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MARL DEPOSITS IN OHIO AND THEIR FOSSIL MOLLUSCA.

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Reports have been published on the marls of several states, but practically nothing is known of such deposits in Ohio. Some years ago collections were made, principally at two places, and the following notes may be of interest. Specimens are in the Carnegie Museum. Many species are also in the museum of the Ohio State University, and in the collection of Dr. R. C. Rush, at Hudson, Ohio. I am indebted to Dr. Frank C. Baker for identifying Lymnæidæ, and to Dr. Bryant Walker for notes on several groups.

TINKERS CREEK MARL.

In July, 1911, Dr. R. C. Rush and I chanced to find a marl deposit along Tinkers Creek, close to the line of Summit and Portage Counties, south of the station Moran of the Wheeling & Lake Erie Railroad. This place is about one thousand feet above sea level and somewhat over four hundred feet above the level of Lake Erie, within the drainage of the latter (Cuyahoga River). Recent dredging of the creek had cut through the marl for about five or six feet, and there was thus an excellent opportunity for collecting. At one place, close to a hill, the marl was partly overlaid with one to several feet of sand and gravel, apparently "glacial drift." How extended the bed is, how deep, or thick, and how much covered, or uncovered at other places, is not yet ascertained. Generally the marl is pure, white, or whitish, but locally somewhat mixed with muck or peat. It is very rich in fossils, and, being soft and fine grained, it could be washed out with a burlap net. Thousands of shells were obtained and others were picked up from the material removed by the dredge. The shells were generally clean and in fair condition, except that the larger and thin shells were mostly broken. All

were chalky (conf. the note on the *Castalia* shells). In September, 1912, the place was visited again and large numbers of specimens were secured.

List of Species.

- Zonitoides arboreus** Say, very scarce.
Vitrea indentata Say, one specimen.
Pyramidula cronkheitei anthonyi Pilsbry, one.
Polygyra profunda Say, one, found by Dr. Rush.
Succinea ovalis Say, very scarce, and so are the two following:
Succinea retusa Lea, and **S. avara** Say.
Carychium exiguum Say, one.
Lymnæa stagnalis appressa Say, rather scarce.
Lymnæa (Acella) haldemani Deshayes, very scarce; two specimens, partly broken. These are the only ones ever found fossil, anywhere, so far as known.
Lymnæa (Pseudosuccinea) columella Say, scarce.
Lymnæa (Galba) humilis modicella Say, frequent.
L. (Galba) humilis rustica Lea, rather scarce.
Lymnæa (Galba) obrussa decampi Streng, common; not typical, but probably of that form. This had not been seen from Ohio, previously, either recent or fossil; but since then, Dr. Rush has found it living in Summit County.
Planorbis campanulatus Say, not common.
Planorbis trivolis binneyi Tryon, scarce.
Planorbis exacutus Say, not common, mostly broken or young.
Planorbis rubellus Sterki, rather scarce.
Planorbis crista Linnæus, scarce.
Planorbis parvus Say, common; adult specimens have the peristome markedly expanded; some are of a more peculiar form: whorls higher and with the outer slope steep. Many are variously deformed. One form has the whorls narrower and more slowly increasing, like those from *Castalia*.
Planorbis albus Muller, common; the last whorl is strongly descending towards the aperture in most specimens. (*P. hirsutus* Gould is probably not distinct from *albus*).
Ancylus kirklandi Walker, form, rather scarce.
Ancylus parallelus Haldeman, scarce.
Ancylus pumilus Sterki, scarce.

There are apparently some other species of *Ancylus* but the specimens were not sufficient for identification; more good material is desirable.

