occurring singly in only a few samples near the middle of the deposit.

Family Physidae

Physa gyrina Say 1821

Physa gyrina Say 1821, Jour. Acad. Nat. Sci. Phila., v. 2, p. 171.
Physella gyrina Baker 1928, F. W. Moll. Wis., pt. 1, p. 449, pl. 27, figs. 30-35. 37-40; pl. 28. figs. 1, 5. 6.
Physa gyrina gyrina La Rocque 1953, Cat. Rec. Moll. Canada, p. 298.

TYPE LOCALITY. Bowyer Creek. near Council Bluffs, Iowa.

DIAGNOSIS. Shell large, elongate or subcylindrical, rather thick; sculpture of coarse growth lines; whorls 5-6, the last rather large, compressed or slightly inflated; spire rather long, acute, whorls well rounded; aperture 5 10 to 7 10 the length of the entire shell. (Condensed from Baker, 1928, p. 450).

ECOLOGY. It is characteristic of shallow, slow-moving, and stagnant bodies of water.

GENERAL DISTRIBUTION. United States east of the Mississippi except that it ranges into Texas; eastern Canada (Ontario, Quebec), northward to the Arctic regions.

GEOLOGIC RANGE. This species has been recorded as far back as the Nebraskan by Taylor (1960, p. 32, 39). It is a common species of late Pleistocene and Recent assemblages.

REMARKS. *P. gyrina* is absent from the lower fourth, fairly common in the middle, and becomes rare in the upper fourth of the deposit.

Its occurrence is similar to that in other marl deposits from which it has been reported. Whittaker (1921, p. 72) states that it is a common species in the Ottawa Valley marl deposits.

Order Pulmonata

Family Succineidae

Oxyloma retusa (Lea) 1834

Succinea retusa Leal834, Trans. Am. Phil. Soc., v. 5 p. 117, pl. 19, fig. 86.

---- ---- Oughton 1948, Zoogeogr. study, Ontario, p. 76.
Oxyloma retusa Pilsbry 1948, Land Moll. N. Am., v. 2, pt. 2, p. 785, fig. 421.
---- ---- La Rocque 1953 Cat. Rec. Moll. Canada, p. 327.

TYPE LOCALITY. Near Cincinnati, Ohio.

DIAGNOSIS. 'Shell ovately oblong. very thin, pellucid; spire short; whorls 3; aperture below dilate and drawn back. D. 0.3 inch. L. 0.7 inch. . . .' (Lea, quoted by Pilsbry, 1948, p. 786).

ECOLOGY. Taylor (1960, p. 78) describes its habitat as semi-aquatic, riparian; among sedges, water cress, and other plants at the water's edge or in debris and vegetation in marshy places. Oughton (1948, p. 94, ff.) lists it for wet locations and notes that it can be collected in large numbers in stream drift; it lives on margins of ponds, streams and other wet places. Baker (1922) lists the following specific habitats: swampy shore of a lake; large bog with floating marsh at its edge; permanent pond: Bayou off the East Branch, formed by old river channel; pool choked by vegetation; beaver meadow: site of former beaver pond not as yet grown over by surrounding thickets; covered with grass, except in a few lower spots where ponds formed after rains. (Condensed from La Rocque, in press).

GENERAL DISTRIBUTION. 'Yukon? and British Columbia? east to Labrador and Maine.' (La Rocque, 1953, p. 327). A much more restricted range is given by Pilsbry (1948, p. 786): Ohio, Illinois, Iowa, Minnesota, North Dakota, Montana.

GEOLOGIC RANGE. Hibbard and Taylor (1960, p. 141) give the range as being 'Early Pleistocene to Recent.'

REMARKS. The species is present in very small numbers; however, its recurrence in two samples in the upper portion of the marl deposit probably indicates the approach of the shoreline to the site.

Family Pupillidae

Vertigo ovata (Say) 1822

Vertigo ovata Say 1822, Jour. Acad. Nat. Sci. Phila., v. 2, p. 375.
---- ---- Pilsbry 1948 Mon. Land. Moll. N. Am., v. 2. pt. 2. p. 952, text fig. 513: 1-3, 4, 7.
---- ---- Oughton 1948, Zoogeogr. Study, Ontario, p. 62.
---- ---- La Rocque 1953, Cat. Rec. Moll. Canada, p. 335.

TYPE LOCALITY Philadelphia, Pennsylvania.

DIAGNOSIS. Shell ovate, apire convexly conic summit obtuse; whorls increasing rapidly. the last much the largest with a strong crest behind the lip; parietal lamella strong and rather long; angular lamella small; columellar lamella strong; basal fold well developed; upper and lower palatal folds strong.

ECOLOGY. The species prefers moist areas near streams and the shores of ponds. It is found in plant debris, leaves, grasses, moss, or under logs and bark, in moist situations near water. Oughton (1948, p. 94, ff.) found it in wet locations, such as floodplains of creeks, margins of ponds, streams, and marshes, in Ontario.

GENERAL DISTRIBUTION. Labrador west to British Columbia and north to Alaska, south to Florida, Mexico, and the West Indies.

GEOLOGIC RANGE. Early Pliocene to Recent. It is known from early and middle Pliocene of Beaver County, Oklahoma.

REMARKS. This species is rare in the deposit.

