TWO NEW CAMBRIAN TRILOBITES FROM TASMANIA

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ABSTRACT. The first published descriptions of Tasmanian Cambrian trilobites are given. Two new species, *Opsidiscus argusi* and *Schmalenseeia gostinensis*, are described from a fauna, the age of which is probably either that of the latest Middle Cambrian *Lejopyge laevigata* III Zone or the Middle Cambrian/Upper Cambrian Passage Zone. *Opsidiscus argusi* has well developed schizochroal eyes, recorded for the first time in this genus. The genera *Opsidiscus* and *Schmalenseeia* are reviewed. *Opsidisus* is placed in the Pagetiidae. *Schmalenseeia acutangula* Westergård is in need of revision and should be removed from *Schmalenseeia*.

THE presence of trilobites in the Middle and Upper Cambrian sediments of western and northern Tasmania has been recorded by various authors (Elliston 1954; Banks 1956, 1962; Blissett 1962; Burns 1964; Öpik 1967; Gee *et al.* 1970; Jago and Buckley 1971). However, although many generic and some specific names have been listed, no descriptions of these trilobites have previously been published.

Pike (1964) discovered a well preserved Cambrian trilobite fauna near the corner of the main Hampshire to Guildford road and Gin Creek road (41° 21·6′ S, 145° 44·3′ E), about 1·5 km south-west of St. Valentine's Peak in north-west Tasmania. Unfortunately, the Cambrian sediments in the vicinity of the fossil locality are poorly exposed, and are probably separated by faulting from a better exposed Cambrian sequence about three kilometres to the north. Thus the exact stratigraphic position of the fauna concerned cannot be determined at present.

Two of the trilobites from this locality are described below as *Opsidiscus argusi* sp. nov., and *Schmalenseeia gostinensis* sp. nov. Other members of this fauna include *Nepea*, *Aspidagnostus*, *Clavagnostus*, *Peronopsis*, *Agnostascus* (?), and a species of a new genus, cf. *Oidalagnostus*. This faunal list indicates that the age of the fauna is either very late Middle Cambrian or very early Upper Cambrian. *Nepea* is not recorded above the *Lejopyge laevigata* Zone in Northern Australia (Öpik 1970). The youngest recorded species of *Opsidiscus* is *O. depolitus* Romanenko from 'layers transitional between the Middle and Upper Cambrian' (Poletaeva and Romanenko 1970, p. 75). *Clavagnostus* is known from both Middle and Upper Cambrian rocks. However, as far as the author is aware, *Aspidagnostus* and *Agnostascus* are known only from the early Upper Cambrian. Other Tasmanian species of cf. *Oidalagnostus* are known only in late Middle Cambrian faunas. Although the question cannot be decided with certainty, it appears from this faunal list, and by comparison with other unpublished Tasmanian Cambrian faunas, that the age of this fauna is probably that of either the *Lejopyge laevigata* III Zone of Öpik (1961), or the Middle Cambrian/Upper Cambrian Passage Zone of Öpik (1967).

The remaining trilobites from this and other Tasmanian localities will be described in later papers. *Opsidiscus argusi* and *Schmalenseeia gostinensis* are described separately in this paper because they are the only well-preserved representatives of their respective families in the Tasmanian Cambrian. A further reason for describing these is that both general are in need of review.

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Almost all Tasmanian Cambrian trilobites have undergone some tectonic distortion. However, the trilobites from near St. Valentine's Peak are among the least distorted of all Tasmanian Cambrian faunas. All trilobites from this locality are preserved as internal and external moulds in a weathered, buff-coloured siltstone. In order to prepare them for description, silicone rubber moulds of the external moulds were prepared. These rubber moulds were then photographed after being whitened with magnesium oxide. All specimens are housed in the collection of the Geology Department, University of Tasmania. The catalogue numbers refer to this collection.

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SYSTEMATIC DESCRIPTIONS

Order AGNOSTIDA Kobayashi 1935
Suborder EODISCINA Kobayashi 1939
Family PAGETIIDAE Kobayashi 1935
Genus OPSIDISCUS Westergård 1949

Opsidiscus Westergård 1949, p. 606; Rasetti 1952, p. 436; Howell 1959, p. 181; Pokrovskaya 1960, p. 56; Kobayashi 1962, p. 21; Rushton 1966, p. 11; Rasetti 1967, p. 8; Palmer 1968, p. 38; Poletaeva and Romanenko 1970, p. 73.

Aulacodiscus Westergård 1946, p. 26, Shaw 1950, p. 588; Hupé 1953, p. 59.

Type Species. Aulacodiscus bilobatus Westergård 1946, p. 26, pl. 1, figs. 16–22.

