

THE TRILOBITE *ENCRINURUS*
MULTISEGMENTATUS (PORTLOCK) AND ALLIED
MIDDLE AND UPPER ORDOVICIAN SPECIES

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ABSTRACT. An *Encrinurus multisegmentatus* species-group is defined. The main diagnostic criterion is the arrangement of the tubercles on the cranium; a system of notation is used to indicate the positions of the main glabellar tubercles. *E. multisegmentatus* (Portlock) from the Killey Bridge Beds, Tyrone, is redescribed, and the Middle and Upper Ordovician species which constitute the group are discussed. One new species, *E. lamonti* from the Lower Drummuck Group, Ayrshire, is established.

INTRODUCTION

THE terminology used in this paper is essentially that of Warburg (1925, pp. 1-7) except that the pleurae (ribs) of the pygidium are considered to be marked off by the interpleural, not the pleural, furrows. Temple (1956, pp. 423-4) has shown that the area between the preglabellar furrow and the facial sutures in the encrinurids is homologous with the anterior border of the cranium in the other members of the Cheiruracea; this area is here referred to as the false preglabellar field. The quoted length of a part is the distance measured parallel to the median line between its extremities; the width is the corresponding measurement at right angles to the median line.

Previous research. There has been little progress in the study of the interrelationships of the species of *Encrinurus* since Reed's paper of 1928. Reed recognized six morphological groups, the fourth of which he defined as follows.

Pygidium with numerous rings on axis, of which the anterior rings are complete, but the posterior ones are interrupted or weakly marked in the middle. Cephalon with glabella coarsely tuberculate; lateral lobes nodular. Example: *E. multisegmentatus* Portl. Range: Upper Ordovician.

Reed regarded his fourth group as ancestral to his fifth, typified by *E. punctatus* (Wahlenberg), and this view is supported here. Rosenstein (1941) has drawn attention to the regularity of the arrangement of the tubercles in the cranium of *E. punctatus*.

Definition of the E. multisegmentatus species-group. Reed's fourth group included a number of species which are not closely related to each other. The following is a definition of a restricted *E. multisegmentatus* group:

Cephalon coarsely tuberculate; main glabellar tubercles symmetrically arranged in transverse or arcuate rows. False preglabellar field separated from glabella by a broad furrow and itself parted by a well-defined median furrow, with four large tubercles on each side. Pygidium composed of twenty-five or more axial rings and eleven to fourteen pairs of pleurae. Occurrence: Middle and Upper Ordovician, Europe, and North America.

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System of notation applied to glabellar tubercles. As stated above, the main glabellar tubercles are symmetrically arranged in the *E. multisegmentatus* group, and they are distributed according to different patterns in each species. These main tubercles occur in transverse or arcuate rows, which are numbered I to VII starting from the back. Rows I, II, and III are opposite the posterior, middle, and anterior lateral glabellar lobes respectively; the remaining rows are situated on the frontal lobe. Tubercles which occur between the transverse rows are symbolized by the small roman numeral of the row in front. Pairs of tubercles are numbered in arabic numerals distally from the centre line, for example, IV-1 indicates the pair of tubercles nearest the centre line in the fourth row counted from the back forwards; when necessary left and right tubercles of a pair are distinguished by the suffix L or R. A median tubercle is denoted 0. In recording the formula for a species, regular tubercles which are not always present are placed in parentheses. Supernumerary tubercles, often asymmetrically arranged, are referred to as adventitious and are not numbered. Text-fig. 1 is a diagrammatic representation of the distribution of the main tubercles in certain of the species discussed.

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DESCRIPTION OF SPECIES

Encrinurus multisegmentatus (Portlock)

Plate 11, figs. 6-8; Plate 12, figs. 1-6

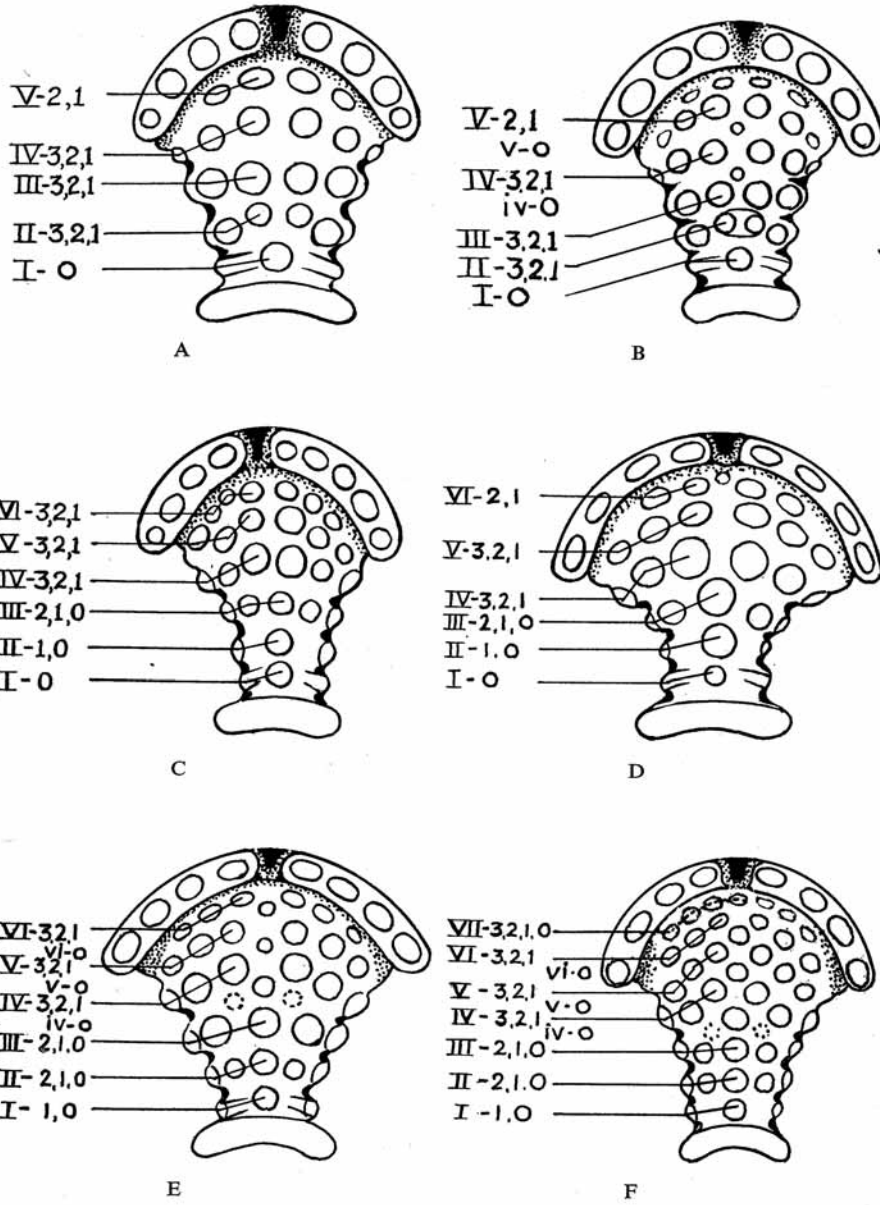
Amphion multisegmentatus Portlock 1843, p. 291, pl. 3, figs. 6a, b.
Ampyx baccatus Portlock 1843, p. 262, pl. 3, fig. 11.

