

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

BY A. F. FOERSTE.

(Continued from page 103).

Pterinea (Caritodens) demissa (Conrad) is represented by specimens 50 millimeters in height, both in the cherty Richmond and in the upper part of the underlying argillaceous Richmond. At both horizons it is associated with a *Byssonychia* which is similar to the form occurring more or less abundantly in the Waynesville member of the Richmond on Manitoulin Island, in Ontario, but good specimens for figuring are rare.

The *Opisthoptera* occurring in the cherty Richmond bears a general resemblance to *Opisthoptera casei* (Meek and Worthen) but probably is a distinct species. Anteriorly, along the umbonal ridge, the shell is convex and elevated above the more posterior parts of the shell very much as in *Byssonychia*, and this appearance is strengthened here by a tendency of the radiating plications here to remain simple. Moreover, the anterior outline of the shell is concavely curved near the beak and convexly curved below, more as in *Byssonychia* than in typical *Opisthoptera casei*. Along the posterior part of the middle third of the shell, posterior to the umbonal part, the plications are arranged in fasciculate groups, while along the posterior third and also along the anterior margin the plications tend to be narrow, numerous, and subequal. This probably is a new species, but no specimens suitable for figuring have been found so far.

CLIONYCHIA ANGUSTA sp. nov., Fig. 20. This species has been figured so as to suggest a form similar to *Clionychia excavata* Ulrich (Geol. Surv. Ohio, vol. 7, 1893, pl. 51, figs. 4, 5), from the White-water member of the Richmond in Indiana. As a matter of fact, however, the specimens at hand do not show any indication of a ligamental area along the upper part of the shell when thus oriented. Compared with the Indiana species, when thus oriented, the shell is narrower and the basal part is more abruptly rounded. It occurs in the cherty Richmond, associated with specimens of *Cymatonota* resembling *Cymatonota typicalis* Ulrich but not sufficiently preserved to make their identity certain. Small modiolopsoid specimens resembling *Colpomya faba* (Emmons) also occur.

Ten feet below the base of the cherty Richmond there is an argillaceous band, 12 to 18 inches in thickness, forming a single layer, usually spalling off in larger masses than the immediately overlying or underlying strata; in this layer fossils, with the exception of certain lamellibranchiata, are few. This is the chief horizon for

Pholadomorpha pholadiformis (Hall), originally described and figured from this locality (Rept. on Geol. of Lake Superior Land District, 1851, page 213, pl. 30, figs. 1 a-c; pl. 31, fig. 1). Here it is associated with a species of *Modiolopsis* curved as in *Modiolopsis concentrica* Hall and Whitfield, but erroneously regarded by Hall as identical with *Modiolopsis modiolaris* (Conrad), from the Lorraine of New York, a form having a relatively straight hinge-line. This form from the Richmond of Little Bay de Noquette is much larger than typical *Modiolopsis concentrica* and probably represents a distinct species. It is more or less abundant in the Lorraine-like strata which form the lower part of the Richmond section in various parts of Manitoulin Island, on the southern shores of Georgian Bay, and north of the western half of Lake Ontario. Among other specimens of *Modiolopsis* found associated with *Pholadomorpha pholadiformis* occurred a specimen, apparently shortened by pressure (Fig. 21), whose affinities for the present must remain in doubt.

The species of *Archinacella* occurring in the cherty Richmond (Figs. 16, A, B), is more circular in outline and more distinctly elevated toward the beak than in *Archinacella richmondensis* Ulrich, from the Whitewater member of the Richmond in Indiana; moreover the concentric striations are rather fine and not distinctly delimited at equidistant intervals. The general appearance of the shell is smooth. Similar specimens occur in the cherty Richmond two miles southwest of Kagawong, on the road to Gore Bay, on Manitoulin Island, Ontario. The shell is regarded as a new species, *ARCHINACELLA KAGAWONGENSIS*, the specimens from Manitoulin Island forming the types.

In the same cherty Richmond, on the eastern shore of Little Bay de Noquette, occurs *Cyrtolites ornatus*, Conrad, a form of *Hormotoma gracilis* (Hall), *Lophospira bicincta* (Hall), *Helicotoma brocki*, Foerste, and a species of *Conularia*. The *Hormotoma*, Fig. 17, is a thick-shelled form, and is notable chiefly for its size. The *Lophospira*, Fig. 18, has a more angular peripheral and upper carina than the enlarged figure suggests, but there is no evidence of a trilineate peripheral band and the lower volution is distinctly convex for some distance below the lower carina. No fourth carina is present.

Helicotoma brocki, Foerste (Bull. Sci. Lab. Denison Univ., vol. 17, 1912) is common and attains a width of 18 millimeters. The only fragment of *Conularia* found evidently belongs to some fairly large species, and may be identical with *Conularia formosa*, Miller and Dyer, from the Richmond and Maysville groups of Indiana and Ohio.