- Gundlachia** sp., one specimen, of an early stage, with the small anterior aperture and no *Ancylus*-like expansion; about 2 mm. long and 1 mm. wide.
- Physa gyrina** Say, rather scarce.
- Physa integra** Say, a few.
- Physa heterostropha** Say, scarce.
- Physa sayi** Tappan, rather frequent, large, mostly broken.
- Ammicola limosa** Say, common, variable with respect to size and shape.
- Ammicola lustrica** Pilsbry, abundant, very variable as to size and shape.
- Ammicola** — smaller and rather different; may be distinct (Dr. Walker).
- Ammicola emarginata** Kuster, scarce.
- Lyogyrus granum** Say, apparently; common.
- Valvata tricarinata** Say, common, most specimens of a somewhat peculiar form: umbilicus narrow, all three keels threadlike or even lamellar; some are scalaroid.
- Valvata sincera** Say, frequent, axial striæ fine and slight; the largest has a diameter of 4.7 mm.
- Pisidium compressum** Prime, common, of different forms: the typical, and *lævigatum* (with the beaks unridged, of quiet water).
- Pisidium fallax** Sterki, rather scarce.
- Pisidium variabile** Prime, common.
- Pisidium pauperculum** Sterki, abundant; different forms, especially: *crystalense*, also recent in Ohio, and *nylanderi*, recent in Maine. A few specimens with partially reversed hinges.
- Pisidium sargenti** Sterki, rather scarce.
- Pisidium adamsi affine** Sterki, a few, like those from Meyer's Lake.
- Pisidium abditum** Haldeman, apparently, rather scarce.
- Pisidium walkeri** Sterki, scarce.
- Pisidium scutellatum** Sterki, scarce.
- Pisidium ohioense** Sterki, rather scarce, like recent specimens, e. g., from Garrettsville, Ohio.
- Pisidium splendidulum** Sterki, frequent.
- Pisidium rotundatum** Prime, scarce.
- Pisidium medianum** Sterki, frequent, rather small form.
- Sphærium sulcatum** Lamarck, frequent; one specimen with partially reversed hinge.

Sphærium striatinum Lamark, scarce.

Sphærium stamineum Conrad (*solidulum* Prime?), a few, imperfect.

Sphærium rhomboideum Say, a few fragments.

Musculium truncatum Linsley, not scarce but almost all broken.

Musculium securis Prime, one valve, immature.

Of *Unionidæ*, fragments only, are frequent in the top layer, below the sand. None of them could be identified.

It appears that there are several species and forms of *Sphæriidæ* in addition to those cited, and more good specimens are needed for exact identification. All those listed (except *P. pauperculum nylanderi*) are found recent in Ohio, and are widely distributed.

On the gastropods, a few additional notes may be in place. *Lymnæa stagnalis* and *L. haldemani* are not known to be living in this section now; however, they are found in other parts of Ohio, but are rare. Years ago they were listed as found, e. g., in Congress Lake; but careful search there by several collectors during the last twenty years has been in vain.

The first eight species of the list, land snails—*Stylommatophora* and *Carychium*—each represented by one or a few specimens, have evidently been brought there by accident and are not real parts of the fauna. Collectively they constitute only a small part of one per cent of the whole number.

It is evident that the marl was formed in a pond or lake, but connected with a stream as shown by the presence of *Sphærium stamineum* (or *solidulum*) and typical forms of *Pisidium compressum* and *fallax*. At least where the material was collected, it was neither marshy nor directly exposed to floods, or there would be numerous shells of land snails washed in, and the marl would be mixed with sand and debris. It is also significant that there are apparently missing some more or less amphibious species, such as *Segmentina*, *Aplexa*, *Pomatiopsis* and *Sphærium occidentale*, which preferably live in the shallow water of marshy places. The first three of these are represented in the Castalia marl.

This deposit is certainly older than the one at Castalia and older than some marl-like deposits, mixed with muck and peat, in the southern part of Summit County, e. g., in the canal cut south of Summit Lake and at the southern end of Long Lake.

CASTALIA MARL.

