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## THE RICHMOND FAUNAS OF LITTLE BAY DE NOQUETTE, IN NORTHERN MICHIGAN.

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The fauna of the Richmond exposures along the northern shore of Drummond island evidently is merely a western continuation of that found on Manitoulin island, and extending thence eastward along the southern shore of Georgian Bay and north of the western half of Lake Ontario, almost as far east as Toronto. It contains the same abundance of coralline growths, such as *Stromatocerium huronense* Billings, *Tetradium huronense* Billings, *Columnaria alveolata* Goldfuss, *Calapoecia huronensis* Billings, *Streptelasma rusticum* Billings, and *Protarea richmondensis* Foerste. It contains also the associated fauna known from the Richmond of the Canadian localities just mentioned.

Nothing is known at present of the Richmond fauna on St. Joseph island nor of that part of the northern peninsula of Michigan extending between Lakes Superior and Michigan, until we reach the eastern shore of Little Bay de Noquette, about four miles east of Escanaba, on the opposite side of the bay. Here only the faunal list published by Rominger (Geol. Surv. Michigan, 1873, part III, page 52) is available, and it was for the purpose of supplying further data that the following studies were undertaken.

A lighthouse is located at the southern end of the peninsula between Little and Big Bay de Noquette. The Skaug Brothers store is located two miles north of the lighthouse, and two miles farther north is the present location, in a farm house, of the post office called Stonington. A short distance southward, an east and west section road leads down to the Farmer's Dock. Two miles farther north, at another east and west section road, is the store of J. B. Stratton, and a mile and a half farther north is another road corner, immediately south of which the shallow ditch following the road exposes the basal part of the cherty Richmond, the top of the underlying argillaceous Richmond strata being exposed a short distance farther southward. Passing



from this road corner westward across the farm lands, the following section was measured approximately, with a Locke level:

Base of cherty Richmond.

Interval, upper part consisting of argillaceous	
Richmond, lower part not exposed -----	57 ft.
Very coarsely granular limestone -----	5 ft.
Clay shale with some indurated clay layers and	
some very thin limestone layers interbedded--	21 ft.

The clay shale here mentioned contains *Bollia permarginata*, at various levels. *Clidophorus noquettensis* and *Rafinesquina alternata-varicosa* occur chiefly in the five-foot limestone section.

Three-quarters of a mile south of the Stratton store the base of the cherty Richmond is 32 feet above the level of the bay; directly west of the Stonington post office this interval is 23 feet, and at the Skaug Brothers store it is 19 feet. The dip evidently is southeastward.

The greatest thickness of the cherty Richmond known at present is 14 feet, and this is exposed directly west of Stonington post office, but the top of this part of the Richmond is not exposed here, so that its total thickness is unknown at present. Only the upper part of the underlying argillaceous Richmond was readily accessible at the time of my visit. This presented the following section at the home of Andrew Rheinholdson, three-quarters of a mile south of the Stratton store:

Cherty Richmond, cream-colored limestone----	5.5 ft.
Argillaceous Richmond, abundantly fossiliferous,	
and readily accessible. At the very base of	
the section <i>Streptelasma</i> (?) <i>divaricans</i> and	
<i>Strophomena sulcata</i> were collected, and at the	
very top <i>Dinorthis subquadrata</i> occurred.	
Thickness -----	11 ft.
Indurated clay layer, spalling off in larger	
masses, containing <i>Pholadomorpha pholadi-</i>	
<i>formis</i> and specimens related to <i>Modiolopsis</i>	
<i>concentrica</i> -----	2 ft.
Fossiliferous grey-blue argillaceous limestone	
carrying the same fauna as the overlying	
layers -----	6 ft.

Directly west of Stonington post office, the *Pholadomorpha* layer is 16 feet below the base of the cherty limestone, and only 5 feet above the bay. At no locality were the exposures below the *Pholadomorpha* layer well exposed for collecting and practically all the fossils described from the argillaceous Richmond were obtained above the level of this layer.