Diagnosis. Cranidium gently convex longitudinally; glabella elongate, depressed posteriorly; frontal lobe approximately half length of glabella. Tubercle formula: I-0; II-0, 1; III-0, 1, 2; (iv-0); IV-V-VI-1, 2, 3. Fixed cheeks strongly tuberculate, with two conspicuously large tubercles one behind the other.

Horizon and locality. Killy Bridge Beds, Desertcreight, Tyrone, Northern Ireland.

Holotype. GSM 35416 (pygidium). Pl. 12, fig. 4.

Other material. 3 cranidia; 5 pygidia.



Dimensions

	<i>Holotype</i>	<i>GSM 35415</i>
Median length of cranium . . . . .	..	10.6 mm.
Length of glabella . . . . .	..	7.5 mm.
Width across false preglabellar field . . . . .	..	8.8 mm.
Width of glabella across basal lobes . . . . .	..	3.1 mm.
Length of pygidium	11.7 mm.	..
Width of pygidium	11.8 mm.	..

Description of cranidia. GSM 35415 (Pl. 11, fig. 6; Pl. 12, figs. 2a, b)—internal mould of incomplete cranium, holotype of *Ampyx baccatus* Portlock. Cranium semicircular in outline; glabella and false preglabellar field elongated towards the left; fixed cheeks moderately swollen; fixigenal spines not preserved. Glabella elongate, subpyriform, longitudinal convexity weak, transverse convexity strong at back, weak anteriorly. Frontal lobe strongly expanded, elliptical, extending for approximately half length of glabella. Lateral lobes represented by swellings on lateral slopes of glabella, posterior pair consisting of narrow ridges reaching to a median tubercle. Lateral furrows deep and broad, almost continuous across glabella. Occipital ring short and strongly convex. Apodemes, pointing inwards, near extremities of lateral and occipital furrows, anterior pair the weakest. Axial furrows narrow and deep; large anterior pits immediately behind facial sutures. False preglabellar field separated from glabella by a well-defined furrow, and divided by a deeper furrow offset towards left side. Fixed cheeks moderately convex, rising higher than glabella at back, broad and flattened distally and sloping outwards. Posterior borders short, transverse proximally, bending gently backwards beyond mid-width; posterior border furrows well defined. Cranium bears dome-shaped tubercles. A median tubercle, I-0, between basal lateral ridges; tubercles II-1 and III-2, which surmount the middle and anterior lateral lobes respectively, are relatively small; three rows of six tubercles on the frontal lobe, tubercles IV-1 large, VI-2, 3 small. Four tubercles on left side of false preglabellar field, five on the extended right side. Occipital ring smooth. Fixed cheeks with scattered small tubercles on inner slopes, and larger tubercles on posterolateral slopes; a large tubercle on summit of

EXPLANATION OF TEXT-FIG. 1

Arrangement of main glabellar tubercles in certain species of the *E. multisegmentatus* group.

- A. *Encrinurus praecursor* Tripp, Craighead (Kiln) mudstones, Craighead, after HM A. 4090a, b (Pl. 11, fig. 1).
- B. *Encrinurus praecursor* Tripp, Craighead (Kiln) mudstones, Craighead, after HM A. 4091 (Pl. 11, fig. 3).
- C. *Encrinurus multisegmentatus* (Portlock), Killy Bridge Beds, Tyrone, after GSM 35413 (Pl. 11, fig. 6).
- D. *Encrinurus lamonti* sp. nov., Lower Drummuck Group, New Dailly, after the holotype (Pl. 11, fig. 9).
- E. *Encrinurus* aff. *trispinosus* Reed, Lower Drummuck Group, New Dailly, after HM A. 4097a, b (Pl. 11, fig. 12).
- F. *Encrinurus trispinosus* Reed, Upper Drummuck Group, Ladyburn, after HM A. 970.

Owing to the strong transverse convexity of the glabella, the lateral tubercles in rows I to IV are only seen in side view.

checks opposite middle lateral glabellar lobes, encircled by a broad, shallow, pitted area; another large tubercle placed in front.

BM In. 51476 (Pl. 11, fig. 7; Pl. 12, fig. 1)—internal mould of cranidium. Differs from foregoing specimen chiefly in that glabella is swollen near base of frontal lobe and longitudinal convexity is stronger at front; a small median tubercle, iv-0, is present; row VI is composed of eight small tubercles. There are eight tubercles on the false preglabellar field, four on each side of the median furrow. Fixigenal spines are long, stout, and rounded, directed backwards and gently outwards; four tubercles on border at base of right spine.

GSM 35421, 35420 (Pl. 11, fig. 8)—internal and fragmentary external moulds of a cranidium. Frontal lobe strongly swollen. A large tubercle intercalated between V-1L and VI-1L paired with a minute tubercle on the right side; the occurrence of these

EXPLANATION OF PLATE 11

The photographs are of natural internal moulds unless otherwise stated. The specimens were coated with ammonium chloride before being photographed.

