

ASHGILLIAN TRILOBITES FROM CO. CLARE, IRELAND

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ABSTRACT. Fifteen species are described and figured, including *Corrugatagnostus convergens* sp. nov., *Shumardia extensa* sp. nov., *Phylacops bituberculatus* sp. nov., and *Dindymene ovalis* sp. nov.; *Thomondia globosa* Harper is redescribed from additional material and assigned to the Family Isocolidae. The trilobites were collected from a thin band in the brown mudstone horizon constituting the lower part of the Ballyvorgal Group, a new division at the top of the Ordovician succession in the Slieve Bernagh Mountains. The fauna has close affinities with that of the Upper Whitehouse Beds (Ashgillian) of the Girvan district, Scotland, and appears to be largely of Bohemian origin.

INTRODUCTION

THIS paper is a systematic description of a trilobite fauna first discovered by Kinahan in brown mudstones cropping out in the stream forming the south-eastern boundary of the townland of Ballyvorgal South, at the south-western end of the Slieve Bernagh Mountains, $2\frac{3}{4}$ miles north-east of the village of Sixmilebridge, Co. Clare. It is proposed that these mudstones, and the overlying brown shales, be termed the Ballyvorgal Group. Baily (*in* Foot and Kinahan 1862, p. 10) gave a short account of the fauna, recognizing its Bohemian affinities, and in 1885 published another short note. In 1939 Stubblefield (p. 61) noted the affinities of the fauna with that of the Upper Whitehouse Beds of the Girvan district; in that year also, Harper (*in* Smyth and others, p. 303) reported the occurrence of the zonal graptolite *Dicellograptus complanatus* a foot below the trilobite bed. Harper (1942) described a new trilobite genus *Thomondia* from the locality and added *Aagnostus perrugatus* to Baily's fossil list. Baily's material is no longer available for study but Stubblefield (1939) interpreted Baily's (1862) illustration of *Olenus?* as being of Barrande's genus *Bohemilla*, an opinion upheld by Harper (*in* Smyth and others 1939) and by Whittard (1952).

The material on which this paper is based was collected by the writer in the course of a revision of the Lower Palaeozoic geology of the area, for which he wishes to acknowledge receipt of a Maintenance Grant from the Department of Scientific and Industrial Research. The writer also wishes to thank the Director of the Geological Survey of Ireland for access to field maps and for the loan of specimens; the British Museum (Natural History) and the Geological Survey of Great Britain for access to fossil collections; also Professor A. Williams, Professor H. B. Whittington, and Mr. R. P. Tripp for guidance, and especially Professor Williams and Mr. Tripp for criticizing the manuscript.

The terminology used is that used in the forthcoming trilobite part of the *Treatise on Invertebrate Paleontology*, which is based on that used by Warburg (1925, p. 7); where possible, dimensions refer to external moulds, although internal moulds are generally more complete and then have to be employed. The type and figured specimens have been presented to the British Museum (Natural History).

SYSTEMATIC ACCOUNT

Family AGNOSTIDAE Hawle and Corda 1847

Genus CORRUGATAGNOSTUS Kobayashi 1939

Corrugatagnostus convergens sp. nov.

Plate 62, figs. 17-19

1862 *Olenus?* Baily, p. 10, fig. 1a.1939 *Agnostus* cf. *perrugatus* Harper (in Smyth and others), p. 303.1942 *Agnostus* cf. *perrugatus* Harper, p. 276.

Material. Holotype: B.M. In. 53367 (cephalon), Pl. 62, fig. 19; dimensions of holotype: length of cephalon 3.2 mm., breadth of cephalon 3.4 mm., length of glabella 2.4 mm. Paratypes: B.M. In. 53368 (pygidium), Pl. 62, fig. 17; B.M. In. 53369 (cephalon), Pl. 62, fig. 18. Other material: 5 cephalata, 2 pygidia.

Horizon and locality. Ballyvorgal Group (Ashgillian), Ballyvorgal South, Co. Clare, Ireland.

Diagnosis. *Corrugatagnostus* with median furrow on preglabellar field reaching anterior border, flanked by two converging furrows not reaching border. Anterior and middle glabellar lobes bearing elongate median ridges.

Description. Cephalon moderately convex, nearly square in outline, anterior margin smoothly rounded. Glabella two-thirds the cephalic length, axial furrows strongly impressed, preglabellar furrow less strong; divided into three lobes, the two anterior of equal length and together occupying half the glabellar length; basal lateral lobes large and triangular. Lateral glabellar furrows incomplete, chevron-shaped, deeply impressed. Middle and posterior glabellar lobes produced forwards in axial line to form ridges lying on lobe in front, that on anterior lobe half length of lobe, that on middle lobe extending full length of lobe. Cheeks moderately convex, uniting in front of glabella in broad preglabellar field and bearing shallow radial furrows extending inwards from border furrows, alternate furrows reaching glabella; several furrows bifurcate near border. Median furrow becoming weaker anteriorly, reaching anterior border; two adjacent furrows converging and dying out before reaching anterior border furrow. Borders strongly convex, nearly horizontal, border furrows strongly impressed.

Pygidium gently convex, almost square, posterior margin rounded. Axis nearly flat, half the pygidial length, margins bent down steeply; divided into two equal parts by second ring furrow. Anterior part tapering posteriorly, consisting of two rings, each bearing a narrow median ridge. Posterior part consisting of a simple ring squarely terminated by broad and deep axial furrow. Pleural regions bearing radial furrows, more anastomosing than those on cephalic cheek lobes. Border furrows shallow. Borders broad, smooth, gently convex, nearly horizontal, produced into a pair of short triangular spines at posterior angles. Thorax unknown.