## DESCRIPTION OF FOSSILS.

*Streptelasma rusticum* (Billings), Fig. 1. Coralla frequently strongly curved as in the specimen figured, but in some individuals the curvature is only moderate. Occurs in the cherty Richmond and in the immediately underlying part of the more argillaceous Richmond. Small specimens of *Streptelasma* (Fig. 2) occur also 10 feet below the cherty Richmond, immediately above the *Pholadomorpha pholadiformis* zone. These specimens have a general resemblance to *Streptelasma divaricans* (Nicholson), especially such forms as occur in the upper part of the Liberty formation in various parts of Clinton county, Ohio, the attachment of the corallum being more or less lateral, frequently with somewhat radicular expansions.

*Cornulites corrugatus* (Nicholson). Specimens resembling figure 27 on plate 115 of the Palaeontology of New York, volume VII, Supplement, occur in the cherty Richmond.

*Lichenocrinus tuberculatus* Miller, Fig. 3. Specimens with the plates not as prominently convex, and therefore not presenting as tubercular an appearance as typical forms of the species, occur in the cherty Richmond. The part here figured forms the attachment disk at the basal part of the stem of a crinoid probably belonging to the *Heterocrinidae* (*Scyphocrinus* and its bulbous root *Camarocrinus*, Springer, 1917, page 11).

*Perenopora decipiens* (Rominger) and *Rhombotrypa quadrata* (Rominger) are common in the upper part of the argillaceous Richmond, within ten feet of the cherty Richmond. *Proboscina auloporoides* (Nicholson) occurs in the cherty Richmond.

The specimens of *Crania* occurring in the upper part of the argillaceous Richmond are more or less granulose, but the granules are only about a tenth of a millimeter wide and the distances between them average from one-fifth to one-fourth of a millimeter. In outline they are more or less irregular, as in *Crania scabiosa* (Hall). The diameters of one specimen are 11 and 13 millimeters respectively.

*DALMANELLA JUGOSA SUBPLICATA*, var. nov., Figs. 4, A, B, C. Specimens resembling the forms figured are common in the upper part of the argillaceous Richmond. Compared with *Dalmanella jugosa* (James), from the Waynesville formation of southern Ohio and neighboring states, they show a tendency toward low folds corresponding to the more prominent fascicular areas among the radiating striae, especially in case of the pedicel valve. The median depression of the brachial valve tends to be narrower, with the immediately adjoining low folds on each side forming a less divergent angle. The term *Dalmanella meeki* was proposed by Miller (Cincinnati Quarterly Journal of Science, 1875, page 20) for specimens described and figured by Meek (Ohio Palaeontology, vol. I, 1873) and which Meek



regarded as identical with *Dalmanella emacerata* (Hall), but which Miller, owing to his more intimate knowledge with Cincinnati fossils, recognized as distinct. The type of this species evidently is the specimen represented by figures 1 a, b, and c on plate VIII of the Ohio Paleontology. This specimen Meek describes as "of the same form as one of the typical examples." Under the heading: Locality and position, on page 111, he gives its horizon as "Cincinnati group, Cincinnati, Ohio, at an elevation of 250 feet above the Ohio; this being the typical form, like Prof. Hall's fig. 1, in the Regents' Report," the reference being to the 15th Regents' Report on the State Cabinet of Natural History of New York. The elevation mentioned is 50 feet above the top of the great range of strata in which different varieties of *Dalmanella multisecta* (Meek) are more or less common. Here it occurs in the lower part of the Fairmount member of the Maysville group, immediately above the *Strophomena planoconvexa* Hall horizon. It formerly was well exposed at this horizon at the Avondale power house, on Hunt street, and at many other localities within the limits of Cincinnati. Figure 1d, on the same plate, also from Cincinnati, is a typical specimen of *Dalmanella fairmountensis* Foerste; the same species occurs at the top of the hills on the western side of the river at Hamilton. The various specimens represented by figures 2 a-g, on the same plate, probably are representatives of the species which is so abundant in the Waynesville member of the Richmond in southern Ohio and neighboring states, and which later (Paleontologist No. 4, 1879) was described by James as *Orthis jugosa*. It evidently was the intention of Meek to describe these specimens from a higher horizon as a separate species, probably owing to the suggestions of James who supplied him with the various brachiopoda described by him from the Cincinnati localities. Before final publication, however, he evidently abandoned this idea.