Description. Pagetiid trilobite with two thoracic segments and closely spaced fine granulation (not visible on most photographs) on the dorsal surface. Cephalon moderately convex, wider than long (excluding the occipital spine). Rim moderately wide at the anterior, but narrowing posteriorly. Shallow marginal furrow with variable number of pits or transverse furrows in its anterior region, and small depressed area immediately in front of glabella. Glabella length about 0·75 cephalon length (excluding occipital spine); outlined by wide, deep furrows and tapering slightly anteriorly. Weak to well-developed anterior transverse glabellar furrow defines an anterior glabellar lobe. Eye ridges well defined to absent. Well defined sub-marginal schizochroal eyes, or large 'eye tubercles'; no facial sutures.

Pygidium moderately convex with narrow border; wider than long. Axis outlined by moderately deep furrows, which shallow posteriorly; does not quite reach posterior border. Large crescentic articulating half-ring. Axis consists of three to five segments plus a terminus. The two segments immediately in front of the terminus are fused and may bear a spine. The only sign of pleural segmentation is close to the axis.

Discussion. The above description of *Opsidiscus* is based on a study of the figures of *O. bilobatus* (Westergård 1946, p. 26, pl. 1, figs. 16–22), *O. altaicus* Poletaeva

(Poletaeva and Romanenko 1970, p. 73, text-fig. 2, pl. 10, figs. 1–5) and *O. depolitus* Romanenko (ibid., p. 74, text-fig, 3, pl. 10, figs. 6–9); two rubber moulds of *O. bilobatus* (a cephalon and pygidium, figured Westergård 1946, pl. 1, figs. 21, 20); and the new species described below. It differs in some respects from that given by Westergård (1946, p. 27) for the type species *Opsidiscus bilobatus*. The first difference is the very fine granulation of the test noted above. This feature is not noted by Westergård with respect to the type species, but an inspection of the rubber moulds of *O. bilobatus* reveals that a fine granulation is present.

The pygidial axes of the other three species are better known than that of *bilobatus* and it is on these three species that the axial description is mostly based. The most important difference between the above description and that originally given for *O. bilobatus* is the mention of schizochroal eyes. These are known to date only in the new species, *Opsidiscus argusi* described below. Only large 'tubercles' are seen in the eye position of the other three species. The eye tubercles on the rubber mould of the holotype cephalon of *O. bilobatus* were closely inspected. They are poorly preserved and as shown in Plate 44, fig. 7, they possess fine granules which could possibly be interpreted as eye lenses. However, they bear no resemblance to the well defined schizochroal eyes of *O. argusi*. It is possible that the eyes were present and have not been preserved. This suggestion is supported by the fact that in the more poorly preserved specimens of *O. argusi* no lenses are seen on the eye surfaces, which have a similar appearance to the 'eye tubercles' of *O. bilobatus*.

Classification and Relationships of Opsidiscus. In discussing this subject a brief nomenclatural observation must be made. The writer found that, in searching the literature on this and related topics, the term eodiscid is used to refer to either the suborder Eodiscina as a whole (i.e. including both the families Eodiscidae and Pagetiidae) or solely to members of the family Eodiscidae. This can be very confusing and in the following discussion the term eodiscid is restricted to members of the family Eodiscidae. Where reference is made to the suborder the term Eodiscina is used.

Westergård (1946, p. 22) considered that *Opsidiscus* was the link between the pagetiids and the eodiscids in that it had a pair of tubercles (homologous with pagetiid eyes) and lacked facial sutures. However, this suggestion cannot be accepted because the first appearance of *Opsidiscus* is later than the last appearance of the eodiscids. Westergård (1946, p. 28) also noted the close similarity between *Opsidiscus* and *Pagetia* and considered *Opsidiscus* to be a descendant of *Pagetia*. He included both the eodiscids and the pagetiids in the family Eodiscidae and suggested that a further breakdown into subfamilies, Pagetiinae and Eodiscinae, was unnecessary, partly due to the presence of the supposed intermediate form *Opsidiscus*. Westergård (1946) discussed *Opsidiscus* under his original generic designation, *Aulacodiscus*. However, Westergård (1949) realized that this name was preoccupied and replaced it with *Opsidiscus*.

