BULLETIN 186

Late Cambrian Trilobites from the Chatsworth Limestone, Western Queensland

J. H. SHERGOLD

DEPARTMENT OF NATIONAL DEVELOPMENT & ENERGY
BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS

BULLETIN 186

Late Cambrian Trilobites from the Chatsworth Limestone, Western Queensland

J.H. SHERGOLD

AUSTRALIAN GOVERNMENT PUBLISHING SERVICE
CANBERRA 1980

DEPARTMENT OF NATIONAL DEVELOPMENT & ENERGY

MINISTER: SENATOR THE HON. J.L. CARRICK

SECRETARY: A.J. WOODS

BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS

ACTING DIRECTOR: L.W. WILLIAMS

ASSISTANT DIRECTOR, GEOLOGICAL BRANCH: J.N. CASEY

Published for the Bureau of Mineral Resources, Geology and Geophysics
by the Australian Government Publishing Service

ISBN 0 642 04680 8

DATE OF ISSUE -2 OCT 1980

This Bulletin was edited by D.L. STRUSZ

Printed by Hedges & Bell Pty Ltd, Maryborough, Vic.

BMR BULLETIN 186

Late Cambrian Trilobites from the Chatsworth Limestone, Western Queensland

by J.H. Shergold

ERRATA

p. 23 Right column, subfamilial heading (also in Contents, p. x) read Quadragnostinae for Quadrahomagnostinae

p. 21 Left column, last paragraph, line 4: read from for form

p. 22 Left column, first paragraph, line 14; read barrel-shaped for barrell-shaped

p. 22 Right column, last paragraph, line 11; read separated for spearated

p. 32 Right column, first paragraph, line 6; read be for by

p. 39 Left hand column, third paragraph from foot of page, line 4; read from for om

p. 45 Right column, first paragraph, line 5; read cranidial for canidial

p. 49 Left column, second paragraph, line 4; read preceding for preceeding

p. 56 Right column, second paragraph, line 3; read apparently for apprently

p. 64 Right column, first paragraph, line 3; read glabella for glaella

p. 64 Right column, second paragraph, line 12; read together for toether

p. 66 Right column, second paragraph from foot of page, line 1; read Diagnosis for Diangosis

p. 73 Left column, third paragraph, second sentence; should read 'Peichiashania is placed in the Family Kaolishaniidae, Subfamily Mansuyiinae, on account of cranidial similarity ....'

p. 78 Left column, second paragraph, line 2; read quarta for quatra

CONTENTS

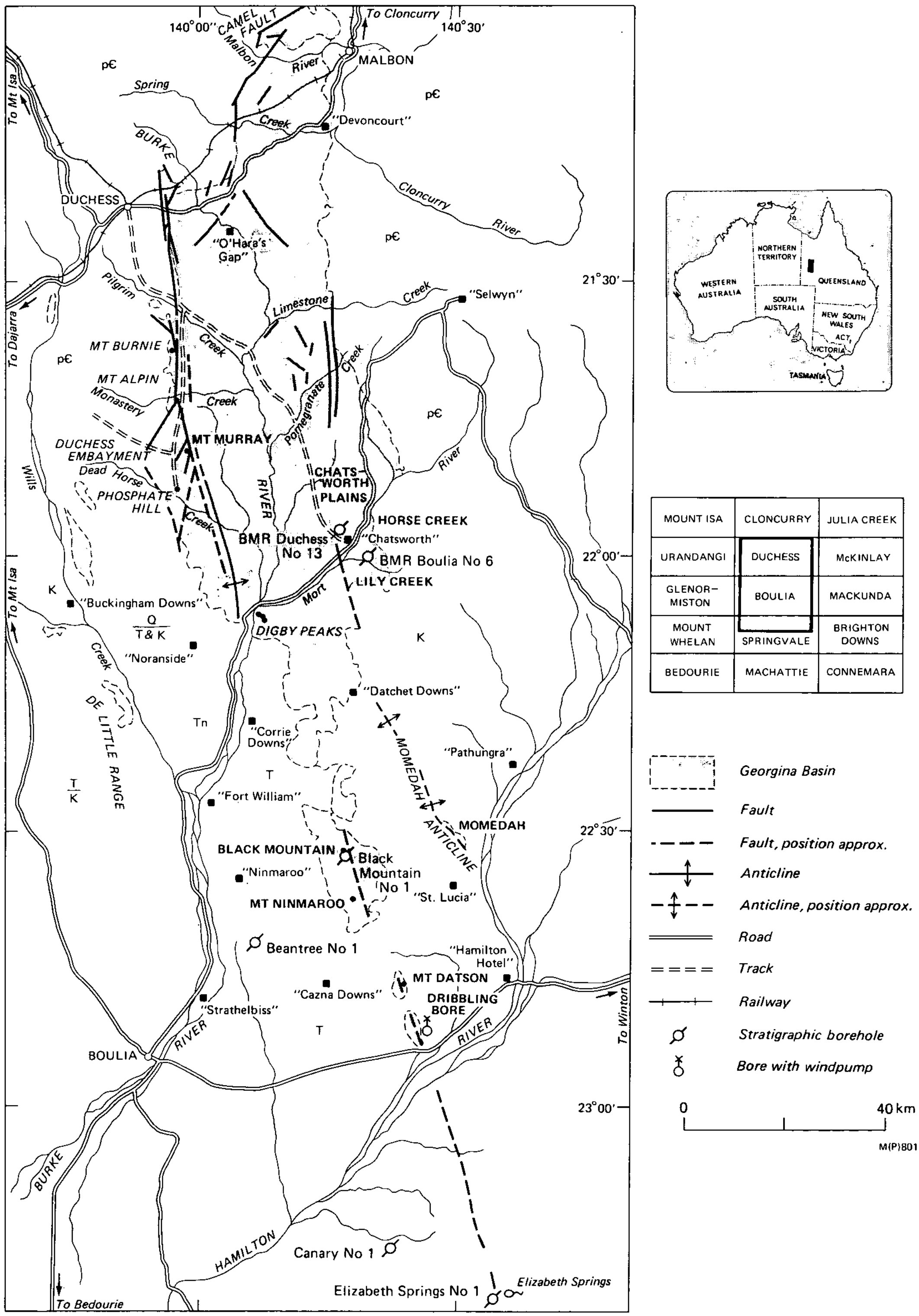
SUMMARY

Fifty-two species of late Cambrian trilobites, belonging to thirty-two genera and subgenera, are described from the Chatsworth Limestone *sensu stricto* at its type section on Lily Creek, at isolated outcrops on the plains to the north and northwest of Chatsworth Homestead, and adjacent to the Mort River and Horse Creek to the east of the Homestead, in western Queensland. Two subfamilies, two genera, one subgenus, and twenty-nine species are described as new; fourteen species are left under open nomenclature. Twenty of the species, twelve new, belong to just seven genera of agnostids.

The age of this fauna is post-Idamean, but pre-Payntonian. It is equivalent in part to the Daizanian fauna of Manchuria, the early Shidertan of Kazakhstan and the north Siberian Platform, and the early Franconian *Elvinia, Taenicephalus* and perhaps *Saratogia* Zones of North America. Greatest affinity lies with northern China, Manchuria, Korea, the north Siberian Platform and Kazakhstan; little similarity exists with the faunas of Europe or North America.

Application of cluster analysis techniques and the Dice Similarity Coefficient to the biostratigraphic profile at Lily Creek reveals the presence of four successive faunal assemblages on the 300 m measured section: from the base, the *Wentsuia iota/Rhaptagnostus apsis, Peichiashania secunda/Prochuangia glabella, Peichiashania tertia/P. quarta*, and *Hapsidocare lilyensis* Assemblage-Zones.

The youngest assemblage, occurring in the Lily Creek Member of the Chatsworth Limestone, has generic affinity with those previously described at the base of the 'Chatsworth Limestone' at Black Mountain, but is specifically distinct. It is best interpreted as a temporal equivalent of the earliest two assemblage-zones occurring at Black Mountain, but representative of fauna from a high intertidal rather than shallow subtidal environment. The oldest assemblage at Lily Creek is more fully developed on the Chatsworth Plains and south of Horse Creek. Its relationship to the youngest assemblage-zone of the underlying Idamean Stage, the *Irvingella tropica - Agnostotes inconstans* Zone, is unknown. Both stratigraphic boreholes drilled into the sequence below the Lily Creek section terminated in rocks containing the *iota/apsis* Assemblage-Zone. However, the presence of some Idamean and earlier genera in the basal Chatsworth Limestone on Chatsworth Plains strongly suggests close biostratigraphic proximity to the late Idamean as defined by Öpik (1963), and it is presently assumed that the *Wentsuia iota - Rhaptagnostus apsis* Assemblage-Zone succeeds that of *Irvingella tropica - Agnostotes inconstans* biochronologically.



140°00'
CAMEL FAULT
To Cloncurry
140°30'
MALBON
Malbon River
Spring Creek
BURKE
"Devoncourt"
Cloncurry River
DUCHESS
"O'Hara's Gap"
21°30'
"Selwyn"
Limestone Creek
Pilgrim Creek
MT BURNIE
MT ALPIN
Monastery Creek
Pomegranate Creek
MT MURRAY
DUCHESS EMBAYMENT
Dead Horse Creek
PHOSPHATE HILL
RIVER
CHATS-WORTH PLAINS
HORSE CREEK
BMR Duchess No 13
"Chatsworth"
BMR Boulia No 6
22°00'
LILY CREEK
Mort River
"Buckingham Downs"
Q
T&K
DIGBY PEAKS
K
"Noranside"
Wills Creek
DE LITTLE RANGE
"Datchet Downs"
Tn
"Corrie Downs"
MOMEDAH ANTICLINE
"Pathungra"
T
T
K
"Fort William"
MOMEDAH
22°30'
BLACK MOUNTAIN
Black Mountain No 1
"Ninmaroo"
"St. Lucia"
MT NINMAROO
Beantree No 1
"Hamilton Hotel"
MT DATSON
"Cazna Downs"
DRIBBLING BORE
"Strathelbiss"
BOULIA
RIVER
RIVER
To Winton
23°00'
BURKE
HAMILTON
Canary No 1
Elizabeth Springs No 1
Elizabeth Springs
To Bedourie
To Mt Isa
To Dajarra
To Mt Isa
pЄ
NORTHERN TERRITORY
QUEENSLAND
WESTERN AUSTRALIA
SOUTH AUSTRALIA
NEW SOUTH WALES
ACT
VICTORIA
TASMANIA
MOUNT ISA
CLONCURRY
JULIA CREEK
URANDANGI
DUCHESS
McKINLAY
GLENOR-MISTON
BOULIA
MACKUNDA
MOUNT WHELAN
SPRINGVALE
BRIGHTON DOWNS
BEDOURIE
MACHATTIE
CONNEMARA
Georgina Basin
Fault
Fault, position approx.
Anticline
Anticline, position approx.
Road
Track
Railway
Stratigraphic borehole
Bore with windpump
0
40 km
M(P)801

INTRODUCTION

The trilobite faunas described in this Bulletin are exclusively from the Chatsworth Limestone *sensu stricto*, as it occurs in the immediate neighbourhood of Chatsworth Homestead, 80 km south-southeast of Duchess, in western Queensland (Fig. 1). The outcrops straddle the Duchess and Boulia 1:250 000 Sheet areas, and form the central portion of the Burke River Structural Belt (Shergold, 1975, pp. 4-7; *in* Shergold, Druce *et al.*, 1976, pp. 4-5).

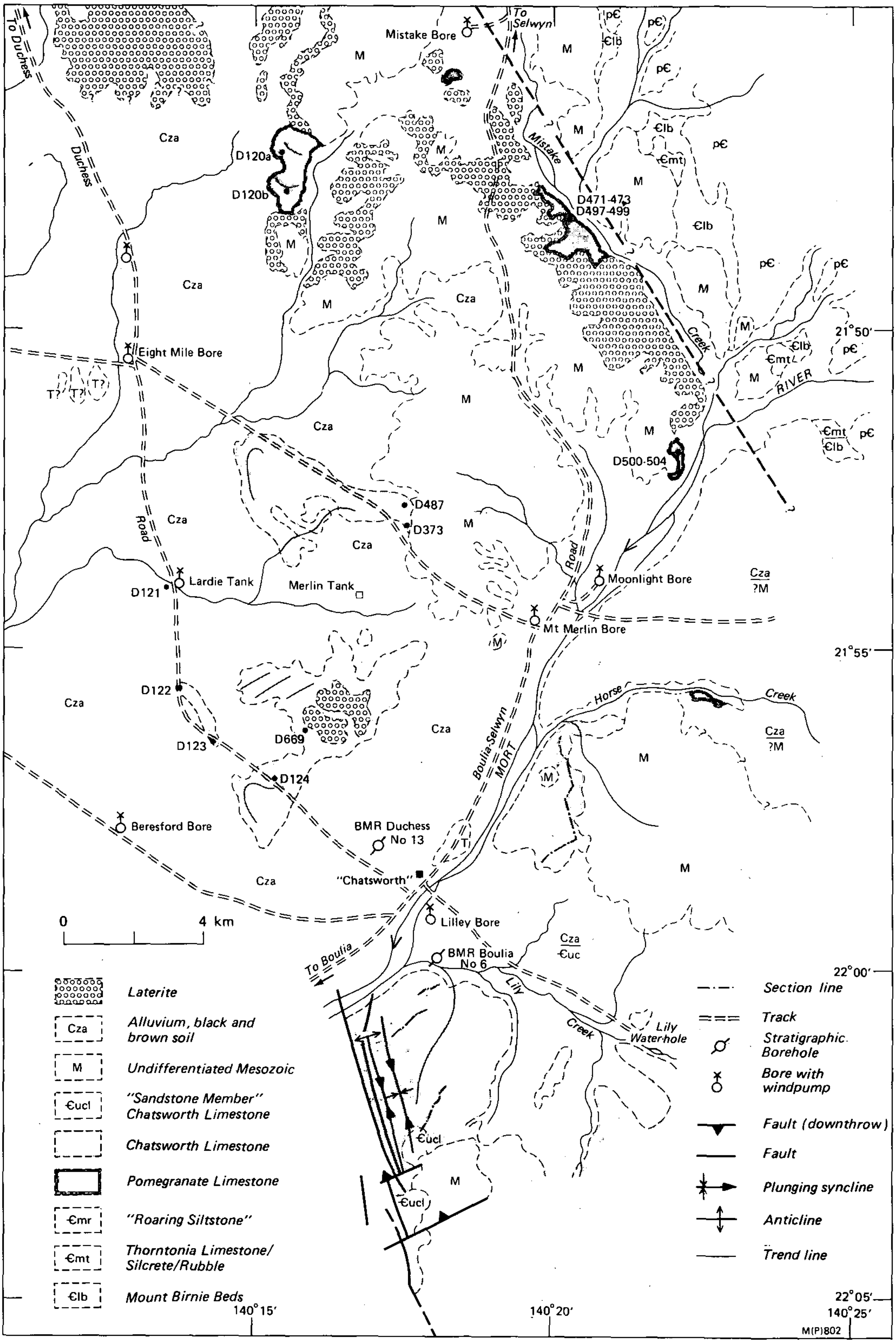
Although trilobites have been described (Öpik, 1963, 1967) from the underlying Pomegranate Limestone, at Pomegranate Creek, 19 km north of 'Chatsworth', no material from the Chatsworth Limestone *s.s.* has been illustrated previously. Those trilobites presently described are from collections made during initial field mapping of the Boulia Sheet area in 1957-60 (Casey, 1968; Casey *et al.*, 1960), and the Duchess area in 1958 (Carter & Öpik, 1963; Öpik, 1963). Frome-Broken Hill Pty Ltd collected two samples from the basal Chatsworth Limestone near 'Chatsworth' in 1958 (Taylor, 1959). Subsequently, collections were assembled by the BMR Northwest Queensland Phosphate Group in 1967 (de Keyser *et al.*, *in* de Keyser, 1968), by the author in 1969, and by B.M. Radke during the course of 1:100 000 scale mapping by the BMR Georgina Basin Project in 1974-75. Material is also currently available from two BMR stratigraphic boreholes, Boulia No. 6 and Duchess No. 13 (Fig. 2 and Appendix 3), drilled for the Georgina Basin Project in 1974.

All material described in this Bulletin is deposited in the Commonwealth Palaeontological Collection (prefix CPC), housed in the Bureau of Mineral Resources, Canberra, Australia.

Acknowledgements
The author acknowledges the time-consuming aid given by H.M. Doyle (BMR) in the preparation of the photographs used herein. B.M. Radke (BMR) is thanked for permitting the reproduction of the Lily Creek section which he measured, and J.M. Kennard (BMR) for making available details of cores logged, and for providing petrographic descriptions of the rocks noted in Appendices 1 and 3. I appreciate the constructive criticism provided by Drs R.A. Henderson, James Cook University of North Queensland, and J.B. Jago, South Australian Institute of Technology, on an earlier draft of this Bulletin.

The drawings were prepared by R. Fabbo and G. Clarke of BMR's Cartographic Section.

Fig. 1. Lower Palaeozoic of the Burke River Structural Belt, showing major localities of Upper Cambrian sediments.



To Duchess
Duchess Road
Mistake Bore
To Selwyn
Mistake Creek
D120a
D120b
D471-473
D497-499
D500-504
Eight Mile Bore
RIVER
D487
D373
Moonlight Bore
Lardie Tank
D121
Merlin Tank
Mt Merlin Bore
21°50'
21°55'
22°00'
22°05'
Horse Creek
D122
D123
D669
D124
Boulia-Selwyn MORT Road
Beresford Bore
BMR Duchess No 13
"Chatsworth"
Lilley Bore
To Boulia
BMR Boulia No 6
Lily Creek
Lily Waterhole
0
4 km
140°15'
140°20'
140°25'
M(P)802
Laterite
Cza
Alluvium, black and brown soil
M
Undifferentiated Mesozoic
€ucl
"Sandstone Member" Chatsworth Limestone
Chatsworth Limestone
Pomegranate Limestone
€mr
"Roaring Siltstone"
€mt
Thorntonia Limestone/ Silcrete/Rubble
€lb
Mount Birnie Beds
Section line
Track
Stratigraphic Borehole
Bore with windpump
Fault (downthrow)
Fault
Plunging syncline
Anticline
Trend line

LITHOFACIES

Chatsworth Limestone, the 'unnamed limestone' of Öpik (1956A, p. 23), was formalised by Casey (1959, p. 32), and has subsequently been referred to, or discussed, by Öpik (1960, p. 100; 1963, p. 22; *in* Casey *et al.*, 1960, p. 33), Casey *et al.* (1960, p. 33), Smith (1972, pp. 113-4, 149) and Shergold, Druce *et al.* (1976, pp. 10-11, 14, 33-4). Chatsworth Limestone, as used herein, refers only to the limestones which occur on the southern part of the Duchess and northern portions of the Boulia 1:250 000 Geological Series Sheet areas, i.e. at Mount Murray, on the Chatsworth Plains, and in the Horse Creek and Lily Creek areas (Fig. 1). For occurrences earlier referred to Chatsworth Limestone at other localities on the Boulia Sheet area, at Black Mountain, Ninmaroo, Mount Datson and Dribbling Bore, Jones *et al.* (1971), Druce & Jones (1971) and Shergold (1975) have recommended the use of the term 'Chatsworth Limestone'. Elucidation of the lithofacies of the Chatsworth Limestone *sensu stricto*, 'Chatsworth Limestone' and Gola Beds (Casey, 1959, p. 32; Öpik, 1960, p. 100; Smith, 1972, p. 114; Shergold, 1972, pp. 3-6), and possible subdivision of the formation, is presently in hand with J.M. Kennard (BMR Georgina Basin Project).

In general, surface outcrops of the Chatsworth Limestone (*s.s.*) in its type area represent sequences of dominantly sandy or silty pelletal skeletal grainstone and packstone, with subordinate wackestone and clast grainstone. These rocks were deposited in high energy shallow subtidal, intertidal and possibly aeolian environments: limestone beds are commonly cross-laminated and ripple marked; trilobites are always disarticulated, the tagmata are generally broken, and evidence of current winnowing and sorting of hydrodynamic shapes seems to be widespread.

Two recently drilled boreholes (1974), BMR Duchess No. 13 (85 m deep) and Boulia No. 6 (98 m) (Fig. 2) intersected strata partly equivalent to, and partly older than those on the Chatsworth Plains and in the Horse Creek area. Both were of dominantly dark grey silty and muddy finely laminated limestone with autochthonous faunas of meraspid and small holaspid trilobites, ostracodes, and dendroid graptolites, punctuated by layers of coarse often micaceous and pyritic skeletal grainstone and recrystallised limestone containing broken exuviae of large holaspid trilobites, and quantities of inarticulate brachiopods. The finer subsurface rocks are not unlike those which are said to characterise Pomegranate Limestone, whose closest outcrops are 6.5 km to the north and 8 km to the northeast of the northernmost Chatsworth Limestone on Chatsworth Plains (Fig. 2).

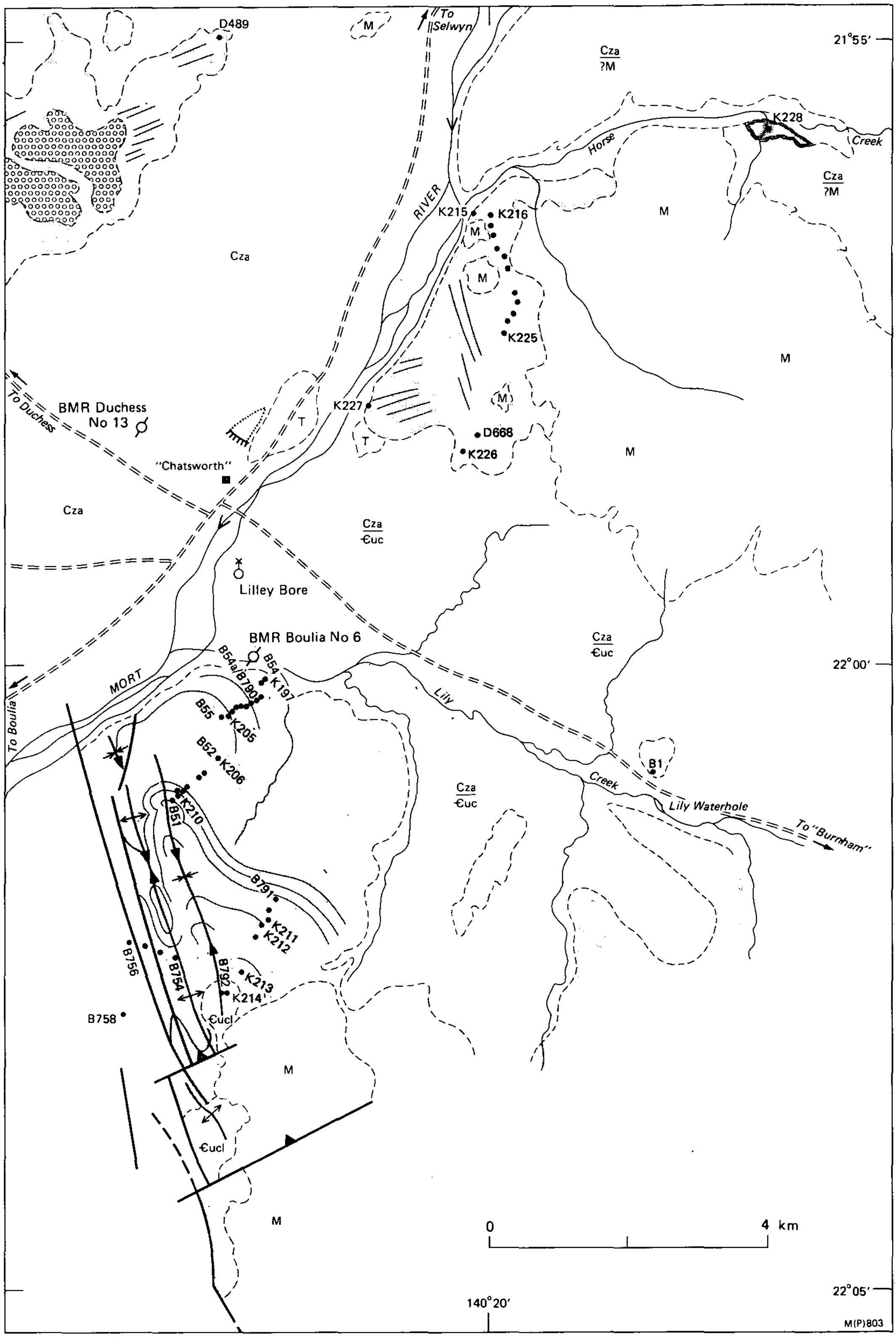
Although it has been stated (Casey, 1959, p. 32) that Chatsworth Limestone rests on O'Hara Shale, which partly overlies and is partly equivalent to Pomegranate Limestone, there is no surface evidence on the plains north of 'Chatsworth' for such a terrigenous clastic intercalation. The situation is probably comparable to that at Mount Murray, 24 km northwest of 'Chatsworth', where Chatsworth Limestone conformably overlies what Shergold, Druce *et al.* (1976, p. 34) term 'Pomegranate Limestone equivalents'. A 49 m terrigenous clastic interval referred to the O'Hara Shale in Black Mountain No. 1 (Phillips Petroleum Co. Ltd, 1963) may represent the predominantly shaly interval between 93-148 m on the Lily Creek type section (Fig. 4), from which it is inferred that the 249 m section referred to the Pomegranate Limestone in Black Mountain No. 1 includes equivalents of a substantial portion of the Chatsworth Limestone, as known at Horse Creek and on Chatsworth Plains. This observation is made on the basis of faunal correlation between beds above 148 m on the Lily Creek section and the lower 75 m of exposed 'Chatsworth Limestone' at Black Mountain (Shergold, 1975, Fig. 4).