Remarks. The cephalon appears to represent a type intermediate between *Corrugatagnostus morea* (Salter) from the D₇¹ beds (Llanvirn-Llandeilo) of Bohemia (Whittard 1956, p. 12, text-fig. 2b), in which the three median furrows on the preglabellar field converge and do not reach the anterior border furrow, and *C. sol* Whittard from the Upper Whitehouse Group (Ashgillian) of Girvan (1956, pl. 1, fig. 12; Reed 1904, pl. 1,

fig. 5) in which the furrows are parallel and reach the anterior border furrow. The two posterior glabellar lobes are extended forwards into discrete median ridges as in *C. morea*, but the ridges are of much greater length than in that species. The pygidium is squarer in outline than in either *C. morea* or *C. sol*, the axis is relatively broader and the posterior lobe more square in outline.

Genus TRINODUS M'Coy 1846

Trinodus? sp.

Plate 63, fig. 9

One incomplete cephalon may be referable to this genus.

Family TRINUCLEIDAE Hawle and Corda 1847

Subfamily NOVASPINAE Whittington 1941

Genus NOVASPIS Whittington 1941

Novaspis aff. *albida* (Reed).

Plate 62, figs. 5-8

1862 *Trinucleus concentricus* Baily, p. 10.

1885 *Trinucleus concentricus* Baily, p. 29.

1939 *Trinucleus* sp. Harper (in Smyth and others), p. 303.

1942 *Trinucleus* sp. Harper, p. 276.

Material. Two cephalata with portions of upper lamella of fringe, three cephalata without fringe, five fragments of lower lamella, two fragments of upper lamella, five pygidia.

Description. Cephalon moderately convex, semicircular, twice as long as broad, posterior margin straight, produced into divergent genal spines. Glabella twice as long as broad, tapering posteriorly, expanded anteriorly into a strongly arched anterior lobe standing high above cheek lobes. Weak glabellar furrows form shallow pits behind anterior lobe. Cheeks as wide as long, posterolateral angles rounded. Posterior border upturned and extended laterally to support fringe; posterior border furrows broad and deeply impressed. Surface apparently smooth.

Fringe imperfect in all specimens; lower lamella produced into divergent genal spines of unknown length, bearing two E-rows of pits, the eight posterior pits in each row combining to form a single row of twin-pits. In upper lamella, fringe formula of I-rows I_1 1-19, I_2 1-19, I_3 18-19, I_4 19, with a pit in IRxix between I_3 and I_4 . One anterior fragment of the outer part of the fringe probably belongs to the upper lamella; there are two rows of pits, in which the three anterior are combined as twin-pits.

Pygidium sub-triangular, $2\frac{1}{2}$ times as broad as long; axis gently convex, narrow, conical, the length of the pygidium, produced posteriorly into a short triangular tubercle; divided into seven rings, the first four distinctly defined. Pleural regions flattened, borders moderately convex and bent down vertically, wide laterally, narrowing to axial line. Three pairs of straight pleurae, two anterior distinctly defined, corresponding to two anterior axial rings; interpleural furrows moderately strongly impressed towards axis, becoming shallower outwards.

Remarks. In all features, including characters of the fringe, where determinable, the cephalon agrees with that of *Novaspis albida* (Reed) from the Upper Whitehouse Group, originally described as *Trinucleus* sp. ind. *b* (Reed 1904, p. 14, pl. 2, figs. 8, 8a), and subsequently assigned by the same author to the new species *T. albidus* (1914, p. 3, pl. 1, figs. 1, 2). Whittington (1941, p. 40) referred this species to *Novaspis*. The pygidium closely resembles that from Whitehouse described by Reed as *Trinucleus* sp. ind. *f*. (1904, p. 16, pl. 2, fig. 11).

Family DIONIDIDAE Gürich 1907, emend. Raymond 1920

Genus DIONIDE Barrande 1847

Dionide aff. *richardsoni* Reed

Plate 63, figs. 7, 8

Material. Three incomplete cephalon, four pygidia.

Description. Cephalon gently convex, sub-semicircular in outline, $2\frac{1}{2}$ times as long as broad, posterior margin straight, anterior margin rounded. Glabella gently convex, out-

EXPLANATION OF PLATE 62

The photographs are of natural internal moulds unless otherwise stated; they are untouched except for blacking-out of the matrix with process black. The specimens were lightly coated with ammonium chloride before being photographed.

