THE UPPER LLANDOVERY TRILOBITES OF THE TORTWORTH INLIER, GLOUCESTERSHIRE

by M. L. K. CURTIS

ABSTRACT. Six species of trilobites from the Upper Llandovery rocks of the Tortworth Inlier are described and figured, including one new species, *Proetus asaphoides*.

INTRODUCTION

THE Upper Llandovery fauna of the Tortworth Inlier is a shelly one, consisting predominantly of brachiopods; the corals, molluscs, and trilobites form important but much less conspicuous elements. Of the trilobites fewer than ten species are known, and the only common forms are *Encrinurus onniensis* and *Dalmanites weaveri*. In the present paper the following species are described: *Calymene sp.*, *Proetus asaphoides* sp. nov., *Proetus sp.*, *Encrinurus onniensis* Whittard, *Phacops* cf. *orestes* Billings, and *Dalmanites weaveri* (Salter). Three other species, *Calymene replicata* Shirley, *Warburgella* cf. *stokesi* (Murchison), and *Arctinurus sp.*, are recorded, but are represented by poorly preserved material which provides no new information. The specimens studied are in the Geological Survey Museum, London (GSM), the Sedgwick Museum, Cambridge (SM), and the Geology Department of the University of Bristol.

Stratigraphy. The Upper Llandovery succession as developed in the Tortworth area consists of about 700 feet of fine-grained sandstones and shales belonging to the highest zones of the Series. These strata are divided into the Damery Beds below, which are fossiliferous throughout, and the Tortworth Beds above, which contain the highly fossiliferous *Palaeocyclus* Band at their base; the two groups are separated on the eastern side of the inlier by the Upper Trap, an extrusive lava (Reed and Reynolds 1908, pp. 513–22; Curtis 1955, pp. 5–6).

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DESCRIPTIONS OF SPECIES

Family CALYMENIDAE Edwards 1840

Calymene sp.

Plate 29, fig. 1

Description. Pygidium is markedly convex. Six rings are visible in the axis, but there would probably be eight or nine in a complete pygidium; an unsegmented posterior part of the axis is as long as the three preceding rings. Deep axial furrows coalesce posteriorly

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to produce a somewhat angulated termination to the axis. Pleurae, of which there are five pairs, are separated by deep rib furrows, and become divided laterally by strong pleural furrows.

Horizon and locality. A single specimen (GSM 90030) was obtained in loose material derived from the Damery Beds at the western end of Ironmill Grove, Damery.

Affinities. The pygidium is narrower and has more axial rings than the form figured by Salter (1865, pl. 9, fig. 1*b*) from Bog Mine, near Shelve, Shropshire, which probably belongs to *Calymene planicurvata* Shirley (1936, p. 412). It is close to a pygidium from the Llandovery rocks of Mulloch, near Girvan (Salter 1865, pl. 9, fig. 2*b*), and also to that of *Calymene intermedia* var. *antigonishensis* McLearn (1924, p. 162, pl. 26, figs. 5–11) from the Stonehouse Formation of Arisaig, Nova Scotia.

Family PROETIDAE Hawle and Corda 1847

Proetus asaphoides sp. nov.

Plate 29, fig. 2

Description. A large and unusual species of *Proetus* is represented by a single incomplete and slightly distorted internal mould, measuring about 55 mm. from the front of the glabella to the posterior margin of the pygidium. Cephalon is imperfectly preserved. Glabella, which is convex and somewhat oval in form, narrows anteriorly and apparently bears no trace of glabellar furrows. Moderately strong furrows separate the occipital ring and occipital lobes from the rest of the glabella; the occipital ring curves forward at the centre, and is separated from the relatively large sub-triangular occipital lobes by shallow and rather indistinct furrows. A fragment of the posterior border of the fixed cheek is preserved, and shows that the pleuroccipital furrow meets the axial furrow at the level of the occipital lobe.

Thorax consists of ten segments. Axis is convex and only slightly tapering; the central portion of each axial ring is broken away showing the articulating half-ring of the succeeding segment. Pleural lobes are nearly flat, and the pleurae carry broad, shallow pleural furrows.