Specimens (Figs. 5 A,B, C) identical with *Hebertella alveata* Foerste occur in the upper part of the argillaceous Richmond, but these specimens are associated with others in which the median depression is confined to a limited area near the beak, as in *Hebertella occidentalis* Hall.

*Dinorthis subquadrata* (Hall) occurs both in the cherty Richmond and in the immediately underlying part of the argillaceous Richmond.

Most of the specimens of *Platystrophia* occurring in the upper part of the argillaceous Richmond have an aspect somewhat similar to that of *Platystrophia clarksvillensis* Foerste (Fig. 13), from the Waynesville and Liberty members of the Richmond in southern Ohio and adjacent states, however, an occasional specimen resembling *Platystrophia acutilirata* (Conrad) (Fig. 14) from the Whitewater member of the Richmond, also occurs.



*Leptaena unicostata* (Meek and Worthen), Figs. 7 A, a, B, b. Types used for figures 11a, and 11b, on plate IV, accompanying the original description in volume III, of the Geology of Illinois, 1868. From Maquoketa strata at Savannah, Illinois. Types numbered 12017 in the Worthen collection at the University of Illinois, and examined owing to the courtesy of Prof. T. E. Savage. Figures introduced here for comparison with *Rafinesquina breviusculus*. Notice the relative flattening of the greater part of the pedicel valve, the geniculation of the anterior part of both valves, the straightening of the anterior margin and the consequent angulation of the anterior outline on both sides of this straightened part. The radiating striations, although numbering 4 or 5 in a width of one millimeter, are distinctly leptaenoid, being broad and flat and separated by very narrow interspaces.

RAFINESQUINA BREVIUSCULUS, sp. nov., Figs. 6 A, B, b, C, c, D. The size and general outline of this species is sufficiently indicated by the accompanying illustrations. Figures b and c indicate the amount of curvature, along the median line, of the exterior of the pedicel and brachial valves illustrated by figures 6 B and C. The interior of the brachial valve is thickened along the anterior margin along a narrow area crossed by vascular markings, and here the interior of the shell has a somewhat leptaenoid appearance. However, there is no geniculation such as that characteristic of the genus *Leptaena*. The curvature of the pedicel valve increases slightly toward the beak and much more rapidly toward the anterior border. The muscular area of the pedicel valve, not figured, is broad and flabellate, similar to that of other species of *Rafinesquina*, but only weakly defined. From 4 to 6 radiating striae occur in a width of one millimeter at a distance of 20 millimeters from the beak, averaging about 5 in one millimeter. The median striation often is more distinct than the remainder, but not prominent. Common in the upper part of the argillaceous Richmond. Readily distinguished from *Strophomena parvula*, in the same strata, by the convexity of the posterior parts of the pedicel valve.

RAFINESQUINA PERGIBBOSA, nov. sp., Figs. 8 A, B, C, D. Pedicel valve strongly convex, almost hemispherical in the more obese specimens, with the greatest convexity about two-fifths of the length of the shell from the beak. This strong convexity is maintained to within a short distance of the postero-lateral angles and sometimes produces an abruptly auriculate appearance here. The more prominent radiating striations occur at intervals of less than a millimeter, and the intermediate spaces are occupied by three much finer striae. The interior markings of the brachial valve are boldly defined and are well represented by the accompanying figures. Usually there is a well defined ridge parallel to the anterior prolongation of the median



elevation on each side of latter near the central part of the valve. In the upper part of the argillaceous Richmond.