COMPOSITION OF FAUNA

General Statement

The non-marine molluscan fauna obtained from the Box Marsh deposit, near Colton Lake, Ontario, contains 22 species. The species represented are mostly characteristic lake forms and have been found in similar associations in other marl deposits. There are six sphaeriid clams, four ctenobranchiate and ten pulmonate gastropods, and two terrestrial gastropods.

The assemblage has been analyzed quantitatively to determine the relative abundance of the species in each sample, and the vertical distribution of the various forms throughout the deposit. An attempt was made to relate the results to variations in lithology and to deduce the environment of the extinct lake.

To evaluate the significance of a species in a sample, the assumption is made that the most abundant species are generally autochthonous, and that the minor elements in the assemblage are allochthonous, or intruders to the area under consideration. However, some autochthonous geners may be more prolific than others under the same environmental conditions. *Ferrissia, Promenetus,* and *Pseudosuccinea* usually occur in small percentages even in favorable habitats.

The quantity of shells per thousand milliliters of sediment in each sample was determined (table 1).

TABLE 1. NUMBER OF SHELLS PER 1000 MILLILITERS OF SEDIMENT

COLLECTION	BOX MARSH
1	-
2	-
3	190
4	10,750
5	3,250
6	5,750
7	5,400
8	6,750
9	8,400
10	6,500
11	10,100
12	8,750
13	5,150
14	4,500
15	5,400
16	1,350
17	3,000
18	2,650
19	1,800
20	2,100
21	1,050
22	1,750
23	1,800
24	1,600
25	1,550
26	1,950
27	1,500

The samples are numbered from the top of the section down, and all figures and tables are referred to the measured section. The vertical distribution of the most significant species is presented graphically to provide a means of evaluating the relative abundance of the species in each sample, indicating variations in abundance through a sequence of samples, and comparing faunas from different deposits.

Box Marsh Deposit

Of the twenty-two species represented, seven are abundant and seven are minor autochthonous forms. Three of the species are minor aquatic forms from adjacent areas of the lake, and five are intruders from land and marsh environments. The most abundant species in the deposit are: *Gyraulus parvus, Valvata tricarinata, Amnicola limosa, A. lustrica, Pisidium compressum, Helisoma anceps striatum,* and *Fossaria obrussa decampi.* The remaining species are less abundant, but provide useful information concerning the environment.

The entire assemblage does not occur contemporaneously. The greatest number of species is found in the upper and the smallest number in the lower portion of the deposit, with some species more favorably represented in the transition sequence between the lower and the upper assemblages (table 2). This sequence is probably controlled by ecological factors which

TABLE 2. VERTICAL DISTRIBUTION OF SPECIES IN THE BOX MARSH DEPOSIT[1]

Coll.	SN	SL	SS	PO	PA	PF	VS	VT	AL	AU	LS	PC	FO	FD	GP	HS	HC	PE	FP	PG	OR	VO
1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3	2.4	0.8	1.1	6.8	4.1	-	-	8.1	16.6	8.7	-	-	4.3	5.7	30.2	5.4	0.8	-	-	0.8	1.1	0.6
4	1.0	0.5	0.8	7.1	1.4	0.4	-	13.4	22.5	15.4	-	0.2	2.3	6.7	19.8	7.5	0.1	-	-	0.6	0.6	0.4
5	1.3	1.9	2.8	11.5	1.3	0.7	-	12.2	21.8	18.4	-	-	1.2	3.3	14.3	6.6	1.0	-	-	0.8	0.3	-
6	0.7	1.3	1.4	7.4	1.4	0.6	-	12.6	26.6	17.5	-	-	3.5	7.4	13.2	6.2	0.4	-	0.3	0.7	0.1	-
7	0.6	0.5	3.0	9.0	2.3	0.2	-	12.6	18.0	10.9	-	-	3.2	6.2	14.0	9.4	0.9	-	-	0.2	-	-
8	0.7	0.3	2.5	7.6	1.8	0.8	-	16.1	22.0	11.4	-	0.1	3.3	7.1	11.7	13.3	0.4	-	-	0.6	-	-
9	1.0	0.2	2.5	6.4	4.3	0.4	-	11.7	22.4	17.1	-	-	3.2	8.1	9.6	8.9	1.5	-	-	1.7	0.7	0.1
10	1.1	0.3	0.1	3.8	1.0	0.3	-	13.0	25.9	7.4	-	0.1	5.9	9.2	16.7	11.3	1.0	-	-	2.6	0.6	0.1
11	1.5	-	1.0	4.6	1.6	0.2	-	16.7	20.1	3.9	-	-	6.6	9.7	16.5	12.1	1.4	-	0.1	3.8	0.4	0.5
12	0.2	0.2	0.9	4.8	1.0	0.2	-	16.7	15.2	2.3	-	-	5.7	9.8	18.4	16.6	1.1	0.4	0.2	6.5	0.3	0.4
13	0.7	0.1	2.3	3.4	1.1	0.5	-	15.1	11.7	1.6	-	-	3.3	12.1	22.8	16.9	2.9	-	0.1	5.4	-	-
14	1.5	0.3	2.3	5.8	2.1	0.3	-	18.4	13.1	0.5	-	-	2.4	8.0	21.8	13.3	2.3	-	0.1	8.3	0.4	-
15	0.5	-	3.2	3.8	1.5	0.4	-	23.6	13.3	-	-	0.1	2.0	5.5	22.0	19.0	0.5	-	0.1	5.1	0.1	0.2
16	0.1	0.4	1.4	6.2	0.3	0.2	-	36.7	7.9	-	-	-	0.8	3.2	27.4	13.9	-	0.1	-	1.0	-	-
17	0.8	0.1	1.7	8.9	1.1	0.4	-	32.4	4.9	-	-	-	0.6	3.1	35.0	10.5	0.6	0.5	-	0.8	-	-
18	0.3	0.5	1.9	11.2	1.4	0.6	-	26.9	1.9	-	-	-	0.4	4.9	41.7	7.7	0.9	-	-	0.4	0.1	-
19	0.4	0.1	2.0	13.6	2.9	0.3	0.9	18.5	-	-	-	-	-	6.7	49.4	5.3	0.9	-	-	0.2	-	-
20	0.3	-	1.4	15.0	4.1	0.5	0.8	30.9	-	-	-	-	-	5.1	37.2	4.2	0.1	-	-	-	-	-
21	0.2	-	2.1	15.9	1.7	-	0.3	32.9	-	-	-	-	-	1.7	39.0	6.6	-	-	-	-	-	-
22	0.3	-	1.3	8.9	1.5	-	0.1	30.5	-	-	-	-	-	1.6	48.2	8.1	0.1	-	-	-	-	-
23	0.1	-	0.7	16.4	1.0	0.2	8.0	17.7	-	-	-	0.1	-	1.5	42.6	2.0	-	-	-	-	-	-
24	-	-	1.3	10.6	0.4	-	21.6	18.8	-	-	-	-	-	0.6	39.8	5.3	0.8	-	-	-	-	-
25	-	-	1.0	12.8	0.6	-	17.1	16.3	-	-	-	-	-	1.6	47.6	3.1	-	-	-	-	-	-
26	-	-	1.5	17.5	1.4	0.3	14.3	17.1	-	-	-	-	-	9.3	37.2	1.3	0.1	-	-	-	-	-
27	-	-	0.1	16.9	1.5	1.2	5.9	14.0	-	-	-	-	-	16.1	44.3	0.6	0.2	-	-	-	-	-

