

CONTRIBUTIONS FROM THE MUSEUM OF PALEONTOLOGY
THE UNIVERSITY OF MICHIGAN

VOL. XIX, No., 5, pp. 47-64 (5 pls., 1 fig.)

SEPTEMBER 22, 1964

RARE CRUSTACEANS FROM THE UPPER DEVONIAN
CHAGRIN SHALE IN NORTHERN OHIO

BY

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AND ROBERT V. KESLING



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RARE CRUSTACEANS FROM THE UPPER DEVONIAN
CHAGRIN SHALE IN NORTHERN OHIO¹

BY

MYRON T. STURGEON,² WILLIAM J. HLAVIN,³
AND ROBERT V. KESLING

ABSTRACT

A collection of nodules from the Upper Devonian Chagrin Shale in northern Ohio contains two new species of *Echinocaris*, *E. sublevis* Whitfield, the largest known specimens of *E. multinodosa* Whitfield, the second known specimen of *Palaeopalaemon*, which we regard as a new species, and undeterminable fragments of *Echinocaris* and *Mesothyra*.

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INTRODUCTION

CERTAIN Upper Devonian crustaceans are such rare fossils that newly discovered specimens usually reveal new information. From nodules in the Chagrin Shale have come two new species of *Echinocaris*, as well as *E. multinodosa* Whitfield and *E. sublevis* Whitfield. They occur with a new species of *Palaeopalaemon* and an abdominal segment of *Mesothyra sp.*

In the spring of 1963, William J. Hlavin found several well-preserved specimens of *Echinocaris* while cracking open ironstone concretions he

¹ The Ohio University has generously contributed \$125 toward the cost of plates in this paper.

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collected from exposures of the Upper Devonian Chagrin Shale along Euclid Creek in eastern Cuyahoga County, Ohio. He conferred about the nature of the fossils with Professor Myron T. Sturgeon, his professor of geology at Ohio University, who sent one of the largest to Professor Robert V. Kesling at the Museum of Paleontology, The University of Michigan, for examination. After exchange of correspondence and shipping of additional fossils, we three met at the Museum of Paleontology in August, 1963, and discussed the specimens. This paper is the result.

Catalogued specimens illustrated and described herewith are deposited in the Museum of Paleontology at The University of Michigan. Other specimens and plaster replicas of some illustrated specimens are deposited in the collection of the Geology Department at Ohio University.

LOCALITIES

Both localities are in northern Ohio, approximately along the strike of the Chagrin Shale.

LOCALITY

1. Exposure about 4 miles southeast of Madison and 3 miles northeast of Thompson, 50 feet south of an east-west county road, below and at the junction of two branches of Mill Creek, Ashtabula County very near the Lake County-Ashtabula County line, northern Ohio. This site is approximately 4 miles east of the former village of LeRoy. Upper Devonian Chagrin Shale. Collected by Hlavin, Bly, and Wagner in June, 1963, and by Hlavin in August and September, 1963.
2. Exposure on the west branch of Euclid Creek, $2\frac{1}{2}$ miles from Lake Erie and $\frac{3}{4}$ mile south of Euclid, $\frac{1}{8}$ mile upstream from the confluence of three branches, Euclid Reservation of Cleveland Metropolitan Park, Cuyahoga County, Ohio. Upper Devonian Chagrin Shale. Collected by Hlavin in April, 1963.

SYSTEMATIC DESCRIPTIONS

Subclass Malacostraca

Superorder PHYLLOCARIDA Packard, 1879

Order Archaeostraca Claus, 1889

Suborder CERATIOCARINA Clarke, 1913

Family Echinocarididae Clarke, 1885

Genus *Echinocaris* Whitfield, 1880

Terminology of echinocarid carapaces was discussed by Beecher (1884, pp. 3-4). The "eye tubercles and optic spots" shown in his Figure 1 cannot be identified in our specimens, and we seriously question whether the protuberances he noted had any function connected with sight. Furthermore, his division of the carapace into cephalic and thoracic regions appears arbitrary. Perhaps Beecher intended the "eye tubercles" and "furrow

limiting the cephalic region" in his figure to be applied to *Elymocaris* and *Tropidocarinaratus*, which he also described in his 1884 contribution.

Certain other features present in our specimens were not illustrated or discussed by Beecher. Therefore, for standardization and convenience, we present a composite labeled diagram as our Figure 1 below.

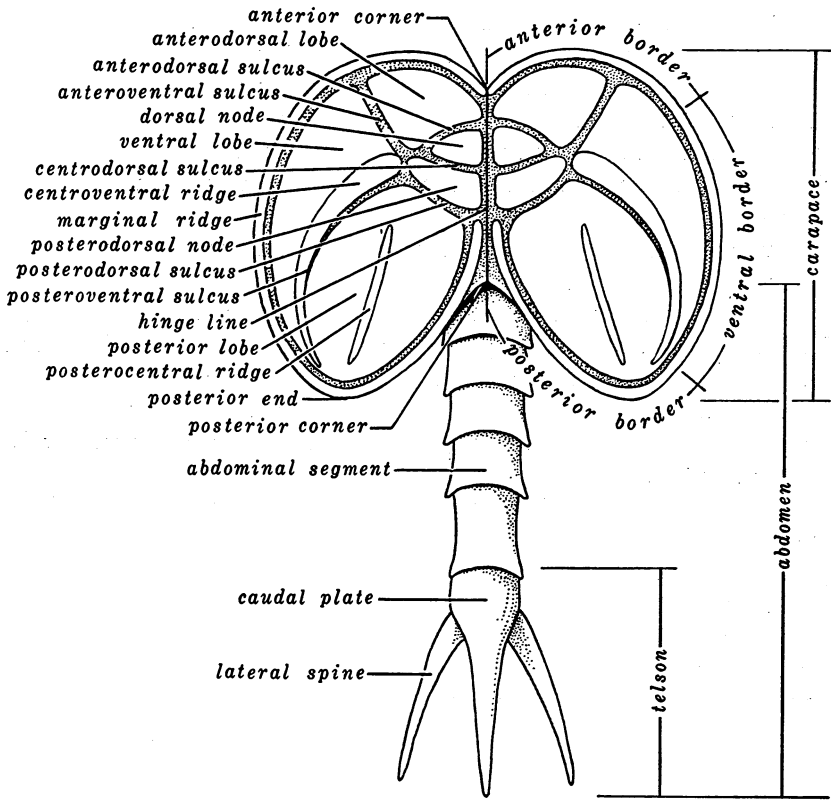


FIG. 1. Composite diagram of *Echinocarid* labeled with terms used in descriptions.