- Figs. 1-4. *Phylacops bituberculatus* sp. nov. 1, B.M. In. 53392. Holotype, cephalon; 1a, dorsal view $\times 10$, showing large paired tubercles beside glabellar furrows; 1b, anterior view $\times 10$, showing eyes separated by narrow band devoid of facets; 1c, lateral view $\times 10$, showing right glabellar furrow and tubercle, and eye facets arranged in horizontal rows. 2, B.M. In. 53393, $\times 10$. Paratype, pygidium, showing weakly segmented axis and faint interpleural furrows. 3, B.M. In. 53394, $\times 10$. Late transitory pygidium with one segment in front of incompletely segmented posterior part. 4, B.M. In. 53395, $\times 10$. Transitory pygidium with five fused segments.
- Figs. 5-8. *Novaspis* aff. *albida* (Reed). 5, B.M. In. 53370. Small cephalon lacking most of fringe. 5a, Dorsal view $\times 10$, showing fragments of inner part of upper lamella of fringe; 5b, lateral view $\times 10$, showing arrangement of pits at posterolateral angle of fringe. 6, B.M. In. 53371, $\times 3$. Fragment of posterior part of fringe of large individual; lower lamella, showing twinning of pits adjacent to girder. 7, B.M. In. 53372, $\times 10$. Fragment of anterior part of fringe of small individual; external part of upper lamella, showing two rows of pits, the five anterior combined as twin-pits. 8, B.M. In. 53373, $\times 15$. Small pygidium.
- Figs. 9-10. *Dindymene ovalis* sp. nov. 9, B.M. In. 53388, $\times 7$. Holotype, cephalon, showing rounding of genal angles, nearly straight axial furrows and posterior border furrows terminating adaxially in pits. 10, B.M. In. 53389, $\times 15$. Paratype, pygidium, showing eight axial rings.
- Figs. 11-15. *Thomondia globosa* Harper. 11, B.M. In. 53377, $\times 20$. Incomplete cephalon, external mould, showing facial suture outside lateral border furrow. 12, B.M. In. 53380, $\times 25$. Pygidium, external mould. 13, B.M. In. 53379, cranidium; 13a, lateral view $\times 20$; 13b, dorsal view $\times 20$. 14, B.M. In. 53378, $\times 20$. Incomplete cephalon, external mould, showing right genal spine and posterior branch of facial suture. 15, B.M. In. 53376, $\times 15$. Crushed dorsal shield with thorax impacted into pygidium.
- Fig. 16. *Pseudosphaerexochus* sp. B.M. In. 53387, $\times 10$. Incomplete cranidium.
- Figs. 17-19. *Corrugatagnostus convergens* sp. nov. 17, B.M. In. 53368, $\times 10$. Paratype, pygidium, showing almost square axis. 18, B.M. In. 53369, $\times 10$. Paratype, cephalon, showing glabellar lobes produced forwards into discrete median ridges (posterior ridge damaged). 19, B.M. In. 53367, $\times 10$. Holotype, cephalon, showing median furrow on preglabellar field reaching anterior border, and flanking furrows converging but not reaching border.
- Fig. 20. *Remopleurides* sp. B.M. In. 53374, $\times 10$. Cranidium.

line subquadrate, smoothly rounded in front, three-quarters the cephalic length, axial and preglabellar furrows narrow. Cheeks gently convex, outline sub-triangular, margins steeply sloping. Genal caecae consisting of two ill-defined ridges commencing at half glabellar length, diverging and reuniting at posterolateral angle of cheek. Fringe moderately broad, continuing in front of glabella; cheeks and fringe bearing small pits in irregular arrangement. Posterior borders short (sag.), moderately convex, furrows broad and deeply impressed.

Pygidium semicircular in outline, slightly convex, length equal to breadth; axis gently convex, almost reaching posterior margin, conical, tapering from one-sixth the pygidial breadth anteriorly to a pointed termination, divided into twelve axial rings decreasing in sagittal length posteriorly, each bearing three circular muscle impressions, two lateral and one median. Pleural lobes flattened, margin bent downwards; twelve pairs of pleurae, widening gradually towards sides. Anterior pair directed outwards initially, bending downwards and slightly backwards beyond fulcrum; successive pleurae run more obliquely backwards with more acute bending beyond fulcrum. Interpleural furrows narrow and deeply impressed, not reaching margins. Inner parts of pleural regions bearing fine concentric ridges; outer parts smooth.

Remarks. In most observed characters the specimens agree with *Dionide richardsoni* Reed, first recorded (Reed 1904, p. 26, pl. 4, figs. 3-8) from the Drummuck Group (Upper Ashgillian) of the Girvan district, and subsequently by the same author from the Upper Whitehouse Group (1914, p. 5, pl. 1, fig. 3); but the glabellae of the Irish specimens are damaged and their features obscured. The fringe is more clearly demarcated from the cheeks than in the Girvan specimens; the pygidium agrees in all respects.

Family REMOPLEURIDIDAE Hawle and Corda 1847

Genus REMOPLEURIDES Portlock 1843

Remopleurides sp.

Plate 62, fig. 20

Material. One cranium.

Description. Glabella moderately convex, sub-pentagonal, rounded in front, three-quarters as broad as long, anterior tongue one-fifth the glabellar length and one half its breadth, bent sharply downwards; two pairs of forwardly-diverging lateral glabellar furrows. Palpebral furrows weak, palpebral lobes narrow, linear. Occipital furrow deep, occipital ring long (sag.), becoming shorter laterally, strongly convex and moderately arched transversely. Surface apparently smooth.

Remarks. Some large eyes provisionally assigned to this genus by Bailly (1862, p. 10) may belong to *Symphysops*; Bailly's material is not available for study.

Family TELEPHINIDAE Marek 1952

Genus TELEPHINA Marek 1952

Telephina aff. *reedi* (Ulrich)

Plate 63, fig. 1

Material. Four cranida, one almost complete.

Description. Cranidium strongly convex, sub-pentagonal in outline, as long as broad; glabella extending to anterior border and two-thirds the cranial breadth, strongly convex, tapering slightly forwards, anterior margin truncated and overhanging anterior border; posterior half bearing a faint ridge and numerous closely-set tubercles in irregular arrangement. Axial furrows broad and deeply impressed, becoming shallow forwards, preglabellar furrow broad but not deeply impressed; occipital furrow broad and shallow, almost dying out laterally, strongly arched forwards; occipital ring long (sag.) in axial line, strongly arched transversely and bearing base of median spine. Fixed cheeks crescentic in outline, strongly convex, breadth one-quarter the glabellar breadth. Palpebral lobes narrow, sickle shaped, extending the length of the fixed cheek, slightly concave behind and weakly convex in front; palpebral furrows broad and shallow, confluent anteriorly and posteriorly with axial furrows. Anterior border narrow, vertical, bearing a pair of short and slightly divergent spines directed vertically downwards.