*RAFINESQUINA ALTERNATA* (Emmons). Most of the specimens in the upper part of the argillaceous Richmond are nearly flat (Fig. 9) or are only moderately curved, but specimens with stronger curvature also occur. In the limestone interbedded with the shale on the lake shore, about a mile and a half north of the store of J. B. Stratton, specimens occur in which the strong radiating striae are unusually prominent, suggesting the name *RAFINESQUINA ALTERNATA VARICOSA*, var. nov. (Fig. 34). These shells are of medium curvature, the curvature being greatest about 35 millimeters from the beak.

*STROPHOMENA PARVULA*, sp. nov., Figs. 10 A-F. Numerous specimens of a small species of *Strophomena* occur in the upper parts of the argillaceous Richmond and also in the overlying cherty Richmond. These are characterized chiefly by their considerable lateral and short anterior extension. The anterior outline varies from more or less evenly rounded to subtriangular and subnasute. This species evidently belongs to the *Strophomena planumbona* group. There is nothing characteristic about the interior of either the brachial or pedicel valve. The surface striations are fine, about 5 or 6 in a width of one millimeter, interrupted at intervals by slightly more prominent striae. This species may be readily distinguished from *Rafinesquina brevisculus* by the flattening of the brachial valve toward the beak, usually accompanied by a gentle concavity, as in all species of *Strophomena*.

Specimens resembling *Strophomena huronensis* Foerste, from the equivalent of the Waynesville member of the Richmond in Manitoulin island, Ontario, occur occasionally in the upper part of the argillaceous Richmond, accompanied by occasional specimens resembling *Strophomena nutans* Meek, and much more numerous specimens of *Strophomena vetusta* (James), Figs. 12 A, B. *Strophomena neglecta* (James), Fig. 11, is fairly common at the same horizon and occurs in the overlying cherty Richmond. In *Strophomena vetusta* the radiating striae on the brachial valve are relatively coarse; those on the pedicel valve are very fine and often are crossed by fine irregular concentric wrinkles; along the hinge line both valves are wrinkled more or less perpendicularly; and the muscular area of the pedicel valve is subrhomboidal in outline. In *Strophomena neglecta* the radiating striae on both valves are fine and subequal in size, the size of the shell is larger, and the muscular area of the pedicel valve is circular and supplied with flabellate markings. In typical *Strophomena planodorsata* the flattened area occupying the posterior part of the brachial valve forms a larger part of the valve and the muscular area of the pedicel valve is relatively larger.



*Strophomena sulcata* (Verneuil) occurs 10 feet below the base of the cherty Richmond, immediately above the *Pholadomorpha pholadiformis* horizon, and also at higher horizons in the argillaceous Richmond, associated with *Dinorthis subquadrata* and *Dalmanella jugosa subplicata*.