Pygidium is large, its length being considerably greater than that of the thorax. Axis is fairly strongly convex and tapers posteriorly. First axial ring is pronounced but short, and separated from the articulating half-ring by a strong groove. Posteriorly the axial rings are faintly marked, though there are indications of at least seven rings. Pleural lobe is gently convex. Pleurae, of which five are visible, consist of broad, low ridges, and are separated by shallow rib furrows. The lateral portion of the pleural lobe is missing, and exposes to view the external mould of the broad doublure with its fine terrace lines. In the region of the third and fourth pleurae the doublure is at least 4 mm. wide and is concave ventrally. Near the posterior end of the pygidium the doublure is more than 6 mm. wide; here it is concave ventrally near the axis, but postero-laterally it flattens and becomes slightly convex ventrally.

Holotype. GSM GSb 4687.

Horizon and locality. The holotype was obtained by Thomas Weaver in Cullimore's Trap Quarry, Charfield. The specimen is undoubtedly from the base of the Tortworth Beds,

for the only sedimentary rocks occurring in Cullimore's Quarry are those which immediately succeed the Upper Trap. The account of the north-western part of Cullimore's Quarry given by Weaver (1824, p. 334, pl. 39, fig. 2) shows that in his time two fossiliferous bands were exposed, and these are referred to as layers 3 and 5. He states that the 'layers No. 3. and 5. contain numerous remains of caryophyllites, favosites, astreites, bivalves, etc., and I found also the impression of a trilobite'. Since no other mention is made of trilobite remains from Cullimore's Quarry, it seems probable that this is the specimen described here. It should be noted, however, that Weaver makes no mention of this form in his discussion of the trilobites (pp. 326–7).

Affinities. Proetus asaphoides (so named from the *Asaphus*-like pygidium) differs from most Silurian Proetids in possessing a large pygidium. It shows some resemblance to certain Devonian forms such as *Proetus rowi* (Green) from the Hamilton Group of North America (Hall and Clarke 1888, p. 119, pl. 21, figs. 2–6, 24–26; pl. 23, figs. 20–29) and *Proetus bohemicus* Hawle and Corda from Stage F of Bohemia (Barrande 1852, p. 452, pl. 16, figs. 1–15); in both these species, however, the pygidium is considerably smaller.

Proetus sp.

Plate 29, fig. 3

Description. Only the pygidium is known. In an internal mould (GSM 90031; Pl. 29, fig. 3*a*), measuring 4·5 mm. in length and 7·5 mm. in breadth, the axis is pronounced and elevated well above the level of the rather flat pleural lobes. Axis tapers and is rounded posteriorly. Axial rings, of which at least seven are visible, are strong and sharp, particularly the first three or four. Pleural lobes are gently convex and almost smooth, but show traces of the first, second, and third pleurae; near the margin the pleurae become distinct and here they carry broad pleural furrows. Running concentrically round the pygidium is a slight depression which coincides in position with the inner limit of the doublure. At the posterior margin the specimen is broken and exposes the mould of the external surface of the doublure, which is slightly convex ventrally, about 1 mm. wide, and carries fine terrace lines. A fragment of the external mould of the same individual remains (Pl. 29, fig. 3*b*), and here the axial rings and pleurae are more clearly defined than in the internal mould, and the pleurae are seen to carry distinct pleural furrows. The posterior margin of the pygidium is entire and is marked by a feebly developed upturned rim.

Horizon and locality. The form is known by two individuals, both of which are from the Damery Beds of the Damery Bridge area.

Affinities. The Tortworth specimens somewhat resemble *Proetus pseudolatifrons* Reed (1904, p. 78, pl. 11, figs. 7–9) from the Camregan Group of Girvan. They are closely similar, as regards the raised axis and rather smooth pleural lobes, to specimens from the Upper Silurian of the Harz, described by Kegel (1928, p. 634, pl. 32, figs. 1–5) as *Proetus conspersus* (Angelin).