Remarks. The anteriorly truncated glabella suggests relationship with *Telephina reedi* (Ulrich) from the Upper Whitehouse Group, the only species so far described with that feature (Ulrich 1930, p. 19, pl. 1, fig. 1; copy of Reed 1904, pl. 4, fig. 11); the species was first recorded by Reed (1904, p. 44) as *T. fractus* Barrande. The two cranidia here discussed differ from this and from other species in the strong convexity and relative narrowness of the glabella, but whether these differences are constant features of the Irish stock remains to be seen.

Family SHUMARDIIDAE Lake 1907

Genus SHUMARDIA Billings 1865

Shumardia extensa sp. nov.

Plate 63, figs. 5, 6

Holotype. B.M. In. 53383 (cephalon) Pl. 63, fig. 5. Dimensions: length of cephalon 1.3 mm., breadth of cephalon 2.5 mm., length of glabella 1.2 mm., breadth of glabella 1.2 mm.

Horizon and locality. Ballyvorgal Group (Ashgillian), Ballyvorgal South, Co. Clare, Ireland.

Diagnosis. *Shumardia* with isolated basal lateral glabellar lobes; glabella overhanging anterior margin. Posterior cephalic border furrows broad (sag.).

Description. Cephalon sub-semicircular in outline, moderately convex, half as broad as long; posterior margin slightly concave forwards, genal angles produced into short spines. Glabella sub-quadrate in outline, moderately convex, almost reaching anterior margin, as broad as long, rounded in front. Axial furrows broad and deeply impressed, preglabellar furrows less deeply impressed. Two pairs of lateral glabellar furrows; anterior pair short and straight, commencing at half the glabellar length and directed obliquely forwards to define a pair of lobate lateral expansions to anterior lobe, deeply impressed laterally and becoming weaker towards axial line, dying out at one-fifth glabellar breadth. Posterior part of glabella moderately convex, parallel-sided; posterior pair of lateral glabellar furrows deeply impressed adaxially, becoming less deep abaxially, commencing behind anterior pair and curving backwards to meet occipital furrow, defining small triangular basal lateral lobes. Occipital furrow broad, straight and deeply impressed from axial line to confluence with posterior lateral glabellar furrows, bending

backwards behind basal lateral lobes. Occipital ring of moderate and uniform sagittal length, moderately arched transversely, gently convex longitudinally.

Cheeks sub-triangular in outline, narrowing anteriorly, strongly convex, bending vertically downwards, continuing anteriorly in narrow vertical preglabellar field, produced posteriorly into short backwardly-directed genal spines. Posterior borders moderately long (sag.), posterior border furrows broad, deeply impressed, directed obliquely backwards.

Remarks. The holotype differs from the syntype of *Shumardia scotica* Reed (1904, p. 42, pl. 4, fig. 12; B.M. In. 21165) from the Upper Whitehouse Beds in the anterior rounding of the glabella and in its greater anterior extension; other specimens of *S. scotica* in the Gray Collection have a glabella more extended than the syntype mentioned, but never so extended as to overhang the anterior margin.

One immature cephalon (Pl. 63, fig. 6) is ascribed to the new species; the glabella is relatively shorter, the preglabellar field wide and the occipital ring bears a tubercle. In the holotype the occipital ring is incomplete and the tubercle probably broken away.

Family ISCOLIDAE Angelin 1854

Genus THOMONDIA Harper 1942

The discovery of additional material from the type locality (Harper 1942) enables a new and expanded account to be given; Harper described the cranidium only.

Diagnosis. Isocolidae with a single pair of pit-like lateral glabellar furrows confluent with occipital furrow; lateral border furrows confluent with preglabellar furrow; facial sutures situated on lateral border.

Thomondia globosa Harper

Plate 62, figs. 11-15

1942 *Thomondia globosa* Harper, pp. 276-8, pl. 4, figs. 1-8.

Material. One complete dorsal shield, three cephalae, seventy cranidia, four pygidia, two detached thoracic segments.

Diagnosis. As for the genus.

Description. Body elongate, sub-ovate, twice as long as broad. Cephalon and thorax of about equal length, pygidium one-sixth length of body.

Cephalon strongly convex, parabolic in outline, length equal to breadth; surrounded anteriorly and laterally by narrow, steeply inclined border produced into short, broad, projecting genal spines.

Glabella four-fifths the cephalic length, defined by strongly-impressed axial and preglabellar furrows, strongly convex, arched downwards. One pair of lateral glabellar furrows, broad and deeply impressed, length one-third glabellar breadth, deepening into prominent pits on either side of glabella behind large anterior lobe and confluent with occipital furrow. Occipital ring long (sag.) in axial line, narrowing to points laterally, moderately convex longitudinally, strongly arched transversely, bearing a median tubercle. Occipital furrow deeply impressed, broad and straight.

Fixed cheeks sub-triangular, bent downwards, slightly convex. Posterior border narrow, raised and rounded; posterior border furrows broad and deeply impressed. Lateral borders of uniform width posteriorly, anterior borders widening slightly to axial line. Strong lateral border furrows coalesce anteriorly with preglabellar furrow and posteriorly with posterior border furrows. Anterior branches of facial sutures converge strongly, posterior branches run parallel to lateral border furrow to cut posterior border. Eyes not preserved. Free cheeks narrow, elongate, produced posteriorly into a pair of short divergent genal spines.