1 The figures under each heading are percentages of total number of individuals in each collection. Abbreviations: AL : *Amnicola limosa;* AU: *Amnicola lustrica;* FD: *Fossaria obrussa decampi;* FO: *Fossaria obrussa;* FP: *Ferrissia* GP: *Gyraulus parvus;* HC: *Helisoma campanulatum;* HS: *Helisoma anceps striatum;* LS: *Lymnaea stagnalis;* OR: *Oxyloma retusa;* PA: *Pisidium casertanum;* PC: *Pseudosuccinea columella;* PE: *Promenetus exacuous;* PF: *Pisidium ferrugineum;* PG: *Physa gyrina;* PO: *Pisidium compressum;* SL: *Sphaerium lacustre;* SN: *Sphaerium nitidum;* SS: *Sphaerium sulcatum;* VO: *Vertigo ovata;* VS: *Valvata sincera;* VT: *Valvata tricarinata.*

tend to form a division of the deposit into recognizable zones. These ecological zones correspond roughly to lithologic variations. Variations in the total number of specimens per thousand milliliters of sample also conform to the overall pattern. There is a general increase in numbers upward in the deposit. From samples 27 through 19 there is an increase from 1500 to about 2000; from samples 19 to 15, an abrupt increase to about 5000 specimens; and from samples 15 to 4 an increase to more than 5000 specimens per thousand milliliters of sample. Sample 3 contained only 384 specimens in 2000 milliliters, and most of these came out of marl from sample 4 that was adhering to the lower side of the sample. There is a minor break in numbers beginning at sample 7 that is reflected in the lithology and probably represents a temporary increase in water depth.

The important species in the fauna listed above are lake forms; however, some of them prefer slightly different environments, which causes them to be somewhat restricted to different portions of the section. Ten of the twenty-two species represented are absent in the lower third of the sequence.

Gyraulus parvus is the most abundant species in the lower half; however, it is considerably reduced in abundance in the upper half of the deposit (figure 5).

Valvata tricarinata and *Pisidium compressum* are not quite as abundant as *G. parvus*, but they have similar vertical distributions (Fig. 4). These three species, with *Valvata sincera*, make up 80 to 90 percent of the assemblage in the lower half of the deposit. *V. sincera* appears in the lowest sample, becomes fairly abundant, and then disappears in sample 22 (figure 7).

Helisoma anceps striatum is common throughout the sequence; however, it is most abundant in the middle third (figure 6). *Fossaria obrussa decampi* is similar, except for a very thin interval at the bottom of the deposit (figure 5). *Physa gyrina* appears late and is common only in the middle third (figure 11). The few specimens of *Ferrissia parallela* found were also in this interval (table 2).

In the upper half of the deposit, *Amnicola limosa* and *A. lustrica* are 40 percent of the assemblage; however they are absent in the lower part (figure 7). When combined with *V. tricarinata* and *G. parvus*, they represent 70 to 80 percent of the assemblage in the upper samples. *F. obrussa* appears in the upper half, but is never greater in abundance than 6 percent (figure 10).

Sphaerium sulcatum, *Pisidium casertanum*, and *Helisoma campanulatum* occur in minor percentages throughout the section, and show a general increase toward the top (figures 9, 8, table 2). *Sphaerium nitidum*, *S. lacustre*, and *Pisidium ferrugineum* are similar, except that they generally represent one percent or less of the assemblage (figure 6 table 2). Adult specimens of *S. nitidum* and *S. lacustre* were found only in the middle and upper portions of the section.

