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Idamean (Late Cambrian) Trilobites, Burke River Structural Belt, Western Queensland

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ABSTRACT

Twenty-four genera of trilobites and forty-one species or subspecies are described from collections of Pomegranate Limestone from the southern part of the Duchess 1:250 000 Sheet area, in the central portion of the Burke River Structural Belt, western Queensland. Two genera—*Chalfontia* and *Mecophrys*—are new, and five are left under open nomenclature. Of the forty-one specific taxa, five are new: *Kormagnostella inventa, Pseudagnostus idalis sagittus, Protemnites burkensis, Mecophrys mecophrys,* and *Mecophrys selenis.* Sixteen species are left in informal nomenclature. Additions and revisions are made to earlier published taxa by Whitehouse, Öpik, and Henderson. In particular, the genus *Protemnites* is revived.

Material from Idamean localities collected during 1967, 1969, and 1974 and described here, permits a more rigorous assessment of the biostratigraphy than was hitherto possible. The zonation proposed by Henderson on Glenormiston sequences can be applied in the Burke River Structural Belt, but the *Erixanium sentum* Assemblage-Zone can be differentiated from the earlier *Proceratopyge cryptica* and later *Stigmatoa diloma* assemblages only with difficulty. It is recommended that the *Irvingella tropica* Assemblage-Zone be removed from the Idamean and regarded as introducing a younger biochronological stage informally designated previously as the post-Idamean/pre-Payntonian interval.

INTRODUCTION

Idamean trilobite assemblages are described in this Bulletin from localities in the central portion of the Burke River Structural Belt, on the southern part of the Duchess 1:250 000 Geological Series Sheet (Carter & Öpik, 1963) (Fig. 1).

Idamean trilobites have been collected in this area several times since their first published descriptions by Öpik in 1963. During 1967 C. E. Murray (Geological Survey of Queensland), then attached to the Bureau of Mineral Resources Northwest Queensland Phosphate Group, collected from localities along the eastern margin of the Structural Belt during routine mapping between Moonlight Bore and Mistake Bore (Fig. 1); and F. de Keyser obtained trilobites from the western side of the Structural Belt southeast of Pilgrim Well. In 1969, J. H. Shergold collected sequences at Mount Murray during an investigation of the trilobite assemblages of the nearby Chatsworth Limestone, and again in 1974 when the Mount Murray sections were surveyed as part of an appraisal of the relation between the Pomegranate and Chatsworth Limestones.

All new material described in this Bulletin is deposited in the Commonwealth Palaeontological Collection (CPC), Bureau of Mineral Resources, Canberra. Older material is re-figured from Whitehouse's collections, which is housed in the Fossil Collections, Department of Geology, University of Queensland, St Lucia (UQF).

Acknowledgements

I am grateful to Dr B. M. Radke (BMR) for providing me with copies of Mount Murray lithological logs; J. M. Kennard (BMR) for permitting me to use the lithological log of BMR Boulia No. 6, and for providing me with the petrological descriptions given in Appendix 2; and H. M. Doyle (BMR) for his photographic assistance. I would like to thank Dr P. A. Jell, National Museum of Victoria, for preparing the holotype of *Pseudagnostus vastulus* Whitehouse on my behalf, and Dr G. Playford for replicating this specimen.

LITHOSTRATIGRAPHY

Distribution of Pomegranate Limestone

Idamean trilobite assemblages in the Burke River Structural Belt are found principally in the Pomegranate Limestone (Öpik, 1960, p. 101). In its type area, Pomegranate Creek (Öpik, 1956a, p. 23; 1960, p. 101; 1963, p. 17; 1967, p. 32; *in* Carter & Öpik 1963, table 2 de Keyser, 1968, pp. 24-25; Smith, 1972, p. 112; Shergold, Druce & others, 1976, p. 41), the Pomegranate Limestone is described as "light-coloured impure (marly) beds, almost shaly bituminous limestone, ellipsoidal beds in flaggy limestone; and interbeds of intraformational breccias" (Öpik, 1960, p. 101). When traced northwards and eastwards the Pomegranate Limestone apparently interdigitates with O'Hara Shale (Öpik, 1956a, p. 15; 1960, p. 101), which also has yielded Idamean trilobites (see Öpik, 1967, p. 32). The O'Hara Shale is also said to overlie Pomegranate Limestone, to have a gradational passage with it, and to have a contact which rises stratigraphically from north to south. While some lateral passage can be demonstrated and dated, the overlying sequence has not been, and this has led Shergold (1980) to express the view that the bulk of the mapped O'Hara Shale overlying Pomegranate Limestone, between Pomegranate Creek and Mistake Creek, belongs to a post-Palaeozoic stratigraphic unit.

To the north of Limestone Creek, however, mapping by de Keyser *et al.* in 1967 (de Keyser, 1968) suggests that a largely non-outcropping clastic unit underlies the Pomegranate Limestone, and that this is probably O'Hara Shale *sensu stricto*. In turn, it is underlain, on a regional stratigraphic basis, by Selwyn Range Limestone (Öpik, 1956a, pp. 15, 20; 1960, p. 102), predominantly a lime mudstone or wackestone formation, which has yielded rare Mindyallan trilobites of the *Glyptagnostus stolidotus* Assemblage-Zone (locality D679, Shergold *in* de Keyser, 1968, Appendix). Possibly there is interdigitation of Selwyn Range Limestone, O'Hara Shale, and Pomegranate Limestone across this region.

To the west, between Petticoat Creek and the northern end of the Mount Murray structure, the Pomegranate Limestone is inferred to overlie a similar variable carbonate complex which can be regarded as Devoncourt Limestone (Öpik, 1956a, pp. 15, 20; 1960, p. 100).

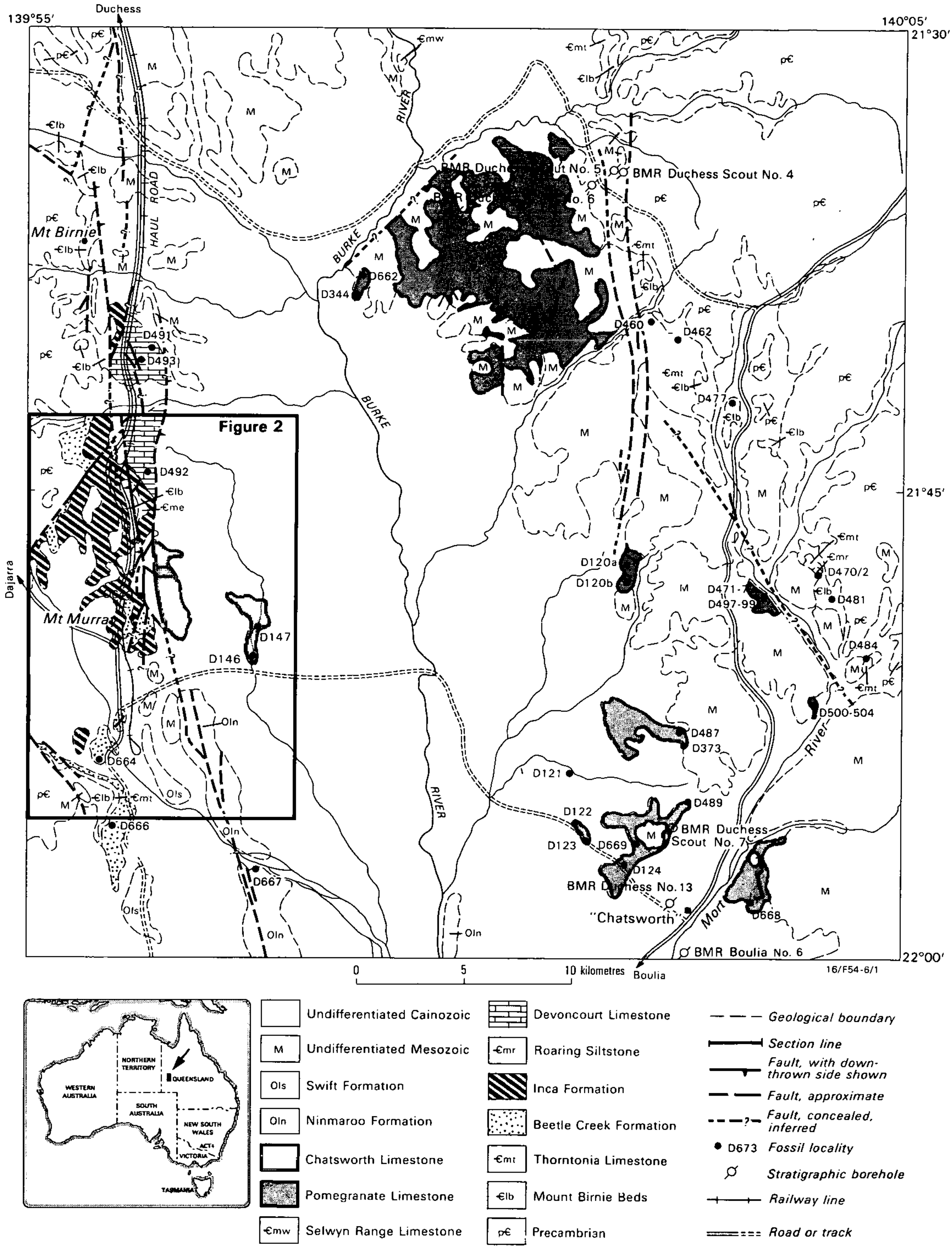

Fig. 1. Distribution of Pomegranate and Chatsworth Limestones, Idamean collection sites, and measured sections.

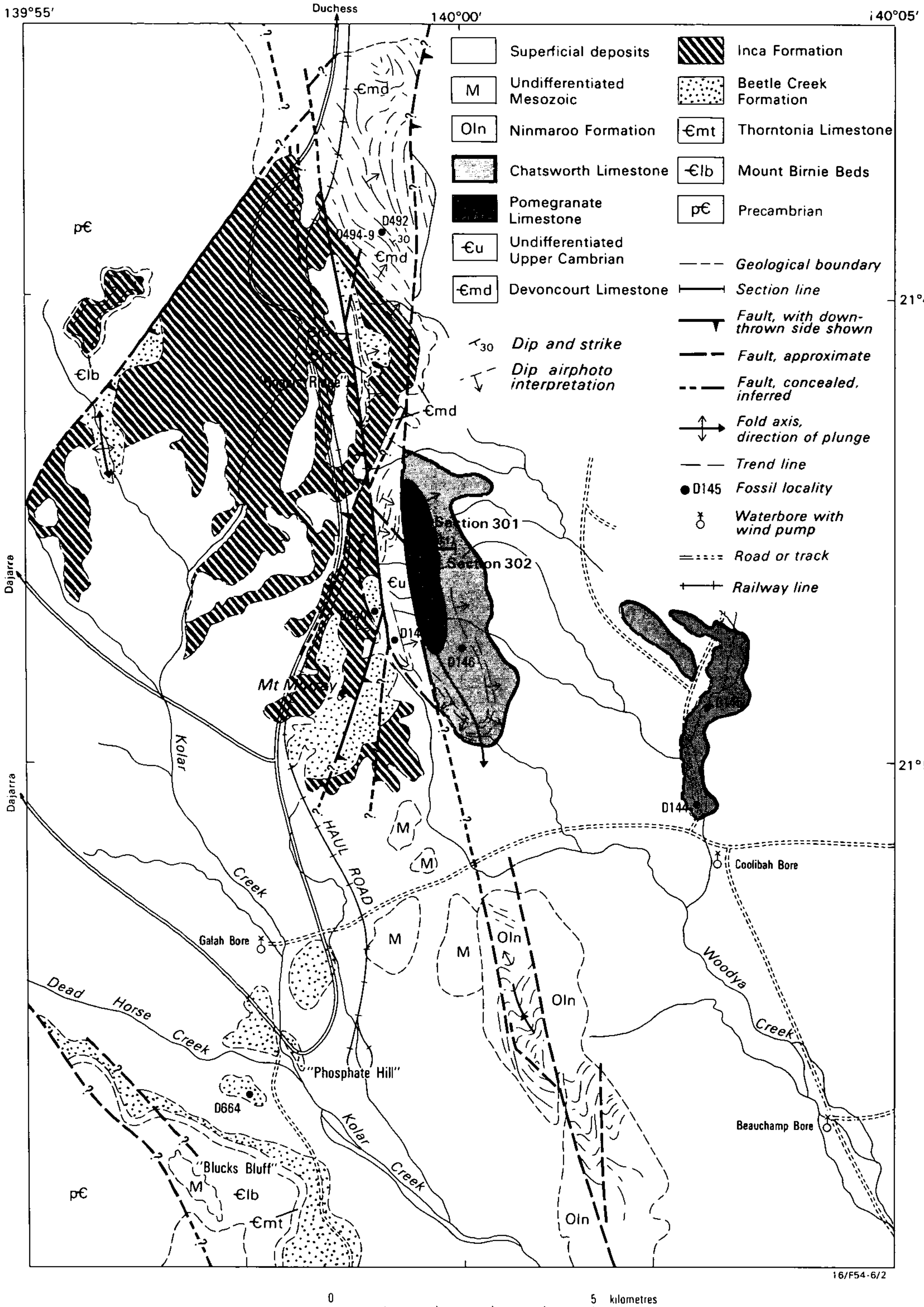

Fig. 2. The geology of Mount Murray and immediate environs, showing the location of measured sections 301 and 302.

Immediately north of Mount Murray (Fig. 2), faunas from localities D492 and D494-499 contain late Middle Cambrian trilobites. However, stratigraphic relations cannot be confirmed in this region due to complex faulting.

To the south, Pomegranate Limestone is conformably overlain by Chatsworth Limestone on the black-soil plains north and northwest of Chatsworth Homestead (Fig. 1). The contact is concealed on these plains and can only be interpreted from sections 301-302 at Mount Murray (Radke *in* Shergold, Druce & others, 1976, pp. 10, 13-14) (see below).

Internal lithostratigraphic variation in the Pomegranate Limestone indicates a gradual upwards shallowing. The oldest dated sequences are along the eastern margin of the Burke River Structural Belt, between Moonlight and Mistake Bores where poorly outcropping siltstone and interbedded bituminous silty pelletal skeletal grainstone and laminated pelletal grainstone, perhaps indicating the deepest of all the environments embraced within the Pomegranate Limestone (localities D120a-b of Öpik (1963), D471-473, 497-504 in Fig. 1), have yielded faunas of the two earliest Idamean biostratigraphic zones, the *Glyptagnostus reticulatus* and *Proceratopyge cryptica* Assemblage-Zones (following Henderson's 1976, 1977 zonal scheme; see p. 9 for discussion). Sampled outcrops on the eastern side of the main pediment between Pomegranate Creek and the Burke River have also yielded fauna of early Idamean age (localities D673-674).

Localities on the western side of this pediment yield younger Idamean faunas (e.g. D119, D133 of Öpik, 1963, p. 18, fig. 2; and D662) of the *Stigmatoa diloma* Assemblage-Zone, and rocks of this age also occur at the base of the sections measured at Mount Murray where they are conformably and gradationally overlain by dominantly muddy carbonates deposited during the time of the *Irvingella tropica* Assemblage-Zone. The regressive sedimentation cycle is completed at Mount Murray by dolomites, micrites and intraclastic grainstones which are regarded as the base of the Chatsworth Limestone (Radke *in* Shergold, Druce & others, 1976, p. 10).

Mount Murray sections

The topographic feature known as Mount Murray is situated on the western margin of the Burke River Structural Belt, 23 km northwest of Chatsworth homestead, 30 km southeast of Dajarra and 33 km south-southeast of Duchess. It is shown on the 10-mile scale geological map of northwestern Queensland (Carter & Öpik, 1959) and the Duchess 1:250 000 Geological Series Sheet (F/54-6) (Carter & Öpik, 1963), and is covered by airphotos at the following scales: K17, 1:50 000, Duchess, Run 13, Photos 5144-5145, September 1950; Australian Government Colour Series, 1:25 000, Dajarra, Run 8, Photos 7068-7069, flown in August 1976.

Pomegranate Limestone crops out in the core of a faulted periclinal structure (Fig. 2) which extends northwards for approximately 2 km from a point one kilometre northeast of Mount Murray itself. Around the periphery of this structure Pomegranate Limestone is overlain conformably by Chatsworth Limestone (*sensu stricto* according to Jones & others, 1971). Two adjacent sections have been measured (Figs. 3, 4): section 301 commences to the east of the major fault zone which bisects the Mount Murray structure, as close as practicable to the fault, at a point 1.25 km east-northeast of Mount Murray; section 302 was measured adjacent to section 301, but extends the sequence well into the Chatsworth Limestone.

On section 301 (Fig. 3) some 87 m of laminated pelletal skeletal grainstone, pelletal wackestone and mottled micritic limestone, cropping out as discrete layers or groups of layers separated by non-outcropping clastic intervals, was deposited during the time of the *Sigmatoa diloma* Assemblage-Zone. These rocks pass gradually into a predominantly silicified micritic limestone sequence during the span of the *Irvingella tropica* Assemblage-Zone.

Section 302 (Fig. 4) commences at this level (bed 301/7 is used as the base of this section —Fig. 7). The micrite/clastic intercalation is overlain by a thick sequence of interbedded dolomite, muddy carbonate and intraclastic grainstone which forms major topographic benches about 105 m above the base of this section. The base of the Chatsworth Limestone is considered to coincide with the first of these dolomite benches on section 302 which forms a distinctive dark band on the colour airphotos (see Radke *in* Shergold, Druce & others, 1976, p. 10, fig. 5; herein, Figs. 4, 7). Trilobites are uncommon in the basal Chatsworth lithofacies both at Mount Murray and on the plains northwest of Chatsworth Homestead (Fig. 7).

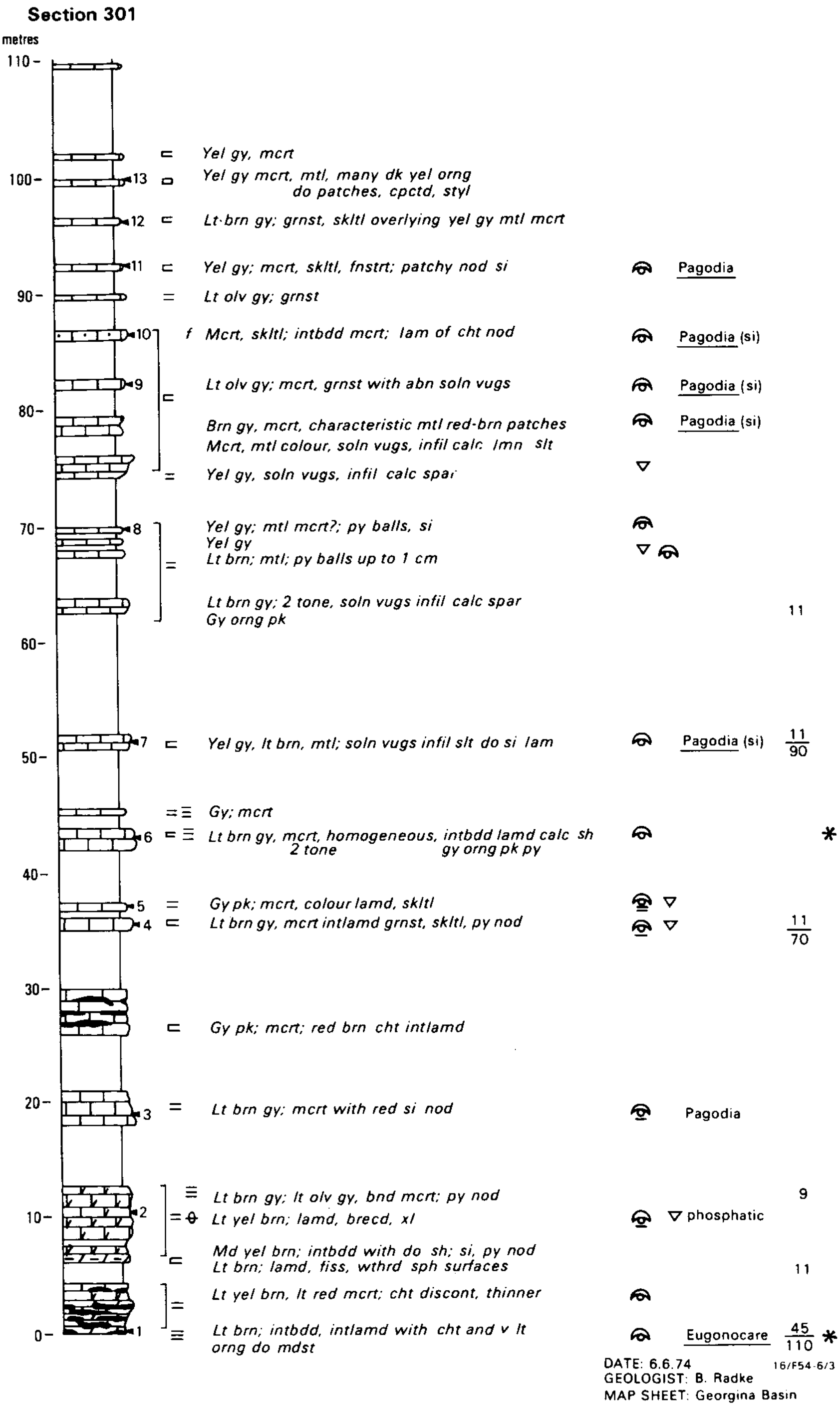

Fig. 3. Lithological log of section 301, after B. M. Radke.

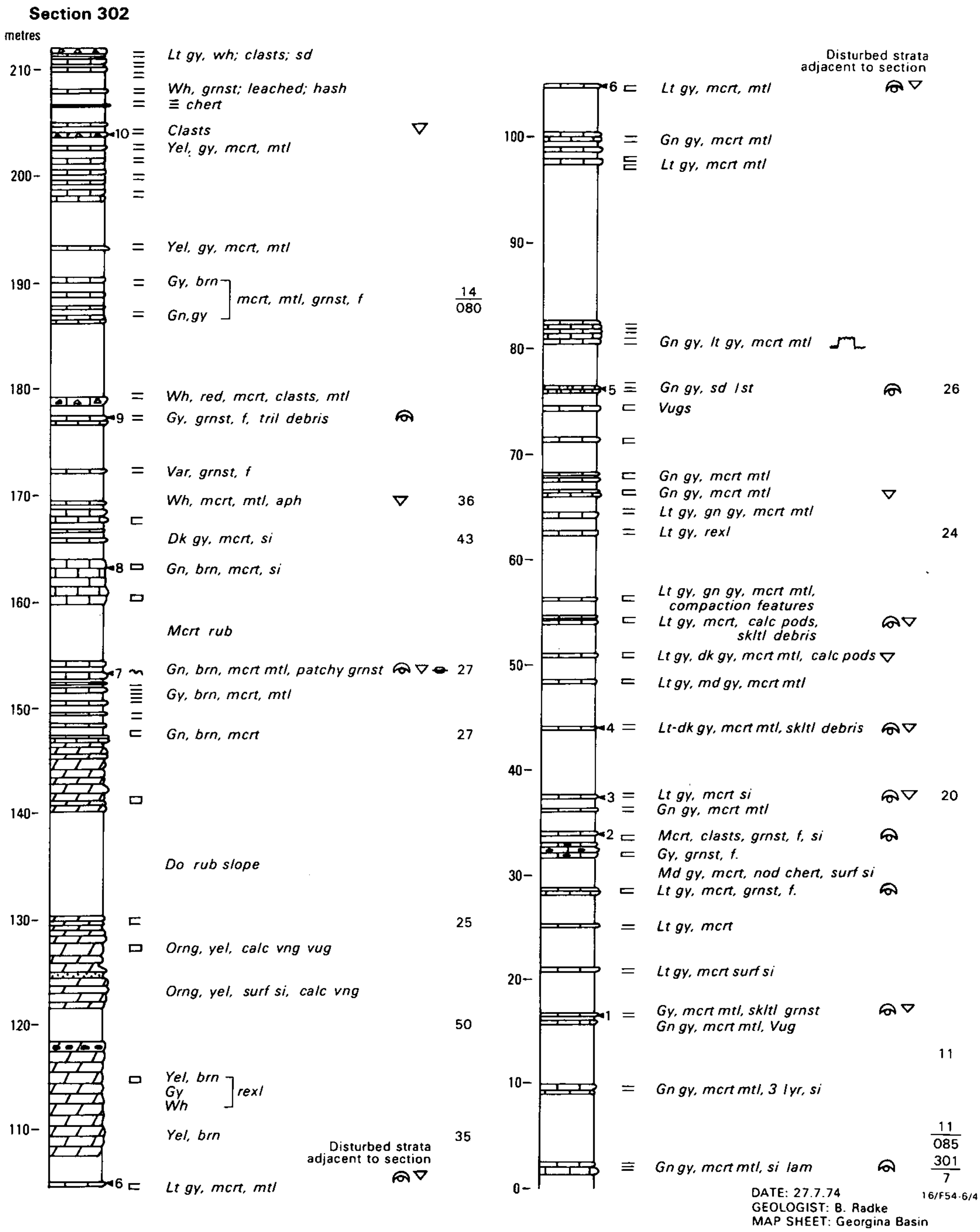

Fig. 4. Lithological log of section 302, after B. M. Radke.

Symbols used on lithological logs

Lithologies

- *Limestone*
- *Dolomite*
- *Limestone and dolomite*
- *Sandstone*
- *Silt*
- *Shale/mudstone*
- *Chert*
- *Breccia*

Bedding and sedimentary structures

- *Thick-bedded*
- *Medium-bedded*
- *Thin-bedded*
- *Laminated bedding*
- *Wavy beddding*
- *Stylolitisation*
- *Trilobites*
- *Echinoderms*
- *Bioturbation, burrows*

Abbreviations used on lithological logs

aph	*aphanitic*
bnd	*banded*
brecd	*brecciated*
cht	*chert*
cpctd	*compacted*
do	*dolomite*
fiss	*fissile*
fnstrt	*fenestrate*
grnst	*grainstone*
intbdd	*interbedded*
intlamd	*interlaminated*
lamd	*laminated*
lmn	*limonite*
lst	*limestone*
lyr	*layered*
mcrt	*micrite*
mdst	*mudstone*
mtl	*mottled*
ooid	*ooid*
pckst	*packstone*
pel	*pelletal*
py	*pyrite (pyritic)*
sh	*shale*
si	*silicified (silica)*
skltl	*skeletal*
slt	*siltstone*
styl	*stylolitic*
vng	*veining*
wckst	*wackestone*
wthrd	*weathered*
xlamd	*cross-laminated*

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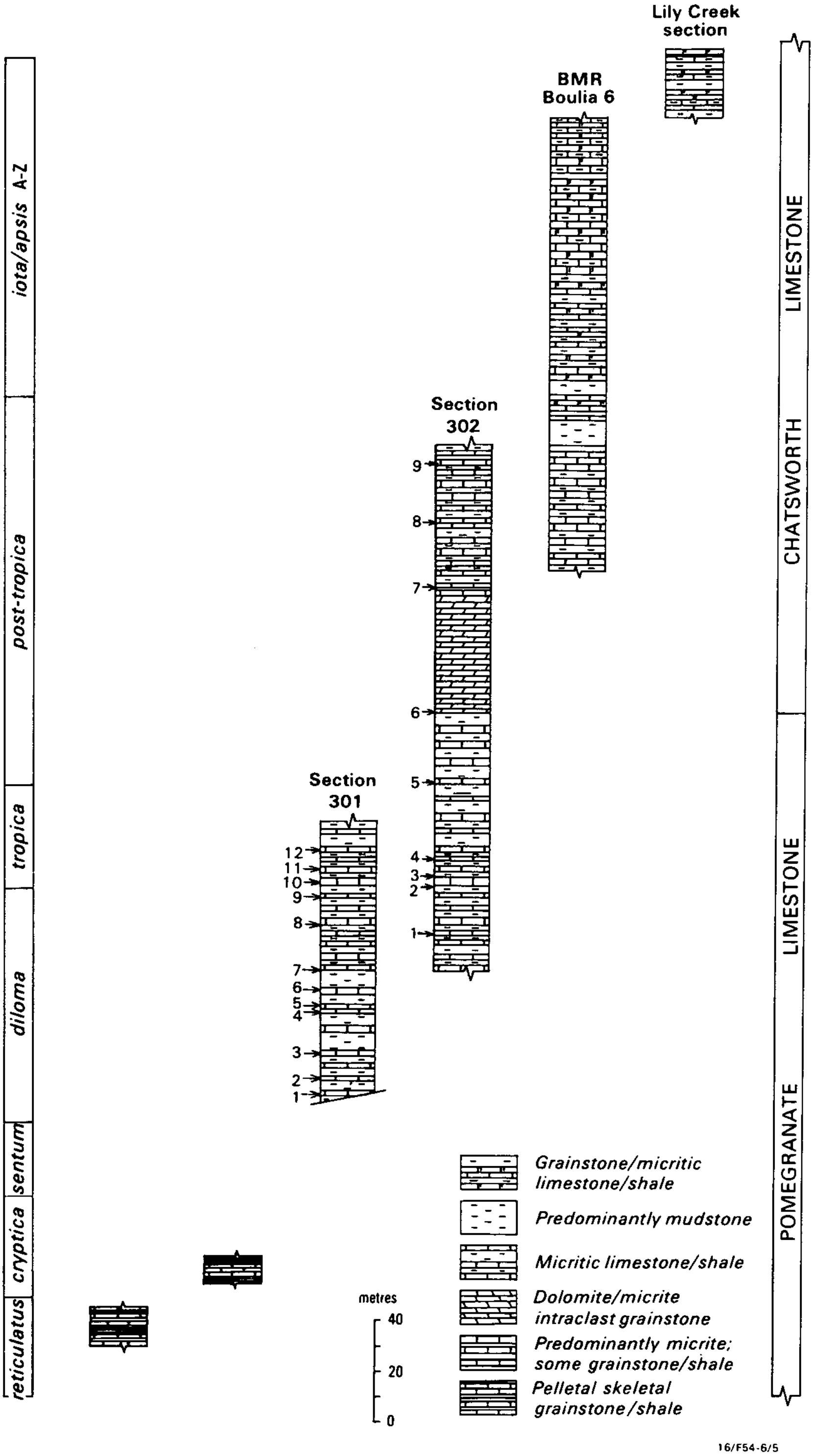


Fig. 5. Lithological correlation and biostratigraphic synthesis of Idamean and immediate post-Idamean sections and coreholes on the southern part of the Duchess 1:250 000 Geological Series Sheet.

Base of the Chatsworth Limestone

The dolomite, muddy carbonate, and intraclastic grainstone sequence at the base of the Chatsworth Limestone at Mount Murray can also be recognised on the black-soil plains north and northwest of Chatsworth Homestead (Fig. 1), and was drilled in BMR Boulia No. 6 (see Shergold & Walter, 1979). In that hole, a mudstone/micritic limestone intercalation (48 m cored) is overlain by a muddy and shaly carbonate interval (10 m thick), a mudstone/grainstone sequence (60 m), and a predominantly grainstone sequence at the top of the hole (62 m). The basal lithofacies at Mount Murray, more than 100 m thick, was deposited during the post-*Irvingella tropica* Assemblage-Zone described here. A paucity of trilobite occurrence is demonstrated by the palaeontological log of BMR Boulia No. 6 (Shergold, Appendix 1, *in* Shergold & Walter, 1979); only inarticulate brachiopods have been identified in the lowermost 70 m of this core, and the *Wentsuia iota/Rhaptagnostus apsis* Assemblage-Zone (Shergold, 1980) is restricted to the grainstone sequences at the top of the corehole. The litho- and biostratigraphy of this interval is summarised in Figure 5.

BIOSTRATIGRAPHY

HISTORICAL REVIEW

The first late Cambrian trilobites recorded in northern Australia were reported by Whitehouse (1931) from limestones in the Glenormiston area which Ogilvie (*in* Whitehouse, 1931, p. 141, footnote) called Georgina Limestones, regarding them as a lithological series. In that paper, Whitehouse recognised two faunal stages in the Upper Cambrian of the Glenormiston area: a younger *Pagodia* Stage was considered to succeed an older *Proceratopyge* Stage, itself succeeding Middle Cambrian faunas. These stages were reproduced by David (1932, p. 37) who showed them constituting a "Duchess-Glenormiston" Series.

In 1936, Whitehouse revised his stratigraphic sequence: the Upper Cambrian sedimentary sequence in the Glenormiston area was considered (p. 64) to constitute the Georgina Limestones at the base with Pituri Sandstones conformably overlying them. The former name appears to have been applied indiscriminately to all the Middle and Upper Cambrian carbonates of the Georgina Basin. The biostratigraphic scheme was also revised (Whitehouse, 1936, p. 72 *et seq.*): eleven Cambrian faunal stages, and one Ordovician one, were now recognised. The late Cambrian is represented by four faunal stages: the *Anorina, Glyptagnostus*, and *Pagodia* Stages were thought to occur in the Georgina Limestones, and the *Elrathiella* Stage in the Pituri Sandstones. These stages were used by Whitehouse in his initial descriptions (1936) of late Cambrian trilobites in the Glenormiston area.

Subsequently (1939, p. 265 *et seq.*), the scheme was further modified largely as a result of Whitehouse's discovery of similar faunas in the Burke River Structural Belt. Twelve Cambrian faunal stages were now recognised, with four Upper Cambrian ones based on *Eugonocare, Glyptagnostus, Rhodonaspis,* and *Elrathiella.* These were used for dating the fossils described in 1939, and they were repeated by Bryan & Jones (1946) without critical comment.

They were, however, critically evaluated by Öpik (1956a, pp. 21-23), who hinted that the sequence *Eugonocare-Glyptagnostus-Rhodonaspis* in the Georgina Limestone is incorrect (it is now known to be inverted), and that the position of Whitehouse's *Elrathiella* Stage in the Pituri Sandstone is uncertain but nevertheless late Cambrian. Öpik used the American term Dresbachian in the absence of a substantiated local stage nomenclature in his 1960 evaluation of the geology of the Georgina Basin, but later (1961b) considered that such usage in Australia would lead to 'uncontrollable instability' in nomenclature because of the difference in concepts applied.

Consequently, the Idamean Stage was introduced in 1963, and the Mindyallan Stage in 1967. Five trilobite Assemblage-Zones (defined as Zones) were considered to constitute the Idamean Stage, and two, later extended to four, the Mindyallan Stage (see Fig. 6). The concept of these zones which are based on collections from both the Glenormiston and Duchess areas, is discussed at length by Öpik (1963, pp. 7-14).

Criticism of this zonal scheme has been published by Henderson (1977, pp. 430, 432), who has re-investigated the faunal stratigraphy south of Glenormiston and attempted to piece

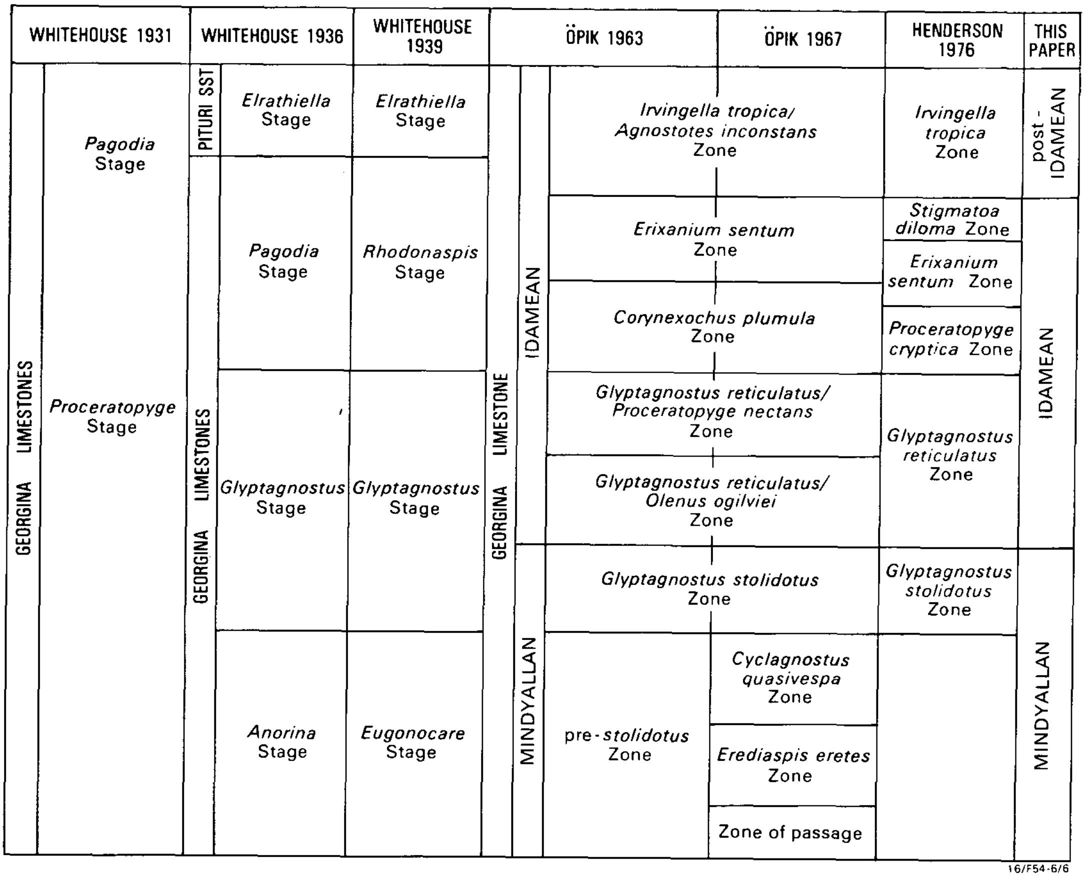


Fig. 6. Idamean zonal schemes in Australia.

together a composite section in this area (Browns Creek Section). This criticism is mainly concerned with stratigraphic practice: Öpik's biostratigraphy is presented independently of rock sequence, because of the inherent difficulties in finding and then measuring such a section before the availability of high-quality airphotos; and the use of *Corynexochus plumula*, a long-ranging form originating in the Middle Cambrian, as an index fossil. Henderson (1976, p. 327) has proposed an alternative zonation in the Glenormiston area in which the Zones of *Glyptagnostus reticulatus* with *Olenus ogilviei* and *G. reticulatus* with *Proceratopyge nectans* are united into a common *G. reticulatus* Zone; the *Corynexochus plumula* Zone is renamed the *Proceratopyge cryptica* Zone; and the *Erixanium sentum* Zone is divided into two—a zone of *E. sentum* followed by a zone of *Stigmatoa diloma*. The *Irvingella tropica*/*Agnostotes inconstans* Zone is abbreviated to *Irvingella tropica* Zone.

BIOSTRATIGRAPHIC SEQUENCE

Since the taxon ranges shown by Henderson (1977, p. 431, fig. 9) for the Glenormiston area are similar to those documented here for the Burke River Structural Belt, Henderson's biostratigraphic scheme is applied. However, Henderson's zones are here regarded as assemblage-zones. A younger assemblage than that constituting the *Irvingella tropica* Assemblage-Zone is recorded at Mount Murray. This is informally designated as a post-*Irvingella tropica* Assemblage-Zone. In the following passages the composition of Idamean Assemblage-Zones in the Burke River Structural Belt is discussed.

1. *Glyptagnostus reticulatus* Assemblage-Zone

Faunas of this assemblage-zone are recorded here from localities D471-473 and D497-499 on the eastern side of the Burke River Structural Belt (western side of Mistake Creek, 300 m south of the junction of Mistake and

Gin Creeks, see Appendix 2), where the following fauna is recorded from an interbedded sequence of dark grey bituminous silty pelletal skeletal grainstone, laminated pelletal grainstone, and poorly outcropping shale.

Aphelaspis sp., *Glyptagnostus reticulatus reticulatus* (Angelin), *Homagnostus* sp. 2, *Innitagnostus inexpectans* (Kobayashi), *Olenus ogilviei* Öpik, *Proceratopyge (P.)* cf. *nectans* Whitehouse, *Pseudagnotus (Ps.) idalis idalis* Öpik and *Pseudagnostus (Ps.) idalis* Öpik *sensu lato.*

Elements of this assemblage are also known now at localities D673-674, about 8 km due north of Pomegranate Bore, where they again occur in silty and sandy laminated pelletal skeletal grainstone with shaly laminae.

Previously, the fauna of the *Glyptagnostus reticulatus* Assemblage-Zone had been recorded by Öpik only at locality D120a (see Öpik, 1963, p. 19, fig. 3), about 6 km southwest of Mistake Bore (herein, Fig. 1), in the Burke River Structural Belt. From localities B259 and D126, in the De Little Range, adjacent Wills Creek, 67 km to the southwest (Boulia 1:250 000 Sheet area), Öpik (1967, vol. 2, pp. 14-15) has added *Eugonocare* cf. *tessellatum* Whitehouse, *Blountia (Mindycrusta) advena* Öpik, and *Aspidagnostus stictus* Öpik to the *Glyptagnostus reticulatus* assemblage.

2. *Proceratopyge cryptica* Assemblage-Zone

The ranges of *Glyptagnostus reticulatus* and *Proceratopyge cryptica* overlap in the Burke River Structural Belt just as they do at Glenormiston (Henderson, 1977, p. 432). Assemblages constituting this zone are described here from localities D500-504 on the eastern side of the Structural Belt (west bank of the Mort River, 8 km south of the intersection of Mistake and Gin Creeks). There, interlaminated silty pelletal grainstone and shaly limestone, sandy pelletal grainstone with laminae, and peloidal grainstone contain:

Corynexochus plumula Whitehouse, *Eugonocare whitehousei* Henderson, *Innitagnostus inexpectans* (Kobayashi), *Peratagnostus nobilis* Öpik, *Proceratopyge (P.) cryptica* Henderson, *Pseudagnostus (Ps.) idalis idalis* Öpik, and *Pseudagnostus (Ps.) vastulus* Whitehouse.

In addition, Öpik (1967, p. 243) has recorded *Blountia (?Mindycrusta) georginae* Öpik from this assemblage at Glenormiston. The pygidium of this species is rather similar to that of *Iwayaspis* as illustrated, in association with *Peratagnostus hillardensis*, in the Hillard Peak area of east-central Alaska (see Palmer, 1968, pl. 10, figs. 9-10). The reported occurrence of *Pagodia (Idamea) venusta* (Whitehouse, 1939) in the *Corynexochus plumula* Zone (= *P. cryptica* Zone of Henderson) is not confirmed by Henderson (1977, fig. 9). The possibility of the occurrence of *Pagodia (Idamea) superstes* (Whitehouse) in rocks of this age at Tyson's Bore is not confirmed either.

3. *Erixanium sentum* Assemblage-Zone

Evidence for the occurrence of this assemblage-zone in the Burke River area was not found during the present study. Öpik (1963) had previously recorded the index species at locality D119, on the opposite side of Pomegranate Creek from Pomegranate Bore, where it was associated with *Peratagnostus nobilis* Öpik and *Pagodia (Idamea) baccata* Öpik. According to Henderson (1977), *Erixanium sentum* continues to range into the *Stigmatoa diloma* Zone. Only the index species and *Proceratopyge lata* Whitehouse are shown as diagnostic of this zone at Glenormiston. At locality D119, all known specimens of *E. sentum* were found on a single bedding plane (Öpik, 1963, p. 81). Without the index fossil there is virtually nothing to distinguish the fauna of the *E. sentum* Assemblage-Zone from that of *Proceratopyge cryptica.*

4. *Stigmatoa diloma* Assemblage-Zone

Faunas referable to this assemblage-zone are now documented at Mount Murray, from horizons 301/1 to 301/9 inclusive, and 302/2, and at locality D662, 3.7 km southeast of Pilgrim Well. At Mount Murray the *Stigmatoa diloma* assemblage extends over at least 70 m of Section 301 (Fig. 3). From Öpik's earlier account it is likely that a fauna of *S. diloma* age also occurs at his localities D119, D120b, and perhaps D133 (see Öpik, 1963, p. 18, fig. 2). A fairly large suite of trilobites occurs in a variety of sediments dominated by laminated pelletal skeletal grainstone and pelletal wackestone, both of which are often silicified:

Aplotaspis mucrora Henderson, *Corynexochus plumula* Whitehouse, *Eugonocare tessellatum* Whitehouse, *Homagnostus?* sp., *Idolagnostus* sp., *Innitagnostus?* sp., *Kormagnostella inventa* sp. nov., *Pagodia (Idamea)* cf. *baccata* Öpik, *Peratagnostus nobilis* Öpik, *Proceratopyge (P.) lata* Whitehouse, *Proceratopyge (P.)* sp., *Prochuangia* sp. undet., *Protemnites* sp., *Pseudagnostus (Ps.) idalis idalis* Öpik, *Pseudagnostus (Ps.) idalis* Öpik *sagittus* subsp.