Thorax composed of not more than six segments, moderately convex, narrowing slightly posteriorly. Axis strongly convex, one-third breadth of thorax. Pleurae straight, horizontally extended to fulcrum, outer parts steeply inclined. Pleural furrows broad and deep, parallel to articulating furrows; pleural bands reduced to narrow ridges.

Pygidium small, semi-oval, twice as broad as long. Axis convex, four-fifths the pygidial length and one-third its breadth, tapering to a rounded extremity; consisting of two narrow, rounded axial rings and a short terminal piece. Ring furrows broad and shallow, terminating laterally in shallow pits; axial furrows broad and deep. Pleural regions taper posteriorly and continue round posterior extremity of axis; divided into three pairs of strongly convex pleurae. Interpleural furrows broad and deeply impressed, not reaching pleural margins. Border depressed. *Dimensions of complete dorsal shield* (B.M. In. 53376, Pl. 62, fig. 15): length (estimated) 2.4 mm. (cephalon impacted into thorax; estimated total length 3.0 mm.), length of cephalon 1.3 mm., length of thorax 1.3 mm., length of pygidium 0.4 mm.

Remarks. *Thomondia* agrees with Whittington's emended diagnosis of the Family Isocolidae (1956, p. 1194) in all characters except the posterior position of maximum glabellar breadth. It is proposed accordingly that *Thomondia* should be placed in the

EXPLANATION OF PLATE 63

The photographs are of natural internal moulds unless otherwise stated; they are untouched except for blacking-out of the matrix with process black. The specimens were lightly coated with ammonium chloride before being photographed.

- Fig. 1. *Telephina* aff. *reedi* (Ulrich). B.M. In. 53375, cranium; 1a, lateral view $\times 7$; 1b, anterior view $\times 7$, showing anterior spines bent down vertically and high convexity of glabella; 1c, dorsal view $\times 7$, showing truncated anterior margin of glabella.
- Figs. 2, 3. *Staurocephalus* aff. *murchisoni* Barrande. 2, B.M. In. 53385, $\times 7$. Detached glabella. 3, B.M. In. 53386, $\times 15$. Pygidium.
- Fig. 4. Cyclopygid pygidium. B.M. In. 53396. 4a, Dorsal view $\times 7$, showing indistinctly defined axis with five pairs of muscle impressions; 4b, lateral view $\times 7$.
- Figs. 5, 6. *Shumardia extensa* sp. nov. 5, B.M. In. 53383, holotype, cephalon; 5a, lateral view $\times 15$, showing glabella overhanging vertical preglabellar field; 5b, anterior view $\times 15$; 5c, dorsal view $\times 15$, showing two pairs of lateral glabellar furrows, posterior pair indistinctly defined. 6, B.M. In. 53384, $\times 25$. Young cephalon, external mould, showing relatively small glabella, wide preglabellar field and tubercle on occipital ring.
- Figs. 7, 8. *Dionide* aff. *richardsoni* Reed. 7, B.M. In. 53382, $\times 10$. Pygidium. 8, B.M. In. 53381, $\times 15$. Incomplete cephalon showing faintly defined genal caecae.
- Fig. 9. *Trinodus?* sp. B.M. In. 53366, incomplete cephalon; 9a, dorsal view $\times 12$; 9b, lateral view $\times 12$.
- Figs. 10, 11. *Symphysops* aff. *subarmatus* (Reed). 10, B.M. In. 53391, $\times 5$. Pygidium. 11, B.M. In. 53390, $\times 3$. Free cheek with portion of eye.
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Isocolidae, this assignment requiring that the words 'greatest width at, or in front of, mid-length' in Whittington's family diagnosis be deleted.

In most of its features *Thomondia* compares closely with *Cyphoniscus* from the Chair of Kildare Limestone (Whittington 1956, p. 1195, pl. 130, figs. 1-9, 11, 12; text-figs. 2a, b), especially in the characters of the glabella and in the confluence of the posterior and lateral border furrows. The glabella is intermediate between that of *Isocolus* from the Kallholn Limestone of Dalarne, Sweden (Whittington 1956, p. 1194, pl. 129, figs. 1-11; text-figs. 1a, b), which has two pairs of lateral glabellar furrows, and *Cyphoniscus*, with none; the glabella of *Thomondia* could be derived from one of the *Isocolus* type by suppression of the anterior glabellar furrows and enlargement of the posterior furrows till they coalesce with the occipital furrow and obliterate the outer parts of the posterior glabellar lobe. *Thomondia* differs from other Isocolids in the anterior coalescence of the lateral border and preglabellar furrows and in the situation of the facial suture on the lateral border.

Family CYCLOPYGIDAE Raymond 1925

Genus PHYLACOPS Cooper and Kindle 1936

Phylacops bituberculatus sp. nov.

Plate 62, figs. 1-4

- 1862 *Aeglina rediviva* Baily, p. 10.
 1885 *Aeglina rediviva* Baily, p. 29.
 1939 *Cyclopyge rediviva* Stubblefield, p. 61.
 1939 *Cyclopyge* cf. *rediviva* Harper (in Smyth and others), p. 303.
 1942 *Cyclopyge* spp. nov. Harper, p. 276.
 1948 *Cyclopyge* Harper, p. 60.

Material. Holotype: B.M. In. 53392 (cephalon), Pl. 62, fig. 1. Dimensions of holotype: length of cephalon 2.8 mm., breadth of cephalon 3.0 mm., breadth of glabella 2.5 mm. Paratype: B.M. In. 53393 (pygidium), Pl. 62, fig. 2. Dimensions of paratype: length of pygidium 1.7 mm., breadth of pygidium 3.4 mm., length of axis 0.7 mm. Other material: 49 cranidia, 3 pairs of connected free cheeks, 10 detached eyes, 98 pygidia.