At all localities in the Chatsworth area, the highest Chatsworth Limestone appears to be faulted against the Ninmaroo Formation, but the contact is everywhere concealed by soil and colluvium.

LILY CREEK

The Chatsworth Limestone outcrops most extensively south of Lily Creek (Boulia 1:250 000

Fig. 2. Sections and localities in the Chatsworth Limestone, and the spatial relationship of the Chatsworth and Pomegranate Limestones.


D489
To Selwyn
21°55′
Cza
?M
K228
Horse
Creek
Cza
?M
RIVER
K215
K216
M
Cza
M
K225
M
To Duchess
BMR Duchess
No 13
T
K227
T
D668
K226
M
"Chatsworth"
Cza
Cza
€uc
Lilley Bore
BMR Boulia No 6
Cza
€uc
22°00′
To Boulia
MORT
B54a/B790
B54
K197
B55
K205
Lily
B52
K206
B1
Creek
Cza
€uc
Lily Waterhole
To "Burnham"
K210
B51
B791
K211
K212
B756
B754
B792
K213
K214
B758
€ucl
M
€ucl
M
0
4 km
22°05′
140°20′
M(P)803

Geological Series Sheet area), where its type section is located 16 km east-northeast of 'Digby Peaks' and 3.5 km south of 'Chatsworth', at Latitude 22°03'S, Longitude 140°18'E (Casey, 1959, p. 33; Casey *et al.*, 1960, p. 33; Smith, 1972, pp. 113-4, 149; Shergold, Druce *et al.*, 1976, pp. 11, 14, fig. 6). Both outcrop area and type section are covered by air photographs at the following scales: K17, 1:50 000, Boulia Run 1, Photos 5741-3, September 1951; RC9, 1:83 000, Boulia Run 1, Photos 0080-4, June 1970; and Australian Government Colour, 1:25 000, Mount Merlin, Run 13, Photos 0049-50, September 1972; Digby Peaks, Run 1, Photos 0019-22, Run 2, photos 0104-07, June and May 1974 respectively.

The Lily Creek outcrop (Fig. 3) is basically a syncline plunging to the south-southeast, whose northeastern limb has shallow dips. The southwestern limb is tighter, and rapidly merges into a series of narrow, linear anticlinal structures. *En echelon* strike faults truncate the southwestern limbs of these anticlinal structures, and are inferred to throw Ninmaroo Formation against Chatsworth Limestone to the west. Alluvium largely covers the contact between these formations, however.

The type section (Fig. 3), originally estimated as having a thickness of 158.5 m (Casey *et al.*, 1960, p. 34; Smith, 1972, p. 149) was remeasured by Shergold in 1969 (261 m) and B.M. Radke (BMR Georgina Basin Project) in 1975 (300 m). Radke's section, to which has been added the positions of samples collected in 1969 and, as far as can be ascertained, those collected in 1957, is shown on Fig. 4.

Sandy and silty pelletal grainstones and packstones are the dominant lithofacies on the Lily Creek section. These rocks are often recrystallised; *Girvanella* clasts, calcispheres, and ooids may occur throughout the section; sandier and predominantly bioclastic layers are often cross-laminated. Radke (*in* Shergold, Druce *et al.*, 1976, pp. 10, 34, fig. 5) recognises cyclicity of sedimentation within the initial 90 m of the type section, a cycle comprising the transition from calcareous and terrigenous sands to accumulations of carbonate pellets. Fauna collected in this part of the sequence is mostly from the pelletal grainstones or similar rocks. Within the interval 90-280 m on the measured section, sandy pelletal grainstones predominate. These are succeeded by mainly cross-stratified calcareous sandstones, of probable aeolian origin, which form the uppermost 20 m of section (Radke, *loc. cit.*). Such sandstones are mapped on the Southern Burke River Structural Belt 1:100 000 Scale Map (preliminary Edition, Druce *et al.*, 1976) as the Lily Creek Member of the Chatsworth Limestone. They form the bulk of the formation south of the type section, where outcrop is limited by faulting and overstepping Mesozoic sediments.

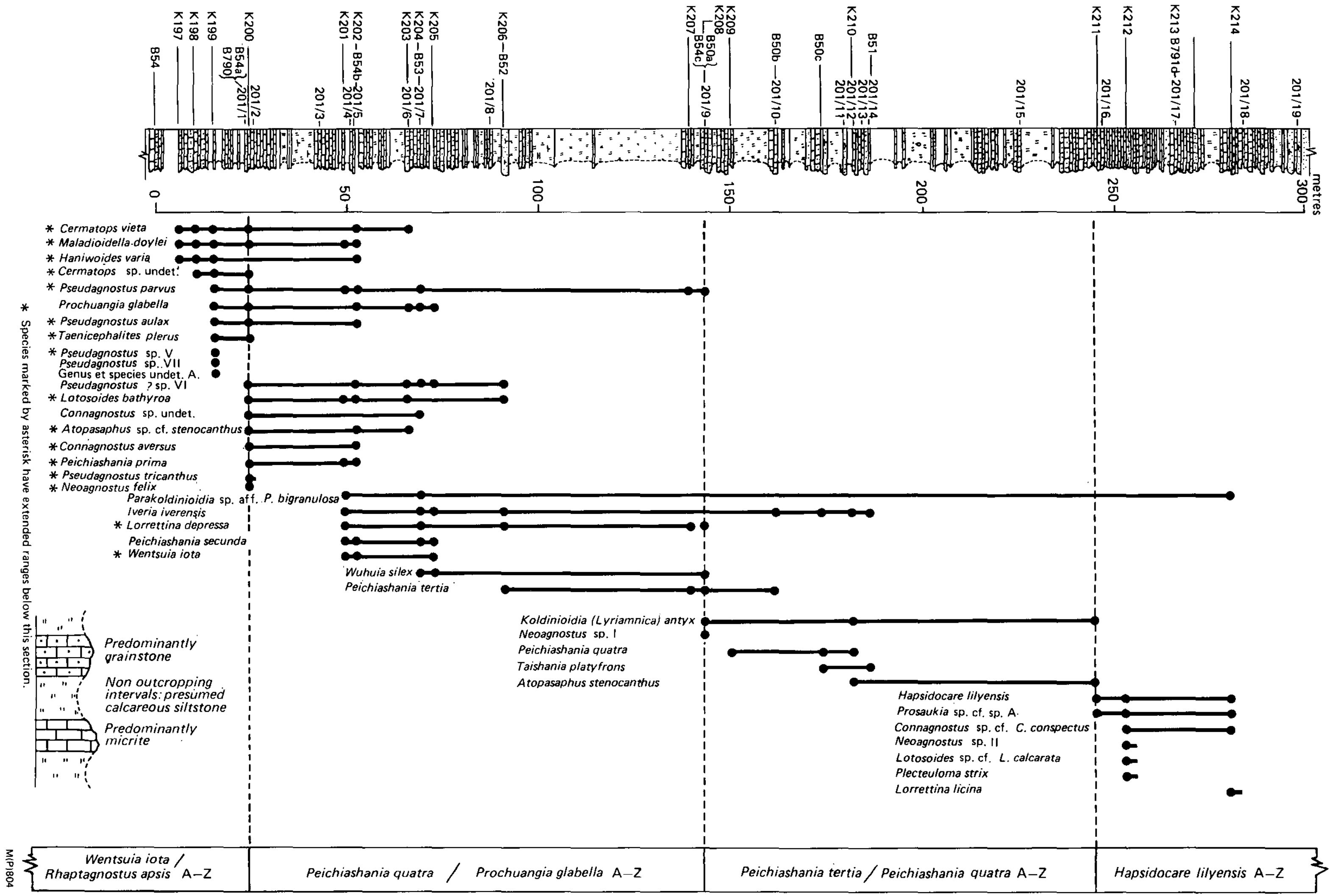
CHATSWORTH PLAINS

'Chatsworth Plains' is used here to describe the location of outcrops of Chatsworth Limestone which protrude through black soil and gravel cover on the plains to the north and northwest of Chatsworth Homestead.

Three such outcrop areas, based on original mapping of the Duchess 1:250 000 Sheet area by Carter & Öpik (1963), with revisions by de Keyser *et al.* (de Keyser, 1968), are shown on Fig. 2. Bedding and structural trends have been taken from aerial photographs (K17 Series, 1:50 000, Duchess Run 14, Photos 5062-4, Run 15, Photos 5020-2, September 1950; RC9 Series, 1:83 000, Duchess Run 8, Photos 0114-8, June 1970; and Australian Government Colour Series, 1:25 000, Mount Merlin Run 12, Photos 0065-9, September 1972).

Chatsworth Limestone lithofacies represented on the Chatsworth Plains are predominantly silty or sandy pelletal skeletal grainstones and clast pelletal skeletal grainstones, often cross-laminated and ripple-marked. Fossils are frequently found in the ripple troughs. As a generalisation, the sandy grainstones occur mainly to the west and northwest of 'Chatsworth' between BMR Scout Hole 7 and locality D124 (Fig. 2), and clast grainstones are most common to the north of 'Chatsworth', for instance at localities D373, 487, 489. On regional dips, it is assumed that the sequence becomes younger from northeast to southwest. Dips in general appear to be low, but are difficult to measure because individual limestone layers are often disorientated due to soil heave (Henderson, 1977, p. 423). Air photographs show that the beds are deformed into very gen-

Fig. 3. Sections and localities in the Chatsworth Limestone in the Lily Creek and Horse Creek areas.



K197
K198
K199
K200
B54
B54a
B790
201/1
201/2
K201
K202 – B54b – 201/5
201/3
201/4
K203 – 201/6
K204 – B53 – 201/7
K205
K206 – B52
201/8
K207
K208
K209
B50a
B54c
201/9
B50b – 201/10
B50c
K210
201/11
201/12
201/13
B51 – 201/14
201/15
K211
201/16
K212
K213 B791a – 201/17
K214
201/18
201/19
0
50
100
150
200
250
300
metres
* Cermatops vieta
* Maladioidella doylei
* Haniwoides varia
* Cermatops sp. undet.
* Pseudagnostus parvus
Prochuangia glabella
* Pseudagnostus aulax
* Taenicephalites plerus
* Pseudagnostus sp. V
Pseudagnostus sp. VII
Genus et species undet. A.
Pseudagnostus ? sp. VI
* Lotosoides bathyroa
Connagnostus sp. undet.
* Atopasaphus sp. cf. stenocanthus
* Connagnostus aversus
* Peichiashania prima
* Pseudagnostus tricanthus
* Neoagnostus felix
Parakoldinioidia sp. aff. P. bigranulosa
Iveria iverensis
* Lorrettina depressa
Peichiashania secunda
* Wentsuia iota
Wuhuia silex
Peichiashania tertia
Koldinioidia (Lyriamnica) antyx
Neoagnostus sp. I
Peichiashania quatra
Taishania platyfrons
Atopasaphus stenocanthus
Hapsidocare lilyensis
Prosaukia sp. cf. sp. A
Connagnostus sp. cf. C. conspectus
Neoagnostus sp. II
Lotosoides sp. cf. L. calcarata
Plecteuloma strix
Lorrettina licina
Predominantly grainstone
Non outcropping intervals: presumed calcareous siltstone
Predominantly micrite
* Species marked by asterisk have extended ranges below this section.
Wentsuia iota / Rhaptagnostus apsis A–Z
Peichiashania quatra / Prochuangia glabella A–Z
Peichiashania tertia / Peichiashania quatra A–Z
Hapsidocare lilyensis A–Z
M(P)804

tle basins and domes, with a general northwest-southeast trend. Thicknesses are difficult to assess, but since BMR Duchess No. 13 failed to intersect thick units of clast grainstone such as those seen at surface north of 'Chatsworth', it is assumed that they lie at a depth greater than the 85m penetrated in this borehole.

Samples collected from the fossiliferous localities listed in Appendix 1 mostly yield elements of the *Wentsuia iota* - *Rhaptagnostus apsis* Assemblage-Zone. At no locality has the *Peichiashania secunda* - *Prochuangia glabella* assemblage been confidently identified, although elements of the assemblage occur at D124 (Fig. 2), a sample representing several different stratigraphic horizons. It is apparent, therefore, that the sequences of the Chatsworth Plains largely underlie those of the Lily Creek section and are the spatial equivalents of the section in BMR Boulia No. 6, but that some overlap with the lower part of the Lily Creek section seems possible.

HORSE CREEK

The confluence of Horse Creek, a westerly flowing tributary, with the Mort River, is approximately 5 km north-northeast of 'Chatsworth'. 'Horse Creek area' (Figs. 2, 3) refers to an extensive pediment of Cambrian limestone which outcrops south of Horse Creek in the angle bounded by Horse Creek and the Mort River. This pediment is separated from a second, to the south of Lily Creek, by a tract of black soil cover. The Horse Creek pediment is poorly exposed: flat or gently dipping individual limestone layers outcrop sporadically from beneath silicified Mesozoic sandstone and quartz pebble rubble. Although bedding trends similar to those on the Chatsworth Plains are visible on air photographs (K17, Duchess Run 15, Photos 5022-4; RC9, Duchess Run 8, Photos 0112-5; and Colour, Mount Merlin Run 12, Photos 0070-2), it is not possible to place the collected samples in a definite stratigraphic sequence.

The lithofacies of the Chatsworth Limestone on the Horse Creek pediment are similar to those on the Chatsworth Plains, silty and sandy pelletal skeletal grainstones and clast pelletal skeletal grainstones predominating. Ripple-marking to the extent seen on Chatsworth Plains has not been observed.

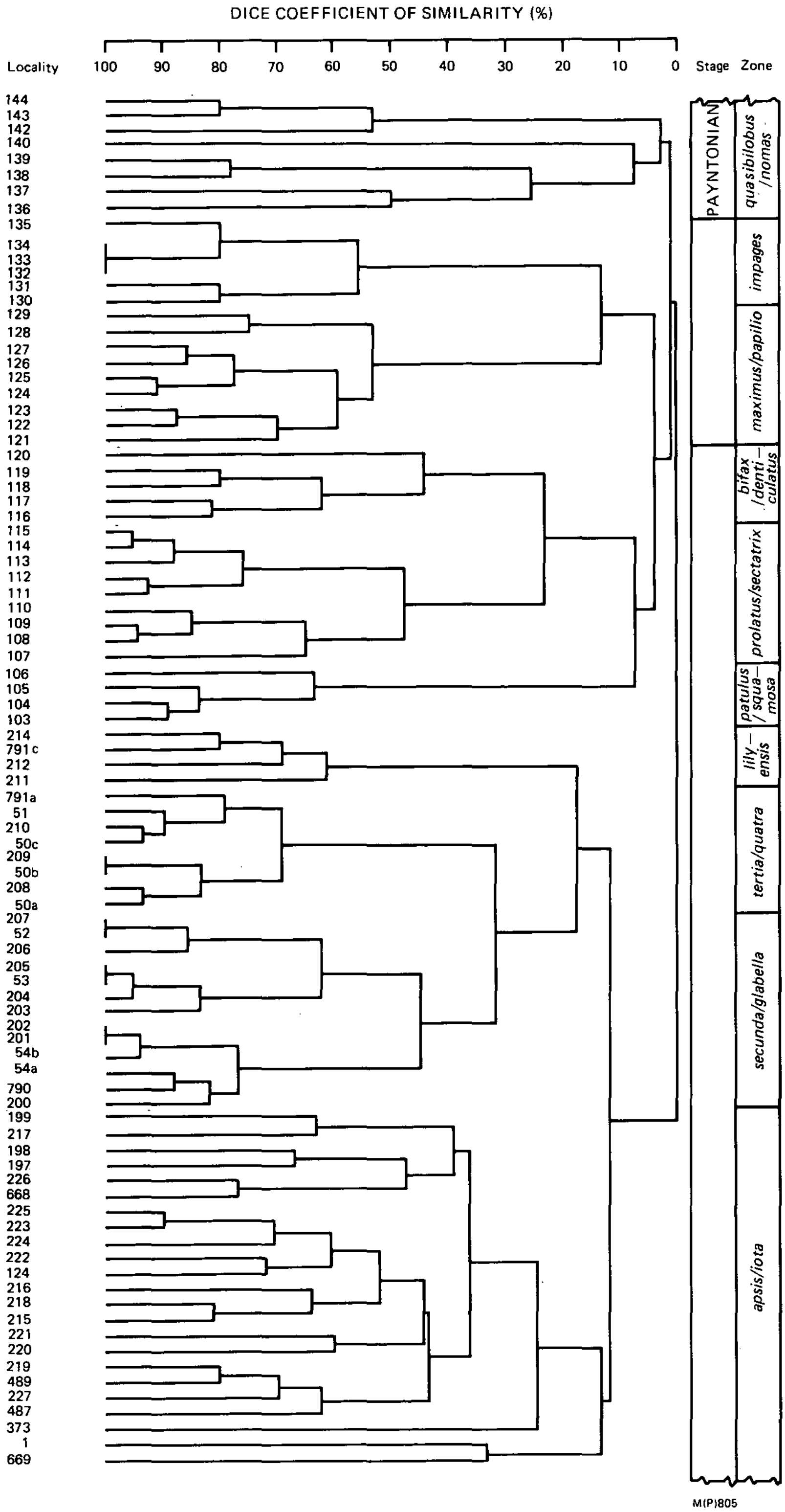
The frequent occurrence of clast pelletal grainstones on the Horse Creek section invites comparison with those observed towards the base of the Chatsworth Limestone on the Chatsworth Plains. Faunas from the localities listed in Appendix 1 are largely representative of the *Wentsuia iota* - *Rhaptagnostus apsis* Assemblage-Zone, which again indicates an overall position below the Lily Creek section for much of that at Horse Creek. Some overlap seems possible with the base of the Lily Creek section, however.

BIOSTRATIGRAPHY

Four successive intergrading biostratigraphical intervals, described as assemblage-zones, are recognised on the measured type section of the Chatsworth Limestone at Lily Creek (Fig. 4). Each assemblage-zone has been recognised by its having amongst its elements a significant number of species found at several horizons within it, but not elsewhere. No one horizon within the zone necessarily contains every element of the assemblage. The common content of horizons has been compared using the cluster analysis techniques previously described (Shergold, 1975, pp. 18-21). This has been applied to both the measured section and spot samples collected elsewhere in the general vicinity of 'Chatsworth', at Horse Creek and on the Chatsworth Plains, but not to horizons within the boreholes.

The Q-mode analysis (Fig. 5) represents the relationship of some 89 collected horizons on the basis of the 127 specific taxa determined from them. As described previously, the dendrogram is generated by the application of the Dice Similarity Coefficient (unweighted pair-groups) (see Melo & Buzas, 1968; Cheetham & Hazel, 1969; Hazel, 1970, 1971; Rowell *et al.*, 1973). By and large, the loose grouping at fairly

Fig. 4. The type section of the Chatsworth Limestone at Lily Creek (after the work of B.M. Radke).
(Correction: for *P. quatra* read *P. quarta*)



DICE COEFFICIENT OF SIMILARITY (%)
100 90 80 70 60 50 40 30 20 10 0
Locality
144
143
142
140
139
138
137
136
135
134
133
132
131
130
129
128
127
126
125
124
123
122
121
120
119
118
117
116
115
114
113
112
111
110
109
108
107
106
105
104
103
214
791c
212
211
791a
51
210
50c
209
50b
208
50a
207
52
206
205
53
204
203
202
201
54b
54a
790
200
199
217
198
197
226
668
225
223
224
222
124
216
218
215
221
220
219
489
227
487
373
1
669
Stage
Zone
PAYNTONIAN
quasibilobus/nomas
impages
maximus/papilio
bifax/denticulatus
prolatus/sectatrix
patulus/squamosa
lilyensis
tertia/quatra
secunda/glabella
apsis/iota
M(P)805

low phenon levels within the spot sample localities at Horse Creek and elsewhere, horizons D669-K199 on Fig. 5, reflects the stratigraphic uncertainty as to the ordering of the samples. These horizons (D669 through K199), however, do illustrate a unit distinct from the block of horizons which follows (commencing at K200), and this being accepted, it would appear that localities on Chatsworth Plains and the Horse Creek section stratigraphically overlap the base of the measured Lily Creek section.

The oldest biostratigraphic datum thus differentiated (including horizons D669-K199) is designated the *Wentsuia iota - Rhaptagnostus apsis* Assemblage-Zone. It is succeeded by three further assemblage-zones, all recognised only at Lily Creek, which are themselves distinct, even though they yield some common faunal elements, from zones previously recognised at Black Mountain, 58 km to the south (Shergold, 1975). These assemblage-zones, based on horizons having a fairly high degree of correlation, thus similarity of fauna, are successively: the *Peichiashania secunda - Prochuangia glabella, Peichiashania tertia - P. quarta,* and *Hapsidocare lilyensis* Assemblage-Zones. Total faunal content is shown on Table 1.

The R-mode analysis (Fig. 6) shows the degree of association of 91 species from 89 horizons. Those taxa most characteristic of a particular group of horizons form the basis for the recognition of the Assemblage-Zone. Interestingly, the fauna of the *Hapsidocare lilyensis* Assemblage-Zone falls between the zones of *Rhaptagnostus clarki patulus - Caznaia squamosa* and R.*c. prolatus - C. sectatrix* at Black Mountain.

ASSEMBLAGE-ZONE OF WENTSUIA IOTA WITH RHAPTAGNOSTUS APSIS:
the iota-apsis Assemblage-Zone

The Q-mode cluster analysis (Fig. 5) shows that horizons K197-199 on the Lily Creek section, K215-227 and D668 on the Horse Creek traverse, and D124, 373, 487, 489 and 669 on Chatsworth Plains have basically a common fauna which is not readily divided. This fauna comprises some 35 trilobite taxa (including 15 of agnostids), of which 40% range upwards into the succeeding assemblage zones (asterisks indicate species ranging upwards):

Acmarhachis hybrida, Atopasaphus cf. *stenocanthus, Atopasaphus* sp. indet., asaphacean undet., *Cermatops vieta*★, *Cermatops* sp. indet., *Connagnostus aversus, Connagnostus* sp. indet., *Eugonocare?* sp. undet., *Guizhoucephalina?* sp., *Haniwoides varia*★, *Innitagnostus medius, Leptoplastus?* sp. nov., *Lorrettina depressa*★, *Lotosoides bathyora*★, *Maladioidella doylei*★, *Neoagnostus felix*★, *N. greeni, Norinia?* sp. undet.; *Onchonotellus* sp. undet., *Peichiashania prima*★, *Peratagnostus* cf. *nobilis, Plicatolina* cf. *yakutica, Prochuangia glabella*★, *Pseudagnostus (Ps.) aulax*★, *Ps. (Ps.) mortensis, Ps. (Ps.) parvus*★, *Ps. (Ps.) tricanthus, Pseudagnostus (Ps.)* sp. VII, *Rhaptagnostus apsis, Rh.* sp. cf. *impressus, Taenicephalites plerus*★, *Wentsuia iota*★, Gen. et. sp. undet. A, hypostoma 1.

The non-trilobite component of the fauna, best documented in the boreholes BMR Boulia No. 6 and Duchess No. 13, comprises: Ostracoda undet., bradoriid ostracode aff. *Bradoria;* inarticulate brachiopods (acrotretids, obolids, *Schizambon* sp. undet.), *Billingsella* sp. undet.; *Pelagiella?* sp. undet., coiled mollusc undet.; pelecypod? undet.; dendroid graptolite fragments; pelmatozoan debris; and sponge spicules.

The R-mode cluster analysis(Fig. 6) indicates the degree of association of the characteristic trilobite taxa. Although they range throughout the assemblage-zone, and into that succeeding, the taxa set out below are of common occurrence, and are closely associated; the figures in parentheses indicating the percentage occurrence within the 22 horizons which contain the *iota-apsis* assemblage:

Cermatops vieta (36%)
Cermatops sp. undet. (45%)
Connagnostus aversus (36%)
Haniwoides varia (68%)
Maladioidella doylei (82%)
Neoagnostus greeni (32%)
Peichiashania prima (32%)
Pseudagnostus aulax (27%)
P. mortensis (36%)
P. tricanthus (27%)
Rhaptagnostus apsis (41%)
Taenicephalites plerus (82%)
Wentsuia iota (77%)

Fig. 5. Q-mode analysis of samples from Lily Creek, Horse Creek, Chatsworth Plains and Black Mountain. Dice Similarity Coefficient (unweighted pair groups): 127 species x 89 stratigraphic horizons.
(Correction: for *P. quatra* **read** *P. quarta***)**

TABLE 1

TOTAL FAUNAL CONTENT OF ASSEMBLAGES RECOGNISED FROM ALL LOCALITIES.