- Figs. 1-5. *Encrinurus praecursor* Tripp. 1, HM A. 4090a, $\times 3$. Cranidium with no adventitious tubercles. Craighead (Kiln) mudstones, Craighead. 2, GSE 11732, $\times 4$. Cranidium with tubercles II-1 joined at the base; three small adventitious tubercles anterior to row V are present. Rubber latex cast from external mould. Mudstones at Trochraigue. 3, HM A. 4091, $\times 4$. Cranidium with tubercles iv-0, v-0 and three small adventitious tubercles anterior to row V present. Craighead (Kiln) mudstones, Craighead. 4, HM A. 4092, $\times 6$. Cranidium showing coalescence of tubercles II-1 at the base. External mould. Craighead (Kiln) mudstones, Craighead. 5, HM A. 4093b, $\times 6$. Cranidium showing coalescence of tubercles II-1 and III-1 at the base; four small adventitious tubercles anterior to row V present. External mould. Craighead (Kiln) mudstones, Craighead.
- Figs. 6-8. *Encrinurus multisegmentatus* (Portlock). Killy Bridge Beds, Desertcreight, Tyrone, Northern Ireland. 6, GSM 35415, $\times 2\frac{1}{2}$. Cranidium figured by Portlock (1843) pl. 3, fig. 11) as *Ampyx baccatus*. Note regularity of the tuberculation except for the extra (fifth) tubercle on the right side of the false preglabellar field. 7, BM In. 51476, $\times 5$. Cranidium possessing tubercle iv-0. 8, GSM 35421, $\times 4$. Cranidium with glabella strongly swollen in front.
- Figs. 9-11. *Encrinurus lamonti* sp. nov. Lower Drummuck Group, east brow of Quarrel Hill, New Dailly, Ayrshire, Scotland. 9, HM A. 4094a, $\times 5$. Holotype, cranidium. 10, HM A. 4095, $\times 5$. Cranidium. 11, HM A. 4096a, $\times 6$. Cranidium.
- Figs. 12-14. *Encrinurus* aff. *trispinosus* Reed. Lower Drummuck Group, East Brow of Quarrel Hill, New Dailly, Ayrshire, Scotland. 12, HM A. 4097a, $\times 4$. Cranidium with a large tubercle iv-0 and a pair of small adventitious tubercles alongside. 13, HM A. 4098, $\times 4$. Cranidium showing arrangement of small adventitious tubercles in circlets around tubercles III-0 and IV-3L. 14, HM A. 4099 (Begg Collection), $\times 2\frac{1}{2}$. Large Cranidium.
- Figs. 15-19. *Encrinurus trispinosus* Reed. Starfish Bed, Upper Drummuck Group, Ladyburn, Ayrshire, Scotland. 15, BM In. 23215 (Gray Collection), $\times 4$. Cranidium with sparse tuberculation, and tubercle iii-0 present; tubercles II-0 and III-0 are replaced by paired tubercles; row VII is lacking. 16, BM In. 46812 (Gray Collection), $\times 3$. Cranidium bearing large tubercles; abnormal in that iv-0 is exceptionally large, and v-0 is lacking. 17, BM In. 23226 (Gray Collection), $\times 2$. Cranidium and thoracic segments, showing axial spines on fifth and seventh rings and pleural spines on sixth segment; five tubercles in rows I, II, and III, tubercle iv-0 large and in line with IV-2. 3. Rubber latex cast from external mould. 18, BM In. 46834 (Gray Collection), $\times 3$. Cranidium with tubercle iv-0 lacking. Rubber latex cast from external mould. 19, HM A. 4002 (Lamont Collection), $\times 3\frac{1}{2}$. Cranidium bearing small, closely spaced tubercles; seven tubercles in row III and row VII well developed. Rubber latex cast from external mould.
- Fig. 20. *Encrinurus laurentinus* Twenhofel. Ellis Bay Formation, Junction Cliff, Anticosti Island. BM In. 19807, $\times 2\frac{1}{2}$. Cranidium showing large VII-0 tubercle.

tubercles may indicate the inception of a new row. Four tubercles on the right side of the false preglabellar field on the external mould; left side not preserved. Surface of tubercles and cheeks granular.

Description of pygidia. Holotype, GSM 35416 (Pl. 12, fig. 4)—internal mould of pygidium. Pygidium six-sevenths as long as wide. Axis one-quarter anterior width of pygidium, narrowing slowly and steadily backwards, imperfectly preserved at front and back; eleventh to twentieth rings distinct laterally, apparently rubbed mesially. Axial furrows moderately deep anteriorly, dying out posteriorly. Postaxial ridge short, flanked by a narrow ridge on left side. Pleural regions gently convex; anterior half-pleurae moderately swollen. Thirteen pairs of pleurae, last pair weakly developed and only one-sixth length of pygidium. Pleurae strongly raised, widening only slowly towards sides, apparently terminating in short free points; anterior pleurae directed outwards and slightly backwards at first, bending downwards and backwards at fulcrum; successive pleurae run more obliquely backwards, hindmost pair subparallel. Interpleural furrows deeply impressed.

GSE 11731 (Pl. 12, fig. 3)—external mould of pygidium. Length two-thirds width of pygidium. Axis one-fifth anterior width of pygidium; thirty axial rings, axial furrows posterior to fifteenth faint, becoming obsolete mesially; third and fourth rings incompletely developed. Thirteen pairs of pleurae. Surface minutely granular, with a row of larger granules along posterior margins of pleurae.

BM In. 51477 (Pl. 12, fig. 5)—internal mould of pygidium, with portion of test preserved at back. Axial rings thirty-two in all, faintly continuous on internal mould, strongly discontinuous on test. Postaxial ridge long and narrow, partially fused with posterior pair of pleurae. Abnormal in that right pleural region is shorter than left and composed of twelve, compared with thirteen, pleurae.

GSM 35417 (Pl. 12, fig. 6)—internal mould of pygidium. Pleural regions bent strongly downwards at fulcrum. Pleurae widen markedly towards sides. Twelfth pair of pleurae meet at posterior tip of pygidium, enclosing the short postaxial ridge.

GSM 35419—internal mould of pygidium. Twelve pairs of pleurae present.

BM In. 51540—external cast of pygidium. Twelve pairs of pleurae present.

