ART. VIII. NEW SPECIES OF ECHINOCARIS FROM THE UPPER DEVONIAN, OF ALFRED STATION, NEW YORK.

By E. R. Eller.

INTRODUCTION

The species of *Echinocaris* described in this paper form part of a large and diversified fauna found in a layer of Upper Devonian shale, "Chemung" age, at Alfred Station, New York. The fauna, as far as has been determined, includes a doubtful species of foraminifera, sponges, starfish, two species of worms, bryozoa, seventeen species of brachiopods including possibly two that are new, thirty-two species of pelecypods with new species, five species of gastropods, and three of cephalopods. Fragments of plants, and scales and spines of fish, are scattered through the shale. The most interesting groups are probably the crinoids and the crustaceans. Besides three new crinoids, a colony of over a hundred *Anamesocrinus lutheri* Goldring was uncovered. In addition to the *Echinocaris* among the crustaceans, the fauna contains *Cardiocaris*, *Spathiocaris*, four new species of ostracods, and a ramus of *Pterygotus*.

The shale in which the fossils are found is about five feet thick, very fine grained, and was probably deposited in quiet and fairly deep water. Above this shale is a barren, silicious shale about forty feet thick. This was formerly used by ceramic plants that were located near by. The name Alfred Shale is proposed here for the shale facies with its large and unique fossil assemblage as well as for the thicker, silicious shale lentile above. This Alfred Shale is overlaid by a layer of heavy, calcareous sandstone about six feet thick. The sandstone breaks off in large pieces which fall to the base of the outcrop. The blocks are very conspicuous and are found for about an eighth of a mile along the banks of the two creeks that meet at Alfred Station. The shale formerly used by the ceramic plants was mined one mile farther up the creek toward the village of Alfred.

The stratigraphy of western New York has been recently revised by Dr. George H. Chadwick. The heavy, calcareous sandstone layer at

ed May 29, 1935.

Alfred Station is considered by Dr. Chadwick* to be the top of the Rushford Sandstone of the Canadaway Group. Search was made at the outcrops where the sandstone and shale should have been found, but all attempts to trace these beds there have been without success. Possibly these rocks have changed in their lithological and paleontological character, or, are only lentiles so common in the Upper Devonian of New York which have not wide distribution.

The location of the fauna is limited to about six inches of the lower, fine grained shale. Collecting was done in the creek bed in an area about fifty feet long and three feet wide. While most of the fossils are found as casts, they are in a very fine state of preservation and many minute details are discernible. Only a few specimens of *Echinocaris* have been found during the collecting extending over several years. Only two were found with the abdomen attached to the carapace. Most of the specimens are a single valve or a carapace in which the valves are partly broken.

The writer feels greatly indebted to Dr. I. P. Tolmachoff of the Section of Invertebrate Paleontology of the Carnegie Museum for his kind help and criticism in connection with this paper.

DISCUSSION

The valves (cephalothorax) of the *Echinocaris*, as a rule, are obliquely subovate with a straight hinge-line. The abdomen is composed of six segments which taper to a caudal plate (telson) that ends in three spines. The appendages, with the exception of the mandibles, were apparently small and delicate, possibly similar to those of ostracods. None of them have been preserved. The chitinous-like carapace is thin except at the margins where it is considerably thickened. The species of *Echinocaris* could not completely close their valves since the posterior half of the body extended out of the carapace.

The carapace bears round or oval nodes often with a tubercle on the top. Small, round tubercles may or may not be found on the surface of the valves and nodes. The surface is also often smooth or it may be partly or completely covered with large or minute pits. An examination of a broken test shows that the tubercles are external ornamentation; for when the tegament is peeled off or split, they are seen not to extend through the shell. The internal side is sculptured

*Personal communication.

as well, but the sculpture does not correspond to that of the external side.

The number of segments in the body of *Echinocaris* is not known exactly. If we accept the number of twenty-one segments as most common in the crustacea with the abdomen with the caudal plate as seven segments, then, for the cephalothorax will remain fourteen segments. According to Milne-Edwards, if a full-grown crustacean possessed less than twenty-one segments it would depend on the absence of a certain number of the most posterior rings of the body. Usually it is more or less possible to determine the number of segments from the number of corresponding paired appendages, but this is not possible in our *Echinocaris* since only the mandible appendages have been found.