The remaining species occur sporadically throughout the deposit and in percentages less than one. Most of these are either swamp or land forms. They generally appear in the upper part of the deposit, indicating proximity of the land environment.

EXPLANATION OF FIGURES 4-11, OPPOSITE PAGE

Fig. 4. Stratigraphic variation of *Valvata tricarinata* and *Pisidium compressum* in the Box Marsh deposit.

Fig. 5. Stratigraphic variation of *Fossaria obrussa decampi* and *Gyraulus parvus* in the Box Marsh deposit.

Fig. 6. Stratigraphic variation of *Sphaerium nitidum* and *Helisoma anceps striatum* in the Box Marsh deposit.

Fig. 7. Stratigraphic variation of *Amnicola lustrica*, *Amnicola limosa*, and *Valvata sincera* in the Box Marsh deposit.

Fig. 8. Stratigraphic variation of *Pisidium casertanum* in the Box Marsh deposit.

Fig. 9. Stratigraphic variation of *Sphaerium sulcatum* in the Box Marsh deposit.

Fig. 10. Stratigraphic variation of *Fossaria obrussa* in the Box Msrsh deposit.

Fig. 11. Stratigraphic variation of *Physa gyrina* in the Box Marsh deposit.

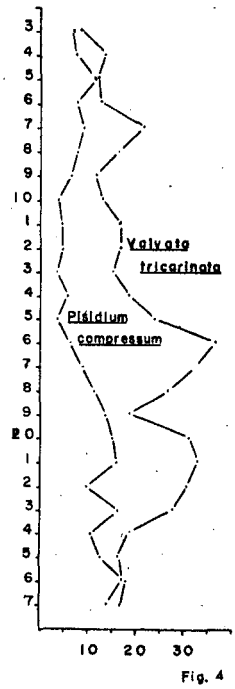

Fig. 4

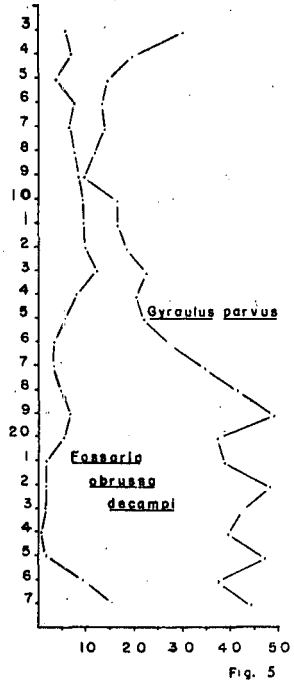

Fig. 5

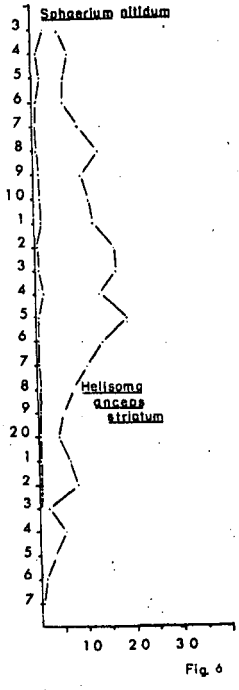

Fig. 6

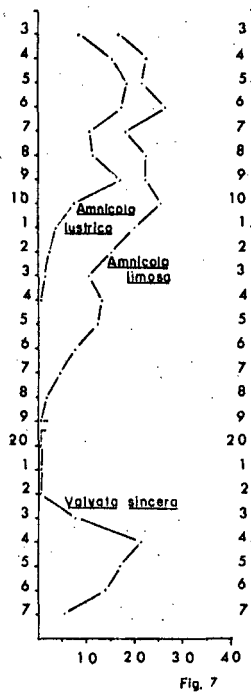

Fig. 7

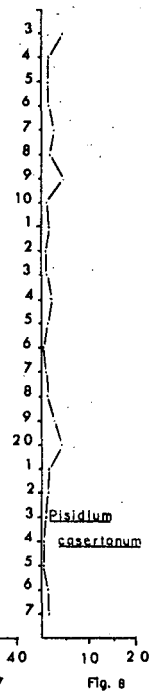

Fig. 8

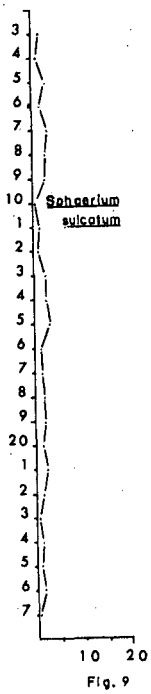

Fig. 9

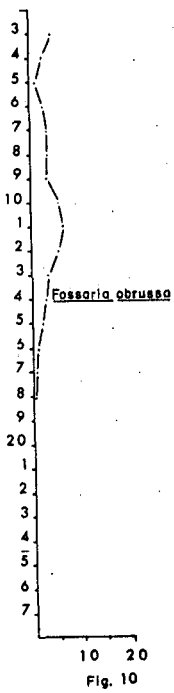

Fig. 10

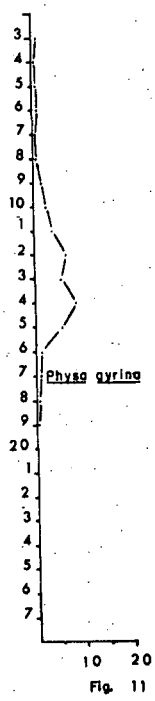

Fig. 11

PALEOECOLOGY

The deposit consists almost entirely of tan to whitish gray marl with varying amounts of organic material. It rests in sharp contact on the reworked surface of the underlying till and ends abruptly at the base of the black clay and included plant remains of the overlying marsh. The marl contains a lacustrine molluscan assemblage which prevails throughout the marl section. The number of specimens per unit volume increases upward from the bottom, probably because of improved environmental conditions and a decrease in the rate of sedimentation. The measured section was described as follows.