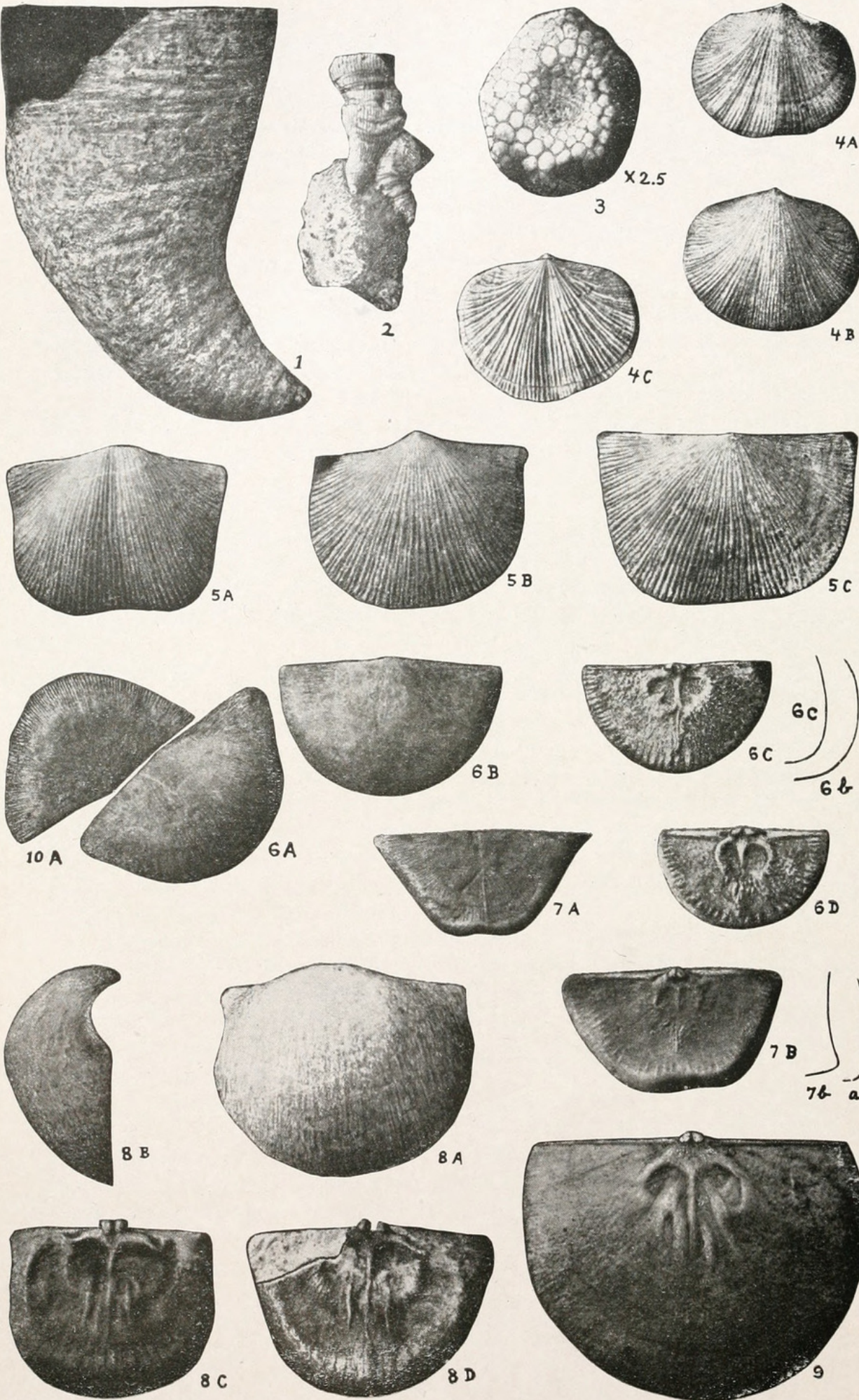
*ZYGOSPIRA RECURVIROSTRIS TURGIDA*, var. nov., Figs. 15 A, B, C, evidently is closely related to *Zygospira recurvirostris* (Hall) and *Zygospira kentuckiensis* James. In all of these forms the plications are subequal in size, the median area of the pedicel valve is not distinctly limited laterally, and the median depression of the brachial valve anteriorly is broad and relatively shallow. In the variety *turgida* the brachial valve is more convex than in either of the other two forms when specimens of the same small size are compared. The variety evidently is nothing but a Richmond representative of the Trenton species *Zygospira recurvirostris*. It occurs in the upper part of the argillaceous Richmond.

Specimens resembling *Clidophorus neglectus* Hall (Fig. 24), from the Maquoketa of Wisconsin, in outline and general appearance, occur in the cherty Richmond. A much smaller species, *CLIDOPHORUS NOQUETTENSIS*, sp. nov., Fig. 25, 3 to 4 millimeters in length, is very abundant in certain layers of limestone interbedded with the shales on the lake shore a mile and a half north of the store of J. B. Stratton. This species is referred to *Clidophorus* on account of the incision made by the clavicular ridge defining the posterior part of the anterior muscular scar, and the absence of any distinct elevation of the casts of this muscular scar in interior casts of this shell, such as occurs commonly in interior casts of typical species of *Ctenodonta*. The shell is relatively shorter than in *Clidophorus neglectus*, and is less produced anterior to the clavicular ridge; the latter is strongly defined and is either vertical or slightly inclined toward the front. In the casts of the interior the beak rises distinctly above the level of the upper margin of that part of the cast which lies anterior to the impression of the clavicular ridge. The umbonal ridge is fairly strong and is sufficiently oblique to give the shell a ctenodontoid appearance.