In the family *Echinocaridae* several genera related more closely to the genus *Echinocaris* have typical nodes on their carapace. *Echinocaris* has often two rows of nodes of three nodes each. The rows are more or less parallel to the hinge-line. *Aristozoe*, a predecessor of *Echinocaris*, has two rows of nodes of two and three nodes each, located anteriorly and rather close to the hinge-line. The number of nodes seems to increase as the group becomes older. Although several nodes could be fused in one large swelling, even in this case the original nodes could be traced. The number and position of the nodes could reflect the original segmentation of the cephalothorax. Some of the nodes could correspond to muscular attachment, and some may be considered eye nodes.

The eye node was indicated by some authors for different species of *Echinocaris*. Beecher found on *E. punctata* Hall, near the middle and just anterior of the limiting or nuchal furrow which in Beecher's opinion separates cephalic and thorax parts of a cephalothorax, a strong, abruptly elevated node carrying the optic spot, which is usually marked by a slight depression on the summit. On *E. sociales* Beecher he found the node situated on the lower side of the largest node and adjacent to the nuchal furrow. In the part of Beecher's report on the *Ceratiocaridae* of the Chemung Group, dealing with the terminology, he says that this tubercle (called node in this paper) is a constant feature which must have a special significance. Under the microscope he observed a sub-circular depression near the summit of the node. In the specimens of *Elymocaris seliqua* Beecher, *Tropidocaris bicarinata* Beecher, and *T. interrupta* Beecher, this depression was

well marked. He did not mention, however, anything about an optic spot in *Echinocaris*. In Hall's monograph on the group, in which he redescribed each species, the following remarks were made in regard to the eye node:

In *E. punctata* Hall a small node near the nuchal furrow is usually slightly depressed at the top and occupies the position of the optic spot or eye. No mention of an eye node was made by Hall in his first description of this species; *E. Whitfieldi* Clarke — "Close upon the hinge are two small tubercles, the posterior of which represents probably the eye node." (Clarke in his description did not define an eye node); *E. condylepis* Hall — "The posterior ventral tubercle holds the position of the optic node of *E. punctata* Hall"; *E. socialis* Beecher —No mention of an eye node; *E. sublaevis* Whitfield — "but it is impossible to determine which of them has served as the optic node"; *E. pustulosa* Whitfield — No mention of an eye node; *E. multinodosa* Whitfield — "The optic spot cannot be satisfactorily located."

In creating his new genus *Echinocaris*, Whitfield neither mentioned an eye node nor described an optic node in any of his new species of *Echinocaris*.

All the nodes in the specimens described by the author in this paper, especially those considered by various authorities to be optic, were examined under high-power magnification and no optic pit or anything of an ocular nature could be discovered on the tops of the nodes with their tubercle which are in an excellent state of preservation. It seems that if there was an evidence of an optic spot it would be observed in these specimens. In *E. turgida* m., fig. 5, the node adjacent to the lateral carina appears to be pitted, but this is probably caused by the breaking off of one of the tubercles. The so-called optic node of *E. turgida* m., fig. 6, bears three tubercles.

Whitfield compared *Echinocaris* with *Aristozoe canadensis* Whitfield of Silurian age which is very similar to *Echinocaris* in outline and like the latter has a large tubercle in the antero-dorsal angle which Whitfield suggested to be an ocular. In Beecher's opinion the node bearing the eye tubercle and its optic spot is located in *Echinocaris* on the posterial ventral margin of the cephalic region. The latter position of the eye spot does not seem natural to the writer. In other groups of the *Phyllocarida* the eyes are located in the anterior section of the cephalothorax as is characteristic for the arthropoda in general.

In addition to the eye node, Beecher attempted to find out the relation of other nodes to the appendages. The large cephalic node was considered to correspond to the mandibles; the anterior dorsal one corresponds to the first antennal, while the small one just behind the latter would be the second antennal segment. The somewhat larger node next to the nuchal furrow indicates the position of the two maxillae.