Fauna \ Assemblage Zones	*Wentsuia iota–Rhaptagnostus apsis*	*Peichiashania secunda–Prochuangia glabella*	*Peichiashania tertia–P. quatra*	*Hapsidocare lilyensis*
Acmarhachis hybrida sp. nov.	*			
Atopasaphus sp. undet.	*			
Eugonocare? sp. undet.	*			
Guizhoucephalina? sp.	*			
Innitagnostus medius sp. nov.	*			
Leptoplastus? sp. nov.	*			
Neoagnostus greeni sp. nov.	*			
Norinia? sp. undet.	*			
Onchonotellus sp. undet.	*			
Peratagnostus sp. cf. *nobilis* Öpik	*			
Plicatolina sp. aff. *yakutica* Pokrovskaya	*			
Pseudagnostus mortensis sp. nov.	*			
Pseudagnostus sp. VII	*			
Pseudagnostus? sp. V	*			
Rhaptagnostus apsis sp. nov.	*			
Rhaptagnostus sp. cf. *impressus* (Lerm.)	*			
Gen. et sp. undet. A	*			
Hypostoma undet. 1	*			
Atopasaphus sp. cf. *stenocanthus* Shergold	*	*		
Cermatops vieta gen. et sp. nov.	*	*		
Cermatops sp. undet.	*	*		
Connagnostus aversus sp. nov.	*	*		
Haniwoides varia sp. nov.	*	*		
Lotosoides bathyora sp. nov.	*	*		
Maladioidella doylei sp. nov.	*	*		
Neoagnostus felix sp. nov.	*	*		
Peichiashania prima sp. nov.	*	*		
Prochuangia glabella sp. nov.	*	*		
Pseudagnostus aulax sp. nov.	*	*		
Pseudagnostus tricanthus sp. nov.	*	*		
Taenicephalites plerus sp. nov.	*	*		
Wentsuia iota sp. nov.	*	*		
Lorrettina depressa sp. nov.	*	*	*	
Pseudagnostus parvus sp. nov.	*	*	*	
Connagnostus sp. undet.		*		
Peichiashania secunda sp. nov.		*		
Pseudagnostus? sp. VI		*		
Hypostoma undet. 4		*		
Iveria iverensis gen. et sp. nov.		*	*	
Parakoldinioidia sp. aff. *bigranulosa*		*	*	
Peichiashania tertia sp. nov.		*	*	
Wuhuia silex sp. nov.		*	*	
Neoagnostus sp. I			*	
Peichiashania quatra sp. nov.			*	
Rhaptagnostus auctor sp. nov.			*	
Taishania platyfrons sp. nov.			*	
Hypostoma undet. 2			*	
Hypostoma undet. 3			*	
Atopasaphus stenocanthus Shergold			*	*
Liriamnica antyx subg. et sp. nov.			*	*
Connagnostus sp. cf. *conspectus* Shergold				*
Hapsidocare lilyensis sp. nov.				*
Lorrettina licina sp. nov.				*
Lotosoides sp. cf. *calcarata* Shergold				*
Neoagnostus sp. II				*
Plecteuloma strix Shergold				*
Prosaukia sp. cf. sp. A? Shergold				*

M(P)842

(Correction: for *P. quatra* read *P. quarta*)

While not the most common taxa, *Rhaptagnostus apsis* and *Wentsuia iota*, which give their names to this assemblage-zone, are quite characteristic morphologically. Both genera are known outside Australia, moreover, which may aid the recognition of the biostratigraphic unit elsewhere.

The *iota-apsis* assemblage extends through an interval of section at least 114 m thick, i.e. through the basal 15 m of the Lily Creek measured section, and throughout the 99 m of BMR Boulia No. 6, which commenced at the base of that section. It also occurs throughout BMR Duchess No. 13 which penetrated 84.80 m of strata. Neither of these boreholes penetrated the base of the *iota - apsis* Assemblage-Zone, which is presumed, on grounds of regional stratigraphic superposition, to overlie the youngest Idamean Zone of *Irvingella tropica* with *Agnostotes inconstans*. This datum is recognised at locality D120 (Öpik, 1963, p. 18, fig. 2; herein Fig. 2), approximately 9 km NNW of the lowest outcropping biostratigraphically controlled Chatsworth Limestone (D487) on the Chatsworth Plains, and at Mount Murray (see Shergold *in* Shergold, Druce *et al.*, 1976, pp. 13 & 14, figs. 4-5), 36 km NW of Chatsworth Homestead. Slightly older Idamean rocks, probably *Corynexochus plumula* Zone (Öpik, 1963), occur adjacent to the Mort River (Fig. 2, localities D500-504), just 8 km ENE of the oldest Chatsworth Limestone on the Chatsworth Plains (D487) and 9 km NNE of the base of the Horse Creek Section (K215).

Stratigraphic proximity to the Idamean is suggested by the occurrence of such Idamean (and earlier) genera as *Acmarhachis, Innitagnostus, Peratagnostus* and *Eugonocare?* in the lower part of the Chatsworth Limestone (localities D373, 487, 489, K215, 216), and the presence of polymerid genera whose close morphological relations elsewhere are either associated with *Irvingella*, or immediately postdate it (see below). The age of the *Wentsuia iota - Rhaptagnostus apsis* Assemblage-Zone is thus assumed to be immediately post-Idamean.

ASSEMBLAGE-ZONE OF PEICHIASHANIA SECUNDA WITH PROCHUANGIA GLABELLA: *the secunda-glabella Assemblage-Zone*

This assemblage-zone occurs on the Lily Creek type section over the interval 24-140 m. Its characteristic fauna occurs at horizons K200-207, B52-53, B54a-54b and B790. The fauna comprises 23 trilobite taxa (including 6 of agnostids) of which 70% (16) range upwards from the preceding *iota-apsis* Assemblage-Zone. Six taxa continue into the succeeding *tertia-quarta* Assemblage-Zone. The fauna so far recorded includes:

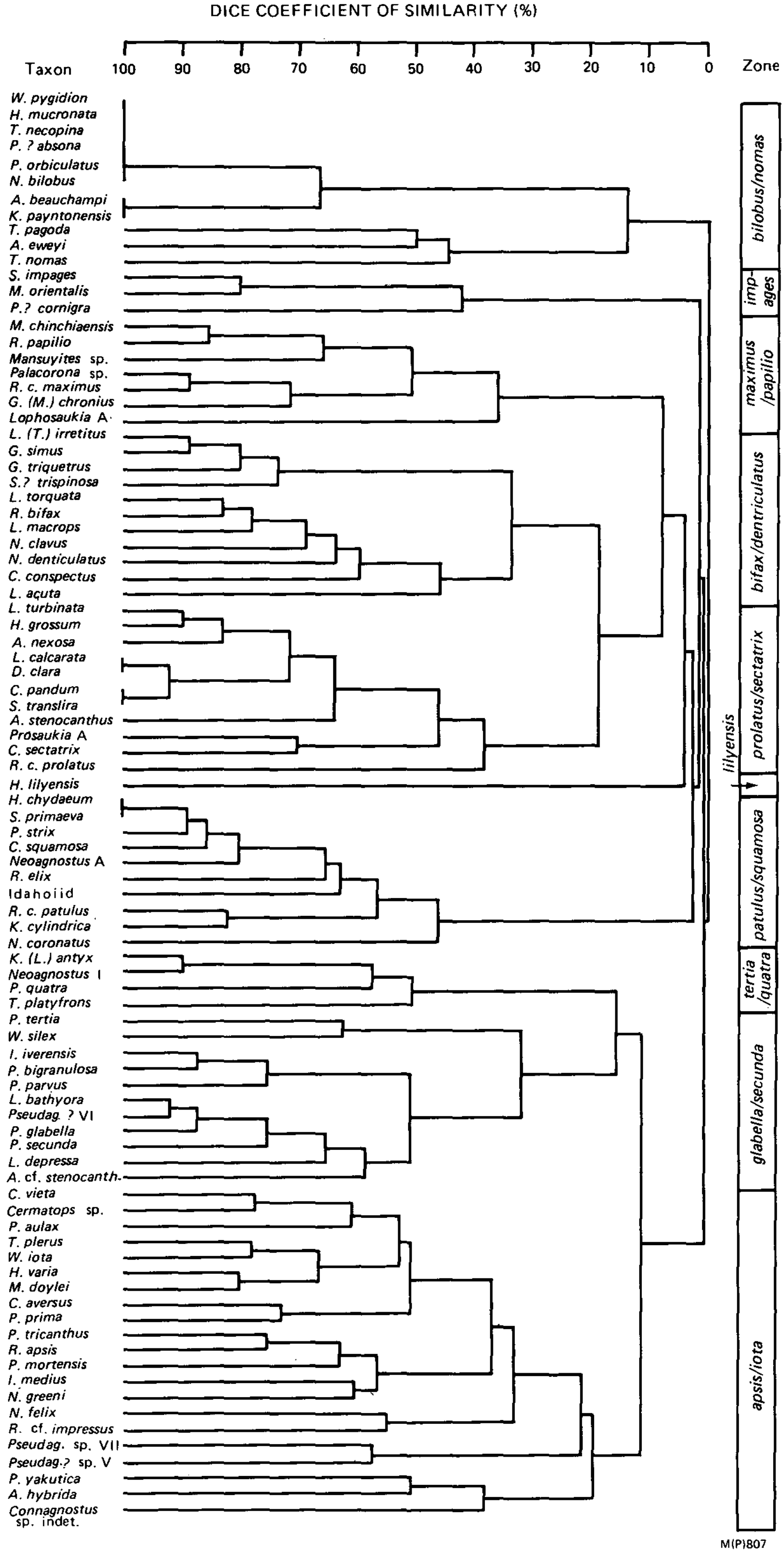
Atopasaphus cf. *stenocanthus, Cermatops vieta, Cermatops* sp. undet., *Connagnostus aversus, Connagnostus* sp. undet., *Haniwoides varia, Iveria iverensis*★, *Lorrettina depressa*★, *Lotosoides bathyora, Maladioidella doylei, Neoagnostus felix, Parakoldinioidia* cf. *P. bigranulosa*★, *Peichiashania prima, P. secunda, P. tertia*★, *Prochuangia glabella, Pseudagnostus (Ps.) aulax. Ps. (Ps.) parvus*★, *Ps. (Ps.) tricanthus, Ps. (Ps.?)* sp. VI, *Taenicephalites plerus, Wentsuia iota, Wuhuia silex*★, hypostomata 3 and 4.

The non-trilobite fauna contains undetermined inarticulate brachiopods, a gasteropod, a monoplacophoran aff. *Proplina,* an eocriniod aff. *Macrocystella*, sponge spicules, conodonts and pelmatozoan debris. In thin section, calcispheres and algal filaments attributed *Girvanella* have been recognised. Some lithologies have been bioturbated by horizontally burrowing organisms.

The R-mode cluster analysis (Fig. 6) shows that the assemblage is characterised by a high degree of association of:

Atopasaphus cf. *stenocanthus*
Lorrettina depressa
Peichiashania secunda
Prochuangia glabella
Pseudagnostus (Ps?) sp. VI
Lotosoides bathyora
Pseudagnostus (Ps.) parvus
Parakoldinioidia cf. *bigranulosa*
Iveria iverensis
Wuhuia silex
Peichiashania tertia

The early part of the *secunda-glabella* Assemblage-Zone is recognised by overlap with species of the underlying *iota-apsis* Assemblage-Zone. Characteristic species of the latter, *Wentsuia iota, Taenicephalites plerus, Haniwoides varia, Cermatops vieta, Maladioidella doylei, Peichiashania prima,* and *Pseudagnostus aulax* overlap the initial ranges of *Prochuangia glabella, Iveria iverensis* and *Peichiashania secunda*. Of the *iota-apsis* assemblage only *Pseudagnostus parvus, Lorrettina depressa* and *Lotosoides bathyora* survive into the later part of the *secunda-glabella* Assemblage-Zone, which is characterised by overlap of the *Peichiashania* species *secunda* and *tertia* with *Wuhuia silex, Iveria iverensis* and *Parakoldinioidia* cf. *bigranulosa*. This assemblage-zone thus forms a buffer between the preceding *iota-apsis* fauna and that of *P. tertia* and *P. quarta* which follows.



DICE COEFFICIENT OF SIMILARITY (%)
Taxon
100
90
80
70
60
50
40
30
20
10
0
Zone
W. pygidion
H. mucronata
T. necopina
P. ? absona
P. orbiculatus
N. bilobus
A. beauchampi
K. payntonensis
T. pagoda
A. eweyi
T. nomas
S. impages
M. orientalis
P.? cornigra
M. chinchiaensis
R. papilio
Mansuyites sp.
Palacorona sp.
R. c. maximus
G. (M.) chronius
Lophosaukia A
L. (T.) irretitus
G. simus
G. triquetrus
S.? trispinosa
L. torquata
R. bifax
L. macrops
N. clavus
N. denticulatus
C. conspectus
L. acuta
L. turbinata
H. grossum
A. nexosa
L. calcarata
D. clara
C. pandum
S. translira
A. stenocanthus
Prosaukia A
C. sectatrix
R. c. prolatus
H. lilyensis
H. chydaeum
S. primaeva
P. strix
C. squamosa
Neoagnostus A
R. elix
Idahoiid
R. c. patulus
K. cylindrica
N. coronatus
K. (L.) antyx
Neoagnostus I
P. quatra
T. platyfrons
P. tertia
W. silex
I. iverensis
P. bigranulosa
P. parvus
L. bathyora
Pseudag. ? VI
P. glabella
P. secunda
L. depressa
A. cf. stenocanth.
C. vieta
Cermatops sp.
P. aulax
T. plerus
W. iota
H. varia
M. doylei
C. aversus
P. prima
P. tricanthus
R. apsis
P. mortensis
I. medius
N. greeni
N. felix
R. cf. impressus
Pseudag. sp. VII
Pseudag.? sp. V
P. yakutica
A. hybrida
Connagnostus sp. indet.
bilobus/nomas
imp-ages
maximus/papilio
bifax/denticulatus
prolatus/sectatrix
lilyensis
patulus/squamosa
tertia/quatra
glabella/secunda
apsis/iota
M(P)807

ASSEMBLAGE-ZONE OF PEICHIASHANIA TERTIA WITH PEICHIASHANIA QUARTA:

the tertia-quarta Assemblage-Zone

The *tertia-quarta* Assemblage-Zone is known over the interval 144-245 m on the Lily Creek type section. Its fauna has been identified at horizons K208-K210, B50a-50c and B51, and comprises eleven trilobite taxa (only one of which is an agnostid), as follows:
*Atopasaphus stenocanthus**, *Iveria iverensis, Koldinioidia (Liriamnica) antyx**, *Lorrettina depressa, Neoagnostus* sp. I, *Parakoldinioidia* sp. cf. *P. bigranulosa, Peichiashania tertia, P. quarta, Pseudagnostus (Ps.) parvus, Rhaptagnostus auctor, Taishania platyfrons, Wuhuia silex,* and hypostoma 2.

The non-trilobite component of the fauna includes undetermined inarticulate brachiopods, an undetermined gasteropod, a hyolithid, and eocrinoid fragments.

Six of the trilobite taxa pass upwards from older zones, and associate in the early part of the Assemblage-Zone with *K.(L). antyx, P. quarta, T. platyfrons* and *Neoagnostus* sp. I. Only *K.(L.) antyx* and *Atopasaphus stenocanthus* continue into the overlying zone on the Lily Creek section, although *Taishania platyfrons* and *A. stenocanthus* both occur in the *Rhaptagnostus clarki patulus - Caznaia squamosa* Assemblage-Zone at Black Mountain in the south of the Burke River Structural Belt (Shergold, 1975). Of the large fauna of the *iota-apsis* Assemblage-Zone, only *Pseudagnostus (Ps.) parvus* extends into the base of the *tertia-quarta* Assemblage-Zone. R-mode cluster analysis (Fig. 6) indicates that the zone is characterised by the association of *P. tertia, P. quarta, T. platyfrons, K. (L.) antyx* and *Neoagnostus* sp. I. The *P. tertia/P. quarta* overlap provides recognition for the base of the assemblage-zone.

ASSEMBLAGE-ZONE OF HAPSIDOCARE LILYENSIS:

the lilyensis Assemblage-Zone

The *lilyensis* Assemblage-Zone is the youngest assemblage on the Lily Creek section, where it occurs in the uppermost 55 m of the measured section, at horizons K211-214 and B791d. It contains only 9 taxa on the measured section:

Atopasaphus stenocanthus, Connagnostus sp. cf. *C. conspectus, Hapsidocare lilyensis, Koldinioidia (Liriamnica) antyx, Lorrettina licina, Lotosoides* sp. aff. *L. calcarata, Neoagnostus* sp. II, *Plecteuloma strix,* and *Prosaukia* sp. cf. *P.* sp. A? Non-trilobite elements in the fauna consist of the brachiopod *Billingsella* and pelmatozoan debris.

Only two of these trilobite taxa range up from the *tertia-quarta* Assemblage-Zone: *K. (L.) antyx* and *A. stenocanthus*. However, at Black Mountain (Shergold, 1975) *Atopasaphus stenocanthus, Lotosoides calcarata,* and *Prosaukia* sp. A are associated in the *Rhaptagnostus clarki prolatus* with *Caznaia sectatrix* Assemblage-Zone, *Plecteuloma strix* occurs in the *R.c. patulus* with *Caznaia squamosa* Assemblage-Zone, and *Connagnostus conspectus* occurs with *A. stenocanthus* and *L.calcarata* in the *Rhaptagnostus bifax - Neoagnostus denticulatus* Assemblage-Zone. Additionally, these three assemblages all contain species of *Hapsidocare,* the *patulus-squamosa* Assemblage-Zone contains a species of *Wuhuia* which continues the lineage of this genus seen in the *secunda-glabella* and *tertia-quarta* Assemblage-Zones at Lily Creek, and the *prolatus-sectatrix* and *bifax-denticulatus* Assemblage-Zones contain a species of *Lorrettina* similar to *L. licina.*

Thus it would appear that the *Hapsidocare lilyensis* Assemblage-Zone at Lily Creek is contemporaneous with the early part of the biostratigraphic sequence at Black Mountain. The R-mode analysis (Fig. 6) relates the zone to both the *patulus-squamosa* and *prolatus-sectatrix* Assemblage-Zones. Indisputably, the three earliest assemblage-zones at Black Mountain and at least the youngest one at Lily Creek represent a similar stage in the development of the late Cambrian peri-Gondwana biota in shallow water carbonate environments.

ECOSTRATIGRAPHIC RELATIONSHIPS

The differentiation of a *lilyensis* Assemblage-Zone at Lily Creek and a *patulus-squamosa* Assemblage-Zone at Black Mountain is a reflection of the differing contemporaneous sedimentary environments at

Fig. 6. R-mode analysis of samples from Lily Creek, Horse Creek, Chatsworth Plains and Black Mountain: 91 species x 89 stratigraphic horizons. (Correction: for *P. quatra* read *P. quarta*)

the two sites. Agnostid trilobites in the fauna, generally regarded as indicators of ocean-facing environments (Robison, 1972; Shergold, 1977A) since they apparently favoured habitats at the oceanic/neritic boundary, emphasise the distinction between the two sites. Two agnostid taxa occur in the aeolian? and intertidal environments represented by the sediments at the top of the Lily Creek section (Radke *in* Shergold, Druce *et al.*, 1976, p. 34), whereas no fewer than five occur in the intertidal and shallow subtidal environments at Black Mountain (Shergold, 1975; *in* Shergold, Druce *et al.*, 1976, p. 14).

Similar reasoning can be applied to the vertical section in the Chatsworth area, which, as a generality, can be regarded as an 'upward-shallowing' sequence. Both BMR Boulia No. 6 and Duchess No. 13 commence with basically muddy carbonate sediments and pass up into dominantly grainstone sequences (Appendix 3), all deposited during the time span of the *Wentsuia iota - Rhaptagnostus apsis* Assemblage-Zone. This assemblage contains trilobites either having similarity to genera previously described from Asia, e.g. *Guizhoucephalina?, Lotosoides, Maladioidella, Peichiashania, Prochuangia, Wentsuia,* or that are more widely distributed, e.g. the seven agnostid genera, olenids *(Plicatolina, Leptoplastus?, Eugonocare?),* and ceratopygids *(Cermatops, Norinia?, Haniwoides).* The presence of the last group, together with the occurrence of dendroid graptolites, bradoriid crustacea and sponge spicules, suggests a basically Australian/ Asian biofacies exposed to open marine influence. Thus it is assumed that the sediments deposited during the span of this Assemblage-Zone were subject to more direct oceanic current activity, and were deposited either on the oceanic side of a carbonate bank, or within influence of a tidal seaway cutting such a bank complex. The fauna of the *iota-apsis* Assemblage-Zone is the most varied and cosmopolitan in affinity of the post - *Irvingella* faunas in the Burke River Structural Belt.

Although the sediments deposited during the span of the *secunda-glabella* Assemblage-Zone at Lily Creek are similarly dominantly pelletal grainstones and skeletal pelletal grainstones (Fig. 4; Radke *in* Shergold, Druce *et al.*, 1976, Fig. 5), Radke recognises cyclic sedimentation in the interval 67-71 m from the base of the measured section at Lily Creek. In such cycles, periods of high energy accumulation of calcareous and terrigenous sand, at times ripple-marked, cross-stratified and containing shell debris layers, alternate with low energy deposits of carbonate pellets, occasionally containing articulated trilobites, eocrinoid calyces, and monoplacophorans. Overall, the fauna is less cosmopolitan than that of the *iota-apsis* Assemblage-Zone, the occurrence of *Haniwoides, Lotosoides, Maladioidella, Parakoldinioidia, Peichiashania, Prochuangia, Wentsuia* and *Wuhuia* suggesting greatest affinity with previously described Asian faunas.

Sediments deposited during the time of the succeeding *tertia-quarta* Assemblage-Zone, although also dominantly grainstones, are often ripple-marked, intraclastic, two-tone (mottled) and more thickly bedded than in earlier intervals. The fauna is yet more restricted to Australo-Asian shelf province forms: *Koldinioidia, Parakoldinioidia, Peichiashania, Taishania* and *Wuhuia.* Cosmopolitan elements are minimal. The trend continues to the top of the Lily Creek section, where in the topmost beds, the Lily Creek Member of the Chatsworth Limestone, thickly bedded cross-stratified grainstones and intraclastic limestones are interpreted (Radke *in* Shergold, Druce *et al.*, 1976, p. 34) as probable aeolianite deposits. These deposits, found during the span of the *lilyensis* Assemblage-Zone, also contain minimal cosmopolitan elements.

AGE AND CORRELATION

CORRELATION WITHIN AUSTRALIA

The *iota-apsis* Assemblage-Zone is presently only fully documented in the Burke River Structural Belt (this account). Elsewhere in Australia its probable correlatives occur in the Amadeus and Bonaparte Gulf Basins and in Tasmania. Rocks of appropriate age are missing in the Daly River (Öpik, 1968; Jones, 1971; Webby, 1974), Wiso (Smith, 1972; Webby, 1974) and Ngalia (Webby, 1974) Basins, where Ordovician rests on rocks of Middle or Early Cambrian age, and probably also elsewhere in the southern part of the Georgina Basin, where latest Cambrian (Payntonian) rests on possible older Upper Cambrian (Mindyallan?) rocks.

In the Amadeus Basin, the Goyder Formation must correlate with the Pomegranate and lower Chatsworth Limestone (*s.s.*) of the Burke River Structural Belt, since Gilbert-Tomlinson (*in* Wells *et al.*, 1970, p. 58) reports the occurrence of a Mindyallan fauna in the lower part of the Goyder Formation and a late Franconian fauna in its upper part. No details of the fauna have been published, although Öpik (1956B, p. 47) has listed some of the latest Cambrian genera.

In the Bonaparte Gulf Basin, northwestern Australia, biostratigraphic units characterised by Parabolinoididae and *Peichiashania* [= *Paramansuyella* of Öpik] have been noted in the upper part of the Pretlove Sandstone and lower part of the Clark Sandstone (Öpik *in* Kaulback & Veevers, 1969, appendix 3).

Contemporaneous faunas are thought to occur in southwestern Tasmania, where Öpik (*in* Banks, 1962, p. 137) considered the faunas of the serpentinitic conglomerate, calcareous sandstone, siltstone and impure limestone which unconformably overlie the Adamsfield ultramafic intrusion, to be similar to those of the basal Chatsworth Limestone of the Burke River area.

In the Denison Range, the basal Singing Creek Formation of the Denison Subgroup (Corbett, 1975, p. 115) is reported to contain early Franconian trilobites, and its correlative in the lower part of the Owens Conglomerate in the Tyndall Range (western Tasmania) is thought to have a similar fauna (Corbett, *loc. cit.*). Jago (pers. comm.) suggests that the Climie Formation, also in western Tasmania, may yield a fauna of equivalent age.

Direct correlatives of the later part of the Lily Creek section, particularly the *Hapsidocare lilyensis* Assemblage-Zone, occur at the base of the Black Mountain sequence, 58 km south of Lily Creek, as noted above.

INTERCONTINENTAL CORRELATION

Outside Australia, correlatives of the sequences described in this Bulletin, and particularly the *Wentsuia iota - Rhaptagnostus apsis* Assemblage-Zone, are known around the northern and northwestern margins of the Siberian Platform, in Kazakhstan, possibly the Tien-shan, northern China, Manchuria and Korea (Fig. 7).