In Erie County, west of Castalia and east of Sandusky Bay, is a marl deposit extending over several miles, with the surface about thirty feet above the level of Lake Erie, about ten feet deep where opened, and underlaid with clay. The marl has been used, for many years, for manufacturing Portland cement, and analyses have shown it to be over ninety-nine per cent carbonate of lime. Most of it is soft, but at places with hard concretions, and here and there are blocks and even rock-like masses of travertine, at least partly formed among reeds and rushes, and mosses, mostly *Hypnaceæ* so far as seen. The surface of most of the area is nearly level, and dry, covered with grass and weeds and locally with shrubbery. Some parts are still marshy with a luxuriant marsh vegetation, and in places even covered with open water.

The marl is rich in shells, from bottom to top, and evidently the mollusks had once inhabited the region. At some places they were found in extraordinary numbers; for example, in a perpendicular, artificial bluff at the end of a digging, about four feet from the surface, there was a layer about three inches thick, which was chiefly composed of small and minute shells. The marl of this layer was quite soft, loose and of finer grain than above and below, and through atmospheric influences had disintegrated to fine sand and dust. The dust and clean shells had accumulated on a narrow ledge at the foot of the bluff. Somewhat less than a quart of it was scooped up and taken along, and at a conservative estimate there were over a hundred thousand shells in it, representing more than fifty species, for the most part land snails. Most common was *Carychium*, probably more numerous than all others combined, then: *Pupillidæ*, small *Zonitidæ*, *Helicodiscus*, *Strobilops*, also *Segmentina*, etc. The largest were *Polygyra monodon* and *hirsuta*. Evidently these snails were washed together and deposited as drift by the outer edge of an exceptionally high and widespread flood. The outcropping layer could be followed on a stretch of more than forty feet, though not everywhere with the same wealth of shells.

Most of the larger shells were picked up at various places where a steam shovel had been working but many were taken in situ. Siftings for the smaller ones were gathered here and there, especially where they had been washed together by

rains. Only parts of the area exposed could be searched over, though on a stretch of about a mile, in 1915 and 1917. I acknowledge with thanks that on both occasions the officers and engineers of the Portland Cement Company showed me much kindness by giving information and chances to ride on the engines of their trains to and from the marl field.

Most of the shells are chalky. Those of *Pyramidula alternata*, *Polygyra multilineata* and some *P. profunda* still show more or less of the reddish markings. But many are like fresh ones, translucent or transparent, e. g., all of *Vallonia* and *Pupoides marginata*, some of *Zonitoides minusculus*, *Vitrea indentata*, *Gastrocopta armifera*, *contracta*, *tappaniana*, and all of one form of *Succinea avara*.

List of Species.

- Gastrodonta ligera** Say, a few.
Zonitoides arboreus Say, rather frequent.
Zonitoides minusculus Binney, abundant, markedly different forms; some are quite small with narrow whorls. Many have a "lip" deposit in the peristome, close to the margin to a good distance from it.
Vitrea hammonis Strom (*radiatula* Alder), common.
Vitrea wheatleyi Bland, a few.
Vitrea rhoadsi Pilsbry, one shell, not full-grown.
Vitrea indentata Say, common; many are distinctly though narrowly umbilicate.
Euconulus fulvus Muller, frequent.
Euconulus chersinus Say, scarce.
Euconulus sterkii Dall, scarce.
Agriolimax campestris Binney, some shell plates.
Limax ——? one shell plate, 5 mm. long, 3.5 broad and rather thick. This is of particular interest, since no indigenous Limacid of large size is known to inhabit this region.
Circinaria concava Say, rather frequent.
Helicodiscus lineatus Say, common.
Pyramidula solitaria Say, a few, rather large.
Pyramidula alternata Say, rather scarce.
Pyramidula perspectiva Say, scarce.
Pyramidula cronkheitei anthonyi Pilsbry, scarce.
Punctum pygmæum Draparnaud, rather scarce.
Sphyradium edentulum Draparnaud, one specimen.