The suprageneric classification here follows that used by Krestovnikov (1960), whose section on Phyllocarida in the Russian *Fundamentals of Paleontology* is the latest study of this taxonomic division.

Echinocarid multinodosa Whitfield

(Pl. I, Figs. 1-5; Pl. II, Figs. 1-4; Pl. V, Fig. 10)

Echinocarid multinodosa Whitfield, 1880, pp. 38-39, Pl. Fig. 8. Packard, 1882, p. 952, Fig. 10; 1883, p. 451, Fig. 71a. Beecher, 1884, p. 5. Etheridge, Woodward, and Jones, 1886, p. 360. Hall and Clarke, 1888, pp. 180-81, Pl. 29, Figs. 18-19.

S. A. Miller, 1889, p. 545. Etheridge, Woodward, and Jones, 1889, p. 180. Vogdes, 1889, pp. 16-17. Vogdes, 1890, p. 164. Whitfield, 1890, p. 568, Pl. 12, Fig. 16. Clarke, 1892, p. 430. Vogdes, 1893, p. 383. Whitfield, 1893, pp. 458-59, Pl. 8, Fig. 16. Whitfield, 1899, p. 182. Clarke and Ruedemann, 1903, p. 701. Grabau and Shimer, 1910, Vol. II, p. 378, Fig. 1680*d*. Gürich, 1929, p. 76. Straelen and Schmitz, 1934, pp. 89-90. Copeland, 1960, p. 3.

Description.—Carapace with equal subovate left and right valves. Each valve with anterior border evenly round, ventral border evenly curved, and posterior border subacuminate, narrowly round at posterior end. Height about three-fifths the length (Pl. I, Fig. 3). Hinge line straight, approximately half the length; anterior corner about one-fifth the length behind the anterior end, posterior corner about three-tenths the length in front of the posterior end (Pl. I, Fig. 4).

Anterodorsal lobe shaped like a circular quadrant, with the arc anterior and the angle directed backward; dorsal third of lobe more prominent than ventral part, separated from it by a shallow, horizontal groove. Dorsal node subtriangular; posterodorsal node subtrapezoidal. Ventral lobe lacking centroventral ridge, but its posterior margin more elevated than its anterior. Posterior lobe large. Marginal ridge prominent, its posterior section enlarged and extending onto posterodorsal region of valve above posterior lobe.

Four major sulci confluent about one-third the height below the hinge line and one-third the length behind the anterior end: anterodorsal, posterodorsal, anteroventral, and posteroventral sulci. Anterodorsal and posterodorsal sulci forming a tapering U with ends at the hinge line. Anteroventral and posteroventral sulci forming an inverted U, its apex confluent with the junction of the anterodorsal and posterodorsal sulci. Anteroventral sulcus markedly shallower and broader toward anteroventral border, scarcely discernible at the margin (Pl. I, Fig. 4). Posteroventral sulcus sloping steeply backward from junction with anteroventral sulcus to position about one-fifth the height above the ventral border, there abruptly turning backward and becoming shallow, finally indistinct by gradual merging into posterior lobe. Centrodorsal sulcus subparallel to posterodorsal sulcus but somewhat shallower, extending from hinge line to junction with anterodorsal sulcus.

Anterior lobe, dorsal node, and posterodorsal node nearly reaching hinge line. Enlarged rear section of marginal ridge separated from posterior corner and hinge line by smooth area. Marginal ridge set off from lobes by distinct groove, deep, narrow, and V-shaped anteriorly and ventrally, becoming shallower, wider, and more smoothly rounded posteriorly.

Ornamentation of two distinct kinds. Reticulation covering dorsal

two-thirds of posterior lobe, each of its meshes enclosing one to four punctae (Pl. I, Fig. 5; Pl. II, Fig. 4). Marginal area of lobe with some crests of the reticulation raised as small pustules or tubercles (Pl. II, Fig. 4) and distal crests extending normal to border of the lobe (Pl. I, Figs. 1-5). Small pustules, rather closely spaced on dorsal areas of anterior lobe, dorsal node, posterodorsal node, and posterior section of marginal ridge, scattered on remainder of anterior lobe and apex of ventral lobe (Pl. I, Figs. 1-3; Pl. II, Figs. 1, 3; Pl. V, Fig. 10). Parts of marginal ridge showing a row of faint papillae or tiny pustules (Pl. II, Fig. 3). All pustules appear to have enclosed pores for passage of sensory setae.

Dimensions of illustrated specimens (in millimeters):

Specimen	Plate, Figure	Valve	Length	Height	Hinge Line
UMMP 47523	I, 4	R	42	24	20½
UMMP 47521	II, 1	L	41½	22	20
UMMP 47527	II, 2	L	...	23	20½
UMMP 47530	V, 10	R	34	20½	16½
UMMP 47539	II, 3	L	...	19½	17
UMMP 47537	I, 2	L	28½	17	13½
UMMP 47540	I, 1	L	24	13½	14

Remarks.—From the dimensions above, it appears that the first three are adults (final instars), the next two penultimate instars, and the last two antepenultimate instars. Inasmuch as all specimens are somewhat distorted, no generalizations can be made about progressive ontogenetic changes in proportions.