A single specimen of a species of *Orthoceras* (Fig. 19) resembling *Orthoceras amplicameratum* Hall, from the Trenton of New York, in its rate of expansion and in the ratio of the distance between the septa

to the diameter of the shell, was found loose, about a mile north of the light house at the southern end of the peninsula. Its horizon appears to have been the cherty Richmond. It differs from the Trenton species named in having the septa relatively even more distant, the ratio mentioned above varying from 5 to 8 in 10. The siphuncle apparently was narrow and cylindrical, probably not exceeding a millimeter and a half in diameter where the width of the shell is 15 millimeters.

A species of *Amphilichas* and one of *Chasmops* occur in the cherty Richmond. The fragment of the first (Figs. 27, A, B), as far as preserved, cannot be distinguished from the type of *Amphilichas cucullus* (Meek and Worthen), described from the Kimmswick limestone, in Alexander county, Illinois, (Geo. Surv. Illinois, vol. III, 1868, pl. 1, figs. 6 a, b, c). This type is numbered 12021 in the Worthen collection in the University of Illinois, and was examined through the courtesy of Prof. T. E. Savage. The axial and lateral lobes of the glabella, the occipital segment, and as much of the fixed cheeks as remains, present the same appearance in the Richmond specimen and in the Kimmswick type from all points of view. Although at first sight the Richmond specimen appears to be much more abundantly tuberculated, a close examination of the Kimmswick type indicates the presence of similar tubercles or granules, but those of the Richmond specimen are much more prominent, at least in their present state of preservation. Two figures of the Kimmswick type (Figs. 26 A, B) are here presented. The first presents the left side of the type of the cephalon, and the second illustrates the anterior, so placed as to have the top of the axial lobe parallel with the line of vision.

The associated specimen of *Chasmops*, mentioned above, consists of a fragment presenting the middle and lateral lobes of the glabella and the occipital segment. This is sufficient to indicate the generic reference. In the illustration here presented (Fig. 32), a faint outline of the probable course of the movable cheeks and genal spines is presented, but this part is not preserved in the specimen at hand. For purposes of comparison, several illustrations of *Chasmops breviceps* (Hall) Figs. 31 A, B, C, from the upper part of the Richmond, at Richmond, Indiana, are here presented. The original specimens were collected hereby Mr. John Misener. The only specimens collected by myself were obtained near the top of the Liberty member of the Richmond, along Cowen creek, in Clinton county, Ohio. Here they were associated with *Xenocrinus baeri* (Meek), *Gyroceras baeri* (Meek and Worthen), *Gomphoceras eos* Hall and Whitfield, *Ceraurus miseneri* Foerste, typical pygidia of *Amphilichas harrisi* (Miller), accompanied by a fragment of a glabella (Figs. 28 A, B) bearing the same kind of pustulose ornamentation as the aforesaid pygidia. In this fragment, the strong downward curvature of the anterior part of the

cephalon suggests a form more or less similar to that of *Amphilichas*. However, this fragment of a glabella was not actually found attached to any specimen which could be identified confidently as *Amphilichas harrisi*.

The species originally described by S. A. Miller (Jour. Cincinnati Soc. Nat. Hist., vol. I, 1878, p. 106, pl. 3, fig. 9) as *Lichas harrisi* is a typical *Amphilichas*, a genus characterized by a pygidium in which the axial lobe anteriorly is marked by two transverse rings, while posteriorly it terminates in a point; there are three pairs of pleural segments with free ends. The lateral lobes of the glabella not only reach the neck furrow but are extended along the latter for some distance. *Lichas halli*, Foerste, and the pygidium recently figured by the writer from the Richmond formation at Richmond, Indiana (Jour. Cincinnati Soc. Nat. Hist., vol. 22, No. 2, 1917, page 43, pl. 1, fig. 2) evidently belongs to another genus, possibly *Arctinurus*.

The specimens of *Calymene* occurring in the cherty Richmond are not sufficiently well preserved to be referred to any definite species, although fragments are not uncommon.

Two figures of cephalons of trilobites are here presented in the hope that they may prove of interest, although not belonging to the fauna here under discussion. They serve at least to fill spaces which otherwise would have been left vacant on the plate. *Synhomalonotus christyi* (Hall), Fig. 29, from the upper part of the Waynesville member of the Richmond, is represented by a slightly crushed cephalon. *Pterygometopus carleyi* (Meek), Fig. 30, is represented by an entire enrolled specimen, lacking only the genal spines; but only the cephalon and the outline of the axial part of the first segment of the thorax is here presented. It was obtained in the Fairmount member of the Maysville group, at Cincinnati, Ohio.