The classification of Hupé (1953) for the eodiscids and pagetiids is quite complicated. It includes the new family Aulacodiscidae, thus raising the preoccupied generic name to familial level. Howell (1959) proposed that the suborder Eodiscina be divided into two families, (1) the Eodiscidae, without facial sutures and usually without eyes, and, (2) the Pagetiidae, with eyes and facial sutures. He placed *Opsidiscus* in the Eodiscidae, presumably because of the lack of facial sutures. The classification of Pokrovskaya

(1960) is basically the same as that of Howell, in that she recognizes the families Eodiscidae and Pagetiidae within the superfamily Eodiscoidea. However, she adds a third family, Opsidiscidae Hupé 1953, in which she places *Opsidiscus*. Prior to this Pokrovskaya (1959) included a new genus *Tannudiscus* in the Opsidiscidae, a move followed by Kobayashi (1962) and Repina (1964). However, as pointed out by Rushton (1966, p. 22) and Rasetti (1966b, p. 10) *Tannudiscus* is not related to *Opsidiscus* and belongs in the Eodiscidae. Rasetti (1967, p. 10) states that *Opsidiscus* could be referred to either the Pagetiidae or the Eodiscidae. Poletaeva and Romanenko (1970) retain *Opsidiscus* in the Opsidiscidae.

Palmer (1968, p. 38) described a new genus, *Yukonia* from the Early Cambrian of Alaska. This genus has three thoracic segments, an unfurrowed glabella, prominent eyes and eye lines, fused facial sutures and a smooth test. As suggested by Palmer *Opsidiscus* and *Yukonia* are probably not closely related, although he tentatively includes *Yukonia* in the Pagetiidae because of its well developed eyes and eye ridges.

The discovery of well preserved eyes in *Opsidiscus argusi* sp. nov. indicates that *Opsidiscus* differs considerably from any known genus of the Eodiscidae, and cannot be included in that family as was done by Howell (1959). *Opsidiscus argusi* is very similar to some species of *Pagetia* as illustrated by Rasetti (1966a), and apart from the lack of facial sutures, it corresponds well to *Pagetia* as defined by him. This fact along with the reasonable presumption that *Opsidiscus* must have been able to moult quite easily without the presence of facial sutures, suggests to the writer that the absence of facial sutures in *Opsidiscus* is not sufficient to be the basis of a familial separation between *Opsidiscus* and the Pagetiidae. This placing of *Opsidiscus* in the Pagetiidae dissolves the necessity for a separate family, the Opsidiscidae.

Whether *Opsidiscus* evolved directly from *Pagetia*, as suggested by Westergård (1946, p. 22), cannot be determined from the Tasmanian faunas. However, Mr. P. Jell (personal communication, March 1971) considers that *Opsidiscus* is descended from the pagetiids in the Cambrian faunas of northern Australia. This suggestion is supported by the presence of schizochroal eyes in both *Opsidiscus argusi*, as described below, and *Pagetia ocellata* Jell 1970.

Opsidiscus argusi sp. nov.

Plate 44, figs. 1–6, 8–18

Holotype. The almost complete specimen on catalogue number UT 92011, figured Plate 44, fig. 1.
Other material. One other well-preserved complete specimen; about ten cephala; and six pygidia, some of which are very well-preserved.

Diagnosis. *Opsidiscus* species with numerous large pustules on the dorsal surface of both cephalon and pygidium. The pustules on the thoracic segments are smaller and much less numerous. Well defined palpebral lobes and schizochroal eyes of about seventeen lenses. Well developed, wide, shallow transverse glabellar furrow, and long occipital spine. Pygidial axis of five segments and a terminus; fourth and fifth segments fused and bear a spine.

Description. Closely spaced, very small granules cover exoskeleton surface.

Moderately convex cephalon distinctly wider than long; it has a semielliptical outline; margins diverge slightly away from straight posterior margin and converge around anterior margin. Shallow, wide anterior border furrow, narrows posteriorly. Anterior border of some specimens has six to eight pits or radial grooves. Convex, narrow, posterior border; narrow, shallow posterior border furrow; both fade adaxially.

Border variable. Rim may be almost flat or markedly convex. Convexity of rim and development of pits and radial grooves show a continuous range of variation and is believed to reflect intraspecific variation rather than the existence of two or more species.

Moderately convex glabella tapers very slightly to bluntly rounded anterior. It extends about 0·75 length of cephalon. Wide, deep axial furrows. Immediately in front of glabella is a deep pre-glabellar depression connected to border furrow. Cephalic margin slightly depressed and indented immediately in front of pre-glabellar depression. Towards glabellar anterior (about one-third of distance towards the posterior) is a well developed, wide, shallow, transverse glabellar furrow. Eye ridges meet glabellar furrows just anterior of transverse glabellar furrow.

Occipital ring slightly wider than rest of axis. Occipital furrow has deep lateral notches and shallow midsection. These pronounced notches give lateral parts of occipital ring a rib-like appearance. Between occipital ring and transverse glabellar furrow are two glabellar segments, separated by faintly impressed lateral notches which are connected rarely by a very faint furrow. Long, strong, posteriorly directed occipital spine not usually preserved except for large spine base. Length of spine preserved in UT 92000 (Pl. 44, fig. 18) indicates that spine extended over thorax and possibly over pygidial anterior.