Occurrence.—Localities 1 and 2.

Hypotypes.—UMMP 47521, 47523, 47527, 47530, 47537, 47539, and 47540.

Echinocaris sp. cf. *E. multinodosa* Whitfield
(Pl. V, Figs. 7-8)

Because of its large size, we suspect that one specimen (UMMP 47533) may be the abdomen of *Echinocaris multinodosa*.

Segments are longer than broad and have ornamentation of low tubercles only in a central band. Spines of the telson narrow and flattened.

Occurrence.—Locality 1.

Illustrated specimen.—UMMP 47533.

Echinocaris sublevis Whitfield

(Pl. V, Figs. 1-2)

Echinocaris sublevis Whitfield, 1880, pp. 36-37, Pl. Figs. 4-6. Packard, 1882, p. 952, Fig. 11; 1883, pp. 450-51, Fig. 71b. Beecher, 1884, p. 5.

E. sublaevis Jones and Woodward, 1884, p. 2, Pl. 13, Figs. 3-5. Etheridge, Woodward, and Jones, 1886, p. 360. Hall and Clarke, 1888, pp. 176-78, Pl. 29, Figs. 11-13. Grabau and Shimer, 1910, Vol. II, p. 377, Fig. 1680 *a-b*.

(Pl. III, Figs. 1-5)

Remarks.—The species has been adequately described, illustrated, and compared. Despite the long synonymy, the knowledge of the species rests on the original specimens of Whitfield, which came from the "Erie shales, at Leroy, Lake County, Ohio." Hall and Clarke gave the locality as "Paine's Creek, Lake County, Ohio," but simply redescribed and reillustrated the types.

Our specimens have small tubercles on the posterodorsal node as well as the dorsal node, although the descriptions and figures of the original left valve fail to mention this feature. We believe they are properly identified because in all other particulars the features present in our valves agree with the published statements.

Occurrence.—Locality 1.

Hypotypes.—UMMP 47522 and 47532.

Echinocaris pulchra, sp. nov.

(Pl. III, Figs. 1-5)

Description.—Valves subovate. Border anterodorsally round, anteriorly and ventrally gently curved, posteriorly subround, and posterodorsally gently convex. Anterior end very high on valve, not far below anterior corner. Height about five-eighths the length. Hinge line straight, approximately five-ninths the length; anterior corner about one-ninth the length behind the anterior end, posterior corner about one-third the length ahead of the posterior end.

Anterior lobe with irregular surface, its ventral two-thirds unevenly inflated and its anterodorsal region sharply indented; a short furrow from the indentation sloping forward and down to the middle of the anterior border of the lobe. Dorsal node subtriangular, its anterior and posterior sides convex, divided into two unequal parts by a vertical shallow groove, the anterior part about half the size of the posterior. Posterodorsal node narrower and longer than dorsal node, its posterodorsal corner confluent with the extension of the marginal ridge. Ventral lobe bearing a prominent centroventral ridge; dorsal end of ridge much inflated, subovate; ridge tapering in short distance and turning backward as a narrow elevation

bearing a crest (Pl. III, Fig. 1). Posterior lobe suboval, bearing a postero-central ridge. Marginal ridge about the same width throughout its length, extending onto valve and confluent with posterodorsal node.

All sulci converging in a pitlike depression about two-fifths the height below the hinge line and one-third the length behind the anterior end. Anterodorsal and anteroventral sulci shallow, their borders not sharply defined. Centrodorsal and posterodorsal sulci narrow and deep. Posteroventral sulcus deep in anterior part, merging into semisulcus posteriorly. Sharp well-defined groove around proximal edge of marginal ridge. Small, elongate triangular, smooth area at posterior corner between marginal ridge and hinge line.

Few low, poorly defined tubercles on anterior lobe (about 4), dorsal node (2, one on each side of median groove), and posterodorsal node (1 or 2). Postero-central ridge formed of about 12 tubercles linked together by a somewhat irregular rounded ridge (Pl. III, Figs. 1-5). Remainder of posterior lobe covered by small, indistinct punctae. Other lobes nearly smooth, somewhat granulose.

Dimensions of types (in millimeters):

Specimen	Plate, Figure	Valve	Length	Height	Hinge Line
Holotype UMMP 47525	III, 1	L	22½	12½	13
Paratype UMMP 47534	III, 3	R	17	11½	10
Paratype UMMP 47531	III, 5	L	18	11½	11

Remarks.—This species differs from most others in having a postero-central ridge. It most closely resembles *E. auricula* Eller, from the Chemung strata at Alfred's Station, New York. Eller (1935, p. 271) described *E. auricula* as having three ridges in the posterior half of each valve: the posteroventral, the postero-central, and a short ridge connected with the posterior margin and midway between the postero-central ridge and the hinge line. The last ridge has no counterpart in our species. In addition, *E. pulchra* differs from several species in having the end of the marginal ridge joined to the posterodorsal node.

Occurrence.—Locality 1.

Types.—Holotype UMMP 47525. Paratypes UMMP 47534 and 47531.

***Echinocaris ohioensis*, sp. nov.**

(Pl. IV, Figs. 1-4)

Description.—Valves subovate, anterior end blunt and posterior sub-acuminate. Anterior border slightly convex, more strongly curved near

anterior corner and at junction with ventral border; ventral border evenly curved; posterior border gently curved in dorsal and ventral parts but rather strongly curved at posterior end. Hinge line straight, about two-thirds the length; anterior corner only one-twelfth the length behind the anterior end, posterior corner about one-fourth the length in front of the posterior end. Height approximately three-fifths the length.