STRATIGRAPHIC SECTION, BOX MARSH DEPOSIT

Unit	Sample	Description
1	1-3	Clay, black, organic (some peat), plant roots, marsh sedge; Mollusca rare.
2	4-8	Marl, whitish gray, clayey, blocky in part compact, shell debris and plant matter common; Mollusca abundant.
3	9-14	Marl, brownish gray, becomes whitish gray downward, calcareous, compact, much plant matter; Mollusca abundant.
4	15-18	Marl, whitish gray, clayey, compact, plant matter abundant in upper part; Mollusca abundant.
5	19-25	Marl, tan gray in upper part, tan pink in lower third, clayey, fine organic matter throughout, organic laminae in lower 2 samples; Mollusca abundant.
6	26-27	Marl, light gray, clayey, contains sand and pebbles in sample 27; Mollusca abundant.

The persistence of certain species throughout the sequence suggests that the lacustrine environment was relatively stable, except for minor fluctuations indicated by changes in the assemblage and the character of the sediment. The overall trend in the development of the lake could be characterized as gradually decreasing water depth and current action, increasing vegetation and diversity in the molluscan fauna.

The most abundant species represented are *Gyraulus parvus, Valvata tricarinata, Amnicola limosa, A. lustrica, Pisidium compressum, Helisoma anceps striatum* and *Fossaria obrussa decampi*. These species occur in distinct associations that distinguish the environment in the lower from that in the upper part of the deposit. These intervals are separated by a transition zone in which new species appear and the predominant indigenous species of the lower assemblage are displaced by those of the upper part of the section.

The assemblage in the lower two units contains 12 species, plus unidentifiable Naiad fragments. The most abundant species are *Gyraulus parvus, Valvata tricarinata,* and *Pisidium compressum,* accompanied by significant numbers of *Fossaria obrussa decampi* and *Valvata sincera,* with minor percentages of *Helisoma anceps striatum, Pisidium casertanum* and *Sphaerium sulcatum*. In sample 27, the indigenous species appear with *Fossaria obrussa decampi,* an intruder from shallow water or mud flats, which is quickly replaced in the assemblage by *Valvata sincera*. This change in the assemblage coincides with a change in the sediment from clayey, whitish gray marl containing reworked sand and pebbles to purer tan to pinkish colored marl. The pink color, confined to the lower part of unit 5, comes from very fine organic debris concentrated in laminae within the marl. This is probably analogous to the reddish-brown laminated unfossiliferous sediment reported by Whittaker (1922, p. 147-153) in the deepest parts of McKay Lake, Ottawa, Ontario. It is possible that this type of sediment exists in the deeper portions of the Box Marsh deposit, and that the tan pink marl in unit 5 is its lateral equivalent in somewhat shallower water, where marl was being actively precipitated. The water depth was probably 2 to 3 meters, possibly 3 meters or more in the interval in which *Valvata sincera* was abundant, with moderate vegetation and some current activity. The great abundance of *Gyraulus parvus* might dictate estimates of somewhat shallower water; however, considering

the nature of the associated species and the probability that many specimens of this prolific form may have been washed into the area or dropped from floating vegetation, the depth estimates seem justified. Its increase in numbers toward the upper part of unit 5 probably indicates the development of shallower, more restricted conditions.

In unit 4, the transition sequence, 8 additional species appear, and *V. sincera* disappears from the assemblage. This interval is marked by the decline of *V. tricarinata, Gyraulus parvus,* and *Pisidium compressum;* the appearance of *Amnicola limosa, Physa gyrina, Fossaria obrussa,* and *Sphaerium nitidum;* and increase in *Helisoma anceps striatum, Fossaria obrussa decampi* and *Sphaerium sulcatum;* and the first appearance of land snails. This interval has been recognized because it marks a period of relatively rapid change in the environment of the lake. The indigenous species of the lower units give way to forms indicative of shallow, quieter water with moderate to dense vegetation. The trends started here continue and develop in the remainder of the deposit.

In the upper half of the deposit 20 species are present. *Amnicola lustrica* joins *Amnicola limosa* to form approximately 40 percent of the assemblage throughout the remainder of the section. *Valvata tricarinata, Gyraulus parvus,* and *Pisidium compressum* are abundant, but greatly reduced. *Fossaria obrussa, Helisoma campanulatum* and *Physa gyrina* increase in unit 3, then decline in unit 2. The abundance of *Amnicola limosa* and *A. lustrica,* and the minor increases in intruders from the shallow water and mud flat environment indicates continued decrease in the water level. In the top of unit 3, the marl is brownish from the included plant debris. However, there is no indication that the environment became swampy or stagnant, because the total number of shells per thousand milliliters remains high and *Gyraulus parvus* and *Valvata tricarinata* persist and then increase slightly in the next unit.