Pleural areas strongly convex. Eye ridges well developed in some specimens (e.g. UT 92009, Pl. 44, fig. 12) but in others are either poorly developed or not developed at all (e.g. UT 92005, Pl. 44, fig. 16). Prominent, convex, small palpebral lobes are slightly elevated above palpebral areas. Poorly developed palpebral furrows in some specimens, but usually palpebral lobe and palpebral area continuous. Ocular surface of each schizochroal eye is curved gently outwards. Each eye, when complete, possesses about 16 or 17 lenses. Facial sutures absent.

As well as the very small granules scattered all over the surface, there are large pustules

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EXPLANATION OF PLATE 44

Figs. 1–6, 8–18. *Opsidiscus argusi* sp. nov. 1, UT 92011, a complete specimen, the holotype, ×22. 2, 4, UT 92011 (separate cephalon); 2, cephalon, showing distinct eye ridges, ×18; 4, right eye, ×20. 3, 6, 9, 11, UT 92011 (the second complete specimen); 3, cephalon, showing fine granulation as well as coarse pustules, ×22; 6, right eye from the anterior, ×30; 9, right eye from the posterior, ×25; 11, thorax, ×22. 5, 15, UT 92006; 5, cephalon showing faint terrace lines on the edge of the doublure, ×19; 15, dorsal view, ×20. 8, UT 92004, pygidium showing fusion of fourth and fifth axial segments, ×16. 10, 14, UT 92003, pygidium; 10, side view showing spine base, ×20 (the axial half-ring is not visible from the side); 14, dorsal view, ×20. 12, UT 92009, cephalon showing radial grooves in border, ×15. 13, UT 92001, pygidium, ×22. 16, 17, UT 92005, cephalon; 16, dorsal view, ×22; 17, anterior view, ×22. 18, UT 92000, poor cephalon showing long spine, ×22.

Fig. 7. *Opsidiscus bilobatus* (Westergård) (rubber mould of holotype figured by Westergård 1946, pl. 1, fig. 21), right eye region, ×20.

Figs. 19–22. *Schmalenseeia gostinensis* sp. nov. 19, 20, UT 92012, the holotype partial cranidium; 19, external mould, ×10; 20, internal mould, ×13. 21, 22, UT 92013, pygidium and part of thorax; 21, internal mould showing full pygidium as well as an associated partial cranidium, ×7; 22, external mould ×8·5.

scattered over the cephalon. On the glabella these are usually placed near the lateral margins, with a pair on first glabellar segment and three evenly spaced pairs on rest of glabella. Each well preserved cephalon has a row of about seven pustules on the pleural areas, close to, and parallel with the axial furrows. Other pustules tend to occur in irregular rows, parallel to either glabella or cephalic margins.

Doublure partly exposed on one specimen (UT 92006 Pl. 44, fig. 5). On edge of border of this specimen, where it starts to turn down to form the doublure, there are well preserved terrace lines, consisting of small rows of granules. These also occur on the doublure, the width of which cannot be determined. Neither rostral plate nor hypostome is known.

The two thoracic segments are moderately well-preserved in only two specimens. Anterior segment is a little larger than posterior. Each pleura of anterior segment has two distinct areas; a small tumid antero-adaxially placed area with a distinct pustule, and a much larger adaxial area which includes the wide shallow pleural furrow (see Pl. 44, fig. 11). Pleural furrow emerges from adaxial area; it deepens abaxially and runs outwards and slightly backwards. Anterior and posterior edges of outer area raised well above furrow, and possess small pustules. Pleural extremities of anterior segment directed outwards and backwards for anterior two-thirds of segment and inwards for the rest. Available posterior thoracic segments not as well preserved as anterior segments. Axial region of posterior segment bears median-sized spine base. Pleural furrows shallow adaxially; widen and deepen abaxially. Small pustules on raised areas on either side of furrow.

Moderately convex pygidium with semicircular outline. At posterior, border is very narrow. Border furrow, shallow, moderately wide; edges of pleural regions very steep; posterior margin of pygidium is slightly indented immediately behind axis. Anterior border, convex, moderately wide, widest near centro-adaxially placed fulcral points. Anterior border furrow, shallow, wide, widening slightly abaxially. Large concave facets seen only in internal moulds. Prominent crescentic, strongly convex, long (sag.) articulating half-ring. Articulating furrow, wide, almost straight, shallow at centre, deeper at extremities.

Axis outlined by moderately wide, deep furrows which shallow posteriorly; axis tapers evenly to rounded posterior and stands out well above pleural areas. Axis does not quite reach border furrow; it consists of five segments and a terminus. First three segments quite convex; each bears a central median sized pustule flanked by two smaller ones. Transverse furrows separating these segments, deep laterally, shallow at centre. Fourth and fifth segments fused, bear a large spine base. In specimen UT 92003 lower part of spine preserved (Pl. 44, fig. 10). Spine probably directed upwards and backwards. Terminus, short, with two small pustules.