Family ENCRINURIDAE Angelin 1854

Encrinurus onniensis Whittard

Plate 29, figs. 4–5

Calymene ?? punctata Murchison 1839, p. 661, pl. 23, fig. 8*a*.
Encrinurus onniensis Whittard 1938, p. 118, pl. 4, figs. 6–11.

Description. Although the Tortworth Encrinurids show much variation in minor characters, it is not possible to divide them into distinct and separate groups, and they are here considered as members of a single species. Some individuals are identical with *Encrinurus onniensis* Whittard (1938, p. 118, pl. 4, figs. 6–11), and consequently all the Tortworth Encrinurids are referred to that species.

Cephalon, which usually occurs in a fragmentary condition, agrees closely with the description of *E. onniensis*. Thorax is not known. It is in the pygidium that the variations are most apparent. Some pygidia are similar in every respect to those of *E. onniensis* described from Shropshire. Others are narrower and more strongly convex (Pl. 29, fig. 4), and in addition to tubercles on the axis, which occur on about every fourth or fifth ring, there are also tubercles on the pleurae; each pleura carries one tubercle, usually towards its inner end, but occasionally near the middle or even towards the outer end; as a rule the outermost tubercles occur on the first and fourth pleurae, but this is not always so. Between these two kinds—the typical *E. onniensis* on the one hand, and the more convex, tuberculate type on the other—come intermediate forms (Pl. 29, fig. 5).

Horizons and localities. The species is common in the Damery Beds at most localities, and also occurs in the *Palaeocyclus* Band at the base of the Tortworth Beds.

Family PHACOPIDAE Hawle and Corda 1847

Phacops cf. *orestes* Billings

Plate 29, fig. 6

Description. An external mould of the pygidium measures 5·5 mm. in length and 9 mm. in breadth (SM A 35410a). Axis is convex and consists of at least seven rings, but posteriorly they become indistinct. First axial ring is considerably broader than the rest; the third and succeeding rings curve forward slightly at the centre and also near the axial furrows, giving the ring furrows a wavy appearance. Five pairs of depressed pleurae are separated by narrow rib furrows which swing forward slightly against the axial furrows. Anterior pleurae, which carry feebly developed pleural furrows, extend about two-thirds of the distance to the margin, ending laterally against the wide smooth border. Articulating half-ring and facets are visible at the anterior end of the pygidium. In the internal mould of the same individual the smooth border is somewhat narrower, and the doublure is seen to be ventrally convex.

Horizon and locality. A single specimen has been obtained from the Damery Beds at Damery.

Affinities. The pygidium is almost identical with that of *Phacops orestes* Billings (1860, p. 65, figs. 10, 10*a*) which is common in the Gun River and Jupiter Formations of Anticosti Island (Twenhofel 1928, p. 335, pl. 50, figs. 11–12; Delo 1940, p. 21, pl. 1, figs. 22–25).

Family DALMANITIDAE Delo 1935

Dalmanites weaveri (Salter)

Plate 29, figs. 7–10

Phacops Weaveri Salter 1849, p. 7, pl. 1, fig. 16.
Phacops Weaveri Morris 1854, p. 114.
Phacops Weaveri Salter 1864, p. 57, pl. 3, fig. 1; pl. 4, figs. 6–7; (*non* pl. 3, figs. 2–3; pl. 4, figs. 8–9).
Phacops Weaveri Reed 1909, p. 69.
Dalmanites (*Dalmanitina*) *Weaveri* Reed 1909, p. 73.
?Dalmanites weaveri McLearn 1924, p. 169, pl. 27, figs. 7–10.
Dalmanitina weaveri Reed 1927, p. 341.
Dalmanites weaveri Whittard 1938, p. 132.
?Dalmanitina weaveri Delo 1940, p. 53, pl. 4, figs. 7–9; (*non* pl. 4, fig. 10).

Description. The following account of the cephalon is founded on an external mould, preserved in fine-grained sandstone, measuring 13 mm. in length and 22 mm. in breadth (GSM 90033; Pl. 29, fig. 7*a*).