- Polygyra profunda** Say, common, mostly large, diam. 30-33 mm., though some are smaller; the spire is rather flat, the shell and lip strong. One shell, apparently normal (not deformed), has no vestige of a tooth on the basal part of the lip.
- Polygyra multilineata** Say, abundant; variable as to size (larger diam. 18-26 mm.) and elevation of the spire. Some, especially the smaller ones, have the umbilicus only partially covered; one has a distinct tooth on the peristome like that of *profunda*, and a few others have a vestige of the same; one is reversed (sinistral).
- Polygyra albolabris** Say, scarce; one has a small parietal tooth.
- Polygyra thyroides** Say, common; one specimen has the last whorl exceptionally rounded, and also the aperture, especially in its basal part.
- Polygyra pennsylvanica** Green, one found.
- Polygyra palliata** Say, rather scarce.
- Polygyra tridentata** Say, rather scarce, near the typical form.
- Polygyra fraudulenta** Pilsbry, common, rather large and strong-shelled.
- Polygyra monodon** Rackett, common to abundant; variable with respect to size, elevation of the spire and width of the umbilicus, but there are no *fraterna* (and none approaching it); in some specimens the parietal lamella is slightly but plainly extending to the umbilical end of the peristome; in one, apparently nowise deformed, it is entirely within the aperture. Most of the shells show more or less reddish color, but some appear to be albinos.
- Polygyra hirsuta** Say, frequent; a few have the umbilicus not entirely covered; some have a distinct projecting tooth on either side of the notch in the peristome.
- Strobilops labyrinthicus** Say, rather scarce.
- Strobilops affinis** Pilsbry, common to abundant.
- Vallonia pulchella** Muller, fairly common; not chalky. A few are apparently near *excentria*.
- Pupoides marginata** Say, common, none chalky. Some apparently mature, have no lip in the peristome or a slight one; one is an albino.
- Gastrocopta (= Bifidaria) armifera** Say, rather scarce, all of the typical form.

Gastrocopta contracta Say, common, variable as to size and shape; mostly rather stout and ventricose, peristome markedly continuous in most, and well everted; in some, the aperture is more than usually obstructed, especially the parieto-angular and the columellar lamellæ being large, while in some others the columellar is exceptionally small.

Gastrocopta pentodon Say, scarce; one specimen is much like the form *gracilis*.

Gastrocopta tappaniana Adams, abundant; few specimens are typical, i. e., of the usual size and subcylindrical shape; most are small, 1.4 to 1.7 mm. long, and oval (form *curta*), generally with the lamellæ and plicæ well formed, though the infraparietal is missing in most; some are more conical, with the last whorl exceptionally large and well rounded.

One specimen, supposedly of a *Gastrocopta*, is of a very peculiar shape: long. 3, diam. 1.5 mm.; cylindrical, perforate, whorls $6\frac{1}{8}$, the last not much larger, well rounded, without any crest or impression over the palate; a very small, vestigial parietal lamella, a somewhat stronger columellar; in the palate there is a slight irregular callus with apparently a vestigial lower palatal plica; shell chalky, had apparently been colorless. In the absence of more evidence it cannot be regarded as a distinct species, but may be a monstrous, overgrown specimen of *G. tappaniana*. Similar forms of recent *G. armifera* have been seen.

Gastrocopta corticaria Say, very scarce.

Vertigo ovata Say, somewhat scarce; some specimens are small, with the lamellæ and plicæ strongly developed; one is larger than the average*, 2.3 mm. long, with the upper palatal plica exceptionally large and strongly directed upward.