Pleural fields, highly pustulate; weak segmentation with about four discernible segments faintly delineated by small notches on abaxial margins of axial furrows. On pleural fields, first two pleural segments outlined by two rows (in each case) of pustules, orientated transverse to axis. These rows run outwards and backwards from axis. Less organization of smaller pustules towards pygidial posterior. Doublure not seen.

Discussion. The large pustules over the surface of both the pygidium and the cephalon, as well as the presence of well developed schizochroal eyes and palpebral lobes, clearly differentiate *Opsidiscus argusi* sp. nov. from other species of *Opsidiscus*. The cephalic pleural regions of *O. argusi* curve further around the front of the glabella than in *O. bilobatus*, which gives the pre-glabellar depression of *argusi* more the look of a furrow than in *bilobatus*. *Opsidiscus argusi* has a much better developed transverse glabellar furrow than has *O. depolitus*. The occipital spine of *O. altaicus* is wider than that of *O. argusi*. The pygidial axis of *O. argusi* is narrower and more clearly segmented than that of *O. altaicus*.

Order PTYCHOPARIIDA Swinnerton 1915
Suborder PTYCHOPARIINA Richter 1933
Superfamily BURLINGIACEA Walcott 1908
Family BURLINGIIDAE Walcott 1908
Genus SCHMALENSEEIA Moberg 1903

Schmalenseeia Moberg 1903, p. 93; Westergård 1922, p. 119; 1929, p. 8; 1948, p. 3; Hupé 1955, p. 198; Poulsen 1959, p. 293; Chernysheva 1960b, p. 130; Lazarenko 1960, p. 253.

Type Species: *Schmalenseeia amphionura* Moberg 1903, p. 93, pl. 4, figs. 1–4, 7–10.

Discussion. Westergård (1948, p. 3) placed *Schmalenseeia* along with *Burlingia* in the family Burlingiidae Walcott, 1908. Hupé (1955) and Poulsen (1959) agreed with this grouping, but Chernysheva (1960b) also included *Fissocephalus* in the Burlingiidae. However, *Fissocephalus* belongs in the family Harpididae Whittington 1950 (Whittington 1959, p. 418).

Prior to this paper there were only three described species placed in *Schmalenseeia*. These were the type species *S. amphionura* Moberg 1903 from Sweden (lowest part of the *Agnostus pisiformis* Zone), *S. acutangula* Westergård 1948 (Zones of *Ptychagnostus atavus*, *Hypagnostus parvifrons* and *Ptychagnostus punctuosus* of Sweden) and *S. spinulosa* Lazarenko 1960 from the *Agnostus pisiformis* Zone of the North Siberian Platform.

Schmalenseeia amphionura Moberg, as illustrated in Chernysheva *et al.* (1960a, pl. 3, fig. 4) from eastern Siberia is different from *S. amphionura* Moberg as illustrated by Westergård 1922 (pl. 1, fig. 19). The palpebral area of the form illustrated by Westergård is much narrower than that in the form illustrated by Chernysheva. Also the anterior thoracic segment in the Siberian form is curved markedly to the anterior, whereas in the Swedish form the anterior thoracic segment has a nearly straight anterior margin, and a posterior margin which is curved to the posterior. The anterior glabellar lobe is much larger in the Swedish form than in that illustrated by Chernysheva; the preglabellar ridge in the latter appears to be much more pronounced than in the former. Although the specimen of *S. amphionura* illustrated by Westergård (1922, pl. 1, fig. 19) is a young individual (Westergård 1948, p. 4) the differences noted above seem much too pronounced to be accounted for by changes during growth. Thus the Siberian form is a different species from *S. amphionura* and is in need of revision.

A rubber mould of the specimen of *Schmalenseeia amphionura* which was illustrated by Westergård (1922, pl. 1, fig. 19) reveals that in fact this figure has been printed reversed. Westergård's figure shows the preglabellar ridge much more prominently than it appears in the specimen. However, an unfigured rubber mould of *S. amphionura* has a more prominent ridge than the figured specimen. Westergård's figure also shows the posterior cranidial margin as straight, whereas in the available mould the posterolateral corners are slightly, but distinctly, turned to the posterior.