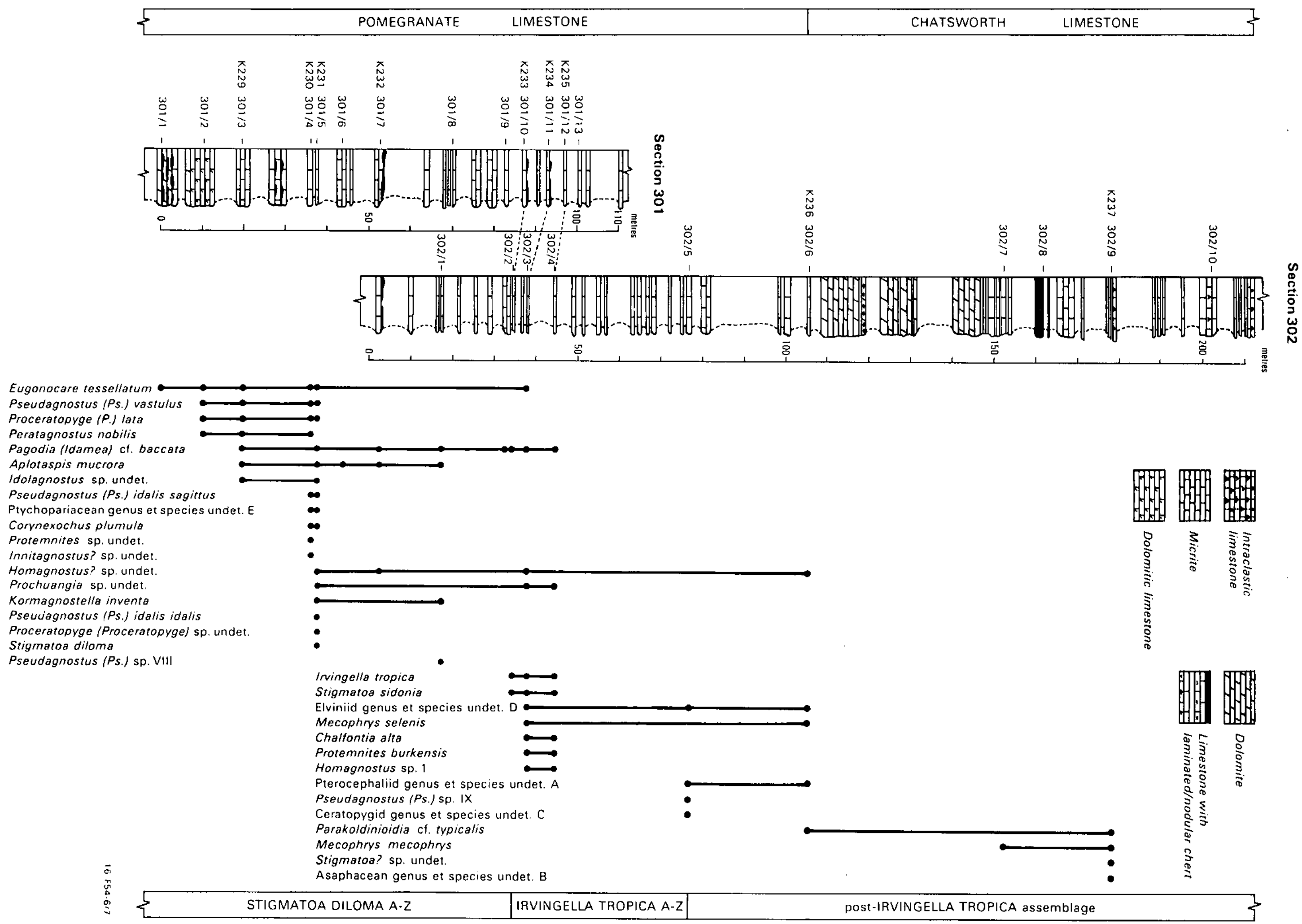


Fig. 7. Biostratigraphic synthesis of Mount Murray sections 301 and 302.

nov., *Pseudagnostus (Ps.) idalis* Öpik *sensu lato, Pseudagnostus (Ps.) vastulus* Whitehouse, *Pseudagnostus (Ps.)* sp. VIII, *Stigmatoa* Öpik, ptychopariacean genus et species undetermined E.

Assuming that the faunas from the late *Erixanium sentum* Zone reported by Öpik can now be referred to that of *Stigmatoa diloma* as defined by Henderson (1976), then *Asilluchus nanus* Öpik, *Olenus* sp. A, and *Pagodia (Idamea) baccata* Öpik should also be included in this assemblage in the Burke River Structural Belt. *Blountia (?Mindycrusta) georginiae* Öpik (= *Iwayaspis?*), *Aplotaspis erugata* (Whitehouse), *Erixanium alienum* Öpik, *E. sentum* Öpik, *E. strabum* Öpik, *Pagodia (Idamea) venusta* (Whitehouse), and *Protemnites brownensis* (Henderson) are reported from this assemblage-zone at Glenormiston by Henderson (1977, p. 431, fig. 9).

5. *Irvingella tropica* Assemblage-Zone

The *Irvingella tropica* Zone (Henderson, 1976, 1977) has been substituted for *Irvingella tropica* with *Agnostotes inconstans* Zone (Öpik, 1963) with some justification: *Agnostotes inconstans* is known only from a single locality (D120b) in the Burke River Structural Belt, and not at all at Glenormiston.

Prior to the work of Henderson (1976, 1977) the *Irvingella tropica* assemblage had been reported only from the single locality in the Burke River area (D120b, Öpik, 1963) where. *Agnostotes inconstans* occurs. The assemblage is now known from Mount Murray, where it is documented in section between horizons 301/10-301/12, 302/2-302/4, over a 10 m interval of pelletal skeletal wackestone, mudstone, grainstone and clast grainstone, often silicified, and chert (Fig. 7).

The following fauna is recorded here: *Chalfontia alta* (Henderson), elviniid gen. et sp. undet. D, *Eugonocare tessellatum* Whitehouse, *Homagnostus* sp. 1, *Homagnostus?* sp., *Irvingella tropica* Öpik, *Mecophrys selenis?* gen. et sp. nov., *Pagodia (Idamea)* cf. *baccata* Öpik, *Prochuangia* sp. undet., *Protemnites burkensis* sp. nov., and *Stigmatoa sidonia* Öpik.

Öpik (1963) has previously reported *Agnostotes inconstans* Öpik, *Aphelaspis?* sp. B, *Hercantyx rudis* Öpik, *Olenus delicatus* Öpik, *Proceratopyge (P.) lata* Whitehouse, *'Proceratopyge'* cf. *chuhsiensis* Lu, and *Pseudagnostus (Ps.) vastulus* Whitehouse.

Henderson (1977, p. 431, fig. 9) reported *Pterocephalia* sp. nov., which is thought to represent ceratopygid gen. et sp. nov. C, described below from the youngest assemblage at Mount Murray.

6. Post-*Irvingella tropica* Assemblage-Zone

On Section 302 at Mount Murray, a younger assemblage than that of *Irvingella tropica* occurs at horizons 302/5-302/9, over an interval of pelletal, skeletal and clast grainstone, mottled micrite and chert more than 100 m thick. The fauna is sparse, and limited in both abundance and diversity; several taxa are inadequately known. Those described here include:

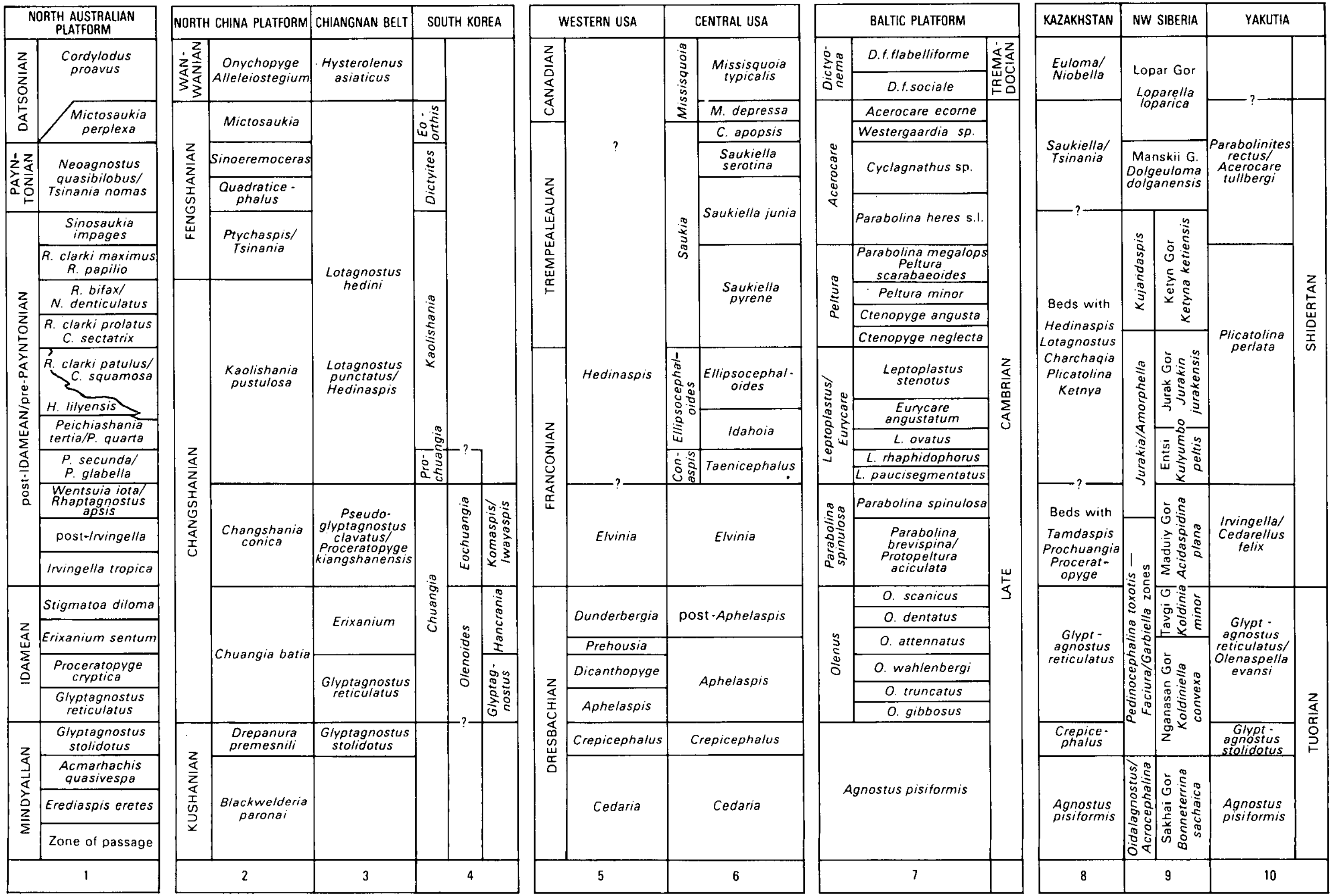
Asaphacean gen. et sp. undet. B, ceratopygid gen. et sp. undet. C, elviniid gen. et sp. undet. D, *Homagnostus?* sp., *Mecophrys mecophrys* gen. et sp. nov., *Mecophrys selenis* gen. et sp. nov., *Parakoldinioidia* sp. aff. *P. typicalis* Endo, *Pseudagnostus (Ps.)* sp. IX, pterocephaliid gen. et sp. undet. A, and *Stigmatoa?* sp. undet.

Several of these faunal elements resemble earlier Idamean forms: *Mecophrys* resembles certain species of *Aphelaspis* and *Dicanthopyge*; the pterocephaliid gen. et sp. A resembles *Sigmocheilus;* and the elviniid gen. et sp. D has some similarity to *Dunderbergia*. *Stigmatoa* and *Homagnostus* are long accepted accepted Idamean genera. However, *Parakoldinioidia* is typically a younger genus. In Australia it occurs in the *Peichiashania secunda/ Prochuangia glabella* Assemblage-Zone at nearby Lily Creek; and *Pseudagnostus* sp. IX has strong resemblance to *Pseudagnostus (Ps.) mortensis* from the *Wentsuia iota/Rhaptagnostus apsis* Assemblage-Zone of the same area (Shergold, 1980).

The post-*Irvingella tropica* Assemblage-Zone at Mount Murray can be regarded as a bridge between the *Irvingella tropica* Assemblage-Zone and the *Wentsuia iota-Rhaptagnostus apsis* Assemblage-Zone, which is the oldest trilobite assemblage occurring in the lower Chatsworth Limestone in the vicinity of Chatsworth homestead, some 20 km southeast of Mount Murray. They may be separated by an interval in which trilobites are as yet unrecorded (for example, as shown in Fig. 5).

Limits of the Idamean Stage

As defined by Öpik, the Idamean Stage is based on the faunas of his (1963) trilobite assemblage-zones *Glyptagnostus reticulatus* through *Irvingella tropica* with *Agnostotes incontans* (see Fig. 6). There is a major faunal reorganisation at the base of the *Glyptagnostus reticulatus* Assemblage-Zone, regarded by


NORTH AUSTRALIAN PLATFORM
DATSONIAN
PAYNTONIAN
post-IDAMEAN/pre-PAYNTONIAN
IDAMEAN
MINDYALLAN
Cordylodus proavus
Mictosaukia perplexa
Neoagnostus quasibilobus/ Tsinania nomas
Sinosaukia impages
R. clarki maximus R. papilio
R. bifax/ N. denticulatus
R. clarki prolatus C. sectatrix
R. clarki patulus/ C. squamosa
H. lilyensis
Peichiashania tertia/P. quarta
P. secunda/ P. glabella
Wentsuia iota/ Rhaptagnostus apsis
post-Irvingella
Irvingella tropica
Stigmatoa diloma
Erixanium sentum
Proceratopyge cryptica
Glyptagnostus reticulatus
Glyptagnostus stolidotus
Acmarhachis quasivespa
Erediaspis eretes
Zone of passage
1
NORTH CHINA PLATFORM
WAN-WANIAN
FENGSHANIAN
CHANGSHANIAN
KUSHANIAN
Onychopyge Alleleiostegium
Mictosaukia
Sinoeremoceras
Quadratice-phalus
Ptychaspis/ Tsinania
Kaolishania pustulosa
Changshania conica
Chuangia batia
Drepanura premesnili
Blackwelderia paronai
2
CHIANGNAN BELT
Hysterolenus asiaticus
Lotagnostus hedini
Lotagnostus punctatus/ Hedinaspis
Pseudo-glyptagnostus clavatus/ Proceratopyge kiangshanensis
Erixanium
Glyptagnostus reticulatus
Glyptagnostus stolidotus
3
SOUTH KOREA
Eo-orthis
Dictyites
Kaolishania
Pro-chuangia
Chuangia
Eochuangia
Komaspis/ Iwayaspis
Olenoides
Hancrania
Glyptag-nostus
?
4
WESTERN USA
CANADIAN
TREMPEALEAUAN
FRANCONIAN
DRESBACHIAN
?
Hedinaspis
Elvinia
Dunderbergia
Prehousia
Dicanthopyge
Aphelaspis
Crepicephalus
Cedaria
5
CENTRAL USA
Missisquoia
Saukia
Ellipsocephal-oides
Con-aspis
Missisquoia typicalis
M. depressa
C. apopsis
Saukiella serotina
Saukiella junia
Saukiella pyrene
Ellipsocephal-oides
Idahoia
Taenicephalus
Elvinia
post-Aphelaspis
Aphelaspis
Crepicephalus
Cedaria
6
BALTIC PLATFORM
Dictyo-nema
Acerocare
Peltura
Leptoplastus/ Eurycare
Parabolina spinulosa
Olenus
D.f. flabelliforme
D.f. sociale
Acerocare ecorne
Westergaardia sp.
Cyclagnathus sp.
Parabolina heres s.l.
Parabolina megalops Peltura scarabaeoides
Peltura minor
Ctenopyge angusta
Ctenopyge neglecta
Leptoplastus stenotus
Eurycare angustatum
L. ovatus
L. rhaphidophorus
L. paucisegmentatus
Parabolina spinulosa
Parabolina brevispina/ Protopeltura aciculata
O. scanicus
O. dentatus
O. attennatus
O. wahlenbergi
O. truncatus
O. gibbosus
Agnostus pisiformis
TREMA-DOCIAN
LATE CAMBRIAN
7
KAZAKHSTAN
Euloma/ Niobella
Saukiella/ Tsinania
?
Beds with Hedinaspis Lotagnostus Charchaqia Plicatolina Ketnya
?
Beds with Tamdaspis Prochuangia Procerat-opyge
Glypt-agnostus reticulatus
Crepice-phalus
Agnostus pisiformis
8
NW SIBERIA
Lopar Gor Loparella loparica
Manskii G. Dolgeuloma dolganensis
Kujandaspis
Ketyn Gor Ketyna ketiensis
Jurakia/Amorphella
Jurak Gor Jurakin jurakensis
Entsi Kulyumbo peltis
Pedinocephalina toxotis — Faciura/Garbiella zones
Maduiy Gor Acidaspidina plana
Tavgi G Koldinia minor
Nganasan Gor Koldiniella convexa
Oidalagnostus/ Acrocephalina
Sakhai Gor Bonneterrina sachaica
9
YAKUTIA
?
Parabolinites rectus/ Acerocare tullbergi
Plicatolina perlata
Irvingella/ Cedarellus felix
Glypt-agnostus reticulatus/ Olenaspella evansi
Glypt-agnostus stolidotus
Agnostus pisiformis
SHIDERTAN
TUORIAN
10

16/F54-6/8

Öpik (1966) as a global faunal crisis. The base of the Idamean stage is readily recognisable in northern Australia, since none of the eighty trilobite species of the latest Mindyallan *Glyptagnostus stolidotus* Assemblage-Zone, and very few of the genera, persist into the earliest Idamean *Glyptagnostus reticulatus* Assemblage-Zone. This latter, although of worldwide distribution, contains a quite limited specific assemblage. In northern Australia no more than twelve trilobite taxa have been listed from this zone. Elsewhere in Australia, the occurrence of *Glyptagnostus reticulatus* has been described from the Huskisson River district of Tasmania (Jago, 1974), where this trilobite is associated with dendroids, hydroids, sponge spicules, and inarticulate brachiopods.

Öpik (1963) considered his *Irvingella tropica* with *Agnostotes inconstans* Zone to represent the youngest Idamean assemblage-zone, but at the time he wrote, nothing much was known about the distribution of succeeding faunas. The *Irvingella tropica* Assemblage-Zone (see p. 13) consists of about 18 trilobite taxa: the number is not known with confidence because collections made by Öpik at his locality D120b (1963) belong to two assemblages (*Erixanium sentum* and *Irvingella tropica*) and there appears to be some reporting of fossil occurrences which are not yet confirmed elsewhere. At Mount Murray 11 taxa constitute the assemblage, and there is a sharp faunal break between the *Stigmatoa diloma* and *Irvingella tropica* assemblages. From the 19 taxa occurring in the former assemblage, only four continue into the latter: *Eugonocare tessellatum, Pagodia* cf. *baccata, Homagnostus?* sp., and *Prochuangia* sp. indet. Eight new taxa, including *Irvingella tropica*, appear to differentiate the *Irvingella tropica* Assemblage-Zone. There is no real evidence for a break in sedimentation at this level. At Mount Murray a younger fauna, the post-*Irvingella tropica* assemblage, accompanies a change in sedimentation at which micritic limestones are replaced by a sequence of dolomite, micrite, and intraclastic grainstone (Fig. 7). This, the youngest assemblage at Mount Murray, contains elements which relate morphologically to both the earlier *Irvingella tropica* Assemblage-Zone and the *Wentsuia iota*/*Rhaptagnostus apsis* Assemblage-Zone which appears to succeed it on the plains to the southeast (Fig. 5). In fact, in gross morphological attributes, this post-*Irgingella tropica* fauna has more in common with the *Irvingella tropica* Assemblage-Zone, than the latter has with the *Stigmatoa diloma* Assemblage-Zone.

The *Irvingella tropica* Assemblage-Zone also is known at Glenormiston (Henderson, 1976, 1977) where it is characterised by the same new faunal elements as at Mount Murray (Henderson, 1977, fig. 9). The sequence succeeding the *Irvingella tropica* Assemblage-Zone there is, however, not known. Outside Australia, *Irvingella* has a wide distribution (see p. 33). The best known species is *I. major* Ulrich & Resser, which occurs widely in North America in discontinuous coquinas at the top of the *Elvinia* Zone (e.g. Wilson & Frederickson, 1950; Stitt, 1971b), the earliest zone of the Franconian Stage. In late Cambrian shelf environments the *Irvingella major* Subzone has been recognised in the Llano Uplift of Central Texas (Morgan Creek Limestone Member of the Wilberns Formation; Wilson, 1949), Oklahoma (Honey Creek Limestone; Frederickson, 1949; Stitt, 1971b), Wisconsin (basal Franconia Formation,

Fig. 8. Idamean biochronological perspectives. Late Cambrian correlation information from the following sources:

1. **North Australian Platform: Öpik, 1963, 1967; Druce & Jones, 1971; Shergold, 1972, 1975, 1980.**
2. **North China Platform: Sun, 1924, 1935, 1937; Chu, 1959; Kobayashi, 1967; Chang, 1980.**
3. **China, Chiangnan Belt: Lu, 1960, 1979; Lu & Liu, 1980; Lu & others, 1974, 1980: Chang, 1980.**
4. **South Korea: Kobayashi, 1935, 1962, 1966, 1967.**
5. **Western USA (Nevada, Alaska): Palmer, 1960, 1962, 1965, 1968; Hintze & Robison, 1975; Taylor, 1976.**
6. **Central USA (Texas, Oklahoma, Wisconsin, western Utah): Palmer, 1954, 1965; Longacre, 1970; Stitt, 1971b, 1977; Taylor, 1976, 1977; Miller, 1978, 1980.**
7. **Baltic Platform: Westergaard, 1944, 1946, 1947; Henningsmoen, 1957, 1958; Landing & others, 1978.**
8. **Kazakhstan: Ivshin, 1956, 1960a, 1961, 1962, 1974; Ivshin & Pokrovskaya, 1968; Lisogor, 1977a, 1977b.**
9. **Northwestern Siberian Platform: Rozova, 1964, 1968, 1977; Lazarenko & Datsenko, 1967.**
10. **North Siberian Platform (Yakutia): Lazarenko, 1966; Lazarenko & Datsenko, 1967; Lazarenko & Nikiforov, 1972.**

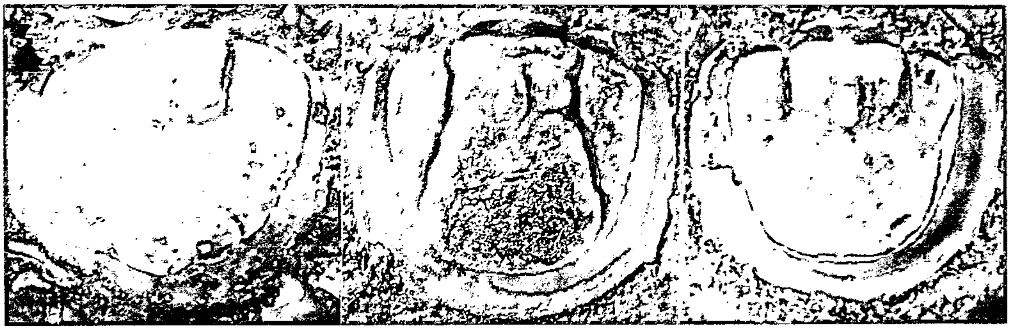


Fig. 9. Comparison of *Pseudagnostus vastulus* Whitehouse and *Pseudagnostus idalis* Öpik: [A] UQF 3203, holotype, *Pseudagnostus vastulus* Whitehouse (1936, pl. 10, fig. 4), after recent preparation, x10; [B] CPC 5908, holotype, *Pseudagnostus idalis* Öpik (1967, pl. 62, fig. 8), x10; [C] CPC 4302, specimen used as basis for *Pseudagnostus vastulus* sensu Öpik (1963, p. 51, fig. 13), x12.

Tomah Member; Bell & others, 1952; Berg, 1953), Pennsylvania (Ore Hill Member, Gatesburg Formation; Wilson, 1951) and Wyoming (above stromatolitic limestones at the base of the Sage Member of the Snowy Range Formation; Grant, 1965). Palmer (1979) has regarded the sudden occurrence of the *Irvingella major* fauna as heralding the Ptychaspid biomere; Stitt (1971a, 1975), conversely, has regarded it as an extinction phase at the termination of the Pterocephaliid biomere. In all the areas noted above the *Irvingella major* assemblage is found in either case overlying sandy or shaly deposits.

Irvingella is also known in Nevada, where an evolutionary lineage has been recognised by Palmer (1960, 1965) through the *Elvinia* Zone. The earliest species of *Irvingella* in this lineage is *I. angustilimbatus* Kobayashi, which possesses a differentiated anterior cranidial border, and the latest is *I. major*, in which this border is not strongly differentiated. The Australian *Irvingella tropica* is most like *I. angustilimbatus*, and it is therefore assumed here that the *Irvingella tropica* Assemblage-Zone is coeval with the early *Elvinia* Zone assemblages of western USA. While the evolutionary development of *Irvingella* species in cratonic North America is restricted only to the later segment of the lineage, in western Queensland only the early segment is represented. The early part of the lineage in cratonic North America and the later part in northern Australia seem to have shared sedimentary environments (regressive sediments) which prevailed against the migration of *Irvingella.*

Since it is not yet possible to recognise the upper limit of the *Irvingella tropica* Assemblage-Zone in northern Australia, and since it is considered undesirable to place a stage boundary within a poorly fossiliferous interval it is suggested here that the *Irvingella tropica* Assemblage-Zone be removed from the Idamean Stage; and that it should be regarded as the initial biostratigraphic unit of a post-Idamean stage, to be defined at a later date. The base of this post-Idamean stage in western Queensland would then coincide with the initial Franconian in North America.

SYSTEMATIC PALAEONTOLOGY

The descriptive terminology used in the systematic descriptions which follow is based on that defined in the Treatise on Invertebrate Palaeontology, Part 0, Arthropoda 1 (R. C. Moore, ed., 1959). Addtionally, terminology defined by Öpik (1961a, 1961b, 1963, 1967) and Shergold (1972, 1975, 1977) is used, primarily for miomeroids.

Symbols used in the text for measured parameters have been tabulated previously (Shergold, 1972, p. 16; 1975, pp. 47-48; 1980). The following are used here:

Lc	maximum length (sag.) of cephalon or cranidium
Lb	length (sag.) of anterior cranidial border in polymeroids, cephalic border length in miomeroids, and pygidial border length (sag.) in both groups
G	length (sag.) of glabella
Gn	length (sag.) of glabella plus occipital ring
A	maximum length (exsag.) of palpebral lobe

Lp_1	maximum pygidial length (sag.) including the articulating half-ring
Lp_2	pygidial length (sag.), excluding the articulating half-ring
Wp	maximum pygidial width (tr.)

The following abbreviations are used in the text for known repositories of compared and described material:

CPC	Commonwealth Palaeontological Collections, Bureau of Mineral Resources, Canberra.
GSC	Collections of the Geological Survey of Canada, Ottawa.
GSM	Geological Survey Museum, UK Geological Survey, London.
JCF	Fossil collection, Department of Geology, James Cook University, Townsville.
NHMM	Natural History Museum, Mendoza.
UQF	Fossil collections, Department of Geology, University of Queensland, St Lucia, Queensland.
USNM	United States National Museum, Washington, DC.
ZSGU	Collections of the West Siberian Geological Office, Novokuznetsk.

Order **MIOMERA** Jaekel, 1909

Suborder **AGNOSTINA** Salter, 1864

Family **AGNOSTIDAE** M'Coy, 1849

Subfamily **AGNOSTINAE** M'Coy, 1849

Genus **Homagnostus** Howell, 1935

[*Homagnostus* Howell, 1935, p. 15 = *Oncagnostus* Whitehouse, 1936, p. 84; 1939, p. 261 = *Proagnostus* Butts, 1926, p. 76 (fide Kobayashi, 1939, p. 163)].

Type species. Agnostus pisiformis Lin., var. *obesus* Belt (1867, p. 295, pl. XII, figs. 4a-d), 'Lower Lingula Flags', River Mawddach, North Wales; designated Howell (1935, p. 15).

Comments. Over thirty specific taxa have been named under this genus or incorporated within it. They include taxa with ovoid, subcircular, and subquadrate shields, deliquiate and non-deliquiate marginal furrows, wide and narrow borders, slim and inflated posterior pygidial axial lobes of quite varying lengths (sag.), and forms with advanced and posteriorly sited spines. Many included taxa are non-congeneric, for instance all of those referred to *Homagnostus* by Rusconi (1951, 1953, 1954).

Such variation is certainly the result of an inadequately known type species. Belt's specimens, which include pygidia with broad (tr.) and narrow (tr.) axes, have never been adequately illustrated.

Accordingly, the concept of *Homagnostus* has come to be based (see Howell *in* Moore, 1959) on specimens figured by Westergaard (1922, p. 116, pl. 1, figs. 4-6). Understanding of *Homagnostus* is, however, further complicated by the obvious morphological relationship with *Agnostus* on the other hand, and *Micragnostus, Rudagnostus,* and younger species of *Connagnostus* on the other. As a general rule, other characteristics notwithstanding, the pygidial axis of *Homagnostus* is wider (tr.) than that of *Agnostus* and *Micragnostus* and related genera. Early holaspid morphogenetic stages of *Homagnostus* species closely resemble late holaspides of *Micragnostus* (see Palmer, 1962, pl. 1, figs. 14, 15).

Three different kinds of pygidium are tentatively referred to *Homagnostus* here. Since their cephala are unknown, and they are represented by only a few specimens, they are left under open nomenclature, and may prove eventually to be non-congeneric. Variation mostly occurs in the width (tr.) of the pygidial axis and position of the marginal spines. All three taxa have the long (sag.) pygidial axes consistent with *Homagnostus* and *Agnostus,* which are wider (tr.) than is commonly regarded as characteristic of *Agnostus,* and slightly constricted acrolobes quite visible when the exoskeleton is exfoliated. Degree of constriction, however, is not great enough to warrant classification with *Connagnostus,* even though late holaspides of Mindyallan species of this genus have large (sag.) pygidial axes. Some precedence for classifying some pygidia with *Homagnostus* is set by the general acceptance of *H. tumidosus* (Hall & Whitfield) which also shows this characteristic (see Palmer, 1955, pl. 19, fig. 4, described as *Geragnostus*; 1960, pl. 4, fig. 2; 1968, pl. 7, fig. 8).

Homagnostus has been previously recorded from northern Australia by Whitehouse as *H.* cf. *obesus* (Belt) (see Whitehouse, 1939, pp. 261-262, pl. XXV, figs. 17, 18). The pygidium referred to this species (UQF 3395, fig. 17) has a long (sag.), relatively narrow (tr.), saccate pygidial axis, and long (exsag.) strongly constricted acrolobes which are not confluent around the rear of the axis. These features do not fall within the range of variation of *Homagnostus,* but they are found among Mindyallan species of *Ammagnostus* (see *A. psammius* Öpik, 1967, p. 139, pl. 55, fig. 3, pl. 66, figs. 1-4; and *A. integriceps* Öpik, 1967, p. 141, pl. 66, figs. 5-8). The cephalon Whitehouse assigned to *Homagnostus* cf. *obesus* (Belt) (UQF 43545, fig. 18) is en grande tenue, scrobiculate, has a pointed anterior glabellar lobe, and belongs to *Innitagnostus*.

Homagnostus sp. 1

(Pl. 5, figs. 10-11)

Material. Two incomplete pygidia preserved as silicified external moulds, CPC 15003, 15004. The latter has a length (Lp_1) of 2.30 mm. Both specimens are illustrated.

Occurrence. Mount Murray, horizons 234 and 235, considered to equate with the interval 93-97 m on section 301.

Age. Late Cambrian, post-Idamean, *Irvingella tropica* Assemblage-Zone.

Description. Both specimens possess wide (tr., sag.) borders with distinct shallow, deliquiate marginal furrows which deepen and widen posterolaterally and narrow (sag.) posteriorly. Stout posterolateral spine bases lie on the same transverse level as the rear edge of the pygidial axis. The acrolobes are narrow (tr.), long (exsag.), laterally slightly constricted, and confluent behind the axis. The axis varies slightly among the two specimens in degree of convexity, and hence shape, but the relative proportions of its constituent segments appear similar. In CPC 15003 (Pl. 5, fig. 11) the axis is more convex and appears wider (tr.), and the intersegmental furrows, particularly the first pair, have more curvature. CPC 15004 (Pl.5, fig. 10) seems to have a less convex and more parallel-sided axis. On both specimens the articulating facets are steeply inclined implying a generally strongly convex (tr.) thorax.

Comments. These specimens most closely resemble material from the Dresbachian-2 fauna of the Hi-Yu area of east central Alaska which Palmer (1968, p. 29, pl. 7, fig. 8) has referred to *Homagnostus tumidosus* (Hall & Whitfield). The Alaskan specimen differs from CPC 15003 only in its more strongly deliquiate marginal furrow behind the axis. A specimen referred also to *H. tumidosus* from the pre-*Irvingella* portion of the Dunderberg Shale in the Great Basin (Palmer, 1960, p. 63, pl. 4, fig. 2) resembles CPC 15004 and also differs in degree of deliquiation of its marginal furrow.

Degree of deliquiation of marginal furrows also distinguishes *Homagnostus* sp. 1 from *Agnostus (Homagnostus) obesus* (Belt) *sensu* Westergaard (1947, pl. 1, fig. 11). This species, from the *Olenus wahlenbergi* Subzone, occurs with *Glyptagnostus reticulatus* in Sweden, and is a little older than *Homagnostus* sp. 1. Other specimens referred to *Homagnostus obesus* (Belt), described by Lermontova (1940, pp. 123-124, pl. 49, fig. 7) from Kharaulakh, may also be similar to *Homagnosuts* sp. 1, but could not be located in the collections of the Central Museum, Leningrad.

Homagnostus sp. 2

(Pl. 5, fig. 12)

Material. A single small exfoliated pygidium, CPC 15005, with a length (Lp_1) of 1.25 mm.

Occurrence. Pomegranate Creek pediment, locality D673.

Age. Late Cambrian, Idamean, *Glyptagnostus reticulatus* Assemblage-Zone.

Description. A small subovoid shield with posteriorly converging sides, wide (tr., sag.) borders, and evenly wide (tr., sag.) strongly deliquiate marginal furrows. Relatively long, distally curving marginal spines are ventrally sited with bases lying on a transverse level to the rear of the end of the pygidial axis. The acrolobes are transversely narrow, laterally subtly constricted, and united posteriorly behind the axis. *Homagnostus* sp. 2 is characterised by a posterior axial pygidial lobe which is considerably more swollen than that of other specimens here assigned to *Homagnostus*.

Comments. Homagnostus sp. 2 most closely resembles two specimens from the Dresbachian-2 fauna of Alaska described by Palmer (1968, pp. 24-25, pl. 7, figs. 13, 14) as *Homagnostus?* sp. and *H. alaskaensis* respectively, in possessing swollen pygidial axes and tapering pygidial flanks. *Homagnostus* sp. 2 also resembles *Homagnostus?* sp. in possessing retrally sited marginal spines, but is distinguished by its shorter (sag.) axis which does not reach the marginal furrow. *H. alaskaensis* Palmer has more advanced marginal spines and its third axial segment is even more expanded laterally than that of *Homagnostus* sp. 2. However, as shown by Palmer (loc. cit., fig. 15), the posteriorly united acrolobes are similar to those of *H.* sp. 2.

Homagnostus sp. 2 is also morphologically similar to pygidia described from the *Irvingella/Cedarellus felix* Assemblage-Zone of the Kharaulakh Mountains, northern Siberian Platform as *Agnostus captiosus* Lazarenko (see

Lazarenko, 1966, pl. 1, figs. 18, 23 inter alia). Both taxa have a swollen posterior pygidial axial lobe, retrally situated distally incurved spines, and deliquiate marginal furrows. In spite of these similarities the two species retain distinctive appearances: *Homagnostus* sp. 2 relates most closely to the *Homagnostus* species which preceded it, but *Agnostus captiosus* looks forwards to species of *Rudagnostus* which post-dated it. Possibly *Rudagnostus* is derived from *Homagnostus* during the *Irvingella* hemera. The previously documented derivation of *Rhaptagnostus* from *Pseudagnostus* at about this time (Shergold, 1980) suggests that the interval was critical for late Cambrian agnostid populations and lends some support for Palmer's (1979) contention of the association of biomeres and faunal crises.

Homagnostus? sp. undet.

(Pl. 5, fig. 9)

Material. Four pygidia (CPC 15006, 17854-6), preserved as silicified replicas or external moulds, with lengths (Lp_1) between 2.00 and 3.40 mm. Specimen CPC 15006 is illustrated.

Occurrence. Mount Murray, horizons 231 and 232, between 37.5 and 52 m on section 301.

Age. Late Cambrian, Idamean, *Stigmatoa diloma* Assemblage-Zone.

Description. Pydigia of this species are characteristically subquadrate, with reasonably wide (tr., sag.) borders and equally wide, strongly deliquiate marginal furrows. The bases of short, backward directed marginal spines are sited on a level with the rear edge of the axis. The acrolobes are only very slightly constricted laterally, very narrow (tr.), and although posteriorly united behind the axis, the area between the axis and the wide (sag.) marginal furrow is very narrow (sag.). The pygidial axis itself is more or less parallel-sided: the transverse width of the second segment is slightly less than that of the anterior and posterior segments, which have the same width. Overall, the axis has a similar shape and convexity to that of *Homagnostus* sp. 1 but is proportionately a little shorter (sag.).

Comments. Proportionately, *Homagnostus?* sp. has narrower (tr., sag.) borders, wider (tr., sag.) marginal furrows, and a shorter (sag.) axis than either *Homagnostus* spp. 1 or 2. *Homagnostus?* sp. is not readily compared to previously described species of *Homagnostus*, largely on account of its wide marginal furrow. This characteristic, together with its shape and its narrow acrolobes, suggests that *Homagnostus?* sp. stands close to Ammagnostinae (e.g. *Agnostoglossa* Öpik, 1967). Only the lesser degree of constriction and posterior extent of the acrolobe and a shorter (sag.) more parallel-sided posterior axial segment prevent classification with *Ammagnostus*. *Agnostoglossa* cannot be compared as its type species, *A. bassa* Öpik (1967, p. 145, figs. 6-14), is known only from heavily silicified material which has been responsible for the effacement of surface features.

Genus **Idolagnostus** Öpik, 1967

[*Idolagnostus* nov., Öpik, 1967, p. 104]

Type species. Idolagnostus agrestis Öpik (1967, pp. 104-106, pl. 59, figs. 9-10; pl. 60, figs. 1, 2; pl. 63, fig. 10; text-figs. 25, 26), Mindyallan, *Glyptagnostus stolidotus* Assemblage-Zone; O'Hara Shale, Duchess area, and Georgina Limestone, Glenormiston area, western Queensland; by original designation.

Other species. Idolagnostus dryas Öpik (1967, pp. 106-107, pl. 60, figs. 3-5; text-fig. 27), Mindyallan, Zones of *Erediaspis eretes, Cyclagnostus quasivespa,* and *Glyptagnostus stolidotus*; Mungerebar Limestone and O'Hara Shale, Duchess area, western Queensland. *Idolagnostus* sp., described below from the Idamean *Stigmatoa diloma* Assemblage-Zone at Mount Murray, is thus considerably younger than previously described species.

Idolagnostus sp. undet.

(Pl. 3, fig. 12)

Material. The species is known from two incomplete cephala with lengths (Lc, sag.) measuring 1.30 and 1.50 mm; the larger one, CPC 14999B, is illustrated.

Occurrence. Mount Murray, horizons 229 and 301/5, the latter being 37.5 m from the base of measured section 301.

Age. Late Cambrian, Idamean, *Stigmatoa diloma* Assemblage-Zone.

Differential diagnosis. Idolagnostus sp. is of similar size to the holotype cephala of both *I. agrestis* Öpik and *I. dryas* Öpik, and has similar trilobate glabellar characteristics; i.e. the anterior lobe is small and ogival, and separated by a transverse anterior furrow from subhexagonal anterolateral lobes fused sagitally, these being separated by a further transverse furrow from the posterior lobe; the axial node lies rearwards on the glabella, posterior to the sagitally fused anterolateral lobes; the posterior lobe is decidedly angulate; and the basal lobes small but wider (tr.) than long (exsag.).

Idolagnostus sp. has a subcircular cephalic shape, most similar to that of *I. agrestis,* but its marginal furrows are non-deliquiate, distinguishing it from both previously described species; and only the proximal end of a median preglabellar furrow is faintly visible.

Comments. Idolagnostus sp. is a partially effaced species whose occurrence is the youngest yet known for this genus. A paucity of material is responsible for this species being left under open nomenclature.

Genus **Innitagnostus** Öpik, 1967

[*Innitagnostus* nov., Öpik, 1967, p. 98; = ?*Barrandagnostus* Ivshin, 1960a, p. 17 (nom. nud.); 1960b, pp. 166-167; Romanenko, 1977, p. 171; = *Tomagnostus* Howell, Kryskov, 1963, p. 277]

Type species. Innitagnostus innitens Öpik (1967, pp. 99-101, pl. 8, fig. 5; pl. 58, figs. 2-4, text-fig. 23), Mindyallan, *Glyptagnostus stolidotus* Assemblage-Zone; Pomegranate Limestone and O'Hara Shale, Duchess and Boulia 1:250 000 Sheet areas, western Queensland; by original designation.

Comments. Other species assigned to *Innitagnostus* are listed by Öpik (1967, p. 98), who has also diagnosed and differentially diagnosed this taxon. To these species should probably be added those described elsewhere under *Barrandagnostus* Ivshin: viz., *B. barrandei* Ivshin (1960b, p. 167, fig. 47, line drawings) and *Barrandagnostus* sp. Romanenko (1977, p. 171, pl. 23, fig. 39); and the Chinese material listed by Shergold (1980).

Barrandagnostus, with *B. barrandei* Ivshin as the original designated type species, is recorded from the Kulbitch Gorizont, Kulbitch Suite, in the Gorniya Altai, where it is associated with *Glyptagnostus* spp., *Aspidagnostus, Peratagnostus, Olenus,* and *Proceratopyge* inter alia (Ivshin, 1960a, p. 17). Although it is a valid genus in terms of the ICZN recommendations, *B. barrandei* is in my opinion inadequately illustrated (by line drawings) for contemporary agnostid taxonomic usage. What is known of *Barrandagnostus* strongly suggests that its morphology is the same as that of *Innitagnostus.* However, until its type species is satisfactorily illustrated it is not possible to be explicit. That cephalon illustrated by Romanenko (1977, pl. 23, fig. 39) is also inadequate as documentation and validation of *Barrandagnostus.* Accordingly, the name *Innitagnostus* is retained here: its concept is clearly defined and its constituent species and their time spans are well known.

Innitagnostus? sp., described below from the *Stigmatoa diloma* Assemblage-Zone at Mount Murray, is part of a biostratigraphic succession of species in northern Australia. *Innitagnostus innitens?* Öpik (1967, p. 101, pl. 58, fig. 6), the oldest, occurs in the Mindyallan *Erediaspis eretes* Zone, and is succeeded by *I. innitens* Öpik and *I.* aff. *innitens* (1967, p. 101, pl. 58, fig. 5) in the *Glyptagnostus stolidotus* Zone. *I. inexpectans* (Kobayashi) (1938, p. 172, pl. 16, figs. 30-33; Palmer, 1962, p. 12, pl. 1, figs. 1-11; Öpik, 1963, pp. 35-37, pl. 2, figs. 10-13; 1967, pp. 101-102, pl. 63, fig. 2; herein) occurs in the *Glyptagnostus reticulatus* and overlying pre-*Irvingella tropica* Zones. The youngest species, *I. medius* Shergold (1980, p. 22, pl. 11, figs. 7-11), occurs in the succeeding *Wentsuia iota-Rhaptagnostus apsis* Assemblage-Zone.

Innitagnostus inexpectans (Kobayashi, 1938)
(Pl. 5, figs. 1-6)

Synonymy

- 1938 *Agnostus inexpectans,* new species; Kobayashi, 1938, p. 172, pl. 16, figs. 30-33.
- ?1939 *Homagnostus* cf. *obesus* (Belt); Whitehouse, 1939, p. 261, pl. 25, fig. 18 (only) (fig. 17 = *Ammagnostus?* sp.)
- 1962 *Agnostus inexpectans* Kobayashi; Palmer, 1962, p. 12, pl. 1, figs. 1-11.
- 1963 *Agnostus inexpectans* Kobayashi, 1938; Öpik, 1963, pp. 35-37, pl. 2, figs. 10-13, text-fig. 6.
- 1963 Agnostidae indet., Hsiang, 1963, pp. 72-73, pl. 11, figs. 5-9.
- 1965 Agnostidae indet., Hsiang, 1965, pp. 18-19, pl. 1, figs. 5-6.
- 1967 *Innitagnostus inexpectans* (Kobayashi, 1938); Öpik, 1967, pp. 101-102, pl. 63, fig. 2.

Types. Kobayashi's (1938) types of *Innitagnostus inexpectans* are deposited in the collections of the Geological Survey of Canada, GSC 12004-12006 (see Bolton, 1966, p. 3); Whitehouse's material is lodged in the fossil collections of the University of Queensland, Brisbane (UQF 43545); Palmer's specimens are deposited in the U.S. National Museum, Washington, D.C. (USNM 143129, b, 143124, 143125a-e); and Öpik's are in the Commonwealth Palaeontological Collections, Canberra (CPC 4260, 4261, 5912). The whereabouts of Chinese material is unknown.

Material. Additional material recorded here (CPC 17845-17853) includes two cephala (CPC 17845-6) and seven pygidia (CPC 17847-17853). The single measurable cephalon has a length (sag.) of 2.0 mm, and the pygidia vary (Lp_2) between 1.45-2.7 mm.

Occurrence. Mort River, localities D501 and 502, i.e. between 3 and 3.4 m above the base of the short section there.