Cephalon is convex, somewhat triangular in outline, and nearly twice as broad as long. Frontal lobe of the glabella is large and sub-rhomboidal; towards its posterior edge, and in the mid-line, is a small elongated pit. First glabellar furrows are deep, extend across the glabella, and are directed antero-laterally. Second and third glabellar furrows directed laterally, and represented by no more than a trace at the mid-line. Occipital ring curves forward at the centre and is elevated slightly above the level of the rest of the glabella, from which it is separated by a well-defined occipital furrow. Axial furrows diverge anteriorly and are slightly curved, being concave outwards. Each axial furrow follows round the anterior part of the eye, joins the first glabellar furrow, and curves outward to coalesce with the lateral border furrow. A feebly developed furrow extends round the anterior of the frontal lobe. Fixed cheek is convex and steepens considerably towards the palpebral lobe; postero-laterally the fixed cheek extends backwards to form a short fixigenal spine. Lateral border furrow meets the pronounced pleuroccipital furrow at the fixigenal angle whence an incipient furrow extends a short distance along the fixigenal spine. Free cheek is small; the lateral border furrow increases in width until it reaches the anterior end of the free cheek where it meets the first glabellar furrow. The course of the anterior branch of the facial suture is not clearly defined, but it appears to swing outward in front of the eye, and then probably continues round the anterior of the frontal lobe. Posterior branch of the facial suture swings forward behind the eye, but between the eye and the lateral border furrow it curves back and continues in a postero-lateral direction. Behind the eye, on the fixed cheek, is a short groove in which is situated the posterior branch of the facial suture. Eyes are prominent, being raised above the level of the rest of the cephalon. The upper part of the eye consists of a smooth, convex, crescentic area, separated from the palpebral lobe by a shallow groove. Visual surface is steep and curved, and near its centre attains a maximum 'height' of about 2·5 mm., but anteriorly and posteriorly it becomes narrower and has rounded ends; the surface is almost vertical at its posterior end, but anteriorly it slopes forward and outward at a steep angle. There are about thirty vertical rows of small facets which appear as sub-hexagonal concavities; the number of facets in each row diminishes from about nine in the central rows to two or three in the extreme anterior and posterior rows; the total

number of facets in each eye is approximately 160. The internal mould of the cephalon (GSM 90033a, which is the counterpart of GSM 90033) differs but slightly from the external mould, the chief difference being that the furrows are shallower. Also, there are small subsidiary ridges in the deeper parts of the glabellar furrows and the occipital furrow (Pl. 29, fig. 7*b*); this feature, however, is only occasionally visible in internal moulds, and may be due to the shell at the base of the furrows having been broken or eroded through prior to fossilization. The ornamentation of the cephalon consists of delicate tubercles, and is seen in a cranidium preserved in limestone (Pl. 29, fig. 8).

The holotype is a small pygidium measuring 6·5 mm. in length and 8·5 mm. in breadth, and showing a marked convexity (Pl. 29, fig. 9). Axis is about 2·7 mm. wide at its anterior end, but tapers gradually and has a rounded posterior termination. Twelve or thirteen axial rings are visible; those towards the anterior end are strongly developed, curve forward slightly at the centre, and are separated by wide ring furrows which are shallow at the mid-line but become deep towards the sides of the axis. Rings become less pronounced as traced in a posterior direction, the last few rings being indistinct. Axis is separated from the pleural lobes by well-marked axial furrows. There are seven distinct pairs of pleurae, but a further feebly developed pair is just visible. Anterior pleurae are strong and carry faint pleural furrows, but posteriorly the pleural furrows are apparently undeveloped. Pleurae are separated by broad rib furrows and end laterally against a smooth border which is about $\frac{1}{2}$ mm. wide. At the posterior extremity of the pygidium is a small rounded point which is possibly an incipient terminal spine.

Most other pygidia examined are larger and less convex than the holotype which may be an immature individual. A more typical specimen is an internal mould measuring 11 mm. in length and about 15 mm. in breadth, and having eight pairs of pleurae (GSM

EXPLANATION OF PLATE 29

Fig. 1. *Calymene sp.* Internal mould of pygidium (GSM 90030), ×1·5. Damery Beds; loose material at western end of Ironmill Grove, Damery, near Tortworth.