The cranidia of *Schmalenseeia acutangula* as illustrated by Westergård 1948 (pl. 1, figs. 2, 3, 5, 6) appear to include two separate forms; form (1), figures 2 and 3; and form (2), figures 5 and 6. In form (2) the free cheeks are bigger in proportion to the size of the cranidium than in form (1). The transverse glabellar furrows in form (1) extend from the lateral margins of the glabella towards the centre of the glabella, but in form (2) they appear more as shallow depressions and do not extend from the lateral margins but commence some distance inside them. A detailed comparison between forms (1) and (2) is difficult because of the poor reproductions of figures 2 and 3 and the lack of pygidia of form (2). The palpebral lobe in form (2) is much larger than in form (1), and it appears to be narrower in comparison with the glabellar width. Figures 5 and 6 have the appearance of internal moulds, but no mention is made of this in Westergård's text.

The cranidium of form (2) of *acutangula* is so markedly different from that of *Schmalenseeia amphionura* that it cannot be included in the same genus. The glabella of form (2) is much larger in relation to the cranidium than that of *amphionura*. The glabellar furrows of form (2) do not reach the lateral glabellar margins, whereas those of *amphionura* are deepest near the glabellar margins. Neither forms (1) or (2) of *acutangula* have the preglabellar longitudinal ridge of *amphionura* and other species of *Schmalenseeia*. It cannot be determined from Westergård's figures whether in fact forms (1) and (2) of *acutangula* as discussed above belong in the same genus.

If both forms (1) and (2) of *acutangula* are removed from *Schmalenseeia*, then this genus as far as is known is restricted to the lowest Upper Cambrian (Siberia and Sweden) and to the highest Middle Cambrian or Middle/Upper Cambrian transition beds (Tasmania). It is very small for a polymerid trilobite with the complete *Schmalenseeia spinulosa* figured by Lazarenko 1960 (pl. 53, fig. 18) having a length of only 7·7 mm. The very small size of *Schmalenseeia*, its lack of convexity, and its widespread distribution probably indicate that it led a pelagic existence. Because of its size and lack of convexity, *Schmalenseeia* is difficult to see in the rock and it can be expected that further examples of this genus will be found in scattered locations around the world. The nomenclature of the facial suture given below is similar to that of Hupé (1953, text-fig. 37).

Schmalenseeia gostinensis sp. nov.

Plate 44, figs. 19–22

Holotype. UT 92012, incomplete cranidium.

Material. Only two specimens are available, one of which is the holotype UT 92012, which is a moderately well preserved cranidium, about two-thirds of which is present. The complete cranidium would have a length of about 1·25 mm. and a width of about 2·3 mm. The other specimen, UT 92013, is one in which part of the thorax and all of the pygidium is known, although only part of the pygidium is preserved as the external mould. Associated with this partial thorax and pygidium is a partial cranidium which is preserved only in the internal mould (Pl. 44, fig. 21). It is possible that this cranidium belongs with the associated thorax-pygidium. Internal and external moulds of both specimens are available.

Diagnosis. *Schmalenseeia* with pronounced posterior marginal furrow on the fixed cheek, short genal spines, and dome-shaped anterior glabellar segment which bears a large node. From this node emerges a distinct ridge which extends to the centre of the anterior cranidial margin. Occipital ring with a well developed node or spine base. At least eighteen thoracic and pygidial segments. Pleurae flat, with a narrow ridge along both anterior and posterior margins; short pleural spines. Pygidium has no distinguishable border.

Description. Complete cephalon would have semicircular outline and be almost twice as wide as is long. Cranidium, almost flat, except for elevated glabella and palpebral lobes. Librigenae unknown, probably flat. No frontal border.

Posterior margin almost straight across base of occipital ring; adaxial parts of margin arched slightly to posterior; abaxial parts arched slightly to anterior, terminating in short genal spines. Posterior border furrow located a little distance anterior of posterior margin; it extends from near occipital furrow to close to tip of genal spine. Posterior border areas slightly raised above level of posterior areas of fixigenae.

Facial sutures, proparian, burlingiiform. Posterior end of each facial suture cuts lateral cephalic margin about one-third of distance from genal spines to cranidial front. From this point (ω) the facial suture runs at about 90° to cephalic margin. 'Posterior' section of facial suture is straight except for the most adaxial part which curves around until the very end of it is directed inwards and forwards. At this point (ϵ), facial suture is very close to glabella. From ϵ, suture is curved gently forward and outward, up to a point about 0·4 of distance along the palpebral lobe, from where it curves gently inward and forward to γ. γ is close to the glabella and opposite the centre of anterior glabellar segment. From γ to α, facial suture straight, meets cranidial margin at about 90°.

Posterior areas of fixigenae, large, flat, narrow (exsag.) near glabella. Small, flat palpebral areas; prominent, long, narrow, steep palpebral lobes; moderately wide, shallow palpebral furrows. Small knob at anterior of each palpebral lobe; there may be a smaller knob at posterior, but this cannot be determined with certainty.