Beecher describes a furrow on the valves of the carapace which he says begins a little anterior to the middle of the hinge-line, curving outward and extending to a point on the lower anterior margin. He was of the opinion that this furrow divided the cephalic and thoracic regions. Hall, in his second work on the group, in which he redescribes all of the known species including Beecher's and his own, called this groove the *nuchal furrow* and defines and considers it in the same light as Beecher. Whitfield, in his first descriptions published in 1880 without plates and later re-published in 1890 with plates, did not mention anything as to the nuchal furrow. He said that "the surface of each valve is divided into three slightly elevated areas, with depressed sulci between; an anterior, a central, and a posterior one." Beecher and Hall in their papers published in the intervening time, both described this furrow. In the Alfred material described in this paper no distinct furrow could be detected corresponding to that described by Beecher and Hall, especially in the antero-ventral area, but it is possible to suggest furrows extending in several directions. The most marked and constant one extends from the antero-dorsal margin between the first and second marginal nodes to a point a little anterior of the middle of the lateral carina or keel at which it ends. This furrow is better seen on left valves, figs. 1, 3, 6, 7, when light is directed from the upper left-hand corner. It was not until several drawings were made that the persistency of this furrow was noticed. These furrows between the nodes are in no way abrupt or definite in structure but are merely smooth grooves. The more developed the nodes, the more noticeable are the furrows. Figure 2, of a large and smooth specimen, shows the low nodes distributed with more space between them than usual. Accordingly, the furrows between the nodes are very indistinct. It is the opinion of the writer that there is no satisfactory evidence of a furrow separating the cephalic and thoracic regions of the carapace in the *Echinocaris*.

DESCRIPTION OF SPECIES

Genus ECHINOCARIS Whitfield, 1880

Echinocaris consanguina sp. nov.

(Plate III, figs. 1-4)

The valves are obliquely sub-ovate, the greatest width being anteriorly or at the center, with the length related to the width as 3 to 2. The hinge-line is straight and is about one-half as long as the carapace. The anterior margin curves gently from the deep set hinge-line, thus forming a broad and deep angle between the valves when they are spread in the same plane. The ventral margin is broadly rounded to the sharply curved posterior extremity, which continues nearly straight to the hinge-line. The margin is thick, elevated, and becomes considerably thickened at the anterior ventral extremity.

On the ventral area is a small but conspicuous ridge or carina which begins anteriorly and continues in a sigmoid curve to the posterior ventral area.

Parallel to the dorsal margin in the anterior half of the valve are two rows of nodes of three each. In the first row the small anterior node is followed by a large triangular one. The third node is large and transversally oval. In the second row the most anterior large and flattened node is followed by a small but prominent one. The third node is oval, with the greatest length parallel to the curve of the carina to which this node is very close.

Each node bears a small but prominent tubercle. Sometimes there is more than one and in this case the tubercles are usually smaller. The posterior dorsal area which is somewhat swollen is often covered with many round tubercles. The surface of the carapace is smooth except the specimen shown in fig. 2 in which the ventral area is pitted.

All four specimens, figs. 1-4, vary to some degree from each other; but in outline, size, and general characters, they must be considered as belonging to the same species. *E. consanguina* m. resembles closely *E. punctata* Hall and *E. condylepis* Hall but is distinguished from both of them by the proportions of the various parts. Hall, in his descriptions, calls *E. condylepis* Hall a miniature of *E. punctata* Hall. He

observed that the general abbreviation of all dimensions was a persistent character and would serve to distinguish the two species. *E. consanguina* m. is larger than *E. condylepis* Hall but smaller than *E. punctata* Hall and in general outline is more oblique. The hinge-line is shorter and is more symmetrically located to both ends of the valve than in *E. punctata* Hall and *E. condylepis* Hall. In connection with these characters the anterior end extends well beyond the hinge-line and thus forms a much deeper angle between the valves than in Hall's species.

The lateral carina is short and similar to that in *E. condylepis* Hall and is not as long as in *E. punctata* Hall. There is no evidence of a nuchal furrow as defined by Beecher and Hall. The nodes adjacent to the carina in Hall's figures of *E. punctata* Hall and *E. condylepis* Hall do not show a tubercle. In *E. consanguina* m. this node was found always bearing a tubercle and in some specimens more than one.

Echinocaris turgida sp. nov.

(Plate III, figs. 5, 6.)

The outline of the valves is ovate, widest at the posterior end of the hinge-line, length to width as 4 to 3. The hinge-line is a little less than one-half the length of the carapace. The anterior margin curves gently from the hinge-line. The ventral margin is slightly curved, almost straight. Posterior margin is broadly rounded. The dorsal margin is slightly incurved. The margins are thickened. In one specimen a subrhomic mandible, without cusps, protrudes in front of the carapace.