Age. Late Cambrian, Idamean, latest *Glyptagnostus reticulatus* or earliest *Proceratopyge cryptica* Assemblage-Zone.

Comments. No morphological distinction can be made between this new material and specimens earlier described by Öpik (1963, pl. 2, figs. 10-13; 1967, pl. 63, fig. 2). Cephala assigned to *I. inexpectans* in Australia are faintly scrobiculate but the exoskeleton is smooth. The glabella is fully en grande tenue and its anterior lobe has only a very gentle median cleft. In these respects they are quite similar to specimens described by Kobayashi (1938, pl. 16, figs. 30, 32-33) from British Columbia, by Palmer (1962, pl. 1, fig. 2) from Nevada, and Hsiang (1963, pl. 11, figs. 5-7) from southwest China. Pygidia from all these regions are also essentially similar. *Innitagnostus tchatertensis* (Kryskov) (1963, pl. 1, figs. 13-15), from central Kazakhstan, has a strongly scrobiculate cephalon with a deeply incised median preblabellar furrow which continues posteriorly into the frontal part of the anterior lobe, and a finely granulose pygidium.

Innitagnostus innitens also has a granulose prosopon, but has a very shallow median preglabellar furrow not reaching the marginal furrow anteriorly, and an apparent proportionately shorter (sag.) anterior glabellar lobe which is undivided at the front, as in *I. inexpectans* (Kobayashi). *Barrandagnostus barrandei* Ivshin (1960b, p. 167, fig. 47) cannot be adequately compared with species here assigned to *Innitagnostus*.

Innitagnostus? sp. undet.

(Pl. 5, figs. 7-8)

Material. The species is known from the single illustrated cephalon, CPC 14998A, with counterpart CPC 14998B, which has a length

Occurrence. Mount Murray, horizon 301/4, 35 m from the base of measured section 301.

of 3.60 mm.

Age. Late Cambrian, Idamean, *Stigmatoa diloma* Assemblage-Zone.

Comments. Innitagnostus? sp. is left under open nomenclature because its diagnostic characteristics cannot be confirmed by other material.

Innitagnostus? is an en grande tenue species. It is non-scrobiculate, with smooth prosopon, and has deliquiate, though narrow (sag., tr.), marginal furrows, and narrow borders. The glabella is proportionately long (sag.), and bears an anteriorly sited axial node on the posterior lobe which is angulate at the rear.

In other species assigned to *Innitagnostus* the axial node is close to the mid-length of the posterior lobe, and the cephalic shields are invariably subcircular in shape rather than subovoid. The shape of the anterior glabellar lobe, the laterally lobate posterior lobe, and the deeply incised rectilinear anterior furrow all indicate classification within Agnostidae rather than Diplagnostidae, and *Innitagnostus* seems to be the morphologically most similar genus.

Subfamily **QUADRAGNOSTINAE** Howell, 1935

Genus **Peratagnostus** Öpik, 1967

[*Peratagnostus* nov., Öpik, 1967, p. 86; = *?Phaldagnostus* Ivshin gen. nov., Ivshin, 1960a, p. 17 (nom. nud.); 1960b, p. 167; = *Cyclopagnostus* Howell, 1937 sensu Lazarenko, 1966, pp. 38-39.]

Type species. Peratagnostus nobilis Öpik (1967, pp. 87-90, pl. 52, figs. 10, 11a-c; pl. 53, figs. 1-11), Idamean, *Erixanium sentum* Assemblage-Zone; Pomegranate and Georgina Limestones, western Queensland; by original designation.

Other species. Agnostus (Lejopyge?) obsoletus Kobayashi (1935c, p. 106, pl. 14, fig. 9; = *Lejopyge? obsoletus* Kobayashi 1939, p. 188; = *Phoidagnostus obsoletus* (Kobayashi), Kobayashi, 1962, p. 30, pl. 3, figs. 12-14), *Eochuangia* Zone; Machari, Yongwol, South Korea. *Phalacroma?* sp. Palmer (1960, p. 63, pl. 4, fig. 13), Dresbachian, *Dunderbergia* Zone; Dunderberg Shale, Nevada, USA. *Phaldagnostus orbiformis* Ivshin, sp. nov. (Ivshin, 1960a, p. 17, nom. nud.; 1960b, p. 168, fig. 48, line drawing; Romanenko, 1977, p. 168, pl. 23, fig. 34), late Cambrian; Kulbitch Stream, Gorniya Altai, Kazakhstan, USSR. *Leiopyge? controversa* Kryskov (*in* Borovikov & Kryskov, 1963, p. 270, pl. 1, figs. 6-8), *Glyptagnostus reticulatus* Zone;

Kendyktas Mountains, central Kazakhstan, USSR. *Phalacroma sinica* Hsiang (*in* Jegorova & others, 1963, p. 73, pl. 11, figs. 10-14; in Lu & others, 1965, p. 39, pl. 3, figs. 23-25), late Cambrian; Ghuizhou-Hunan border, south-central China. *Cyclopagnostus orientalis* Lazarenko (1966, p. 39, pl. 1, figs. 1-10), *Irvingella-Cedarellus felix* Zone, Kharaulakh Mountains, northern Siberian Platform. *Cyclopagnostus asper* Lazarenko (1966, pp. 39-40, pl. 1, figs. 11, 12), horizon and locality as above. *Peratagnostus hillardensis* Palmer (1968, p. 26, pl. 10, figs. 17, 18, 23, 24), early Franconian; east-central Alaska. *Peratagnostus* sp. cf. *P. nobilis* Öpik (Shergold, 1980, p. 24, pl. 11, fig. 12), *Wentsuia iota-Rhaptagnostus apsis* Assemblage-Zone; Chatsworth Limestone, western Queensland.

Comments. Classificatory concepts and diagnoses are amply covered by Öpik (1967, pp. 86-90) whose findings are followed here. As in the case of *Barrandagnostus* and *Innitagnostus* described above, *Peratagnostus* is a probable synonym of *Phaldagnostus* Ivshin, 1960. The Russian genus, although correctly defined under the ICZN, is nevertheless not readily interpreted from the original description and line drawing illustration. Since several other effaced genera have a similar appearance, e.g. *Pseudophalacroma, Leiopyge,* and *Ciceragnostus,* it is not possible to be entirely satisfied as to the precise identity of *Phaldagnostus.* The specimen illustrated by Romanenko (1967, pl. 23, fig. 34), apparently the holotype, is not well enough preserved to establish the genus either. Accordingly, Öpik's name *Peratagnostus* is favoured here: its concept is clear and it has been generally accepted outside Australia.

Shergold (1980) has suggested that specimens from northern Siberia referred by Lazarenko (1966) to *Cyclopagnostus* can be reinterpreted as *Peratagnostus* species less strongly effaced than the type species, *P. nobilis* Öpik. In any case, *Cyclopagnostus* Howell, 1937 is a late Middle Cambrian genus and probable synonym of *Hypagnostus* Jaekel, 1909 (Shergold, 1980, p. 24).

In Australia (Burke River Structural Belt), *Peratagnostus* first appears late in the *Glyptagnostus reticulatus* Assemblage-Zone (reported herein at locality D501), and is last recorded postdating the occurrence of *Irvingella* in the *Wentsuia iota-Rhaptagnostus apsis* Assemblage-Zone (Shergold, 1980). This range is confirmed in Kazakhstan by the association of *Peratagnostus controversus* (Kryskov) with *Glyptagnostus reticulatus,* and in northern Siberia by the later occurrence of *P. asper* (Lazarenko) and *P. orientalis* (Lazarenko) within the *Irvingella-Cedarellus felix* Zone (see Shergold, 1980, fig. 7 for appropriate correlations).

Peratagnostus nobilis Öpik, 1967

(Pl. 6, figs. 1-11)

Synonymy

1956 *Litagnostus*; Öpik, 1956a, p. 23.

1967 *Peratagnostus nobilis* sp. nov.; Öpik, 1967, pp. 87-90. pl. 52, figs. 10, 11a-c; pl. 53, figs. 1-11; text-fig. 18.

Types. Öpik's types are deposited in the Commonwealth Palaeontological Collections, Canberra. The holotpye is pygidium CPC 5787 (Öpik, 1967, p. 152, fig. 11); paratypes are CPC 5786, 5788-5798. Hypotypes figured herein are CPC 14991-14997 and 17857-17860; non-figured hypotypes are CPC 17861-17885.

Occurrence. Provenance of previously described material is noted above. Specimens described here are from Mount Murray, horizons 301/2 and 301/4, 9.5-35 m above the base of section 301, and horizons 229 and 230; additional material is from localities D501 and D662.

Age. Late Cambrian, Idamean, Assemblage-Zones of *Glyptagnostus reticulatus* and *Proceratopyge cryptica.*

Material. The present collection comprises 15 cephala, with lengths between 0.95-3.00 mm; and 21 pygidia between 0.70 and 4.00 mm long (Lp_2). This collection includes ten meraspid pygidia within the size range 0.75-1.10 mm, but only two cephala within the same range, 0.95 and 1.10 mm.

Comments. Holaspid specimens add nothing new to the known morphology of *Peratagnostus nobilis* described by Öpik (1967). The meraspid paradigm (Pl. 6, figs. 1, 4-7) belongs undoubtedly to an agnostid taxon. Pygidia with lengths (Lp_2) less than 1.10 mm are decidedly different from those with lengths greater than 1.50 mm, and are considered to represent meraspid growth stages. No specimens with lengths between 1.10-1.50 mm have been observed. Meraspides possess well defined *Agnostus*-type pygidial axes and swollen anterolateral articulating structures, and apparently either lack borders altogether, as their equivalent cephala do, or possess extremely narrow ones. If they are to be regarded as *Peratagnostus nobilis*, then a substantial pygidial metamorphosis accompanies the change from meraspid to holaspid morphogenetic stages. A similar morphological reorganisation has been observed during the morphogenesis of *Pseudagnostus (Pseudagnostus) communis* (Hall & Whitfield) at this time (see Palmer, 1955, pl. 20). Similarly sized meraspid cephala do not differ significantly from holaspid ones: only the axial glabellar node seems to be sited farther to the rear of the inferred posterior lobe.

Pygidia similar in morphology to the meraspides here included in *Peratagnostus nobilis* are known: that figured by Westergaard (1946, p. 97, pl. 16, fig. 3) as *Phalacroma* sp. appears nearly identical. If this non-bordered specimen can be interpreted as the meraspid condition of *Phalacroma*, whose holaspides possess a border, then the specimens at hand can be similarly interpreted as meraspides of the bordered holaspid pygidium which characterises *Peratagnostus nobilis.*

Subfamily **Glyptagnostinae** Whitehouse, 1936

Glyptagnostinae is here regarded as a subfamily of Agnostidae, thus following the practice established by Kobayashi (1938, 1939), Westergaard (1947), Henningsmoen (1958), Öpik (1961b), and Kryskov (1963). Others, following Whitehouse's (1936) initiative, have recognised Glyptagnostidae Whitehouse, 1936 as a distinct family—a senior synonym of Hastingsagnostidae Howell, 1937, also 1959, according to Öpik (1961b, p. 53) (see Palmer, 1962, 1968; Kobayashi, 1962, Öpik, 1963). Öpik (1967) classified Glyptagnostidae with the Family Diplagnostidae.

The morphology of *Glyptagnostus* Whitehouse, 1936, on which Glyptagnostinae is based, most closely resembles that of Agnostidae. According to Öpik (1961a), the caecal pattern of *Glyptagnostus* is basically that of *Ptychagnostus.* The general structure of the of the pygidium, with its long (sag.), narrow (tr.) axis divided into four parts, also resembles that of late Ptychagnostinae (Agnostidae), and has no morphological similarity at all to Diplagnostidae. The structure of the glabella, however, can be interpreted in two ways. It does not resemble that of Ptychagnostinae, but is most similar to that prevalent in diplagnostids, particularly *Diplagnostus,* and clavagnostids. The axially cleft anterior lobe of some specimens, however, is no drawback to classification with Agnostidae since it is found also in *Tomagnostus* (Tomagnostinae) and *Innitagnostus* (Agnostinae).

Glyptagnostinae therefore possess characteristics intermediate between Agnostidae and Diplagnostidae, with the balance in favour of Agnostidae. Some justification exists for the recognition of Whitehouse's Family Glyptagnostidae.

Only two genera are regarded here as comprising Glyptagnostinae: *Glyptagnostus* and *Agnostardis* Öpik, 1963. In my opinion *Lispagnostus* Öpik 1967, regarded by Öpik (1967, p. 169) as a subgenus of *Glyptagnostus,* cannot be adequately justified since it is based on a single cephalon (see also Jago, 1974), which could equally represent a species of *Ammagnostus.* Of other genera which have been classified with *Glyptagnostus, Glyptagnostotes* Lazarenko (1966, p. 42, pl. 2, figs. 1-2) has a highly scrobiculate agnostoid cephalon associated with a scrobiculate deuterolobate pygidium, and *Pseudoglyptagnostotes* Lu, 1964 (Lu & others 1965, p. 33, pl. 2, fig. 20) may represent a similar genus. They seem to be developed from an *Innitagnostus*-like agnostid.

Genus **Glyptagnostus** Whitehouse, 1936

Type species. Glyptagnostus toreuma Whitehouse (1936, pp. 101-103, pl. 9, figs. 17-20), Idamean; Georgina Limestone, western Queensland; by original designation. This species was synonymised with *Glyptagnostus reticulatus* (Angelin, 1851) by Westergaard (1947, p. 5) (see also Kobayashi, 1949; Öpik, 1961a; Palmer, 1962).

Other species. See Kobayashi (1949), Öpik (1961a, p. 428; 1967, p. 167), and Palmer (1962, pp. 15-18). *Glyptagnostus fossus* Pokrovskaya, a manuscript name, as illustrated by Hsiang (*in* Jegorova & others, 1963, pp. 69-70, pl. 11, figs. 3, 4) is referable to *Glyptagnostus stolidotus* Öpik, 1961 (see Hsiang *in* Lu & others, 1965, p. 32). *Glyptagnostus* sp. aff. *G. stolidotus* Öpik, described as a pygidium by Cawood (1976, fig. 2d) is regarded here as a cephalon of a highly scrobiculate *Ptychagnostus* (cf. *Pt. aculeatus* sensu Lu & others, 1965, pl. 3, fig. 11).

Glyptagnostus reticulatus reticulatus

(Angelin, 1851)

(Pl. 4, figs. 1-12)

Synonymy. Synonymy to 1938 is given by Westergaard (1947, p. 5), and to 1961 by Kobayashi (1962, p. 27) and Palmer (1962,

p. 16). To these lists should be added the following:

1960 *Glyptagnostus reticulatus* (Angelin, 1851); Pokrovskaya *in* Khalfin (ed.) 1960, p. 164, fig. 46 (line drawing).

1960 *Glyptagnostus reticulatus* (Angelin); Pokrovskaya, *in* Tchernysheva (ed.) 1960, p. 464, pl. 2, figs. 1, 2.

1962 *Glyptagnostus reticulatus reticulatus* (Angelin); Palmer, 1962, p. 18, pl. 2, figs. 1, 3, 8.

1963 *Glyptagnostus reticulatus* (Angelin, 1851); Kryskov, *in* Borovikov & Kryskov, 1963, pp. 273, 275, pl. 1, figs. 10-12.

1963 *Glyptagnostus reticulatus* (Angelin); Öpik, 1963, pp. 38-39, pl. 2, figs. 6-9, text-fig. 7.

?1967 *Glyptagnostus reticulatus* (Angelin); Öpik, 1967, p. 167, pl. 67, fig. 3a.

1968 *Glyptagnostus reticulatus* (Angelin); Palmer, 1968, p. 27, pl. 7, fig. 11.

1977 *Glyptagnostus reticulatus* (Angelin), 1851; Rozova, *in* Zhuravleva & Rozova, 1977, p. 83, pl. 1, figs. 13-14.

Concept. Two intergrading morphologies have been placed in *Glyptagnostus reticulatus*, and these are readily distinguished in Kobayashi's (1949) plate. One form, presumably a little earlier in time because it is closest to *G. stolidotus*, retains its cephalic and pygidial caeca quite visibly. It is represented by specimens assigned to *reticulatus* by Brögger (1882), Lake (1906), Westergaard (1922, 1947), Kobayashi (1949, 1962), Hsiang (1963, 1965), and Jago (1974), which can be referred perhaps more correctly to *Glyptagnostus reticulatus nodulosus* Westergaard, 1947. In the other group, left in *G. reticulatus reticulatus* (Angelin, 1851), cephala and pygidia are heavily scrobiculate and caecate so that they appear 'blistered'. The specimens described by Angelin (1851), Belt (1867), Tullberg (1880), Butts (1926), Kobayashi (1938), Westergaard (1947), Henningsmoen (1958), by the authors listed in the synonymy above, and by Whitehouse as *G. toreuma*, are all considered here to represent *G. reticulatus reticulatus* (Angelin). *Glyptagnostus reticulatus angelini* (Resser, 1938) is distinguished mainly on its proportions, and its axial furrows are said to be more effaced (Palmer, 1962, p. 18).

Material. The present material is based on nine cephala with lengths between 1.4 and 6.7 mm; and five pygidia with lengths (Lp_1) between 0.8 mm and 6.1 mm. Specimens CPC 17893-17904 are illustrated; CPC 17905 and 17906 are non-illustrated hypotypes.

Occurrence. Localities D471, 472, 473, 497, 498, and 499 on the western bank of Mistake Creek; D500 and 501 on the western bank of the Mort River, 8 km south of the above localities; and D673 and 674 on pediments 10 km east-northeast of Burke Yards and Bore.

Age. Late Cambrian, early Idamean, Assemblage-Zones of *Glyptagnostus reticulatus* and *Proceratopyge cryptica.*

Comments. Little new holaspid morphology can be obtained from the specimens at hand. Two late meraspid cephala (Pl. 4, figs. 1, 2) give additional information on the development of the caecal pattern of *Glyptagnosus.* Together with the early holaspides (e.g. Pl. 4, fig. 3), they show a gradual increase in the number and density of scrobicular birfurcations which eventually give rise to late holaspides like that in Plate 4, fig. 8. This is accompanied by a gradual forward movement of the axial glabellar node during morphogenesis, from a position one-third the distance from the rear of the glabella to a position two-thirds from the rear of the glabella in late holaspides (cf. Pl. 4, figs. 1 and 8). The posteriorly sited node and weak scrobiculation of the caecal system are conditions very similar to those seen in *Glyptagnostus stolidotus* Öpik, and there can be little doubt that *G. reticulatus* is directly related morphologically to this species.

The single meraspid pygidium illustrated (Pl. 4, fig. 10) also compares closely to that figured by Öpik (1967, pl. 67, fig. 3) as a meraspid of *G. stolidotus*, augmenting the idea of a *stolidotus-reticulatus* species lineage. In fact, it would be difficult to separate the two specimens specificially if it were not for the fact that each is associated with holaspides of its appropriate taxon.

Subfamily INCERTAE SEDIS

Genus **Kormagnostella** Romanenko, 1967

[*Kormagnostella* E. Romanenko, gen. nov., Romanenko, 1967, p. 74; = *Litagnostoides* n. gen. Schrank, 1975, p. 593]

Type species. Kormagnostella glabrata E. Romanenko (*in* Romanenko, E. V., & Romanenko, M. F., 1967, p. 75, pl. 1, figs. 22, 23), late Cambrian; Kulbitch Spring, Gorniya Altai, south Siberian Platform, USSR; by original designation.

Other species. Litagnostoides minutus Schrank (1975, pp. 593-594, pl. 1, figs. 4-10, text-fig.

1), late Cambrian, *Kaolishania quadriceps* fauna; Saimaki, north China.

Comments. *Kormagnostella* is characteristically a very small trilobite: the holotype pygidium (ZSGU 152/166, Romanenko, 1967, pl. 1, fig. 22) and paratype cephalon (ZSGU 152/153, loc. cit., fig. 23) of the type species, *K. glabrata* Romanenko, both have estimated lengths of 1.6 mm. In the cephalon, the anterior glabellar lobe is effaced, as in such genera as *Hypagnostus, Kormagnostus,* and *Plurinodus,* and the glabella is apparently truncated at the anterior furrow. In this respect these genera differ from Geragnostinae in which a similar glabellar morphology is obtained by effacement of the anterior furrow, e.g. as in *Trinodus, Metagnostus* and *Galbagnostus.* Cephala of Quadragnostinae, e.g. *Cotalagnostus, Cyclopagnostus, Grandagnostus, Hypagnostus,* and *Spinagnostus,* also lack an anterior glabellar lobe, but may be distinguished by an anteriorly sited axial glabellar lobe, and thus are thought to represent effaced agnostids.

All species assigned here to *Kormagnostella* have rather wide borders, particularly in the pygidium, narrow deliquiate marginal furrows in the cephalon, and insignificant marginal pygidial spines. In the last respect they differ from *Plurinodus,* which is otherwise similar. There is also a tendency to efface the pydigial axis, which also distinguishes them from *Plurinodus.* The cephalon of *Kormagnostella* resembles those assigned to both *Plurinodus* by Öpik (1967) and *Kormagnostus* by Resser (1938). The pygidium of the type species of *Kormagnostus* (*K. simplex* Resser, 1938, pl. 9, figs. 11-13), however, is quite distinct from that of *Kormagnostella glabrata* Romanenko, in its narrow constricted acrolobes and well defined inflated axis.

In my opinion *Kormagnostella* Romanenko, 1967, cannot be adequately distinguished from *Litagnostoides* Schrank, 1975. The two have similar size, and apart from perhaps shape there is no significant generic difference. Schrank (1975, p. 592) has drawn comparisons between *Litagnostoides (= Kormagnostella)* and *Litagnostus,* but even accounting for the difference in size between these taxa, *Litagnostus* appears to represent an almost totally effaced diplagnostid stock (presumably derived from Pseudagnostinae).

Kormagnostella inventa sp. nov.
(Pl. 6, figs. 12-17)

Synonymy

1963 Gen. et sp. indet.; Whitehouse, 1936, p. 105, pl. 10, fig. 9.

Name. L., *inventa,* f., discovered; participle from *invenire,* to discover.

Types. Holotype, cephalon, CPC 15001 (Pl. 6, fig. 12); paratypes, cephalon with counterpart, CPC 15000A-B, Whitehouse's original cephalon UQF 3205 (Whitehouse Collection, University of Queensland, and pygidia CPC 15002, 17886-87. Non-figured paratypes are CPC 17888-92.

Material. Including Whitehouse's material, the species is known from three cephala measuring between 1.25 and 1.4 mm long, and eight pygidia between 0.95 and 1.2 mm (Lp_2).

Occurrence. At Mount Murray the species occurs in horizons 301/5, 37.5 m above the base of section 301, and 302/1, 16 m from the base of the section 302. The species also occurs at D662 adjacent to the intersection of Pilgrim Creek and the Burke River.

Age. Late Cambrian, Idamean, *Stigmatoa diloma* Assembalge-Zone.

Diagnosis. *Kormagnostella* with ovoid cephalon and subcircular pygidium; wide (sag.) borders with narrow deliquiate marginal furrows; circular non-constricted pygidial acrolobe.

Differential diagnosis. *Kormagnostella inventa* sp. nov., *K. glabrata* Romanenko, *Litagnostoides minutus* Schrank, and *Plurinodus discretus* Öpik share a common cephalic morphology, and differ only in degree of proportion, deliquiation, and border dimension. The Australian species is perhaps a little longer (sag.) than that described from Siberia, and is more like the Chinese species *minutus.* Adequate comparison is not really possible with *Plurinodus discretus* Öpik because the only known specimen is very small, only 0.6 mm long (sag.), and incomplete. The specimen described by Whitehouse (1936) as gen. et sp. indet. (UQF 3205) and refigured here (pl. 6, fig. 14) is undoubtedly conspecific with *Kormagnostella inventa.*

In terms of pygidial shape, the Australian specimen is slightly more tapered posteriorly, the Chinese species is more circular, and the Siberian one more oval. In all, the acrolobe is circular. Borders, particularly the posterior one, are widest (sag.) in the smallest specimens. *Kormagnostella glabrata* and *Litagnostoides minuta* appear to be more effaced than *K. inventa* which mostly has its axial furrows quite visible.

Description. The cephalon has subovate outline, slightly longer (sag.) than wide (tr.), L:W is 100-105%. Borders are relatively wide, 10-20% (sag.), with shallow deliquiate marginal furrows which are widest anterolaterally. The acrolobe is gently pointed (sag.) anteriorly and lacks a median preglabellar furrow. The anterior glabellar lobe is effaced, the anterior transverse glabellar furrow forming the anterior limit of the glabella. Anterolateral glabellar lobes merge into the posterior lobe, and are poorly defined. The rear of the posterior lobe appears to be angulate, and the basal lobes laterally extensive. The cephalic axial node lies towards the rear of the posterior lobe.

Like the cephalon, the pygidium has a subovate outline, with wide borders, especially posteriorly, and deliquiate marginal furrows. The pygidial acrolobe is unconstricted and subcircular, being a little pointed at the terminal node. The axis is poorly preserved, but apparently occupies two-thirds of the length of the acrolobe. Its segmentation and the nature of its axial node are unknown. If pygidial spines are present, they are extremely small and tucked below the convexity of the shield.

Family **DIPLAGNOSTIDAE** Whitehouse, 1936 emend. Öpik, 1967

Subfamily **PSEUDAGNOSTINAE** Whitehouse, 1936

Genus **Pseudagnostus** Jaekel, 1909

Subgenus **Pseudagnostus** Jaekel, 1909

Type species. Agnostus cyclopyge Tullberg (1880, p. 26, pl. 2, figs. 15a, 15c), Zones of *Parabolina spinulosa* with *Orusia lenticularis* and *Olenus*, Andrarum, Skaane (fide Westergaard, 1922, pp. 116-7); designated Jaekel (1909, p. 400).

Comments. Brief notes on the concept of *Pseudagnostus* have been given previously (Shergold, 1975, 1977). Species other than the type are too numerous to list here. They, and the problems of their classification, have been published elsewhere (Shergold, 1977).

The taxa considered here are all spectaculate, and mainly represent a morphological complex centred on *P. idalis* Öpik and *P. vastulus* Whitehouse. They are not associated with any of the species groups previously recognised (Shergold, 1975, 1977), but seem to fall within the concept of the Subgenus *Pseudagnostus* as conceived by Shergold (1977).

Pseudagnostus (Pseudagnostus) idalis Öpik, 1967

A significant proportion of pseudagnosti from Mount Murray have morphology referable to *Pseudagnostus (Ps.) idalis* Öpik sensu lato. Differences in degree of effacement and subtle change of shield shape prevent confident classification with *P. (Ps.) idalis* sensu stricto. Together with *P. (Ps.) idalis* they form a morphologically closely related complex. The use of subspecific taxa is advocated to investigate this relationship.

Pseudagnostus (Pseudagnostus) idalis idalis Öpik, 1967

(Pl. 2, figs. 1-13)

Synonymy

1967 *Pseudagnostus idalis* sp. nov.; Öpik, 1967, pp. 153-154, pl. 62, figs. 8, 9; pl. 63, fig. 1 *non* fig. 3 [= *Ps. (Ps.) idalis sagittus* subsp. nov.]

Types. Holotype, pygidium, CPC 5908 (Öpik, 1967, pl. 62, fig. 8); paratypes, CPC 5909, 5910, 5911; hypotypes, CPC 17907-17919 (figured), 17920-17926 and 19177-19208 (unfigured).

Material. Present material includes 20 cephala with lengths between 2.4 and 4.1 mm; and 33 pygidia with lengths (Lp_2) between 1.1 and 4.9 mm.

Occurrence. Primary type material is from the Georgina Limestone, Glenormiston area, western Queensland. The secondary types are from localities D499 on the western bank of Mistake Creek, and D501 on the western bank of the Mort River, both on the eastern side of the Burke River Structural Belt; and D662 and 673 on the pediment to the northeast and east of Burke Yards on the western side of the Structural Belt. The species, per se, has not been recorded at Mount Murray.

Age. Late Cambrian, Idamean, Assemblage-Zones of *Glyptagnostus reticulatus, Proceratopyge cryptica,* and *Stigmatoa diloma* in the Burke River Structural Belt.

Diagnosis. Pseudagnostus (Ps.) idalis idalis Öpik has an en grande tenue, strongly deliquiate, spectaculate cephalon with slim (tr.) glabella and prominent median preglabellar furrow. Its pygidium is also en grande tenue, strongly deliquiate and plethoid, with ampullate deuterolobe, and retral posterolateral spines sited a little forwards of a transverse line drawn across the rear of the deuterolobe.

Comments. Henderson (1976, p. 328) has synonymised Öpik's species *idalis* and *Pseudagnostus vastulus* Whitehouse. As discussed under the heading *Ps. vastulus* below, this judgement was based on ignorance of the holotype pygidium of *Ps. vastulus*, which has been prepared to clarify concepts for this study, and led to the proposal of the species *Ps. curtare*, which is a synonym of *Ps. vastulus*. Those specimens referred to *Ps. vastulus* by Henderson (1976, pl. 47, figs. 10-12) look like the taxon distinguished by Öpik (1967, pl. 63, fig. 4) as *Pseudagnostus* cf. *idalis*.

Pseudagnostus (Ps.) idalis idalis has been adequately described by Öpik (1967). The specimens at hand represent mostly undeformed material preserved in fine limestone which accounts for observed differences between this and Öpik's (op. cit.) paradigm.

Since the present collection is the largest yet described, proportions of some measured parameters are given here to show the range of variation involved in what appears to be a homogeneous species, and for comparison with others:

glabella 61-69% of the cephalic length; distance of axial node from rear of glabella is 32-40% of the cephalic length; distance of axial node from rear of glabella is 50-62.5% of the glabellar length; the anterior border attains 9-13% of the total cephalic length; the maximum cephalic length is 88-98% of the maximum width; the pygidial length exclusive of the articulating half-ring is 78-90% of the width; and the posterior pygidial border is 10-22.5% of the maximum pygidial length (exclusive of the half-ring).

Borders are distinctly wider (sag.) in late meraspides and early holaspides, whereas glabellar and cephalic lengths appear to increase gradually with morphogenesis.

Pseudagnostus (Pseudagnostus) idalis Öpik, 1967 sensu lato

(Pl. 2, figs. 14-15)

Material. Three cephala, CPC 14986A, 19209-10, measuring between 3.2 and 4.45 mm (Lc); and three pygidia, CPC 14985, 19211-12, with lengths (Lp_2) between 4.25 and 5.0 mm. Specimens CPC 14985-6 are illustrated.

Occurrence. Mount Murray, horizons 301/5, 37.5 m from the base of the measured section 301, 231.

Age. Late Cambrian, Idamean, *Stigmatoa diloma* Assemblage-Zone.

Comments. This taxon is identified by comparison with the cephalon and pydigium (CPC 5909, 5910) illustrated by Öpik (1967, pl. 62, fig. 9) from the Georgina Limestone. The cephalon here illustrated is unusual in being considerably wider (tr.) than others in the the paradigm. The nature of its borders and glabella is similar to that observed in cephala of *Ps. idalis* previously figured by Öpik (op. cit.). The pygidium, which has greater external effacement than is common is *Ps. idalis* sensu Öpik, has a more similar shape to this taxon than to *Ps. idalis sagittus* subsp. nov., and its spines are also similarly situated.

The illustrated cephalon (Pl. 2, fig. 14) differs only in proportions from those figured by Öpik (1967; 150-152, pl. 61, figs. 10, 11) as *Pseudagnostus ampullatus.* The pygidium presented here (Pl. 2, fig. 15) cannot be referred to that species however: it is non-plethoid and in general too effaced. Nevertheless, its shape, its borders, and the position of its spines are similar. The matched specimens may not, of course, be conspecific.

Caecal morphology is well displayed on the exfoliated portions of the illustrated pygidium (Pl. 2, fig. 15), the pattern of scrobiculations being not unlike that of the pygidium which Öpik (1963, p. 51, fig. 13) has ascribed to *Ps. vastulus* Whitehouse. On these specimens the pleural lobes are scalloped, particularly along the visible accessory furrows, fractures apparently formed by transverse diverticula crossing from the extranotular axis to the pleural lobe. Similar diverticula are also preserved in *Ps. ampullatus* Öpik (1967, pl. 61, fig. 7).

Pseudagnostus (Pseudagnostus) idalis sagittus subsp. nov.

(Pl. 3, figs. 1-8)

Synonymy

1967 *Pseudagnostus idalis* sp. nov. [pars]; Öpik (1967, pp. 153-154, pl. 63, fig. 3; *non* pl. 62, figs. 8, 9, pl. 63, fig. 1 [= *Ps. (Ps.) idalis idalis* Öpik].

Name. L., *sagittus* arrow, referring in this instance to the sagittal dimension of the pygidium of this taxon compared with other subspecies.

Types. Holotype, CPC 14978, pygidium; figured paratypes CPC 14979-84, 14987, non-figured paratypes CPC 14976-77.

Material. Three cephala, CPC 14980-82, with lengths between 3.7 and 4.25 mm; and seven pygidia, CPC 14976-79, 14983-84, 14987, measuring (Lp_2) 0.95-4.35 mm.

Occurrence. As conceived here, the subspecies is restricted to the Burke River area of western Queensland, where it occurs at Mount Murray, horizons 301/4 and 301/5, between 35 and 37.5 m from the base of the measured section 301, and at 230 and 231. Öpik's specimen, which is placed in synonymy, is from his locality D132 at the heads of Pomegranate Creek.

Age. Late Cambrian, Idamean, *Stigmatoa diloma* Assemblage-Zone.

Diagnosis. A subspecies of *Pseudagnostus (Ps.) idalis* Öpik with elongate ovoid shields, and with deuterolobe saccate rather than ampullate; retrally sited posterolateral spines lie just behind a line constructed across the rear of the deuterolobe.

Differential diagnosis. This subspecies is differentiated from *Pseudagnostus (Ps.) idalis idalis* on account of its pygidial spines lying behind the rear of the deuterolobe, and its more elongate pygidial shape. The cephalon has a slightly more ovoid (sag.) form than that of *idalis idalis*, but is similarly deliquiate and spectaculate. The external morphology of both pygidial and cephalic carapaces is partly effaced, mode of preservation accounting for most of the observed variation: replicas of silicified surfaces in particular (Pl. 3, figs. 3, 5. 6) are apparently more effaced than specmens preserved in limestone.

Description. The cephalon has an ovoid shape, obtusely rounded anteriorly, with length (sag.) 92-98% of the maximum width (tr.) which lies on a traverse line across the front of the axial glabellar node. Borders are wide (sag.), over 10% of the cephalic length, with wide (sag.) deliquiate marginal furrows and very narrow (sag.) rims on both exoskeletal and parietal surfaces. The cephalic acrolobe is unconstricted, but separated sagittally by a median preglabellar furrow, which is also present on both exoskeletal and parietal surfaces.

The glabella, occupying approximately two-thirds of the cephalic length (sag.), is plump (tr.), with a small semicircular anterior lobe separated from the remainder of the glabella by a backward curved anterior furrow, and large triangular basal lobes. The subspecies is spectaculate.

Holaspid pygidia have ovoid shape; the holotype has a length equivalent to 79% of the transverse width. The pygidial borders bear subdeliquiate marginal furrows, less deep and less wide (sag.) than those of the cephalon, and wider (sag.) rims. If the meraspides at hand (CPC 14976-77) certainly represent this species, then there is a subtle variation in shape during morphogenesis, from a subquadrate late meraspid and early holaspid (see Pl. 3, fig. 4), to the more ovoid late holaspid shape (cf. Pl. 3, figs. 6-8). As a result, the pygidial spines, sited posteriorly behind the deuterolobe, move towards the sagittal line. There is also subtle change in deuterolobe shape during morphogenesis, from a pyriform meraspid to a more sack-like holaspid shape. Accessory furrows are visible only on parietal surfaces. The articulating half-ring is simple, and the articulating facets are only gently inclined, and lack fulcral points apparently.

The parietal morphology of *Pseudagnostus (Ps.) idalis sagittus* is not well known from material available. The cephalic acrolobe is scrobiculate, with scrobicules passing across the marginal furrow as they do in *Ps.* cf. *idalis* Öpik (1967, pl. 63, fig. 4).

Glabellar musculature is displayed to some extent on the specimen illustrated in Pl. 3 (fig. 3), on which the large anterolateral and major posterior muscle insertion areas are shown. The holotype (Pl. 3, fig. 7) displays traces of the intranotular axis and notulae. It also shows the accessory furrows to advantage, being a series of discontinuous elongate grooves which are the spaces between transverse diverticula which cross from the extranotular axis to the acrolobe. Similar diverticula are also preserved in *Ps. ampullatus* Öpik (1967, pl. 67, fig. 7).

Pseudagnostus (Pseudagnostus) vastulus

Whitehouse, 1936

(Pl. 1, figs. 1-14, Text-fig. 9A)

Synonymy

1936 *Pseudagnostus vastulus* sp. nov.; Whitehouse, 1936, pp. 99-100, pl. 10, figs. 3, 4.

1936 *Pseudagnostus nuperus* sp. nov.; Whitehouse, 1936, p. 100, pl. 10, fig. 5, ?6, *non* fig. 7 (undet.).

1971 *Pseudagnostus vastulus* Whitehouse 1936; Hill & others, 1971, pl. Cm XII, figs. 8, 9.

1976 *Pseudagnostus curtare* sp. nov.; Henderson, 1976, pp. 330-331, pl. 47, figs. 1-5.

non 1963 *Pseudagnostus vastulus;* sensu Öpik, 1963, pp. 50-53, text-fig. 13.
non 1976 *Pseudagnostus vastulus* Whitehouse; sensu Henderson, 1976, pp. 328, 330, pl. 47, figs. 10-12 [= *Pseudagnostus* cf. *idalis* Öpik, 1963].

Types. Whitehouse (1936) selected a cephalon, UQF 3202 (pl. 10, fig. 3), and an unprepared pygidium, UQF 3203 (pl. 10, fig. 4), as the paratype and holotype respectively of *Pseudagnostus vastulus*, and these are refigured in Hill & others (loc. cit.). The holotype cephalon which was figured by Whitehouse as *Ps. nuperus* is essentially identical with the paratype cephalon of *Ps. vastulus* (see Pl. 1, figs. 6, 7 herein). The holotype pygidium of *Ps. vastulus* has now been prepared, and is illustrated in text-figure 9A. It is a late holaspid parietal surface similar to those illustrated here in Plate 1. It confirms beyond doubt the synonymy of *Ps. curtare* Henderson with *Ps. vastulus* Whitehouse.

The type of *Ps. vastulus* is associated with several other cephala and pygidia referable to this species, *Ps. (Ps.) idalis* Öpik sensu lato, *Kormagnostella inventa* sp. nov., *Apoltaspis mucrora* Henderson, *Corynexochus plumula* Whitehouse, *Eugonocare tessellatum* Whitehouse, *Proceratopyge lata* Whitehouse, and a variety of inarticulate brachiopods. It comes from the *Stigmatoa diloma* Assemblage-Zone at Glenormiston.

Material. Twenty-one cephala ranging in length between 1.25 and 5.0 mm; 15 pygidia with lengths (Lp_2) between 0.95 and 5.5 mm; and a single complete late meraspid individual. Specimens CPC 14959-14970 are illustrated; CPC 19213-19238 are the unfigured part of the paradigm.

Occurrence. Mount Murray, collections K229, 230, and 231, and at horizons 301/2, 301/4 and 301/5 on measured section 301, i.e. at 9.5, 35, and 37.5 m from the base of this section; D662, pediment northeast of Burke Yards.

Age. Late Cambrian, Idamean, *Stigmatoa diloma* Assemblage-Zone at Mount Murray.

Comments. The material at hand is compared to the types of *Pseudagnostus vastulus* as described by Whitehouse, and the holotype cephalon of *Ps. nuperus* Whitehouse, which is synonymised. What is available of the last suggests that the cephalon of *Ps. nuperus* conforms with the morphology of *Ps. vastulus* in possessing a narrow rim and subdeliquiate marginal furrows. The holotype (Pl. 1, fig. 7) has a narrow (tr.) spectaculate glabella with rectilinear transverse anterior furrow and slightly pointed anterior lobe. The median preglabellar furrow is only weakly impressed. As such, Whitehouse's material does not differ significantly from that referred here to *Ps. vastulus* (see Pl. 1, fig. 6).

Pygidia figured here in Plate 1 are essentially identical with the holotype of *Ps. vastulus* (see Text-fig. 9A). The pygidium CPC 4302, which forms the basis of Öpik's (1963, p. 51, fig. 13) reconstruction of *Ps. vastulus*, is reillustrated as Text-figure 9C. It differs substantially from pygidia of *Ps. vastulus*, but only in degree from those of *Ps. (Ps.) idalis idalis* Öpik, 1967, whose holotype is refigured as Text-figured 9B (compare also with Pl. 2, figs. 9-12). It is also quite obvious that pygidia which Henderson illustrated as *Ps. curtare* are the same as the holotype of *Ps. vastulus*, and accordingly that his concepts of both *vastulus* and *idalis* are in error.

Revised diagnosis. A spectaculate, subdeliquiate thin shelled species, with subcircular shields and narrow borders. A median preglabellar furrow is faintly indicated on parietal surfaces. The pygidium has well advanced posterolateral spines during holaspid morphogenesis, and a transversely ovoid deuterolobe characterises meraspid and early holaspid morphogenesis.

Differential diagnosis. Cephalic shield shapes are somewhat similar to those of *Ps. idalis* Öpik (1967, pl. 62, fig. 9, pl. 63, fig. 1), from which *Ps. vastulus* is distinguished by narrower marginal furrows and borders, and a more effaced glabella. *Ps. sericatus* Öpik (1967, pl. 62, fig. 7) has similarly narrow borders but wider, stronger, deliquiate marginal furrows. Among other Australian species, *Ps. mestus* Öpik (1967, pl. 62, fig. 6) has most similar pygidial shield and deuterolobe shape, but has wider borders and less rounded acrolobe. A tendency to restrict the pygidial pleural areas is common to *Ps. ampullatus* Öpik (1967, pl. 62, figs. 1-3), *Ps. mestus*, and *P. vastulus*. Cephala assigned to these species are, however, quite different.

A possibly similar species, with narrow borders and ovoid deuterolobe, is *Ps. marginisulcatus* Kobayashi (1962, p. 32, pl. 3, figs. 10, 11) from South Korea. However, the type pygidium of this species has suffered some lateral distortion which renders accurate comparison difficult.

In degrees of effacement and deliquiation *Pseudagnostus vastulus* resembles *Ps. communis* (Hall & Whitfield) (sensu Palmer, 1955, pp. 94-96, pl. 19, figs. 16, 19-21, pl. 20, figs. 4-11, 14) which occurs in the Dunderberg Shale of the Eureka district, Nevada. The Australian species is distinguished by less elongate shield shapes, a transversely ovoid rather than ampullate pydigial deuterolobe, and more obviously advanced pygidial spines.

Description. The cephalic shield is subcircular, anteriorly slightly truncate in some specimens, with maximum width (tr.) through the anterolateral glabellar lobes; the length (sag.) varies between 85 and 95% of the width (tr.). Cephalic borders are narrow (sag., exsag.), slightly upraised; and marginal furrows are narrow (sag., exsag.), deeply incised and subdeliquiate. The cephalic acrolobe is subcircular, unconstricted; on crushed specimens it is externally very faintly divided by a median preglabellar furrow, more obviously so on parietal surfaces.

The glabella, externally semi-effaced, is cylindrical and narrow (tr.) in meraspides and early holaspides but expands posteriorly in late holaspides. It occupies approximately two-thirds of the cephalic length (sag.). Although the anterior transverse furrow is non-effaced externally and prominent parietally, the furrows separating the basal lobes from the posterior lobe are distinctly visible only parietally. Anterolateral lobes are small and not prominent. *Pseudagnostus vastulus* is spectaculate, the axial glabellar node lying approximately at glabellar mid-length and one-third cephalic mid-length (sag.).

The pygidium is subcircular, posteriorly rounded, with length (Lp_2)-to-width ratio of 79-92%. The maximum width (tr.) lies, in general, on a line just behind the axial node. There is an apparent change in shape during morphogenesis (Pl. 1, figs. 8-14).

Pygidial borders are somewhat wider than the cephalic ones, 7-16% of the pygidial length (Lp_2). Marginal furrows are more strongly deliquiate than in the cephalon, but degree of exfoliation of the shell emphasises this characteristic. The pygidial acrolobe is only very gently constricted. The axis is narrow (tr.), with effaced transverse furrowing. The deuterolobe lacks tumidity, and accessory furrows are effaced. Posterolateral spines lie well forwards with respect to a line drawn across the rear of the deuterolobe.

The articulating half-ring is a simple curved bar (Pl. 1, fig. 11), the articulating facets have gentle inclination, and fulcral points are developed.

Parietal morphology. Furrows largely effaced on the external testaceous surface are visible parietally: particularly the median preglabellar furrow, those furrows separating the posterior from the basal lobes, and the proximal ends of the pygidial accessory furrows.

Cephalic musculature is only vaguely visible on available material, but the scrobicules of the acrolobe are preserved (Pl. 1, fig. 2).

Pygidial parietal morphology is better expressed: pleural lobes are scrobiculate (Pl. 1, fig. 13) and caeca cross the marginal furrows to join a distinct diverticulum which follows concentrically to the border (Pl. 1, fig. 13). Accessory furrows are seen to be widely divergent (exsagittally, posterolaterally) and define a transversely ovoid deuterolobe whose length (sag.) varies between 53 and 74% of its width (tr.), depending on size. There is a definite increase in deuterolobe length (sag.) with increase in pygidial length (sag.).