Frontal area, large, flat, featureless except for a pronounced ridge which commences at centrally placed node on anterior glabellar segment and continues to midpoint of anterior cephalic margin. Ridge becomes narrower and lower toward cranidial front; at posterior it is bounded by faint furrows.

Glabella stands well above fixigenae; it consists of four segments, plus occipital ring, which appears to be an integral part of the glabella and is described as such. Length and width of glabella respectively about two-thirds and one-third those of cranidium. From occipital ring, glabella tapers to third glabellar segment; second glabellar segment slightly wider than third segment. Glabellar front, subangular; glabellar furrows, deep. Frontal glabellar segment has length about one-third that of glabella. First pair of glabellar furrows commence very close to, and just to the posterior of the knobs at the anterior ends of the palpebral lobes. They are directed inwards and backwards quite markedly and are concave abaxially. In the centre of the subelliptical dome, which is the anterior glabellar segment, there is a large node, from which runs the ridge across the frontal area. Second glabellar segment may have a small central node, but further specimens will be required to confirm this point.

Second pair of glabellar furrows curve gently inwards and backwards; deepest adaxially with distinct pits near the abaxial extremities as is the case in other glabellar furrows and the occipital furrow. Pits probably represent muscle attachments. Posterior pair of glabellar furrows run almost straight across glabella and meet in the middle. Occipital ring, narrow (sag.), well developed node or spine base on anterior part of central region. Occipital furrow, wide, deep, separated at centre by the node.

Thorax of at least nine, and possible twelve or more segments. As noted above only one partial thorax is available. Axial region not present except for what are probably the last two or three segments. Narrow axis raised slightly above pleural areas. Along anterior margin of axis of each known thoracic segment is a low convex ridge, which is the axial half-ring. All known thoracic and pygidial segments are narrow (sag.). Immediately behind axial half-ring is a relatively wide furrow, which is of moderate depth abaxially; it shallows adaxially, where it is interrupted by a low hemispherical node. Low ridge along posterior margin of axis.

Thoracic pleurae, basically flat; low, narrow, convex ridges along anterior margins; somewhat higher, narrow, convex ridges along posterior margins. Small transversely elongated depression antero-laterally placed on each pleura. From these depressions, poorly defined, shallow pleural furrows run outwards and backwards until they meet the posterior pleural ridges about one-third of the distance to segment margins. For the rest of its course each furrow runs just in from the posterior ridges. Pleural furrows, narrower and better defined abaxially.

Pleural margins make an angle of about 120° with anterior border; they are straight and end in very short pleural spines. Pleurae widen slightly abaxially. On the most anterior pleural segment present on specimen UT 92013 the anterior margin is curved; its outline is concave to the anterior (Pl. 44, figs. 21, 22). In the more posterior segments the margins gradually straighten until in the most posterior segment which can be definitely assigned to the thorax the curvature is slightly in the reverse sense.

On the available specimen it is impossible to determine the junction between thorax and pygidium. Pygidial axial region is similar to that of thorax. Pointed pygidial axis terminates some distance in front of broadly rounded pygidial margin. No distinguishable pygidial border. In posterior part of axis, the central axial nodes tend to merge to give the appearance of a ridge.

Near the thoracic posterior there is a slight posterior geniculation where posterior axial ridges continue on to posterior pleural ridges. This feature becomes more pronounced to the posterior, until on the third last pygidial segment these ridges are aligned almost parallel to the axis. On the last two segments the pleural ridges are directed inwards and backwards. The available specimen has a total of at least eighteen thoracic and pygidial segments.

Discussion. *Schmalenseeia gostinensis* sp. nov. differs from all other described and illustrated forms of *Schmalenseeia* in that it has a pronounced posterior marginal furrow on the fixigenae.

S. gostinensis is probably closest to '*S. amphionura*' as illustrated by Chernysheva (1960a, pl. 3, fig. 4), because the latter appears to have faint posterior marginal furrows on the fixigenae. However, *S. gostinensis* differs from this form in that the anterior glabellar lobe of *gostinensis* is much more pronounced, the posterolateral limbs of the fixigenae are much bigger and it has more thoracic and pygidial segments. *Schmalenseeia gostinensis* differs from *S. amphionura* as illustrated by Westergård (1922, pl. 1, fig. 19) in the much more pronounced preglabellar ridge that the former possesses. *S. amphionura* does not possess the well developed node on the most anterior glabellar segment as does *S. gostinensis*. A third difference is that the anterior thoracic segments in *gostinensis* are curved to the anterior, whereas those of *amphionura* are straight or curved to the posterior.