In unit 2, whitish gray marl quickly replaces the brownish marl, the number of intruders declines and species from slightly deeper water increase. *Amnicola limosa, A. lustrica, Gyraulus parvus,* and *Valvata tricarinata* are the most abundant species in the remaining marl samples. This change indicates a slight increase in water depth and a reduction in the amount of vegetation present from that observed in sample 9. In subsequent samples, the water apparently continued to become shallower; however, there is no transition into peat, and no indication that mudflats or beach accumulations developed in the immediate area prior to the end of marl deposition. The marl section terminates sharply with the appearance of the black muck and organic deposits of the marsh. Apparently, the marsh environment invaded Box Marsh in a manner similar to that observed by Whittaker (1921, p. 155) in McKay Lake. He reported that there was '. . . no bottom area exposed between water level and 1 foot in depth, as the clumps of grass sedge and peat go down vertically to a depth of a foot or more.' This explains how aquatic conditions could persist into the last samples and be replaced without transition through intermediate stages.

The Box Marsh deposit follows a pattern of development similar to that observed in other deposits. The site was occupied by a perennial body of water in which marl was deposited continuously prior to the extinction of the lake. The water depth was 2 to 3 meters at the beginning and progressively declined to less than 1 meter, but probably never less than a foot. The bottom was probably soft, because it was occupied by a diverse assemblage of clams, most of which prefer a soft substrate. Organic activity increased progressively toward the top of the marl section, as more species are represented in the assemblages and greater numbers of specimens per unit volume of marl are found in the upper part. Many of the species are rare or occur in small percentages, but they indicate the development of favorable habitats for Mollusca in areas adjacent to the collecting locality The species present indicate that the pH was between 7 and 8, probably near 7.5; and the fixed carbon dioxide 10 to 20 p.p.m., probably around 15 p.p.m. The amount of vegetation present increased, but never became thick enough to crowd out the Mollusca. The highly organic marl in sample 9 does not contain peat, but it probably corresponds with peat accumulations observed in some of the shallow extremities of the deposit.

The presence of *Helisoma anceps striatum, Sphaerium nitidum,* and *Pisidium ferrugineum* indicates that the climate was cooler than at present. *Sphaerium nitidum* is a species restricted to northern areas or cold deep waters, and has not previously been reported as a fossil. *Helisoma anceps striatum* has been considered a cold climate indicator in other stu-

dies. Baker (1935, p. 271) records the species in North Star and Little North Star lakes in Minnesota. He stated that 'the race is more abundant in the north and its presence as a fossil farther south indicates colder water then than now.' The persistence of *Helisoma anceps striatum* and *Sphaerium nitidum* into the shallow water in the upper part of the deposit indicates that the climate remained colder throughout the existence of the lake.

AGE AND CORRELATION

A number of methods may be used to determine the age of the Box Marsh deposit. The most direct method is radiocarbon dating but so far, funds have not been available for this work. Therefore, the age must be determined through the relationship of the deposit to other sediments of known age in the area, and by comparison of the fauna with faunas from similar lake marl deposits.

The marl section rests in sharp contact on a reworked till surface that is strewn with material of sand to cobble size. Many of the larger cobbles are faceted and are definitely of glacial origin. The exact thickness of this layer of pebbly clay and till could not be determined, because groundwater flooded the sampling pit and stones in the sediment prevented drilling with the hand auger; however, considering the close proximity of the site to bedrock exposures and the low inclination of the bedrock surface in those areas, a maximum thickness of 2 feet for the layer would be a generous estimate. A minor amount of plant debris is incorporated in the upper part, but not enough to indicate a significant time break between deposition of the reworked material and the beginning of marl accumulation. The marl is relatively homogeneous, contains no significant breaks, and is well compacted throughout the section. The compactness of the marl differentiates it from very recent marl accumulations, most of which contain large amounts of water and are unconsolidated. Cores taken by Whittaker (1922 p. 150) in soft sediment from the bottom of McKay Lake, Ottawa, Ontario, shrank as much as 50 percent when the material was compacted in the coring process.

According to Gadd (1963B), studies made in the Chalk River region and the Ottawa map-area (1963A, p. 1) show that the area was glaciated during the late Wisconsin ice advances, and local surficial deposits are considered to be Wisconsin and younger. Following the retreat of the ice the area was depressed, and the Ottawa-St. Lawrence lowlands were occupied by extensive late-glacial lakes and then invaded by the Champlain Sea. Marine fossils have been found in the vicinity of Pembroke, Ontario, and Gadd (1963B, Descriptive Notes) found broken, reworked *Macoma* shells and marine sand deposits in the Chalk River area, north of Pembroke, possibly the greatest known inland extension of the sea. Marine clays fill the Bonnechere River valley a short distance from Box Marsh; however, clays of this type were not observed in the immediate vicinity of Colton Lake. Apparently the area did not receive large amounts of sediment when it was inundated, and any that did accumulate probably has been removed by subsequent erosion. A period of active erosion is indicated by the reworked till surface underlying the marl. Fragments of rock on this surface that were in contact with the marl have carbonate encrustations on their upper surfaces, which indicates that they remained undisturbed after the small lake occupied the site and marl began to accumulate.