Musculature is observed on several specimens (Pl. 1, figs. 10, 12). Ten pygidial metameres are indicated by a count of muscle scar impressions. Features of the intranotular axis are, however, poorly preserved on the material at hand.

Pseudagnostus (Pseudagnostus) sp. VIII

(Pl. 3, figs. 10, 11)

Material. The species is known from a single cephalon measuring 3.40 mm long (sag.), and two pygidia, whose lengths (Lp_2) are 3.40 and 4.60 mm. CPC 14988-14989 are illustrated; CPC 19239 is not figured.

Occurrence. Mount Murray, horizon 302/1, 16 m above the base of measured section 302.

Age. Late Cambrian, Idamean, *Stigmatoa diloma* Assemblage-Zone.

Comments. This taxon is left under open nomenclature because of the small number of specimens known, and the questionable association of cephalon and pygidium.

The species has the wide marginal furrows typical of *Pseudagnostus (Ps.) idalis* Öpik sensu lato to which the cephalon could possibly be assigned. It is proportionately larger (sag.) than that of the subspecies *idalis idalis, idalis sagittus,* or the specimen referred by Öpik (1967, pl. 63, fig. 4) to *Ps.* cf. *idalis.* In its proportions it clearly resembles some of the cephala which Henderson (1976, pl.

47, figs. 10, 11) referred to *Ps. vastulus* Whitehouse (for validity see discussion above).

The associated pygidia are subrectangular with posterolateral spines lying well in front of the rear of the deuterolobe. They are non-plethoid, and but for their wider borders (sag.), resemble *Ps. communis* (Hall & Whitfield).

Of the other described species perhaps that combination with most closely comparable morphology has been described by Kobayashi (1933, pp. 98-99, pl. IX, figs. 20-22; 1935, pp. 110-111, pl. III, figs. 7-11, 23) as *Pseudagnostus orientalis*. The specimens described in Lu & others (1965, pp. 41-42, pl. 4, figs. 6-8) as *Ps. communis* (Hall & Whitfield) may also represent a similar combination.

Pseudagnostus (Pseudagnostus) sp. IX

(Pl. 3, fig. 9)

Material. A single imperfectly preserved cephalon, CPC 14990A, with length 3.3 mm.

Occurrence. Mount Murray, horizon 302/5, 76 m from the base of section 302.

Age. Late Cambrian, post-Idamean, immediately postdating the occurrence of *Irvingella* at Mount Murray.

Comments. The specimen represents a partially effaced, subovoid, non-deliquiate, spectaculate species. Cephalic flanks converge somewhat forwards, borders are narrow (sag.), the median preglabellar furrow is weakly impressed, and the anterior glabellar furrow is nearly completely effaced. Gross morphology suggests classification with previously described species such as *Pseudagnostus communis* (Hall & Whitfield), from which sp. IX differs in shape and degree of effacement.

Order **PTYCHOPARIIDA** Swinnerton, 1915

Suborder **PTYCHOPARIINA Swinnerton,** 1915

Superfamily **PTYCHOPARIACEA** Matthew, 1887

Family **EULOMIDAE** Kobayashi, 1955

Subfamily **EULOMINAE** Kobayashi, 1955

Genus **Stigmatoa** Öpik, 1963

Type species. Stigmatoa diloma Öpik (1963, pp. 89-90, pl. 4, fig. 2, text-figs. 31, 32), late Cambrian, *Erixanium sentum* Zone; Georgina Limestone, Pomegranate Limestone, Glenormiston and Duchess areas, western Queensland; by original designation (Öpik, 1963, p. 87).

Other species. Other species are listed by Shergold (*in* Shergold, Cooper & others, 1976). To these should be added *Stigmatoa reticulata* Romanenko (*in* Zhuravleva & Rozova, 1977, pp. 179-180, pl. 24, figs. 23-25, pl. figs. 1-3), late Cambrian, Gorinya Altai, South Siberian Platform; and *Stigmatoa plana* Romanenko (loc. cit., pp. 180-181, pl. 25, figs. 4-7), from the same locality.

Comments. Öpik has diagnosed *Stigmatoa* (1963, pp. 87-89) and compared it to *Euloma* and *Annamitella*. Henderson (1976, pp. 352-353) has also given a generic diagnosis, but the pygidial characteristics quoted are based on olenacean pygidia (Henderson, 1976, pl. 51, figs. 7, 9) rather than the more eulomatoid one on which Öpik based his diagnosis (Öpik, 1963, p. 88, text-fig. 32). Henderson considered that that pygidium was wrongly assigned by Öpik to *Stigmatoa*. However, the pygidia he assigns are more like those referred here to *Eugonocare*.

Stigmatoa diloma Öpik, 1963

(Pl. 7, fig. 1)

Synonymy

1963 *Stigmatoa diloma* sp. nov.; Öpik, 1963, pp. 89-90, pl. 4, fig. 2, text-figs. 31, 32 (CPC 4276).

1971 *Stigmatoa diloma* Öpik, 1967; Hill & others, 1971, p. Cm 14, pl. Cm VII, fig. 1 (CPC 4276), Öpik's specimen refigured.

1976 *Stigmatoa diloma* Öpik, 1963; Henderson, 1976, p. 353, pl. 51, figs. 5, 6, *non* fig. 7 (JCF 8349, 8348, 8328 respectively).

Types. The holotype cranidium is CPC 4276; the paratype pygidium (Öpik, text-fig. 32) is untraced; CPC 4301, 4306, although unfigured, were used in part for the original descriptions. Henderson's hypotypes are cited above in the synonymy.

Material. A single cranidium, CPC 15148, having a length (sag.) of 5.6 mm, is illustrated.

Occurrence. Mount Murray, horizon 231.

Age. Late Cambrian, Idamean, *Stigmatoa diloma* Assemblage-Zone.

Comments. Both Öpik (1963) and Henderson (1976) have described *Stigmatoa diloma*. The cranidium illustrated in Plate 7, fig. 1 is so closely similar to the holotype and specimen JCF 8349 (Henderson, 1976, pl. 5, fig. 5) that further descriptive comment is unwarranted. As at Glenormiston, *S. diloma* occurs earlier than *S. sidonia*.

Stigmatoa sidonia Öpik, 1963

(Pl. 7, figs. 2, 3)

Synonymy

1963 *Stigmatoa sidonia* sp. nov.; Öpik, 1963, pp. 91-92, pl. 4, fig. 1, text-fig. 34 (CPC 4275).

1976 *Stigmatoa sidonia* Öpik, 1963; Henderson, 1976, pp. 353-354, pl. 51, figs. 15, 16 (JCF 8391, 8390).

Types. Holotype, CPC 4275 (Öpik, loc. cit.); hypotypes, JCF 8390-1 (Henderson, loc. cit.).

Material. Two silicified cranidia, CPC 15149, 15150, with estimated lengths of 5.3 and 7.7 mm respectively.

Occurrence. Mount Murray, horizon 302/2, 34 m above the base of section 302; and 233, which is equivalent to 302/2 and 301/10.

Age. Late Cambrian, post-Idamean, *Irvingella tropica* Assemblage-Zone.

Comments. The specimens, although silicified, appear to have longer (exsag.) palpebral lobes and more anteriorly rounded glabellae than *Stigmatoa diloma.* The preglabellar field is shorter (sag.), and the anterior cranidial border is wider (sag.) than in *S. diloma.* In the last characteristic the Mount Murray specimens differ from the holotype in which this border is narrow (sag.). Specimens from Glenormiston described by Henderson have similar preglabellar areas.

Silification has obliterated surface detail so that no comparison of prosopon can be offered.

Stigmatoa? sp. undet.

(Pl. 11, fig. 11)

Material. A single pygidium, CPC 15189A, incomplete exfoliated mould and counterpart, CPC 15189B, with estimated length (sag.) of 5 mm.

Occurrence. Mount Murray, horizon 302/9, 178 m from the base of measured section 302.

Age. Late Cambrian, post-Idamean, post-*Irvingella tropica* Assemblage-Zone.

Comments. Stigmatoa? sp. is represented by a semicircular pygidium characterised by decidedly angulate anterolateral corners and a narrow (trans.) pleural zone. A short (sag.) axis apparently consists of three segments without a post-axial ridge. The first pleural segment is confluent with the marginal furrow which differentiates a convex (tr., sag.) pleural zone from an addorsally reflected border.

In shape, segmentation, and border morphology this pygidium most closely resembles that assigned by Öpik (1963, p. 88, fig. 32) to *Stigmatoa diloma* Öpik. As the specimen at hand can be differentiated only on its anteriorly narrower (tr.) pleural zones, it is left in open nomenclature.

Ptychopariacean genus et species undetermined E

(Pl. 14, figs. 6B, 8)

Material. Only the two illustrated cranidia are known with certainty. CPC 15151 has an estimated length of 3.3 mm; and CPC 15152 a length of 1.1 mm.

Occurrence. Mount Murray, horizon 301/4, 35 m from the base of section 301; and 231 (which is equivalent to 301/4).

Age. Late Cambrian, Idamean, *Stigmatoa diloma* Assemblage-Zone.

Description. Ptychopariacean genus et species undetermined E is a nepeiform species lacking boss and bacculae, characterised by extensive falcate backward-swept posterolateral limbs, small elevated palpebral lobes, anteriorly divergent preocular facial sutures, and evenly arched anterior cranidial margin. It has a gently arcuate profile when viewed anteriorly. When observed posteriorly, the posterolateral limbs slope strongly adventrally from a distinct geniculation.

The glabella is cylindrical, anteriorly truncate, occupies approximately half the cranidial length (G is 49% Lc), and possesses lateral notches indicating the presence of three pairs of glabellar furrows. These notches deepen rearwards; there are no continuous furrows across the sagittal line on the holaspid but the associated meraspis demonstrates their continuity during early morphogenesis. The glabella is marginally widest (tr.) across the preoccipital lobes, and is slightly narrower (tr.) than the occipital ring, which is known in entirety only on the meraspid paratype.

The palpebral lobes are small, 37% of the glabellar length (G) on the holotype, anteriorly situated adjacent to the anterior lateral and frontal glabellar lobes, posteriorly equidistant from both the axial furrows and cranidial margin, and elevated (vertically) to the level of the dorsal surface of the glabella. Strong, undivided ocular ridges, widening abaxially, intersect the axial furrows opposite the anterolateral corners of the glabella.

The preocular facial sutures diverge forwards on the holaspid at 65°, and enclose a convex (sag.) preglabellar field, with wide and shallow cranidial border. In plan view the last has a gently arcuate profile. The post-ocular facial sutures enclose extensive adventrally down-sloping falcate posterolateral limbs bearing only a shallow posterior marginal furrow. The posterior margin is straight, with a narrow border which extends only as far as the geniculation. The postulated abaxial margins of the palpebral lobes and the geniculation lie on the same exsagittal line.

The glabella, fixed cheeks, and posterolateral limbs bear a coarse and random granulosity. The preglabellar field bears radiating caeca.

Comments. Genus et species undetermined E most closely resembles *Guizhoucephalina* Chien (1961, p. 120, pl. 4, figs. 1-6, pl. 5, fig. 1, text-fig. 2) from the late Cambrian Sandu Shale of Ghuizhou, China. Species of both have transversely wide preglabellar areas, well defined anterior cranidial borders, and lack a preglabellar boss.

Similarly, both genera have small, elevated, palpebral lobes distant from the glabella and apparently connected to the corners of the frontal lobe by prominent ocular ridges. *Guizhoucephalina*, however, has effaced glabellar furrows, its glabella is anteriorly rounded rather than truncate, and its posterolateral limbs are swept back into intergenal spines.

Crucicephalus Shergold (1972, p. 69) also has intergenal spines, but is readily distinguished by the possession of a boss and small, elevated palpebral lobes.

Penarosa Öpik (1970, p. 24), *Pareuloma* Rasetti (1954, pp. 583-584), and *Zacompsus* Rasetti (1945, p. 475) have similar glabellar and ocular morphology. *Pareuloma* and *Penarosa* are distinguished by their preglabellar bosses. The preglabellar area of *Zacompsus* is similar but the preocular facial sutures converge forwards whereas those of Genus E diverge. *Pareuloma* and *Zacompsus* lack intergenal spines or modification of the distal extremities of the posterolateral limbs. *Penarosa* has similar falcate posterolateral limbs, particularly *P. vittata* Öpik, (1970, pp. 29-30, pl. 10, fig. 2, pl. 15, figs. 1a, 2) and *P. zeabunda* Öpik (1970, pp. 31-33, pl. 10, figs. 3-5, pl. 11, figs. 1a-3, pl. 12, fig. 1, pl. 17, figs. 5, 6).

The familial classification of these nepeiform fragments is problematical. It is assumed that the genus is opisthoparian and that the articulation of the librigena was similar to that demonstrated (Öpik, 1963, 1967, 1970) for Nepeacea. Thus trilobites with extensively developed posterolateral limbs such as Norwoodiacea are excluded from further comment.

Classification within Nepeacea is initially suggested by the nature of the posterolateral limbs, the glabellar, and ocular morphology. Genus et species undetermined E, however, lacks the highly vaulted vertical anterior profile of Nepeacea and no preglabellar boss is evident on either meraspis or holaspis. Meraspid cranidia assigned (Öpik, 1970, pl. 17, figs. 7-9) to *Penarosa retifera*, however, lack a preglabellar boss and closely resemble those of Genus E, differing only in their more pointed posterolateral limbs.

Since Genus et species undetermined E closely resembles *Guizhoucephalina* Chien, which has previously been classified with Ptychopariacea, and the nature of the preglabella area is ptychopariacean, a classification within this superfamily is suggested.

Superfamily **OLENACEA** Burmeister, 1843

Family **ELVINIIDAE** Kobayashi, 1935

Subfamily **ELVINIINAE** Kobayashi, 1935

Genus **Irvingella** Ulrich & Resser, 1924

Type species. Irvingella major Ulrich & Resser (*in* Walcott, 1924, p. 58, pl. 10, fig. 3; Walcott, 1925, p. 98, pl. 15, figs. 26-29, cotypes USNM 70238), late Cambrian; Franconia Formation, Wisconsin, USA; by original designation.

Other species. A multitude of species was recognised by Resser (1942), of which Palmer (1965, pp. 46-48) has synonymised 18 with the type species, one with *Irvingella flohri* Resser (1942, p. 24, pl. 4, figs. 12-14), and two with *I. angustilimbata* Kobayashi (1938, p. 175). The 24 species remaining in *Irvingella* are not listed here. Species recognised until 1962 are listed by Ivshin (1962, pp. 47-49), although several of these taxa were later placed in synonymy by Palmer (1965).

Species from North America have been described by Kobayashi (1938) and Palmer (1960, 1965, 1968); from the Soviet Union by Walcott & Resser (1924), Ivshin (1960a, 1962) and Tchernysheva (1968); from Sweden by Westergaard (1947); from England by Rushton (1967); from South America by Rusconi (1953, 1954); from Korea by Kobayashi (1935, 1954, 1962); from China by Lu (*in* Lu & others, 1957, 1965); and from Australia by Öpik (1963) and Henderson (1976). A possible *Irvingella* species also occurs in northern Victoria Land, Antarctica (Shergold, Cooper & others, 1976).

Comments. The concept of *Irvingella* has been discussed at length by Ivshin (1962), Palmer (1960, 1965), Öpik (1963), and Rushton (1967). Justification for the current usage of *Irvingella* rather than *Komaspis* Kobayashi, 1935 and the discontinued use of *Parairvingella* and *Irvingella* as subgenera is given by Palmer (1960, p. 73) and Öpik (1963, pp. 95, 97).

Palmer (1960, p. 73) recognised two groups of *Irvingella* species: an early one characterised by the presence of a distinct anterior cranidial border, as in *I. angustilimbata* Kobayashi, and a later one lacking such a border, as in *I. major* Ulrich & Resser. It has been subsequently reported (Palmer, 1965, p. 48) that meraspides of the latter group do in fact possess cranidial borders which are lost during subsequent morphogenesis (see also Rushton, 1967, p. 341, pl. 52, figs. 4, 5). Hence the distinction between *Irvingella* and *Parairvingella* which is based on this characteristic is reduced.

Irvingella is classified within Elviniidae (Elviniinae) Kobayashi, 1935 rather than Komaspididae Kobayashi, 1935 following Palmer (1960, 1965), a classification supported by Rushton's (1967) discovery that the rostrum and ventral sutures of *Irvingella nuneatonensis* (Sharman) are 'exactly like those of *Dunderbergia*' which is undisputedly an elviniid.

Irvingella tropica Öpik, 1963

(Pl. 7, figs. 4-7; Pl. 8, fig. 10)

Synonymy

1963 *Irvingella tropica* sp. nov.; Öpik, 1963, pp. 96-97, pl. 4, figs. 5-8; text-fig. 36 (CPC 4279, 4283).

1971 *Irvingella tropica* Öpik; Hill & others, 1971, p. Cm 16, pl. Cm VIII, fig. 4 (CPC 4279).

1976 *Irvingella tropica* Öpik; Henderson, 1976, p. 352, pl. 51, figs. 17, 18 (JCF 8388, 8389).

Types. Holotype, cranidium, CPC 4279, see Öpik (loc. cit., figs. 5-7); paratype, pygidium, CPC 4283 (loc. cit., fig. 8); hypotypes, cranidia, JCF 8388-9, see Henderson (loc. cit., figs. 17, 18).

Material. Ten silicified cranidia ranging in length (sag.) from 2.6-8.2 mm, of which four, CPC 15161-15164, are illustrated. Non-illustrated material is CPC 19240-19245.

Occurrence. Mount Murray, horizons 301/10, 301/11, 87-93 m from the base of section 301; 302/3, 302/4, 37-44 m from the base of section 302; and 233, 234 and 235, which are equivalent to the interval 87-97 m on section 301.

Age. Late Cambrian, post-Idamean, *Irvingella tropica* Assemblage-Zone.

Comments. The specimens at hand are indistinguishable from the holotype cranidium of *Irvingella tropica*, and share the following diagnostic characteristics: possession of an anterior cranidial border, anteriorly tapering glabella which bears a frontal node parietally, large fixigenae, and posterolateral limbs. Only three pairs of furrows, however, have been observed on material from Mount Murray, whereas that from the Pomegranate Limestone, at the heads of Pomegranate Creek, has four (Öpik, 1963, p. 96). As in material illustrated from the Glenormiston area by Henderson (1976, pl. 51, figs. 17, 18), there is some variation in the appearance of the preglabellar area (compare his illustrations with those in Pl. 7, figs. 4, 6 and Pl. 8, fig. 10 herein). The smallest specimen in the present paradigm (CPC 15164, Pl. 8, fig. 10), having a cranidial length of 2.6 mm, has a proportionately long (sag.), anteriorly sloping preglabellar field, and a gently convex addorsally inclined anterior cranidial border a little over one-third the length (sag.) of the preglabellar area. The last is only 7% of the cranidial length (sag.). In the largest specimen which can be adequately assessed (CPC 15162, Pl. 7, fig. 4, length 8.1 mm), the preglabellar field is a gentle concavity which rises anteriorly into a border occupying about 55% of the length (sag.) of the preglabellar area, itself about 15% of the total cranidial length (sag.). During morphogenesis, therefore, there appears to be a distinct shortening (sag.) of the preglabellar area and an increase in the dimension (sag.) of the cranidial border at the expense of the preglabellar field.

The mode of preservation of the available material allows little observation of the external prosopon. Silicified parietal surfaces on occasion show traces of a caecal network on the fixigenae (e.g. Pl. 7, fig. 4). One specimen (Pl. 7, fig. 5) also shows a node axially sited on the frontal glabellar lobe, from which a low carina runs rearwards.

Subfamily INCERTAE SEDIS

Genus **Protemnites** Whitehouse, 1939

Type species. Protemnites elegans Whitehouse (1939, p. 210, pl. 22, figs. 12a, b, UQF 3330, *non* fig. 13 = pagodiid pygidium), exact stratigraphic horizon and locality unknown, but from the Georgina Limestone, in the vicinity of 'Tyson's Bore', Glenormiston area, western Queensland; by original designation.

Other species. Prismenaspis brownensis Henderson (1976, p. 351, pl. 50, figs. 14-19), Idamean, *Stigmatoa diloma* Zone (of Henderson, op. cit.); Georgina Limestone (Glenormiston area, western Queensland (see discussion under *Chalfontia*).

Comments. The unfortunate introduction of the new genus *Prismenaspis* by Henderson (1976) has confused the concept of *Protemnites.* As discussed under the concept of *Chalfontia* below, *Prismenaspis brownensis,* the nominated type species, is a combination of pygidia similar to those previously referred to *Eugonocare propinquum* Whitehouse, and cranidia referable to *Protemnites elegans* Whitehouse. The *propinquum* pygidium is considered here to represent *Protemnites brownensis* (Henderson, 1976), which may be, but cannot be proved to be, a synonym of *Protemnites elegans* Whitehouse, 1939.

Protemnites is an elviniid genus with wide (sag.) anterior cranidial border, gently convex (sag.) or flat preglabellar field, and more strongly convex (exsag.) preocular areas; relatively short (exsag.) palpebral lobes sited forwards of the mid-length of the glabella and distant from it; broad-based posterolateral limbs. Its species are distinguished from each other by degree of convexity which affects the observed courses of the preocular facial sutures, and the position of the palpebral lobes with regard to the axial furrows. There is apparent decrease in the sagittal dimension of the preglabellar field with increase in size of the specimen. A granulose prosopon is seen in all species.

Protemnites elegans Whitehouse, 1939

(Pl. 9, fig. 1)

Synonymy

1939 *Protemnites elegans* sp. nov.; Whitehouse, 1939, p. 210, pl. 22, figs. 12a, b, *non* fig. 13 = pagodiid species.

Types. Holotype cranidium, UQF 3330, illustrated by Whitehouse (1939, pl. 22, figs. 12a, b); paratype cranidium illustrated in association has the same number.

Comments. Protemnites brownensis (Henderson) may well represent the same species of *P. elegans.* Both have a somewhat depressed preglabellar field, small palpebral lobes placed relatively close to the glabella, similar glabellae gradually tapering anteriorly, and posterolateral limbs of equivalent size and shape. It is not possible to observe the exact course of the preocular facial sutures on the holotype of *P. elegans* but there is no reason to think that they will differ greatly from those of *P. brownensis.*

The pygidium of *P. elegans* is not known. That of *brownensis* is known, so it is considered proper at this stage to regard the specimens as representing distinct taxa.

Protemnites burkensis sp. nov.

(Pl. 9, figs. 3-7)

Synonymy

1976 *Prismenaspis brownensis* gen. et sp. nov., Henderson, 1976, p. 351, pl. 50, fig. 18, JCF 8345, *non* figs. 14-17, 19 [= *Protemnites brownensis* (Henderson)].

Name. L., *burkensis,* derived from the Burke River.

Types. Holotype, cranidium, CPC 15171; paratypes, cranidia, CPC 15172, 3.

Material. Three cranidia, ranging in length between 12.7-18.1 mm.

Occurrence. Mount Murray, horizons 234. 235.

Age. Late Cambrian, post-Idamean, *Irvingella tropica* Assemblage-Zone.

Diagnosis. A species of *Protemnites* with more convex (sag.) preglabellar field and preocular areas, and palpebral lobes spaced at some distance from the axial furrows.

Description. Protemnites burkensis has a moderately high degree of convexity (sag.) when viewed in lateral profile: the preglabellar field lies in a plane lying at more than 60° to horizontal. In anterior view, the species possesses a low non-vaulted profile.

The glabella, occupying 59-61% of the cranidial length (G:Lc), is cylindrical, tapers only slightly forwards, and is strongly rounded anteriorly. Its furrows are effaced on the exoskeleton, and only faintly visible on exfoliated specimens. Three pairs of backward curved, sagittally discontinuous furrows are preserved on CPC 15172 (Pl. 9, fig. 6). The occipital ring, which is sagittally narrow, has the same transverse width as the preoccipital glabellar lobes. It lacks an occipital node.

The preglabellar area is bounded by preocular facial sutures which run direct from the anterior ends of the palpebral lobes to the anterolateral cranidial margin. It comprises a gently convex (sag.), anteriorly strongly sloping preglabellar field, 40-50% of the length (sag.) of the preglabellar area; and a gently convex (sag.) anterior cranidial border which lies, in profile, considerably lower than the frontal glabellar lobe. Preocular areas slope strongly anteriorly, lying in a near-vertical plane. The differential convexities between the preglabellar field and preocular areas impart a boss-like appearance to the former. A fairly well delineated anterior cranidial marginal furrow is present on either side of the 'boss'.

The palpebral lobes are arcuate, short, 38-39% of the glabellar length (exsag.), and situated forwards of the mid-point of the glabella. They are spaced from the axial furrows a distance equivalent to their exsagittal length. Anteriorly, the palpebral lobes pass into long (tr.), narrow (sag.) ocular ridges, faintly visible mainly on parietal surfaces. The postocular facial sutures enclose broad-based, short (exsag.) posterolateral limbs.

The external prosopon is bigranulose.

Protemnites sp. undet.

(Pl. 9, figs. 8, 9)

Material. Mould and counterpart of a single cranidium, CPC 15174A, which has an estimated length (sag.) of 6.15 mm.

Occurrence. Mount Murray, horizon 301/4, 35 m from the base of the measured section.

Age. Late Cambrian, Idamean, *Stigmatoa diloma* Assemblage-Zone.

Comments. The illustrated specimen resembles the holotype of *Protemnites elegans* Whitehouse in the shape of its glabella and posterolateral limbs, and the size and position of its palpebral lobes. The ocular ridges are similarly orientated and the preglabellar field of similar dimension (sag.); its lateral extent cannot be compared. *Protemnites* sp. appears to have a smooth exoskeleton; *P. elegans,* known as a pareital surface, is coarsely granulose, as in *P. burkensis* sp. nov.

Eurostina trigona Whitehouse (1939, p. 209, pl. 22, figs. 11a-b) (see here Pl. 9, fig. 2) has a similarly convex preglabellar field. Its preocular areas, however, are not completely preserved on the holotype (UQF 3332), which is an external mould. They appear to have sloped off anterolaterally with a slightly stronger convexity than that of the preglabellar field. *E. trigona* has a more bluntly rounded glabella than *Protemnites* sp., but its ocular characteristics are comparable (cf. Pl. 9, figs. 1 and 2).

Elviniid genus et species undetermined D

(Pl. 8, fig. 9)

Material. A single well preserved cranidium, CPC 15191, measuring 10.8 mm, and two further fragments (unnumbered).

Occurrence. Mount Murray, horizons 302/3, 302/5 and 302/6, between 37 and 105 m from the base of measured section 302.

Age. Late Cambrian, post-Idamean, *Irvingella tropica* Assemblage-Zone, and post-*Irvingella tropica* assemblage.

Description. The single complete cranidium has an anteriorly tapering and rounded glabella with length some 60% of the total cranidial length. Only the preoccipital furrows which are slightly sigmoidal and directed obliquely rearwards, are not totally effaced. The occipital ring is wider (tr.) than the preoccipital lobes, but is sagittally narrow, and bears a prominent median spinule which in lateral profile curves upwards and rearwards above the general surface of the glabella.

Palpebral lobes are of moderate length, 46% of the glabellar length (G), sited about the mid-length of the glabella, close to the axial furrows. Palpebral furrows are prominent, but ocular ridges are faint.

The preocular facial sutures diverge forwards at 70°, and enclose a preglabellar area comprising a flat, moderately sloping preglabellar field and a gently convex, prominent anterior cranidial border; the anterior cranidial marginal furrow is a shallow depression. Postocular facial sutures enclose narrow (exsag.) triangular posterolateral limbs.

Surface prosopon consists of large randomly orientated granules, many of which are perforated.

Comments. Genus et species undet. D appears most similar to the species which Kobayashi (1938, 183, pl. 15, fig. 32, GSC 11962) assigned to *Dunderbergia (Megadunderbergia) quadrata,* subsequently refigured by Palmer (1960, pl. 4, fig. 27) as *Dunderbergia quadrata,* from British Columbia. Similar glabellar furrows, similar ocular characteristics, and similar prosopon ally these species. The Australian material, however, has a narrower (tr.) preglabellar area and somewhat wider (sag.)

border, and its occipital ring bears a short spine, the like of which has not been described for any North American elviniid.

Some similarity is also noted with *Karagandoides seletanus* Ivshin (1962, pp. 127-129, pl. 7, fig. 18), Kuyanda Stage, Seletin horizon, central Kazakhstan. As both Australian and Russian specimens are somewhat distorted, adequate comparison cannot be made; the Russian specimen appears, however, to lack the occipital spine, and may have a shorter (sag.) preglabellar field.

Family **PTEROCEPHALIIDAE** Kobayashi, 1935

Subfamily **APHELASPIDINAE** Palmer, 1960

Comments. The concept of Aphelaspindinae used here is that originally proposed by Palmer (1960, pp. 80-81) and later modified by him (Palmer, 1962, p. 32). Subfamilial diagnosis and discussion is given in those papers. Aphelaspidinae are the most morphologically simple representatives of the Family Pterocephaliidae, with basic morphology closer to the Oleninae (Olenidae) than to other subfamilies within the Superfamily Olenacea as envisaged herein.

In North America, the subfamily includes such genera as *Aphelaspis, Labiostria, Litocephalus, Dicanthopyge, Taenora,* and *Olenaspella. Eugonocare,* an Australian representative of this subfamily, is found also on the northwest Siberian Platform (Chopko River), where it has been called *Aphelaspis? buttsi* (Kobayashi) by Rozova (1977, p. 55, pl. 1, figs. 1-4); and in eastern Ghuizhou *(Eugonocare?* sp. of Lu, 1956b, p. 376, pl. 1, figs. 3-4; *in* Lu & others, 1965, p. 172, pl. 29, figs. 1-2). Possibly, a whole range of genera described from the Siberian Platform is derived from a basic aphelaspidinid morphology: *Maduiya, Pedinocephalites, Amorphella, Kuraspis, Ketnya, Kaninia, Kujandaspis* and probably others.

Genus **Aphelaspis** Resser, 1935

[*Aphelaspis* Resser, 1935, p. 11; = *Proaulocopleura* Kobayashi, 1963, p. 93; Howell, 1959, p. 269; = *Clevelandella* Resser, 1938, p. 68; = *Labiostria* Palmer, 1954, p. 750; Lochman, 1959, p. 258; see Palmer, 1962, p. 33.]

Type species. Aphelaspis walcotti Resser (1938, p. 59, pl. 13, fig. 14), late Cambrian, Nolichucky Formation, Virginia, USA, designated Palmer (1953, p. 157). For synonymy see Palmer (1953).

Other species. As defined by Palmer (1962, p. 33), *Aphelaspis* includes ten described American species. Species from Kazakhstan are also attributed to this genus by Ivshin (1956), namely *Aphelaspis nobilis* Ivshin (1956, pp. 33-36, pl. 3, figs. 1-6, 7-12, 13, 27; pl. 4, figs. 16, 17), *A. boshchekulensis* Ivshin (1956, pp. 36-39, pl. 4, figs. 1-11), and *A. formosus* Ivshin (1956, pp. 39-41, pl. 4, figs. 12, 13). Of these, only *A. nobilis* appears to have morphological affinity with any American species. Kuo (*in* Jegorova & others, 1963, pp. 59-60, pl. 14, figs. 7-11) has described *Aphelaspis granulata* from Ghuizhou which in general morphology resembles *A. australis* Henderson (1976, pp. 342-343, pl. 49, figs. 5-7) from Henderson's *Glyptagnostus reticulatus* and *Proceratopyge cryptica* Zones in the Glenormiston area, western Queensland, and aphelaspidinid fragments from northern Victoria Land, Antarctica (see Shergold, Cooper & others, 1976, pp. 274-276, pl. 42, fig. 6). *Aphelaspis* sp. B (Öpik, 1963, p. 76, pl. 4, figs. 14, 15), from the *Irvingella tropica* Assemblage-Zone at Pomegranate Creek in the Burke River Structural Belt, may be younger than any other species assigned to *Aphelaspis,* and may not be congeneric.

Distribution. As indicated by Henderson (1976, p. 357, Table 2) the range of *Aphelaspis* species in North America largely coincides with that of *Glyptagnostus reticulatus* sensu lato. In China, species assigned to *Aphelaspis* also appear to be associated with *G. reticulatus* and *Peratagnostus,* and similarly in Australia where, with the exception of *Aphelaspis* sp. B noted above, *Aphelaspis* occurs in the *G. reticulatus* and immediately succeeding assemblage.

Aphelaspis sp. undet.

(Pl. 17, figs. 5, 6)

Material. Two cranidia, CPC 19265 (fig. 5) and 19266 (fig. 6), measuring 3.75 and 6.6 mm respectively.

Occurrence. Locality D473, west side of Mistake Creek, 300 m south of the junction of Mistake and Gin Creeks, eastern Burke River Structural Belt.

Age. Late Cambrian, Idamean, *Glyptagnostus reticulatus* Assemblage-Zone.

Comments. This taxon is represented by aphelaspidinid cranidia having a short (52-54% of cephalic length), anteriorly truncate glabella similar to *Eugonocare whitehousei* Henderson.

Olenaspella separata Palmer (1962, p. 39, pl. 5, figs. 6, 8-21, 23-26, 28, 30-32), and species of *Aphelaspis* such as *A. haguei* (Hall et Whitfield) sensu Palmer (1965, p. 59, pl. 9, figs. 19-26). Two pairs of glabellar furrows are defined, and a third, anterior pair, is very faint. This style of the furrowing is more strongly developed than normal in North American species of *Aphelaspis*, being more similar in definition and orientation once more to *Eugonocare* and *Olenaspella*.

Aphelaspis sp. has a relatively narrow (tr.) preglabellar area, with a width less than the total cranidial length, narrower (tr.) than that of *Eugonocare tessellatum*, in which it is always wider than the cranidial length. In the sagittal dimension, the preglabellar area of *Aphelaspis* sp. is a little over one-third of the cranidial length. The anterior cranidial border, 12-13% of the cranidial length (sag.), is flat-lying in lateral profile. The morphology of the preglabellar area resembles closely that of *Eugonocare* and previously described American species of *Aphelaspis*, particularly such forms as *A. longispina* Palmer (1965, p. 60, pl. 9, fig. 13), *A. subditus* Palmer (1962, p. 35, pl. 4, figs. 20, 22) and *A. buttsi* (Kobayashi) (see Palmer, 1962, p. 35, pl. 4, fig. 23; 1965, p. 59, pl. 8, fig. 14). It is also similar to *Dicanthopyge* (see Palmer, 1965, p. 62, pl. 9, figs. 1-3).

In *Aphelaspis* sp. the ocular ridges have variable definition: they appear to be short (tr.), duplicated, and to pass distally into rather long, arcuate palpebral lobes, set closer towards the glabella than in, say, *Eugonocare*, but similar to the position observed in American *Aphelaspis* and *Dicanthopyge* spp. The posterolateral limbs appear to be short (tr.) and triangular, but are not fully preserved on the material available.

Overall the convexity of *Aphelaspis* sp. cranidia is low, both sagittally and transversely. The exoskeleton (Pl. 17, fig. 6) is smooth: no manifestation of the caecal system is apparent in the two specimens at hand.

Genus **Eugonocare** Whitehouse, 1939

Type species. Eugonocare tessellatum Whitehouse (1939, p. 226, pl. 23, figs. 15, 17, *non* figs. 16, 18, pl. 25, fig. 7b (fide Henderson, 1976)), late Cambrian, Idamean; Georgina Limestone, Glenormiston, western Queensland.

Other species. Eugonocare sp. indet. Whitehouse (1939, p. 227), from the Glenormiston area, has been noted but not figured. *Eu.* cf. *tessellatum* has been recorded (Öpik, 1967, p. 203, pl. 8, fig. 2) from the O'Hara Shale, Selwyn Range, Duchess area. *Eu. whitehousei* Henderson (1976, p. 346, pl. 49, figs. 15-19) and *Eu. quadratum* Henderson (op. cit., p. 346, pl. 49, figs. 8-14) have recently been described from the Georgina Limestone of the Glenormiston area. A species of *Eugonocare* has also been reported (Thomas & Singleton, 1956, p. 158) from the Dolodrook Limestone of central Victoria. *Eugonocare(?)* sp. occurs in eastern Ghuizhou, China (Lu, 1956b, p. 376, pl. 1, figs. 3-4; *in* Lu & others, 1965, p. 172, pl. 29, figs. 1, 2); and is described, under the name *Aphelaspis? buttsi* (Kobayashi), from the northwestern Siberian Platform, Chopko River section, by Rozova (1977, p. 55, pl. 1, figs. 1-4).

Comments. The classificatory position of *Eugonocare* has been commented upon by Palmer (1962) and Öpik (1963, p. 75; 1967, pp. 202-3), both of whom have noted probable synonymy and the similarity of Aphelaspidinae to Olenidae. Henderson (1976) has revised the type material of *Eugonocare* and provided a new diagnosis.

The holotype pygidium of *Eugonocare propinquum* Whitehouse, which formed the basis of *Prismenaspis* Henderson (1976), is now referred to *Protemnites* Whitehouse (1939) (see discussion on p. 34).

Eugonocare tessellatum Whitehouse, 1939

(Pl. 10, figs. 1-8)

Synonymy

1939 *Eugonocare tessellatum* sp. nov., Whitehouse (1939, p. 226, pl. 23, figs. 15, 17, *non* figs. 16, 18, pl. 25, fig. 7b (UQF 3369a, 3366, 3369a respectively)).

1939 *Eugonocare propinquum* sp. nov.; Whitehouse (1939, p. 227, pl. 23, fig. 20 (untraced), *non* fig. 19 (UQF 3392) = *Protemnites propinquum*).

1976 *Eugonocare tessellatum* Whitehouse; Henderson (1976, pp. 344-346, pl. 50, figs. 1-5 (JCF 8259, 8317, 8260, 8350 respectively)).

Types. Holotype, cranidium, UQF 3369a, mould and counterpart figured by Whitehouse (1939, pl. 23, fig. 15, pl. 25, fig. 7b); paratype pygidium, UQF 3366 (op. cit., pl. 23, fig. 17).

Material. Hypotype material consists of 19 cranidia, three thoraces and seven pygidia. Cranidia vary in length between 3.0 and 11.9 mm, and pygidia between 0.9 and 5.3 mm (Lp_1). No fully articulated specimens are known. Specimens CPC 15153-15160 are illustrated in Plate 10; CPC 19246-19260 are not figured.

Occurrence. Mount Murray, horizons 301/1, 301/2, 301/3, 301/4, and 301/5, between 3 and 37.5 m from the base of section 301; and at 229, 230, 231, and 234 (= 301/11, 93 m from the base of section 301).

Age. Late Cambrian, Idamean, *Stigmatoa diloma* Assemblage-Zone; post-Idamean, *Irvingella tropica* Assemblage-Zone.

Comment. Eugonocare tessellatum has been fully described by Whitehouse (1939) and Henderson (1976). Species of *Eugonocare* have almost indistinguishable cranidia, and are recognised (according to Henderson) on pygidial characteristics. The combination of parts illustrated in Plate 10 most closely resembles that which Henderson (op. cit., pl. 4) refers to *Eu. tessellatum.*

Cranidia from Mount Murray are characterised by wide (sag.) anterior cranidial borders; preglabellar areas slightly less wide (tr.) than the maximum palpebral width (tr.); a rectangular glabella, with three pairs of glabellar furrows varyingly impressed, the preoccipital ones of which may be transversely continuous across the sagittal line; transverse straight or rearwards sloping ocular ridges; palpebral lobes which are arcuate, occupy 42-66% of the glabellar length (G) and become shorter with increase in cranidial length; and long (tr.), very narrow (exsag.), spine-like posterolateral limbs.

Associated thoracic segments (Pl. 10, fig. 2) have similar terminations to the posterolateral limbs of the cranidium. Their articulating facets comprise the entire distal extremity of the pleurae. Thoracic geniculations are weak and sited in line (exsag.) with the palpebral furrows of the cranidium.

Pygidia are semicircular, Lp_1 is 45-57% of the maximum width (tr.), and characterised by strong pleural furrows (four, possibly five pairs), and strong interpleural furrows separating the first and second pleural segments. The axis is composed of four distinct segments, and a fifth is occasionally visible but mostly is fused to the terminal piece, and reaches close to the posterior margin of the pygidium, which is gently indented. Anterolaterally, articulating facets are broad (exsag.). Little is known of pygidial morphogenesis: a transitory pygidium with four unliberated segments, illustrated in Plate 10, fig. 5, can be only tentatively assigned to *Eu. tessellatum.*

Eugonocare whitehousei Henderson, 1976
(Pl. 17, figs. 1-4)

Synonymy

1976 *Eugonocare whitehousei* sp. nov.; Henderson, 1976, p. 346, pl. 49, figs. 15-19.

Types. Holotype (JCF 8159), pygidium, Henderson, op. cit., pl. 49, figs. 18; paratypes, JCF 8154, 8155, 8158, 8160, 8161, 8168, 8175, 8262, 9266, 8270.

Material. The present sample consists of two cranidia, with lengths (Lc) of 4.6 (CPC 19264) and 5.0 mm (CPC 19261), and two pygidia, with lengths (Lp_1) of 1.9 (CPC 19263B) and 3.7 mm (CPC 19262A, B).

Occurrence. Localities D501 and D502, on the west bank of the Mort River 8 km south of the junction of Mistake and Gin Creeks. Locality 501 is 2.70 m, and 502 is 3.00 m from the base of a short section measured there.

Age. Late Cambrian, Idamean, latest *Glyptagnostus reticulatus* Assemblage-Zone.

Comments. As Henderson (1976, p. 346) indicates, cranidia of *Eugonocare whitehousei* are not readily distinguished from those of *Eu. tessellatum.* Holaspid pygidia, however, are considerably more elongate in a sagittal direction. They also have an indentation in the posterior outline of the shield, and more axial segments, up to six clearly defined (Pl. 17, fig. 2). As Henderson indicates, the pleural furrows merge distally into the marginal furrow.

Subfamily INCERTAE SEDIS

Genus **Mecophrys** gen, nov.

Name. Gk, *mekos,* length; *ophrys,* eyebrow; referring to the long palpebral lobes.

Type species. Here designated, *Mecophrys mecophrys* gen. et sp. nov. (Pl. 11, figs. 4-10), late Cambrian, post-*Irvingella tropica* Assemblage-Zone; Mount Murray, Burke River Structural Belt, western Queensland.

Other species. Mecophrys selenis sp. nov. is described below. It is possible that the cranidium from the *Chuangia* Zone of Saimaki, north China, figured by Schrank (1974, pl. 5, fig. 8) as Asaphiscidae(?) gen. et sp. indet., represents a third species of *Mecophrys.* The cranidium from Ghuizhou illustrated by Yin (1978, pl. 166, fig. 2) as *Paranomocare elongata* Lee & Yin, which has superficial resemblance to *Mecophrys,* may represent a species of *Parachangshania* Chien, 1959.

Diagnosis. Mecophrys gen. nov. has an interesting combination of pterocephaliid and changshaniid cephalic characteristics. It has an anteriorly rounded, proportionately short (sag.) aphelaspidine glabella and pterocephaline or aphelaspidine preglabellar morphology combined with long (exsag.) changshaniid-like palpebral lobes and a broad, flat and narrow-bordered librigena.

Differential diagnosis. The shape of the glabella, anteriorly tapered and rounded; the mostly effaced glabellar furrows; and the presence of an occipital node, are characteristics of Aphelaspidinae as recognised by Palmer (1960, 1962, 1965). The preglabellar area, which is composed of a flat to gently convex (sag.) preglabellar field, shallow anterior cranidial marginal furrow, and gently reflected anterior cranidial border, also closely resembles that of Aphelaspidinae. In glabellar and preglabellar morphology, particularly the somewhat angular anterior cranidial contour and the courses or the preocular facial sutures, *Mecophrys mecophrys* is reminiscent of *Aphelaspis longispina* Palmer (1965, p. 60, pl. 9, fig. 13), *Aphelaspis* sp. indet. Palmer (1962, p. 36, pl. 4, fig. 27) and *Dicanthopyge convergens* Palmer (1965, p. 62, pl. 9, fig. 1).

In general *Mecophrys* may be distinguished from Aphelaspidinae, as construed by Palmer, but its large palpebral lobes, which extend from a point close to the anterolateral corners of the glabella to near the occipital furrow, and are situated close to the axial furrows. Ocular ridges, which continue the palpebral lobes anteriorly, are very short and intersect the axial furrows obliquely. This palpebral morphology is reminiscent of the damesellacean family Changshaniidae Kobayashi, 1935, as construed by Lu & others (1965), and Anomocaridae, as conceived by Poulsen (*in* Moore, 1959, p. 0286 et seq.). *Parachangshania* Chien, 1959 and *Westergaardella* Kobayashi, 1962 among Changshaniidae, are particularly similar, both in palpebral and librigenal morphology, but are differentiated by their proportionately longer (sag.), generally straight-sided and anteriorly truncate glabellae and wider (tr.) occipital rings. Anomocarids, however, generally have quite different glabellar and preglabellar morphology. *Schoriella* Sivov, 1955 (= *Schoriecare* Rozova, 1964), classified by Lazarenko (*in* Lazarenko & Nikiforov, 1968, p. 35) as Anomocaridae, differs mainly by degree of transverse extension of the preglabellar area and possession of defined glabellar furrows. *Maspakites* Lazarenko, 1966 has similar glabellar and palpebral morphology to *Mecophrys*, but has a more prominent occipital ring, and apparently a plicate (sag.) anterior cranidial border.