Remarks. It is unfortunate that the fine cranidium which Portlock figured is deformed, having five tubercles on the right side of the false preglabellar field; no other specimen belonging to the species-group has been noticed with this abnormality. Despite numerous records of *E. multisegmentatus* from various localities, the only authentic specimens known are those described above, all from the Killey Bridge Beds.

Encrinurus praecursor Tripp

Plate 11, figs. 1-5

Encrinurus praecursor Tripp 1954, p. 681, pl. 4, figs. 13-25.

Diagnosis. Glabella broad posteriorly, strongly convex; frontal lobe not more than half length of glabella. Tubercle formula: I-0; II-III-1, 2, 3; (iv-0); IV-1, 2, 3; (v-0); V-1, 2. Fixed cheeks sparsely tuberculate, with two large tubercles one behind the other.

Horizon and locality. Craighead (Kiln) mudstones (Lower Caradocian), Craighead Quarry, and mudstones at Trochraigue, Ayrshire, Scotland.

Remarks. There is little variation in the arrangement of the first three rows of tubercles; the adventitious tubercle alongside I-0 previously figured (Tripp 1954, pl. 4, fig. 14) is unique. However, tubercles II-1 and III-1 are occasionally joined near the base (Pl. 11, figs. 2, 4, 5), an important point suggesting comparison with the single median tubercle in these rows in other members of the group. The median tubercle v-0, though small, occurs in over half the forty specimens studied. There is great variation in the occurrence of the small tubercles anterior to row V (Pl. 11, figs. 2, 3, 5), but these tubercles are too irregular to be considered as other than adventitious.

Encrinurus sp.

Plate 12, figs. 19-21

Horizon and locality. Cynr-y-brain Beds, 150 yards north-east of Plâs-uchaf, Denbighshire, N. Wales.

EXPLANATION OF PLATE 12

The photographs are of natural internal moulds unless otherwise stated. The specimens were coated with ammonium chloride before being photographed.

- Figs. 1-6. *Encrinurus multisegmentatus* (Portlock). Killy Bridge Beds, Desertcreight, Tyrone, Northern Ireland. 1, BM In. 51476, $\times 1\frac{1}{2}$. Cranidium; see Pl. 11, fig. 7. 2a, b, GSM 35415, $\times 2\frac{1}{2}$. Cranidium, frontal and lateral views; see Pl. 11, fig. 6. 3, GSE 11731, $\times 4$. Pygidium showing granulation and incomplete development of third and fourth axial rings. Rubber latex cast from external mould. 4, GSM 35416, $\times 2\frac{1}{2}$. Holotype, pygidium. Figured by Portlock (1843, pl. 3, figs. 6a, b. 5, BM In. 51477, $\times 2\frac{1}{2}$. Pygidium with long postaxial ridge; abnormal in that there are twelve pleurae on the right side and thirteen on the left. The test is preserved at the back; note discontinuous axial rings. 6, GSM 35417, $\times 2\frac{1}{2}$. Pygidium with twelve pairs of wide pleurae.
- Figs. 7-10. *Encrinurus lamonti* sp. nov. Lower Drummuck Group, east brow of Quarrel Hill, New Dailly, Ayrshire, Scotland. 7a, b, HM A. 4094a, $\times 5$. Holotype, cranidium, frontal and lateral views. 8, HM A. 943b (Lamont Collection), $\times 4$. Right free cheek. Rubber latex cast from external mould. 9, HM A. 4100, $\times 6$. Pygidium showing the row of granules along margins of pleurae. Rubber latex cast from external mould. 10, HM A. 4101a, $\times 4$. Pygidium with paired axial tubercles.
- Figs. 11-17. *Encrinurus trispinosus* Reed. Starfish Bed, Upper Drummuck Group, Ladyburn, Ayrshire, Scotland. 11, BM In. 41279 (Gray Collection), $\times 3$. Cranidium and thoracic segments; note pair of small tubercles alongside tubercle iv-0. Rubber latex cast from external mould. 12, BM In. 41402 (Gray Collection), $\times 2$. Cranidium with a pair of large tubercles alongside, tubercle iv-0 and tubercle IV-1L divided. 13, BM In. 46867 (Gray Collection), $\times 3$. Enrolled dorsal shield; lateral view. Rubber latex cast from external mould. 14, BM In. 46842 (Gray Collection), $\times 2$. Pygidium with fourth and fifth right pleurae joined proximally. Rubber latex cast from external mould. 15, HM A. 4011 (Lamont Collection), $\times 3$. Pygidium showing granulation. External mould. 16a, b. HM A. 4103 (Lamont Collection), $\times 2\frac{1}{2}$. Narrow pygidium with fifth and sixth pleurae joined distally; dorsal and lateral views. 17, HM A. 4003a (Lamont Collection), $\times 3\frac{1}{2}$. Broad pygidium.
- Fig. 18. *Encrinurus* sp. *Tretaspis* Shales, road section south of Lunner, Hadeland, Norway. PM 35059 Høltedahl Collection), $\times 3$. Pygidium with test partly preserved, figured by Stormer (1945, pl. 2, fig. 14) as *E. laurentinus*.
- Figs. 19-21. *Encrinurus* sp. Cynr-y-brain Beds, 150 yds. north-east of Plâs-uchaf, Denbighshire, North Wales. 19, GSM LW 1098, $\times 3$. Right free cheek. 20, GSM LW 1096, $\times 2\frac{1}{2}$. Cranidium. Rubber latex mould from external cast. 21, GSM LW 1096, $\times 2$. Pygidium with eleventh and twelfth left pleurae joined near base; closely associated with cranidium.

Material. Incomplete external mould of cranidium and associated internal mould of pygidium; 1 free cheek.

Description. Glabella elongate and pointed anteriorly, gently convex longitudinally and transversely. Frontal lobe long and narrow; posterior part of glabella not preserved. False preglabellar field separated from glabella by a narrow furrow, and divided by a broad median furrow. Fixed cheeks narrow, strongly convex. Palpebral lobes stout, situated close to glabella; palpebral furrows shallow and broad. Lateral borders broad; fixigenal spines short, broad-based, directed backwards and gently outwards. Cranidium bears large, rounded tubercles arranged as follows: III-0, 1, 2; IV-V-VI-1, 2, 3; VII-1, 2. Four tubercles on each side of false preglabellar field. Fixed cheeks coarsely tuberculate; one large tubercle opposite palpebral lobe, and another in front of it; a row of small tubercles just above base of palpebral lobe. A few tubercles near base of genal spines.