The deposit post-dates the retreat of the last ice sheet and the accompanying inundation of the area by the Champlain Sea. Karrow (1961, p. 101) estimates the beginning of the sea invasion at 11,000 to 12,000 C_{14} years B.P., and Terasmae (1965 p. 36) places its retreat at a minimum of 9 500 C_{14} years B.P. or earlier. Terasmae also states that the Champlain Sea is, in part at least, a correlative of the Two Creeks interstadial. The older dates are based on radiocarbon dates of marine shells, but the minimum date was taken on a peat layer at the base of a bog overlying marine clays, near Cornwall, Ontario. In the same report Terasmae (1965, p. 38) suggests that the early St. Lawrence River came into existence not later than 9,500 C_{14} years ago and occupied its present site at Cornwall, Ontario, 7,000 to 8,000 C_{14} years ago. During the closing stages of the Champlain Sea, the Great Lakes drained into the Ottawa River through the Fossmill and the North Bay-Mattawa outlets (Gadd, 1963B, p. 3) and eventually displaced the marine environ-

ment with freshwater. This provided an immediate migration route into the region for non-marine Mollusca.

The Box Marsh post-dates these events and it is probably a reasonable assumption that the area emerged earlier than that around Cornwall; therefore, marl could have started accumulating 9,500 C_{14} years ago or earlier and continued until the extinction of the lake. Mollusca appear immediately in the first marl sample. On the basis of pollen stratigraphy, Terasmae (1960, p. 18) found that the Champlain Sea interval was followed by a cold climate that persisted until about 8 000 C_{14} years B. P., when the warming trends in the Hypsithermal (Deevey and Flint 1957, p. 182) began to affect the area. In the Box Marsh deposit, the faunal evidence shows no indication of a significant warming trend toward the top of the section; which suggests that the lake may

TABLE 3. DISTRIBUTION OF SPECIES IN THE BOX MARSH DEPOSIT AND A FEW DEPOSITS OF SIMILAR AGE IN ONTARIO

	BM[1]	CL	OM	WL	ML
Sphaerium sulcatum	2.5		0.4	3.8	X
Sphaerium nitidum	1.0	8.9			
Sphaerium lacustre	0.2		0.4		
Pisidium compressum	6.4	7.1	1.6	3.4	-
Pisidium casertanum	4.3	2.9	1.6	10.1	X
Pisidium ferrugineum	0.4	0.6	0.4	1.8	-
Valvata tricarinata	11.7	23.8	25.2	13.2	X*
Valvata sincera	-			6.2	-
Amnicola lustrica	17.1	5.6	5.2	20.2	X*
Amnicola limosa	22.4	10.0	27.2	18.3	X*
Fossaria obrussa decamp.	8.1	13.2	6.0	2.3	X*
Fossaria obrussa	3.2	9.6	3.6		X
Helisoma campanulatum	1.5	0.6		1.2	X
Helisoma anceps	-			-	X
Helisoma anceps striatum	8.9	7.5	11.6	1.8	-
Gyraulus parvus	9.6	17.6	11.2	15.4	X*
Physa gyrina	1.7	0.3	3.2	0.5	X
Oxyloma retusa	0.7		1.2		-
Vertigo ovata	0.1				-
Helicodiscus parallelus	-		1.2		X

1 BM: Box Marsh marl deposit, Renfrew County, Ontario. (Sample No. 9).
CL: Colton Lake marl deposit, Renfrew County, Ontario.
OM: Marsh adjacent to Colton Lake outlet, Renfrew County, Ontario.
WL: White Lake marl deposit, Renfrew and Lanark counties, Ontario.
ML: McKay Lake marl deposit, Ottawa, Ontario. (X*: reported abundant)

have become extinct in the sample locality prior to the warming of the climate and probably indicates a minimum age for the deposit.

The time of extinction of the lake cannot be established definitely without radiocarbon dates; however, comparison of the Box Marsh fauna with that of other marl deposits in the area and from quantitative studies conducted in other glaciated regions tends to confirm the late-glacial age suggested for the deposit. The fauna is similar both in composition and development to the faunas reported from quantitatively studied deposits. In Ontario, no other quantitative studies have been made which could be used for comparison. Most of the records are from materials obtained from bulk samples, not stratigraphically oriented. Marl samples of this nature were obtained by the

writer from the upper part of the marl deposits surrounding Colton Lake and from a marsh just below the Colton Lake outlet. Additional material was collected with a hand auger from the bottom of White Lake, near Arnprior, Ontario.

The assemblages and the relative abundance of each of the species contained in them are listed in table 3 along with the assemblage from sample 9 of the Box Marsh deposit and one reported by Whittaker (1921, p. 62) from McKay Lake, Ottawa Ontario. There is a great deal of similarity in the assemblages, which indicates that they come from comparable environments. The factor that distinguishes them is the occurrence of *Sphaerium nitidum*, *Pisidium ferrugineum*, and *Helisoma anceps striatum* in the deposits. These are cold climate indicators. They are present in the Box Marsh assemblage and are absent or reduced in abundance in some of the other assemblages. This probably indicates that these deposits are somewhat younger and were accumulated in a slightly warmer climate, than Box Marsh. All of the deposits are in the area covered by the Champlain Sea, and post-date that event.