BOLLIA PERMARGINATA, sp. nov., Figs. 33 A, B, C. Carapace only three-fourths of a millimeter in length, closely resembling the specimen from the Arnheim member of the Richmond identified by Ulrich and Bassler (New American Paleozoic Ostracoda, Proc. U.S. Nat. Mus., 1908, p. 288, fig. 13) as *Bollia regularis* (Emmons). It differs chiefly in the prominence and continuity of the ventral part of the marginal ridge. The two middle ridges are slightly more elevated than the anterior and posterior branches of the marginal ridge, and are connected at the base so as to produce a more or less U-shaped aspect. They vary from vertical to slightly divergent, with the basal part inclining slightly toward the rear, especially in case of the anterior one of this pair. The anterior branch of the marginal ridge tends to be vertical, and as far separated from the anterior one of the middle pair as the latter are separated from each other. It is located at a distinct interval from the anterior margin of the carapace. The posterior branch of the marginal ridge, however, is marginal, and tends

to be narrower than the other vertical ridges. A very narrow border, Fig. 33 C, extends around the entire carapace, excepting, of course, along the dorsal line. All four vertical ridges are abruptly elevated to a height varying from one-tenth to one-eighth of a millimeter. Very abundant in thin limestone layers, about half a centimeter in thickness, interbedded in the shales, and in much smaller numbers in the shales themselves, about a mile and a half north of the store of J. B. Stratton, along the lake shore.

FAUNAL CORRELATIONS.

Lithologically, the cherty, light-brown or light-blue Richmond limestone, forming the upper part of the section along the eastern shore of Little Bay de Noquette, resembles the cherty Richmond exposed one and a half miles southwest of Kagawong, on the road to Gore Bay, on Manitoulin island. *Archinacella kagawongensis* is common to both localities, but no conclusions can be based upon this species alone. Among the more significant fossils found in the cherty Richmond of the Michigan locality are *Lichenocrinus tuberculatus* and *Dinorthis subquadrata*; the first is known only from the Whitewater member of the Richmond in the typical Cincinnati areas, while *Dinorthis subquadrata* occurs both in the Liberty and Whitewater members. *Chasmops breviceps* is known by me only from the Liberty member, although listed by Bassler also from the Waynesville. If *Clionychia angusta* is closely related to *Clionychia excavata*, then the occurrence of the latter in the Whitewater member should be noted. Apparently this cherty Richmond limestone may be correlated provisionally with the post-Waynesville portion of the typical Richmond section. *Helicotoma brocki* has been known hitherto only from the lower, or Waynesville member of the Richmond section on Manitoulin island. *Strophomena neglecta* is known chiefly from the upper third of the Waynesville member, although characteristic specimens occur occasionally in the Whitewater member, especially in the vicinity of Richmond, Indiana. The presence of *Amphilichas cucullus* is merely another instance of the occurrence in the Richmond, with very little change, of a characteristic Trenton species. It is very evident that, while the Cynthiana, Eden, and Maysville invasions were taking place in the states bordering on the Ohio river, a large part of the Trenton fauna was able to maintain itself in some other area, as yet unrecognized, and from this area it was able to make a second incursion into the area surrounding Cincinnati. Something similar appears to have taken place in case of the Kimmswick limestone and the upper Richmond in northern Michigan.

The more significant fossils in the argillaceous Richmond limestones on the eastern shore of Little Bay de Noquette include *Hebertella alveata* and *Platystrophia acutilirata*, from the Liberty and

Whitewater members of the typical Richmond, and *Strophomena neglecta*, *Strophomena sulcata*, and *Strophomena vetusta*, which range from the upper third of the Waynesville member into the Liberty and Whitewater members. In Ohio, *Dalmanella jugosa* is most abundant in the Waynesville member. *Platystrophia clarksvillensis* occurs both in the Waynesville and Liberty members. These fossils may represent a late stage of the Waynesville fauna or an early stage of the post-Waynesville portion of the typical Richmond.

The underlying *Pholadomorpha pholadiformis* horizon is regarded as a part of the Richmond section.

The shale section along the shore of the bay, a mile and a half north of the J. B. Stratton store, lithologically resembles the Shegundah clay shales of Manitoulin island, but not a single fossil has been found which would warrant such a correlation. The nearest relative of *Bollia permarginata* appears to be *Bollia regularis*, from the basal or Arnheim member of the Richmond. Considering the inadequacy of the small fauna collected it is not worth while to discuss the possibility of this Michigan shale corresponding to the Maquoketa shale of more western states. It may not belong to the Richmond at all. For the present, at least, its correlation must remain in doubt.

PLATE IV.