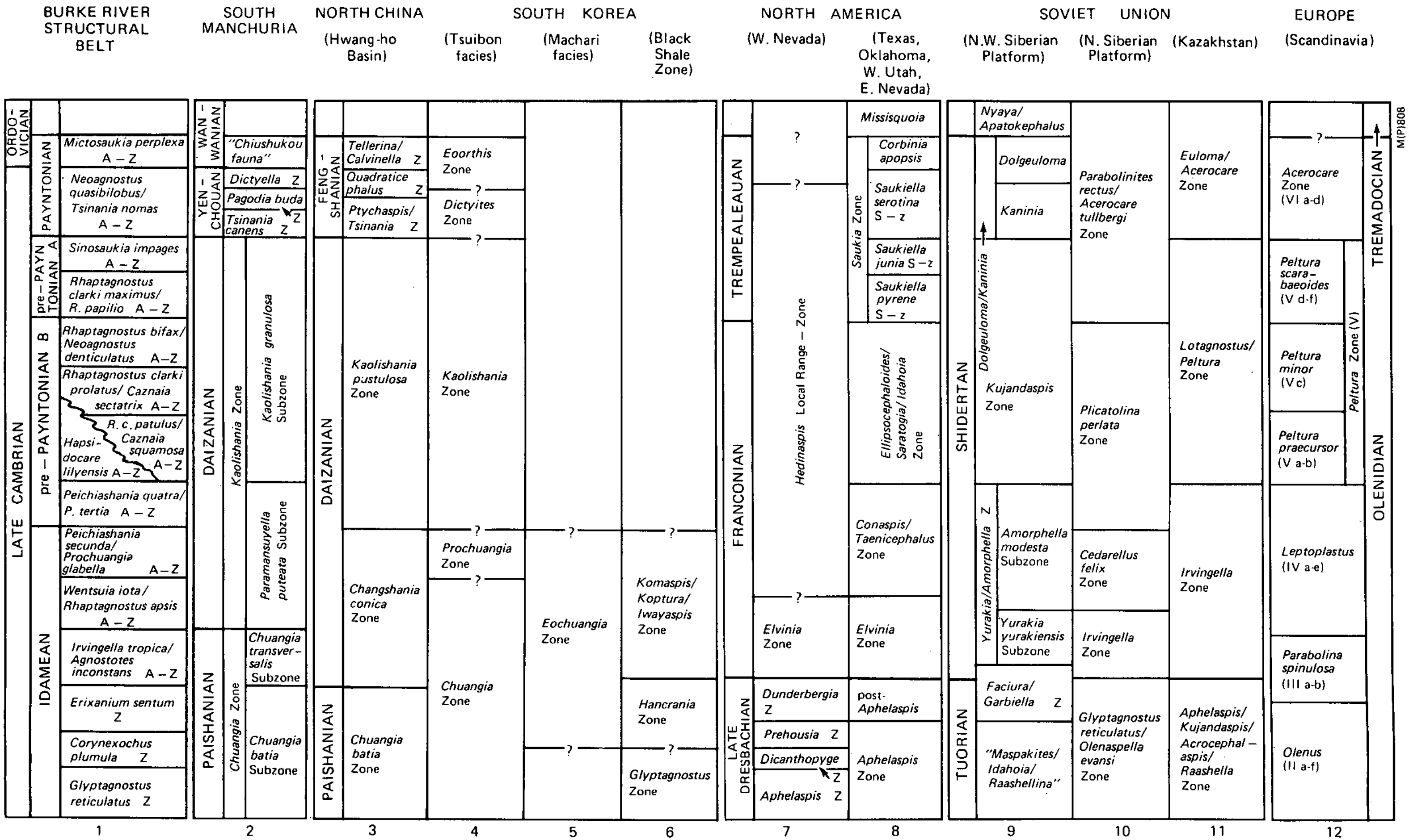
Soviet Union

On the northern margin of the Siberian Platform (Fig. 7, Col. 10), in the Kyutyungdinsk Depression, on the Olenek Uplift, and in the Kharaulakh Mountains, Lazarenko (1966, 1972) has established a biostratigraphy in which two of the three youngest Zones, *Cedarellus felix* and *Plicatolina perlata*, contain trilobites with morphological affinites to those of the *Wentsuia iota - Rhaptagnostus apsis* Assemblage-Zone. From the *Cedarellus felix* Assemblage-Zone, which immediately overlies that of *Irvingella* in northern Siberia, *Cyclopagnostus orientalis* Lazarenko is a less effaced and more convex version of *Peratagnostus nobilis* Öpik; *Cedarellus felix* Lazarenko is cranidially comparable with *Maladioidella; Amorphella modesta* Rosova, listed by Lazarenko (*in* Lazarenko & Nikiforov, 1972, p. 7), is morphologically similar to *Taenicephalites plerus;* and *Rhaptagnostus* cf. *impressus* (Lermontova) is identified in the Australian sequence. The succeeding assemblage in northern Siberia is characterised by *Plicatolina*, a species of which, cranidially similar to *P. yakutica* Pokrovskaya and pygidially to *P. perlata* Lazarenko, also occurs in Australia. This zone further contains *Iwayaspis caelata* Lazarenko, a ceratopygacean trilobite whose pygidium resembles both the Idamean *Aplotaspis* Henderson and that of *Cermatops* gen. nov.

On the northwest flanks of the Siberian Platform (Column 9), between Igarka on the Yenesei River and Norilsk on the Rybnaya, slightly different biostratigraphic schemes have been proposed, presumably reflecting lateral lithofacies variation. In the Kulyumbe River sections (Rosova, 1963, 1964, 1968; Lazarenko & Datsenko, 1967; Lazarenko & Nikiforov, 1968), the *iota-apsis* Assemblage-Zone probably correlates with the *Amorphella modesta* Subzone of the *Amorphella - Yurakia* Zone, since the index fossil is most similar to the Australian *Taenicephalites plerus*, and this time interval appears to represent the maximum development of parabolinoidid morphologies.

In the Norilsk region (Datsenko & Lazarenko, 1968; Lazarenko, 1968), the lower part of the *Amorphella - Yurakia* Zone is replaced by that of *Irvingella norilicǎ - Tagenarella eniseica*, an assemblage which contains similar elements to those of the *Irvingella* and *Cedarellus felix* assemblages of the northern Siberian Platform. *Cedarellus* and *Amorphella*, resembling *Maladioidella* and *Taenicephalites* respectively, occur with *Onchonotellus abnormis* Ivshin among others in this Zone.

In Kazakhstan (Lermontova, 1951; Ivshin, 1956, 1960A, 1962; Ivshin & Pokrovskaya 1968) (Column 11) and the Altai-Sayan (Ivshin, 1960A), the *Wentsuia iota - Rhaptagnostus apsis* Assemblage-Zone probably correlates with the upper part of the *Irvingella* Zone (the Selety faunal horizon of Ivshin, 1962). Agnostids apart, however, there are few


BURKE RIVER STRUCTURAL BELT
ORDO-VICIAN
LATE CAMBRIAN
PAYNTONIAN
pre-PAYNTONIAN A
pre-PAYNTONIAN B
IDAMEAN
Mictosaukia perplexa A – Z
Neoagnostus quasibilobus/ Tsinania nomas A – Z
Sinosaukia impages A – Z
Rhaptagnostus clarki maximus/ R. papilio A – Z
Rhaptagnostus bifax/ Neoagnostus denticulatus A – Z
Rhaptagnostus clarki prolatus/ Caznaia sectatrix A – Z
R. c. patulus/ Caznaia squamosa A – Z
Hapsidocare lilyensis A – Z
Peichiashania quatra/ P. tertia A – Z
Peichiashania secunda/ Prochuangia glabella A – Z
Wentsuia iota/ Rhaptagnostus apsis A – Z
Irvingella tropica/ Agnostotes inconstans A – Z
Erixanium sentum Z
Corynexochus plumula Z
Glyptagnostus reticulatus Z
1
SOUTH MANCHURIA
WANWANIAN
YENCHOUAN
DAIZANIAN
PAISHANIAN
"Chiushukou fauna"
Dictyella Z
Pagodia buda
Tsinania canens Z
Z
Kaolishania Zone
Kaolishania granulosa Subzone
Paramansuyella puteata Subzone
Chuangia Zone
Chuangia transversalis Subzone
Chuangia batia Subzone
2
NORTH CHINA (Hwang-ho Basin)
FENGSHANIAN
DAIZANIAN
PAISHANIAN
Tellerina/ Calvinella Z
Quadraticephalus Z
Ptychaspis/ Tsinania Z
Kaolishania pustulosa Zone
Changshania conica Zone
Chuangia batia Zone
3
SOUTH KOREA
(Tsuibon facies)
Eoorthis Zone
Dictyites Zone
Kaolishania Zone
Prochuangia Zone
Chuangia Zone
4
(Machari facies)
Eochuangia Zone
5
(Black Shale Zone)
Komaspis/ Koptura/ Iwayaspis Zone
Hancrania Zone
Glyptagnostus Zone
6
NORTH AMERICA
(W. Nevada)
TREMPEALEAUAN
FRANCONIAN
LATE DRESBACHIAN
Hedinaspis Local Range – Zone
Elvinia Zone
Dunderbergia Z
Prehousia Z
Dicanthopyge Z
Aphelaspis Z
7
(Texas, Oklahoma, W. Utah, E. Nevada)
Missisquoia
Saukia Zone
Corbinia apopsis
Saukiella serotina S – z
Saukiella junia S – z
Saukiella pyrene S – z
Ellipsocephaloides/ Saratogia/ Idahoia Zone
Conaspis/ Taenicephalus Zone
Elvinia Zone
post-Aphelaspis
Aphelaspis Zone
8
SOVIET UNION
(N.W. Siberian Platform)
SHIDERTAN
TUORIAN
Nyaya/ Apatokephalus
Dolgeuloma/Kaninia
Dolgeuloma
Kaninia
Kujandaspis Zone
Yurakia/Amorphella Z
Amorphella modesta Subzone
Yurakia yurakiensis Subzone
Faciura/ Garbiella Z
"Maspakites/ Idahoia/ Raashellina"
9
(N. Siberian Platform)
Parabolinites rectus/ Acerocare tullbergi Zone
Plicatolina perlata Zone
Cedarellus felix Zone
Irvingella Zone
Glyptagnostus reticulatus/ Olenaspella evansi Zone
10
(Kazakhstan)
Euloma/ Acerocare Zone
Lotagnostus/ Peltura Zone
Irvingella Zone
Aphelaspis/ Kujandaspis/ Acrocephalaspis/ Raashella Zone
11
EUROPE (Scandinavia)
TREMADOCIAN
OLENIDIAN
Acerocare Zone (VI a-d)
Peltura Zone (V)
Peltura scarabaeoides (V d-f)
Peltura minor (V c)
Peltura praecursor (V a-b)
Leptoplastus (IV a-e)
Parabolina spinulosa (III a-b)
Olenus (II a-f)
12
M(P)808

similarities, and it is difficult to establish taxonomic relationships because of the close splitting of the Kazakhstan taxa by Ivshin (1956, 1962): leiostegiacean, parabolinoidid and dokimocephalid morphologies are apparent in Ivshin's illustrations. Among the agnostids, Ivshin (1962, pl. 1, figs. 1-6) illustrates homagnostoid pygidia with constricted acrolobes similar to those referred here to *Connagnostus aversus*, and pseudagnostids figured as *Pseudagnostus leptoplastorum* Westergaard (Ivshin, 1962, pl. 1, figs. 8-18), resembling the Australian *P.(P.) aulax*, and *P. pseudocyclopyge* Ivshin (1962, pl. 1, figs. 19-22), perhaps representing a less effaced variant of *P.(P.) mortensis*.

Southwards of Kazakhstan, in the western Tien-shan (Zarafshan-Turkestan structural-formational Zone), Jaskovich (1968, p.24) has recorded the association of *Onchonotellus, Olentella, Prochuangia* and *Homagnostus,* which may correlate with or be older than the *iota-apsis* Assemblage-Zone. In the regions of the Turkestan-Alai Mountains (Jaskovich, 1968; Repina *et al.*, 1975) and the Zarafshan-Alai (Jaskovich, 1968), Ordovician sediments overlie Middle Cambrian. In the eastern Tien-shan, however, in the western Quruq-tagh, Troedsson (1937) has recorded the presence of *Norinia* and illustrated *Cermatops*-like morphologies, which may indicate the existence of correlatives of the *iota-apsis* Assemblage-Zone there.

China

The eastern Tien-shan fauna also includes such genera as *Irvingella, Hedinia, Proceratopyge (Lopnorites), Charchaqia* and *Westergaardites,* which occur again as the Chiangnan fauna (Kobayashi, 1967, pp.458-466, fig. 5) in the Machari facies (Kobayahsi, 1962) of the Yangtze Basin of south-central China and the Yokusen Geosyncline of South Korea. Agnostids apart, this Chiangnan fauna of China has little in common with that described here from the Burke River area, and yet must be at least partly contemporaneous. That of the Yokusen geosynclinal area of Korea has rather more common elements (see below).

The Hwang-ho fauna, of the Hwango-ho Basin (Column 3) to the north of the Tsing-ling axis (Kobayashi 1967, fig. 5), is common also to North Korea and Manchuria, and correlates with the Tsuibon fauna of South Korea. Both lithostratigraphy and biostratigraphy are summarised by Kobayashi (1966B, 1967, 1971). The biostratigraphic scale applied is based on the work of Sun (1924, 1935), Kobayashi (1931, 1933, 1935C), Endo (1931, 1937, 1939, 1944) and Lu *et al.* (1974) on sequences in western Shantung (Tawenkou, Kaolishan), western Hopei (Huolu), eastern Hopei (Kaiping, Lin-yü and Shihmenchai Basins), southeastern Shansi (Licheng), and Manchuria (Taitzuho valley and the Wuhutsui Basin of Liaotung). Of the zones and stages shown on Fig. 7, however, the *Changshania conica* Zone is observed only in the Kaiping Basin of eastern Hopei (Sun 1935, p. 6); the *Chuangia batia* Zone is not recognised in Shantung or the Kaiping Basin (Sun, *loc. cit.*); and in the Hualienchai area of the Taitzuho valley, in Manchuria, all zones between the Kushanian and Fengshanian are missing (Kobayashi 1931). A similar situation occurs on the Jehol Block (Shakuotun), and in northern Shansi (on the Ordos). Fengshanian overlies Middle Cambrian in the Tatung coalfield (north Shansi), and the Upper Cambrian is missing altogether in the Ala-shan (see Kobayashi, 1967, for synthesis), as in the western Tien-shan. Thus, fully documented stratigraphic sequences appear to be available only in the Wuhutsui Basin, Liaotung Peninsula, southern Manchuria (Kobayashi, 1933; Endo, 1937).

Fig. 7. Correlation of the Late Cambrian (Idamean to Payntonian) assemblage-zones of the Burke River Structural Belt. Columns 1 - 12 are based on consideration of the following accounts:

1 Öpik, 1963, 1967; Shergold, 1975 and this paper
2 Endo (*in* Endo & Resser, 1937); Kobayashi, 1931, 1933, 1966B, 1967; Resser & Endo (*in* Endo & Resser, 1937)
3 Sun, 1924, 1935; Kobayashi, 1935C, 1967, 1971; Lu *et al.*, 1965, 1974
4 Kobayashi, 1935C, 1966A, 1967
5 Kobayashi, 1962
6 Kobayashi, 1962
7 Palmer, 1960, 1962, 1965, 1968; Taylor, 1976
8 Longacre, 1970; Palmer, 1965; Taylor, 1976; Stitt, 1977
9 Lazarenko, 1968; Lazarenko & Datsenko, 1967; Datsenko & Lazarenko, 1968; Lazarenko & Nikiforov, 1968; Rosova, 1963, 1964, 1968
10 Lazarenko, 1966; Ivshin & Pokrovskaya, 1968
11 Ivshin, 1956, 1960A, 1962
12 Westergaard, 1944, 1947; Henningsmoen, 1957; Landing & Taylor, 1977
(Correction: for *P. quatra* read *P. quarta*)

The Paishan and Daizan Formations of the Liaotung Peninsula (Column 2) have yielded somewhat similar faunas to those of the Pomegranate and basal Chatsworth Limestones of the Burke River area. Kobayashi (1966B, 1967) has summarised the stratigraphy from original work undertaken by Kobayashi (1931, 1933), Resser & Endo (1937), and Endo (1937, 1939, 1944). Recent revisions of parts of the Paishan fauna at Saimaki, based on reworking of the von Richthofen collections in the Humbolt University Palaeontological Museum, have been presented by Schrank (1974, 1975). The Paishan Formation has yielded *Chuangia* species, documented by Endo (1928, 1937), Resser & Endo *in* Endo (1931), Resser & Endo (1937), and Kobayashi (1933), which are referred to the *Chuangia* Zone. Endo (1937) divided this Zone into two assemblages, an early one based on *Ch. batia*, and a younger one on *Ch. transversalis*. The faunas, listed by Kobayashi (1933, pp. 66-7; 1966B, p. 244) and Endo (1937, p. 305), are characterised by pagodiids *(Pagodia, Chuangia)* and changshaniids *(Changshania, Changshanocephalus, Parachangshania, Lioparia)*. *Irvingella* has been recorded at the top of the zone by Lu *(in* Lu *et al.*, 1957) and Kobayashi (1966B, p. 244; 1971, p. 171). If *I. taitzuhoensis* Lu is contemporaneous with *I. tropica* Öpik, then the bulk of the Manchurian Paishanian must correlate with the Australian Idamean. Some support for this is given by the fact that the pygdium figured by Endo (1937, pl. 67, fig. 8) as *Kingstonia kuantungensis* appears to represent a species of *Erixanium*.

If there is no stratigraphic break between the Paishan and over-lying Daizan Formations at Paichiashan, as it seems by the continuing changshaniid lineages, then the earliest Daizanian zone recognised by Endo (1937), the *Paramansuyella puteata* Subzone, must correlate with the post-*Irvingella* assemblages of the Burke River area. Support for this correlation is given by the common occurrence of *Maladioidella* and *Peichiashania* species (in Manchuria and throughout the basal Chatsworth Limestone), the latter recorded in Manchuria under *Eymekops rectangularis* Endo and *Paramansuyella planilimbata* Endo.

A case has been made earlier (Shergold, 1975, p. 37) for regarding the youngest Daizanian assemblage recognised by Endo (1937, p. 304) as equivalent to the pre-Payntonian interval (Jones *et al.*, 1971; Shergold, 1975) in the southern part of the Burke River Structural Belt, because of the common occurrence of leiostegiaceans *(Kaolishania, Mansuyia, Tingocephalus)*.

Historically, the Paishanian and Daizanian of Manchuria have been correlated with the Changshanian of Shantung and Hopei. Changshanian (Kobayashi, 1933), derived from the Changshan Series (Sun, 1924), embraces the Zones of *Chuangia batia, Changshania conica* and *Kaolishania pustulosa,* as envisaged by Sun (1935) in the Huolu district and the Kaiping Basin of Hopei, and the Taian district of Shantung. The *Chuangia batia* Zone (Lower Tawenkou Formation of Shantung) contains *Wentsuia granulosa* Sun in association with species of *Chuangia, Changshanocephalus,* and a possible dokimocephalid identified as *Psuedosolenopleura kotoi* (Kobayashi). Whether *W. granulosa* pre-dates or is contemporaneous with the Australian *W. iota* remains to be established. Revision of the numerous species of *Chuangia,* and an understanding of their relationships to *Pagodia* on the one hand and *Changshania* on the other, is urgently required. A third species, originally described (Resser & Endo *in* Endo & Resser, 1937, pl. 56, fig. 11) as *Elrathia* (?) *munda,* from the Yenchouan near Liaoyang, Manchuria, is considered by Kobayashi (1962, p. 47) to resemble *Wentsuia*. Possibly the genus has a considerable time span, or possibly not all the species assigned to it are conspecific.

Korea

Components of the faunas described in this Bulletin are known in South Korea in both basinal (Fig. 7, Cols. 5-6) and shelf sequences (Col. 4). Related biostratigraphic units are the *Chuangia-* and *Prochuangia*-bearing horizons of the shelf carbonate sequences in the Tsuibon facies (Kobayashi, 1935C, 1956, 1960B, 1966A, 1967), and the *Eochuangia* and *Komaspis-Koptura-Iwayaspis* faunas of the Machari facies and the dark shales and limestones occurring around Neietsu and Yeongweol in the axial portion of the Yokusen geosyncline (Kobayashi, 1935C, 1956, 1962, 1966A, 1971).

In the Tsuibon facies (Col. 4), rocks of equivalent age to those described here are biostratigraphically divided into the *Chuangia* and *Prochuangia* Zones (Kobayashi, 1935C). Kobayashi (1956, 1960, 1966A, 1967, 1971) considers the former to overlie the latter. The *Prochuangia* Zone in South Korea contains *Prochuangia mansuyi* Kobayashi, *P. posterospina* Kobayashi and *Pseudoliostracina monkei* (Kobayashi). The close resemblance of *Prochuangia glabella* sp. nov. to *P. mansuyi* leads me to consider that the *Prochuangia* Zone of South Korea and the *P. glabella - Peichiashania secunda* Assemblage-Zone of western Queensland may be contemporaneous. If this is the case, and Kobayashi is correct with his stratigraphical superposition, then the *Chuangia*

Zone would equate with the *Peichiashania tertia* - *P. quarta* and younger assemblages of Daizanian (late Changshanian) age in the Burke River area. It seems more likely, however, that the *Chuangia* Zone underlies that of *Prochuangia* in South Korea (an opinion supported by Schrank, 1974), and is equivalent to the Australian Idamean (as currently defined by Öpik, 1963) combined with the post-*Irvingella* assemblage of *Wentsuia iota* with *Rhaptagnostus apsis*. This interval, like the *Changia* Zone, is characterised by the occurrence of pagodiid morphologies, e.g. *Pagodia (Idamea)*, *Lotosoides* and *Prochuangia*. Thus in Korea the *Chuangia* Zone of the Tsuibon facies would mostly correlate with the *Eochuangia* Zone of the Machari facies.

The fauna which forms the basis for the *Olenoides* Zone of Neietsu (Kobayashi, 1935C), originally considered to be of late Middle Cambrian age, was subsequently (Kobayashi, 1962) reported to comprise two distinct assemblages. One, renamed the *Tonkinella* Zone, is of definite late Middle Cambrian age because it contains such genera as *Kootenia*, *Olenoides*, *Tonkinella*, and *Peronopsis* among others (Kobayashi 1962, table 1). The other assemblage, called the *Eochuangia* Zone, was also thought to be of Middle Cambrian age (late Paradoxididian) (Kobayashi, 1966A, pp. 58-9; 1971, p. 178). Its fauna, when the determinations given by Kobayashi (1962, table 2; 1966A, *loc. cit.*) are revised, is surprisingly similar to the combined *Wentsuia iota* - *Rhaptagnostus apsis* and *Irvingella tropica* - *Agnostotes inconstans* Assemblage-Zones of the Burke River Structural Belt.

The *Eochuangia* Zone (Col. 5) certainly contains *Pseudagnostus*, *Irvingella [=Komaspis (Parairvingella)* of Kobayashi], *Eochuangia*, *Proceratopyge* and *Haniwoides*. Kobayashi's *Phoidagnostus obsoletus* (Kobayashi, 1935) is probably a species of *Peratagnostus;* the cranidia illustrated as *Elrathia taira* Kobayashi, 1962, *Megagraulos medius* Kobayashi, 1962, and *M. breviscapus* Kobayashi, 1962, seem to be referable to *Maladioidella*, and that of *Anomocarella (Entorachis) longifrons* (Kobayashi, 1935) to *Eugonocare*. The pygidium (Kobayashi, 1962, pl. II, fig. 14) which represents *Mesocrepicephalus subquadratus* (Kobayashi, 1935) in the *Eochuangia* Zone could equally well represent a species of *Peichiashania*, while the cephalon representing *Lisania conica* Kobayashi (1962, pl. V, fig. 3) is surprisingly reminiscent of *Prochuangia*, and its associated pygidium (*loc. cit.*, fig. 4) that of *Taenicephalites*. *Solenoparia subtoxea* Kobayashi, 1962 could also well represent a pagodiid, possibly *Pagodia (Idamea)* or *Lotosoides*.

The *Eochuangia* fauna occurs in the Machari Formation, a 'platy black limestone, black claystone and bluish grey massive limestone' unit (Kobayashi, 1966A, p. 56). It shares common elements — *Irvingella*, *Eochuangia*, *Proceratopyge* and *Pseudagnostus* — with the *Komaspis-Koptura-Iwayaspis* fauna (Kobayashi, 1966A) (Fig. 7, Col. 6) which occurs in a black shale lithofacies (for faunas see Kobayashi, 1962, table 3; 1966A, pp. 59-61). *Iwayaspis asaphoides* Kobayashi (1962, pp. 122-124, pl. VI, figs. 1-10, pl. IX, fig. 24), although having longer palpebral lobes, has considerable cranidial similarity with *Cermatops* gen. nov.

North America

Correlation with North America is tenuous for continental shelf sections. The position of the *Conaspis/Taenicephalus* Zone is so shown in Column 8 because this interval seems to represent the maximum dispersal of parabolinoidid morphologies. The *Elvinia* Zone is correlatable perhaps by the parallel evolution shown by the preglabellar areas of cranidia of *Pterocephalia* and *Haniwoides;* the base of the *Saratogia/Idahoia* Zone is matched on the first appearance of saukiids of the North American type *(Prosaukia)*.

In the basinal or unrestricted ocean-facing environments of western Nevada (Column 7) (Cook & Taylor, 1975; Taylor & Cook, 1976; Taylor, 1976) and east-central Alaska (Kobayashi, 1938; Palmer, 1968), olenids, ceratopygaceans and agnostids permit a somewhat more precise correlation. The Franconian 1 fauna of east-central Alaska (Palmer, 1968, pl. 10), for instance, contains *Peratagnostus* and *Iwayaspis*, which may suggest a degree of correlation with the *iota-apsis* Assemblage-Zone of the Burke River area.