Four major sulci confluent slightly less than one-third the length behind the anterior end and about one-third the height below the hinge line. Anterodorsal and posterodorsal sulci forming a V, their junction not sharply acuminate. Anteroventral and posteroventral sulci forming an inverted U, its posterodorsal edge tangent to the junction of the anterodorsal and posterodorsal sulci. As a result, anterodorsal and anteroventral sulci join ahead and slightly above the junction of the posterodorsal and posteroventral sulci. From this junction, anteroventral sulcus extending toward anteroventral border as a short, deep, narrow section, then abruptly expanding in a V-shaped depression with the anterodorsal wall much steeper than the posteroventral (Pl. IV, Fig. 1). Posteroventral sulcus posteriorly assuming the form of a semisulcus along the edge of the centroventral ridge. Centrodorsal sulcus narrow, slanting downward and forward from hinge line to junction with anterodorsal sulcus not far above junction of the latter and the posteroventral sulcus. Well-defined groove along proximal edge of marginal ridge, joining posterodorsal sulcus.

Anterior lobe subtriangular, nodular; triangular corner area of lobe nearly separated from rest of lobe by a deep furrow slanting anteroventrally from hinge line about two-thirds the distance to the anterior edge of the lobe; shallow but distinct groove across anteroventral area; shallow depression forming re-entrant on posterodorsal margin. Dorsal node subtriangular. Posterodorsal node linguliform, its slanting sides subparallel; node confluent with extension of marginal ridge. Apex of ventral lobe inflated to form the end of centroventral ridge; rear part of centroventral ridge emphasized by ridgelike crest (Pl. IV, Figs. 2-3). Posterior lobe shield-shaped, no posterocentral ridge (Pl. IV, Fig. 1). Marginal ridge about the same width throughout the free border of valve, expanded to fill posterior corner area, and extending forward along hinge line to junction with posterodorsal node.

Ornamentation consisting of papillae or small pustules, fairly concentrated on anterior lobe, dorsal and posterodorsal nodes, and front part of centroventral ridge, sparse on dorsal part of posterior lobe (Pl. IV, Figs. 3-4). Remainder of valve smooth.

Dimensions of types (in millimeters):

Specimen	Plate, Figure	Valve	Length	Height	Hinge Line
Holotype UMMP 47536	IV, 1-2	L	29½	17½	19½
Paratype UMMP 47538	IV, 3-4	R	31½

Remarks.—*Echinocaris ohioensis*, sp. nov., resembles *E. multinodosa* Whitfield in the general form of lobation, the lack of a posterocentral ridge, and the kind of ornamentation on the anterior half of the carapace. It can be readily distinguished by the absence of reticulation on the posterior lobe, the confluence of marginal ridge and posterodorsal node, stronger relief in the anterodorsal lobe, proportionally longer and more nearly equilateral dorsal lobe, and the extension of the marginal ridge to the posterior corner.

Occurrence.—Locality 1.

Types.—Holotype UMMP 47536. Paratype UMMP 47538.

Echinocaris sp.

(Pl. IV, Fig. 5; Pl. V, Fig. 3)

The collection includes two poorly preserved carapaces with abdominal segments protruding from the rear. They are of nearly equal size. Neither shows clearly the shape of the valves or details of lobation. Neither retains the telson. The fragments of the carapace indicate that both probably belonged to one species.

One carapace, UMMP 47528, has linguliform posterodorsal nodes joined to the rear extensions of the marginal ridges (Pl. V, Fig. 3). The only recognized species having these features is *Echinocaris ohioensis*, sp. nov. We suspect that the two specimens are immature *E. ohioensis*. From the dimensions listed below, we are led to the tentative belief that they are two instars younger than the holotype, UMMP 47536.

The abdominal segments are rather well exposed. Four segments can be recognized in each specimen. Each segment is about 3 mm long and about 3½ mm in greatest diameter. It bears a pronounced encircling ridge at each end, the proximal smaller than the distal, with a deep groove between. On one side, presumed to be the ventral, a short tapered ridge is inserted, wedgelike, between the other two. Tubercles ornament distal and central ridges, low but distinct.

Dimensions of specimens (in millimeters):

Specimen	Plate, Figure	Carapace Length	Abdomen Length and Diameter
UMMP 47524	IV, 5	Est. 17½	Ca. 10 x 3½
UMMP 47528	V, 3	Est. 18½	Ca. 10 x 3½

Occurrence.—Locality 1.

Illustrated specimens.—UMMP 47524 and UMMP 47528.

Suborder RHINOCARINA Clarke, 1913
 Family Rhinocarididae Clarke, 1913
 Subfamily Rhinocaridinae Clarke, 1913
 Genus *Mesothyra* Hall, 1888
Mesothyra sp.
 (Pl. V, Fig. 9)

One concretion contained parts of two abdominal segments, which from their shape and size we believe belong to the genus *Mesothyra*. The slightly convex exposed surface is irregularly crenulate. We cannot determine the species, although it could possibly be the type species, *Mesothyra oceani* Hall and Clarke.

Occurrence.—Locality 1.

Illustrated specimen.—UMMP 47535.

Superorder PERACARIDA Packard, 1879
 Order Mysidacea Boas, 1883
 Suborder LOPHOGASTRIDA Tattersall, 1925
 Family Lophogastridae Sars, 1856
 Genus *Palaeopalaemon* Whitfield, 1880

Although Whitfield originally described his genus (1880, p. 40) as a "Macrouran Decapod crustacean," later paleontologists have placed it in the Mysidacea or Schizopoda. The classification of the rare Palaeozoic malacostracans is subject to change with each new discovery of better-preserved specimens. The diagnostic features are also subject to review and revision. We regard the placement above as tentative.