Vertigo morsci Sterki, very common; many are rather small (length 2.3 to 3 mm.), and more ovoid-turriculate than cylindrical, but in these also the last whorl is comparatively small; the presence of an infraparietal is rather exceptional: of one hundred specimens it was found only in ten, a small nodule or vestigial. Some specimens are quite short, oval, with the last whorl somewhat flattened below

*W. G. Binney, in Mon. Am. Land Shells, p. 334, gives the length of *V. ovata* as 3 mm. This is evidently a mistake, or error.

and keeled at the periphery; evidently they had been injured, and then formed a premature aperture, of almost normal configuration. All are remarkably alike, and resembling *ovata* more than *morsei*, but a careful examination reveals their nature.

This, the largest of the vertigos, has a rather restricted area of distribution, recent, so far as known: Michigan, northwestern Ohio (Castalia), and northeastern Indiana. It should be looked for also in marls of other states.

Vertigo elatior Sterki, common; some specimens are rather small, short, but still different from *ventricosa* Morse, at the basal part, and with the palatal callus and plicæ stronger. It is widely distributed as recent, and found also e. g., in loess of southern Indiana, collected by Mr. A. A. Hinkley.

Vertigo tridentata Wolf, one shell, like the originals from Illinois.

Vertigo milium Gould, a few, of different shapes: some rather ventricose, others narrowly cylindrical.

Succinea ovalis Say, frequent, with a short spire, form *totteniana* or near.

Succinea retusa Lea, frequent, small and mostly young; different forms; a few with the whorls rather ventricose, the majority narrow with the whorls flattened; the latter appear to be of the form *decampi* Gould (Dr. Walker).

Succinea avara Say, rather scarce; near the common, or typical form with the whorls well rounded; not chalky but like fresh, a few reddish, the others pale corneous.

Succinea avara? peculiar form, possibly distinct; larger, 8–10 mm. long, with 4–4½ rather flat whorls; the spire is long and very slender. All of these are chalky, as are also *L. ovalis* and *retusa*.

Carychium exiguum Say, abundant, variable as to size and shape; generally somewhat small, 1.5–1.9 mm. long; some are ventricose with the penultimate and middle whorls large, others narrowly cylindrical or turriculate, resembling *exile*.

Carychium exile Lea, rather scarce; some appear not to be characteristic and are doubtful; their rib-like striæ are slight and irregular.

- Lymnæa (Galba) reflexa** Say, common. "The specimens are mostly immature and show a great amount of variation. Evidently the body of water in which they lived was subject to much fluctuation in amount of water." (Dr. Baker). Some specimens are much like *elodes* Say, and a few resemble *palustris* Muller.
- Lymnæa (Galba) nashotahensis** Baker, rather frequent. "This species was originally described from marl deposits in Wisconsin and it is of great interest to find it in your locality. It is apparently related to both *reflexa* and *elodes*." (Dr. Baker).
- Lymnæa (Galba) humilis modicella** Say, fairly common.
- Lymnæa (Galba) humilis rustica** Lea, rather common, small; there are forms intermediate between the two.
- Lymnæa (Galba) parva** Lea, not common, small.
- Lymnæa (Galba) dalli** Baker, common, small and variable.
- Lymnæa (Galba) caperata** Say, common, mostly rather small.
- Lymnæa (Galba) — caperata, form?** Small, with short, pinched-in spire and pointed apex, and comparatively large body whorl; nothing like it has been seen before.
- Planorbis trivolvis** Say, abundant, somewhat variable; some are more or less deformed, crippled.
- Planorbis umbilicatellus** Cockerell, two specimens, rather small and apparently immature.
- Planorbis parvus** Say, common; somewhat small, with narrow whorls, markedly different from most of the Tinkers Creek marl. Many are variously deformed, crippled.
- Planorbis crista** Linnæus, scarce; both forms: the one known as *cristatus*, and *nautileus*, smooth, also intermediate specimens. Rare, recent, in Ohio, Indiana, etc., but probably overlooked at some places, on account of its small size.
- Segmentina armigera** Say, common, rather small.
- Ancylus kirklandi** Walker, apparently, a few.
- Ancylus rivularis** Say (?) few.
- Ancylus pumilus** Sterki, several.