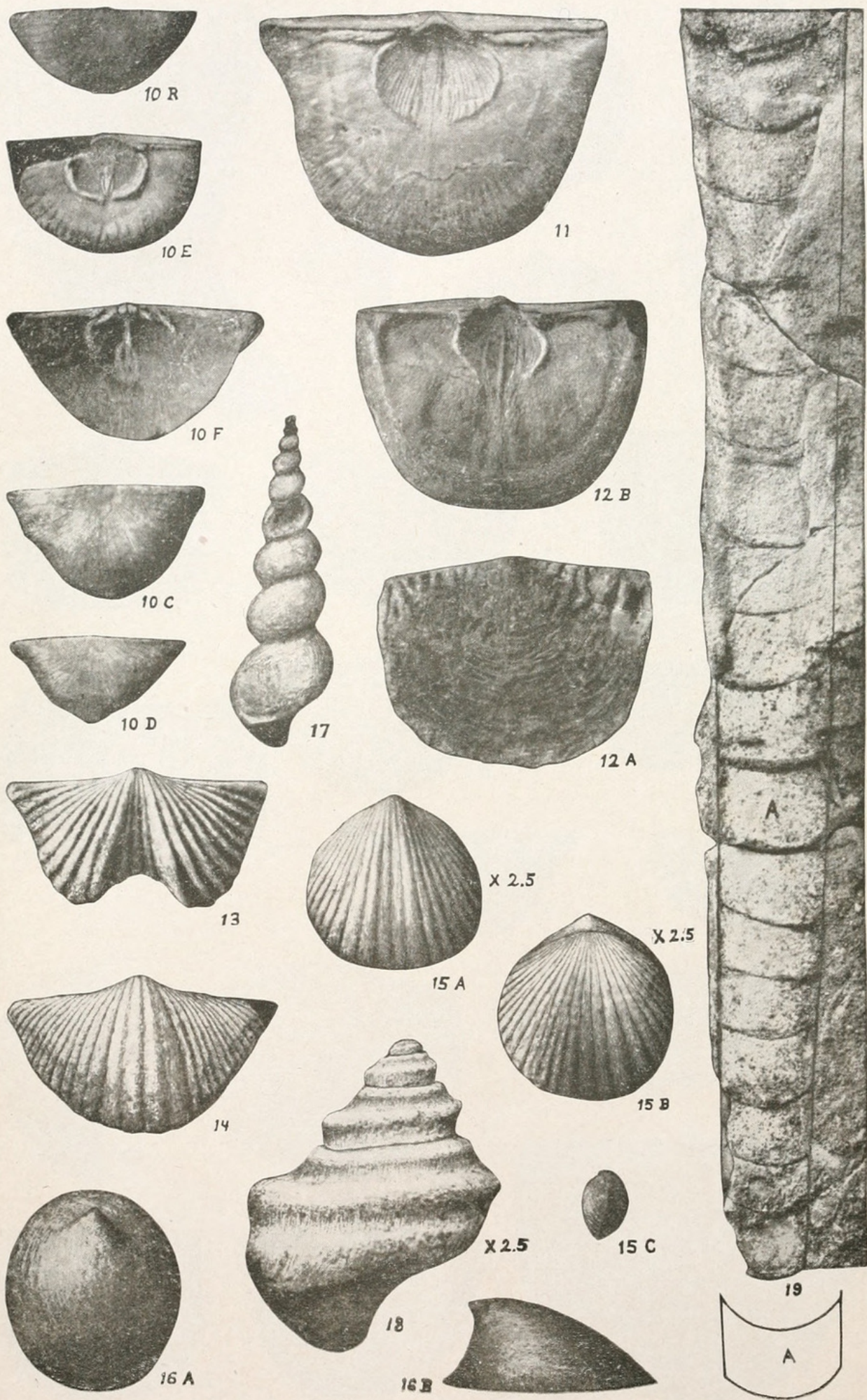
In Rominger's list of fossils from the area here discussed, along the east shore of Little Bay de Noquette (Geology of Michigan, vol. I, Part II, 1873, page 52) an undetermined species of *Cyrtodonta* is included. Specimens having a general cyrtodontoid appearance occur in the cherty Richmond, and two of these are here figured, but the hinge and teeth are not distinctly defined in the specimens collected so far and hence their generic relations are not definitely determined. One of these, Fig. 22, bears some resemblance in outline to *Cyrtodonta affinis*, Ulrich, and the other, Fig. 23, to *Cyrtodonta persimilis*, Ulrich, both of which are Black river forms occurring in the Minnesota area.