Fig. 2. *Proetus asaphoides* sp. nov. Internal mould of holotype (GSM GSb 4687), ×1·5. Base of Tortworth Beds; Cullimore's Trap Quarry, Charfield.

Figs. 3*a*, *b*. *Proetus sp.* 3*a*, Internal mould of pygidium, damaged at the posterior margin and showing the external mould of the doublure (GSM 90031), ×3. Damery Beds; loose material at extreme western end of Damery Quarry, 150 yards west 30° north of Damery Bridge, near Tortworth. 3*b*, Cast in latex of fragment of external mould of the same individual (GSM 90031b), ×3.

Figs. 4–5. *Encrinurus onniensis* Whittard. 4, Internal mould of pygidium (SM A 29519), ×3. Damery Beds; Avening Green, near Tortworth. 5, Internal mould of pygidium (GSM Geol. Soc. Coll. *p* 42), ×3. Figured by Murchison 1839, pl. 23, fig. 8*a*. Damery Beds; Micklewood Chase, near Tortworth.

Fig. 6. *Phacops* cf. *orestes* Billings. Cast in latex of external mould of pygidium (SM A 35410c), ×3. Damery Beds; Damery, near Tortworth.

Figs. 7–10. *Dalmanites weaveri* (Salter). 7*a*, Cast in latex of external mould of cephalon (GSM 90033b), ×2. Damery Beds; roadside section about 60 yards south of Damery Bridge, near Tortworth. 7*b*, Part of internal mould of glabella of the same individual showing small subsidiary ridges within the glabellar and occipital furrows (GSM 90033a), ×4. 8, Portion of exterior of frontal lobe of glabella showing fine tuberculate ornamentation; specimen preserved in limestone (GSM 90032), ×10. Damery Beds; Damery, near Tortworth. 9, Internal mould of pygidium (GSM GSd 3154), ×3. Holotype, figured by Salter 1849, pl. 1, fig. 16. Damery Beds; Long's Quarry, Charfield. 10, Internal mould of pygidium (GSM 19221), ×2. Topotype, figured by Salter 1864, pl. 4, fig. 7. Damery Beds; Long's Quarry, Charfield.

Photographs by Mr. E. W. Seavill.

19221; Pl. 29, fig. 10). The specimen is damaged at the posterior margin, but clearly shows the mould of the external surface of the doublure which is ventrally convex and about 1 mm. wide. Some internal moulds show small subsidiary ridges within the deeper parts of the ring furrows of the axis, similar to those described as occurring in the glabellar furrows, and in some pygidia there is a short but distinct terminal spine.

Holotype. GSM GSd 3154. This specimen, which was collected by Thomas Weaver from the Damery Beds in Long's Quarry, Charfield, is undoubtedly the original from which Salter's figure was drawn (see note by Whittard 1938, pp. 132–3).

Horizons and localities. The species occurs commonly at most localities in the Damery Beds and in the *Palaeocyclus* Band at the base of the Tortworth Beds.

Affinities. The form is similar to *Dalmanites weaveri* var. *tenuimucronata* Whittard (1938, p. 130, pl. 5, figs. 11–14), particularly as regards the cephalon. The pygidium of this variety, however, carries a long terminal spine; it also has more clearly defined rib furrows and pleural furrows, and the smooth border is somewhat broader.

The specimen figured by Salter (1864, p. 57, text-fig. 15) from Ile Percé, Gaspé, Canada, is not *Dalmanites weaveri*, but a Lower Devonian form to which Clarke (1908, p. 129) has given the name *Dalmanites* (*Probolium*) *biardi*.

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3*a*

3*b*

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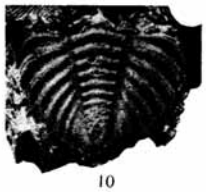
7*a*



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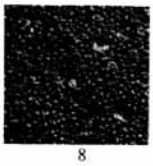

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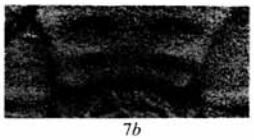

7*b*

CURTIS, Llandovery trilobites