Eye stalks stout, with scattered tubercles at base. Free cheeks narrow, with three tubercles in inner area. Pseudoglabellar areas large, tubercles three deep. Lateral borders narrow; one main row of tubercles, decreasing in size away from axial furrow, and a few smaller, scattered tubercles.

Pygidium longer than wide. Axis one-quarter anterior width of pygidium, axial rings faintly continuous; postaxial ridge one-eighth length of pygidium. Axial furrows deep and broad at front, becoming faint posteriorly. Pleural lobes strongly convex, composed of thirteen pairs of pleurae; eleventh and twelfth left pleurae joined near base. Interpleural furrows relatively shallow.

Encrinurus trispinosus Reed

Plate 11, figs. 15-19; Plate 12, figs. 11-17

Encrinurus multisegmentatus Reed 1906, p. 122, pl. 16, figs. 9-11a.

Encrinurus multisegmentatus var. *trispinosus* Reed 1914, p. 39, pl. 7, figs. 1-3.

Encrinurus multisegmentatus var. *girvanensis* Reed 1935, p. 50, pl. 4, fig. 9.

Diagnosis. Glabella subpentagonal, moderately convex; frontal lobe about four-sevenths length of glabella. Tubercle formula: I-0, 1; II-0, 1, 2; (iii-0); III-0, 1, 2; iv-0; IV-1, 2, 3; v-0; V-1, 2, 3; vi-0; VI-1, 2, 3; (VII-0, 1, 2, 3). Fixed cheeks coarsely tuberculate, with one large tubercle at the front.

Horizon and locality. Starfish Bed, Upper Drummuck Group, Ladyburn, Ayrshire, Scotland.

Remarks. Reed does not state the features which distinguish his subspecies *girvanensis* from *trispinosus*, but he makes no mention of thoracic spines in the description of the former, and it seems that he regarded the absence of spines as the diagnostic character. Certainly, thoracic spines are not distinguishable on the holotype of *girvanensis*, but only the internal mould is preserved, and spines are rarely preserved on internal moulds. A large number of external moulds have been examined, and all show a pair of pleural spines on the sixth segment, a small axial spine on the fifth ring and a large spine on the seventh ring (there is no axial spine on the sixth ring, contrary to Reed's statement).

Even if thoracic spines are occasionally absent, this is not necessarily a matter of taxonomic importance. There is no other significant difference between the holotype of *girvanensis* and specimens referable to *E. trispinosus*, and consequently the two forms are considered synonymous.

The size and arrangement of the glabellar tubercles is much more variable in *E. trispinosus* than in the other species of the group. It is quite common for any of the regular tubercles, particularly the lateral ones (Pl. 11, fig. 19), to subdivide, and adventitious tubercles are frequent. *E. trispinosus* is distinguished in having tubercles on the posterior lateral glabellar lobes; adventitious tubercles occur on about one-third of the specimens between the lateral and median tubercles (Pl. 11, figs. 16, 17, 18), corresponding with the rows in front. The median tubercle iv-0 is rarely absent (Pl. 11, fig. 18); it sometimes occurs between rows III and IV (Pl. 11, fig. 16), but it is often situated anteriorly, displacing tubercles IV-1 towards the front (Pl. 11, figs. 17, 18). This tubercle iv-0 is frequently flanked by a pair of tubercles (Pl. 12, figs. 11, 12) which appear as small, posteriorly placed, adventitious tubercles in the Lower Drummuck form related to this species (Pl. 11, figs. 12, 14). *E. punctatus* has a pair of large tubercles in corresponding positions (Rosenstein 1941, pl. 1, fig. 1). Tubercle v-0 is present in all except one of the specimens of *E. trispinosus* studied (Pl. 11, fig. 16) and tubercle vi-0 is usually present also. Row VII is composed of well-formed tubercles in about half the specimens (Pl. 11, fig. 19), and it often includes a median tubercle, which sometimes occurs alone (Pl. 11, fig. 16). The cranidium figured as Pl. 11, fig. 15 is an unusual variant. The tuberculation is sparse, and the glabella is short and broad posteriorly. It is one of the few specimens possessing tubercle iii-0, and tubercles II-0 and III-0 are replaced by paired tubercles; the tendency towards a quincunxial arrangement might account for this modification, but the arrangement of the tubercles is reminiscent of that in *E. praecursor*.

Encrinurus aff. *trispinosus* Reed

Plate 11, figs. 12-14

Horizon and locality. Lower Drummuck Group, east brow of Quarrel Hill, New Dailly, Ayrshire, Scotland.

Remarks. This form may be closely compared with simple specimens of *E. trispinosus*. It differs from *E. trispinosus* and approaches *E. multisegmentatus* in the less uniform size of the cranidial tubercles, and in the occurrence of a large tubercle on the fixed cheek opposite the palpebral lobe. There is a tendency for small adventitious tubercles to be arranged in a circler round one of the main tubercles (Pl. 11, fig. 13).

Encrinurus lamonti sp. nov.

Plate 11, figs. 9-11; Plate 12, figs. 7-10

Diagnosis. Glabella broad and inflated anteriorly, strongly convex longitudinally; frontal lobe more than half length of glabella. Tubercle formula: I-0; II-0, 1; III-0, 1, 2; IV-V-1, 2, 3; VI-1, 2. Fixed cheeks sparsely tuberculate, with largest tubercle opposite palpebral lobe.

Horizon and locality. Lower Drummuck Group, east brow of Quarrel Hill, New Dailly, Ayrshire, Scotland.

Holotype. HM A. 4094a, b (cranium). Pl. 11, fig. 9; Pl. 12, figs. 7a, b.

Other material. 2 cranidia, 7 free cheeks, 4 pygidia.

Dimensions

	<i>Holotype</i>	<i>HM</i> <i>A. 4096 a, b</i>
Median length of cranium	5.5 mm.	4.8 mm.
Length of glabella	4.4 mm.	3.9 mm.
Width across false preglabellar field	6.5 mm.	5.7 mm.
Width of glabella across basal lobes	2.3 mm.	2.2 mm.