Europe

Correlation with the European biostratigraphic scale (Column 12) is equally tenuous. The presence of olenids, including a possible *Leptoplastus* species, in the *Wentsuia iota* - *Rhaptagnostus apsis* Assemblage-Zone, suggests perhaps equivalence in part, at least, to the *Leptoplastus* Zone of Scandinavia. *Pseudagnostus aulax* sp. nov., also from the *iota-apsis* Assemblage-Zone, is compared below to *Ps. leptoplastorum* Westergaard, a species characterising Zone 4b on the Scandinavian zonal scale (Westergaard, 1947; Henningsmoen, 1957).

SYSTEMATIC PALAEONTOLOGY

DESCRIPTIVE TERMINOLOGY

No new terms are introduced in the ensuing systematic descriptions: the terminology used is basically that defined in the *Treatise on Invertebrate Paleontology, Part O, Arthropoda 1* (Moore, 1959), with modifications suggested by Öpik (1961A, 1961B, 1963, 1967) and Shergold (1972, 1975, 1977A).

Symbols used for various measured parameters have been tabulated elsewhere (Shergold, 1972, p. 16; 1975, pp. 47-48). In this account the following symbols are used:

Lc	Maximum length (sag.) of cephalon or cranidium
Lb	Length (sag.) of border, used for both cephalon and pygidium in miomerids and polymerids
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 width (tr.) of pygidium

Order **MIOMERA** Jaekel, 1909
Suborder **AGNOSTINA** Salter, 1864
Family **AGNOSTIDAE** M'Coy, 1849
Subfamily **AGNOSTINAE** M'Coy 1849

Genus **Acmarhachis** Resser, 1938
[= *Cyclagnostus* Lermontova, 1940]

Type species. *Acmarhachis typicalis* Resser (1938, p. 47, pl. 10, figs. 4-5; USNM 94858), Dresbachian, Nolichucky Formation, Alabama; by original designation.

Other species. *Homagnostus acutus* Kobayashi (1938, pp. 172-3, pl. XVI, figs. 18-22), *Parabolinella* Limestone, Harrogate, British Columbia; *Acmarhachis acuta* (Kobayashi) *sensu* Rasetti (1961, p. 109, pl. 23, figs. 1-8), Frederick Limestone, Frederick area, Maryland; *Acmarhachis acutus* Kobayashi) *sensu* Palmer (1962, p. 20, pl. 2, figs. 12, 13, 17), *Crepicephalus* Zone, Hamburg Limestone, McGill, Nevada; *Acmarhachis* sp. indet., Shaw (1952, p. 481, pl. 57, figs. 22-24), *Cedaria* Zone, Rockledge Conglomerate, St Albans, Vermont; *Cyclagnostus elegans* Lermontova (1940, p. 127, pl. 49, figs. 10, 10a; Tchernysheva 1960, pl. 1, figs. 19-20), Kharaulakh Mountains, north Siberian Platform; *Cyclagnostus quasivespa* Öpik (1967, pp. 109-111, pl. 59, figs. 1-7), *Cyclagnostus quasivespa* Zone, Mungerebar Limestone, western Queensland; *Cyclagnostus* sp. aff. *quasivespa* Öpik (1967, p. 112, pl. 59, fig. 8), Zone of Passage, Mungerebar Limestone, western Queensland. *Acmarhachis?* sp. (Palmer, 1962, p. 20, pl. 2, figs. 9-10) is referred to *Oxyagnostus* Opik (Öpik, 1967, p. 160).

Comments. Palmer's (1962, p. 19) synonymy of *Acmarhachis* and *Cyclagnostus* is supported here; his contention that *Oedorhachis* Resser, 1938, should also be placed in synonymy with *Acmarhachis* is not (for argument see Öpik, 1967, p. 108). Öpik's (1967, p. 109) comments regarding the type materials of *Acmarhachis* and *Cyclagnostus* are however pertinent, but the combination of cephalon and pygidium constituting the *Acmarhachis* species illustrated here can only be interpreted meaningfully if the two genera are synonymised. Following the argument advanced by Öpik (1967, pp. 109-9) for the suprageneric classification of *Cyclagnostus, Acmarhachis* is assigned to the Agnostidae (Agnostinae). *Acmarhachis* is non-deuterolobate and cannot therefore be placed with the Pseudagnostinae (see Palmer, 1962). Glabellar features closely compare with *Agnostus* and *Homagnostus*, and the inflated posterior pygidial lobe has a parietal morphology (Palmer, 1962; pl. 2, fig. 17) comparable with that of *Lotagnostus trisectus* Salter (cf. Westergaard, 1922, p. 117, pl. 1, fig. 12). *Oxyagnostus* Öpik (1967), which is cephalically similar, is readily differentiated from *Acmarhachis* by its constricted pygidial acrolobe.

Acmarhachis thus constituted is adequately diagnosed by Öpik (1967, p. 109), but its time span is lengthened: *Cedaria* to *Elvinia* Zones in North America, Mindyallan to post-Idamean in Australia. Its distribution is extended to include Siberia and northern Australia.

Acmarhachis hybrida sp. nov.
(Pl. 11, figs. 1-6; Text-fig. 8)

Name. L. *hybrida*, hybrid, referring to the combination of characteristics which defines the species.

Types. Holotype, pygidium CPC 15107a, with counterpart CPC 15107b, see pl. 11, figs. 4-5; illustrated paratypes, CPC 15104-6, 15108; non-illustrated paratypes, CPC 15397-15399.

Material. Three cephala varying in length between 1.40 and 2.20 mm, and five pygidia with Lp_2 between 1.25 and 2.00 mm.

Occurrence. Plains north of 'Chatsworth', horizon D487; section south of Horse Creek, horizon K215.

Age. Late Cambrian, *Wentsuia iota - Rhaptagnostus apsis* Assemblage-Zone.

Diagnosis. *Acmarhachis* with the following combination of characteristics: narrow (sag.) cephalic border with non-deliquiate marginal furrows, axial glabellar node anteriorly sited; wide (sag.) pygidial border with non-deliquiate marginal furrows, laterally expanded posterior axial lobe reaching marginal furrow posteriorly, transverse furrows on axis clearly incised, not effaced.

Differential diagnosis. As far as can be judged from the illustration (Resser, 1938, pl. 10, fig. 5), the holotype pygidium of *Acmarhachis typicalis* differs little from those illustrated on Pl. 11. The posterior lobe of the pygidial axis in the Australian material is perhaps somewhat more inflated and posteriorly less pointed. The paratype cephalon (Resser, *loc. cit.*, fig. 4) is inadequately illustrated so that cephalic details cannot be compared. The cephalon attributed to *A. typicalis* by Palmer (1962, pl. 2, fig. 12) has more deliquiate marginal furrows and wider borders. Australian pygidia have axes with well developed transverse furrows, as in *A. typicalis;* according to Palmer (1962, p. 20) this would distinguish them from *A. acuta* (Kobayashi) *sensu stricto* as interpreted by Palmer (1962, p. 20) and Rasetti (1961, p. 109). Of species previously assigned to *Cyclagnostus*, *C. quasivespa* Öpik has most similar glabellar morphology, but *Acmarhachis hybrida* has a more anteriorly situated axial glabellar node, non-deliquiate marginal furrows, and thus wider pygidial borders. Its pygidial shape is less transverse, more similar to that of *C. elegans* Lermontova (see Tchernysheva, 1960, pl. 1, figs. 19-20).

Description. Description is based on exfoliated material showing no trace of parietal morphology.

The cephalon is subrectangular, anteriorly rounded, with maximum width across the anterolateral glabellar lobes; length : width for the three specimens, expressed as a percentage, varies form 86-95%. Cephalic borders are narrow, approximately 7% of the total length (sag.) on the measureable material available; marginal furrows are non-deliquiate. The shape of the acrolobe mirrors that of the cephalic outline. A median preglabellar furrow is variably impressed (Pl. 11, figs. 1-3). The glabella, occupying in excess of two-thirds the total cephalic

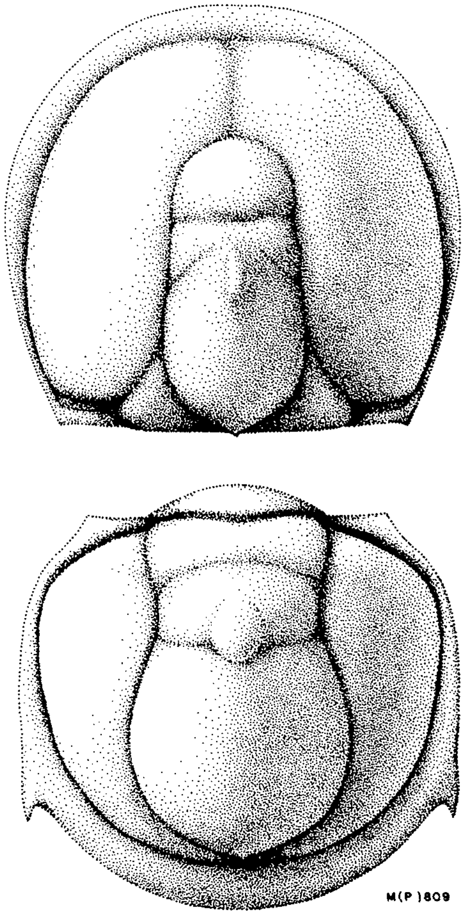


Fig. 8. Reconstruction of the principal exoskeletal morphology of *Acmarhachis hybrida* sp. nov., based on CPC 15104 (cephalon), x26, and CPC 15107a (pygidium), x28.

length, has an anteriorly pointed anterior lobe separated from the remainder of the glabella by a straight, narrow, well impressed anterior furrow. Anterolateral lobes, not laterally extensive, are small, subtriangular, and separated from the posterior lobe by a chevronate furrow which lies in front of the axial glabellar node. The latter lies some 42-48% of the glabellar length from the rear of the cephalon. The posterior lobe is narrow (tr.), parallel-sided, and angulate at the rear. Basal lobes are relatively large, triangular, and separated by well defined furrows from the posterior lobe.

The pygidium is subovoid, with maximum width (tr.) across the second transverse furrow of the axis, and flanks converging evenly rearwards; length (Lp_2) varies from 80-90% of the width. Pygidial borders are wider than those of the cephalon, approximately 12% of the total length (Lp_2); marginal furrows are non-deliquiate. Posterolateral spines are prominent, stout, and situated well in advance of the rear of the posterior axial lobe. The acrolobe is very gently constricted on some specimens (Pl. 11, figs. 4, 6). The axis is long, reaching the marginal furrow posteriorly, is constricted laterally about the second segment, and widest (tr.) across the middle of the posterior segment. The first transverse furrow is narrow but clearly incised and is arched forwards sagittally, restricting the first axial segment which forms a collar. The second transverse furrow curves rearwards, thus delineating a barrell-shaped second segment. This bears a strong node whose base is confined to the segment. The posterior lobe is long (sag.), exceeding the length of the first two segments combined, is inflated (tr., sag.), pointed at the rear, and circumscribed by prominent axial furrows. The external surface of both cephalon and pygidium is smooth.

Genus **Innitagnostus** Öpik, 1967

Type species. *Innitagnostus innitens* Öpik (1967, pp. 99-101, pl. 8, fig. 5; pl. 58, figs. 2-4; text-fig. 23; CPC 5853-5, 5417), Mindyallan, *Glyptagnostus stolidotus* Zone, Pomegranate Limestone, O'Hara Shale, Duchess and Boulia Sheet areas, western Queensland; by original designation.

Comments. To other species assigned to *Innitagnostus* by Öpik (1967, p. 98) should be added: Agnostidae indet. (Hsiang *in* Jegorova *et al*., 1963, p. 72, pl. 11, figs. 5-9; *in* Lu *et al*., 1965, pp. 18-19, pl. 1, figs. 5-6), 'late Cambrian', Kweichow-Hunan border, south-central China.

Innitagnostus medius sp. nov.
(Pl. 11, figs. 7-11; Text-fig. 9)

Name. L. *medius*, middle, referring to the intermediate taxonomic status of this species, which stands mid-way between *Innitagnostus* and *Lotagnostus (Trilobagnostus)*.

Types. Holotype, CPC 15109, the partly exfoliated cephalon figured on Pl. 11, fig. 8; illustrated paratypes CPC 15110-15113; non-illustrated paratypes CPC 15400, 15401.

Material. Two cephala with lengths of 1.80 and 2.00 mm, and five pygidia measuring (Lp_2) between 1.50 and 1.90 mm. Specimens CPC 15109-15113 are illustrated.

Occurrence. Section south of Horse Creek, horizons K215, 216 and 218.

Age. Late Cambrian, *Wentsuia iota - Rhaptagnostus apsis* Assemblage-Zone.

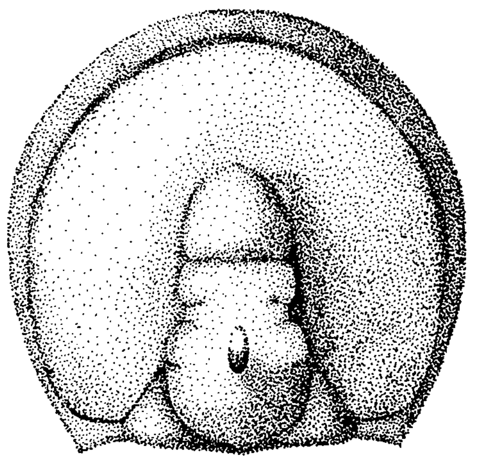
Diagnosis. A partly effaced species of *Innitagnostus* with subovoid cephalic shield; marginal furrows are non-deliquiate and glabellar furrows, apart from the anterior one, are lacking, as is the median preglabellar furrow.

Differential diagnosis. Degree of effacement readily distinguishes this species from others assigned to *Innitagnostus*, which are *en grande tenue*. Furthermore, while most other species have subcircular to subsemicircular cephala, that of *I. medius* is elongate and more fully rounded laterally. Pygidial characteristics are more similar to other species of *Innitagnostus*, although the axis appears to be proportionately shorter (sag.) than that of either *I. inexpectans* (Kobayashi) *sensu* Öpik (1963, pl. 2, figs. 10-13), or *I. innitens* Öpik (1967, pl. 58, figs. 2-4).

Innitagnostus medius is also comparable with species of *Lotagnostus (Trilobagnostus)* which have been listed by Shergold (1975, pp. 48-9). With the Australian species *L. (T.) ergodes* Shergold, 1972 and *L. (T.) irretitus* Shergold, 1975, *I. medius* has comparable shield shapes, but it is effaced to a lesser extent. All three species lack a median preglabellar furrow and have non-deliquiate marginal furrows. The pygidial axis of *I. medius*, however, is perhaps somewhat shorter (sag.) than in species of *Lotagnostus (Trilobagnostus)*. Morphologically, it stands midway between *Innitagnostus* and *Trilobagnostus*.

Description. This species is described from partly exfoliated and exfoliated surfaces which give no indication of parietal morphology.

The cephalon is subovoid, with equal length and width, the maximum width (tr.) passing through the middle of the anterior lobe. Cephalic borders are narrow, 6-7% of the total cephalic length (sag.), and bear non-deliquiate marginal furrows. The acrolobe has similar shape to the cephalic margin, is unconstricted laterally, and undivided by a median preglabellar furrow. The glabella, which occupies less than two-thirds of the total cephalic length (sag.), has a comparatively long anteriorly rounded anterior lobe spearated from the remainder of the glabella by a clearly defined, straight, transverse anterior furrow. Anterolateral lobes, and the pair of lateral swellings interposed between them and the basal lobes in *en grande tenue* species of *Innitagnostus*, are represented only by low swellings. The rear of the posterior lobe is angular. Basal lobes are laterally extensive, and the furrows separating them from the posterior lobe are mainly effaced. The axial glabellar node lies approximately one-third of the glabellar length from the rear of the cephalon.



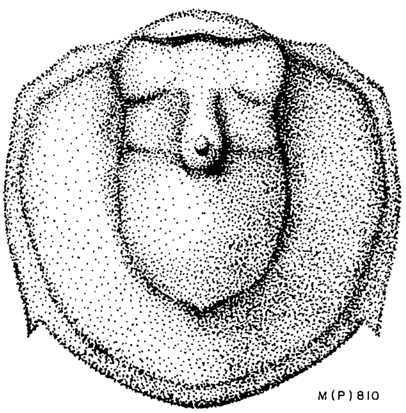


Fig. 9. Reconstruction of the principal exoskeletal morphology of *Innitagnostus medius* sp. nov., based on CPC 15109 (cephalon), x29, and CPC 15112 (pygidium), x26.

The pygidium is subovoid, with length (Lp_2) 80-93% of the width, and maximum width (tr.) passing through the middle of the posterior pygidial segment. Pygidial borders, like those of the cephalon, are narrow, 5-7% of the length (Lp_2), and bear non-deliquiate marginal furrows. The shape of the pygidial acrolobe is similar to that of the pygidial margins. The axis is bullet-shaped with the first segment divided into three parts: the first transverse furrow is non-continuous across the sagittal line so that the central portion of the segment is confluent with the second segment, and is flanked by a pair of lateral lobes. The axis is widest (tr.) across this first segment, the axial furrows slightly constricting the sides of the second segment. The second transverse furrow is straight, but interrupted sagittally by a prominent axial node which lies on the rear of the second segment. The third segment is elongate, a little longer (sag.) than the two anterior segments combined, and posteriorly pointed. Its flanks are not laterally extensive, and it does not reach the marginal furrows posteriorly, occupying approximately two-thirds of the total pygidial length (Lp_2). Marginal spines are short and laterally deflected, and lie on a transverse line across the rear of the pygidial axis. Anterolateral articulating facets have low inclination and their fulcral points, lying close to the axial furrows, are blunt. The nature of the articulating half-ring cannot be adequately assessed from the material at hand, and is reconstructed on Text-fig. 9 with reference to *Innitagnostus inexpectans* (Kobayashi) *sensu* Palmer (1962, pl. 1, figs. 9-11).

Subfamily **QUADRAHOMAGNOSTINAE** Howell, 1935.

Genus **Peratagnostus** Öpik, 1967

Type species. Peratagnostus nobilis Öpik (1967, pp. 87-90, pl. 52, figs. 10, 11a-c; pl. 53, figs. 1-11; CPC 5786-98), Idamean, *Erixanium sentum* Zone, Pomegranate and Georgina Limestones, western Queensland; by original designation.

Other species. Agnostus (Leiopyge?) obsoletus Kobayashi (1935C, p. 106, pl. XIV, fig. 9, = *Phoidagnostus obsoletus* (Kobayashi, 1935)), *Eochuangia* Zone, Yongwol and Machari, South Korea; *Cyclopagnostus orientalis* Lazarenko (1966, p. 39, pl. 1, figs. 1-10) and *Cyclopagnostus asper* Lazarenko (1966, pp. 39-40, pl. 1, figs. 11-12), both from the *Irvingella-Cedarellus felix* Zone, Kharaulakh Mountains, River Lena below Chekurovka, northern Siberia; *Leiopyge? controversa* Kryskov (*in* Borovikov & Kryskov, 1963, p. 270, pl. 1, figs. 6-8), Kendyktas Mountains, southern Kazakhstan, associated with *Glyptagnostus reticulatus; Peratagnostus hillardensis* Palmer (1968, p. 26, pl. 10, figs. 17-18, 23-24), early Franconian, east-central Alaska; *Phalacroma sinica* Hsiang (*in* Jegorova *et al.*, 1963, p. 73, pl. 11, figs. 10-14; *in* Lu *et al.*, 1965, p. 39, pl. 3, figs. 23-25), 'late Cambrian', Kweichou-Hunan border, south-central China (*fide* Kobayashi, 1967, p. 462). Possibly: *Phalacroma?* sp. Palmer (1960, p. 63, pl. 4, fig. 13), *Dunderbergia* Zone, Dunderberg Shale, Nevada, USA.

Comments. The material compared below to *Peratagnostus nobilis* Öpik probably represents the youngest occurrence of the genus yet known.

Peratagnostus sp. cf. **P. nobilis** Öpik, 1967
(Pl. 11, fig. 12)

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

Material. A single cephalon, CPC 15114, with length of 3.00 mm.

Occurrence. Plains north of 'Chatsworth', horizon D487.

Age. Late Cambrian, *Wentsuia iota - Rhaptagnostus apsis* Assemblage-Zone.

Comments. The available cephalon, which retains its exoskeletal surface, is effaced: only the rear of the posterior glabellar lobe is defined. The position of the axial node can be faintly discerned, as can a faint border.

The general shape of the cephalon, whose length is 97% of its maximum width (tr.), and its degree of effacement, closely resemble specimens previously illustrated by Öpik (1967, pl. 53, figs. 5a, 6a, 7, 8, 10, 11). One specimen from Öpik's type paradigm even possesses a faint border similar to that of the specimen at hand (see Öpik, *op. cit.*, pl. 53, fig. 9a).

It is preferred to classify the present cephalon with *Peratagnostus,* in which the cephalic borders are generally effaced, rather than *Cyclopagnostus* Howell, 1937, *sensu* Lazarenko (1966, p. 38). Although *Peratagnostus* is mostly an effaced genus, the faint indication of cephalic borders in *P.* cf. *nobilis* ally it to specimens from northern Siberia previously referred to *Cyclopagnostus* (see Lazarenko, 1966). *Cyclopagnostus* Howell, 1937, however, is typically a late Middle Cambrian genus and a probable synonym of *Hypagnostus* Jaekel, 1909. Lazarenko's species, *C. orientalis* (1966, p. 39, pl. 1, figs. 1-10) and *C. asper* (1966, pp. 39-40, pl. 1, figs. 11-12), from the *Irvingella - Cedarellus felix* Zone of the Kharaulakh Mountains, are better interpreted as less severely effaced *Peratagnostus* in which the glabella is effaced but the cephalic borders are preserved. Only degree of effacement distinguishes their pygidia from those of *P. nobilis*. Thus interpreted, they form a link in time between those species,e.g. *P. nobilis*, which predate *Irvingella*, and those, *P.* cf. *nobilis*, which post-date or are contemporaneous with that genus.

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

Subfamily **DIPLAGNOSTINAE** Whitehouse, 1936

Genus **Connagnostus** Öpik, 1967

Type species. Connagnostus venerabilis Öpik (1967, pp. 130-2, pl. 54, figs. 11-14; pl. 55, figs. 1-2; text-fig. 3C; CPC 5809-14), Mindyallan, *Glyptagnostus stolidotus* Zone, Georgina Limestone, O'Hara Shale, western Queensland; by original designation.

Other species. Other species are considered by Shergold (1972, p. 24; 1975, p. 56).

Comments. Following previous practice (Shergold, 1972, 1975), agnostids which in general resemble *Homagnostus* or *Geragnostus* but have strongly constricted pygidial acrolobes are placed in *Connagnostus*. The genus thus constituted has a time span from late Mindyallan *(stolidotus* Zone) to pre-Payntonian *(maximus/papilio* Assemblage-Zone) in western Queensland. Previously described species occur either early or late in the time range of the genus, but those described here occur towards the middle part of the range.

Connagnostus aversus sp. nov.
Pl. 12, figs. 1-4; Text-fig. 10)

Name. L. *aversus,* turned backward, referring to the retrally sited pygidial spines.

Types. Holotype, CPC 15115, the exfoliated pygidium illustrated on pl. 12, fig. 2; figured paratypes CPC 15116-15118; non-figured paratypes CPC 15402-15407.

Material. The species is based on three cephalic and seven pygidial fragments. The measurable cephala have lengths between 1.80 and 2.55 mm, and the six pygidia range (Lp_2) between 1.65 and 1.90 mm.

Occurrence. Plains north and northwest of 'Chatsworth', horizons D124, 487; section south of Horse Creek, horizons K218, 220, 222, 223, 225; Lily Creek, horizons B54a, 54b, 24-52 m above base of section. *Connagnostus* cf. *aversus* occurs in BMR borehole Duchess No. 13 between 84.05 and 84.30 m.

Age. Late Cambrian, Assemblage-Zones of *Wentsuia iota - Rhaptagnostus apsis* and *Peichiashania secunda - Prochuangia glabella.*

Diagnosis. A species of *Connagnostus* with subovoid shields, strongly deliquiate marginal furrows, unconstricted cephalic acrolobe, strongly constricted pygidial acrolobe, *Homagnostus*-like pygidial axis, and retrally sited marginal spines.

Differential diagnosis. Shield shape primarily distinguishes *Connagnostus aversus* from *C. junior* Shergold (1972, pp. 25-6, pl. 5, figs. 1-2) and *C. conspectus* Shergold (1975, pp. 57-8, pl. 13, figs. 13-15), from the *maximus/papilio* Assemblage-Zone at Momedah and the *bifax-denticulatus* Assemblage-Zone at Black Mountain respectively. Additionally, *C. aversus* has a proportionately wider and longer pygidial axis than either *C. junior* or *C. conspectus*. *C. aversus* and *C. junior* have posteriorly sited pygidial spines, whereas those of *C. conspectus* are more anteriorly placed. *Connagnostus aversus* has similar shield shapes and degree of deliquiation to the type species, *C. venerabilis* Öpik from the *Glyptagnostus stolidotus* Zone near Glenormiston, western Queensland. These species differ mainly on the proportions and shapes of their pygidial axial segments, particularly the posterior one. In *C. aversus* it is posteriorly evenly and obtusely rounded and very similar to that of *Homagnostus* species, whereas in *C. venerabilis* it tends to be more rectangular. Cephala of *C. aversus* and *C. venerabilis* are distinguished by the more forward placed axial glabellar node of the latter.