Horizon and locality. Ballyvorgal Group (Ashgillian), Ballyvorgal South, Co. Clare, Ireland.

Diagnosis. *Phylacops* with oblique lateral glabellar furrows placed far back; one pair of tubercles situated between lateral glabellar and occipital furrows.

Description. Body oval in outline, convexity moderate anteriorly, decreasing posteriorly. Cephalon subcircular, moderately convex. Glabella sub-triangular, slightly longer than wide, anterior margin abruptly, posterior gently rounded. Lateral glabellar furrows oblique, discontinuous anteriorly and posteriorly and placed far back; a pair of large, ill-defined tubercles situated between lateral glabellar and occipital furrows. Median tubercle absent. Axial and preglabellar furrows coincident with palpebral furrows, faintly defined. Occipital ring broad and short (sag.), slightly convex forwards, moderately arched transversely, narrowing to points laterally; occipital furrow narrow. Palpebral lobes narrow, concave, continuing round front of glabella and extending backwards to occipital furrow. Facial sutures run parallel to axial and preglabellar furrows, joining anteriorly. Free cheeks uniting in front of glabella, forming narrow vertical band separating eyes. Eyes large, elongate, length three times the breadth and equal to the

glabellar length, extending to lateral border and anteriorly to doublure; facets hexagonal, arranged in fourteen alternating horizontal rows of thirty-five facets each; total number of facets approximately 490. Lateral borders narrow, concave, almost vertical; lateral border furrows indistinct, becoming obsolete at one-fifth cephalic length, in front of which border turns under to merge with doublure, which widens thence to axial line. Doublure with closely-set striations parallel to outer margins of eyes.

Thorax of unknown number of segments presumably of uniform breadth, moderately convex; axis narrow posteriorly, widening rapidly anteriorly, gently convex; axial furrows moderately deeply impressed and broad. Axial rings short, of equal length, posterior part convex, anterior part concave; articulating furrows narrow. Pleurae gently convex, anterior pleural bands narrow, posterior wider; pleural furrows broad and shallow.

Pygidium transversely semi-oval, twice as broad as long, moderately convex, anterior margin gently rounded; axis semi-oval, length equal to anterior breadth and two-fifths pygidial length, convex, divided into three weakly-defined axial rings; articulating half-ring short (sag.) and strongly convex. Pleural regions divided into three pleurae of unequal size by two pairs of poorly-defined interpleural grooves corresponding in position to axial ring furrows, the two anterior pleurae together occupying one-fifth the pygidial length; anterior pleurae with narrow pleural bands, pleural furrows broad and shallow. Border moderately convex, broadening postero-laterally and narrowing to axial line; doublure coincides in extent, inner surface bearing faint concrescent striations. Border furrows moderately impressed.

Remarks. No complete specimen was found; the characters of the thorax, as far as determinable, were deduced from numerous transitory pygidia with up to five fused segments in front of the large posterior segment.

P. bituberculatus closely resembles *P. kloučeki* (Richter) from the Svata Dobrotiva Shales (Dy², Llandeilo) of Malé Pílepy, Bohemia (Whittard 1952, p. 310, pl. 32, fig. 9), in the separation of the eyes by a narrow band devoid of facets, but is considerably smaller; from the figure, the eye facets in *P. kloučeki* appear to be much more numerous and closely packed. The other Irish species, *P. mirabilis* Forbes MS., Salter from the Portraine Limestone (Whittard 1952, p. 309, pl. 32, figs. 6-8), lacks the distinct band separating the eyes, has the facets arranged in vertical rows, and possesses a single median tubercle.

Genus SYMPHYSOPS Raymond 1925

Symphysops aff. *subarmatus* (Reed)

Plate 63, figs. 10, 11

Material. Four free cheeks, one pygidium.

Description. Pygidium semi-oval, moderately convex, length equal to breadth, anterior margin gently rounded; axis triangular with a short triangular terminal piece, moderately convex, one half the pygidial length, with a single, weakly-defined axial ring at one-fifth the axial length; axial furrows broad and deeply impressed. Pleural regions moderately convex, bearing five pairs of poorly-defined interpleural grooves. Borders narrow, convex, and smooth; border furrows deeply impressed.

Remarks. This pygidium corresponds in most respects to that of *Symphysops subarmatus* (Reed) (1914, pl. 3, fig. 9), except in relative breadth, which is much greater in Reed's figured specimen. Four detached free cheeks with portions of the eye compare with that figured by Reed (1904, pl. 7, fig. 14) and assigned by him firstly to *Cyclopyge armata* (Barrande) and later (1914, p. 21) to the new species *C. subarmata*.

Cyclopygid gen. et sp. indet.

Plate 63, fig. 4

Material. One pygidium.

Description. Transversely semi-oval, moderately convex, two-thirds as long as broad, anterior margin gently rounded. Axis poorly defined, half the pygidial length, triangular in outline, apex rounded; consisting of five weakly-defined rings, each ring bearing a pair of circular muscle impressions laterally. Pleural regions moderately convex, triangular in outline. Border concave, depressed, broadening posteriorly to half the pygidial length, narrowing thereafter towards median line and becoming weaker. Inner surface of doublure ornamented by fine, irregular, concentric furrows.

Remarks. This pygidium resembles that of *Cyclopyge bumasti* Reed (1914, p. 19, pl. 3, fig. 8) in the weakly-defined axis with poor segmentation.