Description. Cranium elliptical in outline; fixed cheeks gently swollen; fixigenal spines not preserved. Glabella subrhomboidal, depressed at back, strongly inflated anteriorly. Frontal lobe widely expanded, gently rounded in outline, extending for more than half length of glabella. Lateral lobes represented by swellings on lateral slopes of glabella, posterior pair consisting of faint ridges reaching to a median tubercle. Lateral furrows broad, defined only at sides. Occipital ring short, strongly convex. Apodemes near extremities of lateral and occipital furrows, anterior pair weakly developed. Axial furrows deep; large anterior pits immediately behind facial sutures. False preglabellar field separated from glabella by a shallow furrow, and divided by a broad median furrow, sloping steeply forwards and downwards. Fixed cheeks narrow, strongly convex. Palpebral lobes large and elevated, situated close to glabella and opposite middle lateral furrows; palpebral furrows broad, encircling base of lobes. Posterior borders short, transverse proximally; posterior border furrows well defined. Cranium bears elongated dome-shaped tubercles. A small median tubercle, I-0, between basal lateral ridges. Small tubercles, II-1 and III-2, surmount the middle and anterior lateral lobes respectively; on the frontal lobe, two rows of six tubercles, IV-V-1, 2, 3, and one row of four, VI-1, 2. Smaller adventitious tubercles, irregularly placed, at the front. Four large tubercles on each side of false preglabellar field. Fixed cheeks sparsely tuberculate; one large tubercle opposite middle lateral lobes, and another opposite anterior lateral furrows. Palpebral lobes with four tubercles near base, and scattered small tubercles above.

Eye stalks slender, with a row of small tubercles near base. Free cheeks narrow, sloping steeply outwards; inner areas sparsely tuberculate. Pseudoglabellar areas large and swollen, with scattered tubercles up to four deep. Lateral and false anterior borders narrow, continuous, weakly convex, narrowing rapidly anteriorly; two rows of tubercles and a few scattered ones outside; posterior inner areas smooth. Border furrows broad and shallow.

Pygidium composed of about thirty-two axial rings and twelve to fourteen pairs of pleurae. Axis one-quarter anterior width of pygidium, narrowing slowly backwards; axial rings barely continuous at back on internal moulds, discontinuous behind the fifth ring on external moulds. Postaxial ridge short. Axial furrows well developed anteriorly, dying out posteriorly. Pleural regions strongly convex; anterior half-pleurae

moderately swollen. Pleurae strongly raised, widening little towards sides, terminating in short, free points. Interpleural furrows deeply impressed. HM A. 4101a, b (Pl. 12, fig. 10) shows paired axial tubercles on seventh, eleventh, seventeenth, and twenty-fourth rings, and tubercles on pleurae. A row of granules along anterior and posterior margins of pleurae.

Remarks. Our new species differs from *E. trispinosus* and resembles *E. multisegmentatus* in having no tubercles on the basal lateral lobes, only three tubercles in row II, and no inter-row tubercles. *E. lamonti* resembles the specimen of *E. multisegmentatus* with the swollen frontal lobe (Pl. 12, fig. 8) so closely that the writer was formerly inclined to regard the new form as a subspecies (Tripp 1954, p. 683). Two types of encrinurid free cheek occur in the Lower Drummuck Group; that with sparse tuberculation (Pl. 12, fig. 8) is provisionally attributed to *E. lamonti*, that with strong tuberculation to *E. aff. trispinosus*, in accordance with the characters of the fixed cheeks. In this respect *E. lamonti* occupies an intermediate position between *E. praecursor* and *E. trispinosus*. The pygidia referred to *E. lamonti* differ from those included in *E. aff. trispinosus* in having the granules restricted to the anterior and posterior margins of the pleurae (Pl. 12, fig. 9), as in *E. praecursor* (Tripp 1954, pl. 4, fig. 18b).

Encrinurus laurentinus Twenhofel

Plate 11, fig. 20

Encrinurus laurentinus Twenhofel 1928, p. 328, pl. 59, figs. 2-5.

Diagnosis. Glabella rounded, swollen anteriorly; frontal lobe approximately three-fifths length of glabella; tubercle formula: I-0; II-0, 1; III-0, 1, 2; IV-1, 2, 3; (v-0); V-VI-1, 2, 3; VII-0. Fixed cheeks devoid of large tubercles.

Horizons and localities. English Head (Richmondian) to Ellis Bay (Gamachian) Formation, Anticosti Island, North America.

Remarks. This species bears a closer resemblance to *E. lamonti* than to *E. multisegmentatus*, but differs from both in the shape of the glabella and in the more uniform size of the tubercles on the cranidium. The pygidium from the *Tretaspis* Shales referred to *E. laurentinus* by Størmer (1945, p. 411, pl. 2, fig. 14; this paper, Pl. 12, fig. 18) does not appear to belong to this species, though it may well be a member of the group; pygidial characters alone are not diagnostic. The specimen demonstrates clearly how the furrows are fainter on the external surface than on the internal.

COMPARISON OF THE *E. MULTISEGMENTATUS* GROUP WITH
OTHER SPECIES

The character of the false preglabellar field distinguishes the *E. multisegmentatus* group from almost all other known forms. The cranidium from the Slade Beds (SM A. 30718), referred by Reed (1904, p. 387) to *E. multisegmentatus*, has nine tubercles on the false preglabellar field and no median depression, and the same applies to the cranidium

from the Estonian Lyckholm Formation, figured as *E. cf. multisegmentatus* by Schmidt (1881, pl. 15, figs. 19a, b, c). Both these forms may be distantly related to our group.

The *E. multisegmentatus* group resembles *E. punctatus* (Wahlenberg), the type species of *Encrinurus*, in certain important features. Many Swedish, most British, and apparently all Estonian (Rosenstein 1941, p. 52) specimens of *E. punctatus* have eight tubercles on the false preglabellar field, though the field is not distinctly divided or separated from the glabella. As Rosenstein (1941, p. 55) has shown, the main glabellar tubercles of *E. punctatus* are symmetrically arranged in transverse rows; the pattern is fundamentally similar to that in the *E. multisegmentatus* group, although the shape of the glabella is quite different. It is intended to discuss *E. punctatus* and some other Silurian forms in a subsequent paper.