***Palaeopalaemon elegans*, sp. nov.**

(Pl. V, Figs. 4-6)

Description.—Cephalothorax elongate, tapering toward the blunt anterior end, divided into distinct cephalic and thoracic sections by a sharply incised cervical groove forming an elongate V as seen in dorsal view. Anterior end convex, but without rostrum. Median carina on both sections of cephalothorax, low, becoming less pronounced anteriorly. Dorsolateral carina developed only on each side of thoracic section, sharp, forming outer boundary of rather broad triangular dorsum. Laterum incompletely preserved on each side, but apparently narrower than dorsum. Slight constriction at cervical groove between latera and cephalic section. Posterior end of cephalothorax not preserved.

Abdomen not in natural position, separated from cephalothorax; only

three segments and telson preserved. Segments strongly arched, provided with posteroventral lobes. Rear abdominal segment bearing on each side leaflike endopod and exopod, which strongly overlap to form, with the telson, a fan-shaped caudal fin; each element reinforced by a lamellar spine, the spine of each endopod along its outer margin, the spine of each exopod nearly median. Telson broad, tapering rapidly, strongly convex, particularly along midline.

Preserved parts of antennae (Pl. V, Fig. 4) consisting of incomplete "distal peduncular" podomere of each side, very large and long, each with convex sides and bearing a very deep longitudinal groove.

Cephalothorax ornamented with inconspicuous venate lines. Lateral elements of caudal fin striate.

Dimensions of holotype (in millimeters):

Length of cephalothorax	14.2
Width of cephalothorax	9.4
Length of telson	8.0
Median length of abdominal segments	
Ultimate	3.5
Penultimate	4.0
Antepenultimate	4.0
Width caudal fin (as preserved)	12.8

Remarks.—Before the discovery of this specimen, the knowledge of the genus was based on the holotype of the type species. Inasmuch as this is only the second specimen of *Palaeopalaemon* discovered, we were reluctant to make it a new species. Yet the differences between our specimen and the type of *Palaeopalaemon newberryi* Whitfield are so conspicuous that we cannot reconcile them as one species. The following are significant differences:

Character	<i>P. newberryi</i>	<i>P. elegans</i>
Cervical groove	None apparent	Sharply incised, distinct
Dorsa of thoracic section of cephalothorax	Narrow	Wide
Dorsolateral carina	Extending to anterior end	Terminating at cervical groove
Antenna ("distal peduncular" podomere)	Dorsally rounded	Dorsally bearing deep longitudinal groove

The characteristics of *P. newberryi* are adequately described and illustrated by Whitfield (1880, pp. 41-42, Pl. Figs. 1-3) and by Hall and Clarke (1888, pp. 203-205, Pl. 30, Figs. 20-23).

Occurrence.—Locality 1.

Holotype.—UMMP 47529.

LITERATURE CITED

- BEECHER, C. E. 1884. Ceratocaridae from the Chemung and Waverly Groups, at Warren, Pennsylvania. Rept. Prog. PPP, Second Geol. Surv. Penn., 22 pp., 2 pls.
- CLARKE, J. M. 1892. List of the Original and Illustrated Specimens in the Palaeontological Collections, Part I, Crustacea. N. Y. State Mus., 45th Rept., 1891, pp. 373-439.
- and RUEDEMANN, RUDOLPH. 1903. Catalogue of Type Specimens of Paleozoic Fossils in New York State Museum. Bull. N. Y. State Mus., No. 65, Paleontol. 8, 847 pp.
- CLAUS, C. 1889. Ueber den Organismus der Nebaliden und die systematische Stellung der Leptostraken. Arb. zool. Inst. Wien, Vol. 8, pp. 1-148, 15 pls.
- COPELAND, M. J. 1960. The Occurrence of *Echinocaris* and *Spathiocaris* (Phyllocarida) in Western Canada. In: Copeland, M. J., and Bolton, T. E., Canadian Fossil Arthropoda, Eurypterida, Phyllocarida and Decapoda. Geol. Surv. Canada, Bull. 60, pp. 1-11, Pl. 1, 2 figs.
- ETHERIDGE, R., WOODWARD, H., and JONES, T. R. 1886. Third Report of the Committee, Consisting of Mr. R. Etheridge, Dr. H. Woodward, and Professor T. Rupert Jones (Secretary), On the Fossil Phyllopoda of the Palaeozoic Rocks. Rept. Brit. Assoc. Adv. Sci., 1885, pp. 326-61.
- , ———, and ———. 1889. Sixth Report of the Committee, Consisting of Mr. R. Etheridge, Dr. H. Woodward, and Professor T. Rupert Jones (Secretary), On the Fossil Phyllopoda of the Palaeozoic Rocks. *Ibid.*, 1888, pp. 173-81, 10 figs.
- ELLER, E. R. 1935. New Species of *Echinocaris* from the Upper Devonian, of Alfred Station, New York. Ann. Carnegie Mus., Vol. 24, pp. 263-74, Pl. 3.
- GRABAU, A. W., and SHIMER, H. W. 1910. Index of North American Fossils, Vol. 2. New York: A. G. Seiler and Co. xiv + 909 pp.
- GÜRICH, G. 1929. Silesicaris von Leipe und die Phyllokariden überhaupt. Mitt. min.-geol. Staatsinst. Hamburg, No. 11, pp. 21-90, 1 pl., 10 text-pls., 5 text-figs.
- HALL, JAMES, and CLARKE, J. M. 1888. Trilobites and Other Crustacea of the Oriskany, Upper Helderberg, Hamilton, Portage, Chemung and Catskill Groups. N. Y. Geol. Surv., Palaeontology, Vol. 7, lxxiv + 236 pp., 36 pls.
- JONES, T. R., and WOODWARD, H. 1884. On Some Palaeozoic Phyllopoda. Geol. Mag., Vol. 1, pp. 348-56 (cont'd in 1885, Vol. 2, pp. 539-45).
- KRESTOVNIKOV, V. N. 1960. Superorder Phyllocarida Packard, 1879. In: Fundamentals of Paleontology, Investigations in Paleontology and Geology of the USSR (Y. A. Orlov, editor), Trilobites and Crustacea (N. E. Chernysheva, editor), pp. 425-29. [In Russian.]
- MILLER, S. A. 1889. North American Geology and Palaeontology for the Use of Amateurs, Students and Scientists. Cincinnati, Ohio: Western Methodist Book Concern. 664 pp.
- PACKARD, A. S., JR. 1879. The Nebaliad Crustacea as Types of a New Order. Amer. Naturalist, Vol. 13, p. 128; Journ. Micros. Soc. London, Vol. 2, No. 6, p. 713; Ann. Mag. Nat. Hist., Ser. 5, Vol. 3, p. 459.
- 1882. The Palaeozoic Allies of *Nebalia*. Amer. Naturalist, Vol. 16, pp. 945-53, 12 figs.