Family CHEIRURIDAE Hawle and Corda 1847

Genus PSEUDOSPHAEREXOCHUS Schmidt 1881

Pseudosphaerexochus sp.

Plate 62, fig. 16

Material. One cranidium.

Description. Cranidium triangular in outline, rounded in front, moderately convex, $2\frac{1}{2}$ times as long as broad. Glabella subcircular, truncated behind, reaching front of cranidium, tumid, defined by deeply-impressed axial furrows. Lateral glabellar furrows broad and shallow, anterior pair one-third breadth of glabella, commencing at anterior extremity of fixed cheek and directed obliquely backwards; middle pair one-quarter the glabellar breadth, transversely directed; posterior pair oblique, confluent with occipital furrow and enclosing a small pair of triangular basal lateral lobes. Occipital furrow broad and deeply impressed, occipital ring strongly arched transversely. Cheeks triangular in outline, three-quarters the cephalic length, posterior border furrow deeply impressed.

Genus STAUROCEPHALUS Barrande 1846

Staurocephalus aff. *murchisoni* Barrande

Plate 63, figs. 2, 3

1862 *Staurocephalus globiceps* Baile, p. 10.

Material. Two cranidia, three pygidia.

Description. Glabella anteriorly inflated, $1\frac{1}{2}$ times as long as broad; divided into two parts by anterior glabellar furrows. Anterior lobe tumid; posterior lobe short, tapering

slightly forwards, strongly convex. Anterior lateral glabellar furrows continuous, straight and weak; middle and posterior pairs reduced to small lateral pits equally spaced. Occipital furrow strong and straight, occipital ring short and convex, moderately arched transversely, slightly concave forwards. Cheeks not preserved.

Pygidium subquadrate, flattened; axis strongly convex, sharply conical, half the pygidial length; anterior part tapering rapidly posteriorly, carrying three rings short and convex lengthwise, ring furrows broad and deep; posterior part unsegmented and tapering less rapidly. Pleural regions consisting of three pairs of flattened pleurae in close contact throughout their length and of uniform breadth, corresponding to rings on anterior part of axis; inner part of anterior pair transverse, turning sharply backwards at one-third the length to lie parallel to axis, bearing short pleural furrows adaxially; second and third pairs turn backwards progressively closed to axis and lack pleural furrows. A flattened plate is assumed to correspond to a fused pair of pleurae, their pointed extremities forming short projections from hinder margin.

Remarks. The strongly inflated anterior glabellar lobe is characteristic of *Staurocephalus*; the typically cheirurid pygidium is distinctive of *S. purchisoni* Barrande (Reed 1898, p. 213) and generally similar to those figured by Barrande (1852, pl. 43, figs. 28, 31).

Family ENCRINURIDAE Angelin 1854

Genus DINDYMENE Hawle and Corda 1847

Dindymene ovalis sp. nov.

Plate 62, figs. 9, 10

1862 *Dindymene haidingeri* Baily, p. 10.

1885 *Dindymene haidingeri* Baily, p. 29.

1939 *Dindymene* Stubblefield, p. 61.

1942 *Dindymene haidingeri* Harper, p. 276.

1948 *Dindymene* Harper, p. 60.

Material. Holotype: B.M. In. 53388 (cephalon), Pl. 62, fig. 9. Paratype: B.M. In. 53389 (pygidium) Pl. 62, fig. 10. Other material: seven cephalae, one pygidium.

Horizon and locality. Ballyvorgal Group (Ashgillian), Ballyvorgal South, Co. Clare, Ireland.

Diagnosis. *Dindymene* with cephalon bearing sparse small tubercles, axial furrows slightly convex outwards, genal angles smoothly rounded and cheek lobes sub-semicircular in outline.

Description. Cephalon nearly oval in outline, twice as broad as long, moderately convex. Glabella pyriform, strongly convex, extending in front of cheek lobes, length slightly greater than breadth, narrowing posteriorly to less than half the breadth, bearing a large median tubercle near posterior extremity; lateral glabellar furrows absent. Axial furrows broad, deeply impressed, almost straight but slightly convex outwards. Occipital ring short (sag.) and narrow, strongly arched longitudinally and transversely, occipital furrow broad and shallow. Cheek lobes much less highly elevated than glabella, sub-semicircular in outline; genal angles smoothly rounded. Lateral borders of moderate breadth, narrowing anteriorly, gently convex, sloping slightly downwards, lateral border

furrows deeply impressed posteriorly, becoming shallower forwards. Posterior border continuous laterally with lateral border, narrowing and turning backwards towards axial line, gently convex. Posterior border furrows strongly impressed, joining axial furrows in shallow pits. Facial sutures, eyes and palpebral lobes absent. Thorax unknown.

Pygidium narrow, length slightly less than breadth; axis half pygidial length, conical, apex pointed, composed of seven rings. Axial rings short and strongly convex (sag.), of equal length; moderately arched transversely. Ring furrows deeply impressed, continuous. Axial furrows narrow and weak. Pleural regions composed of two pairs of pleurae, corresponding to two anterior axial rings; strongly curved backwards to lie parallel to axis, free for half their length beyond posterior extremity of axis, points slightly curved outwards.

Remarks. The shape of the glabella is similar to that of *D. cordai* Nicholson and Etheridge (Reed 1906, p. 132, pl. 17, fig. 9) from the Drummuck Group (Ashgillian) of the Girvan district, though this species differs in the greater acuteness of the genal angle and the relatively longer pygidial axis; the pygidium of *D. ovalis* resembles that of *D. haidingeri* Barrande (1852, p. 819, pl. 43, fig. 25) in most respects, but the cephalon is very different, *D. haidingeri* having well-developed genal spines and a relatively broader glabella with the axial furrows concave outwards. *D. ovalis* also differs from the above species in the poorly-developed tuberculation.