Schmalenseeia gostinensis differs from *S. spinulosa* Lazarenko in that the latter has pronounced axial spines or at least large nodes on each glabellar segment; the posterior cranidial margin of *spinulosa* is much more curved forward than in *gostinensis*; the glabella of *spinulosa* tapers more than that of *gostinensis*, and the most anterior glabellar lobe in the latter is slightly bigger than that of *spinulosa*. Although one and probably both forms of *Schmalenseeia acutangula* as described by Westergård (1948) do not belong in *Schmalenseeia* (see above) they are briefly compared with *S. gostinensis* for the sake of completeness. *S. gostinensis* differs from both forms of *acutangula* in that it has a distinct preglabellar median ridge and that its palpebral areas are comparatively much larger. The glabella of *gostinensis* does not extend as far forward as that of either form of *acutangula*. *S. gostinensis* also differs from form (1) of *acutangula* in that the anterior thoracic segments of the latter are curved to the posterior.

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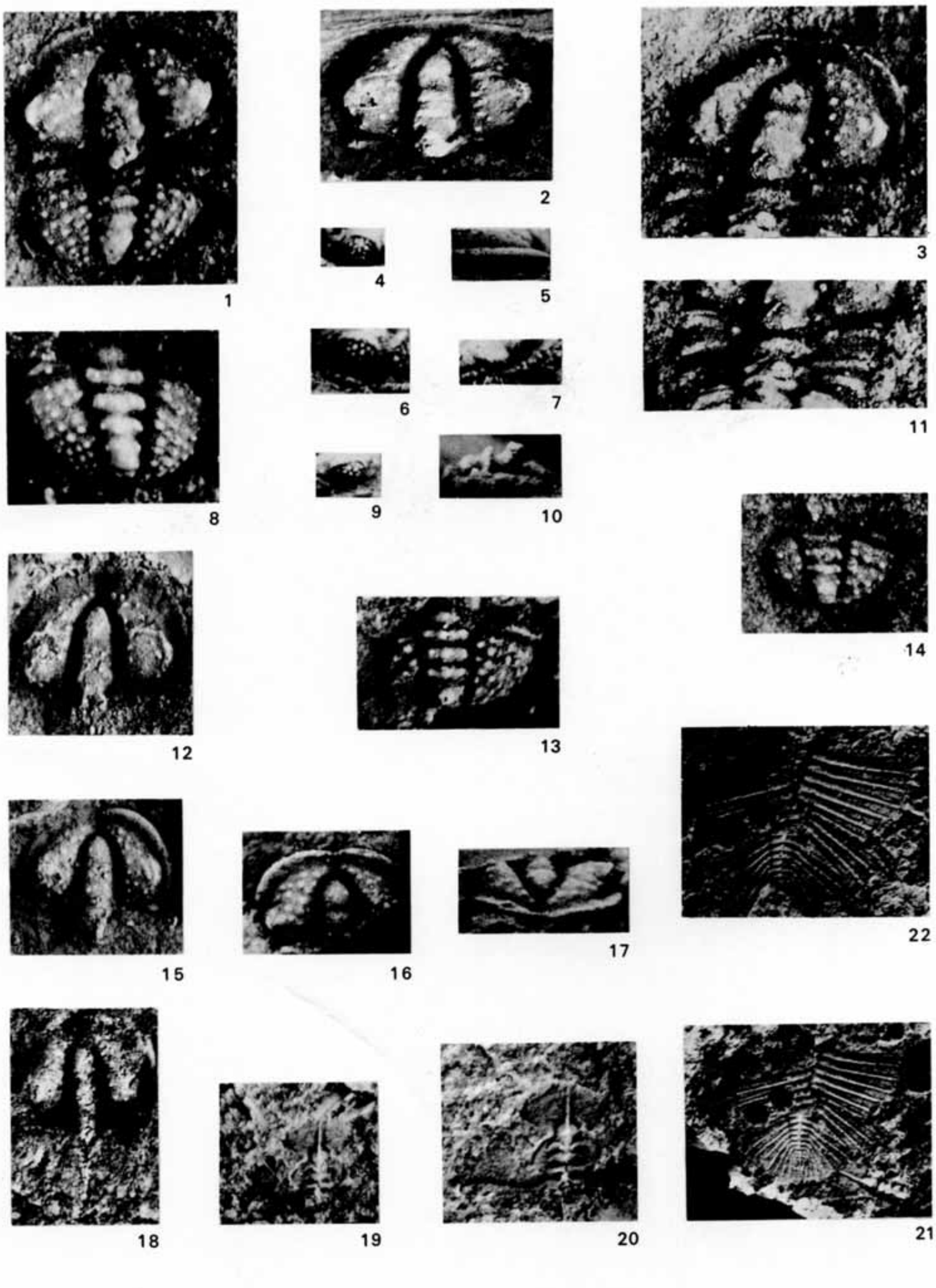

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