GENERAL REMARKS

1. The chief diagnostic feature of the *Encrinurus multisegmentatus* species-group lies in the false preglabellar field, which is separated from the glabella by a broad furrow and is itself parted by a well-defined median furrow, with four tubercles on each side.
2. The basic arrangement of the main glabellar tubercles is constant in each species. Adventitious tubercles occur also, and are particularly numerous on some specimens of *E. trispinosus*, in which they are often as large as the main tubercles and indistinguishable from them except in position.

TABLE SHOWING THE BASIC NUMBER OF GLABELLAR TUBERCLES IN EACH TRANSVERSE ROW IN THE SPECIES OF THE *E. MULTISEGMENTATUS* GROUP

species	row										
	I	II	III	iv	IV	v	V	vi	VI	VII	
<i>E. praecursor</i> Tripp	1	6	6	..	6	(1)	4	..	..	..
<i>E. multisegmentatus</i> (Portlock)	1	3	5	..	6	..	6	..	6	..	
<i>E. lamonti</i> sp. nov.	1	3	5	..	6	..	6	..	4	..	
<i>E. laurentinus</i> Twenhofel	1	3	5	..	6	..	6	..	6	1	
<i>E. sp.</i> , Cynr-y-brain Beds	?	?	5	..	6	..	6	..	6	4	
<i>E. aff. trispinosus</i> Reed	3	5	5	1	6	(1)	6	..	6	..	
<i>E. trispinosus</i> Reed	3	5	5	1	6	1	6	1	6	(7)	

Rows I, II, and III occur opposite the posterior, middle, and anterior lateral lobes respectively; the remaining rows are situated on the frontal lobe.

3. There is a marked gradation in the arrangement of the glabellar tubercles in the species discussed. *E. praecursor* is distinguished by having six tubercles in rows II and III, but the partial fusion of the two middle tubercles in some specimens (Pl. 11, fig. 5) indicates their equivalence to the single median tubercle in these rows in the other members of the group. *E. multisegmentatus*, *E. lamonti*, and *E. laurentinus* are almost identical in the arrangement of the glabellar tubercles; *E. trispinosus* is much more complex.

4. The density of tuberculation on the fixed and free cheeks differs considerably both between specimens of the same species (Pl. 11, figs. 15 and 17) and between different species. One or two tubercles on the fixed cheeks are much larger than the rest, except in *E. laurentinus*.

5. The thorax is known only in *E. trispinosus* and in one specimen of *E. praecursor*. In both forms there are spines on the fifth and seventh axial rings, and on the sixth pair of the pleurae.

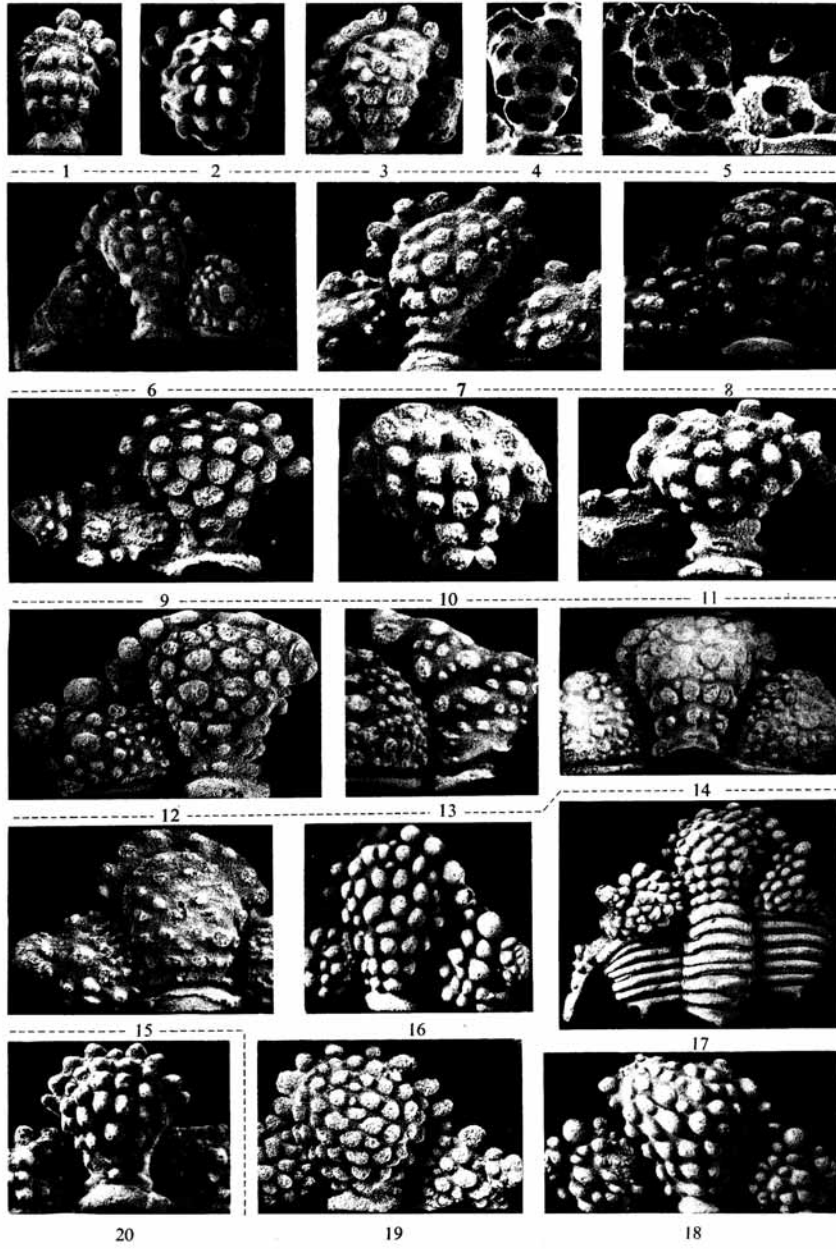
6. The pygidium is distinguished by the large number of axial rings and pairs of pleurae which it carries. The rings are faintly continuous on the internal surface, but become discontinuous posteriorly on the external surface (Pl. 12, fig. 18). Within specific limits pygidia vary in relative proportions (Pl. 12, figs. 16a, 17), in numbers of pairs of pleurae (Pl. 12, figs. 4, 5, 6), and in possession of axial tubercles (Pl. 12, fig. 10; Twenhofel 1928, pl. 49, fig. 3; Tripp 1954, pl. 4, fig. 24). There is a tendency for adjacent pleurae to unite (Pl. 12, figs. 14, 16, 21; Tripp 1954, pl. 4, fig. 22).