Among species assigned to other genera, *Homagnostus comptus* Palmer (1962, p. 12, pl. 1, figs. 12-15), from Nevada, is the most similar, being distinguishable only by unconstricted pygidial acrolobes. Cephala are easily confused, differing only by proportionate lengths.

Description. Notes given here are based on exfoliated and partly exfoliated material showing little indication of parietal morphology.

The cephalon is subovoid, the only assessable specimen being longer than wide. Borders, achieving 8-12% of the total cephalic length, comprise thick rims and strongly deliquiate marginal furrows. The cephalic acrolobe is unconstricted, subovoid, and undivided by a median preglabellar furrow, although there may be a trace of it proximally. The glabella is proportionately short (sag.), less than two-thirds the cephalic length. Its anterior lobe is rounded and separated from the remainder of the glabella by a straight, transverse anterior furrow. Glabellar lobation is only faintly indicated by low anterolateral swellings. Basal lobes are laterally and exsagittally extensive, and delineated from the posterior lobe by clearly visible furrows. The posterior lobe bears an axial glabellar node approximately one-third the glabellar length from the rear, which is apparently rounded rather than angulate.

Like the cephalon, the pygidium is subovoid: the width (Wp) is greater than the length (Lp_2), but including the articulating half-ring, length (Lp_1) and width are nearly equal. Pygidial borders, 10-12% of the length (Lp_2), bear strongly deliquiate marginal furrows. The pygidial acrolobe is strongly constricted, and restricted in extent both laterally and posteriorly by a long and wide pygidial axis which occupies 76-81% of the total pygidial length(Lp_2). The first axial segment is sagittally confluent with the second, the first transverse furrow is discontinuous, and narrow (exsag.) side lobes are divided off anterolaterally. The second segment is long (sag.), as wide (tr.) as the first, and differentiated from the third by a straight second transverse furrow which is interrupted sagittally by a small node subcentrally sited on the second segment. The third, posterior, axial segment is shorter (sag.) than segments one

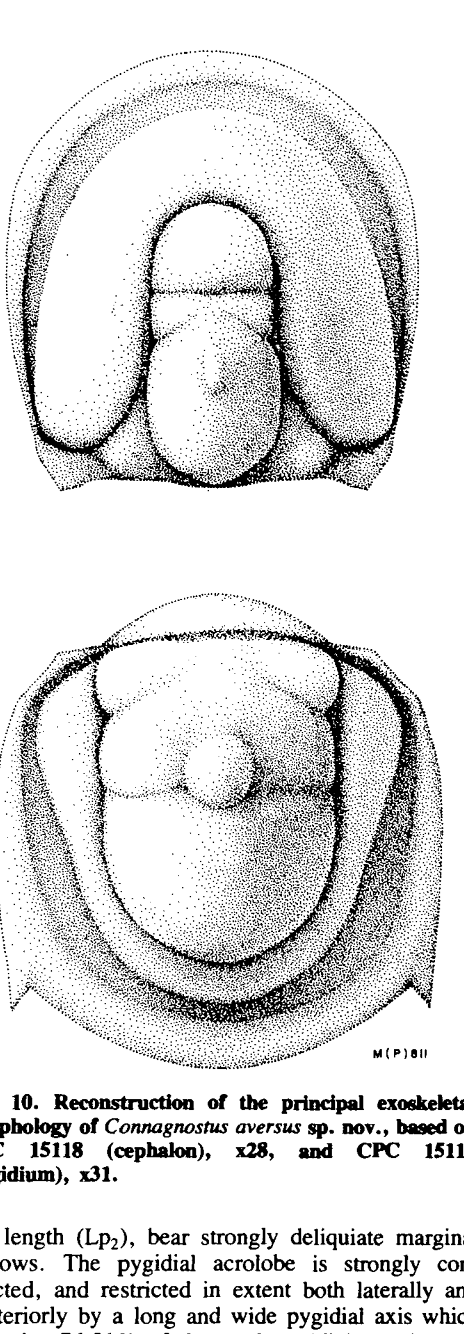


Fig. 10. Reconstruction of the principal exoskeletal morphology of *Connagnostus aversus* sp. nov., based on CPC 15118 (cephalon), x28, and CPC 15116 (pygidium), x31.

and two combined, has equal width (tr.) to segment two, is obtusely and evenly rounded posteriorly, and fails to contact the marginal furrow. Posterolateral spines are retrally sited, on a transverse line drawn across the rear of the pygidial acrolobe. The nature of the articulating half-ring and facets is not adequately known.

Connagnostus sp. cf. **C. conspectus** Shergold, 1975
(Pl. 12, figs. 5-9; Text-fig. 11)

cf. 1975 *Connagnostus conspectus* sp. nov.; Shergold, 1975, pp. 57-8, pl. 13, figs. 13-15 (CPC 11734-6).

Material. Two cephalic fragments and four pygidia constitute the available material. The single cephalon (CPC 15119) which can be measured has a length of 4.30 mm; and the single pygidium (CPC 15120) a length (Lp_2) of 2.60 mm. Specimens CPC 15119-15120, 15122 are illustrated; specimen CPC 15121 is not illustrated.

Occurrence. Lily Creek section, horizons K212, 214 and B791c, 200 to 281 m from the base of the measured section.

Age. Late Cambrian, *Hapsidocare lilyensis* Assemblage-Zone.

Comments. *Connagnostus* cf. *conspectus* differs from *C. conspectus* in possessing a less highly constricted pygidial acrolobe. Other characteristics — shield shape, degree of deliquiation, pygidial axial characters, and position of pygidial spines — indicate compatibility.

C. cf. *conspectus* occurs slightly earlier than *C. conspectus*. At Black Mountain the latter is present in the *Rhaptagnostus bifax-Neoagnostus denticulatus* Assemblage-Zone, which is two assemblages later than that containing *C.* cf. *conspectus*.

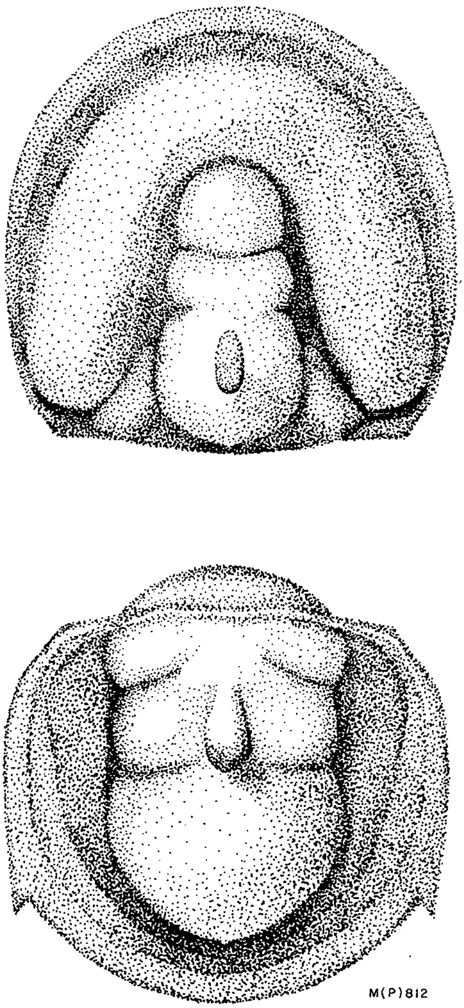


Fig. 11. Reconstruction of the principal exoskeletal morphology of *Connagnostus* sp. cf. *conspectus* Shergold, 1975, based on CPC 15119a (cephalon), x18, and CPC 15120a (pygidium), x21.

Connagnostus sp. undet.
(Pl. 12, fig. 10)

Material. Two pygidia, of which only one, CPC 15123, is sufficiently complete for measurement: this specimen has a length (Lp_2) of 1.80 mm. CPC 15408 is not illustrated.

Occurrence. Lily Creek section, K200, 204, 24-69 m from the base of the measured section.

Age. Late Cambrian, Assemblage-Zone of *Peichiashania secunda - Prochuangia glabella*.

Comments. There is insufficient material for the proper assessment of this species. It appears to differ from *Connagnostus conspectus* Shergold, 1975, *C.* cf. *conspectus* Shergold and *C. aversus* sp. nov. in possessing a narrower and shorter pygidial axis, which is most comparable with that of *C. junior* Shergold, 1972. Degree of constriction of the pygidial acrolobe is similar to that of *C.* cf. *conspectus*, i.e. it is less than that characterising *C. venerabilis*, *C. junior*, *C. conspectus* or *C. aversus*. Compared with *C. venerabilis*, *C. junior* and *C. aversus*, the pygidial spines are advanced, lying at the level of the rear of the posterior axial segment, in this characteristic being most similar to *C. conspectus*.

Subfamily **PSEUDAGNOSTINAE** Whitehouse, 1936

Pseudagnostid species formerly referable to *Pseudagnostus* Jaekel, 1909, have been recently revised (Shergold, 1977A), and as a result classified among three genera: *Pseudagnostus, Rhaptagnostus* Whitehouse, 1936, and *Neoagnostus* Kobayashi, 1955. *Pseudagnostus* is retained for spectaculate species in which the axial glabellar node lies to the rear of the anterior furrow and to the rear of the anterolateral lobes (muscle attachment areas internally), which are separated sagittally. *Rhaptagnostus* is revived for papilionate species in which the axial glabellar node lies between the anterolateral lobes and thus separates them sagittally. *Neoagnostus* is applied to spectaculate forms in which the anterolateral lobes meet sagittally.

Genus **Pseudagnostus** Jaekel, 1909

Type species. Agnostus cyclopyge Tullberg (1880, p. 26, pl. II, figs. 15a, 15c), Zone of *Parabolina spinulosa* with *Orusia lenticularis*, and *Olenus* Zone, Andrarum, Skaane, Sweden *(fide* Westergaard, 1922, pp. 116-7; see Shergold, 1977A, for discussion).

Other species. Other species of *Pseudagnostus* have been distributed among five species groups (Shergold, 1977A), themselves assigned to three subgenera: *Pseudagnostus (Pseudagnostus)* Jaekel, 1909, *Pseudagnostus (Pseudagnostina)* Palmer, 1962, and *Pseudagnostus (Sulcatagnostus)* Kobayashi, 1937B.

Subgenus **Pseudagnostus (Pseudagnostus)** Jaekel, 1909

Type species. As for the genus *Pseudagnostus.*

Comments. Species assigned to *Pseudagnostus (Pseudagnostus)* are classified within three species groups, based on *P. bulgosus* Öpik, 1967, P. *communis* (Hall & Whitfield, 1877) and *P. cyclopyge* (Tullberg, 1880), for which definitions and concepts have previously been given (Shergold, 1977A). Species recorded here belong mainly to the *communis* and *cyclopyge* groups. Some, however, cannot be adequately classified on present knowledge because they are either poorly preserved, described from insufficient material, or exhibit a morphology which is intermediate between established species groups.

Pseudagnostus communis species group

Nominal species. Agnostus communis Hall & Whitfield (1877, pp. 228-229, pl. 1, figs. 28-9), Late Cambrian, Dunderberg Shale, Nevada (see Palmer, 1955, pp. 94-96, pl. 19, figs. 20-21).

Pseudagnosti having subcircular to subovoid, partly effaced, spectaculate cephala with non-deliquiate to subdeliquiate marginal furrows, straight anterior glabellar furrow, and median preglabellar furrow invariably present; and subcircular to subovoid, partly effaced, subplethoid, weakly to strongly deuterolobate pygidia, with non-deliquiate to subdeliquiate marginal furrows, spines well in advance of the rear of the deuterolobe, and eight holaspid metameres.

Other species included in the *communis* species group are listed elsewhere (Shergold, 1977A).

Pseudagnostus (P.) mortensis sp. nov.
(Pl. 1, figs. 1-8; pl. 2, figs. 1-10; Text-fig. 12)

Name. Named from the Mort River, Duchess Sheet area, western Queensland.

Types. Holotype, pygidium, CPC 15022, pl. 2, figs. 9-10; figured paratypes CPC 15007-15021; unfigured paratypes 15409-15459, 17225-17246.

Material. The species is known from 35 cephala ranging in length (sag.) between 1.40 and 3.80 mm, and 38 pygidia with lengths (Lp_2, sag.) between 1.50 and 3.60 mm.

Occurrence. Pediment outcrop in plains north of 'Chatsworth' D487 and 489; section south of Horse Creek, horizons K215, 216, 218, 219, 224, 225; BMR Boulia No. 6, 26.75-73.00 m; *Ps.* aff. *mortensis* occures in BMR Duchess No. 13 between 66.60 and 68.10 m.

Age. Late Cambrian, *Wentsuia iota - Rhaptagnostus apsis* Assemblage-Zone.

Diagnosis. A partly effaced species of *Pseudagnostus* with a non-deliquiate, spectaculate cephalon, and a non-deliquiate, non-plethoid pygidium which has an unconstricted acrolobe, and laterally deflected posterolateral spines in an advanced position relative to the rear of the deuterolobe. Both cephalic and pygidial articulating devices are prominent.

Differential diagnosis. Of previously described species, *Pseudagnostus mortensis* is most similar in degrees of effacement and deliquiation to specimens from Nevada and Alaska assigned by Palmer (1960,

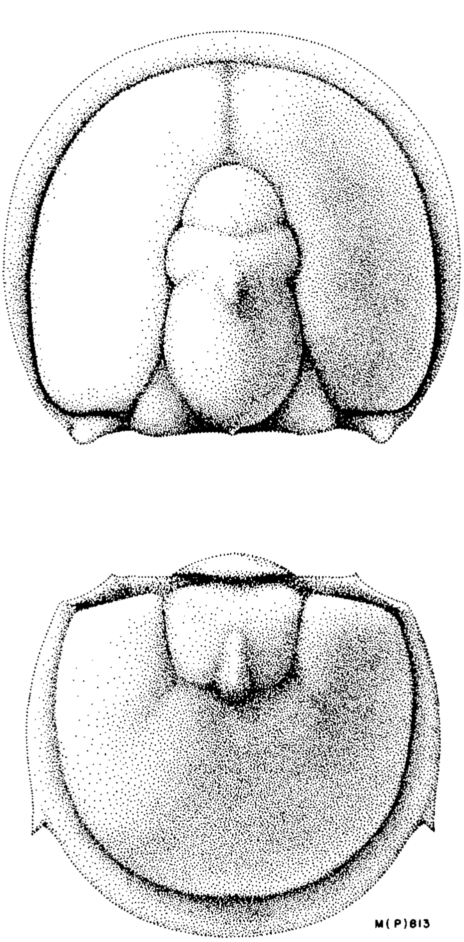


Fig. 12. ***Pseudagnostus (Pseudagnostus) mortensis*** **sp. nov.; principal exoskeletal morphology, based on CPC 15012 (cephalon), x17, and CPC 15020 (pygidium), x16.**

p. 61, pl. 4, figs. 3-4, USNM 136832 a-b; 1968, pp. 29-30, pl. 7, figs. 5, 10, USNM 146762-3) to *Pseudagnostus communis* (Hall & Whitfield), and others from Wyoming assigned by Grant (1965, p. 108, pl. 13, figs. 13-14, USNM 14209-10) to *P. josepha* (Hall). Pygidia of these North American species also have forward-sited posterolateral spines. *P. mortensis* is distinguished, however, on account of the shape of its shields, the prominence of the articulating nodes at the posterolateral cephalic corners, and the strongly convex pygidial articulating facets. There are no close morphological allies among Australian species.

Description. The descriptive notes given below are based solely on exoskeletons; no parietal morphology has been observed

Cephalic exoskeletons have low convexity (tr., sag.) and are partly effaced. Early holaspid cephalic shields have a subcircular shape which gradually becomes subovoid during holaspid morphogenesis; maximum length varies from 86-96% of the maximum width. Borders are narrow, generally 5-10% of the total length (sag.), with non-deliquiate marginal furrows, but widen slightly sagittally at the confluence of the marginal and median preglabellar furrows. The cephalic acrolobe is unconstricted, but divided anteriorly by a median preglabellar furrow which connects axial and marginal furrows. The glabella, occupying approximately two-thirds of the cephalic length (sag.) (G/Lc is 61-71%), is mainly effaced externally, although low swellings indicate the positions of the anterolateral lobes. The anterior furrow is generally represented by a faint depression, and on some specimens (Pl. 1, figs. 6, 8) even the furrows separating the basal lobes from the posterior lobe are effaced. Where differentiated, however, the latter are large and triangular. The axial glabellar node apparently lies behind these swellings, which represent the anterolateral lobes: thus the species is spectaculate. Both anterior and posterior lobes have low convexity (tr., sag.), the former being anteriorly pointed and the latter posteriorly angulate without exception. *Pseudagnostus mortensis* bears prominent fulcral nodes (Pl. 1, fig. 6) posterolaterally. The cephalic exoskeleton is smooth.

Like the cephala, pygidial shields have low convexity, are partly effaced, and lack surface prosopon. Late meraspides and early holaspides have subcircular shields, which become increasingly pointed posteriorly with increase in size (Pl. 2), and there is an apparent shift in the position of the posterolateral spines (Lp_2/Wp is 77-93%). Borders are generally a little wider (sag.) than those of the cephalon, between 5-15% of the total length (sag.; Lp_1 or Lp_2) of the shield, but are similarly non-deliquiate. Their posterolateral spines always lie in front of a line drawn across the rear of the deuterolobe, the actual position depending on size and shape of the shield. The pygidial acrolobe is mostly unconstricted in late meraspides and only gently constricted during holaspid morphogenesis. Segmentation of the anterior portion of the axis, which is defined by axial furrows, is effaced, its only relief being the axial pygidial node which is faintly bifid posteriorly on some specimens. On all specimens a shallow V-shaped furrow separates the anterior part of the axis from the deuterolobe, whose accessory furrows are mainly effaced. On some specimens which have had their shells almost completely dissolved (Pl. 2, fig. 5) faint indications of the accessory furrows demonstrate a narrow (tr.) saccate deuterolobe. Pleural lobes are therefore extensive. Anterolateral articulating devices have appreciable inclination, and fulcral points were apparently well developed. The articulating half-ring is a simple bar.

Pseudagnostus (P.) parvus sp. nov.
(Pl. 3, figs. 1-12; Text-fig. 13)

Name. L. *parvus*, small, referring to the size of this species.

Types. Holotype, CPC 15032, cephalon, illustrated on Pl. 3, fig. 1; figured paratypes 15033-15041; unfigured paratypes CPC 17247-17263.

Material. The species is known from 14 cephala, ranging in length (Lc) between 1.60 and 3.90 mm, and 13 pygidia measuring (Lp_2) between 2.05 and 4.00 mm.

Occurence. Plains northwest of 'Chatsworth', D124; Horse Creek section, K222, 223, 224, 225; Lily Creek section, K199, 200, 201, 202, 204, 207, B54a, 54b, 53, 50a and 791a, 15-ca 190m from base of measured section; BMR Duchess No. 13, 41.40-69.45 m.

Age. Late Cambrian, Assemblage-Zones of *Wentsuia iota - Rhaptagnostus apsis, Peichiashania secunda - Prochuangia glabella,* and *Peichiashania tertia - P. quarta*.

Diagnosis. A partly effaced spectaculate, subdeliquiate, non-plethoid species of *Pseudagnostus* with slightly constricted cephalic and pygidial acrolobes, and subquadrate pygidium with ampullate deuterolobe.

Differential diagnosis. Cephalic shape resembles that of *Pseudagnostus cyclopyge* (Tullberg) *(cyclopyge* group), from Sweden, and *P. primus* Kobayashi (1962, pp. 31-2, pl III, figs. 15-17; pl. V, figs. 8-12) *(cyclopyge* group), from the *Eochuangia* Zone of South Korea. These species share with *P. parvus* clearly defined median preglabellar furrows and axial glabellar nodes which, although spectaculate, begin to approach the papilionate condition. From both of these species of the *cyclopyge* group, *P. parvus* differs considerably by virtue of more weakly deliquiate marginal furrows, pygidial shape, and deuterolobe morphology.

Cephalically, *P. parvus* may be compared with members of the *communis* group referred by Bell & Ellinwood (1962, p. 389, pl. 51, figs. 8, 10) to *P. communis* (Hall & Whitfield), from central Texas; by Lochman & Hu (1959, p. 412, pl. 57, fig. 3) to *P. convergens* Palmer, from Idaho; and by Kobayashi (1935C, pp. 110-111, pl. III, fig. 9) to *P. orientalis* Kobayashi, from the Wuhutsui Basin, southern Manchuria. The last named species (see Kobayashi 1933, pl. IX, figs. 20-22; 1935C, pl. III, figs. 8, 10-11) also appears to have comparable pygidial characteristics.

Description. The description is based on exoskeletons, exfoliated specimens, and silicified replicas. Little parietal morphology is apparent.

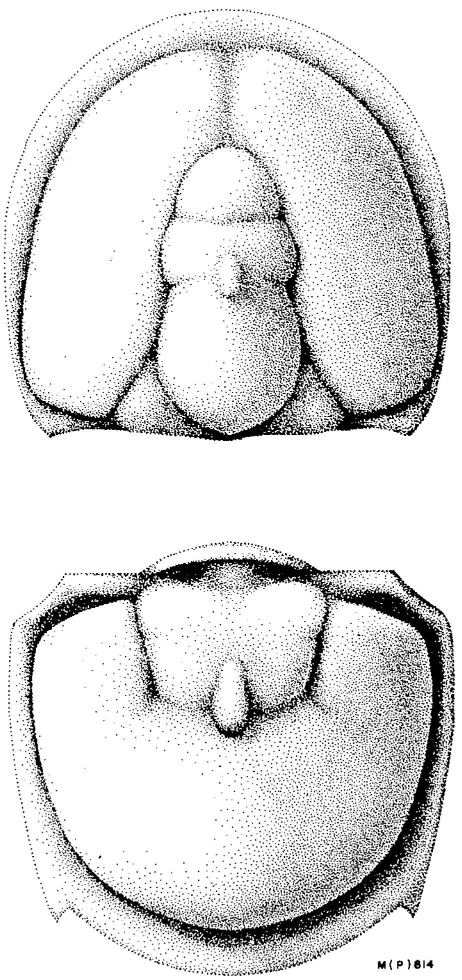


Fig. 13. ***Pseudagnostus (Pseudagnostus) parvus*** **sp. nov.; principal exoskeletal morphology, based on CPC 15032 (cephalon), x15, and CPC 15041 (pygidium), x26.**

The cephalic outline is ovoid, with maximum width (tr.) on a transverse line across the front of the anterior glabellar lobe; the length (Lc) varies between 100 and 108% of the maximum width. Cephalic borders are narrow (sag.), 8-12% of the cephalic length (sag.), and bear subdeliquiate marginal furrows. The acrolobe converges anteriorly, is slightly constricted, and is divided sagittally by a median preglabellar furrow regardless of preservation. The glabella, occupying 64-73% of the total cephalic length (sag.), is partly effaced on external exoskeletal surfaces (Pl. 3, fig. 3), and its anterior furrow is weakly impressed even on moulds. The axial glabellar node, which lies a little further than one-third of the cephalic length from the rear of the glabella, is almost papilionate, not quite resting between the anterolateral lobes. The furrows dividing the basal and posterior lobes are effaced on exoskeletons.

The pygidium is subquadrate, with length (Lp_2) 83-95% of the width (tr.). Its borders are narrow (sag.), 7-14% of the total length (Lp_2), and its marginal furrows subdeliquiate. The acrolobe is subquadrate, and laterally gently constricted. Axial transverse furrows are effaced on exoskeletons, and accessory furrows very weakly impressed. The deuterolobe is rather strongly convex (tr., sag.), ampullate, with squared-off or obtusely rounded posterior margins. Articulating facets have high inclination and are marginally situated (Pl. 3, fig. 7), i.e. the fulcra are wide spaced (tr.). The articulating half-ring (Pl. 3, fig. 9) is simple, of the glyptagnostoid type. Marginal spines, sited a little in advance of the rear of the deuterolobe, are short and posterolaterally deflected when fully preserved.

Pseudagnostus (P.) tricanthus sp. nov.
(Pl. 4, figs. 6-12; Text-fig. 14)

Name. L. *tricanthus,* three-cornered, referring to the triangular anterior cephalic shape.

Types. Holotype, CPC 15043, cephalon illustrated on Pl. 4, figs. 7,11; illustrated paratypes CPC 15042, 15044-15047; non-illustrated paratypes CPC 17264-17267.

Material. The species is known from seven cephala, measuring (Lc) 2.55 - 3.50 mm; and three pygidia with lengths (Lp_2) of 2.15 - 2.75 mm.

Occurrence. Plains northwest of 'Chatsworth', D124; section south of Horse Creek, K 215, 216, 218, 224, 225; Lily Creek, B54a, 24 m above base measured section; BMR Boulia No.6, 41.30-72.45 m.

Age. Late Cambrian, Assemblage-Zones of *Wentsuia iota - Rhaptagnostus apsis* and *Peichiashania secunda - Prochuangia glabella.*

Diagnosis. A spectaculate, deliquiate to subdeliquiate, partly effaced species of *Pseudagnostus* characterised by a triangular anterior cephalic shape.

Differential diagnosis. The shape of the anterior cephalic margin distinguishes *Pseudagnostus tricanthus* from all other described pseudagnosti, although the front of the damaged holotype of *Sulcatagnostus securiger* (Lake, 1906, p. 20, pl. II, fig. 11) may have borne a sagittal point. A similar triangular shape is known in *Aspidagnostus* Whitehouse.