- Fig. 1. *Streptelasma rusticum*.
- Fig. 2. *Streptelasma* cf. *divaricans*.
- Fig. 3. *Lichenocrinus tuberculatus*, magnified.
- Fig. 4. *Dalmanella jugosa subplicata*. A, B, brachial valves; C, pedicel valve.
- Fig. 5. *Hebertella alveata*. A, brachial valve; B, C, pedicel valves.
- Fig. 6. *Rafinesquina brevisculus*. A, B, pedicel valves, on the same slab with 10A; C, D, interiors of brachial valves; b, c, outlines of the corresponding valves.
- Fig. 7. *Leptaena unicastata*. Type. A, pedicel valve; B, interior of brachial valve; a, b, outlines of the corresponding valves. *Maquoketa strata*, Savannah, Illinois.
- Fig. 8. *Rafinesquina pergibbosa*. A, B, pedicel valve and lateral view of the latter; C, D, interiors of brachial valves.
- Fig. 9. *Rafinesquina alternata*. Interior of brachial valve.
- Fig. 10. *Strophomena parvula*. A, brachial valve.

PLATE V.

- Fig. 10. *Strophomena parvula*. B, C, D, brachial valves; E, interior of pedicel valve; F, interior of brachial valve.
- Fig. 11. *Strophomena neglecta*. Interior of pedicel valve.
- Fig. 12. *Strophomena vetusta*. A, pedicel valve; B, interior of pedicel valve.
- Fig. 13. *Platystrophia clarksvillensis*. Pedicel valve.
- Fig. 14. *Platystrophia acutilirata*. Brachial valve.
- Fig. 15. *Zygospira recurvirostris turgida*. A, pedicel valve; B, brachial valve; both enlarged; C, lateral view, with brachial valve on left side.
- Fig. 16. *Archinacella kagawongensis*; not the type. A, viewed from above; B, lateral view.
- Fig. 17. *Hormotoma gracilis*, var.
- Fig. 18. *Lophospira bicincta*.
- Fig. 19. *Orthoceras* sp. Curvature of septa limiting chamber A shown separately.

PLATE VI.

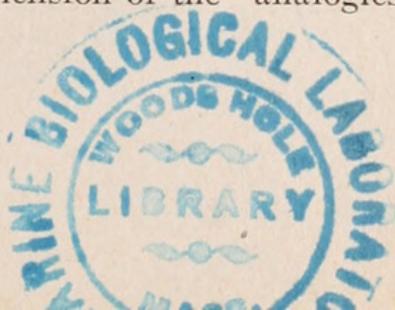
- Fig. 20. *Clionychia angusta*.
 Fig. 21. *Modiolopsis* sp. Shortened by pressure.
 Fig. 22. *Cyrtodonta* cf. *affinis*.
 Fig. 23. *Cyrtodonta* cf. *persimilis*.
 Fig. 24. *Clidophorus neglectus*.
 Fig. 25. *Clidophorus noquettensis*, enlarged.
 Fig. 26. *Amphilichas cucullus*. Type; A, left side of cephalon; B, anterior view; from Kimmswick limestone, in Alexander County, Illinois.
 Fig. 27. *Amphilichas cucullus*. A, left side of cephalon; B, viewed from above; from Richmond section on east side of Little Bay de Noquette.
 Fig. 28. *Amphilichas* sp. A, left side of glabella; B, viewed from above, magnified; from near top of Liberty member of Richmond, Clinton county, Ohio.
 Fig. 29. *Synhomalonotus christyi*, magnified; Waynesville member of Richmond, at Oxford, Ohio.
 Fig. 30. *Pterygometopus carleyi*, magnified; Fairmount member of Maysville, at Cincinnati, Ohio.
 Fig. 31. *Chasmops breviceps*, magnified. A, cephalon of enrolled specimen; B, imperfect cephalon; C, pygidium of enrolled specimen. From Liberty member of Richmond, at Richmond, Indiana.
 Fig. 32. *Chasmops* sp. middle part of cephalon, with indications of missing parts. From Richmond strata on east side of Little Bay de Noquette.
 Fig. 33. *Bollia permarginata*, magnified. A, left valve; B, right valve; C, posterior view of left valve.

BOOK NOTICE.

OUTLINES OF COMPARATIVE ANATOMY OF VERTEBRATES. By J. S. Kingsley, Professor of Zoology in the University of Illinois, Philadelphia, P. Blakiston's Sons & Co. Second Edition, Revised, 1917; pp. 449; price \$2.50.

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It has been the author's endeavour not to treat of anatomical facts only in so far as they affect isolated representatives of several classes, but to correlate and compare these facts with each other and with the conditions in other animals. Thus a more intelligent representation of the subject is made, answering the needs and satisfying the conceptions of modern science. To the zoologist who must necessarily found his knowledge on the dissection of types, Professor Kingsley's book will supply a deeper comprehension of the "analogies and homologies" of vertebrate structure.





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