The carina is long, beginning in the anterior area of the carapace and extending well toward the posterior margin. It has the form of a well defined sigmoid curve, often angular, and is surmounted with elongated tubercles. The typically situated nodes are irregularly round, oval, and triangular in shape. The most anterior node is the largest and is divided by sulci which extend from the ventral side into the node about half way. Each node bears from three up to a score or more of small but prominent tubercles.

The surface is covered with rather large pits. A swollen posterior area between the dorsal line and the carina is covered with round tubercles.

Both specimens, figs. 5 and 6, are similar in outline, ornamentation, and number of nodes, but the distribution of the latter is somewhat different. In fig. 5 the node in the anterior dorsal angle is round, while in fig. 6 the corresponding round rather obscure node appears to be a part on an elongated and well defined node. Anterior to this node on fig. 5 is seen a small and indistinct node not heretofore noticed in *Echinocaris*. The central marginal node on fig. 5 is oval with its longest axis forming an angle of about 45 degrees with the hinge-line. In fig. 6 this second marginal node has the shape of an equilateral triangle, the base of which is parallel and close to the hinge-line. Some of the tubercles on this node are elongated. The third node in both specimens is oval with the longest axis perpendicular to the hinge-line.

The three nodes of the second row are in general similar in both specimens. The large anterior one is different, however, from any one so far observed in the *Echinocaris*. It is similar in size to *E. socialis* Beecher and *E. sublaevis* Whitfield but differs from both of them, having been divided by grooves or sulci. In fig. 5 this node is rounded and well defined ventrally, but becomes obsolete toward the dorsal region. A number of sulci extend from the central part toward the ventral side of the node. The same node in fig. 6 is more angular and the sulci are parallel to each other. The upper section of this node is covered with very minute tubercles. The large tubercles characteristic for this node are more numerous in the specimen of fig. 5 and extend in rows parallel to the sulci.

Echinocaris turgida m. can be compared with *E. punctata* Hall and *E. condylepis* Hall as to the general outline and perhaps the distribution of the nodes. It is more broadly ovate than both these species. In the same way *E. turgida* m. is different from *E. consanguina* m. *E. punctata* Hall is much larger than *E. turgida* m. *E. condylepis* Hall and *E. consanguina* m. are both smaller than *E. turgida* m. The carina of *E. turgida* m. is similar to that of *E. punctata* Hall but is much more angular. Taking into consideration the stratigraphical position of *E. turgida* m. and the Hamilton *E. punctata* Hall, it is possible to think that the former species is a direct descendant of the latter. On the other hand, *E. turgida* m. may be only an old age individual of *E. condylepis* Hall or *E. consanguina* m.

Echinocaris auricula sp. nov.

(Plate III, fig. 7)

This species is represented by a well preserved left valve. It is obliquely sub-ovate in form, broadly rounded posteriorly and subtruncate anteriorly. The relation of the length to the width is 3 to 2. The length of the carapace is 10.5 mm., the width 6.8 mm., and the hinge-line 5 mm. The hinge-line, located anteriorly, is shorter than half of the width of the valve.

The anterior margin curves abruptly from the hinge-line and continues in nearly a straight line to the gently curved ventral margin. The anterior margin bears three tubercles. The posterior margin is regularly rounded. The posterior-dorsal part of the valve is slightly concave and extends in the form of a small wing. Six tubercles are widely but uniformly distributed on the posterior and dorsal margins.

The carina in the ventral area is long and curved only slightly. About one-half the distance between this carina and the hinge-line is present another short, curved carina bearing a row of elongated tubercles. Between the latter carina and the hinge-line there is a third, short carina connected with the posterior margin. It bears also one tubercle.

The three nodes along the hinge-line are from round to oval in outline. They increase in size from the smaller anterior to the very large posterior node. The three nodes of the second row are from round to oval in shape, the anterior one is rather large and flattened, the second small and acute, and the third large and oval. All six nodes bear each a single, round, acute tubercle.

Between both anterior nodes and slightly in front of them is located a large, round, shallow pit. There are also two similar pits on the anterior node of the second row. The surface of the carapace is finely pitted, especially in the ventral region.

The general outline of this species differs from other *Echinocaris* in the shape of its anterior margin and the wing-like extension of the posterior-dorsal margin. Peculiar to this species is also the presence of three carinae. The number and distribution of the nodes is similar to that of *E. punctata* Hall, *E. condylepis* Hall, *E. consanguina* m., and *E. turgida* m. Two large carinae and the tubercles along the margins remind one of *E. socialis* Beecher.