Glabellar characteristics, a rather wide (tr.) posterior lobe and short (sag.) anterior lobe, are reminiscent of *Pseudagnostus sentosus* Grant (1965, pp. 108-9, pl. 9, figs. 2,3,5) from Montana, and specimens assigned to *P. convergens* Palmer by Lochman & Hu (1959, p. 412, pl. 57, figs. 1-6) from Idaho. The saccate pygidial deuterolobe resembles that of *Sulcatagnostus* (see Lake, 1906) and *Pseudagnostus leptoplastorum* Westergaard (1944, p. 39, pl. 1, fig. 1) from Andrarum, Skaane, Sweden.

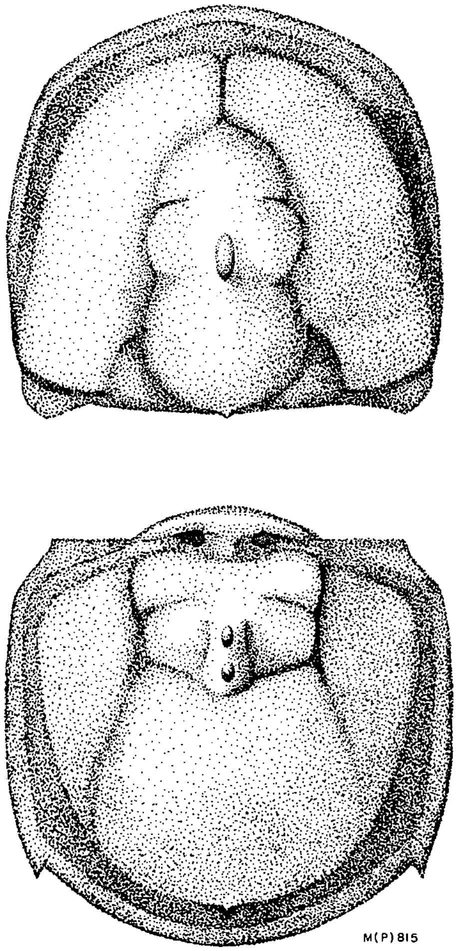


Fig. 14. ***Pseudagnostus (Pseudagnostus) tricanthus*** **sp. nov.; principal exoskeletal morphology, based on CPC 15046 (cephalon), x20, and CPC 15047 (pygidium), x25.**

In terms of degree of effacement and overall morphology, the most similar Australian species is perhaps *Pseudagnostus parvus* sp. nov., with which *P. tricanthus* is classified in the *communis* group. *P. parvus,* however, has a less angulate cephalic outline, and its deuterolobe is ampullate rather than saccate. In both species the cephalic acrolobe is gently constricted, and the axial glabellar node begins to approach a papilionate condition. The two species are virtually contemporaneous.

Description: Description is based both on exfoliated moulds and exoskeletons; little parietal morphology is, however, observed.

The cephalic shape is subovoid, having, in general, anteriorly tapered flanks. The outline is angulate anterolaterally, coming to a rounded apex sagittally. The length (Lc) varies between 100 and 103% of the width (Wc), whose maximum dimension is at the level of the middle of the posterior glabellar lobe. Parietally, the borders, which occupy 10-13% of the total cephalic length (sag.), have deliquiate marginal furrows; testaceous specimens are non-deliquiate (cf. Pl. 4, figs. 6, 10). The cephalic acrolobe is ovoid, tapers anteriorly, is gently constricted laterally, and bisected sagittally by amedian preglabellar furrow which is partly effaced on exoskeletons. The glabella has appreciable width (tr.), and length (G) two-thirds that of the cephalon. On exoskeletons, the anterior and anterolateral lobes and anterior furrow are mostly effaced, as are the furrows separating the basal lobes from anangulate posterior lobe. The positioning of these lobes and furrows is, however, visible on parietal surfaces (Pl. 4, figs. 7, 10), and the axial node is seen to exhibit a more or less spectaculate condition.

The pygidial outline is subovoid, but posteriorly rounded, with length (Lp_2) 90-94% of the width (Wp). Its borders occupy 10-13% of the pygidial length (Lp_2), and like the cephalon, its marginal furrows are deliquiate only when the shell is removed. The acrolobe is subrectangular, gently constricted laterally. Both transverse furrows on the axis accessory furrows are faintly visible on some specimens, indicating a saccate deuterolobe whose posterior angulation is responsible for the observed shape of the acrolobe. Pleural lobes are thus more extensive than in other species described herein. Marginal posterolateral spines are located posteriorly, but a little in front of the rear of the deuterolobe. Articulating facets are steeply inclined; the articulating half-ring is simple, glyptagnostoid.

Pseudagnostus cyclopyge species group

Nominal species. Agnostus cyclopyge Tullberg (1880, p. 26, pl. 11, figs. 15a, c), as interpreted by Westergaard (1922, pp. 116-7, pl. 1, figs. 7-8), Late Cambrian, *Olenus* and *Parabolina spinulosa* with *Orusia lenticularis* Zones, Andrarum, Skaane, Sweden.

Pseudagnosti having subovoid to rounded subquadrate, *en grande tenue,* spectaculate cephala, with wide borders and deliquiate marginal furrows, subovoid to subcircular acrolobe, transverse rectilinear, curvilinear or V-form anterior glabellar furrow, and median preglabellar furrow generally present; and subovoid to rounded subquadrate, *en grande tenue,* plethoid, deuterolobate pygidia, with deliquiate marginal furrows and posterolateral spines lying in advance of the rear of the deuterolobe.

Other species thought to comprise the *cyclopyge* species group are listed in Shergold (1977A).

Pseudagnostus (P.) aulax sp. nov.
(Pl. 5, figs. 1-12; Text-fig. 15)

Name. L. *aulax,* furrow, noun in apposition, referring to the strongly deliquiate marginal furrows.

Types. Holotype, CPC 15053, an exfoliated cephalon, illustrated on Pl. 5, figs. 2, 3; figured paratypes CPC 15052, 15054-15061; unfigured paratypes CPC 17268-17279.

Material. The investigated paradigm consists of ten cephala and eleven pygidia. Cephala measure (Lc) 3.90 - 5.80 mm and pygidia (Lp_2) 2.80 - 5.20 mm (Lp_1), 3.20 - 5.55 mm).

Occurrence. Plains northwest of 'Chatsworth', D124, 669; section south of Horse Creek, K215, 216, 217, 220, 225; Lily Creek, K199, 200, B54a, 54b, 15-52 m from the base of the measured section; BMR Boulia No. 6, 42.55-83.00 m; BMR Duchess No. 13, 24.50-44.40 m.

Age. Late Cambrian, Assemblage-Zones of *Wentsuia iota - Rhaptagnostus apsis* and *Peichiashania secunda - Prochuangia glabella.*

Diagnosis. An externally partly effaced, spectaculate, strongly deliquiate, non-plethoid species of *Pseudagnostus,* with V-form parietal anterolateral glabellar furrows, and elongated (sag.), acutely posteriorly rounded, saccate deuterolobe. Nine pygidial metameres.

Differential diagnosis. Pseudagnostus aulax most closely resembles *P. idalis* Öpik (1967, pp. 153-4, pl. 62, figs. 8-9; pl. 63, figs. 1, 3), from the Idamean of western Queensland, which has similarly shaped strongly deliquiate shields. *P. idalis,* however, is generally preserved *en tenue,* and its cephala are distinguished by a straight anterior glabellar furrow, and more deeply impressed median preglabellar furrow. Pygidia are also less effaced than those of *P. aulax,* and have more posteriorly sited lateral spines. Specimens assigned by Henderson (1976, pl. 1, figs. 10, 12) to *P. vastulus* Whitehouse are cephalically essentially similar to *P. aulax,* but pygidially distinct by virtue of proportionate length and deuterolobe shape.

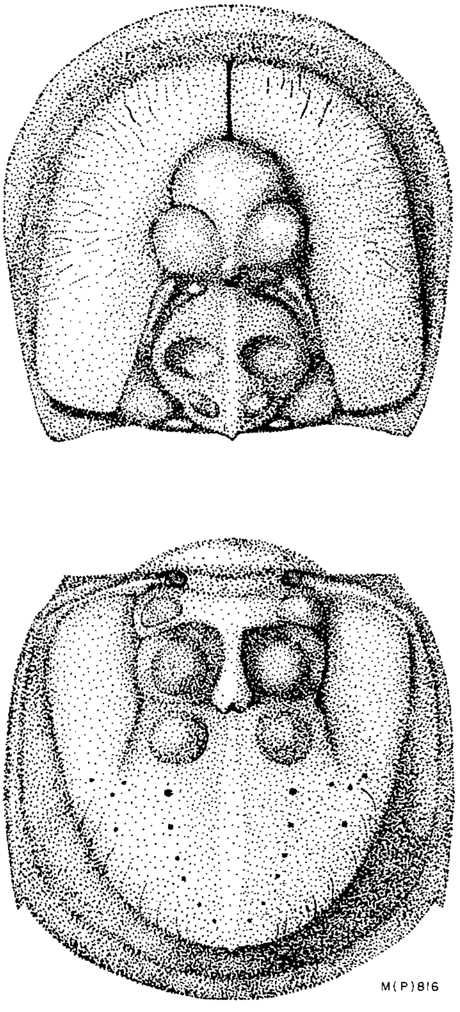


Fig. 15. ***Pseudagnostus (Pseudagnostus) aulax*** **sp. nov.; parietal morphology, based on CPC 15053 (cephalon), x11, and CPC 15060 (pygidium), x13.**

Cephalic shape is sufficient to differentiate *P. aulax* from the nominal species of the *cyclopyge* group (see reference above). *P. aulax* resembles *P. chinensis* (Dames, 1883) (see Schrank, 1974, pp. 622-3, pl. 1, figs. 1-7) from the Taitzuho Valley, Manchuria - a species which appears to be closely related to *P. idalis* Öpik, and to other species from the latest Tuorian and early Shidertan (Ivshin & Pokrovskaya, 1968), Kuyanda faunal horizon, of Kazakhstan. These latter species, placed by Ivshin (1956, 1962) in *Pseudagnostus angustilobus* (1956, pp. 1920, pl. 9, figs. 11-15, 18-23), *P. pseudocyclopyge* (1956, pp. 17-19, pl. 1, figs. 1-5, 6-8, 10, 16-17; 1962, p. 18, pl. 1 figs. 19-22), and *P. leptoplastorum* Westergaard (Ivshin, 1962, pp. 16-18, pl. 1, figs. 8-18), appear to represent an interrelated group of taxa. Judging from the published material, they may even by synonyms, and where the Australian species fits morphologically is difficult to assess, as each of the Russian taxa appears to be composite. The ages of the Russian and Australian species are similar.

Pseudagnostus leptoplastorum Westergaard (1944, p. 39, pl. 1, fig. 1), a flattened pygidium from Skaane, Sweden, may well have had similar proportions to *P. aulax*, and its saccate deuterolobe may indicate relationship. Again, its age is similar - Zone 4b, of *Leptoplastus raphidophorus*, on the Scandinavian zonal scale of Westergaard (1947).

Deuterolobe shape also resembles that of *Pseudagnostus vulgaris* Rosova (1960, pp. 14-16, pl. 1, figs. 5-13), Tolstochinsk Suite, Salair, which has been previously referred (Shergold, 1977A) to *Neoagnostus* (*clavus* species group). Other characteristics of *P. aulax* suggest that it stands close to the morphological separation of *Neoagnostus* from *Pseudagnostus (Pseudagnostus)* (see comments under *N. felix* sp. nov., following).

Description. Descriptions are based on specimens preserved with shell (pl. 5, figs. 7-8), or as exfoliated (Pl. 5 figs. 1-5, 9-11) or partially exfoliated (Pl. 5, fig. 6) moulds: parietal morphology is well displayed.

No cephalic exoskeletons are known, all specimens being exfoliated, or partly so. Cephalic shape is subovoid, anteriorly expanding and with maximum width (tr.) in front of the anterolateral muscle scar impressions; length is equal to, or slightly greater than, the maximum width - L:W is 100-105%. Exfoliated specimens are characterised by wide borders, 12-18% of the cephalic length (sag.), with strongly deliquiate marginal furrows. As degree of deliquiation depends on preservation, exoskeletons would be expected to have shallower marginal furrows. The gently constricted cephalic acrolobe is more acutely rounded anteriorly than the cephalic outline, and is bisected sagittally by a weakly impressed median preglabellar furrow even on parietal surfaces. Generally the glabellar length is less than two-thirds the cephalic length (sag.). Parietally, the anterior lobe is long (sag.), evenly rounded frontally, and is separated from large ovoid anterolateral muscle scar impressions by strongly V-form anterolateral furrows. The axial node lies just behind these muscle scars and thus exhibits a spectaculate condition. The posterior lobe is broadly angulate at the rear and separated from the basal lobes by furrows which become effaced abaxially. It appears that the basal lobes pass anteriorly into some kind of diverticular structure which defines the abaxial margins of the posterior lobe. Major posterior muscle scar impressions are clearly visible (Pl. 5, figs. 1, 2, 4, 5, 10) as are the oblique lateral scars and ridges, morphology being essentially similar to that of *Rhaptagnostus clarki prolatus* Shergold (1975, pl. 3) except that a small subcircular muscle scar impression is sited at the anterior end of the oblique lateral scars. The cephalic acrolobe is scrobiculate, and the paired diverticula of the anterior lobe clearly visible (Pl. 5, figs. 2, 4). A further diverticulum issue from the glabella at the rear of the anterolateral muscle scar impressions (Pl. 5, fig. 2).

The pygidium is ovoid is shape, with maximum width just in front of the posterolateral spines; the length (Lp_1) is equal to or slightly longer than the width (Wp), but Lp_2 is consistently shorter, 90-93%. Pygidial orders are wide, 11-17% of the length (Lp_2), with marginal furrows that are parietally strongly deliquiate but less so when shell is preserved. Posterolateral spines are sited well in front of the rear of the deuterolobe. The pygidial acrolobe is very gently constricted indeed. On pygidial exoskeletons transverse and accessory furrows are totally, and axial furrows partly, effaced. Parietally, these furrows are weakly impressed. The deuterolobe is saccate, longer (sag.) than wide (tr.), posteriorly acutely rounded, even pointed in some specimens, and scrobiculate marginally (Pl. 5, fig. 11). Pleural lobes are thus long (exsag.), but narrow (tr.), and are also scrobiculate. Muscle scar impressions and notulae are well preserved (Pl. 5, figs. 6, 11), indicating nine holaspid segments. The axial pygidial node, which is posteriorly bifid on parietal surfaces, is merely a large pustule on the exoskeleton. This structure is seen to be intimately associated with transverse diverticula which define the posterior margins of both the first and second axial segments. Articulating facets are highly inclined, and the articulating half-ring simple - glyptagnostoid.

Pseudagnostus (Pseudagnostus) sp. VII
(Pl. 7, figs. 9-10)

Material. Two pygidia, both having an estimated length (Lp_2) of 4.6 mm. Specimens CPC 15073-4 are illustrated.

Occurrence. Horse Creek section, K216 and 217.

Age. Late Cambrian, *Wentsuia iota - Rhaptagnostus apsis* Assemblage-Zone.

Comments. Specimens referred to *Psuedagnostus* sp. VII are set aside by virtue of their very wide posterolateral borders and strongly deliquiate marginal furrows. Posterolateral spines appear to be strong, hooked, and deflected from the lateral pygidial margin. All specimens are exfoliated and show a gently constricted acrolobe. Transverse furrows on the axis are faint, as are accessory furrows. The latter indicate a long sack-like deuterolobe, obtusely rounded posteriorly. Pleural lobes are long (exsag.) and narrow (tr.). Traces of nine holaspid metameres are shown.

Pseudagnostus sp. VII is most similar to *P. aulax* sp. nov. with which it is contemporaneous, and may merely represent a variant of this species (compare Pl. 7, fig. 7, with Pl. 5, fig. 11) with more obtusely rounded deuterolobe and wider marginal furrows. Only the width of the posterolateral borders differentiates these pygidia from those assigned to *Pseudagnostus* sp. VI.

Species not assigned to species groups.

Pseudagnostus (Pseudagnostus?) sp. V
(Pl. 8, figs. 10-12)

Material. Four pygidia, measuring (Lp_2) between 1.70 and 2.50 mm. Specimens CPC 15075-7 are illustrated; CPC 17280 is unfigured.

Occurrence. Horse Creek section, horizons K215, 217, 218; Lily Creek section, K199, 15 m from the base of the measured section.

Age. Late Cambrian, *Wentsuia iota - Rhaptagnostus apsis* Assemblage-Zone.

Comments: Pseudagnostus sp. V is characterised by straight or adaxially concave flanks; long, curved posterolateral spines placed to the rear of the termination of the deuterolobe; a decidedly constricted acrolobe; and deuterolobe with subrectangular shape. Marginal furrows are subdeliquiate on the exfoliated specimens available, and the species therefore should be externally effaced or partly effaced.

All specimens assigned to *Pseudagnostus* sp. V are small, and may represent the early holaspides of some other species, e.g. *Pseudagnostus aulax* sp. nov. If so, then the spines must migrate forwards considerably during holaspid morphogenesis.

Pseudagnostus (Pseudagnostus?) sp. VI
(Pl. 4, figs. 1-5)

Material. This taxon is based on five cephalic and five pygidial fragments. Cephala measure (Lc) between 5.90 and 7.30 mm, and pygidia (Lp_2) between 4.50 and 7.50 mm. Specimens CPC 15062-66 are illustrated; CPC 17281-17285 are unfigured specimens.

Occurrence. Lily Creek section, horizons K200, 202, 203, 204, 206 and B790, 24-92 m from the base of the measured section.

Age. Late Cambrian, *Peichiashania secunda Prochuangia glabella* Assemblage-Zone.

Comments. *Pseudagnostus* sp. VI is left under open nomenclature mainly because of an inadequacy of diagnostic characters among the available specimens, which are generally imperfectly preserved. All the specimens are large, in excess of 4.50 mm long, and cannot be related to co-occuring species. The exoskeleton is completely effaced, rendering relationship with moulds subjective. Only one characteristic appears sound — the oval cephalic shape — but even this may be subject to query in distorted material.

Pseudagnostus sp. VI is thus an externally effaced, subdeliquiate, spectaculate species, with ovoid terminally acutely rounded cephalon, and more obtusely rounded pygidium, whose shape alone distinguishes it from previously described species.

By and large, its characteristics are shared with those of species of the *Rhaptagnostus clarki* species group (Shergold, 1975), from which it differs by the non-papilionate condition of its axial glabellar lobe. In particular, pygidial characteristics are close to those of *R. clarki clarki* Kobayashi (1935A, p. 47, pl. IX, figs. 1-2; Palmer, 1968, p. 29, pl. 15, figs. 10, 13, 14) from east-central Alaska, and *R. clarki laevis* Palmer (1955, pp. 97-8, pl. 19, figs. 8, 9, 11, 12) from the Eureka district, Nevada.

Pseudagnostus sp VI is doubtless a morphological intermediate between *Pseudagnostus* and *Rhaptagnostus* species of the *clarki* species group, e.g. *R. auctor* n. sp., and *R. clarki patulus* Shergold (1975, pp. 62-64, pl. 1, figs. 1-6; pl. 2, figs. 1-2) from the 'Chatsworth Limestone' of Black Mountain.

Description. Description is based on both exoskeletons and parietal surfaces.

Exoskeletons are more or less completely effaced (Pl. 4, fig. 3), only the marginal furrows being preserved. Cephalic shape is ovoid, egg-shaped, with maximum width (tr.) at the front of the anterolateral glabellar muscle scar impressions, and length (sag.), slightly greater than the width (tr.). Borders are wide (sag.), about 12% of the total cephalic length (sag.), with shallow dished marginal furrows on shelly material, and deeper subdeliquiate ones on parietal surfaces. The cephalic acrolobe also has an ovoid shape, is unconstricted, and undivided sagittally by a median preglabellar furrow, both on exoskeleton and parietal surface. Glabellar morphology is visible only parietally. Large anterolateral and major posterior muscle scar impressions, which resemble those of *P. aulax*, are the most striking morphological features. Anterolateral glabellar furrows, the margins of the anterolateral muscle scars, are V-form, converging rearwards on the axial glabellar node, which is spectaculate. Furrows separating the basal lobes from the posterior lobe are anteriorly effaced. The cephalic acrolobe is strongly scrobiculate, and the points of emergence of caecal diverticula from the anterior glabellar lobe are visible (Pl. 4, figs. 1-2).

The pygidial outline is subovoid, terminally more obtusely rounded than the cephalon, with maximum width (tr.) across the mid-length of the shield; length (Lp_1) is slightly greater than the width (Wp), Lp_2 slightly less. As with the cephalon, only the marginal furrows are not effaced on exoskeletons. Borders extend to 12-14% of the pygidial length (Lp_2) and have shallow marginal furrows on both exoskeletal and parietal surfaces. The acrolobe is constricted only on exfoliated material. The latter shows weakly incised transverse furrows but accessory furrows are effaced. From a count of muscle scar impressions and notulae, ten segments constitute the pygidial axis. A long (sag.) saccate deuterolobe and long (exsag.), narrow (tr.) pleural lobes are indicated. Posterolateral pygidial spines are sited well in advance of the rear of the deuterolobe. Musculature associated with the intranotular axis is visible in CPC 15066 (Pl. 4, fig. 5). Articulating mechanisms are imperfectly preserved on all available specimens.

Genus **Rhaptagnostus** Whitehouse, 1936

Type species. *Agnostus cyclopygeformis* Sun (1924, p. 26, pl. 2, figs. 1a-h), Lower Kaolishan Limestone, Taianfu, Shantung, China; designated by Whitehouse (1936, p. 97).

Other species. Other species have been listed elsewhere (Shergold, 1977A) under species groups based on *R. convergens* (Palmer) and *R. clarki* (Kobayashi).

Comments. *Rhaptagnostus* has been rediagnosed and discussed by Shergold (1977A).

Rhaptagnostus convergens species group

Nominal species. *Pseudagnostus convergens* Palmer (1955, pp. 96-7, pl. 19, figs. 14-15), Late Cambrian, Trempealeauan, *Saukia* Zone, Nevada, USA.

Pseudagnosti having effaced and partly effaced, subovoid to subcircular, papilionate cephala, with narrow borders, non-deliquiate to sub-deliquiate marginal furrows, and median preglabellar furrow externally mostly effaced; and subovoid, subplethoid, generally weakly deuterolobate pygidia, with non-deliquiate to sub-deliquiate marginal furrows, small posterolateral spines situated well in advance of the rear of the deuterolobe, and 10 late holaspid metameres.

Species previously assigned to this group are listed in Shergold (1977A), to which should be added *R. impressus* (Lermontova) (1940, p. 125, pl. LXIX, figs. 13, 13a). Those referred here to this species group, *R. apsis* and *R.* sp. cf. *impressus*, although they have comparable shield shapes and border morphology, and similar degrees of effacement to other species comprising the group, are not undoubtedly papilionate. They represent the earliest species which can be placed in *Rhaptagnostus*, but in the "subpapilionate" condition of their axial glabellar nodes obviously lie close to a spectaculate *Pseudagnostus* source.

Rhaptagnostus apsis sp. nov.
(Pl. 6, figs. 1 - 11; Text-fig. 16)

Name. L. *apsis*, arch or vault, noun in apposition, referring to original shapes of both cephalic and pygidial shields.

Types. Holotype, CPC 15029, pygidium, illustrated on Pl. 6, figs. 8-9; illustrated paratypes CPC 15023-15028, 15030, 15031; non-illustrated paratypes CPC 17286-17298.

Material. The species is known from nine cephala ranging in size (Lc) from 2.95 - 4.70 mm; and thirteen pygidia ranging (Lp_2) from 2.50 - 4.50 mm.

Occurrence. Plains north of 'Chatsworth' at D124; section south of Horse Creek, horizons K215, 216, 218, 223, 224, 225, 226 and D668; BMR Boulia No. 6, 43.85-45.35 m.

Age. Late Cambrian, *Wentsuia iota - Rhaptagnostus apsis* Assemblage-Zone.

Diagnosis. A papilionate species of Pseudagnostinae with highly distinctive ogival shields, markedly constricted acrolobes, and subdeliquiate marginal furrows. Additionally, the species possesses a median preglabellar furrow and an effaced glabella. Its pygidium is deuterolobate, non-plethoid, and its spines are extremely small, adventrally directed.

Differential diagnosis. Similarity to other members of the *convergens* group, in the form of convergent pygidial flanks, is obvious (Shergold, 1975, 1977A). These species, however, occurring mostly later in time, are in general more strongly papilionate, their cephala are generally more ovoid in shape, and their borders are narrower and bear non-deliquiate marginal furrows. Some degree of similarity in shield shape exists between *R. apsis* sp. nov. and the specimens from Nevada assigned by Palmer (1960, p. 61, pl. 4, figs. 5-6) to *Pseudagnostus prolongus* (Hall & Whitfield). The American species appears to be more effaced and its marginal furrows non-deliquiate.