When the fossil faunas are compared with the living Mollusca in the area some notable changes may be seen. Many of the same species are present, but the cool climate forms are absent and several new species appear. The White Lake fauna reported by La Rocque (1965, p. 1, 40) includes *Lymnaea stagnalis*, *Bulimnea megasoma* (Say), *Helisoma trivolvis*, and a recent, artificially introduced species of *Viviparus*, in addition to many of the species found as fossils. *Lymnaea stagnalis* and *Helisoma trivolvis* were found living in the Colton Lake drainage. The situation is similar to that reported from late-glacial marl deposits quantitatively studied in Wisconsin. Roy (1964, p. 35) found fossil assemblages very similar to those in Ontario that apparently occupied lake sites immediately following the retreat of glacier ice, possibly when stagnant ice still remained. Some of the lakes were extinct prior to discernible warming trends; however, in others the reduction of the cool climate forms in the upper parts indicated slightly warmer conditions. In this area *Lymnaea stagnalis*, *Bulimnea megasoma*, *Helisoma trivolvis*, and *Acella haldemani* are found living, but are rare or absent as fossils. Roy (1964, p. 71) concluded that they arrived in a second wave of migration following the extinction of the lakes. These are present in the upper part of the Newell Lake deposit, Logan County, Ohio (Zimmerman 1960 p. 33), in association with an assemblage similar to those previously discussed. Baker (1935, p. 266) reported the species in Little North Star Lake, Itasca County, Minnesota, living with the species found in the fossil assemblages. Apparently they have become established in northern areas only in fairly recent times. The presence or absence of the species in an assemblage is probably indicative of the relative age of the deposit and the climatic conditions under which it was deposited.

Box Marsh probably began to accumulate marl soon after the close of the Champlain Sea interval, around 9,500 C_{14} years ago, and may have become extinct before the end of the cold climate period that existed in the area until about 8,000 C_{14} years P.B. The fauna is very similar to assemblages found in marl deposits that formed in the region during about the same time interval. The assemblages do not contain certain distinctive species that have been demonstrated to be slow migrating forms, which have arrived only recently in northern areas. This indicates a pattern of migration that seems to be characteristic in areas glaciated in late Wisconsin time. Therefore, the Box Marsh deposit is considered to be late Wisconsin, not more than 9,500 C_{14} years B. P. and probably not less than 7,000 to 8,000 C_{14} years B. P.

CONCLUSIONS

The fauna obtained from Box Marsh marl deposit contains 22 species, most of which are lake forms. The species are not uniformly distributed in the deposit, but occur in vertically restricted associations that probably reflect the environmental conditions controlling the local habitat in each part of the section. The variations recorded in the abundance of the most important species indicate progressive changes in conditions during the development of the lake.

Mollusca appear in the first marl samples

and increase both in the number of species present and in the total number of specimens per 1000 milliliters of sample. The Mollusca inhabited a lake in which marl was continuously precipitated from the time marl accumulation began until it ceased and marsh conditions appeared. The water depth was initially 2 to 3 meters and progressively declined to 1 meter or less; however, the water was probably never less than 1 foot deep and never became stagnant near the sample locality. The species present indicate that the pH was between 7 and 8, probably 7.5; and the fixed carbon dioxide 10 to 20 p.p.m., probably around 15 p.p.m. The amount of vegetation increased toward the top of the deposit but never enough to crowd out the Mollusca until the grass sedge, muck, and peat of the overlying marsh covered the locality. Apparently no beach or mud flat accumulation was formed in the closing stages of the lake. The presence of *Sphaerium nitidum*, *Pisidium ferrugineum*, and *Helisoma anceps striatum*, and their persistence into the upper part of the deposit indicate that a colder climate than now prevailed during the existence of the lake. The colder climate indicated by the Mollusca and the stratigraphic position relates the deposit to the late-glacial cold interval defined by Terasmae (1960, p 18) on the basis of pollen stratigraphy. This period of cold climate existed during and for a short time following the Champlain Sea episode. The Box Marsh deposit was probably accumulated in this cold climate period, immediately following the recession of the Champlain Sea in the late Wisconsin, and prior to the coming of the Hypsithermal, approximately 8,000 C_{14} years B. P.

In determining the paleo-environment, greater significance was placed on the most abundant autochthonous species than on the other species. However, many of the less abundant species contributed useful information concerning the development of the lake at the collecting site and adjacent areas.

The fauna seems to be common in late Wisconsin marl deposits formed in glaciated areas. The species are all of small size and apparently were capable of occupying suitable lakes in the immediate proximity of the retreating glaciers. Equally important in this migration sequence are certain species which were rare or absent in the Box Marsh deposit and in marl deposits of northeastern Wisconsin. Roy (1964, p. 71, 72) found that *Lymnaea stagnalis*, *Bulimnea megasoma*, *Acella haldemani*, and *Helisoma trivolvis* were slow to migrate and only recently arrived in northern areas. In the same report Roy compared the Wisconsin record with that in Ohio, where *Acella haldemani* and *Lymnaea stagnalis* were found as fossils, but are no longer living. Roy (1964, p. 72) states that the northward migration of these species has probably been controlled by post-Wisconsin climatic changes, and concluded that the species remained in southern areas until the more rigorous northern climate had moderated. The Ontario fossil record reveals a situation parallel to that in Wisconsin. The same species are late arrivals, especially *A. haldemani* which has been reported only in the southern part of the province.

This succession of assemblages observed in the stratigraphic studies of lake marl deposits demonstrates progressively changing conditions and patterns of migration that are largely controlled by climate and probably reflect late Wisconsin adjustments in the previously displaced climatic zones. When the continental glaciers retreated northward, a corresponding shift of the climatic zones apparently occurred and Mollusca populated the glaciated areas when suitable habitats were available and the changes in climate permitted their dispersal into new regions. The series of events could be interpreted in much the same manner as a stratigrapher would treat a transgressive marine sequence. In one complete marl section or in a series of related deposits, most, if not all of this remarkable transgression may be observed in a vertical sequence.

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