- 1883. A Monograph of the Phyllopod Crustacea of North America, with Remarks on the Order Phyllocarida. *In*: F. V. Hayden, Twelfth Annual Report of the United States Geological and Geographical Survey of the Territories: a Report of Progress of the Exploration in Wyoming and Idaho for the Year 1878, Part 1, Geol., Paleontol., and Zool., Sec. 2, Zool., pp. 295-457, 39 pls., 73 figs.
- ROGER, JEAN. 1953. Sous-Classe des Malacostracés. *Traité de Paleontologie*, Tome 3, Les Formes Ultimes d'Invertébrés, Morphologie et Évolution, Onychophores, Arthropodes, Échinodermes, Stomocordés, pp. 309-78, 11 pls.
- SALTER, J. W. 1860. On New Fossil Crustacea from the Silurian Rocks. *Ann. Mag. Nat. Hist.*, Ser. 3, Vol. 5, Art. 15, pp. 153-62, figs.
- SHROCK, R. R., and TWENHOFEL, W. H. 1953. Principles of Invertebrate Paleontology (A Revised and Enlarged Edition of Twenhofel and Shrock, *Invertebrate Paleontology*), 2d ed., New York: McGraw-Hill Book Co., Inc. xx + 816 pp.
- STRAELEN, V. VAN, and SCHMITZ, G. 1934. Crustacea Phyllocarida (= Archaeostraca). *Fossilium Catalogus*, I, Animalia (W. Quenstedt, ed.), Paris 64, 246 pp.
- VOGDES, A. W. 1889. Catalogue of North American Palaeozoic Crustacea Confined to the Non-trilobitic Genera and Species. *Ann. N. Y. Acad. Sci.*, Vol. 5, pp. 1-38, Pls. 1-2.
- 1890. Bibliography of Palaeozoic Crustacea from 1698 to 1889. *Bull. U. S. Geol. Surv.*, No. 63, 177 pp.
- 1893. A Classified and Annotated Bibliography of the Palaeozoic Crustacea, 1698-1892, to which is added a catalogue of North American species. *Occ. Papers Calif. Acad. Sci.*, Vol. 4, 412 pp.
- WHITFIELD, R. P. 1880. Notice of New Forms of Fossil Crustaceans from the Upper Devonian Rocks of Ohio, with Descriptions of New Genera and Species. *Amer. Journ. Sci.*, Ser. 3, Vol. 19, pp. 33-42, 1 pl.
- 1890. Contributions to Invertebrate Palaeontology. *Ann. N. Y. Acad. Sci.*, Vol. 5, pp. 562-68, 572, Pl. 12, Figs. 12-18.
- 1893. Contributions to the Palaeontology of Ohio. *Rept. Geol. Surv. Ohio*, Vol. 7, Pt. 2, Palaeontol., pp. 454-59, 462, Pl. 8, Figs. 12-18.
- 1899. List of Fossils, Types and Figured Specimens, Used in the Palaeontological Work of R. P. Whitfield, Showing Where They are Probably to be Found at the Present Time. *Ann. N. Y. Acad. Sci.*, Vol. 12, pp. 139-186.

Manuscript received January 31, 1964

PLATES

EXPLANATION OF PLATE I

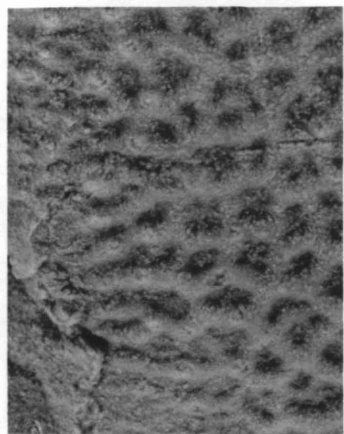
(Figures $\times 2$, except as noted)

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|---|------|
| <i>Echinocaris multinodosa</i> Whitfield | 49 |
| <p>FIG. 1. Lateral view of left valve of immature carapace, Hypotype UMMP 47540. Locality 1. Another specimen, not illustrated, contained in same concretion.</p> | |
| <p>FIG. 2. Lateral view of immature left valve, Hypotype UMMP 47537. Locality 1. Specimen thin and wrinkled, apparently a molted valve.</p> | |
| <p>FIGS. 3-5. Adult carapace, Hypotype UMMP 47523. Locality 2. Fig. 3, dorsal view of specimen. Fig. 4, dorsal view of plaster replica cast from flexible mold that was arranged to eliminate some of the obvious distortion in the left valve. Fig. 5, ornamentation in posterodorsal part of posterior lobe of right valve, $\times 10$.</p> | |