Family BOHEMILLIDAE Barrande, 1872

Genus BOHEMILLA Barrande, 1872

Bohemilla sp.

- 1862 *Olenus?* Baily, p. 10, text-fig. 1b.
- 1939 *Bohemilla* Stubblefield, p. 61.
- 1939 *Bohemilla* Harper (in Smyth and others), p. 303.
- 1942 *Bohemilla* Harper, p. 276.
- 1948 *Bohemilla* Harper, p. 60.
- 1952 *Bohemilla* Whittard, p. 319.

The specimen in the collection of the Geological Survey of Ireland, figured by Baily and subsequently determined from the figure as *Bohemilla* by Stubblefield, is unfortunately not available for study; no other specimen was found.

COMPARISON WITH OTHER *CYCLOPYGE* FAUNAS

The mudstone band yields a prolific shelly fauna without graptolites, in which trilobites greatly outnumber all other forms both in species and in individuals; all are disarticulated except one dorsal shield of *Thomondia*. Of particular interest is the assignment of this genus to the Family Isocolidae, this being the first definite record of an isocolid from other than a reef-limestone facies. The most abundant member of the fauna is *Phylacops bituberculatus* sp. nov., ninety-eight pygidia in various stages of development and fifty cranidia having been collected. *Thomondia* comes second in order of abundance with seventy cranidia.

As Baily (1862, p. 10) and Stubblefield (1939, p. 61) have shown, the Slieve Bernagh

trilobite bed contains several species closely related to forms occurring in Bohemia, mostly in the Křán Series ($D\gamma_1$, Llanvirn-Llandeilo), though certain genera are found also in the *D. bifidus* zone in Wales. The following species appear to be of Bohemian derivation:

	<i>Number o specimens</i>
<i>Corrugatagnostus convergens</i> sp. nov.	9
<i>Dionide richardsoni</i> Reed	7
<i>Phylacops bituberculatus</i> sp. nov.	160
<i>Symphysops</i> aff. <i>subarmatus</i> Reed	5
Cyclopygid gen. et sp. indet.	1
<i>Staurocephalus</i> aff. <i>murchisoni</i> Barrande	5
<i>Dindymene ovalis</i> sp. nov.	10
Total	197

Other species total 105 specimens, the percentage of forms of Bohemian affinity being sixty-five, a remarkably large proportion considering the difference in geological age between the faunas.

The fauna with which the closest comparison can be made is that of the Upper Whitehouse Beds of the Girvan District, Ayrshire, which was clearly derived from the main Bohemian source, though the species are more specialized. Twelve of the fifteen Slieve Bernagh genera (all except *Thomondia*, *Pseudosphaerexochus* and *Staurocephalus*) and the four species *Novaspis albida* (Reed), *Dionide richardsoni* Reed, *Telephina reedi* (Ulrich), and *Symphysops subarmatus* (Reed) occur in the Whitehouse Beds, both horizons being considered to belong to the zone of *D. complanatus*.

Cyclopyge faunas appear at various other horizons in the Upper Ordovician of the British Isles and Ireland, for instance in the Abercwmiddaw Group of the area around Corris, Dinas Mawddwy, and Towyn, above the *Phillipsinella parabola* Beds (Pugh 1923, 1928), and in the Oriel Brook Mudstone of Grangegeeth, Co. Meath, which may be of *Pleurograptus linearis* age (Harper 1952). The occurrence of *Phylacops mirabilis* Forbes MS., Salter and *Staurocephalus* at Portraine (Gardiner, Reynolds, and Reed 1897) and of *Cyclopyge rediviva* Barrande in the Upper Tirnaskea Beds of Pomeroy, Co. Tyrone (Fearnside, Elles, and Smith 1907), in association with *D. mucronatus* indicates the firm establishment of those genera of Bohemian origin in the Irish faunas, whereas few of the exotic Whitehouse forms survived in the Girvan area till Drummuck times. Stubblefield (1939, p. 62) postulated an Upper Ordovician migration from Central Europe to Scotland, possibly through Co. Clare and Co. Tyrone, with a diversion to Central Wales.

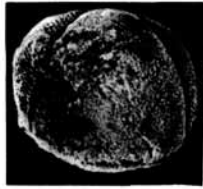
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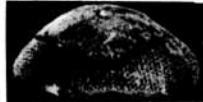
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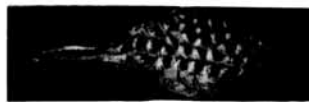
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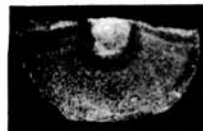
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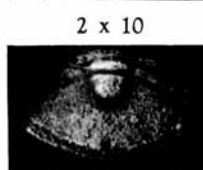
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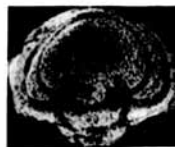
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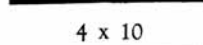
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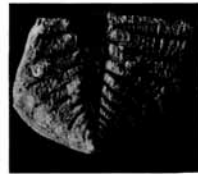
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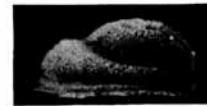
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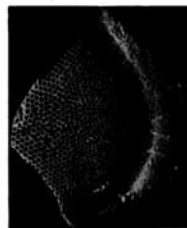
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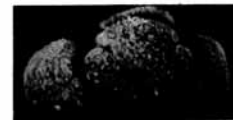
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WEIR, Ashgillian trilobites