Pterocephalia constricta Palmer (1968, p. 72, pl. 8, figs. 7, 8) has similarly long and situated palpebral lobes, and similarly constituted preglabellar area. This species, however, has a strongly furrowed subquadrate glabella quite unlike that of Australian material, and its anterior cranidial border is poorly defined.

The pygidium assigned to *Mecophrys* has obtusely rounded anterolateral corners and is presumed to have an entire posterior margin. It closely resembles in shape and segmentation some dokimocephalid and pterocephaliid pygidia described by Palmer (1965), and is distinct from elviniid-type pygidia which have a subtrapezoidal shape, with posteriorly convergent sides, e.g. *Irvingella.*

Mecophrys mecophrys sp. nov.

(Pl. 11, figs. 4-10)

Name. See under derivation of generic name.

Types. Holotype, CPC 15177, an exfoliated cranidium (Pl. 11, figs. 6, 7); figured paratypes, CPC 15178-15181; non-figured paratypes are CPC 19267-19276.

Material. Six cranidia ranging in estimated length (sag.) between 2.6 and 6.7 mm; six librigenae; and three pygidial fragments.

Occurrence. Mount Murray, horizons 302/7, 302/9, between 154 and 178 m from the base of measured section 302; and 237, equivalent to 302/7 at 154 m from the base of the same section.

Age. Late Cambrian, post-Idamean, *Irvingella tropica* Assemblage-Zone and post-*Irvingella tropica* assemblage.

Diagnosis. Mecophrys species with long (exsag.) arcuate palpebral lobes extending rearwards to the level of the occipital furrow, anteriorly confluent with short ocular ridges; and prominent palpebral furrows which intersect the axial furrows.

Differential diagnosis. See this section under heading *Mecophrys selenis* sp. nov.

Description. The anterior cranidial contour is angulate, slightly pointed anteriorly. The glabella tapers forwards, is evenly rounded anteriorly, lacks furrows apart from a very faint indication of the preoccipital ones, and occupies (G:Lc) 55-61% of the total cranidial length. The glabellar sides bulge slightly outwards at the preoccipital lobes.

The occipital ring is as wide (tr.) as the preoccipital glabellar lobes, and in lateral profile barely rises to the level of the dorsal surace of the glabella. It bears a faint median node.

The palpebral lobes are arcuate, wide (tr.), and long (exsag.), occupying 63-75% of the glabellar length (G) and extending from a point nearly opposite the anterolateral corners of the glabella to its posterior edge; posteriorly they lie close to the axial furrows and enclose semicircular palpebral areas delineated by strong palpebral furrows which contact the axial furrows anteriorly. The palpebral lobes appear to pass into similarly wide (tr.) ocular ridges which intersect the axial furrows at the anterolateral corners of the glabella at angles of approximately 60 degrees. These ocular ridges cross the axial furrows and pass into a very narrow (exsag.) parafrontal band just visible at the anterolateral edges of the glabella (Pl. 11, fig. 4). This same specimen also shows a diverticulum passing across the axial furrows from the frontal tip of the palpebral areas. Between this diverticulum and the ocular ridge/parafrontal band the palpebral furrow meets the axial furrow and forms a shallow pit. A pair of deeper pits lie in the preglabellar furrow adjacent to the anterolateral glabellar margins. Between these, a shallow platform occupies the floor of the middle portion of the preglabellar furrows, and, although not well preserved on the illustrated specimens, caeca pass from the parafrontal band to the preglabellar field at this point.

The preocular facial sutures diverge forwards at angles of 60-80 degrees, and enclose a flat or gently convex (sag.) preglabellar field which merges anteriorly into a clearly defined anterior cranidial marginal furrow. The anterior cranidial border has an an angulate leading edge and is consequently widest on the sagittal line. Parietal surfaces (e.g. Pl. 11, figs. 4, 5) show a faint caecal network on the preglabellar field, with individual caeca terminating at the marginal furrow. An incipient boss or plectrum is present on all but the smallest cranidia. On the exfoliated material, this appears to be connected with a diverticulum lying below, or adjacent to, the marginal furrow and another running below the cranidial border.

Six preserved librigenae have rather flat genal fields, well developed lateral and posterior marginal furrows meeting at the base of the genal spine, and lateral borders of even width from spine base to anterior tip. The posterior marginal furrow is slightly sinuous and does not cut the postocular facial suture. The genal spine is long and not advanced. On the illustrated specimen (Pl. 11, fig. 9) the base of the visual sufrace overlies the subocular groove without the intervention of an eye socle (Shaw & Ormiston, 1964, p. 1002). All exfoliated specimens show faint caeca which radiate across the genal field from the vicinity of the subocular groove and can be seen in the floor of the lateral marginal furrow. A principal caecal vein (Öpik, 1967, p. 60) is not identified.

The available pygidial fragments, only tentatively assigned to this species by common association, have a vague semicircular shape (Pl. 11, fig. 10) with obtusely rounded anterolateral corners. Three axial fragments and two pleural ones are defined.

Mecophrys selenis sp. nov.

(Pl. 11, figs. 1-3)

Name. Gk, *selenis*, f., referring to the crescentic palpebral lobes.

Types. Holotype, CPC 15175A, an imperfectly preserved cranidium with counterpart, CPC 15175B, Pl. 11, figs. 1, 2; illustrated paratype CPC 15176B.

Material. Only a single cranidium, with length of 7.6 mm, and a single librigena can be definitely assigned to this species.

Occurrence. Mount Murray, horizons 302/6, 105 m from the base of section 302, and 234 and 236. The latter is equivalent to 302/6, and the former lies approximately 37 m above the base of section 302.

Age. Late Cambrian, post-Idamean, *Irvingella tropica* Assemblage-Zone, and post-*Irvingella tropica* assemblage.

Diagnosis. Mecophrys species with gently arched palpebral lobes posteriorly extending as far as the middle of the preoccipital glabellar lobes.

Differential diagnosis. As *Mecophrys selenis* is so similar to *M. mecophrys* this differential diagnosis serves also as a description. *M. mecophrys* and *M. selenis* differ principally on the shape and length of their palpebral lobes. Those of *mecophrys* are strongly arcuate and almost semicircular, whereas *selenis* has gently arcuate lobes. By virtue of its shorter palpebral lobes, extending posteriorly only as far as the middle of the preoccipital glabellar lobes, *M. selenis* has short (tr.), blade-like, triangular posterolateral limbs. It has also perhaps a shallower and less well demarcated anterior cranidial marginal furrow, and decidedly shallower marginal librigenal furrows. The cranidium figured by Schrank (1974, pl. 5, fig. 8) as Asaphicidae(?) gen. et sp. indet. appears to belong to *Mecophrys*. It has the smaller palpebral lobes typical of *M. selenis* combined with the more definite marginal furrowing of *M. mecophrys*.

Pterocephaliid genus et species undetermined A
(Pl. 12, fig. 9)

Material. A single cranidial fragment, CPC 15182A, with counterpart, having an estimated length of 8 mm.

Occurrence. Mount Murray, horizons 302/5, 76 m from the base of section 302; and 236, the same horizon on an unmeasured section.

Age. Late Cambrian, post-Idamean, post-*Irvingella tropica* Assemblage-Zone.

Description. The glabella is narrow (tr.), anteriorly strongly tapered, and rounded, and bears traces of three pairs of furrows. Preoccipital and median lateral glabellar furrows are short, abaxially deeply incised, open into the axial furrows, are adaxially rearwards directed, fade rapidly, and are discontinuous across the sagittal line. The anterior lateral furrows are very faint and transverse.

The occipital ring is wide (tr.) and forms a pedestal for the anteriorly tapering glabella, from which it is divided by a prominent occipital furrow.

The preglabellar area of this species is rectangular, its width (tr.) being a little over twice the length (sag.), and is composed of an anteriorly steeply sloping preglabellar field and a flat (sag.) anterior cranidial border which lies in the same horizontal plane as the dorsal surface of the glabella when viewed in profile; the marginal furrow is a shallow break in slope at the junction of the preglabellar field and border. The preocular sections of the facial suture run directly forwards; post-ocular ones apparently enclose long (tr.) triangular posterolateral limbs.

Palpebral lobes are wide (tr.), strongly arcuate—almost semicircles, differentiated from steeply inclined palpebral areas by strongly incised palpebral furrows. These palpebral lobes are sited close to the axial furrows, between the preoccipital glabellar furrows and the anterolateral corners of the glabella. There is thus a considerable amount of postocular fixigena. Anteriorly there is no ocular ridge as such, but a single narrow diverticulum cuts adaxially from the front edge of the palpebral lobe to the anterolateral corner of the glabella, where it merges with a well defined parafrontal band. Several caeca pass from this band into the preglabellar field, crossing the preglabellar furrow in between a pair of distinct pits sited at the corners of the glabella.

Genus et species undetermined A has a dense granulation which in places, on the frontal glabellar lobe and palpebral area, has a tendency to fuse into a Bertillon pattern.

Comment. Genus et species undetermined A most closely resembles the cranidium which Palmer (1960, pl. 10, fig. 4; 1965, pl. 15, fig. 2; USNM 136900a) has referred previously to *Sigmocheilus pogonipensis*. This species, from the *Dunderbergia* Zone of the Eureka district, Nevada, has a slightly wider (tr.) preglabellar area and glabella, and its glabellar furrows are more deeply incised. Its palpebral lobes are perhaps a little shorter (exsag.), and it possesses ocular ridges which are as wide as the palpebral lobes and are anterior continuations of them.

While glabellar form resembles certain *Blackwelderia* species, e.g. *B. paronai* (Airaghi), the structure of the preglabellar area and the size and position of the palpebral lobes prohibit classification with Damesellacea. Accordingly, Genus et species undetermined A is temporarily clasified among Pterocephaliidae (Pterocephaliinae).

Superfamily **DIKELOCEPHALACEA** Miller, 1889

Family **DOKIMOCEPHALIDAE** Kobayashi, 1935

Subfamily **WUHUIINAE** Shergold, 1980

Genus **Chalfontia** gen. nov.

Name. Derived from the Parish of Chalfont, in the Country of Windsor, western Queensland, a feminine gender is assigned.

Type species. Prismenaspis alta Henderson (1976, pp. 351-352, pl. 51, figs. 1-4), post-Idamean, *Irvingella tropica* Assemblage-Zone; Georgina Limestone, Glenormiston, western Queensland; here designated.

Other species. Pagodia mina Endo (1944, p. 63, pl. 8, fig. 5 = *Wuhuia(?) mina* (Endo) *in* Lu & others, 1965, p. 437, pl. 85, fig. 17), Paishan Formation, Lashushan, Laohushan village, Kuantung Peninsula, Laioning, north China.

Diagnosis. A dokimocephalid genus with anteriorly tapering glabella having four pairs of faintly impressed furrows; a preglabellar area comprising a narrow (sag.) flat or slightly convex, forward sloping preglabellar field, and a slightly longer (sag.) anterior cranidial border; moderately long (exsag.) crescentic palpebral lobes situated close to the glabella; small transverse pygidium with 2-3 segments and a significantly defined encompassing border.

Concepts. Prismenaspis was proposed by Henderson (1976, p. 348) for the pygidium (UQF 3392) which Whitehouse (1939, p. 227) had previously selected as the holotype of *Eugonocare propinquum.* Henderson (op. cit.) has considered the paratype cranidium of *Eu. propinquum* referrable to *Eu. tessellatum* Whitehouse, a view supported here. The species *propinquum* thus becomes the type of the genus *Prismenaspis* Henderson. *Prismenapis propinquum* (Whitehouse), however, represents an association of *propinquum*-like pygidia and cranidia which I think belong to *Protemnites elegans* Whitehouse (1939, p. 210, pl. 22, figs. 12a-b, *non* fig. 13 = *Pagodia* sp.; see herein the holotype cranidium refigured in Pl. 9, fig. 1).

According to Henderson, *Prismenaspis* cranidia can be distinguished from those of *Protemnites* only on account of an additional (fourth) pair of weakly impressed glabellar furrows (not evident on Henderson's pl. 50 illustrations), and by 'the obliquity of its ocular ridges' (Henderson, 1976, p. 350). Unfortunately, the course of the ocular ridges must be regarded as a most subjective characteristic for the basis of a new genus.

If *propinquum*-type pygidia are matched with *elegans*-type cranidia, then *Prismenaspis* can be regarded as a junior subjective synonym of *Protemnites.* Two of Henderson's species, *Prismenaspis brownensis* and *P. alta,* thereby require new generic assignations. The species *brownensis,* based on pygidia similar to those of *Protemnites elegans* as construed above, may be regarded as a second species of *Protemnites. Prismenaspis alta,* based on a cranidium, is here designated the type species of *Chalfontia.*

Comments. The concept of the Family Dokimocephalidae employed here is that previously discussed by Shergold (1980, p. 46).

Chalfontia gen. nov. is classified with Dokimocephalidae because of the shape and orientation of its glabellar furrows, and its palpebral lobes placed close to the axial furrows, all characteristics resembling those of North American representatives of this family, e.g. *Iddingsia, Kindbladia* and *Pseudosaratogia* (see Palmer, 1965, pls. 2, 3). Furthermore, the structure and appearance of the preglabellar area (although differing in the proportions of its elements) and librigena are also similar to those genera which Palmer (op. cit.) has classified as Dokimocephalinae. Asian and Australian Dokimocephalidae, represented by the genera *Wuhuia* Kobayashi, 1933, *Saimakia* Kobayashi, 1937, *Maladioides* Kobayashi, 1933, and *Lorrettina* Shergold, 1972, have been placed in a new subfamily Wuhuiinae by Shergold (1980, p. 46).

Of these genera, *Chalfontia* most closely resembles *Wuhuia,* based on *Solenopleura belus* Walcott (1905, p. 90), differing mainly in having a wider (sag.) cranidial border, and more convex (sag.) preglabellar field. *Saimachia,* judging from Schrank's (1974, pp. 596-597, pl. 3, figs. 3-6) re-illustrations of *S. damesi* Kobayashi (1937, p. 114, pl. 17, fig. 16), is a less effaced derivative of *Wuhuia,* with a pygidium resembling that of both *Lorrettina* and *Chalfontia. Lorrettina* (see *L. macrops* Shergold, 1972, pp. 68-69, pl. 17, figs. 1-4; 1975, pp. 104-105, pl. 53, figs. 1-8) has altogether greater overall convexity (sag.), but has lesser vaulting when viewed anteriorly.

Cranidia of both species of *Maladioides* recognised by Kobayashi (1933), *M. asiatica* (1933, pp. 146-7, pl. 15, figs. 9, 10) and *M. fragmenta* (1933, p. 147, pl. 15, fig. 13), and of *Maladia,* e.g. *Maladia americana* Walcott (1925, p. 105, pl. 16, figs. 23, 24), have similar glabellar characteristics, similarly directed facial sutures, and similar degree of transverse convexity (when viewed anteriorly), to *Chalfontia alta* (Henderson). They all differ in the structure of their preglabellar areas, having convex (sag.), rather than depressed, preglabellar fields. Species of *Maladioides* also have similarly sited palpebral lobes, but those of *Maladia* are smaller and placed closer to the glabella.

Chalfontia alta (Henderson, 1976)

(Pl. 8, figs. 1-8)

Synonymy

1976 *Prismenaspis alta,* sp. nov., Henderson, 1976, pp. 351-352, pl. 51, figs. 1-4, JCF 8420, 8419, 8421.

Types. The holotype is a cranidium, JCF 8419 (Henderson, loc. cit., fig. 3); paratypes are numbered JCF 8420-52. Hypotype material illustrated here includes CPC 15165-15170.

Material. Eight cranidia, ranging in length (sag.) between 6.3 and 15.4 mm.

Occurrence. Mount Murray, horizon 301/11, 93 m from the base of section 301; 302/3 and 302/4, 37 and 44 m from the base of section 302; and possibly also 234.

Age. Late Cambrian, post-Idamean, *Irvingella tropica* Assemblage-Zone.

Description. The following notes are intended to amplify the description given by Henderson (1976, pp. 351-352).

Chalfontia alta has appreciable convexity (tr. and sag.), and has a decidedly vaulted profile when viewed from the front. In lateral profile the preglabellar field is flat and slopes steeply forwards so that the gently upturned convex (sag.) anterior cranidial border lies lower than the front of the glabella. Specimens from Mount Murray have more or less straight glabellar sides; the frontal glabellar lobe is sagittally indented; and there are four faint pairs of gently curved and sagittally discontinuous glabellar furrows. Several exfoliated cranidia show that these furrows effectively define areas of muscle attachment, which increase in size rearwards. The glabella (G) occupies 59-64% of the total cranidial length. The occipital ring is as wide (tr.) as the preoccipital glabellar lobes, sagitally narrow, and bears a medium node. The preocular facial sutures diverge forwards and enclose a flat, forward sloping preglabellar field, which has a length (sag.) between 36 and 44% of the preglabellar area, separated by a shallow depression from a gently upturned anterior cranidial border. Postocular facial sutures enclose narrow (exsag.), short (tr.), triangular posterolateral limbs. The palpebral lobes are arcuate in plan, and separated from narrow (tr.) gently convex (tr.) palpebral areas by prominent palpebral furrows. They occupy 40-44% of the glabellar length (G); and their midpoints are situated slightly in advance of the midpoint of the glabella. Anteriorly the palpebral lobes pass into a faint diverticulum which encircles the front of the glabella and constitutes the preglabellar field. On exfoliated specimens a caecal network is observed faintly associated with this diverticulum, on the palpebral and preocular areas. Short caeca also cross the anterior cranidial marginal furrow.

The external test, when preserved, is smooth. The pygidium attributed to *Ch. alta* has been described by Henderson. The librigenae, thorax, and hypostoma are unknown.

Superfamily **LEIOSTEGIACEA** Bradley, 1925

Family **LEIOSTEGIIDAE** Bradley, 1925

Subfamily **PAGODIINAE** Kobayashi, 1935

Genus **Pagodia** Walcott, 1905

Subgenus **Idamea** Whitehouse, 1939

Type species. By original designation, *Idamea venusta* Whitehouse (1939, pp. 232-233, pl. 24, figs. 4-6), specimens untraced.

Other species. Idamea superstes Whitehouse (1939, p. 233, pl. 24, fig. 7, UQF 3364), Georgina Limestone, Tyson's Bore, Glenormiston area, western Queensland. *Pagodia (Idamea) venusta* (Whitehouse, 1939) sensu Öpik (1967, pp. 260-261, pl. 18, fig. 6, CPC 5509), *Stigmatoa diloma* Assemblage-Zone (of Henderson, 1976), Georgina Limestone, Glenormiston area, western Queensland. *Pagodia (Idamea) venusta* (Whitehouse) sensu Henderson (1976, pp. 355-356, pl. 51, figs. 11-14, JCF 8394, 8392, 8407, 8473), *Erixanium sentum* and *Irvingella tropica* Assemblage-Zones, Glenormiston area, western Queensland. *Pagodia (Idamea) extricans* Öpik, 1967, pp. 261-262, pl. 18, figs. 4, 5, CPC 5507-8, *Erixanium sentum* Zone, Georgina Limestone, Glenormiston area, Queensland. *Pagodia (Idamea) baccata* Öpik (1967, pp. 262-265, pl. 17, figs. 1-8, pl. 18, figs. 1-3, CPC 5496-5506), *Erixanium sentum* Zone, Pomegranate Limestone, Burke River area; and Georgina Limestone, Glenormiston area, Queensland. Possibly also included in this subgenus are *Pagodia laohuensis, P. trisulcata,* and *P. perquadrata,* all described by Endo (1937) from the Paishan Formation of northern China.

Comments. Öpik (1967, p. 257 et seq.) has described and diagnosed *Pagodia* and its subgenus *Idamea* at length, remarked on the complex relationships of Pagodiinae to forms such as *Chuangia,* and discussed the type species, *P. (I.) venusta* Whitehouse. Henderson (1976, p. 355) has also discussed *P. (I.) venusta,* and included Öpik's species *P. (I.)*

extricans in its synonymy. It seems likely that *P. (I.) superstes* (Whitehouse) can be added to this synonymy. Thus in Australia, only two species can be satisfactorily recognised: *P. (I.) venusta,* which occurs in the Glenormiston area, and is smooth-shelled; and *P. (I.) baccata,* which occurs mainly in the Burke River Structural Belt and is granulose. Smooth and granulose species may also occur in northern China. An appraisal of the subgenera of *Pagodia* has been given earlier by Shergold (1975, p. 169 et seq.).

Pagodia (Idamea) cf. **baccata** Öpik, 1967

(Pl. 13, figs. 1-7)

Synonymy

cf. 1967 *Pagodia (Idamea) baccata* sp. nov.; Öpik, 1967, pp. 262-265, pl. 17, figs. 1-8, pl. 18, figs. 1-3.

Material. The present sample consists of 33 cranidia ranging in length between 3.5 and 16.0 mm (Lc), 20 pygidia with lengths between 2.25 and 9.0 mm (Lp_2), and three librigenae. Illustrated material is numbered CPC 15192-15198; non-figured specimens used here are CPC 19277-19325.

Occurrence. Mount Murray, horizons 301/3, 301/7, 301/9, 301/11, and 301/12, between 19 and 97 m from the base of section 301; 302/1, 302/2, 302/3, and 302/4, 16-44 m from the base of section 302; and at 231, 232, 233, 234 and 235, equivalent to the interval 37-97 m on section 301.

Age. Late Cambrian, Idamean, *Stigmatoa diloma* Assemblage-Zone, and post-Idamean, *Irvingella tropica* Assemblage-Zone.

Comments. The morphology of *Pagodia (Idamea) baccata* has been described in detail by Öpik (1967, pp. 262-265), who has noted the different appearance of tests and exfoliated specimens. The specimens at hand are preserved as silicified replicas of both testaceous and exfoliated exuviae. Degree of silicification, and thus degree of obliteration of surface features, is variable. Hence, both apparently smooth and granulose specimens are illustrated here under the nomen cf. *baccata.* Variation in external prosopon (cf. Pl. 13, figs. 2, 4) is responsible for the addition of the 'confer' in the name, particularly the fact that few pygidia are as regularly granulose as the cranidia. The specimens illustrated herein (Pl. 13) show little evidence for the punctate, as well as granulose, test stated by Öpik (1967, p. 262) to be characteristic of *P. (I.) baccata,* although minute grains of silica may obscure such punctae. Granules are, however, occasionally perforated (Pl. 13, fig. 2). *P. (I.)* cf. *baccata* was evidently more strongly granulose (Pl. 13, fig. 2) than *P. (I.) baccata:* even parietal surfaces are faintly granulose (Pl. 13, fig. 3). In this characteristic they possibly resemble *Pagodia perquadrata* Endo (1937, p. 317, pl. 67, fig. 26) from northern China. Probably the observed variation in granulosity can be accommodated within the concept of the species taxon *baccata,* sample size and degree of effacement due to silicification being responsible for the recorded differences. In this respect it should be noted that Henderson (1976, p. 356) records 'incipient granulation' among his paradigm of the smooth-shelled species *venusta,* and notes that *baccata* 'may prove to be an extreme variant of *P. (I.) venusta*'.

Before silicification, the paradigm at hand represented an externally granulose species of *Pagodia (Idamea)* characterised by the possession of: constricted glabellar flanks adjacent to the point at which the ocular ridges meet the axial furrows; glabella width 69-77% of the cranidial length (Lc), with externally poorly defined furrows; externally poorly defined ocular ridges, parietally duplicated; gently arched palpebral lobes, 40-50% of the glabellar length (G), sited a little behind the mid-point of the glabella, and posteriorly 39-47% of the glabellar length (G) away from the axial furrows; an anterior cranidial border which is overturned on to the front of the glabella (Pl. 13, figs. 2, 4); a small median occipital node; wide-spaced pygidial fulcral points; no pygidial marginal furrow; a wide doublure; three well-defined axial segments, with a fourth and sometimes a hint of a fifth less well defined; evidence for three pleural segments; and entire margins.

In most of these characteristics *P. (I.)* cf. *baccata* compares closely with *P. (I.) baccata;* they are particularly similar in glabellar proportions and the size and position of their palpebral lobes. Illustrated pygidia of *P. (I.) baccata* appear to possess a more obvious fourth axial segment. Contrary to the statement of Öpik (1967, p. 262) regarding the presence of a 'border furrow' in *baccata,* both species lack a pygidial marginal furrow externally.

Genus **Prochuangia** Kobayashi, 1935

Type species. By original designation, *Prochuangia mansuyi* Kobayashi, (1935, pp.

186-187, pl. 8, fig. 8, pl. 10, figs. 1-7), Saisho-ri, South Korea.

Other species. See Shergold (*in* Shergold, Cooper & others, 1976) for listing of previously described species. *Prochuangia* sp., described by Henderson (1976, p. 354, pl. 51, fig. 19) from the *Irvingella tropica* Zone, Georgina Limestone, western Queensland, should be added.

Prochuangia sp. undet.

(Pl. 13, fig. 8)

Synonymy

?1976 *Prochuangia* sp.; Henderson, 1976, p. 354, pl. 51, fig. 19, JCF8366.

Material. Only a single pygidium, CPC 15199, with a length (Lp_2) of 4.8 mm, is referable without question to this genus.

Occurrence. Mount Murray, horizon 301/5, at 37.5 m from the base of measured section 301.

Age. Late Cambrian, Idamean, *Stigmatoa diloma* Assemblage-Zone; and post-Idamean, *Irvingella tropica* Assemblage-Zone.

Comments. Because of its fragmentary nature, the available material cannot be conclusively determined at specific level. It appears to represent a new species of *Prochuangia* which is characterised by the possession of (1) a long pygidial axis which reaches close to the posterior margin, composed of three well defined axial segments separated by transverse furrows which contact the axial furrows laterally, three further indistinct segments differentiated by discontinuous furrows, and a bulbous terminal piece; (2) a very short postaxial ridge; (3) long anterolaterally sited spines; (4) a deep pygidial 'bowl' (Shergold, 1972).

This new species is distinguished from all others on account of its anterolaterally, rather than laterally (*Prochuangia mansuyi* Kobayashi, 1935, pp. 186-187, pl. 8, fig. 8, pl. 10, figs. 1-7; *P. quadriceps* (Dames), Kobayashi, 1937, p. 426, pl. 17, figs. 2a-c) or posteriorly (*P. posterospina* Kobayashi, 1935, pp. 187-188, pl. 10, fig. 8) positioned spines, which consequently increase the curvature of the posterior margin between the spine bases. In terms of axial similarity, *P. granulosa* Lu (1956b, pp. 376-377, pl. 1, fig. 5; Lu *in* Lu & others, 1965, p. 414, pl. 78, figs. 22, 23) and *Prochuangia* sp. (Henderson 1976, p. 354, pl. 51, fig. 19) have the same number of segments, but the former lacks the bulbous terminal piece of the presently described pygidium, tapering evenly rearwards instead: the latter has a similar termination to the material described here and is probably conspecific.

The cranidium belonging to *Prochuangia* sp. nov. has not been recognised in the present collections. If it is similar to that of the species *P.* sp. aff. *P. granulosa* Lu recently described from northern Victoria Land, Antartica (Shergold *in* Shergold, Cooper & others, 1976, pl. 3, figs. 1-6), it is probably indistinguishable from those illustrated herein for *Pagodia (Idamea)* cf. *baccata.* As the presently illustrated pygidium bears a somewhat heavy axial granulation, it is possible that the densely granulose cranidium (CPC 15193) figured herein (Pl. 13, fig. 2) as *P. (I.)* cf. *baccata* could represent the cranidium of *Prochuangia* sp. undet.

Family **MISSISQUOIIDAE** Hupé, 1955

Genus **Parakoldinioidia** Endo, 1937

Type species. By original designation, *Parakoldinioidia typicalis* Endo (*in* Endo & Resser, 1937, pp. 329-330, pl. 71, figs. 17-22, *non* fig. 23), from the Yenchou Formation of Paichiashan, and near Lashufang, north China.

Other species. See Shergold (1975, pp. 195-196).

Parakoldinioidia sp. aff. **P. typicalis** Endo, 1937

(Pl. 12, figs. 10-12)

Synonymy

aff. 1937 *Parakoldinioidia typicalis* new species; Endo *in* Endo & Resser, 1937, pp. 329-330, pl. 71, figs. 17-22, *non* fig. 23; cotypes MSMSM 1267, 1280, 2577.

aff. 1937 *Pagodia triangulata,* new species; Endo *in* Endo & Resser, 1937, p. 320, pl. 71, figs. 9-11; cotypes MSMSM 1272.

Material. One cranidium, CPC 19326; and five pygidia, CPC 15190B, 19327-19330, with lengths between 4.9 and 6.0 mm.

Occurrence. Mount Murray, horizons 302/6 and 302/9, between 105 and 178 m from the base of the measured section 302; and 236-237, equivalent horizons on a previous undocumented section.

Age. Late Cambrian, post-Idamean, post-*Irvingella tropica* Assemblage-Zone.

Description. Available pygidia are distinctly triangular, posteriorly turning slightly into a prong or point which is most often broken; and are highly vaulted when viewed posteriorly. They have a long, gently tapered axis which does not reach to the posterior extremity, composed of about 10 segments, the anterior four divided by transverse furrows confluent with the axial furrows, and the remainder by non-confluent ones. A short post-axial ridge continues into the base of the terminal pygidial spine. Six or seven pleural segments bear strong sigmoidal pleural furrows which terminate at a narrow marginal furrow; interpleural furrows are effaced. The pleural zone is strongly curved adventrally so that anteriorly the marginal furrow and narrow margin appear to pass below the convexity of the pleura. Posteriorly the margin increases in width and loses convexity as it passes into the terminal mucronation. This margin is entire. Specimens retaining shell, however, lack traces of a marginal furrow anteriorly, and an even convexity from axial furrow to margin is apparent. Scattered granules are observed both on the axial segments and pleural 'ribs'.

Comments. A case has been made previously (Shergold, 1975, p. 196) for associating the pygidia Endo (1937, p. 320) assigned to *Pagodia triangulata* with the cranidia he described (op. cit., p. 327) as *Parakoldinioidia typicalis* Endo, thus rejecting the pygidium he originally associated with *typicalis.*

P. typicalis thus combined is a relatively large species, larger than the subsequently described *P. bigranulosa* Shergold (1975, pp. 195-197, pl. 45, figs. 2-5) from Black Mountain, western Queensland. The present species, also large, differs very little from the northern Chinese one. The latter appears not to have a prominent spine-like termination, but close examination of the photographs shows that all three pygidia figured by Endo (pl. 71, figs. 9-11) have broken terminations. Such inconclusiveness renders accurate determination of the present material impossible. Shape, segmentation, and apparently convexities are otherwise similar.

P. sp. aff. *typicalis* has more axial segments than *P. bigranulosa* Shergold, and a more prominent posterior mucronation, *bigranulosa* having merely a pointed termination.

P. sp. aff. *P. typicalis* occurs earlier in Australia than *P. typicalis* does in northern China: *typicalis,* according to Endo (op. cit.), is from the Yenchou Formation, of latest Cambrian age.

Order **CORYNEXOCHIDA** Kobayashi, 1935

Family **CORYNEXOCHIDAE** Angelin, 1854

Genus **Corynexochus** Angelin, 1854

[= *Karlia* Walcott, 1889 *fide* Walcott, 1916, pp. 309-310]

Type species. Corynexochus spinulosus Angelin (1854, p. 59, pl. 33, figs. 9, 9a, *non* fig. 11), Middle Cambrian, Zones of *Solenopleura brachymetopa* and *Leiopyge laevigata,* Andrarum Limestone and Exporrecta Conglomerate, Andrarum and other places, Skaane; Vastergötland; Närke (fide Westergaard, 1948, pp. 10-11); designated Grönwall (1902, p. 136); see Westergaard (loc. cit) for synonymy.

Other species. Species assigned to *Corynexochus* by Walcott (1916, p. 312) were discussed by Lake (1934, pp. 181-183) and revised by Resser (1936). Currently recognised species, totalling 15 definite and one possible, are listed by Suvorova (1964, p. 199). Seven of these species are Russian. All species, with the exception of *C. plumula* Whitehouse, 1939, are of Middle Cambrian age.

Comments. The concept of *Corynexochus* has been discussed at length by various authors: Walcott (1916), Lake (1934), Resser (1936), Whitehouse (1939), Suvorova (1964), and Öpik (1967). The suprageneric classification adopted here follows Öpik (1967, pp. 177-178) and Palmer (1968).

Corynexochus plumula Whitehouse, 1939

(Pl. 14, figs. 1-6A, 7)

Synonymy

1939 *Corynexochus plumula* sp. nov.; Whitehouse, 1939, pp. 234-235, pl. 24, figs. 8-10 (see below).

1967 *Corynexochus plumula* Whitehouse, 1939; Öpik 1967, pp. 178-181, pl. 3, figs. 1-11, text-fig. 57 (CPC 5369-5379).

1968 *Corynexochus plumula* Whitehouse; Palmer 1968, pp. B42-43, pl. 10, figs. 15, 16, 19-22 (USNM 146831-6).

1971 *Corynexochus plumula* Whitehouse, 1939; Hill & others, 1971, p. Cm 14, pl. Cm VII, figs. 3, 4a, b (CPC 5374, 5372 respectively)—Öpik's specimens refigured.

Types. The holotype (Whitehouse, 1939, pl. 24, fig. 8), a cephalon, is untraced: paratypes, both pygidia, are numbered UQF 42743 and 3367 respectively (Whitehouse, loc. cit., figs. 9, 10).

Material. Eight cranidia with lengths (sag.) ranging between 2.3 and 3.4 mm; and four pygidia, with lengths (Lp_1) between 1.7 and 3.1 mm. Material is either preserved with shell (301/4), or as silicified replicas (K231). Figured material is CPC 15141-15147, and non-figured specimens are numbered CPC 19331-19335.

Occurrence. Mount Murray, horizon 301/4, 35 m from the base of section 301; horizon 231 (which is equivalent to 301/4).

Age. Late Cambrian, Idamean, *Stigmatoa diloma* Assemblage-Zone.

Comments. Corynexochus plumula Whitehouse has been adequately diagnosed and described by Whitehouse (1939, pp. 234-235) and Öpik (1967, pp. 178-181). Both authors have made comparisons with existing described species. The material at hand closely resembles that described by Öpik (loc. cit.). Tests are 'impunctate', 'with erratically and weakly granulose cheeks and pleurae', with 'straight palpebral furrows' (Öpik, loc. cit.). As far as can be judged, the blind ends of the posterior cranidial marginal furrows terminate on a level across the middle of the preoccipital glabellar lobe, but most material is distorted to some extent. Silicified replicas (Pl. 14, figs. 2, 4) have an overall granulose appearance, which may be due to the silicification process but is otherwise difficult to reconcile with the testaceous condition.

The preglabellar area is reduced to an extremely narrow (sag.) rim (CPC 15145, Pl. 14, fig. 4) which bears terrace lines anterolaterally and merges with the anterior end of the palpebral lobes (CPC 15141, Pl. 14, fig. 1). Up to four pairs of glabellar furrows are faintly indicated on this latter specimen. Palpebral lobes, on three assessable specimens, range between 28 and 30% of the glabellar length (G) exclusive of the occipital ring. An occipital node is present on all material on which the occipital ring is preserved.

The pygidium has a length which varies between two-thirds and three-quarters of the width, an axis with two well defined anterior segments and two faintly defined posterior ones, three pleural segments, and a Bertillon pattern prosopon on its axis and borders. The silicified replica (CPC 15146, Pl. 14, fig. 6A) has a roughened surface resulting from silicification.

Corypnexochus plumula has been described from the late Dresbachian of Alaska (Palmer, 1968, pp. B42-43, pl. 10, figs. 15, 16, 19-22). The Alaskan cranidia have shorter (exsag.) palpebral lobes (14-25% of the glabellar length (G)) and are stated to be externally smooth. Pygidia are indistinguishable from those occurring at Mount Murray.

Order **ASAPHIDA** Salter, 1864

Superfamily **ASAPHACEA** Burmeister, 1843

Family et Subfamily INCERTAE SEDIS

Asaphacean genus et species undetermined B

(Pl. 12, figs. 1-4)

Material. One cranidial fragment, CPC 15186; two pygidia, CPC 15187A, 19383; and possibly two librigenae of which CPC 15188 is illustrated. The cranidium has an estimated length of 5.90 mm and the meraspid pygidium 1.90 mm (Lp_1).

Occurrence. Mount Murray, horizon 302/9, 178 m from the base of measured section 302; and 237, the same horizon on an undocumented section.

Age. Late Cambrian, post-Idamean, post-*Irvingella tropica* assemblage.

Description. Gen. et sp. undet. B has an effaced asaphoid cranidium with apparently pyriform glabella. It lacks an occipital ring, and preoccipital lobes may be represented by large swellings, as in *Asaphus* or *Basilicus*. An axial node lies about half-way along the fused glabella/occipital ring unit, between the mid-points of the palpebral lobes. The latter are of moderate length, close to the glabella, their mid-points lying behind the mid-glabellar line (tr.). The preglabellar area is poorly preserved and its anterior contour impossible to delineate. An associated effaced librigena (Pl. 12, fig. 2) is characterised by an asaphoid eye socle and terrace-lined marginal prosopon. The extent of its genal spine cannot be determined.

A meraspid pygidium with three unliberated segments is illustrated in Pl. 12, fig. 4. It is semicircular, possesses entire margins, narrow borders with shallow marginal furrow, and a long axis reaching close to the posterior pygidial margin. An associated asaphacean holaspid pygidium (Pl. 12, fig. 3) is more transverse, and apart from the first pleural furrow, the segmental furrows are totally effaced. The marginal furrow is also preserved.

Comments. Classification of these fragments is difficult, as the advanced position of the median node is unusual for the majority of asaphids. Ordovician Symphysurininae, as recognised by Jaanusson (1959), which mostly have similarly situated nodes, may represent the nearest morphological group. Of these, *Parabellefontia* Hintze (1952, pp. 193-194) appears to be the most similar genus in terms of glabellar, preglabellar, and ocular characterestics.

Superfamily **CERATOPYGACEA** Linnarsson, 1869

Family **CERATOPYGIDAE** Linnarsson, 1869

Subfamily **PROCERATOPYGINAE** Wallerius, 1895

Comments. As in an earlier publication (Shergold, 1980), the Superfamilies Asaphacea and Ceratopygacea are united into the Order Asaphida. This classification was based on observance of common meraspid morphologies within the two superfamilies and intergrading holaspid characteristics, and lent support to discussion of the composition of the Order Asaphida recently published by Sdzuy (1979). Neither Sdzuy nor I can accept the classification proposed earlier by Bergström (1973, pp. 39-43) in which the Asaphacea are included in a Suborder Asaphina and the Ceratopygacea in a Suborder Redlichiina. According to Bergström Asaphina and Redlichiina form the Order Redlichiida.

Genus **Proceratopyge** Wallerius, 1895

Subgenus **Proceratopyge** Wallerius, 1895

Type species. By original designation, *Proceratopyge conifrons* Wallerius (1895, pp. 56-57, fig. 6; Westergaard, 1948, pp. 5-6, pl. 1, figs. 7-16), Middle Cambrian, *Leiopyge laevigata* Zone, Gudhem, Falbygden area, Vastergötland, Sweden.

Other species. Species described until 1975 were listed by Shergold (*in* Shergold, Cooper & others, 1976, pp. 281-282) in which those with five or fewer pygidial axial segments were referred to *Proceratopyge (Proceratopyge)* and those with more to *Proceratopyge (Lopnorites)* Troedsson, 1937, or *Proceratopyge (Kogenium)* Kobayashi, 1935. To this list should be added *Proceratopyge corrugis* E. Romanenko (*in* Zhuravleva & Rozova, 1977, pp. 178-179, pl. 24, figs. 18-21), late Cambrian, Gorniya Altai, River Bolishaya Isha, southern Siberia, USSR; and *Proceratopyge cryptica* Henderson (1976, pp. 334-336, pl. 47, figs. 19-24, pl. 48, figs. 1-3), late Cambrian, *Proceratopyge cryptica* Zone, Georgina Limestone, Glenormiston area, western Queensland. Both of these species belong to *Proceratopyge (Proceratopyge).*

Comments. Proceratopyge is a cosmopolitan genus known from Europe (Sweden, Norway, England), USSR (northern and southern Siberian Platform, Kazakhstan), China (Tien-Shan, Liaoning, Anhui), USA (Alaska), Australia (western Queensland) and Antarctica (northern Victoria Land); of mid to late Cambrian ages, *Leiopyge laevigata* Zone to *Protopeltura aciculata* Zone (3a of Westergaard, 1947) in Europe, but confined to the late Cambrian elsewhere (Tuorian-Shidertan in USSR, Dresbachian in Alaska, Paishanian in China, Idamean in Antarctica and Australia). Australian species referable to *Proceratopyge (Proceratopyge)* have been described previously by Whitehouse (1939), Öpik (1963) and Henderson (1976), all of whom have described material from the Glenormiston area of western Queensland.

Of the four species described by Whitehouse (1939), two, *Proceratopyge lata* Whitehouse (1939, pp. 248-249, pl. 25, fig. 12, UQF 3391) and *P. nectans* Whitehouse (1939, pp. 249-250, pl. 25, figs. 8a (UQF 3386) and 8b (UQF 3387)) can be referred to *Proceratopyge (Proceratopyge)* with confidence. The type material of *nectans* is re-illustrated here in Plate 17, figs. 9, 10. Henderson (1976, p. 334) has referred the paratype pygidium of *nectans* to his new species *P. cryptica.* The holotype cranidium of *'P. rutellum'* Whitehouse (1939, pp. 250-251, pl. 25, figs. 9-11) is untraced, but the paratype cranidium (loc. cit., fig. 10, UQF 3389b), refigured here in Plate 15, fig. 1, has been referred by Henderson (1976, p. 340) to *Aplotaspis erugata* (Whitehouse). *'P. polita'* Whitehouse (1939, p. 251, pl. 25, fig. 14, UQF 3393), refigured in Plate 17, fig. 7, lacks the glabellar node characteristic of Ceratopygidae and cannot be referred to *Proceratopyge.* Its long palpebral lobes, unfurrowed glabella, and concave preglabellar field suggest perhaps a Leiostegiacean (mansuyiinid) form. Cranidia assigned by Öpik (1963, pp. 98-99, pl. 4, figs. 9, 10, CPC 4281-2, pl. 5, figs. DD, FE, FG, CPC 4281) to *Proceratopyge lata* Whitehouse are similar to the holotype in the nature of their plectral lines and narrow (sag.) preglabellar areas. *Proceratopyge* cf. *chuhsiensis* Lu sensu Öpik (1963, pp. 99-100, pl. 5, fig. AA, CPC 4281) is considered here to represent a distinct ceratopygid genus. Henderson (1976, pp. 336-338, pl. 48, figs. 4-11) has also referred material to *P. lata* Whitehouse, one pygidium of which (fig. 9) compares well with that illustrated for this species by Öpik (1963, pl. 4, fig. 9, CPC 4281), in having a postaxially truncate pygidial margin. Henderson's species *P. cryptica* (1976, pp. 334-336, pl. 47, figs. 19-24, pl. 48, figs. 1-3) appears to have cranidial characteristics, particularly those associated with the preglabellar area, intermediate between *P. nectans* and *P. lata.*

Proceratopyge (Proceratopyge) lata

Whitehouse, 1939

(Pl. 16, figs. 1-9)

Synonymy

1939 *Proceratopyge lata* sp. nov.; Whitehouse, 1939, pp. 248-249, pl. 25, fig. 12 (UQF 3391).

1963 *Proceratopyge lata* Whitehouse, 1939; Öpik, 1963, pp. 98-99, pl. 4, figs. 9 (CPC 4281), 10 (CPC 4282), pl. 5, figs. CC, EF, GF (CPC 4281).

1971 *Proceratopyge lata* Whitehouse, 1939; Hill & others, 1971, p. Cm 16, pl. Cm VIII, figs. 2, 3 (Öpik's pl. 4, figs. 9, 10 refigured).

1976 *Proceratopyge lata* Whitehouse; Henderson, 1976, pp. 336, 338, pl. 48, figs. 4-11 (JCF 8287, 8258, 8448, 8435, 8446, 8267, 8452, 8329 respectively).

Holotype. By monotypy, the cranidium (UQF 3391) figured by Whitehouse (1939, pl. 25, fig. 12), refigured here in Plate 15, fig. 9.

Material. The present collection includes 18 cranidia CPC 15130-15131 (figured), 19336-19349 (not figured), 24 pygidia CPC 15128, 15129 (figured), seven librigenae CPC 19350-19356, three thoraces CPC 15127, 19378-19379, and three completely articulated specimens CPC 15124-15126 (figured). Cranidia have lengths (sag.) between 1.2 and 7.0 mm, and pygidia (Lp_1) between 0.7 and 6.4 mm. The three complete specimens have total lengths of 2.45 mm, 10.8 mm, and 13.6 mm.

Occurrence. Mount Murray; horizons 229, 230, 301/2, 301/3, 301/4 and 301/5; between 9.5 and 37.5 m from the base of measured section 301. The species also occurs at locality D662.

Age. Late Cambrian, Idamean, *Stigmatoa diloma* Assemblage-Zone.