PLATE I



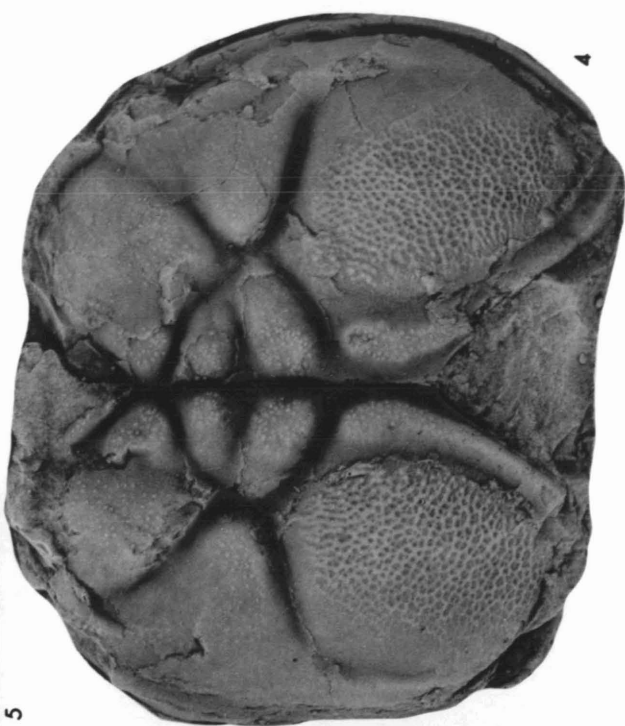
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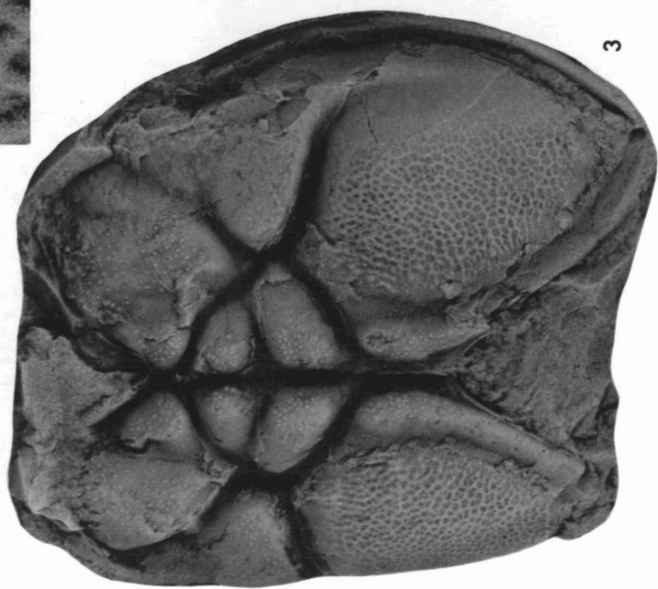
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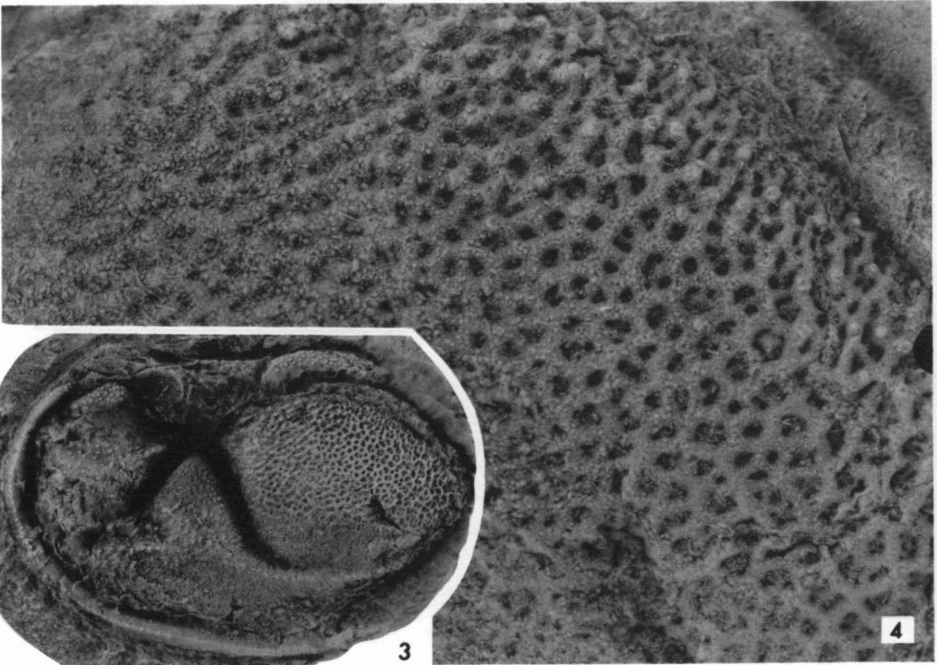
PLATE II



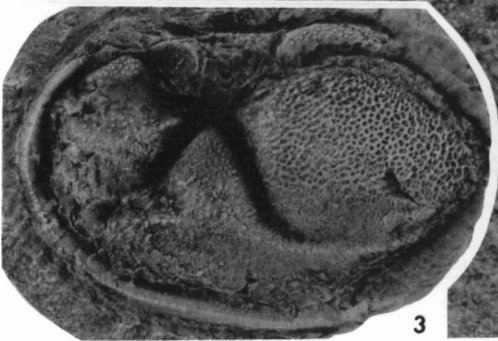
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EXPLANATION OF PLATE II

(Figures $\times 2$, except as noted)

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FIG. 2. Lateral view of adult left valve, Hypotype UMMP 47527. Locality 1.	
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EXPLANATION OF PLATE III

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Fig. 1, dorsal view. Fig. 2, posterior lobe with posterocentral ridge, $\times 10$.	
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Fig. 4, posterior lobe with posterocentral ridge, $\times 10$.	
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PLATE III