BIBLIOGRAPHY

BARRANDE, J.
1872. Systeme Silurien du centre de la Boheme, I. Suppl.

BEECHER, C. E.
1884. Second Geol. Surv. Pa., Report of Progress PPP, pp. 1-13, pl. I.
1902. Quart. Journ. Geol. Soc. London, Vol. 58, pp. 441-449, pls. 17-19.

CALMAN, W. T.
1909. Treatise on Zoology, ed. by Sir Ray Lankester, pt. 7, 3d fascicle.

CLARKE, J. M.
1885. Bull. U. S. G. S. No. 16, pp. 44, 45, pl. 2, figs. 3, 4.
1893. Amer. Nat., Vol. 27, pp. 793-801.
1897. 15th Ann. Rept. N. Y. State Geol., pp. 731-738.

CLARKE, J. M. AND RUEDEMANN, R.
1912. N. Y. State Mus., Mem. No. 14.

DANA, J. D.
1856. Amer. Journ. Sci., 2d Ser., Vol. 22, No. 64, pp. 1-17.

ETHERIDGE, R., WOODWARD, H., AND JONES, T. R.
1883. First Rept. Comm. Foss. Phyllopoda Pal. Rocks, p. 3.
1885. Third Rept. Comm. Foss. Phyllopoda Pal. Rocks, pp. 34-35.
1888. Sixth Rept. Comm. Foss. Phyllopoda Pal. Rocks, p. 8.

GRABAU AND SHIMER
1910. N. A. Index Fossils, pp. 376-378.

GUERICH, G.
1929. Mitteilungen aus dem Mineralogisch-Geologischen Staatsinstitut in Hamburg, Heft. II, pp. 21-90.

HALL, J.
1863. 16th Ann. Rept., N. Y. State Cab. Nat. Hist., pp. 72, 74, pl. 1.
1876. Illustrations of Dev. Fossils, pl. 23.

HALL, J. AND CLARKE, J.
1888. Paleont. of N. Y., Vol. 7, pp. 166-181, pls. 28-30.

JONES, T. R. AND WOODWARD, H.
1884. Geol. Mag., Vol. I, No. 9, pp. 393-396, pl. 13.
1888-1899. British Paleozoic Phyllopoda, Paleont. Soc. London, pp. 1-211, pls. 1-31.
1889. Geol. Mag., Decade 3, Vol. 6, No. 303, pp. 385-386, pl. 11, figs. 1, 2.

NOVAH, M. O.
1885. Sitzungsber. k. boehm, Gesellsch. Wiss.

PACKARD, A. S.
1882. Amer. Nat., Vol. 16, pp. 952-953, Figs. 10-12.
1883. 12th Rept. U. S. G. S. Territories, pp. 451, 452, figs. 70, 71a, 71b.

RICHTER, RUD. AND E.
1918. Jahrbucher des Nassauischen Vereins fur Naturkunde, Jahrgang 70, pp. 151-153, fig. 4.

VOGDES, A. W.
1889. Ann. N. Y. Acad. Sci., Vol. 5, No. 1, pp. 16-18.
1890. Bull., U. S. G. S., No. 63, pp. 164-165.

WHIDBORNE, G. F.
1896. Monograph Dev. Fauna, Paleon. Soc. London, Vol. 3, pt. I, pp. 6, 7, Pl. 1, fig. 3.

WHITFIELD, R. P.
1880. Amer. Jour. Sci., 3d ser., Vol. 19, No. 109, pp. 33-42.
1890. Ann. N. Y. Acad. Sci., Vol. 5, pp. 562-572, pl. 12, figs. 12-18.

WOODWARD, H.
1866-1878. Monograph British Fossil Crustacea, Paleon. Soc. London.

ZITTEL, K. A.
1913. Text-book of Paleontology, ed. by Eastman, p. 751.

EXPLANATION OF PLATE III

Figures magnified 3 times.

FIGS. 1–4. *Echinocaris consanguina* sp. nov. Numbers 7222-7225.

FIGS. 5, 6. *Echinocaris turgida* sp. nov. Numbers 7226, 7227.

FIG. 7. *Echinocaris auricula* sp. nov. Number 7228.

All specimens are in the Carnegie Museum, Section of Invertebrate Paleontology.

The above numbers refer to the catalogue of Invertebrate fossils of Carnegie Museum.