Diagnostic features. Material at hand is characterised by a narrow (sag.) but distinct anterior cranidial border, and short (sag.) preglabellar area. The front of the glabella lies well behind the anterior margins of the preocular areas, which are defined by distinct plectral lines. In general, the transverse distance between the midpoints of the palpebral furrows is wider than the preglabellar area. Most pygidia from Mount Murray have posteriorly indented margins which become more apparent with increase in size. Generally, four axial segments are visible, and occasionally a fifth. The anterolateral corners of the pygidium are distinctly angled.

Comments. The holotype of *Proceratopyge lata* is refigured in Plate 16, fig. 7 for comparative purposes. Apart from possessing a less obvious anterior cranidial border and more effaced ocular ridges it is essentially similar to the remainder of the illustrated material. The narrow cranidial border is a characteristic shared with the cranidia assigned to this species by Öpik (1963) and Henderson (1976). The pygidium referred by Öpik to this species lacks a marked indentation posteriorly. Those figured by Henderson possess a gentle indentation. As this characteristic is variable among the specimens at hand no great emphasis can be placed upon it for classificatory purposes. Variation within material from a single locality has been previously noted by Henderson.

Proceratopyge lata is distinguished from *P. nectans* Whitehouse by its shorter (sag.) and wider (tr.) preglabellar area, the possession of a distinct anterior cranidial border; shorter (exsag.) palpebral lobes placed farther from the axial furrows; pygidium (as interpreted by Henderson) with more acute 'shoulders', narrower (sag.) postaxial doublure, and more delicate spines; and librigena with wider (tr., exsag.) genal field, narrower borders, and more delicate spine. It is distinguished from *P. cryptica* Henderson (1976, pp. 334-336, pl. 47, figs. 19-24, pl. 48, figs. 1-3), by its shorter preglabellar area, more effaced glabellar furrows, and in its possession of one fewer axial segment in its pygidium: four or five as against five or six.

Apparently no other previously described species of *Proceratopyge* have posteriorly indented pygidial margins.

Descriptive notes. Proceratopyge lata has been described by Whitehouse (1939), Öpik (1963), and Henderson (1976) but this is the first time that fully articulated carapaces have been available for study.

The single degree 4 meraspis illustrated (Pl. 16, fig. 3) possesses a cranidium which has a length (sag.) 46% of the total carapace length, a thorax 25% this length, and a transitory pygidium which is 28% of the total length. In the cranidium the preglabellar area is very short, 19% of the cranidial length; the palpebral lobes occupy 50% of the glabellar length (G) and their posterior tips lie well in front of the axial glabellar node; and the posterolateral limbs are broadly triangular. The posterior margins of the posterolateral limbs are sinuous: there is a distinct node at the geniculation which lies on an exsagittal line passing through the abaxial margin of the palpebral lobes (Pl. 16, figs. 8, 9). Glabellar furrows are effaced, but on all meraspid material at hand an occipital furrow is sharply incised and connected with the axial furrows. Meraspid thoracic segments are apparently no different from holaspid ones, being characterised by wide and transverse furrows which equally bisect the pleurae as far as the geniculation, then curve gently posteriorly where they pass into the spine bases. The transitory pygidium is triangular in shape, with a posterior postaxial indentation. A pair of spines lie at the posterolateral corners of the shield, these representing the spines of the first pygidial segment of the holaspis. All five of the thoracic segments to be liberated during further meraspid development are visible in the axial margin of the degree 4 transitory pygidium.

Holaspides possess thoraces containing nine segments and pygidia with four or five segments. Two complete specimens, with total carapace lengths of 10.80 mm and 13.60 mm, have cranidia 39 and 31%, thoraces 40 and 50%, and pygidia 21 and 19% of the total length respectively. Holaspid cranidia differ from meraspides in that the preglabellar area is longer (sag.), 20-27% of the cranidial length, the palpebral lobes are shorter, 27-45% of the glabellar length (G) depending on size, sited closer to the axial furrows, and their posterior tips lie only slightly in front of the axial glabellar node. Glabellar furrows are generally faintly visible, but the occipital furrow is not connected with the axial furrows. The holaspid thorax has short posteriorly deflected spines formed from the abaxial extremities of the articulating facets of the propleuron and anteriorly curved extremities of the opisthpleuron. Holaspid pygidia are transversely subtriangular in shape with lengths varying between 39 and 46% of the width, and with indented posterior postaxial margins. The pygidial doublure is relatively narrow; the marginal furrows are wide and shallow; and a distinct narrow (exsag., sag.) rim is evident. The pygidium, which is widest anterolaterally, has rounded corners, very narrow (tr.) articulating facets, and a geniculation close to the margin of the shield. The pygidium is spinose, posteriorly directed spines being derived from the opisthopleuron of the first and propleuron of the second segments. The pleural furrows of the first segment pass laterally into the bases of these spines.

One of the illustrated pygidia, CPC 15129 (Pl. 16, fig. 6), which has a length of 6.40 mm, is deformed. The posterior marginal indentation is develped to the left of the sagittal line. The postaxial ridge, however, appears to be unaffected by this distortion, although there is some deflection of the anterior edge of the doublure in front of the identation as seen from its imprint on the dorsal surface of the pygidium. This same specimen shows additionally the caecal network of the *Proceratopyge* pygidium.

Apart from the development of terrace lines on the genal and pygidial spines, and the doublures of the librigena and pygidium, the external prosopon of *Proceratopyge lata* Whitehouse is smooth.

Proceratopyge (Proceratopyge) sp. undet.

(Pl. 17, figs. 11, 12)

Material. One cranidial and one pygidial external mould, and one incomplete silicified pygidial replica. The single measurable cranidium, CPC 15132, has a length of 4.0 mm, and the illustrated pygidium, CPC 15133, an estimated length (Lp_2) of 2.7 mm. CPC 19381 is not figured.

Occurrence. Mount Murray, horizon 231, approximately equivalent to 301/5, 37.5 m from the base of section 301.

Age. Late Cambrian, Idamean, *Stigmatoa diloma* Assemblage-Zone.

Comments. The illustrated cranidium represents a species closely related to *Proceratopyge (P.) lata* Whitehouse, but distinguished by a greater degree of effacement of its ocular ridges and glabellar furrows—even the occipital furrow is effaced. The associated pygidium is also more effaced than those referred here to *P. (P.) lata,* and may additionally lack a postaxial indentation. As all material is preserved in weathered chert, silicification may be responsible for the degree of observed effacement. This being so, the species is not readily identifiable, which accounts for the open nomenclature. By comparison with the type of *P. lata* (see Pl. 16, fig. 7), *Proceratopyge* sp. undet. has a somewhat narrower preglabellar area, but otherwise essentially similar morphology.

Subfamily INCERTAE SEDIS

Genus **Aplotaspis** Henderson, 1976

Type species. Charchaqia erugata Whitehouse (1939, pp. 239-240, pl. 25, figs. 5, 7a, UQF 3369a, b), late Cambrian, Idamean, *Proceratopyge cryptica* and *Erixanium sentum* Zones (sensu Henderson, 1976), Georgina Limestone, Glenormiston area, western Queensland.

Other species. Aplotaspis mucrora Henderson (1976, p. 342, pl. 48, figs. 13, 14), late Cambrian, Idamean, *Stigmatoa diloma* Assemblage-Zone, Georgina Limestone, Glenormiston area, western Queensland.

Comment. The genus *Aplotaspis* resembles Asaphacea on the one hand and Ceratopygacea on the other. Asaphacean characteristics are the appearance of the preglabellar area, glabella with fused occipital ring, conical effaced glabella, and broad non-spinose, more or less effaced pygidium. Ceratopygacean characteristics include a subcentrally sited axial glabellar node, and the possession in meraspid and early holaspid morphogenesis of an anterior cranidial border. The type species, *A. erugata* (Whitehouse), has paradoublural lines similar to those of Ceratopygacea, whereas in *A. mucrora* they are more similar to Asaphacea. Other genera having similar hybrid characteristics are *Yuepingia* Lu, 1956b, *Iwayaspis* Kobayashi, 1962, *Eoasaphus* Kobayashi, 1936, *Norinia* Troedsson, 1937, *Charchaquia* Troedsson, 1937, and *Hániwoides* Kobayashi, 1935. *Aplotaspis* may eventually prove to be synonymous with *Haniwoides*. It is here classified with Ceratopygacea because of the position of its axial glabellar node, thus following Henderson (1976), and by similarity Palmer's (1968, p. 55) assignation of *Yuepingia*.

Aplotaspis mucrora Henderson, 1976

(Pl. 15, figs. 1-9)

Synonymy

1976 *Aplotaspis mucrora* sp. nov. Henderson, 1976, p. 342, pl. 48, figs. 13, 14; JCF 8234-5.

Material. Present material consists of eight cranidia between 2.4 and 11.4 mm long; and ten pygidia with lengths (Lp_1) between 3.3 and 12.5 mm. Specimens CPC 15134-15140 and 19382 are illustrated, and 19383-19392 not illustrated.

Occurrence. Mount Murray, horizons 301/3, 301/5 and 301/6, between 19 and 43 m from the base of section 301; 302/1 (= 301/7), 16 m from the base of section 302; and at 231 and 232 (= 301/5, 301/7 respectively).

Age. Late Cambrian, Idamean, *Stigmatoa diloma* Assemblage-Zone.

Comments. Aplotaspis mucrora has been adequately described by Henderson (1976, p. 342). Material at hand includes meraspid or early holaspid cranidia which demonstrate the presence, at this morphogenetic stage, of an anterior cranidial border and long palpebral lobes, similar to those of *Yuepingia glabra* Palmer (1968, p. 55, pl. 13, figs. 9-16). During cranidial morphogenesis the palpebral area increases in length (sag.) at a greater rate than the glabella. Early holaspid pygidia are shorter (sag.) than late holaspides, which have a longer postaxial border (sag.).

Aplotaspis mucrora is distinguished from *A. erugata* (Whitehouse) principally by the orientation of its paradoublural lines. Those of *erugata* resemble *Proceratopyge,* whereas those of *mucrora* are more asaphacean, sloping gently posterolaterally from a point on the sagittal line immediately in front of the glabella. The pygidium of *A. erugata* has a shorter postaxial border than that of late holaspides of *A. mucrora,* but is similar to early holaspides of *mucrora.*

Ceratopygacean genus et species undetermined C

(Pl. 12, figs. 5-8)

Material. Two cranidial fragments, CPC 15183-4, and an associated pygidium, CPC 15185. The most complete cranidium has an estimated length of 14 mm, and the pygidium 4.6 mm (Lp_1).

Occurence. Mount Murray, horizon 302/5, 76 m above the base of measured section 302.

Age. Late Cambrian, post-Idamean, post-*Irvingella tropica* Assemblage.

Description. Cranidia have a ceratopygid-type glabella, anteriorly tapering and rounded, with complex preoccipital furrows, mostly effaced median and anterior lateral ones, and a median node situated about one-third the glabellar length in front of the occipital furrow.

The palpebral lobes of this form are short, and situated well forwards, their posterior tips apparently lying in front of a transverse line drawn across the glabellar node, and close to the axial furrows. Short, slightly oblique ocular ridges connect the anterior palpebral tips to a point just in front of depressions representing the anterior lateral glabellar furrows.

Genus et species undetermined C has preocular facial sutures diverging forwards at 60° and enclosing a preglabellar area which is twice as wide (tr.) as long (sag.), and nearly equal, when fully preserved, to the glabellar length (G). This preglabellar area, not divided into a preglabellar field and border, is a shallow concavity. Sinuous paradoublural lines delineate preocular areas. Postocular sutures enclose long (tr.), wide (exsag.), posterolateral limbs which bear faint posterior marginal cranidial furrows.

A poorly defined caecal system underlies a surface prosopon of fine, approximately concentric, terrace lines on the preglabellar area.

A complete pygidium which probably belongs to this species (Pl. 12, fig. 8) is semicircular, possesses shallow confluent marginal furrows separating a distinct rim from the remainder of the shield, and a conical axis with distinct postaxial ridge composed of three indistinct segments. The caecal diverticula of a single pleural segment are readily visible anteriorly. The pygidial margin is nonspinose.

Comments. Genus et species undetermined C is classified among Ceratopygidae on account of its median glabellar node, which is well in front of the occipital furrow, as for example in *Proceratopyge*. It is quite distinct from other described Ceratopygidae, however, by virtue of its small palpebral lobes, anteriorly and adaxially sited, and its asaphoid preglabellar area.

The only previously described form with which Genus et species undetermined C can be closely compared, and with which it may be congeneric, is that which Henderson (1976) has identified as *Pterocephalia* sp. nov. (Henderson, 1976, pp. 347-348, pl. 51, fig. 10), which is associated with *Irvingella tropica* in the Glenormiston area of western Queensland, Australia. Henderson's specimen (JCF 8418), apart from lacking paradoublural lines, has the same preglabellar morphology and prosopon. Its glabella may have a more truncated shape, its furrows are more strongly developed, and the position of its glabellar node, if it in fact possesses one, is in doubt. Ocular morphology, and the shape of its posterolateral limbs, are similar.

Some comment may also be offered on the possible glabellar and preglabellar similarity of Gen. et sp. undet. C with *Haniwoides longa* Kobayashi (1935, p. 248, pl. 17, fig. 3), which is mostly distinguished by its longer palpebral lobes. The pygidium illustrated by Kobayashi (1935, pl. 17, fig. 12) as *Anomocarella brevifrons* Kobayashi appears very close to that illustrated here.

UNDETERMINED HYPOSTOMATA

Only two kinds of hypostomata have been recognised in the material presently under study. These are referred to informally as Hypostoma undetermined 5 and 6 to distinguish them from the four different hypostomata previously illustrated (Shergold, 1980).

Hypostoma undetermined 5
(Pl. 7, fig. 9; Pl. 15, fig. 2)

Material. Three specimens, one an external mould, CPC 15201 (figured) and 19393-19394.

Occurence. Mount Murray, horizons 301/11, 93 m above the base of measured section 301, and localities 231 (= 301/5) and 234 (= 301/11).

Age. Late Cambrian, Idamean, *Stigmatoa diloma* Assemblage-Zone.

Comments. This type of hypostoma is characterised by long anterior wings, a wide anterior margin, subrectangular median body, narrow parallel lateral borders, and a gently rounded posterior margin. The anterior and posterior lobes of the median body are poorly separated, and the maculae are only faintly visible. The lateral marginal furrows are anteriorly deepened.

A generic assignation is not possible at the present time.

Hypostoma undetermined 6
(Pl. 7, fig. 8)

Material. Two specimens, one an external mould, CPC 15202 (illustrated) and CPC 19395.

Occurrence. Mount Murray, horizon 301/4, 35 m above the base of section 301; and locality 231 (= 301/4).

Age. Late Cambrian, Idamean, *Stigmatoa diloma* Assemblage-Zone.

Comment. Hypostoma 6 is characterised by an ovoid, convex median body, with prominent elongate bean-shaped maculae. It also has narrow lateral borders, and anterior wings which are broad-based and appear to slope strongly addorsally (in life position). A Bertillon pattern of terrace lines is present on CPC 19395.

These specimens most closely compare to that previously illustrated (Shergold, 1980, pl. 20, fig. 10) as hypostoma undet. 1, which was considered to probably represent the ceratopygid *Haniwoides varia.* By analogy hypostoma undetermined 6 could belong to *Proceratopyge (Proceratopyge)* or even *Aplotaspis.*

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APPENDIX 1: CATALOGUE OF REGISTERED MATERIAL

1. Figured material

CPC No.	*Taxon*			
14959	*Pseudagnostus (Ps.) vastulus* Whitehouse	Hypotype	1	2
14960		Hypotype	1	1
14961		Hypotype	1	3
14962		Hypotype	1	4
14963		Hypotype	1	5
14964		Hypotype	1	8
14965		Hypotype	1	14
14966		Hypotype	1	13
14967		Hypotype	1	10
14968		Hypotype	1	12
14969		Hypotype	1	11
14970		Hypotype	1	9
14978	*Pseudagnostus (Ps.) idalis* Öpik *sagittus* subsp. nov.	Holotype	3	7
14979		Plastoparatype	3	6
14980		Paratype	3	1
14981		Plastoparatype	3	3
14982A		Paratype	3	2
14983		Plastoparatype	3	5
14984		Paratype	3	4
14985	*Pseudagnostus (Ps.) idalis* Öpik sensu lato	Hypotype	2	15
14986A		Hypotype	2	14
14987	*Pseudagnostus (Ps.) idalis* Öpik *sagittus* subsp. nov.	Paratype	3	8
14988	*Pseudagnostus (Ps.)* sp. VIII	Figured specimen	3	10
14989		Figured specimen	3	11
14990A	*Pseudagnostus (Ps.)* sp. IX	Figured specimen	3	9
14991	*Peratagnostus nobilis* Öpik	Hypotype	6	1
14992		Hypotype	6	2
14993		Hypotype	6	3
14994A		Hypotype	6	4
14995		Hypotype	6	5
14996		Plastohypotype	6	6
14997		Plastohypotype	6	7
14998A	*Innitagnostus?* sp. undet.	Figured specimen	5	8
14998B		Figured specimen	5	7
14999B	*Idolagnostus* sp. undet.	Figured specimen	3	12
15000A	*Kormagnostella inventa* sp. nov.	Paratype	6	13
15001		Holotype	6	12
15002		Paratype	6	15
15003	*Homagnostus* sp. 1	Figured specimen	5	11
15004		Figured specimen	5	10
15005	*Homagnostus* sp. 2	Figured specimen	5	12
15006	*Homagnostus?* sp. undet.	Figured specimen	5	9
15124	*Proceratopyge (P.) lata* Whitehouse	Hypotype	16	1
15125		Plastohypotype	16	2
15126		Hypotype	16	3
15127		Hypotype	16	4
15128		Hypotype	16	5
15129		Hypotype	16	6
15130		Hypotype	16	9
15131		Hypotype	16	8
15132	*Proceratopyge (P.)* sp. undet.	Figured specimen	17	11
15133		Figured specimen	17	12
15134	*Aplotaspis mucrora* Henderson	Hypotype	15	3
15135		Plastohypotype	15	4
15136		Plastohypotype	15	5
15137A		Hypotype	15	6
15138		Plastohypotype	15	7
15139		Hypotype	15	9

CPC No.	*Taxon*	*Type*	*Plate*	*Figure*
15140		Hypotype	15	8
15141	*Corynexochus plumula* Whitehouse	Hypotype	14	1
15142		Hypotype	14	3
15143		Hypotype	14	5
15144		Hypotype	14	2
15145		Hypotype	14	4
15146		Hypotype	14	6A
15147		Hypotype	14	7
15148	*Stigmatoa diloma* Öpik	Hypotype	7	1
15149	*Stigmatoa sidonia* Öpik	Hypotype	7	2
15150		Hypotype	7	3
15151	Genus et species undetermined E	Figured specimen	14	8
		Figured specimen	14	6B
15153	*Eugonocare tessellatum* Whitehouse	Plastohypotype	10	1
15154		Hypotype	10	2
15155		Hypotype	10	3
15156		Hypotype	10	4
15157		Hypotype	10	6
15158		Hypotype	10	5
15159		Hypotype	10	7
15160		Hypotype	10	8
15161	*Irvingella tropica* Öpik	Hypotype	7	6, 7
15162		Hypotype	7	4
15163		Hypotype	7	5
15164		Hypotype	8	10
15165	*Chalfontia alta* (Henderson)	Hypotype	8	1
15166		Hypotype	8	2, 3
15167		Hypotype	8	6
15168		Hypotype	8	7
15169		Hypotype	8	4, 5
15170		Hypotype	8	8
15171	*Protemnites burkensis* sp. nov.	Holotype	9	3–5
15172		Paratype	9	6
15173		Paratype	9	7
15174A	*Protemnites* sp. undet.	Figured specimen	9	8, 9
15175A	*Mecophrys selenis* gen. et sp. nov.	Holotype	11	2
15175B		Plastoholotype	11	1
15176B		Plastoparatype	11	3
15177	*Mecophrys mecophrys* gen. et sp. nov.	Holotype	11	6, 7
15178		Paratype	11	8
15179		Plastoparatype	11	4, 5
15180		Paratype	11	9
15181		Paratype	11	10
15182A	Genus et species undetermined A	Figured specimen	12	9
15183A	Genus et species undetermined C	Figured specimen	12	6
15183B		Figured specimen	12	5
15184		Figured specimen	12	7
15185A		Figured specimen	12	8
15186	Genus et species undetermined B	Figured specimen	12	1
15187A		Figured specimen	12	4
15188		Figured specimen	12	2
15189A	*Stigmatoa?* sp. undet.	Figured specimen	11	11
15190B	*Parakoldinioidia* sp. aff. *P. typicalis* Endo	Hypotype	12	11, 12
15191	Genus et species undetermined D	Figured specimen	8	9
15192	*Pagodia (Idamea)* cf. *baccata* Öpik	Hypotype	13	1
15193		Hypotype	13	2
15194		Hypotype	13	3
15195		Hypotype	13	4
15196		Hypotype	13	5
15197		Hypotype	13	6
15198		Hypotype	13	7
15199	*Prochuangia* sp. undet.	Figured specimen	13	8

CPC No.	*Taxon*	*Type*	*Plate*	*Figure*
15201	Hypostoma undetermined 5	Figured specimen	7	9
15202	Hypostoma undetermined 6	Figured specimen	7	8
17845	*Innitagnostus inexpectans* (Kobayashi)	Hypotype	4	2
17846B		Hypotype	4	1
17847B		Hypotype	4	3
17848B		Hypotype	4	4
17849		Hypotype	4	5
17850		Hypotype	4	6
17857	*Peratagnostus nobilis* Öpik	Hypotype	6	8
17858		Hypotype	6	9
17859		Hypotype	6	10
17860		Hypotype	6	11
17886	*Kormagnostella inventa* sp. nov.	Paratype	6	16
17887		Paratype	6	17
17893	*Glyptagnostus reticulatus reticulatus* (Angelin)	Plastohypotype	4	1
17894		Plastohypotype	4	2
17895		Hypotype	4	3
17896B		Plastohypotype	4	4
17897B		Plastohypotype	4	5
17898A		Hypotype	4	6
17899		Hypotype	4	7
17900A		Hypotype	4	8
17901		Hypotype	4	10
17902B		Plastohypotype	4	11
17903		Hypotype	4	9
17904B		Plastohypotype	4	12
17907	*Pseudagnostus (Ps.) idalis idalis* Öpik	Hypotype	2	1
17908		Hypotype	2	2
17909		Hypotype	2	3
17910		Hypotype	2	4
17911		Hypotype	2	5
17912		Hypotype	2	6
17913A		Hypotype	2	7
17914		Hypotype	2	8
17915		Hypotype	2	9
17916		Hypotype	2	10
17917		Hypotype	2	11
17918		Hypotype	2	12
17919		Hypotype	2	13
19261	*Eugonocare whitehousei* Henderson	Plastohypotype	17	1
19262B		Plastohypotype	17	2
19262A		Hypotype	17	3
19263B		Plastohypotype	17	4
19265	*Aphelaspis* sp. undet.	Figured specimen	17	5
19266		Figured specimen	17	6
19326	*Parakoldinioidia* sp. aff. *P. typicalis* Endo	Hypotype	12	10
19382	*Aplotaspis mucrora* Henderson	Plastohypotype	15	2
19383	Genus et species undetermined B	Figured specimen	12	3

2. Non-figured paratypes

CPC No.	*Taxon*
14976–14977	*Pseudagnostus (Ps.) idalis* Öpik *sagittus* subsp. nov.
17851–17853	*Innitagnostus inexpectans* (Kobayashi)
17854–17856	*Homagnostus?* sp.
17861–17885	*Peratagnostus nobilis* Öpik
17888–17892	*Kormagnostella inventa* sp. nov.
17905–17906	*Glyptagnostus reticulatus reticulatus* (Angelin)
17920–17926	*Pseudagnostus (Ps.) idalis idalis* Öpik
19177–19208	*Pseudagnostus (Ps.) idalis idalis* Öpik
19209–19212	*Pseudagnostus (Ps.) idalis* Öpik sensu lato
19213–19238	*Pseudagnostus (Ps.) vastulus* Whitehouse
19239	*Pseudagnostus (Pseudagnostus)* sp. VIII

CPC No.	*Taxon*
19240–19245	*Irvingella tropica* Öpik
19246–19260	*Eugonocare tessellatum* Whitehouse
19264	*Eugonocare whitehousei* Henderson
19267–19276	*Mecophrys mecophrys* gen. et. sp. nov.
19277–19325	*Pagodia (Idamea)* cf. *baccata* Öpik
19327–19330	*Parakoldinioidia* sp. aff. *P. typicalis* Endo
19331–19335	*Corynexochus plumula* Whitehouse
19336–19380	*Proceratopyge (P.) lata* Whitehouse
19381	*Proceratopyge (Proceratopyge)* sp. undet.
19383–19392	*Aplotaspis mucrora* Henderson
19393–19394	Hypostoma undetermined 5
19395	Hypostoma undetermined 6

3. Registered numbers by taxon

(Figured specimens are marked with asterisk)

	CPC
Aphelaspis sp. undet.	19265–19266*
Aplotaspis mucrora Henderson	15134–15140*
	19382*
	19383–19392
Chalfontia alta (Henderson)	15165–15170*
Corynexochus plumula Whitehouse	15141–15147*
	19331–19335
Eugonocare tessellatum Whitehouse	15153–15160*
	19246–19260
Eugonocare whitehousei Henderson	19261–19263*
	19264
Genus et species undetermined A	15182*
Genus et species undetermined B	15186–15188*
	19383*
Genus et species undetermined C	15183–15185*
Genus et species undetermined D	15191*
Genus et species undetermined E	15151–15152*
Glyptagnostus reticulatus reticulatus (Angelin)	17893–17906*
Homagnostus sp. 1	15003–15004*
Homagnostus sp. 2	15005*
Homagnostus? sp. undet.	15006*
	17854–17856
Hypostoma undetermined 5	15201*
	19393–19394
Hypostoma undetermined 6	15202*
	19395
Idolagnostus sp. undet.	14999*
Innitagnostus inexpectans (Kobayashi)	17845–17850*
	17851–17853
Innitagnostus? sp. undet.	14998*
Irvingella tropica Öpik	15161–15164*
	19240–19245
Kormagnostella inventa sp. nov.	15000–15002*
	17886–17887*
	17888–17892
Mecophrys mecophrys gen. et sp. nov.	15177–15181*
	19267–19276
Mecophrys selenis gen. et sp. nov.	15175–15176*
Pagodia (Idamea) cf. *baccata* Öpik	15192–15198*
	19277–19325
Parakoldinioidia sp. aff. *P. typicalis* Endo	15190*
	19326*
	19327–19330
Peratognostus nobilis Öpik	14991–14997*
	17857–17860*
	17861–17885

	CPC
Proceratopyge (P.) lata Whitehouse	15124–15131*
	19336–19380
Proceratopyge (P.) sp. undet.	15132–15133*
	19381
Prochuangia sp. undet.	15199*
Protemnites burkensis sp. nov.	15171–15173*
Protemnites sp. undet.	15174*
Pseudagnostus (Ps.) idalis idalis Öpik	17907–17919*
	17920–17926
	19177–19208
Pseudagnostus (Ps.) idalis Öpik *sagittus* subsp. nov.	14978–14984*
Pseudagnostus (Ps.) idalis Öpik sensu lato	14985–14986*
	19209–19212
Pseudagnostus (Ps.) vastulus Whitehouse	14959–14970*
	19213–19238
Pseudagnostus (Ps.) sp. VIII	14988–14989*
	19239
Pseudagnostus (Ps.) sp. IX	14990*
Stigmatoa diloma Öpik	15148*
Stigmatoa sidonia Öpik	15149–15150*
Stigmatoa? sp. undet.	15189*

APPENDIX 2: INDEX OF SECTIONS AND LOCALITIES

Trilobite faunas are listed from sections at Mount Murray, and localities scattered over the central portion of the Burke River Structural Belt, in the southern part of the Duchess 1:250 000 Geological Series Sheet, SF/54-6 (see Fig. 1).

Localities labelled with prefix D refer to collecting sites investigated in 1958 during the mapping of the Duchess 1:250 000 Sheet (Carter & Öpik, 1963), and in 1967 by members of the BMR Northwest Queensland Phosphate Party (F. de Keyser, J. H. Shergold, C. E. Murray, & R. Thieme *in* de Keyser, 1968).

Localities with a K prefix were collected by the author in 1969. Sections were measured during the course of BMR's Georgina Basin Project in 1974.

Most of the samples containing trilobites have been thin-sectioned and the resulting petrological determinations, based on the Dunham (1962) classification, were made by J. M. Kennard (BMR). The eight-figure numbers quoted refer to an informal BMR data recovery system.

Mount Murray Section 301

301/1 74713070—3 m from the base of section. Finely laminated pelletal grainstone with interlaminated patchily silicified pelletal mudstone and wackestone; some chert biscuits.
Eugonocare tessellatum Whitehouse, indeterminate librigenal and pygidial fragments.

301/2 74713071—9.5 m from the base of section. Pelletal wackestone with irregular patches of silty pelletal mottled grainstone; spar filled vugs, fenestrae, pyrite, compacted.
Eugonocare tessellatum Whitehouse, *Peratagnostus nobilis* Öpik, *Proceratopyge (P.) lata* Whitehouse, *Pseudagnostus (Ps.) vastulus* Whitehouse; undetermined inarticulate brachiopods; sponge spicules.

301/3 74713072—19 m from the base of the section. Finely laminated dark grey chert; silicified aphanitic micrite with silicified skeletal patches; recrystallised pelletal ghosts (after pelletal grainstone?).
Aplotaspis mucrora Henderson, *Eugonocare tessellatum* Whitehouse, *Pagodia (Idamea)* cf. *baccata* Öpik, *Proceratopyge (P.) lata* Whitehouse, *Pseudagnostus* sp. indet.

301/4 74713073—35 m from the base of the section. Interlaminated skeletal pelletal grainstone, silty pelletal grainstone, with slightly silicified skeletal layers.
Corynexochus plumula Whitehouse, *Eugonocare tessellatum* Whitehouse, *Innitagnostus?* sp., *Peratagnostus nobilis* Öpik, *Proceratopyge (P.) lata* Whitehouse, *Protemnites* sp., *Pseudagnostus (Ps.) idalis sagittus* subsp. nov., *Pseudagnostus (Ps.) vastulus* Whitehouse, ptychopariacean genus et sp. undet. E, hypostoma undetermined 6; undetermined inarticulate brachiopods; sponge spicules.

301/5 74713074—37.5 m from the base of the section. Interlaminated pelletal grainstone and skeletal pelletal grainstone.
Aplotaspis mucrora Henderson, *Eugonocare tessellatum* Whitehouse, *Idolagnostus* sp., *Kormagnostella inventa* sp. nov., *Proceratopyge (P.) lata* Whitehouse, *Prochuangia* sp. undet., *Pseudagnostus (Ps.) idalis* Öpik *sagittus* subsp. nov., *Pseudagnostus (Ps.) idalis* Öpik sensu lato, *Pseudagnostus (Ps.) vastulus* Whitehouse; sponge spicules.

301/6 74713075—43 m from the base of the section. Mottled micrite with calcite filled vugs.
Aplotaspis mucrora Henderson, *Pseudagnostus* sp. indet.; undetermined inarticulate brachiopods.

301/7 74713076—52 m from the base of the section. Skeletal grainstone with algal *(Girvanella)* clasts and laminar silicified skeletal 'limestone'.
Pagodia (Idamea) cf. *baccata* Öpik, *Pseudagnostus* sp. indet.; sponge spicules.

301/8 74713077—68 m from the base of the section. Mottled micrite, with pyrite; surface silicification.
No fauna determined.

301/9 74713078—81.5 m from the base of the section. Silicified clast grainstone, minor skeletal grainstone; chert.
Pagodia (Idamea) cf. *baccata* Öpik; sponge spicules.

301/10 74713079—87 m from the base of the section. Finely laminated silicified skeletal micrite, chert nodules.
Irvingella tropica Öpik.

301/11 74713080—93 m from the base of the section. Mottled pelletal skeletal wackestone? with patches of pelletal grainstone.
Chalfontia alta (Henderson), *Homagnostus* sp. indet., *Irvingella tropica* Öpik, *Pagodia (Idamea)* cf. *baccata* Öpik, *Pseudagnostus* sp. indet., hypostoma undetermined 5; undetermined articulate brachiopod.

301/12 74713081—87 m from the base of the section. Clast skeletal grainstone interlaminated with skeletal mudstone with patches of pellet ghosts, disseminated pyrite.
Pagodia (Idamea) cf. *baccata* Öpik, *Prochuangia* sp. undet.?; undetermined inarticulate brachiopods.

Mount Murray Section 302

This section commences on horizon 301/7 approximately 160 m to the south of section 301.

302/1 74713083—16 m from the base of the section, i.e. equivalent to 301/8.
Mottled micrite, skeletal grainstone, with

vugs and weathered micrite clasts.
Aplotaspis mucrora Henderson, *Kormagnostella inventa* sp. nov., *Pagodia (Idamea)* cf. *baccata* Öpik, *Pseudagnostus (Ps.)* sp. VIII; undetermined inarticulate brachiopods.

302/2 74713084—34 m from the base of the section, equivalent to 301/10. Peloidal skeletal grainstone with *Girvanella* peloids, finely recrystallised mudstone laminae; partial silicification of skeletal fragments, and mud infilled skeletal fragments.
Pagodia (Idamea) cf. *baccata* Öpik, *Stigmatoa sidonia* Öpik; undetermined inarticulate brachiopods; pelmatozoan ossicle.

302/3 74713085—37 m from the base of the section, equivalent to 301/11. Skeletal pelletal grainstone with irregular laminae, and skeletal and *Girvanella* peloidal wackestone; pyritic blebs; silicification of skeletal debris.
Chalfontia alta (Henderson), elviniid genus et species undetermined D, *Irvingella tropica* Öpik, *Pagodia (Idamea)* cf. *baccata* Öpik, *Prochuangia?* sp. undet.; *Billingsella* sp. undet., undetermined articulate brachiopod.

302/4 74713086—44 m from the base of the section, equivalent to 301/12. Partially silicified peloidal skeletal minor clast grainstone; pyrite with interstitial silicification; *Girvanella* peloids; geopetals; irregular and oval pellets.
Chalfontia alta (Henderson), *Homagnostus* sp., *Irvingella tropica* Öpik, *Pagodia (Idamea)* cf. *baccata* Öpik, *Stigmatoa sidonia* Öpik; *Billingsella* sp.; undetermined inarticulate brachiopods.

302/5 74713087—76 m from the base of the section. Laminated silty micaceous pelletal grainstone.
Ceratopygacean genus et species undetermined C, elviniid genus et species undetermined D, *Pseudagnostus (Ps.)* sp. IX, pterocephaliid genus et species undetermined A; undetermined inarticulate brachiopod.

302/6 74713088—105 m from the base of the section. Mottled partially silicified patchy skeletal pelletal grainstone, pelmatozoan grainstone, and skeletal pelletal packstone to wackestone.
Elviniid genus et species undetermined D, *Mecophrys selenis* gen. et sp. nov., *Parakoldinioidia* sp. aff. *P. typicalis* Endo, *Pseudagnostus (Ps.)* sp. indet.; *Billingsella* sp. undet.; undetermined inarticulate brachiopods.

302/7 74713089—154 m from the base of the section. Mottled pelletal grainstone, skeletal pelletal wackestone to packstone; partial silicification mainly associated with recrystallised carbonate patches.
Mecophrys mecophrys gen. et sp. nov.; undetermined inarticulate brachiopods; silicified branching horizontal borings.

302/8 74713090—163 m from the base of the section. Silicified micrite.
No recorded fauna.

302/9 74713091—178 m from the base of the section. Silty pelletal skeletal grainstone.
Asaphacean genus et species undetermined B, *Mecophrys mecophrys* gen. et sp. nov., *Parakoldinioidia* sp. aff. *P. typicalis* Endo, *Stigmatoa* sp. undet.

302/10 74713092—202 m from the base of the section. Pelletal skeletal clast grainstone, minor silicification as cement; disseminated pyrite.
Eoorthis sp. undet.

Mount Murray localities not on section

K229 74713061—Equivalent to 301/3. Recrystallised limestone.
Eugonocare tessellatum Whitehouse, *Idolagnostus* sp., *Peratognastus nobilis* Öpik, *Proceratopyge (P.) lata* Whitehouse, *Pseudagnostus vastulus* Whitehouse; sponge spicules.

K230 74713062—Equivalent to 301/4. Silty pelletal grainstone, skeletal debris and pelletal ghosts.
Eugonocare tessellatum Whitehouse, *Peratagnostus nobilis* Öpik, *Proceratopyge (P.) lata* Whitehouse, *Pseudagnostus (Ps.) idalis* Öpik *sagittus* subsp. nov., *Pseudagnostus (Ps.) vastulus* Whitehouse; undetermined inarticulate brachiopods; sponge spicules.

K231 74713063—Equivalent to 301/5. Laminated chert biscuits in brecciated silicified skeletal wackestone.
Aplotaspis mucrora Henderson, *Corynexochus plumula* Whitehouse, *Eugonocare tessellatum* Whitehouse, *Homagnostus* sp., *Pagodia (Idamea)* cf. *baccata* Öpik, *Proceratopyge (P.)* sp., *Pseudagnostus (Ps.) idalis idalis* Öpik, *Pseudagnostus (Ps.) idalis* Öpik *sagittus* subsp. nov., *Pseudagnostus (Ps.) vastulus* Whitehouse, *Stigmatoa diloma* Öpik, ptychopariacean gen. et sp. undet. E, hypostoma undetermined 5, hypostoma undetermined 6; undetermined inarticulate brachiopods; sponge spicules.

K232 74713064—Equivalent to 301/7 and 302/0. Silicified skeletal packstone and grainstone over skeletal mudstone.
Aplotaspis mucrora Henderson, *Homagnostus?* sp., *Pagodia (Idamea)* cf. *baccata* Öpik, *Pseudagnostus* sp. indet.; *Billingsella* sp. undet., undetermined inarticulate brachiopods; sponge spicules.

K233 74713065—Equivalent to 301/10 and 302/2. Patchily silicified skeletal wackestone with patches of pelletal grainstone.
Irvingella tropica Öpik, *Pagodia (Idamea)* cf. *baccata* Öpik, *Pseudagnostus (Ps.)* sp.

indet., *Stigmatoa sidonia* Öpik; undetermined inarticulate brachiopods.

K234 74713066—Equivalent to 301/11 and 302/3. Patchily silicified skeletal wackestone.
Chalfontia alta (Henderson), *Eugonocare tessellatum* Whitehouse, *Homagnostus* sp. 1, *Homagnostus?* sp. undet., *Irvingella tropica Öpik, Mecophrys selenis* gen. et sp. nov.?, *Pagodia (Idamea)* cf. *baccata* Öpik, *Protemnites burkensis* sp. nov., *Pseudagnostus (Ps.)* sp. indet., hypostoma undetermined 6; articulate brachiopod undetermined; undetermined inarticulate brachiopods.

K235 74713067—Equivalent to 301/12 and 302/4. Patchily silicified skeletal wackestone.
Homagnostus sp. 1, *Irvingella tropica* Öpik, *Pagodia (Idamea)* cf. *baccata* Öpik, *Protemnites burkensis* sp. nov.; undetermined inarticulate brachiopods.

K236 74713068—Equivalent to 302/6. Silicified skeletal grainstone.
Homagnostus? sp., *Mecophrys selenis* gen. et. sp. nov., *Parakoldinioidia* sp. aff. *P. typicalis* Endo, pterocephaliid genus et species undetermined A.

K237 74713069—Equivalent to 302/9. Patchily recrystallised clast skeletal grainstone.
Asaphacean genus et species undetermined B, *Mecophrys mecophrys* gen. et sp. nov., *Parakoldinioidia* sp. aff., *P. typicalis* Endo, *Pseudagnostus* sp. indet., *Stigmatoa?* sp.; undetermined articulate brachiopods.

Other localities

Other sampled localities occur in two distinct clusters, one on the western side of the Burke River Structural Belt, in the general vicinity 10 km east-northeast of Burke Yards and Bore, and the other on the eastern side of the Structural Belt, on the western side of Mistake Creek.

D471–473, 497–499—Eastern side of Burke River Structural Belt, western side of Mistake Creek (Fig. 1), 300 m south of the junction of Mistake and Gin Creeks. Pomegranate Limestone here forms a series of benches which dip eastwards to Mistake Creek from which they are separated by an alluvial plain 300 m wide. Locality D473 is on the lowest exposed bench, and D499 on the highest. The spacing of localities is related to D473 which is regarded as a basal datum. The samples were collected in 1967 by C. E. Murray.

D473 74713137—Lowest exposed terrace comprising beds of hard, dark grey bituminous limestone and alternate softer calcareous siltstone. Thin section is of partly recrystallised coarsely laminated silty pelletal skeletal grainstone with infiltered mud.
Aphelaspis sp.,. *Glyptagnostus reticulatus reticulatus* (Angelin), *Proceratopyge (P.)* cf. *nectans* Whitehouse, *Pseudagnostus* sp. indet.; undetermined inarticulate brachiopods.

D472 74713138—Approximately 0.6 m above locality D473. Finely laminated silty pelletal skeletal grainstone with finely disseminated pyrite.
Glyptagnostus reticulatus reticulatus (Angelin).

D471 74713139—Approximately 2.4 m above locality D473. Finely laminated silty pelletal minor skeletal grainstone, with finely disseminated pyrite.
Glyptagnostus reticulatus reticulatus (Angelin), *Innitagnostus inexpectans* (Kobayashi), *Olenus ogilviei* Öpik.

D497 74713140—Approximately 8.5 m above locality D473. Finely laminated silty pelletal grainstone interlaminated with shaly pelletal limestone.
Glyptagnostus reticulatus reticulatus (Angelin), *Innitagnostus inexpectans* (Kobayashi), *Pseudagnostus* sp. aff. *Ps. idalis* Öpik sensu lato.

D498 74713141—Approximately 10.6 m above locality D473. Finely laminated silty pelletal grainstone interlaminated with 'fine grained limestone'.
Glyptagnostus reticulatus reticulatus (Angelin), *Pseudagnostus (Ps.) idalis idalis* Öpik.

D499 74713142—Approximately 12.4 m above locality D473. Laminated silty pelletal grainstone.
Glyptagnostus reticulatus reticulatus (Angelin), *Pseudagnostus idalis idalis* Öpik; undetermined acrotretid brachiopod.

D500–D504 West bank of Mort River, 9 km south of locality D473 above. A series of limestone terraces with locality D500 at the base, and D504 at the top. Collected C. E. Murray, 1967.

D500 74713143—1.5 m above the base of this section. Interlaminated silty pelletal grainstone with shaly limestone.
Glyptagnostus sp. indet.

D501 74713144—2.7 m from base of section. Recrystallised peloidal grainstone.
Glyptagnostus sp. indet., *Eugonocare whitehousei* Henderson, *Innitagnostus inexpectans* (Kobayashi), *Peratagnostus nobilis* Öpik, *Proceratopyge (P.) cryptica* Henderson?, *Pseudagnostus (Ps.) idalis idalis* Öpik; undetermined inarticulate brachiopods; sponge spicules.

D502 74713145—3 m above base of section. Recrystallised laminated, cross-laminated, fine sandy pelletal grainstone with minor shaly laminae.
Corynexochus plumula Whitehouse, *Eugonocare whitehousei* Henderson, *Innitagnostus inexpectans* (Kobayashi), *Procerato-*

pyge (P.) cryptica Henderson?, *Pseudagnostus (Ps.) idalis idalis* Öpik, *Pseudagnostus (Ps.) vastulus* Whitehouse; undetermined inarticulate brachiopods; sponge spicules.

D503 74713146—3.6 m above base of section. Silty and shaly pelletal recrystallised limestone.
Innitagnostus inexpectans (Kobayashi), *Pseudagnostus (Ps.)* cf. *idalis idalis* Öpik; sponge spicules.

D504 74713147—5.8 m above base of section. Silty skeletal mudstone.
Agnostacean trilobite undetermined; undetermined inarticulate brachiopods.

D662, D673–674 Outcrop areas on the western side of the Burke River Structural Belt between Pomegranate Creek and the Burke River (Fig. 1). Collected by F. de Keyser (BMR) in 1967.

D662 74713148—3 km northeast of the junction of the Burke River and Pilgrim Creek, and 3.70 km southeast of Pilgrim Well. A small outcrop of silty limestone. In thin section, the sample is finely laminated silty pelletal grainstone with shaly laminae.
Eugonocare tessellatum Whitehouse, *Kormagnostella inventa* sp. nov., *Peratagnostus nobilis* Öpik, *Proceratopyge (P.) lata* Whitehouse, *Pseudagnostus (Ps.) idalis idalis* Öpik, *Pseudagnostus (Ps.) idalis* Öpik *sagittus* subsp. nov., *Pseudagnostus (Ps.) vastulus* Whitehouse; undetermined inarticulate brachiopods; sponge spicules.

D673 74713149—8 km due north of Pomegranate Bore. Outcrops of limestone and silty or flaggy limestone in creek cutting through 'O'Hara Shale'. In thin section, interlaminated finely laminated silty pelletal grainstone and shaly laminae, with disseminated pyrite.
Glyptagnostus reticulatus reticulatus (Angelin), *Homagnostus* sp. 2, *Pseudagnostus (Ps.) idalis idalis* Öpik; sponge spicules.