(To be continued)





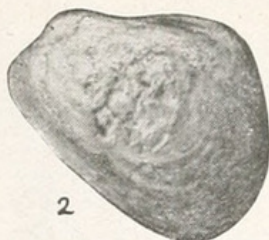




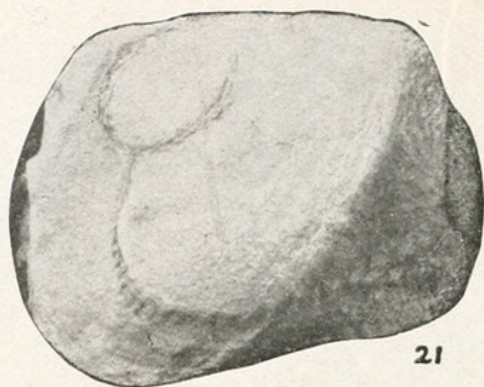




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2



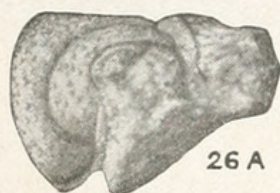
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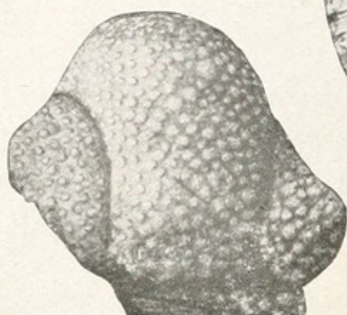
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23



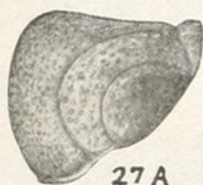
26 A



28 B X 2.5



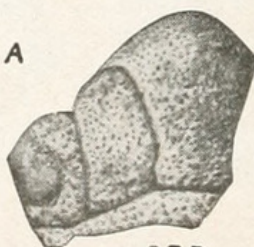
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27 A



28 A



27 B



25

X 2.5



X 23

33 C



29 X 2



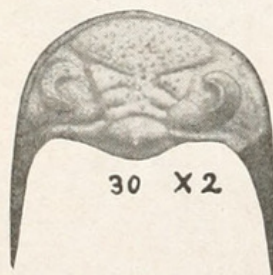
X 20

33 B



X 20

33 A

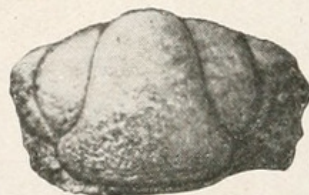


30 X 2



31 C

X 2.4

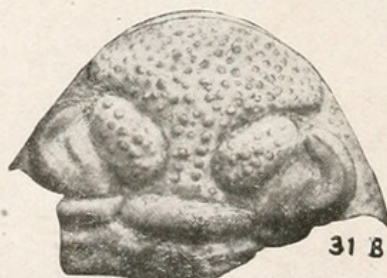


26 B



31 A

X 2.4



31 B

X 2.4

32



X 2.4





Foerste, Aug. F. 1917. "The Richmond Faunas of Little Bay de Noquette, in Northern Michigan." *The Ottawa naturalist* 31(9), 97–103.

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