REFERENCES

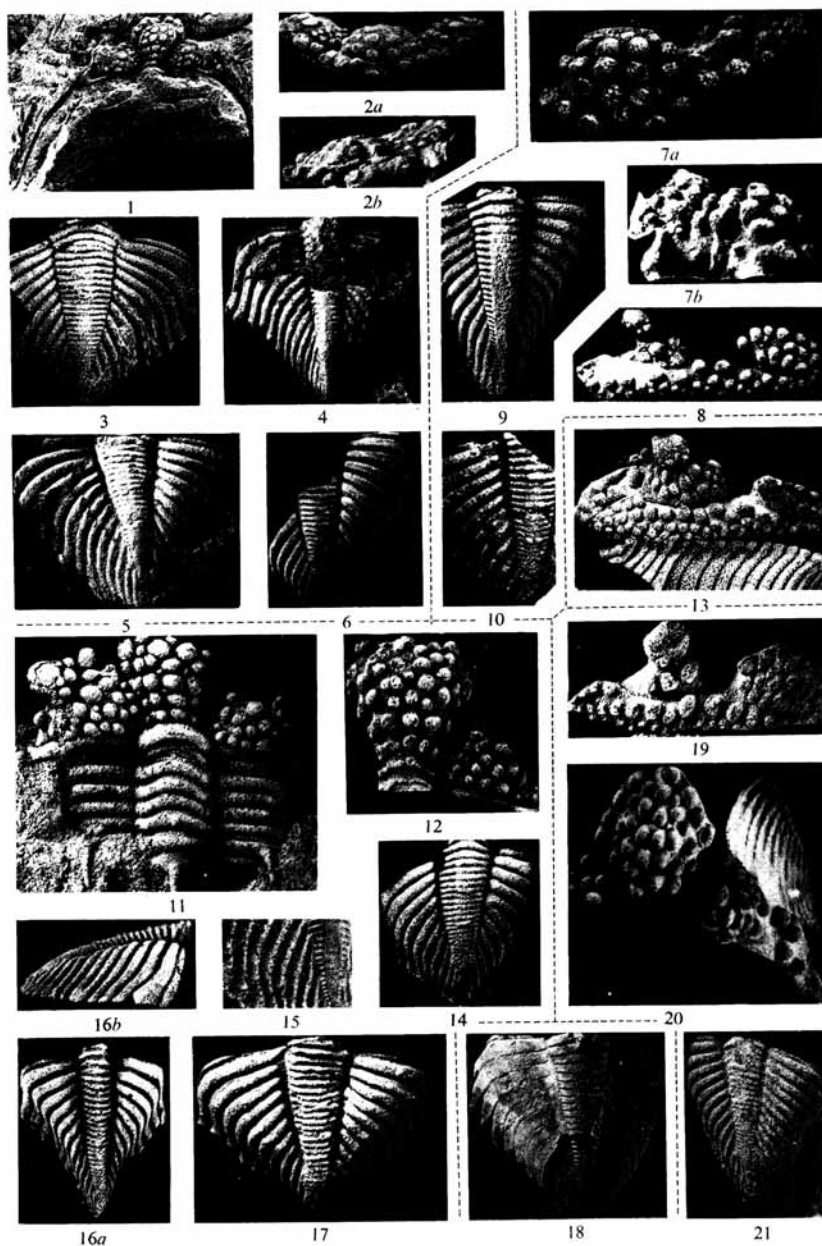
- LAMONT, A. 1935. The Drummuck Group, Girvan; a stratigraphical revision, with descriptions of new fossils from the lower part of the Group. *Trans. Geol. Soc. Glasg.* **19**, 288-334, pl. 7-9.
- PORTLOCK, J. E. 1843. *Report on the Geology of the County of Londonderry and parts of Tyrone and Fermanagh*. Dublin and London.
- REED, F. R. C. 1904. Fossils from the Haverfordwest District, II. *Geol. Mag.* (5), **1**, 383-8, pl. 12.
- 1928. Notes on the Family Encrinuridae. *Geol. Mag.* **65**, 51-77.
- 1903-35. The Lower Palaeozoic Trilobites of the Girvan District, Ayrshire. *Palaeont. Soc.*, 1904, pt. 2, 49-96, pl. 7-13; 1914, *ibid.*, suppl., 1-56, pl. 1-8; 1935, *ibid.*, suppl. 3, 1-64, pl. 1-4.
- ROSENSTEIN, E. 1941. Die *Encrinurus*-Arten des estländischen Silurs. *Geol. Inst. Univ. Tartu.* **62**, 73-77, pl. 1-4.
- SCHMIDT, F. 1881. Revision der Ostbaltischen silurischen Trilobiten. I. *Acad. Imp. des Sci. St.-Petersbourg Mém.* (7), **30**, 1-237, pl. 1-14.
- STØRMER, L. 1945. Remarks on the Tretaspis (Trinucleus) Shales of Hadeland. *Norks. geol. Tidsskr.* **25**, 379-425, pl. 1-4.
- TEMPLE, J. T. 1956. Notes on the Cheiruracea and Phacopacea. *Geol. Mag.* **93**, 418-30.
- TRIPP, R. P. 1954. Caradocian Trilobites from mudstones at Craighead Quarry, near Girvan, Ayrshire. *Trans. Roy. Soc. Edin.* **62**, 655-93, pl. 1-4.
- TWENHOFEL, W. H. 1928. Geology of Anticosti Island. *Geol. Surv. Canada, Mem.* **154**, 1-481, pl. 1-60.
- WARBURG, E. 1925. The Trilobites of the *Leptaena* Limestone in Dalarne. *Bull. geol. Inst. Univ. Upsala*, **17**, 1-446, pl. 1-11.

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