D674 74713150—8.6 km north-northeast of Pomegranate Bore. Outcrops of silty or sandy bituminous limestone in deep creek bed, about 5 km northeast of Öpik's locality D132. Finely laminated silty shaly clast pelletal skeletal grainstone.
Glyptagnostus reticulatus reticulatus (Angelin), *Innitagnostus inexpectans* (Kobayashi), *Proceratopyge* sp. undet., *Pseudagnostus* sp. indet.; undetermined inarticulate brachiopods.

PLATE 1

Pseudagnostus (Ps.) vastulus Whitehouse, 1936

Fig. 1 CPC 14960, partially exfoliated cephalon; length 2.5 mm; locality K230; x14

Fig. 2 CPC 14959, as above; length 3.85 mm; locality K230; x9

Fig. 3 CPC 14961, as above; length 3.7 mm; locality 301/4; x10

Fig. 4 CPC 14962, typical cephalic exoskeleton, showing striated border; length 4.0 mm; locality K230; x8

Fig. 5 CPC 14963, crushed, incomplete, articulated exoskeleton, cephalic length 1.25 mm; locality K230; x25

Fig. 6 UQF 3202, paratype cephalon of *Pseudagnostus (Ps.) vastulus* Whitehouse (1936, pl. 10, fig. 3); x7.5

Fig. 7 UQF 3199, silicified holotype of *Pseudagnostus (Ps.) nuperus* Whitehouse, replica of exfoliated cephalon (see Whitehouse, 1936, pl. 10, fig. 5); x8

Fig. 8 CPC 14964, meraspid pygidial exoskeleton; length (Lp_2) 0.95 mm; locality K230; x32

Fig. 9 CPC 14970, late meraspid or early holaspid pygidial exoskeleton; length (Lp_2) 1.2 mm; locality D662; x25

Fig. 10 CPC 14967, exfoliated pygidium; length (Lp_2) 3.0 mm; locality 301/5; x10

Fig. 11 CPC 14969, late holaspid pygidial exoskeleton; length 4.5 mm; locality 301/5; x8

Fig. 12 CPC 14968, exfoliated pygidium; length (Lp_2) 2.8 mm; locality 301/5; x12

Fig. 13 CPC 14966, exfoliated late holaspid pygidium showing traces of caecal morphology; length (Lp_2) 5.5 mm; locality 301/4; x6

Fig. 14 CPC 14965, exfoliated late holaspid pygidium; length (Lp_2) 4.7 mm; locality 301/4; x8

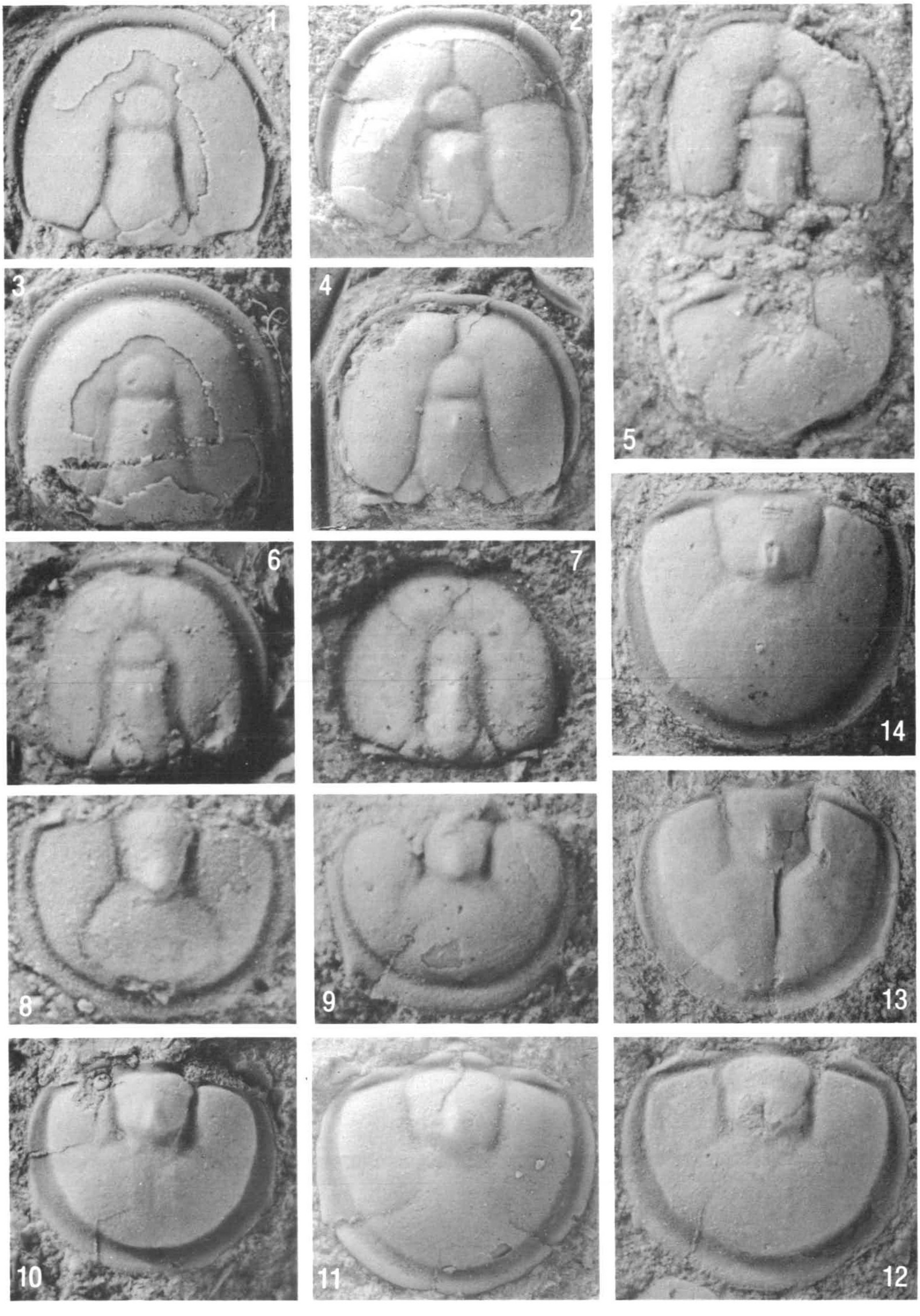
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PLATE 2

Figs. 1-13	**Pseudagnostus (Ps.) idalis idalis** Öpik, 1967
Fig. 1	CPC 17907, exfoliated cephalon; length 4.1 mm; locality D662; x8
Fig. 2	CPC17908, as above; length 3.4 mm; locality D662; x10
Fig. 3	CPC 17909, as above, showing caeca crossing marginal furrow; length 3.3 mm; locality D662; x10
Fig. 4	CPC 17910, as above, vestiges of shell; length 2.4 mm; locality D662; x15
Fig. 5	CPC 17911, exfoliated cephalon; length 3.8 mm; locality D662; x10
Fig. 6	CPC 17912, as above; length 3.8 mm; locality D662; x10
Fig. 7	CPC 17913A, partly exfoliated early holaspid pygidium; length (Lp_2) 1.6 mm; locality D662; x20
Fig. 8	CPC 17914, exfoliated pygidium, showing diverticula crossing accessory furrows; length (Lp_2) 2.9 mm; locality D662; x12
Fig. 9	CPC 17915, partly exfoliated pygidium; length (Lp_2) 2.8 mm; locality D662; x12
Fig. 10	CPC 17916, exfoliated pygidium; length 3.7 mm; locality D662; x8
Fig. 11	CPC 17917, as above; length (Lp_2) 3.6 mm; locality D662; x8.5
Fig. 12	CPC 17918, as above, late holaspid; length (Lp_2) 4.4 mm; locality D662; x6.5
Fig. 13	CPC 17919, as above, with scrobiculate acrolobe; length (Lp_2) 3.5 mm; locality D662; x10
Figs. 14, 15	**Pseudagnostus (Ps.) idalis** Öpik, 1967, sensu lato
Fig. 14	CPC 14986A, exfoliated late holaspid cephalon; length 4.45 mm; locality 301/5; x8
Fig. 15	CPC 14985, partly exfoliated pygidium showing scrobiculation of acrolobe; length (Lp_2) 4.25 mm; locality 301/5; x8

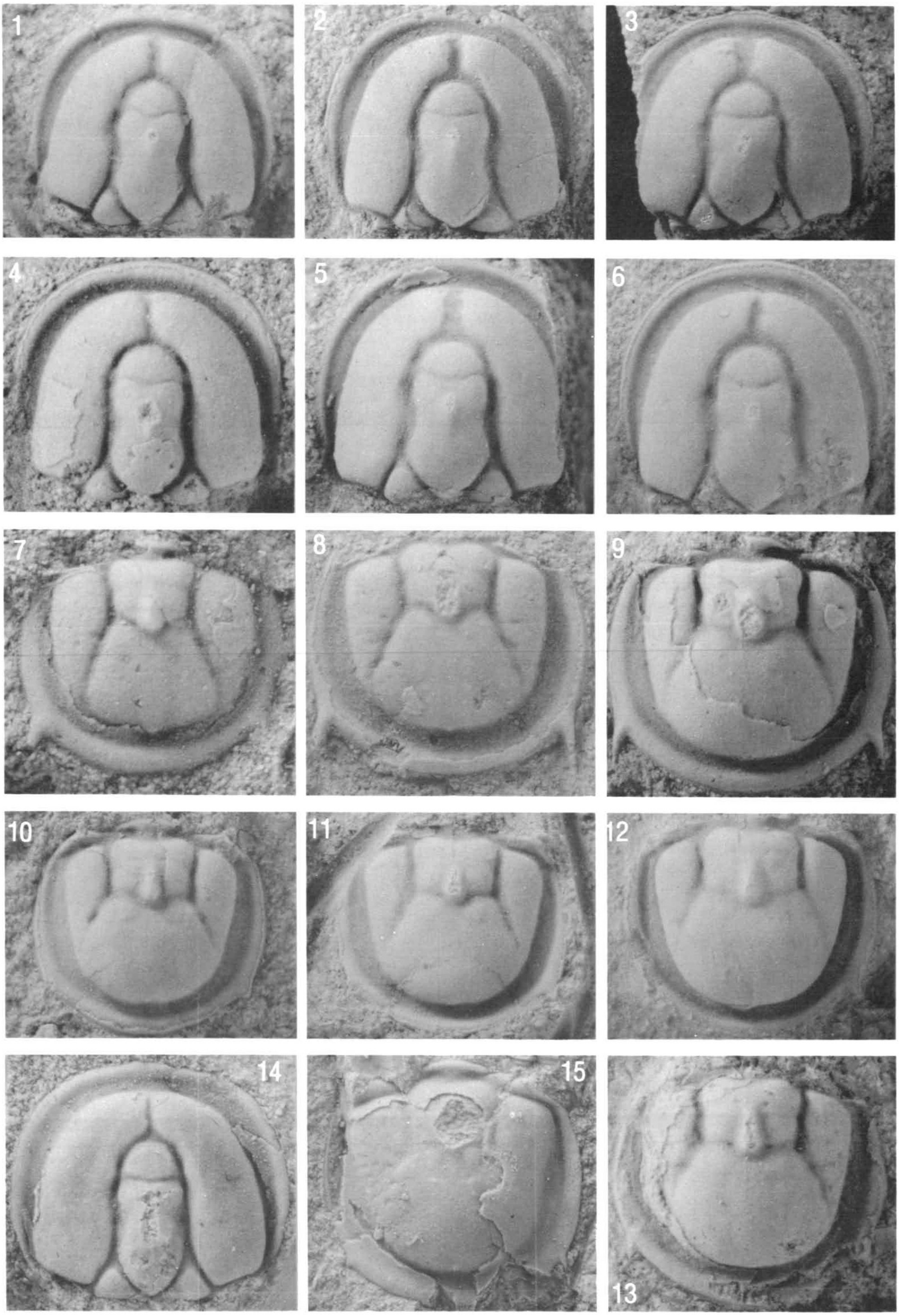
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PLATE 3

Figs. 1-8 **Pseudagnostus (Ps.) idalis sagittus** subsp. nov.

Fig. 1 CPC 14980, exfoliated cephalon showing scrobiculation of the acrolobe, length 4.25 mm; locality 301/5; x9

Fig. 2 CPC 14982A, exfoliated cephalon; length 3.7 mm; locality K231; x10

Fig. 3 CPC 14981, latex replica of silicified parietal mould, showing glabellar locality K231; x20

Fig. 4 CPC 14984, partially exfoliated early holaspid pygidium retaining quadrate shape and posteriorly sited spines; locality 301/5; x16

Fig. 5 CPC 14983, latex replica of silicified pygidial exoskeleton; length (Lp_2) 2.65 mm; locality K231; x14

Fig. 6 CPC 14979, latex replica of partly exfoliated silicified pygidial exoskeleton; length (Lp_2) 4.0 mm; locality K231; x9

Fig. 7 CPC 14978, holotype, exfoliated pygidium showing parietal morphology, characteristic shape; length (Lp_2) 3.0 mm; locality D662; x12

Fig. 8 CPC 14987, exfoliated pygidium with second thoracic segment attached; length (Lp_2) 3.0 mm; locality 301/4; x10

Fig. 9 **Pseudagnostus (Ps.)** sp. IX

Fig. 9 CPC 14990A, exfoliated cephalon; locality 302/5; x9

Figs. 10, 11 **Pseudagnostus (Ps.)** sp. VIII

Fig. 10 CPC 14988, silicified parietal surface, showing cephalic musculature; length 3.4 mm; locality 302/1; x12

Fig. 11 CPC 14989, mostly exfoliated pygidium; length (Lp_2) 4.6 mm; locality 302/1; x8

Fig. 12 **Idolagnostus** sp. undet.

Fig. 12 CPC 14999B, latex replica of incomplete late meraspid or early holaspid cephalon; length 1.5 mm; locality 301/5; x24

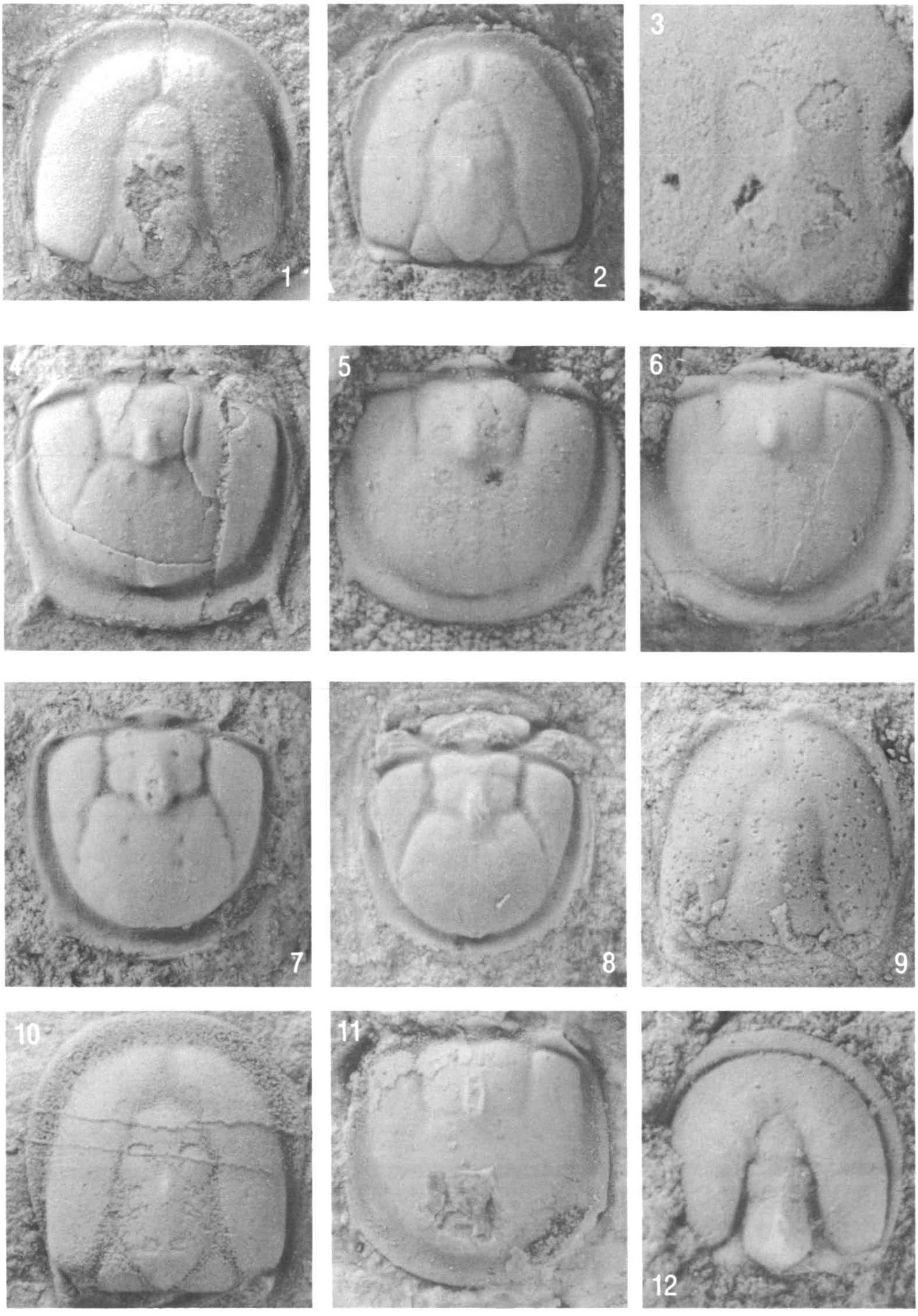
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PLATE 4

Glyptagnostus reticulatus reticulatus (Angelin, 1951)

Fig. 1 CPC 17893, latex replica of late meraspid cephalon showing low density scrobiculation; locality D674; x24

Fig. 2 CPC 17894, latex replica of late meraspid cephalon as above, showing increasing scrobiculation; length 1.4 mm; locality D674; x25

Fig. 3 CPC 17895, exfoliated early holaspid cephalon with three generations of scrobicular bifurcations; length 3.05 mm; locality D471; x12

Fig. 4 CPC 17896B, latex replica of exfoliated cephalon; length 3.8 mm; locality D674; x10

Fig. 5 CPC 17897B, latex replica of exfoliated cephalon with at least four generations of bifurcating scrobicules; length 5.8 mm; locality D674; x6

Fig. 6 CPC 17898A, exfoliated cephalon, as above; length 5.9 mm; locality D471; x6

Fig. 7 CPC 17899, exfoliated cephalon; length 5.2 mm; locality D472; x7

Fig. 8 CPC 17900A, exfoliated, late holaspid, cephalon; length 6.7 mm; locality D471; x5

Fig. 9 CPC 17903, exfoliated pygidium; length 5.0 mm; locality D674; x7

Fig. 10 CPC 17901, meraspid pygidium showing axis simply divided into four parts, and weakly scrobiculate pleural lobes; length (Lp_1) 0.8 mm; locality D674; x24

Fig. 11 CPC 17902B, latex replica of early holaspid pygidium showing muscle scar impressions on 2nd and 3rd axial segments and notulae on remainder, probably representing a total of seven segments; length (Lp_2) 3.8 mm; locality D674; x10

Fig. 12 CPC 17904B, latex replica of late holaspid pygidium showing five generations of scrobicular bifurcations, and notulae of the axis; length (Lp_1) 6.1 mm; locality D674; x6

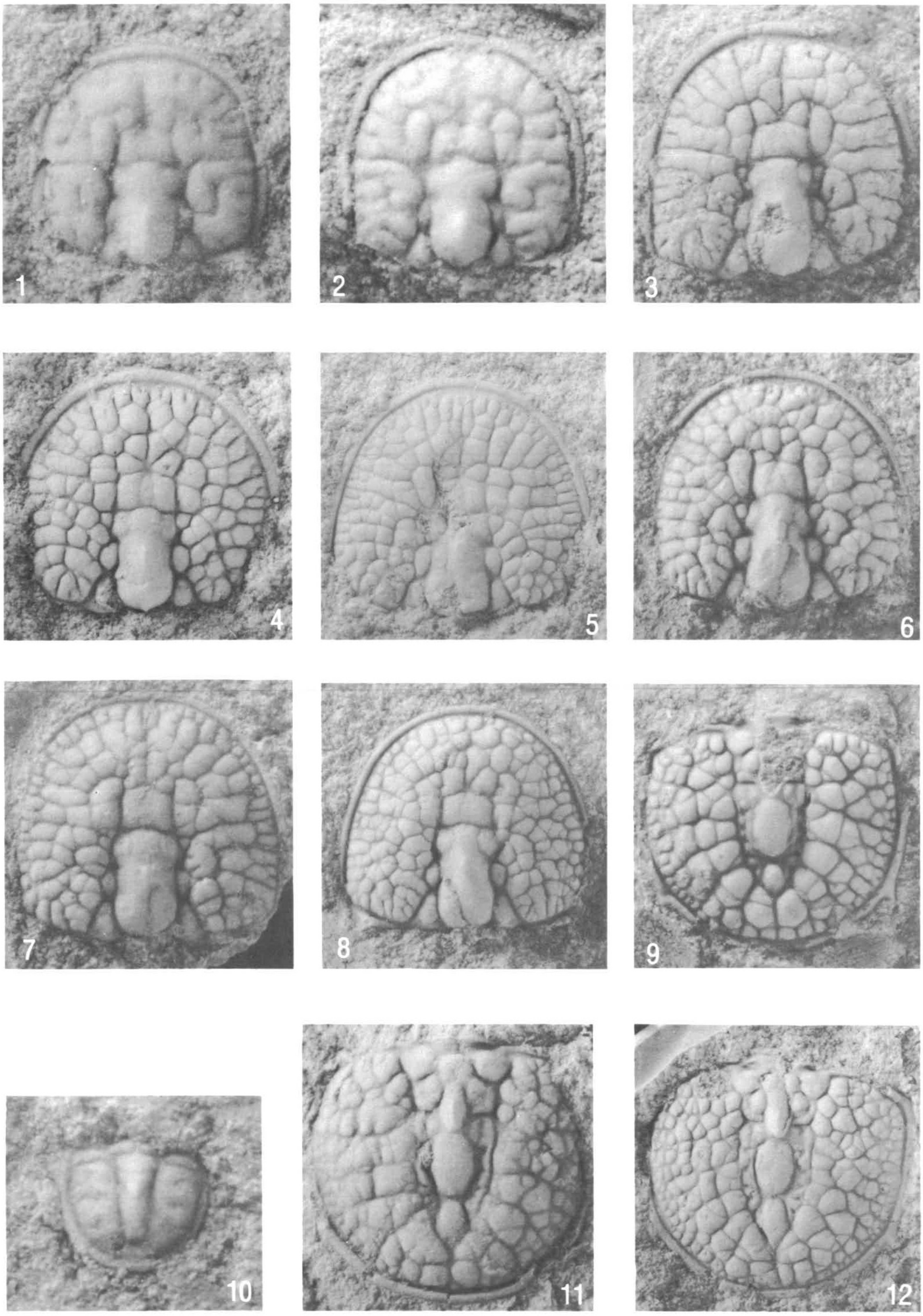
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PLATE 5

Figs. 1-6 **Innitagnostus inexpectans** (Kobayashi, 1938)

Fig. 1 CPC 17846B, latex replica of cephalic exoskeleton, partly exfoliated, showing faint external scrobiculation; locality 502; x20

Fig. 2 CPC 17845, exfoliated cephalon; locality 502; estimated length 2.0 mm; x16

Fig. 3 CPC 17847B, latex replica of partly exfoliated pygidium; locality 502; estimated length (Lp_2) 1.8 mm; x21

Fig. 4 CPC 17848B, latex replica pygidial exoskeleton; locality 502; length (Lp_2) 1.45 mm; x21

Fig. 5 CPC 17849, partly exfoliated pygidium; locality 502; length (Lp_2) 2.3 mm; x12

Fig. 6 CPC 17850, latex replica of partly exfoliated pygidium; locality 501; estimated length (Lp_2) 2.25 mm; x16

Figs. 7, 8 **Innitagnostus?** sp. undet.

Fig. 7 CPC 14998B, latex replica of exfoliated cephalon showing anteriorly sited axial node; locality 301/4; x10

Fig. 8 CPC 14918A, exfoliated cephalon, as above; x12

Fig. 9 **Homagnostus?** sp. undet.

Fig. 9 CPC 15006, weathered silicified replica of probable exfoliated pygidium; length (Lp_1) 3.4 mm; locality K232; x10

Figs. 10, 11 **Homagnostus** sp. 1

Fig. 10 CPC 15004, latex replica from silicified external mould of pygidium; length (Lp_1) 2.3 mm; locality K234; x20

Fig. 11 CPC 15003, latex replica from silicified external mould of pygidium; locality K235; x24

Fig. 12 **Homagnostus** sp. 2

Fig. 12 CPC 15005, pygidial exoskeleton; length (Lp_1) 1.6 mm; locality D673; x24

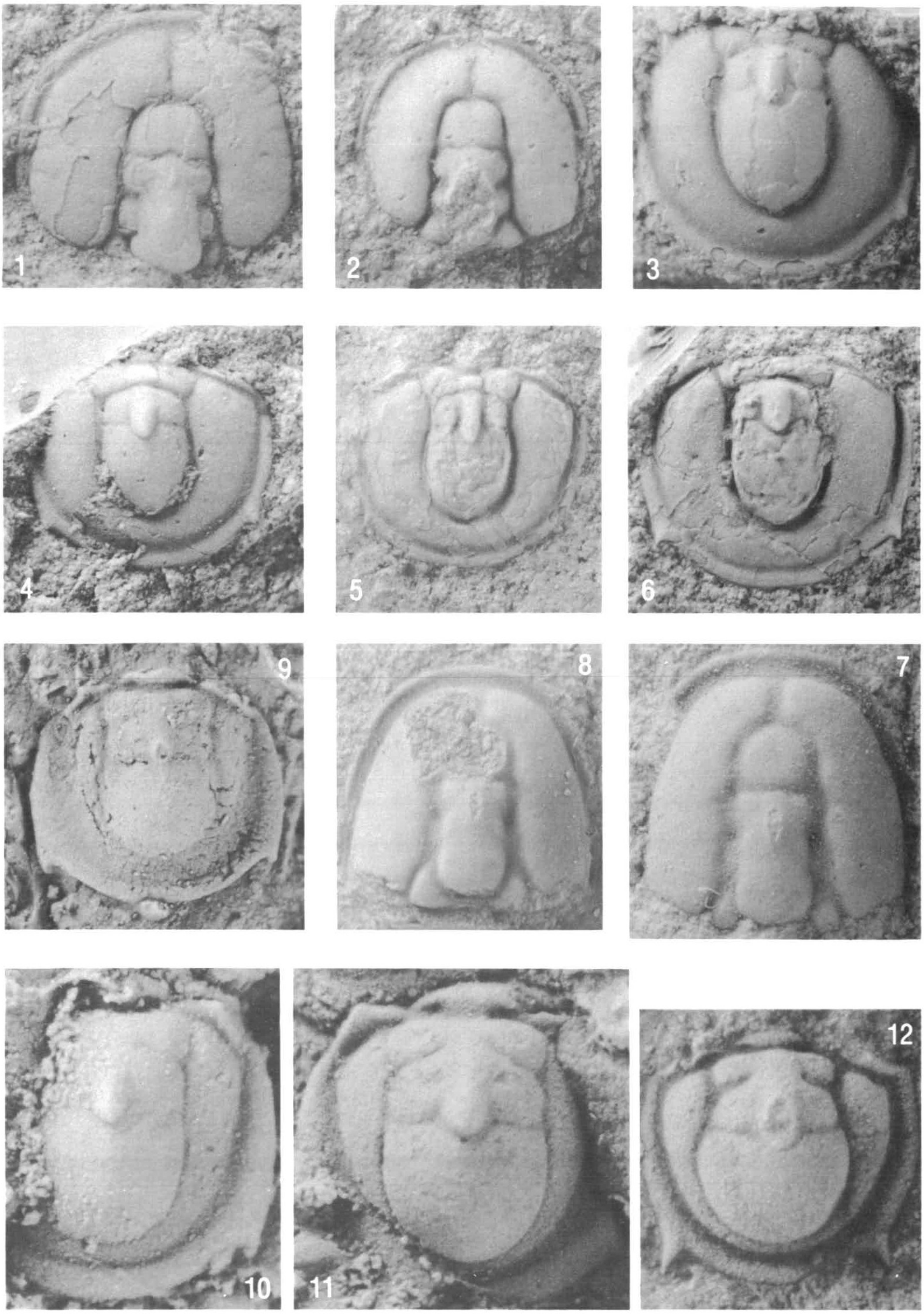
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PLATE 6

Figs. 1-11	**Peratagnostus nobilis** Öpik, 1967
Fig. 1	CPC 14991, meraspid cephalon showing trace of border and posteriorly sited axial glabellar node; length 1.1 mm; locality D662; x25
Fig. 2	CPC 14992, as above; length 1.2 mm; locality K230; x24
Fig. 3	CPC 14993, as above; length 1.2 mm; locality K230; x24
Fig. 4	CPC 14994A, juxtaposed meraspid cephalon and pygidium, cephalic length 0.95 mm, pygidial length (Lp_1) 1.0 mm; locality 301/4; x23
Fig. 5	CPC 14995, meraspid pygidium showing trace of border; length (Lp_2) 1.0 mm; locality 301/4; x22
Fig. 6	CPC 14996, as above, latex replica of exoskeleton; length (Lp_2) 0.95 mm; locality D662; x24
Fig. 7	CPC 14997, latex replica as above; length (Lp_2) 0.85 mm; locality D662; x25
Fig. 8	CPC 17857, early holaspid cephalic exoskeleton showing more anterior glabellar node; length 1.6 mm; locality D662; x21
Fig. 9	CPC 17858, holaspid cephalic exoskeleton; length 3.0 mm; locality 301/2; x12
Fig. 10	CPC 17859, holaspid pygidial exoskeleton, showing completely metamorphosed axial and border morphology; length (Lp_2) 2.0 mm; locality D662; x20
Fig. 11	CPC 17860, early holaspid pygidial exoskeleton showing traces of axial morphology; length (Lp_2) 1.6 mm; locality D662; x20
Figs. 12-17	**Kormagnostella inventa** sp. nov.
Fig. 12	CPC 15001, holotype, exfoliated cephalon; length 1.25 mm; locality 302/1; x32
Fig. 13	CPC 15000A, exfoliated cephalon; length 1.4 mm; locality 301/5; x25
Fig. 14	UQF 3205, cephalon illustrated by Whitehouse (1936, pl. 10, fig. 9) as Gen. et sp. indet.; Glenormiston area; x16
Fig. 15	CPC 15002, pygidial exoskeleton, length (Lp_1) 1.05 mm; locality D662; x24
Fig. 16	CPC 17886, as above; length (Lp_2) 1.2 mm; locality D662; x25
Fig. 17	CPC 17887, as above; length (Lp_2) 1.15 mm; locality 301/5; x28

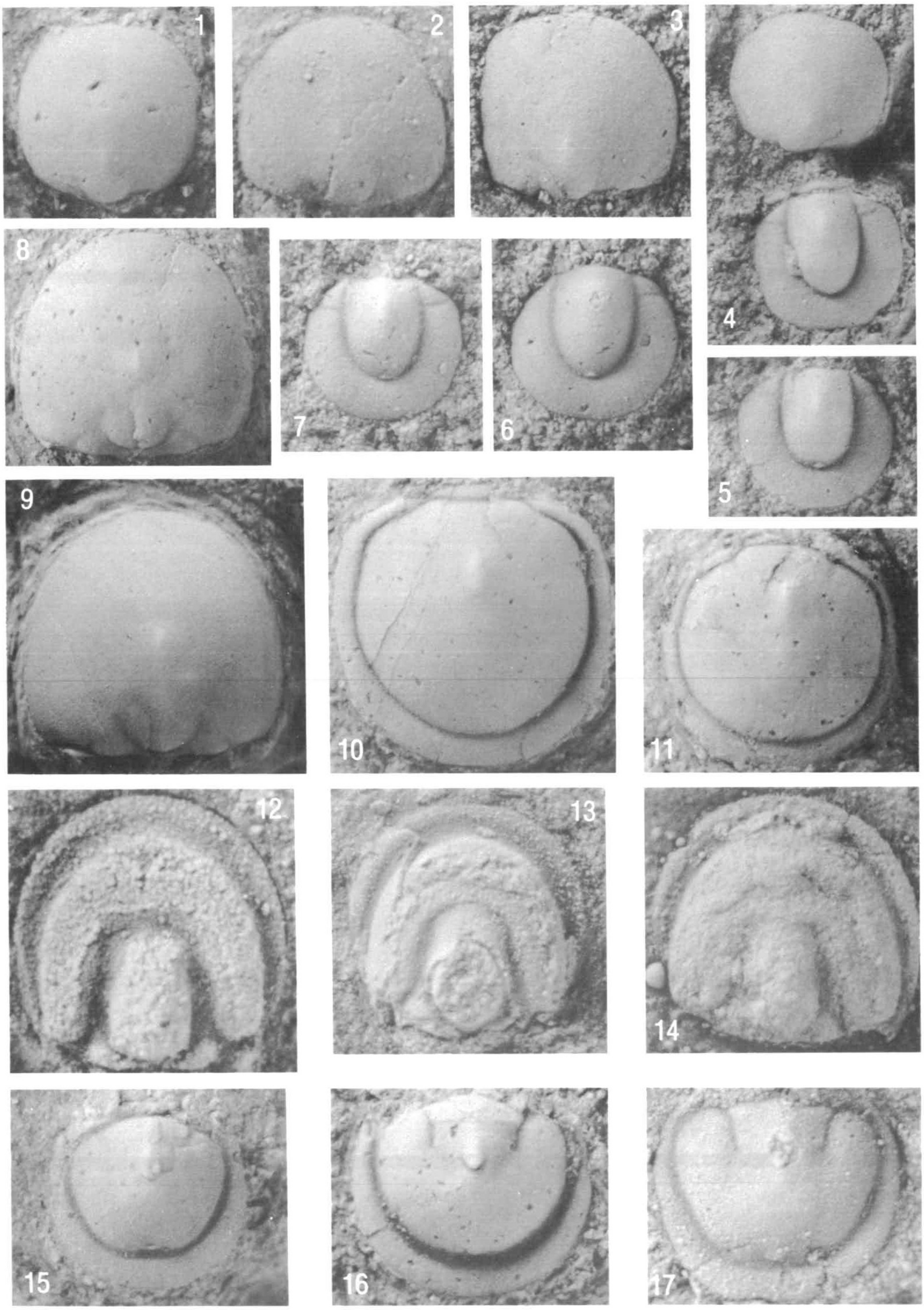
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PLATE 7

Fig. 1	**Stigmatoa diloma** Öpik, 1963
Fig. 1	CPC 15148, silicified replica of cranidial exoskeleton; length 5.6 mm; locality K231; x8.5
Figs. 2, 3	**Stigmatoa sidonia** Öpik, 1963
Fig. 2	CPC 15149, silicified replica of partly exfoliated cranidium; estimated length 5.3 mm; locality 302/2; x8.5
Fig. 3	CPC 15150, as above; estimated length 7.7 mm; locality 302/2; x6
Figs. 4-7	**Irvingella tropica** Öpik, 1963
Fig. 4	CPC 15162, silicified replica of exfoliated cranidium; length 8.1 mm; locality 302/3; x6
Fig. 5	CPC 15163, partly exfoliated incomplete cranidium; locality K234; x4
Fig. 6	CPC 15161, exfoliated cranidium; length 5.2 mm; locality K234; x7.5
Fig. 7	CPC 15161, as above, lateral view, x7.5
Fig. 8	Hypostoma undetermined 6
Fig. 8	CPC 15202, silicified replica of partly exfoliated hypostoma; locality K231; x12
Fig. 9	Hypostoma undetermined 5
Fig. 9	CPC 15201, silicified replica of external hypostomal surface; locality K234; x8

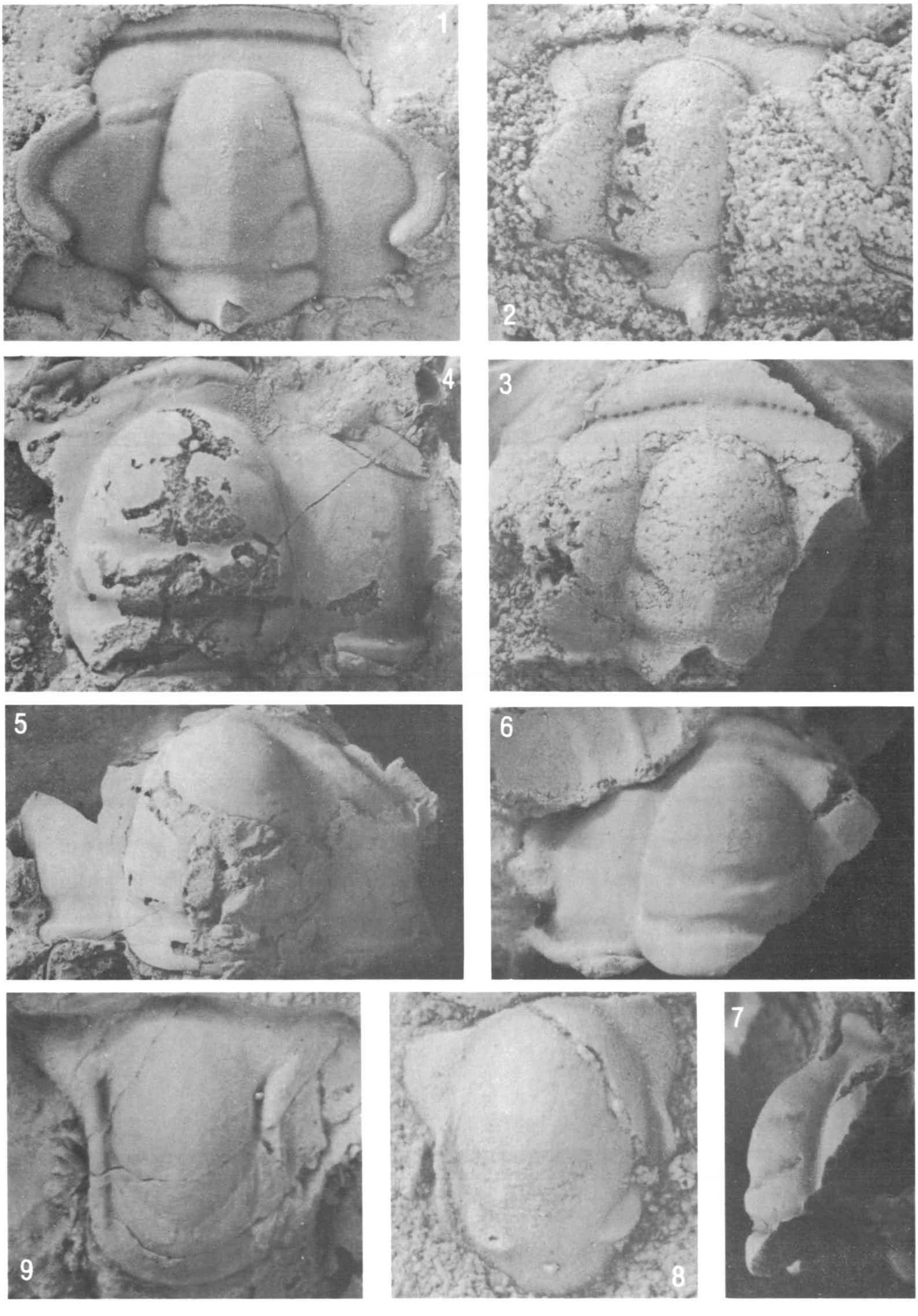
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PLATE 8

Figs. 1-8	**Chalfontia alta** (Henderson, 1976)
Fig. 1	CPC 15165, silicified exfoliated cranidium; length 6.3 mm; locality 301/11; x8
Fig. 2	CPC 15166, as above; length 12.9 mm; locality 301/11; x4
Fig. 3	CPC 15166, as above, anterior profile, x4
Fig. 4	CPC 15169, exfoliated cranidium, length 14.6 mm; locality 301/11; x2
Fig. 5	CPC 15169, as above, lateral profile, x2
Fig. 6	CPC 15167, incomplete silicified exfoliated cranidium; locality 302/4; x8
Fig. 7	CPC 15168, silicified exfoliated cranidium; length 11.5 mm; locality 302/4; x4
Fig. 8	CPC 15170, as above, incomplete; estimated length 7.3 mm; locality 301/11; x8
Fig. 9	Elviniid genus et species undetermined D
Fig. 9	CPC 15191, exfoliated cranidium, length 10.8 mm; locality 302/3; x4
Fig. 10	**Irvingella tropica** Öpik, 1963
Fig. 10	CPC 15164, early holaspid cranidium, length 2.6 mm; locality K233; x16

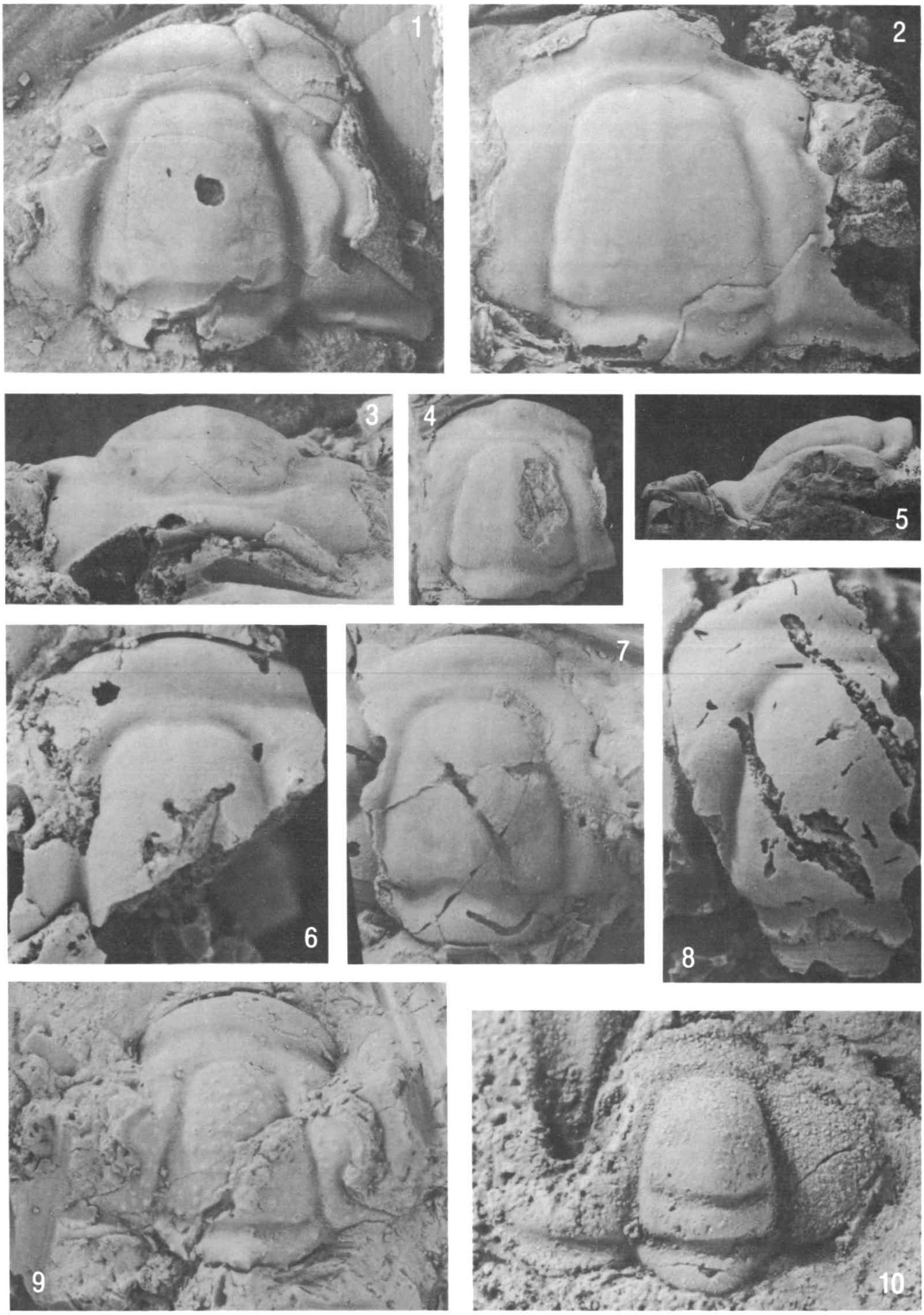
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PLATE 9

Fig. 1	**Protemnites elegans** Whitehouse, 1939
Fig. 1	UQF 3330, silicone replica of holotype (Whitehouse, 1939, pl. 22, fig. 12b), associated with cephalon of *Kormagnostella inventa* sp. nov.; x6
Fig. 2	**Eurostina trigona** Whitehouse, 1939
Fig. 2	UQF 3332, silicone replica of holotype cranidium (Whitehouse, 1939, pl. 22, figs. 11a, 11b); x8
Figs. 3-7	**Protemnites burkensis** sp. nov.
Fig. 3	CPC 15171, silicified exfoliated cranidium, length 13.2 mm; locality K235; x4
Fig. 4	CPC 15171, as above, lateral view; x4
Fig. 5	CPC 15171, as above, anterior view; x4
Fig. 6	CPC 15172, as above, estimated length 12.7 mm; locality K234; x3
Fig. 7	CPC 15173, silicified cranidial fragment; estimated length 18.1 mm; locality K235; x2
Figs. 8, 9	**Protemnites** sp. undet.
Fig. 8	CPC 15174A, partly exfoliated cranidium; locality 301/4; x8
Fig. 9	CPC 15174A, as above, anterior view, x8