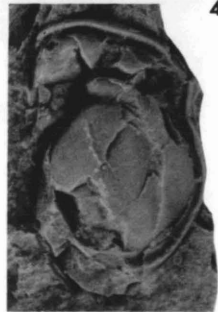
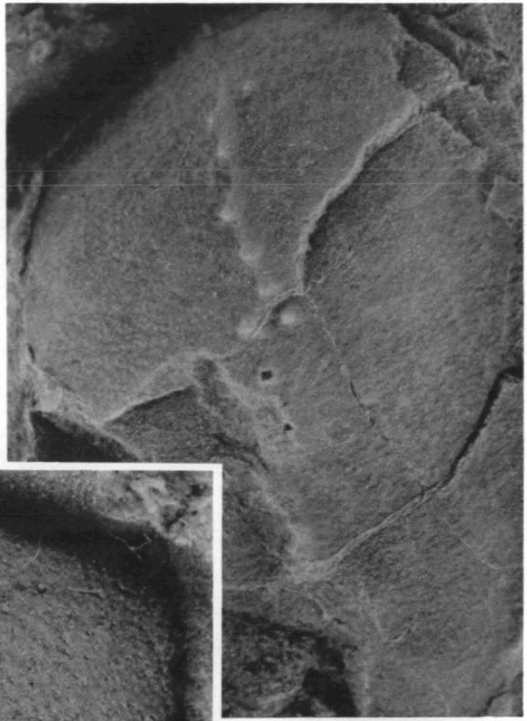
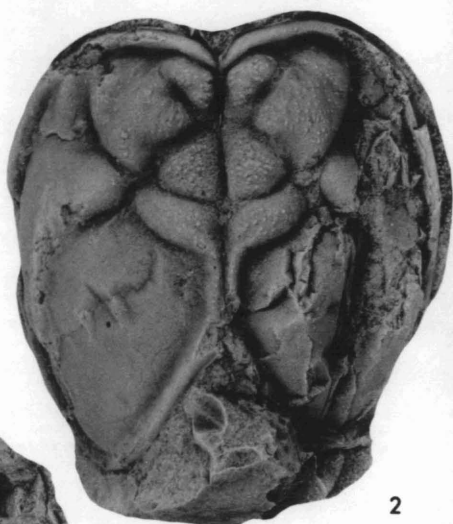


PLATE IV



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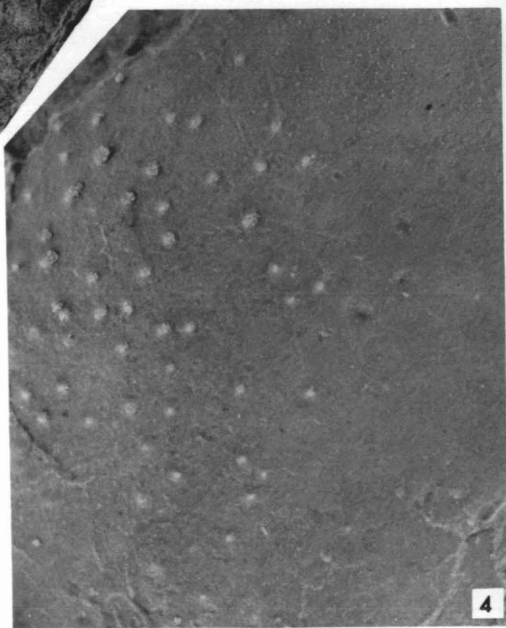
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EXPLANATION OF PLATE IV

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<i>Echinocaris</i> sp.	55
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EXPLANATION OF PLATE V

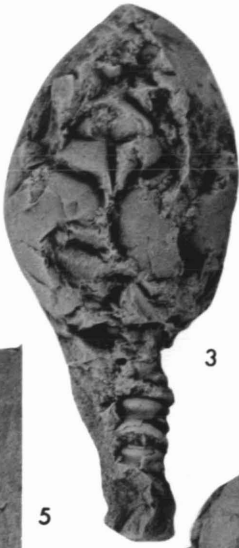
(All figures $\times 2$)

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<i>Echinocaris sublevis</i> Whitfield	52
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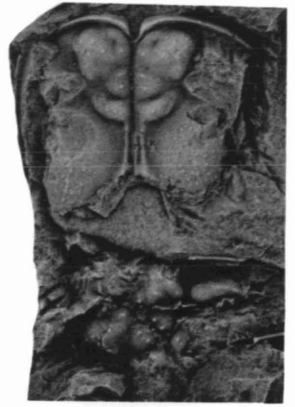
PLATE V



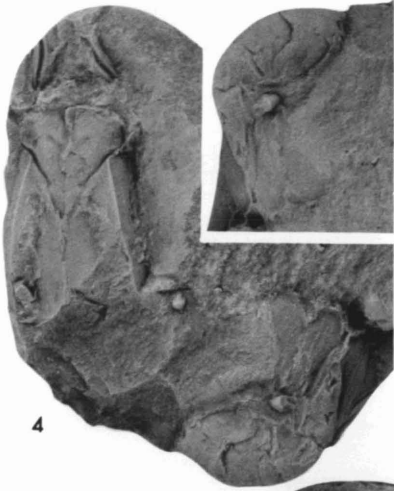
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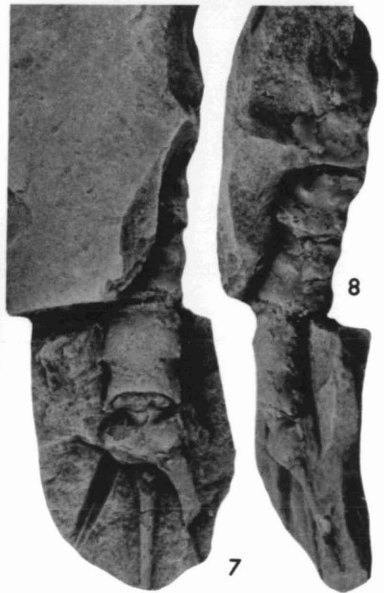
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