There are evidently several other Ancyli, but the specimens were insufficient, immature, and broken. One is probably of an undescribed species.

Gundlachia —, one specimen; the same as from the Tinkers Creek marl, partly broken, but enough is left to show its shape.

Physa gyrina Say, common; different forms: typical, and *hildrethiana* Lea. (Dr. Walker).

Physa elliptica Lea, frequent.

Physa integra Say, rather scarce, with the whorls strongly convex.

Physa aplectoides Sterki, scarce.

Aplexa hypnorum, Linnæus, rather scarce, mostly young and adolescent.

Goniobasis livescens Menke, frequent; "a river form like the one in the Sandusky River above Fremont."—(Mr. Calvin Goodrich). This is a remarkable occurrence especially since the snail was found over a wide stretch and at various depths, so that it could hardly have been confined to a stream, or streams, running through the marsh.

Pomatiopsis lapidaria Say, frequent.

Pisidium compressum Prime, scarce.

Pisidium pauperculum Sterki, scarce.

Pisidium abditum Haldeman, rather scarce, small and slight.

Pisidium ohioense Sterki, a few.

Pisidium rotundatum Prime, scarce.

Pisidium medianum Sterki, a few, small.

Of *Unionidae* not a trace was found.

In this fauna the "land-snails" are largely predominating, composing about fifty species out of seventy-three gastropods, and the proportion is still more marked with the numbers of specimens. As previously mentioned, they were found over a wide stretch, from bottom to top, and had evidently been living there* and gradually buried. The region was evidently marshy, possibly with streams running through it, with parts permanently above water covered with mosses and taller vegetation, inhabited by land snails favored by a moist atmosphere. The water was probably generally shallow, its level changing considerably with the seasons. This appears to account for quite a number of things: the irregular and stunted growth of many *Lymnæidæ* and *Planorbidæ*, the absence of Naiades and Sphæria,† and the scarcity of Pisidia, also for the absence of

*Except possibly part of those in the probable drift layer mentioned; unfortunately an exact separate list of them has not been kept.

†Except *G. occidentale* Prime, which might have been expected.

Campeloma, *Amnicolidæ* and *Valvata* and the presence of *Segmentina* and *Pomatiopsis*. The occurrence of *Goniobasis* is difficult to account for; possibly it is a case of adaptation.

There is hardly a doubt that the Castalia marl is of comparatively recent origin, possibly still in the process of formation in the eastern marshy part of the area. It would be worth while to study more exactly than has been done, the present fauna of the vicinity and compare it with that of the marl.

CONCLUSION.

The two lists, though probably not complete, show that the faunas under consideration are radically different. The Tinkers Creek deposit is a lake or pond formation. As has been pointed out, the few land snails may be left out of consideration, since the fauna is essentially lacustrine, even with a few amphibious species missing. The Castalia fauna, on the other hand, is for the most part terrestrial, there being fifty species of *Stylomatophora* and *Carychium*. By a coincidence the numbers of *Basommatophora* in each list is about the same, twenty-one, nine of which are common to both:

***Lymnæa humilis modicella* and *rustica*.**

Planorbis trivolvis, the common form abundant at Castalia with nothing like *binneyi*, which (alone) is scarce at Tinkers Creek.

Planorbis parvus, the only species abundant at both places, but represented by markedly different forms;

Planorbis crista, scarce in both;

Ancylus Kirklandi, and ***pumilus***, apparently in both;

Gundlachia —, one specimen in each;

Physa gyrina, and ***integra***, somewhat different forms.

Of *Streptoneura*, *Tænioglossa*, there are eight in all, six at Tinkers Creek, two at Castalia, none of them common to both.

Sphæriidæ: about nineteen species, all at Tinkers Creek, some common to abundant, others apparently scarce; six of *Pisidium* are also at Castalia, all scarce.

There is a total of 110 species, only 15 of which are common to both faunas.

New Philadelphia, Ohio.