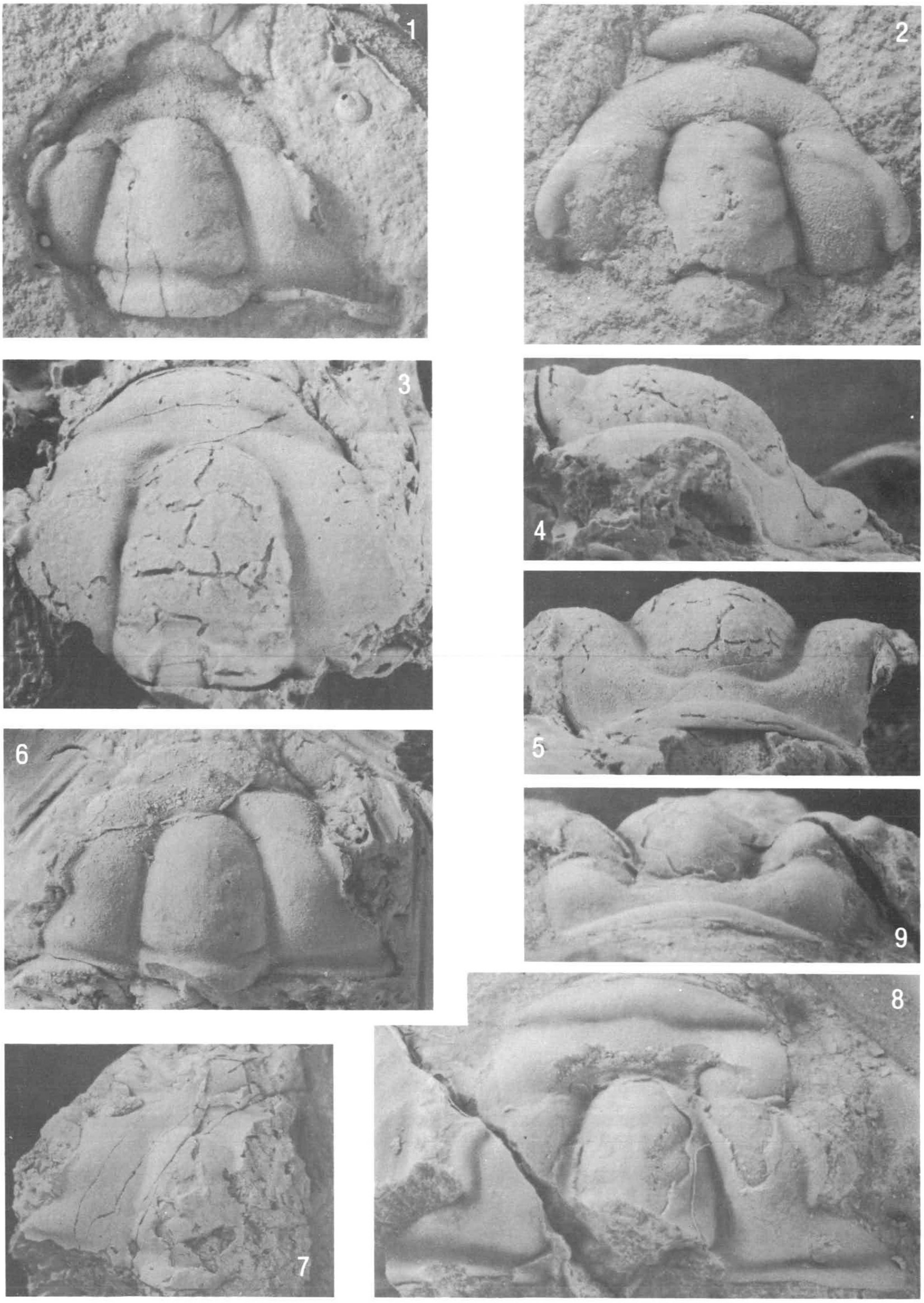
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PLATE 10

Eugonocare tessellatum Whitehouse, 1939

Fig. 1 CPC 15153, latex replica of incomplete cranidial exoskeleton, length 11.9 mm; locality K231; x4

Fig. 2 CPC 15154, cranidium with first two thoracic segments attached, estimated cranidial length 5.25 mm; locality K229; x8

Fig. 3 CPC 15155, cranidial exoskeleton, length 6.1 mm; locality 301/4; x8

Fig. 4 CPC 15156, partly exfoliated cranidium, length 7.3 mm; locality 301/5; x5

Fig. 5 CPC 15158, meraspid pygidium with four unliberated segments, estimated length 0.9 mm; locality K230; x30

Fig. 6 CPC 15157, partly exfoliated holaspid pygidium, length (Lp_1) 3.1 mm; locality 301/5; x12

Fig. 7 CPC 15159, exfoliated late holaspid pygidium, length (Lp_1) 5.3 mm; locality 301/5; x6

Fig. 8 CPC 15160, exfoliated pygidium, length (Lp_1) 3.0 mm; locality K229; x10

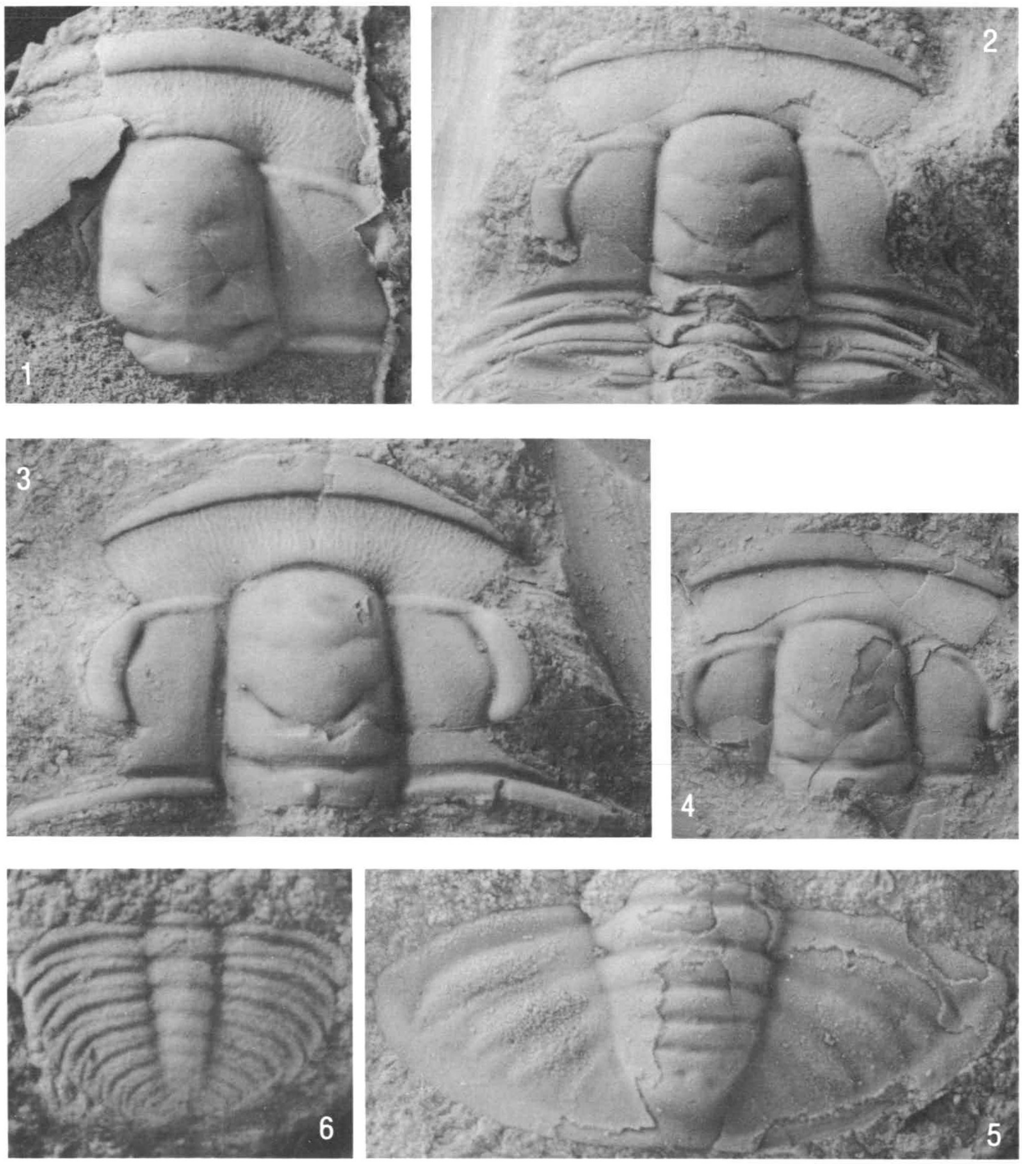
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PLATE 11

Figs. 1-3	**Mecophrys selenis** gen. et sp. nov.
Fig. 1	CPC 15175B, Holotype, latex replica of partly exfoliated cranidium, length 7.6 mm; locality 302/6; x6
Fig. 2	CPC 15175A, Holotype, partly exfoliated cranidium; x6
Fig. 3	CPC 15176B, latex replica of exfoliated librigena; locality 302/6; x16
Figs. 4-10	**Mecophrys mecophrys** gen. et sp. nov.
Fig. 4	CPC 15179, latex replica of cranidial fragment exposing parietal morphology of preglabellar area; locality 302/9; x12
Fig. 5	CPC 15179, as above, anterior profile; x12
Fig. 6	CPC15177, Holotype, exfoliated cranidium, length 3.9 mm; locality K237; x12
Fig. 7	CPC 15177, Holotype, lateral view; x12
Fig. 8	CPC 15178, exfoliated incomplete cranidium, length 6.7 mm; locality 302/9; x6
Fig. 9	CPC 15180, exfoliated librigena; locality K237; x8
Fig. 10	CPC 15181, exfoliated pygidial fragment assigned to this species; locality K237; x6
Fig. 11	**Stigmatoa?** sp. undet.
Fig. 11	CPC 15189A, incomplete exfoliated pygidium; locality 302/9; x4

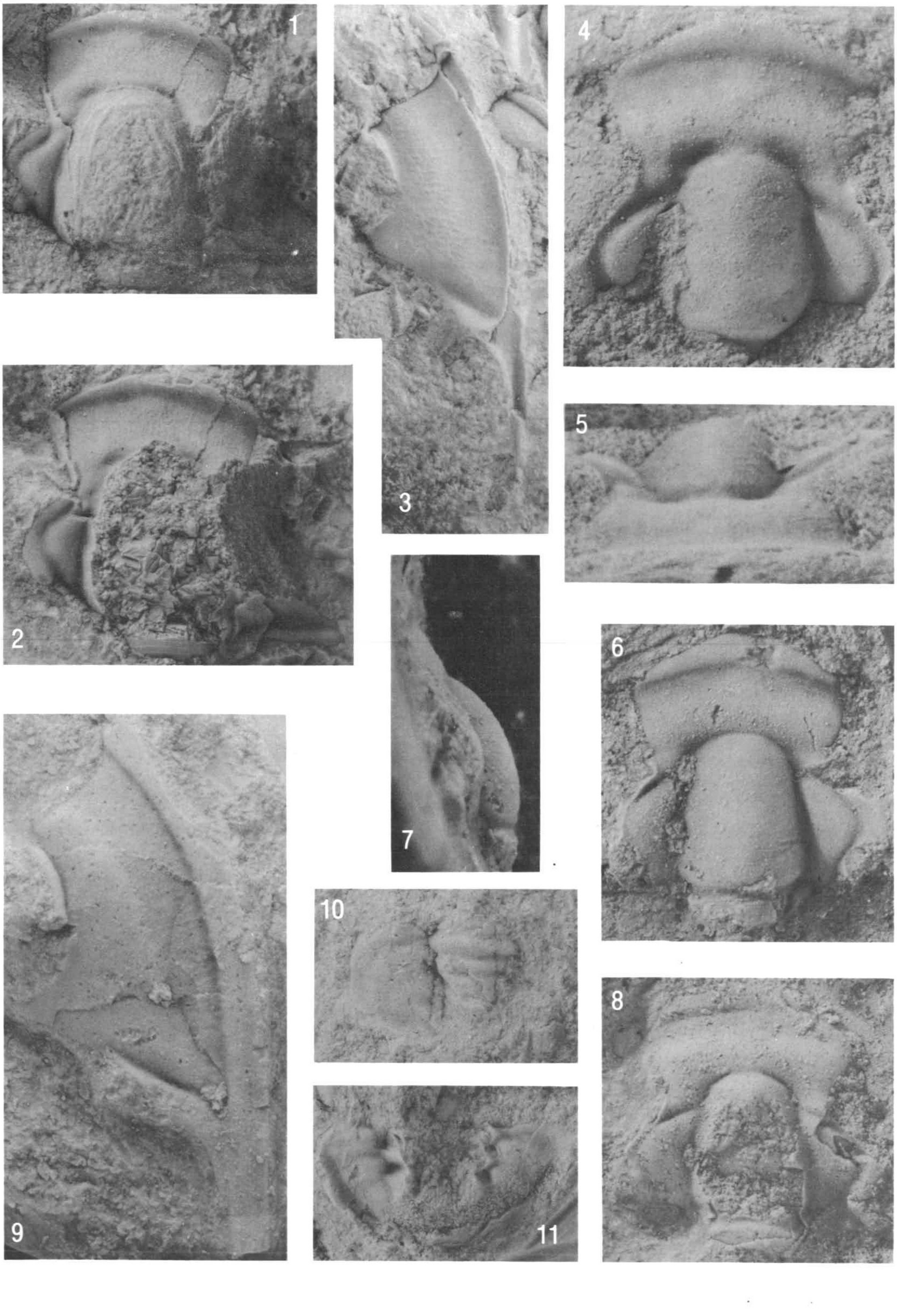
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PLATE 12

Figs. 1-4	Asaphacean genus et species undetermined B
Fig. 1	CPC 15186, exfoliated cranidium, length 5.9 mm; locality K237; x8
Fig. 2	CPC 15188, exfoliated librigena with well preserved eye socle; locality K237; x12
Fig. 3	CPC 19383, holaspid pygidium associated with above specimens and assigned to this species, locality 302/9; x8
Fig. 4	CPC 15187A, exfoliated meraspid pygidium assigned to this species; length (Lp_1) 1.9 mm; locality 302/9; x16
Figs. 5-8	Ceratopygacean genus et species undetermined C
Fig. 5	CPC 15183B, latex replica of exfoliated incomplete cranidium; locality 302/5; x4
Fig. 6	CPC 15183A, incomplete exfoliated cranidium; estimated length 14.0 mm; locality 302/5; x2.5
Fig. 7	CPC 15184, latex replica of cranidial fragment showing size of palpebral lobes and position of axial node; locality 302/5; x8
Fig. 8	CPC 15185A, exfoliated pygidium; length (Lp_1) 4.6 mm; locality 302/5; x8
Fig. 9	Pterocephaliid genus et species undetermined A
Fig. 9	CPC 15182A, incomplete exfoliated cranidium; locality 302/5; x5
Figs. 10-12	**Parakoldinioidia** sp. aff. **P. typicalis** Endo, 1937
Fig. 10	CPC 19326, incomplete exfoliated cranidium; locality K235; x16
Fig. 11	CPC 15190B, latex replica of exfoliated pygidium; locality 302/6; x12
Fig. 12	CPC 15190B, as above, posterior profile; x12

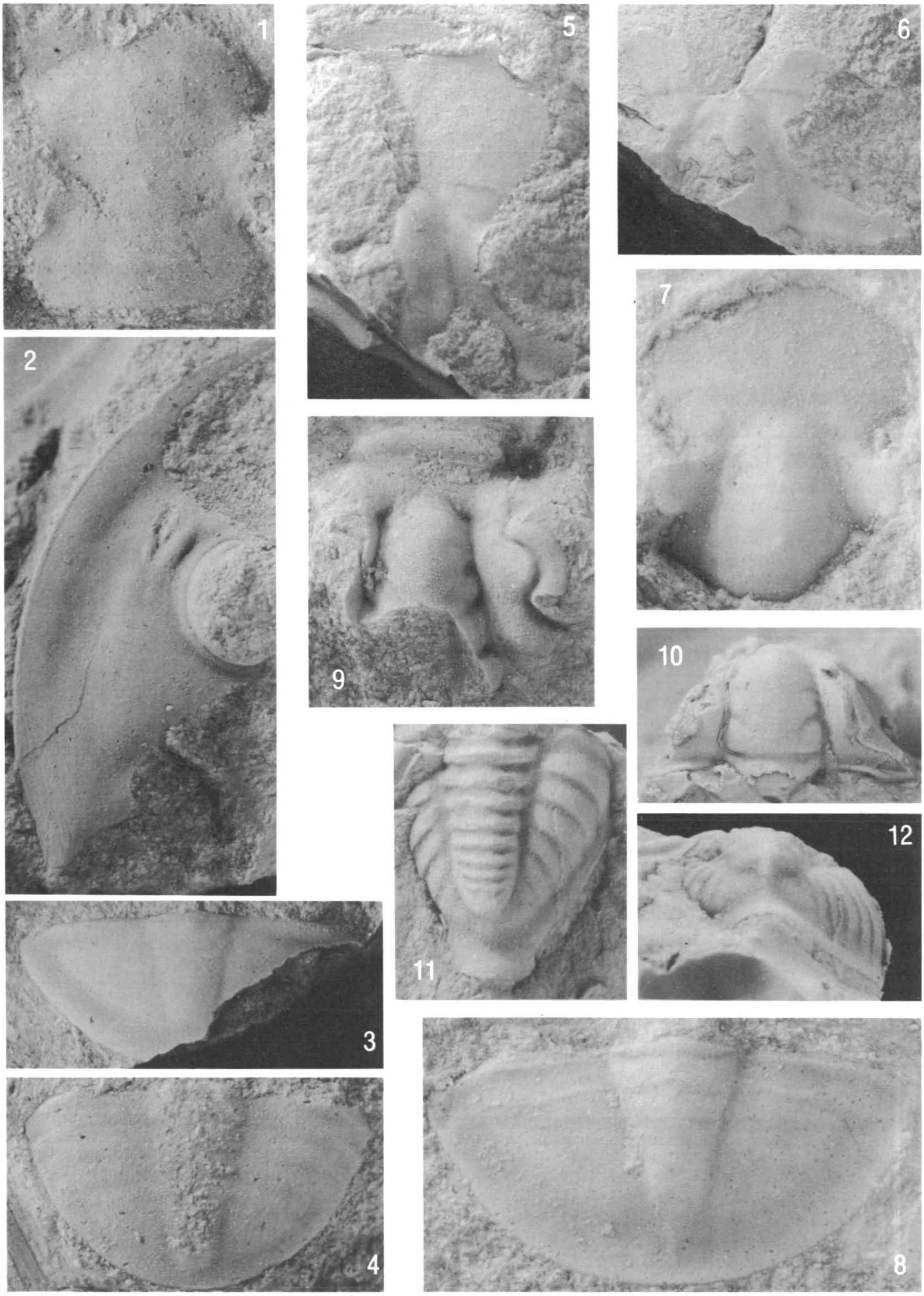
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PLATE 13

Figs. 1-7	**Pagodia (Idamea)** cf. **baccata** Öpik, 1967
Fig. 1	CPC 15192, silicified exfoliated cranidium showing faint granulation; length 8.85 mm; locality 302/4; x5
Fig. 2	CPC 15193, cranidial exoskeleton with coarse granulose prosopon; length 3.5 mm; locality K232; x13
Fig. 3	CPC 15194, silicified exfoliated cranidium showing muscle scar impressions; length 4.85 mm; locality 301/11; x8
Fig. 4	CPC 15195, exfoliated cranidium with granulosity obscured by silicification; length 5.85 mm; locality 301/11; x8
Fig. 5	CPC 15196, exfoliated librigena, locality 302/1; x12
Fig. 6	CPC 15197, silicified pygidial exoskeleton; length (Lp_1) 4.4 mm; locality 301/7; x9
Fig. 7	CPC 15198, exfoliated pygidium coated with secondary silica; length (Lp_2) 3.0 mm; locality 302/2; x12
Fig. 8	**Prochuangia** sp. undet.
Fig. 8	CPC 15199, incomplete pygidial exoskeleton; length (Lp_2) 4.8 mm; locality 301/5; x4

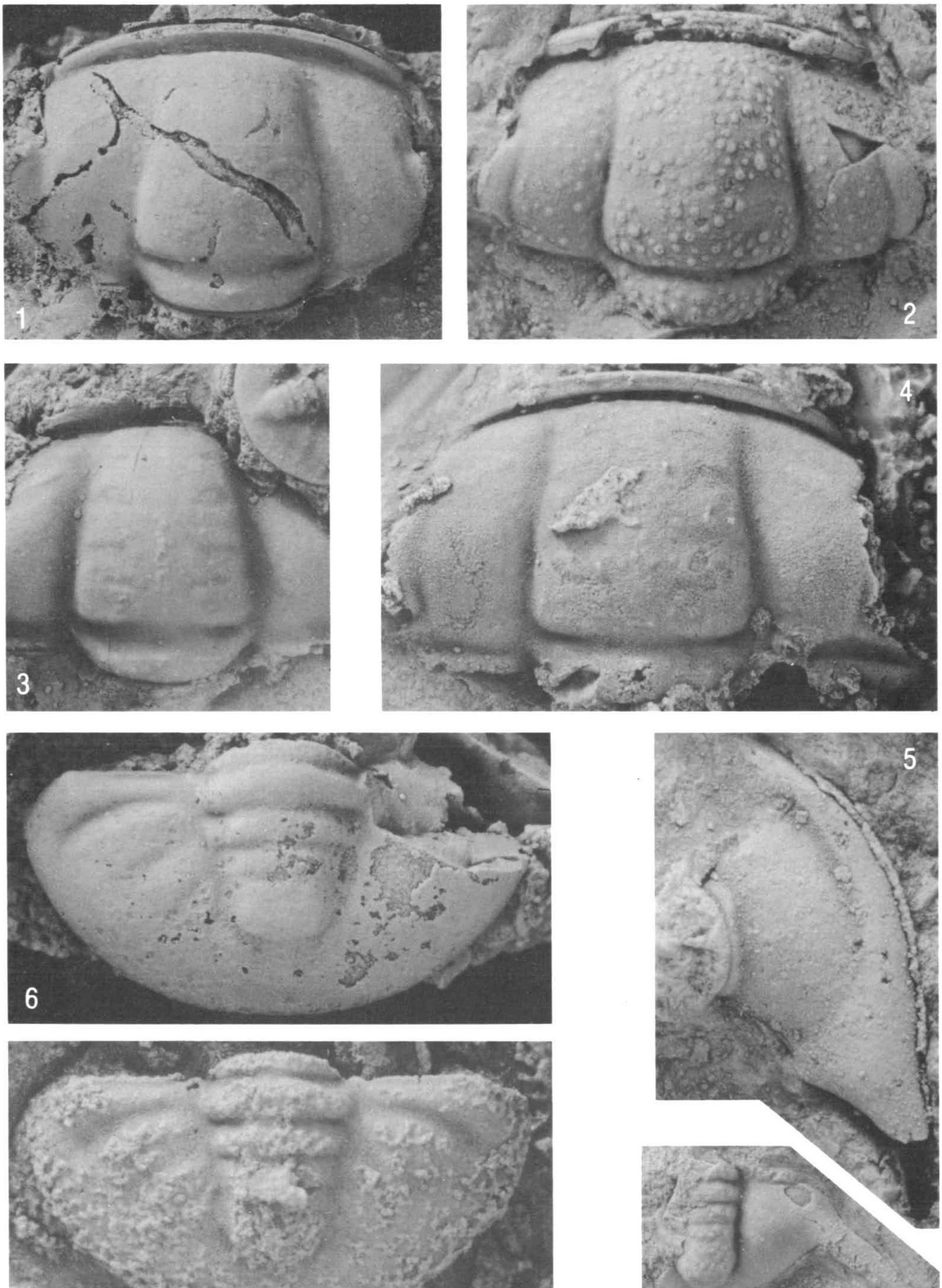
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PLATE 14

Figs. 1-6A, 7 **Corynexochus plumula** Whitehouse, 1939

Fig. 1 CPC 15141, cranidial exoskeleton; length 3.4 mm; locality 301/4; x12

Fig. 2 CPC 15144, silicified exfoliated cranidium; glabellar length (G) 2.7 mm; locality K231; x12

Fig. 3 CPC 15142, partly exfoliated cranidium; length 2.5 mm; locality 301/4; x16

Fig. 4 CPC 15145, silicified exfoliated cranidium; length 2.85 mm; locality K231; x12

Fig. 5 CPC 15143, portion of cranidial exoskeleton; locality 301/4; x12

Fig. 6A. CPC 15146, exfoliated pygidium; length (Lp_1) 2.6 mm; locality K231; x12

Fig. 7 CPC 15147, pygidial exoskeleton, length (Lp_1) 3.1 mm; locality 301/4; x12

Figs. 6B, 8 Ptychopariacean genus et species undetermined E

Fig. 6B. CPC 15152, meraspid cranidium, length 1.1 mm; locality K231; x12

Fig. 8 CPC 15151, silicified exfoliated cranidium; estimated length 3.3 mm; locality K231; x10

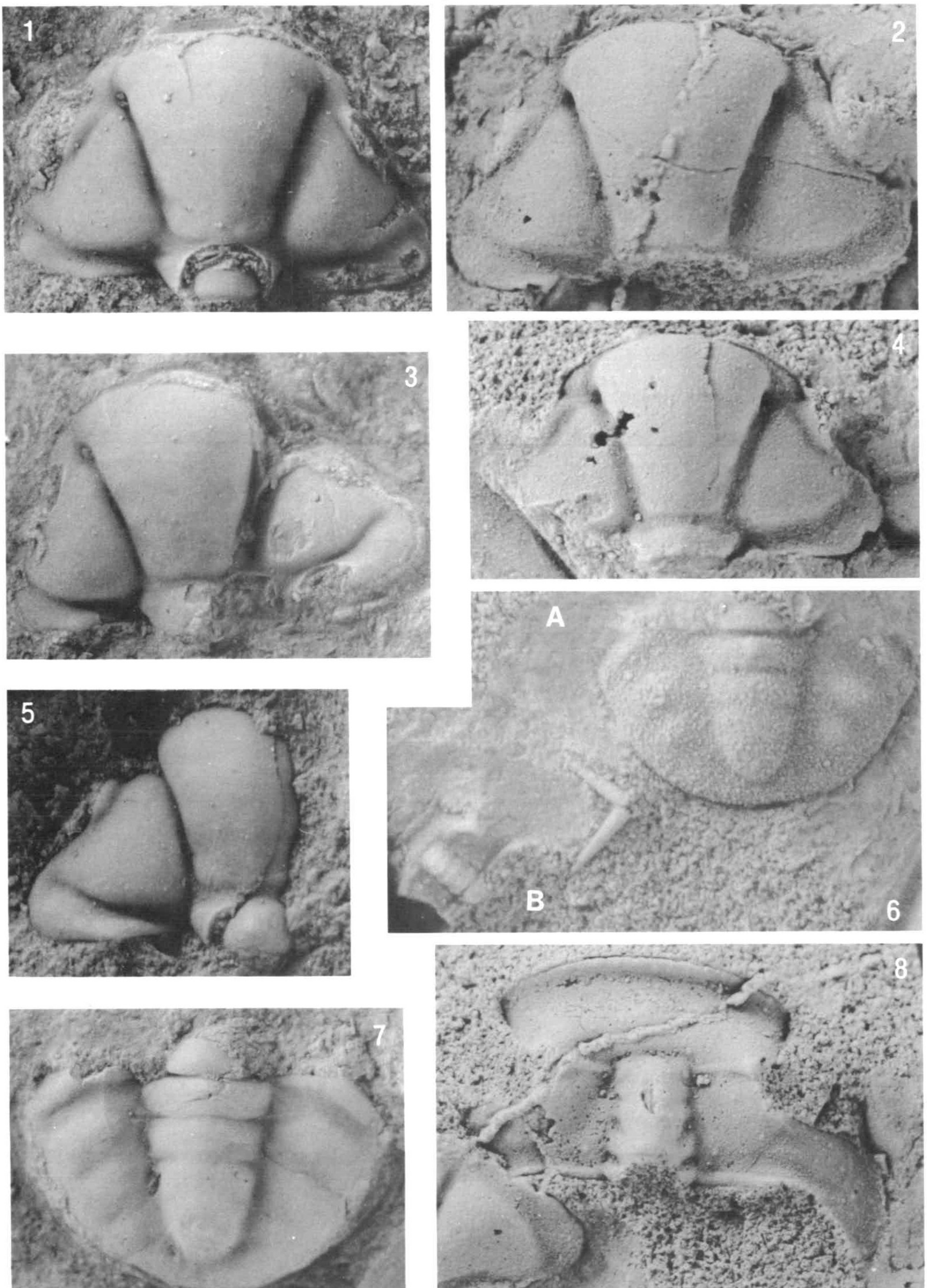
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PLATE 15

Aplotaspis mucrora Henderson, 1976

Fig. 1 UQF 3389(B), paratype of *Proceratopyge rutellum* Whitehouse (1939, pp. 250-251, pl. 25, fig. 10), latex replica of partly exfoliated cranidium; x4

Fig. 2 CPC 19382, latex replica of silicified cranidial exoskeleton associated with hypostoma undetermined 5 (CPC 19393); estimated length 5.9 mm; locality K231; x8

Fig. 3 CPC 15134, silicified exfoliated cranidium showing glabellar muscle scar impressions; length 6.75 mm; locality K231; x8

Fig. 4 CPC 15135, latex replica of silicified cranidial exoskeleton; length 8.75 mm; locality K231; x4

Fig. 5 CPC 15136, latex replica of exfoliated cranidium showing glabellar muscle scar impressions; length 10.8 mm; locality K231; x4

Fig. 6 CPC 15137A, incomplete exfoliated cranidium; length 6.3 mm; locality 301/6; x8

Fig. 7 CPC 15138, latex replica of pygidial exoskeleton; length (Lp_1) 7.1 mm; locality K231; x4

Fig. 8 CPC 15140, early holaspid pygidial exoskeleton; length (Lp_1) 2.5 mm; locality 301/6; x14

Fig. 9 CPC 15139, late holaspid pygidial exoskeleton; length (Lp_1) 8.9 mm; locality 301/5; x4

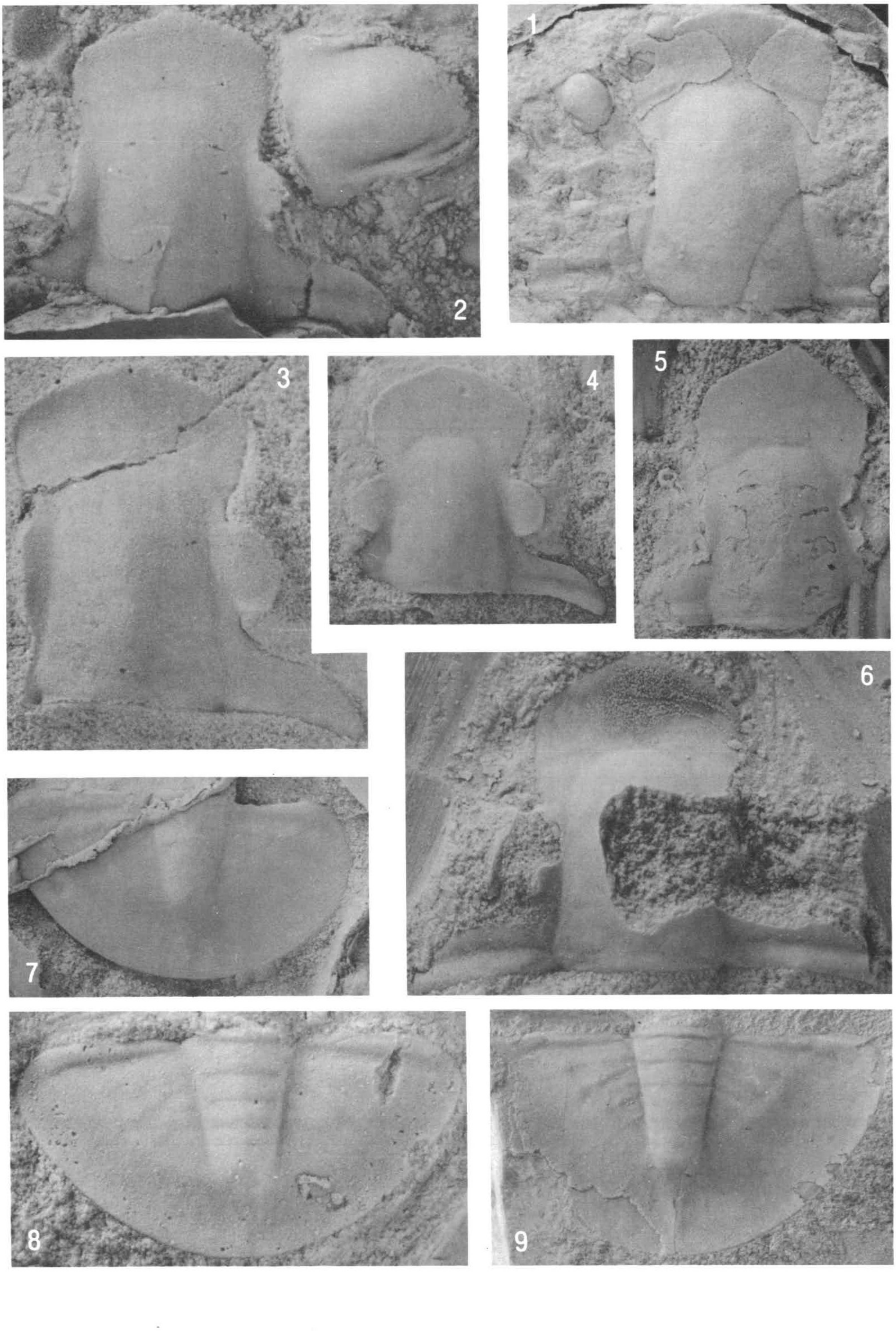
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PLATE 16

Proceratopyge (Proceratopyge) lata Whitehouse 1939

Fig. 1 CPC 15124, complete articulated dorsal exoskeleton; total length 13.6 mm; locality K229; x4

Fig. 2 CPC 15125, as above but without librigenae; total length 10.8 mm; locality K230; x4

Fig. 3 CPC 15126, degree 4 meraspid exoskeleton, complete apart from librigenae; total length 2.45 mm; locality K230; x21

Fig. 4 CPC 15127, early holaspid (?) pygidial exoskeleton with seven associated thoracic segments; pygidial length (Lp_2) 1.8 mm; locality K229; x7.5

Fig. 5 CPC 15128, early holaspid pygidial exoskeleton; length (Lp_1) 2.75 mm; locality K230; x12

Fig. 6 CPC 15129, late holaspid pygidial exoskeleton showing deformity in misalignment of post-axial border and indentation; length (Lp_1) 6.4 mm; locality K230; x4

Fig. 7 UQF 3391, Holotype (see also Whitehouse, 1939, pl. 25, fig. 12), silicone replica of cranidial exoskeleton; x6

Fig. 8 CPC 15131, early holaspid cranidium with narrow (sag.) preglabellar area; length 2.7 mm; locality 301/2; x15

Fig. 9 CPC 15130, typical holaspid cranidial exoskeleton; length 5.15 mm; locality K229; x8

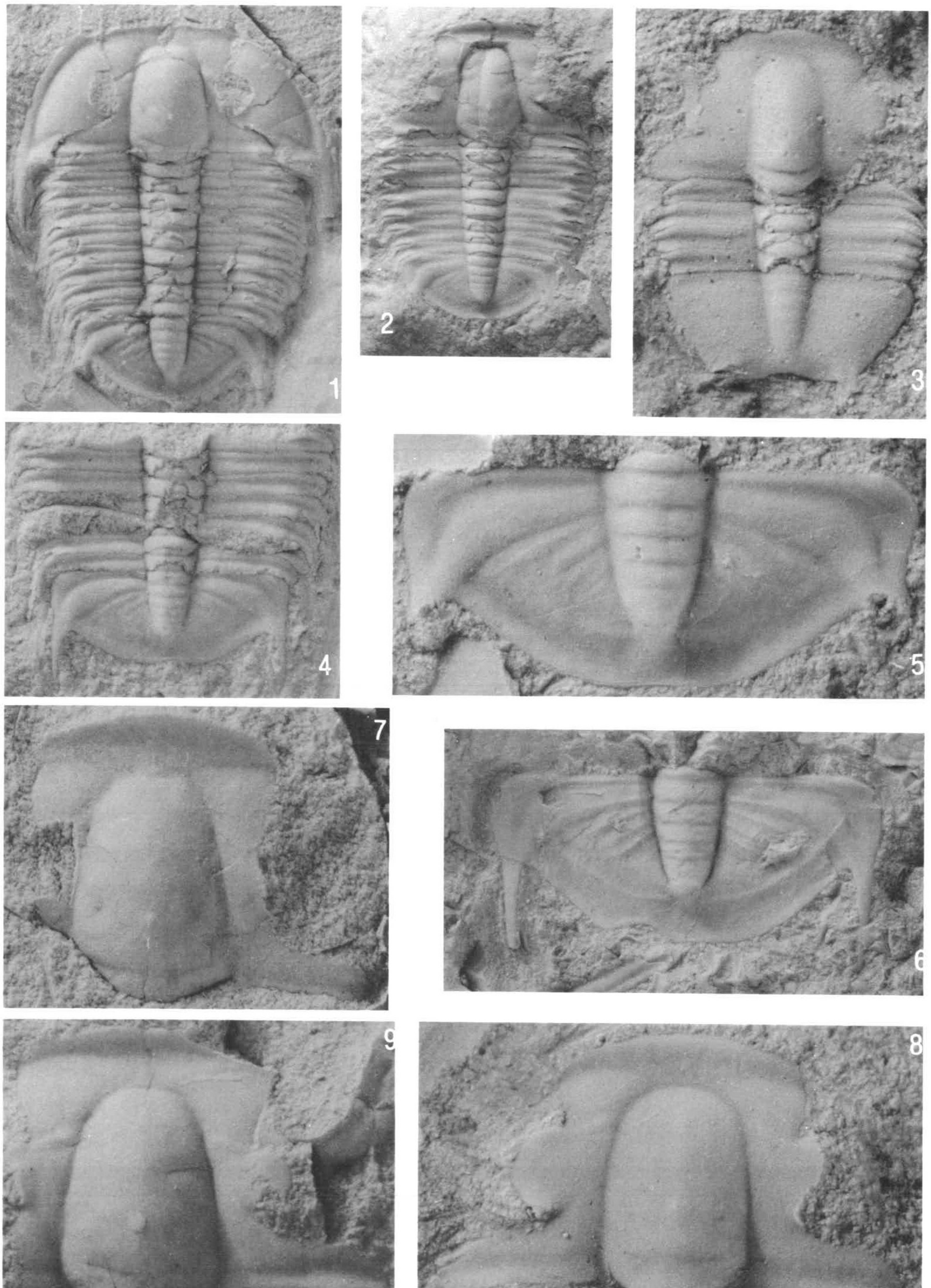
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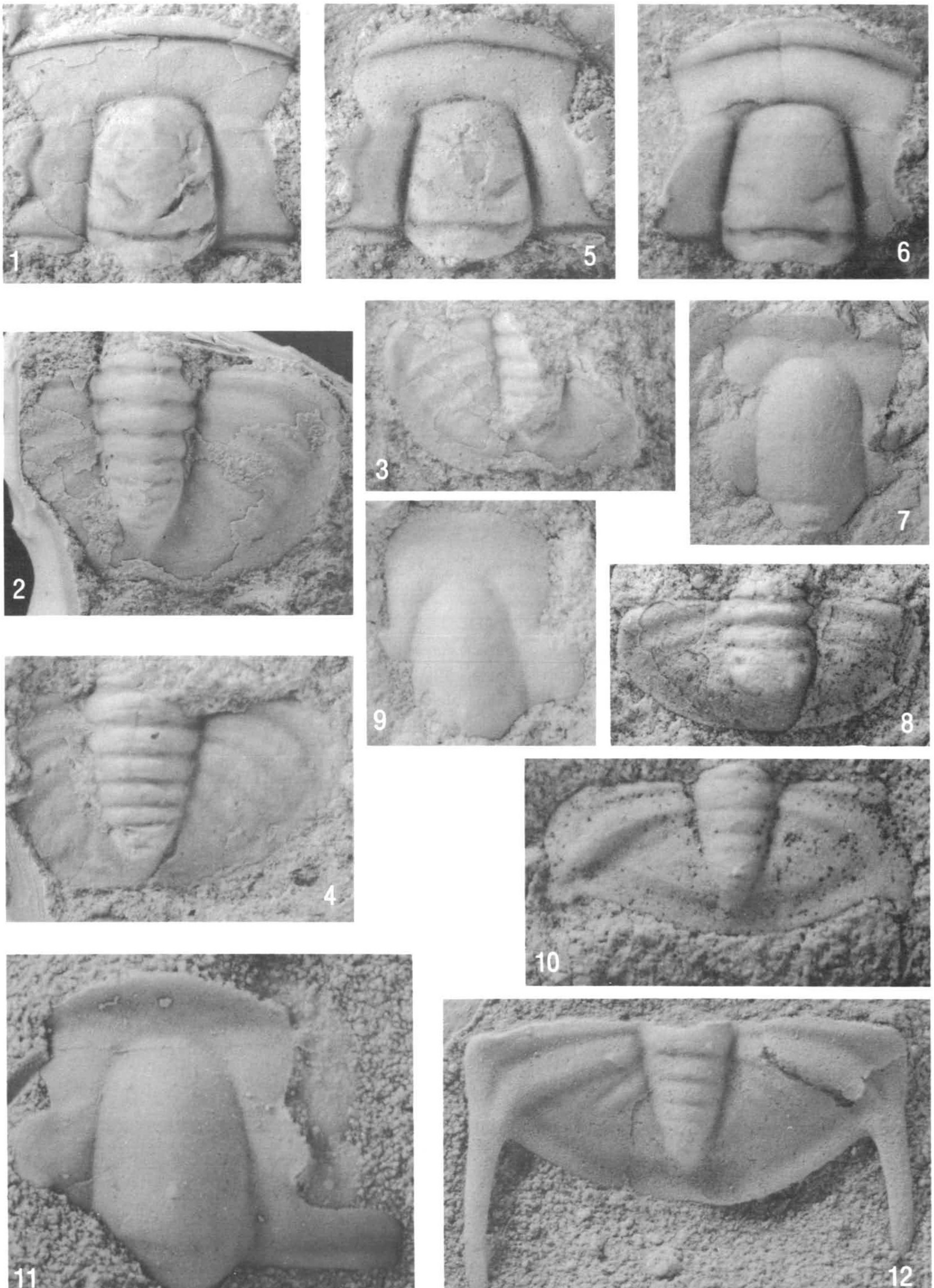
PLATE 17

Figs. 1-4	**Eugonocare whitehousei** Henderson, 1976
Fig. 1	CPC 19261, latex replica of partly exfoliated cranidium; length 5.0 mm; locality D501; x7.5
Fig. 2	CPC 19262B, latex replica of partly exfoliated pygidium; length (Lp_2) 3.7 mm; locality D502; x8.5
Fig. 3	CPC 19262A, partly exfoliated incomplete pygidium; counterpart of above; x6
Fig. 4	CPC 19263B, latex replica of exfoliated early holaspid pygidium; length (Lp_2) 1.9 mm; locality D502; x16
Figs. 5, 6	**Aphelaspis** sp. undet.
Fig. 5	CPC 19265, exfoliated cranidium; length 3.75 mm; locality D473; x10
Fig. 6	CPC 19266, cranidial exoskeleton; length 6.6 mm; locality D473; x6
Fig. 7	**'Proceratopyge polita'** Whitehouse, 1939
Fig. 7	UQF 3393, Holotype (see also Whitehouse, 1939, pl. 25, fig. 4), re-figured for comparison with other *Proceratopyge* species herein; silicone replica; x4
Fig. 8	**'Proceratopyge rutellum'** Whitehouse, 1939
Fig. 8	UQF 3390, specimen said to be pygidium of this species (Whitehouse, 1939, pl. 25, fig. 11)
Figs. 9, 10	**Proceratopyge nectans** Whitehouse, 1939
Fig. 9	UQF 3386, Holotype (see also Whitehouse, 1939, pl. 25, fig. 8a); silicone replica of exfoliated cranidium; x8
Fig. 10	UQF 3387, original paratype of *P. nectans* (Whitehouse, loc. cit., fig. 8b), considered by Henderson (1976) to represent *P. cryptica* Henderson; x16
Figs. 11, 12	**Proceratopyge (Proceratopyge)** sp. undet.
Fig. 11	CPC 15132, latex replica of silicified cranidial exoskeleton; length 4.0 mm; locality K231; x12
Fig. 12	CPC 15133, latex replica of silicified pygidial exoskeleton; estimated length (Lp_2) 2.7 mm; locality K231; x10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