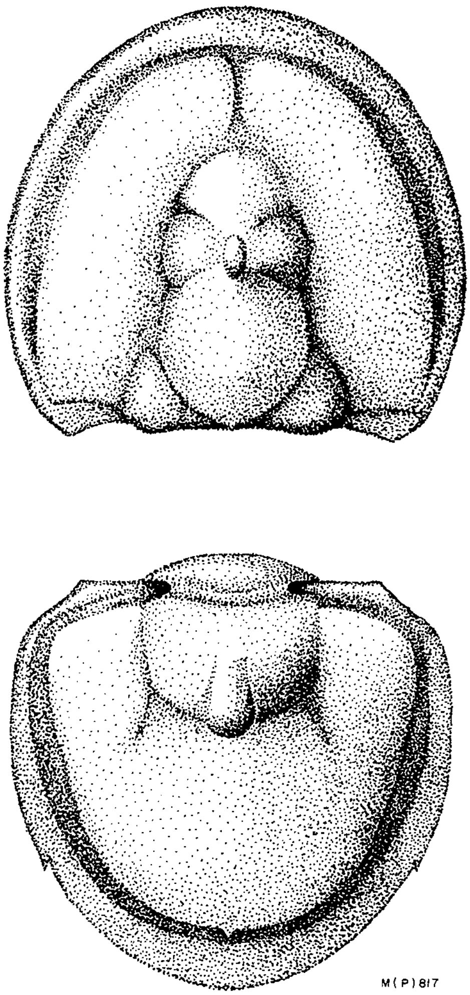


Fig. 16. *Rhaptagnostus apsis* **sp. nov.; principal exoskeletal morphology, based on CPC 15024 (cephalon), x16, and CPC 15029 (pygidium), x15.**

Description. The description is based on specimens retaining shell or partly exfoliated. Little information is available on parietal morphology.

The cephalon is ogival, being widest (tr.) at a transverse line drawn through or slightly in front of the axial glabellar node, the flanks converging from this point forwards, becoming sagittally pointed: length (Lc) varies between 96 and 113% of the width (Wc). Borders, varying from 12-14% of the total cephalic length, have deliquiate to subdeliquiate marginal furrows on exoskeleton and mould respectively (compare Pl. 6, fig. 1 with fig. 10), and are narrowest (sag., exsag.) anteriorly. Conversely, the rim of the border is widened sagittally. The acrolobe is also ogival in outline, being anterolaterally gently constricted, markedly pointed anteriorly, and cleft sagittally by a prominent median preglabellar furrow. On exoskeletons (Pl. 6, fig. 1) the glabella is mostly effaced, but its outlines can be discerned on exfoliated specimens (Pl. 6, figs. 2, 10). In particular, the anterior lobe and transverse furrow are heavily effaced, while the rear of the posterior lobe, the basal lobes and axial node remain visible. The glabella appears to occupy two-thirds of the total cephalic length (sag.), and its axial node lies at approximately one-third of the cephalic length (sag.) from the rear of the cephalon. The axial node of this species appears to have a condition more nearly papilionate than spectaculate, but this is difficult to evaluate because of glabellar effacement. *Rhaptagnostus apsis* may well represent the earliest papilionate species occurring in the late Cambrian of northern Australia.

The pygidium has a similar ogival shape to that of the cephalon: length (Lp_2) to width (Wp) ratios vary between 90 and 100%, and the maximum width (tr.) lies just to the rear of the axial pygidial node. Borders are laterally broad, widening posteriorly to the apex of the shield where 12-15% of the total length (Lp_2), and have deliquiate marginal furrows, particularly laterally. The acrolobe is elongate, ovoid, and laterally gently constricted. Axial furrows are discernible anteriorly, but the transverse furrow between the first and second axial metameres is effaced. The furrow separating the anterior axis from the posterior deuterolobe is impressed to the same depth as the axial furrows. The species is deuterolobate, non-plethoid, and accessory furrows are only faintly visible. When seen, the deuterolobe is observed to be ampullate. Marginal spines are petite, lie on the posterolateral concavity of the shield well in front of the rear of the deuterolobe, and are adventrally directed. Little information is available on the morphology of the articulating facets, but the articulating half-ring is simple, and of glyptagnostoid type.

Rhaptagnostus sp. cf. **R. impressus** (Lermontova, 1940)
(Pl. 10, figs. 1-6; Text-fig. 17)

cf. 1940. *Pseudagnostus impressus* Lerm. (MS); Lermontova, 1940, p. 125, pl. XLIX, figs. 13, 13a.

Types. The cotypes of *Pseudagnostus impressus* Lermontova are extant in the collections of the Central Scientific Research Geological Exploration Museum (at VSEGEI), Leningrad, numbers 44/9182 and 45/9182, cephalon and pygidium respectively.

Material. Material referred here to *Rhaptagnostus* cf. *impressus* (Lermontova) comprises fragments of six cephala, ranging in length (Lc) between 2.10 and 3.30 mm, and three pygidia which measure (Lp_2) from 2.70-3.60 mm. Specimens CPC 15048-15051 illustrated; non-illustrated specimens are CPC 17299-17303.

Occurrence. Plains northwest of 'Chatsworth', D124; section south of Horse Creek, K223, 224, and 225; BMR Duchess No. 13, 57.75-62.25 m from the top.

Age. Late Cambrian, *Wentsuia iota - Rhaptagnostus apsis* Assemblage-Zone.

Comments. Rhaptagnostus cf. *impressus* is a semi-effaced, papilionate, non-deliquiate and non-plethoid species with parallel-sided glabella, bulbous deuterolobe, narrow (tr., sag.) borders in both cephalon and pygidium, and posteriorly convergent pygidial flanks. It is not readily distinguished from *R. impressus* (Lermontova) — the deuterolobe may be a little more tumid, and the pygidial borders narrower. *R.* cf. *impressus* is morphologically close to *R. convergens* (Palmer) (1955, pp. 96-7, pl. 19, figs. 14-15), but is differentiated by its shorter (sag.) anterior glabellar lobe and more tumid and effaced pygidium.

Pseudagnostus impressus was previously assigned (Shergold, 1977A, p. 99) to the *communis* group of pseudagnosti. Through the similarity of the Russian and Australian species, it can now be confidently classified with *Rhaptagnostus* and placed with the *convergens* group of species.

Description. Although this species is described from exfoliated material, details of the parietal morphology are unknown.

As far as can be judged from the available material the cephalon is ovoid in outline, with equal length and width, and appreciable convexity (tr., sag.). Borders are narrow (sag.), 5-7% of the total cephalic length, and marginal furrows are non-deliquiate, although decidedly deeper when the shell

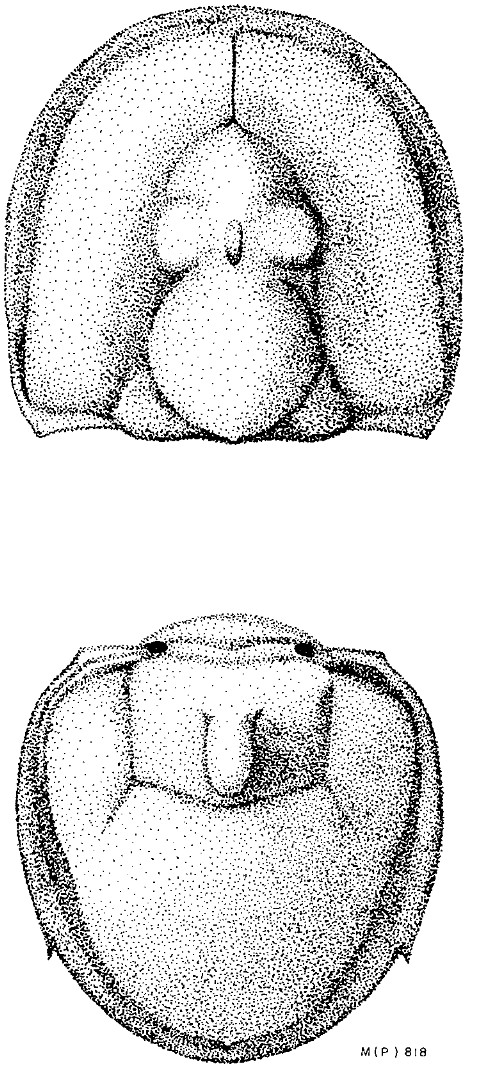


Fig. 17. ***Rhaptagnostus*** **sp. cf.** ***R. impressus*** **(Lermontova); principal exoskeletal morphology, based on CPC 15048 (cephalon), x19, and CPC 15051 (pygidium), x16.**

is exfoliated. The acrolobe is ovoid, unconstricted, and divided sagittally by a median preglabellar furrow of variable strength. The glabella is long (sag.), in excess of two-thirds the cephalic length (sag.), wide (tr.) and parallel-sided (Pl. 10, fig. 1). Its anterior lobe is short (sag.) and anteriorly distinctly pointed.

Anterolateral lobes, represented on the available material by impressions of areas of muscle attachment, are large but not laterally extensive, and are separated from the anterior lobe by V-form anterolateral furrows. The axial glabellar node lies between these lobes, thus exhibiting a papilionate condition. The posterior lobe is long (sag.), parallel-sided, posteriorly angulate, and differentiated by distinct furrows from the basal lobes. The latter are tucked well into the corners of the posterior lobe so that the axial furrows are deflected only slightly around them.

The pygidium is ovoid, with strongly convergent flanks; length (Lp_2) is about equal to the maximum width (Wp). As in the cephalon, the borders are narrow, approximately 7% of the length parameter (Lp_2), and bear non-deliquiate posterior marginal furrows which widen laterally due to the constriction of the pygidial acrolobe. Axial furrows are subparallel, but transverse furrows are effaced. The deuterolobe is highly tumid, restricts the extent of the pleural areas, and posteriorly slightly overhangs the marginal furrows. Accessory furrows are only faintly impressed. Posterolateral spines are small denticles lying well in advance of the rear of the deuterolobe, adjacent to the constriction of the acrolobe.

Rhaptagnostus clarki species group

Nominal species. *Pseudagnostus (Plethagnostus) clarki* Kobayashi (1935A, p.47, pl.IX, figs. 1-2), Late Cambrian, *Briscoia* fauna, Hard Luck Creek, east-central Alaska (see also Palmer, 1968, p.29, pl.15, figs. 10,13-14).

Papilionate pseudagnosti having effaced subovoid to subcircular cephalic exoskeletons with wide borders, non-deliquiate to subdeliquiate marginal furrows, and median preglabellar furrow externally mostly effaced; and effaced, subovoid, non-plethoid, weakly deuterolobate pygidia with wide borders and non-deliquiate to subdeliquiate marginal furrows, small posterolateral spines sited well in advance of the rear of the deuterolobe, and 9-10 axial metameres.

Species previously assigned to the *clarki* group are listed by Shergold (1977A). The species described here, *Rhaptagnostus auctor*, like those referred herein to the *convergens* group, exhibits an approximate papilionate, or 'subpapilionate', axial glabellar node condition, which underlines its morphological derivation from a spectaculate predecessor. In the remainder of its morphological characteristics, *R. auctor* sp. nov. very closely resembles *clarki* group species occurring probably contemporaneously at Black Mountain (Shergold, 1975, pp.60-71).

Rhaptagnostus auctor sp. nov.
(Pl.7, figs. 1-8, Text-fig. 18)

Name. L. *auctor,* founder, progenitor, referring to the postulated phylogenetic position of this species with respect to later members of the *clarki* species group.

Types. Holotype, CPC 15070, partly exfoliated cephalon, illustrated on Pl.7, fig.1; figured paratypes CPC 15067-15069, 15071-15072; unfigured paratypes CPC 17304-17313.

Material. The species is based on the remains of four cephala and thirteen pygidia. Cephala measure (Lc) between 3.10 and 4.85 mm, and pygidia (Lp_2) from 2.10-4.50 mm.

Occurrence. Lily Creek section, horizon B791a, which is not on the measured line of section, but lies about 190 m from its base.

Age. Late Cambrian, Assemblage-Zone of *Peichiashania tertia* with *P. quarta.*

Diagnosis. An externally effaced 'subpapilionate', subdeliquiate species of *Rhaptagnostus* with subsemicircular shields and wide borders.

Differential diagnosis. Rhaptagnostus auctor is a species exhibiting intermediate glabellar morphology between those species assigned to *Pseudagnostus* which are decidely spectaculate, and those referred to *Rhaptagnostus* which are definitely papilionate. *R. auctor* is more papilionate than spectaculate, whereas *Pseudagnostus* sp. VI, another intermediate, is more spectaculate. Degrees of effacement and deliquiation indicate relationship of *R. auctor* with members of the *clarki* species group with which it is here classified. *R. clarki patulus* (Shergold) (1975, pp.62-4, pl.1, figs. 1-6; pl.2, figs. 1-2), the most similar and probably contemporaneous species, is distinguished from *R. auctor* by the proportions of its shields.

Description. Both exoskeletons and exfoliated specimens are illustrated on Pl. 7.

The cephalon has subsemicircular shape, is widest (tr.) across the rear of the anterior glabellar lobe, and is slightly wider (tr.) than long (sag.). The borders are wide (sag.), 10-12% of the total cephalic length (sag.), with subdeliquiate marginal furrows which are more deeply incised on parietal surfaces, and gently upraised marginal rims. The cephalic acrolobe is unconstricted, separated sagittally by a median preglabellar furrow, very faint when preserved with shell (Pl. 7, fig. 1), but slightly stronger on exfoliated cephala. On exoskeletons the glabellar outline is very faint, although the position of the anterolateral glabellar lobes is visible. Parietally, the glabella is seen to be somewhat convergent forwards and to possess extensive, and perhaps duplicated, anterolateral muscle scar impressions. Anterolateral furrows are V-form, and the axial node lies very nearly in the full papilionate position. Furrows separating the basal and posterior lobes are anteriorly effaced, and the posterior lobe is decidedly angulate posteriorly. Major posterior muscle scar impressions and oblique lateral ones are observable, their orientation being similar to those of *R. clarki patulus* (see Shergold, 1975, text-fig. 15). The cephalic acrolobe is weakly scrobiculate (Pl. 7, fig. 2), but three pairs of caecal diverticula are visible, two issuing from the anterior lobe, and one from the middle portion of the anterolateral scar impressions (1-3 on Text-fig. 18).

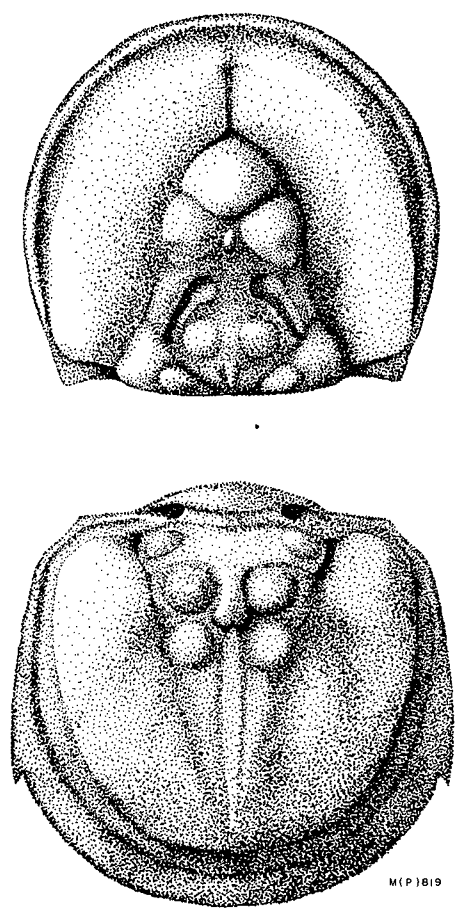


Fig. 18. ***Rhaptagnostus auctor*** **sp. nov.; parietal morphology, based on CPC 15071 (cephalon), x12, and CPC 15068 (pygidium), x14.**

The pygidium has similar shape to the cephalon, with length (Lp_2) 78-90% of the maximum width, which lies across the mid-point of the shield. Borders are wider (sag.) than in the cephalon, approximately 15% of the total length (Lp_2), and are likewise subdeliquiate. The pygidial acrolobe is only very gently constricted. On the exoskeleton (Pl. 7, fig. 8), transverse furrows and accessory furrows are effaced, and the axial furrows only weakly impressed. Parietally, the transverse furrows are very weakly impressed, and accessory furrows mostly obliterated, although a sack-like deuterolobe, obtusely rounded or even slightly pointed posteriorly, is visible sometimes. Transverse diverticula separating the muscle scar impressions of the anterior two segments of the pygidial axis, and intimately associated with the axial node, are visible on CPC 15067 (Pl. 7, fig. 7). Nine late holaspid metameres are in evidence from a count of muscle scar impressions and notulae. Pleural lobes are scrobiculate. Posterolateral spines lie well in front of the rear of the deuterolobe, and are hooked and laterally deflected. Articulating facets are not preserved.

Genus **Neoagnostus** Kobayashi, 1955

[=*Hyperagnostus* Kobayashi, 1955
=*Machairagnostus* Harrington & Leanza, 1957
?=*Euplethagnostus* Lermontova, 1940, which
=*Pseudorhaptagnostus* Lermontova, 1940]

Type species. Neoagnostus aspidoides Kobayashi (1955, pp. 473-4, pl. VII, fig. 5, *non* fig. 4 [=geragnostoid pygidium]; pl. IX, fig. 5 [line drawing], om the early Ordovician *Symphysurina* fauna, McKay Group, Harrogate area, British Columbia, Canada; by original designation.

Other species. Other species assigned to *Neoagnostus* have been considered elsewhere (Shergold, 1977A), and divided into four species groups based on *N. araneavelatus* (Shaw), *N. canadensis* (Billings), *N. clavus* (Shergold), and *N. bilobus* (Shaw). These groups have been previously defined and discussed (Shergold, 1975, 1977A).

Comments. The concept of *Neoagnostus* and the problems associated with its status are reviewed by Shergold (1977A). *Neoagnostus* is temporarily applied, pending adequate revision of the Russian genera *Pseudorhaptagnostus* and *Euplethagnostus* which are probable synonyms. Either of these would take priority over *Neoagnostus*.

Neoagnostus araneavelatus species group.

Nominal species. Pseudagnostus araneavelatus Shaw (1951, p. 113, pl. 24, figs. 12-16), Early Ordovician, *Missisquoia* Zone, Vermont, U.S.A.

En grande tenue to partly effaced pseudagnosti having subcircular, spectaculate cephala with subdeliquiate to deliquiate marginal furrows, generally effaced anterolateral glabellar and median preglabellar furrows, but with a tendency to develop prominent furrows at the back of the anterolateral lobes; and subcircular, non-plethoid, weakly deuterolobate pygidia, with non-deliquiate to subdeliquiate marginal furrows, spines situated close to a transverse line drawn across the rear of the deuterolobe, and possibly 8 late holaspid metameres.

Other species of this group previously recognised are listed by Shergold (1977A).

Neoagnostus greeni sp. nov.
(Pl. 9, figs. 1-12; Text-fig. 19)

Name. Named for R. Green Esq., manager of 'Chatsworth' Pastoral Property on behalf of Australian Estates Pty Ltd.

Types. Holotype, CPC 15078, cephalic exoskeleton, illustrated on Pl. 9, fig. 3; figured paratypes CPC 15079-15088; unfigured paratypes CPC 17314-17330.

Material. Based on fourteen cephala ranging in length (Lc) from 1.00-4.60 mm; and fourteen pygidia measuring (Lp_2) between 1.30 and 2.90 mm.

Occurrence. Horse Creek section, horizons K215, 216, 218, 220, 221, 223 and 225; BMR Boulia No. 6, 26.75-72.45 m; *N.* sp. aff. *greeni* occurs in BMR Duchess No. 13 between 69.45 and 79.30 m.

Age. Late Cambrian, *Wentsuia iota - Rhaptagnostus apsis* Assemblage-Zone.

Diagnosis. A semi-effaced, subdeliquiate, spectaculate, non-plethoid, weakly deuterolobate species of *Neoagnostus* with well developed cephalic fulcral spines.

Differential diagnosis. Neoagnostus greeni sp. nov. most closely resembles those species previously considered to represent the *araneavelatus* species group (Shergold, 1977A). Of these, *N. greeni* has greatest similarity with the Australian species *N. coronatus* (Shergold) (1975, pp. 85-7, pl. 6, figs. 1-6) and *N. denticulatus* (Shergold) (1975, pp. 87-9, pl. 8, figs. 1-5) from the *patulus/squamosa* and *bifax/denticulatus* Assemblage-Zones respectively at

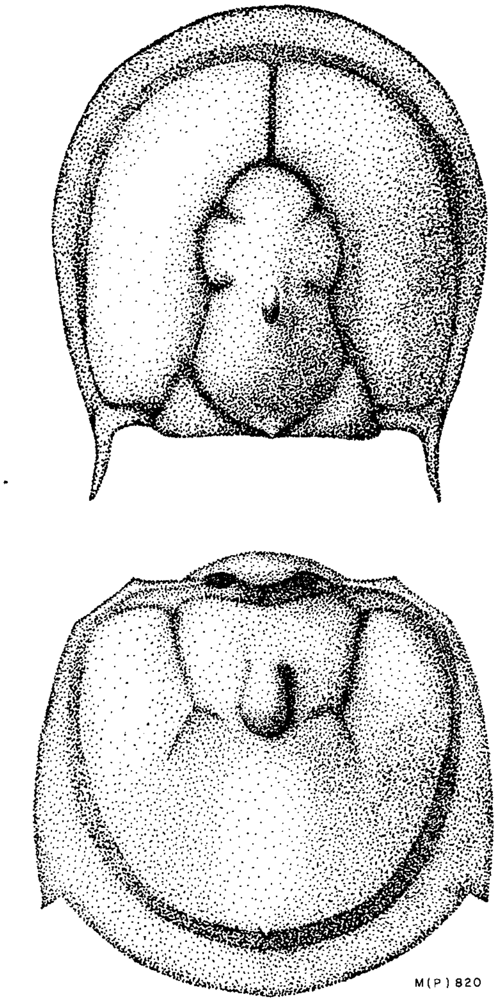


Fig. 19. *Neoagnostus greeni* **sp. nov.; principal exoskeletal morphology, based on CPC 15078 (cephalon), x24, and CPC 15086 (pygidium), x20.**

Black Mountain (Shergold, 1975). From both of these, *N. greeni* differs in having a longer (sag.) glabella in front of the axial node, and possessing a median preglabellar furrow parietally, albeit faintly. Pygidia of all Australian species are essentially similar. *N. araneavelatus* (Shaw) (1951, p. 113, pl. 24, figs. 12-16), from the early Ordovician *Missisquoia* Zone of Vermont, is distinguished by reticulate prosopon, and pygidial proportions. *N. greeni* is the oldest species presently assignable to the *araneavelatus* species group.

Description. Both exfoliated and partly exfoliated specimens are available, but little parietal morphology is apparent.

The cephalon is subrectangular, anteriorly obtusely rounded, with more or less equal length and width, and maximum width (tr.) at the level of the rear of the anterior glabellar lobe, well in front of the axial glabellar node. Borders are moderately wide, 8-12% of cephalic length (sag.) depending on preservation, and marginal furrows are subdeliquiate to non-deliquiate, also depending on preservation. The cephalic acrolobe is subquadrate with a faintly impressed median preglabellar furrow visible only on exfoliated specimens. When the exoskeleton is preserved, glabellar lobes and furrows are partly effaced; even on parietal surfaces they are poorly delineated, although a V-form anterior furrow is faintly indicated on some, and chevronate median lateral furrows on others. The axial node is strongly spectaculate. Furrows distinguishing the basal and posterior lobes are effaced on testaceous material, faintly but visibly present on exfoliated specimens. Parietal morphology is expressed, among the illustrated material, only on CPC 15080 (Pl. 9, fig. 4), which shows a scrobiculate cephalic acrolobe; no diverticula are seen. Long cephalic fulcral spines are developed from the posterolateral margins (Pl. 9, fig. 1).

Associated pygidia are more subcircular than subquadrate, with total length (Lp_1) approximating maximum width (Wp); (Lp_2) is 82-91% of the width. Borders are generally wider (sag.) than in the cephalon, 12-19% of the length (Lp_2), 11-17% of (Lp_1), and marginal furrows are generally non-deliquiate. The pygidial acrolobe is also more subcircular than subquadrate and is laterally only gently constricted. Axial furrows converge rearwards and are visible regardless of preservation, but transverse segmental furrows are invariably effaced, even that to the rear of the axial node, as are accessory furrows on all but the smallest specimens. The deuterolobe is also effaced, and has low convexity, but its shape is difficult to evaluate. Posterolateral spines are sited on a line across the rear of the deuterolobe in meraspides, but in advance of the rear of the deuterolobe in holaspides. The only parietal morphology visible (CPC 15085, pl. 9, fig. 9) is the possible scrobiculation of the pleural lobes. Articulating facets are steeply inclined, with prominent fulcral points, and the articulating half-ring is a simple bar.

Neoagnostus clavus species group

Nominal species. *Pseudagnostus clavus* Shergold (1972, pp. 31-4, pl. 3, figs. 1-8; 1975, pp. 84-5, pl. 8, figs. 6-12), Late Cambrian, *bifax/denticulatus* and *maximus/papilio* Assemblage-Zones, Black Mountain and Momedah, Boulia district, western Queensland, Australia.

En grande tenue to partly effaced pseudagnosti having subquadrate, spectaculate cephala, with subdeliquiate to deliquiate marginal furrows, prominent V-form anterolateral glabellar furrows, weakly chevronate furrows to the rear of the anterolateral lobes and rhomboid anterior lobes; and subquadrate to subovoid, non-plethoid to weakly plethoid, varyingly deuterolobate pygidia, with non-deliquiate to subdeliquiate marginal furrows, retrally sited pygidial spines, and 7-8 late holaspid metameres.

Species comprising the *clavus* group have been listed elsewhere (Shergold, 1977A).

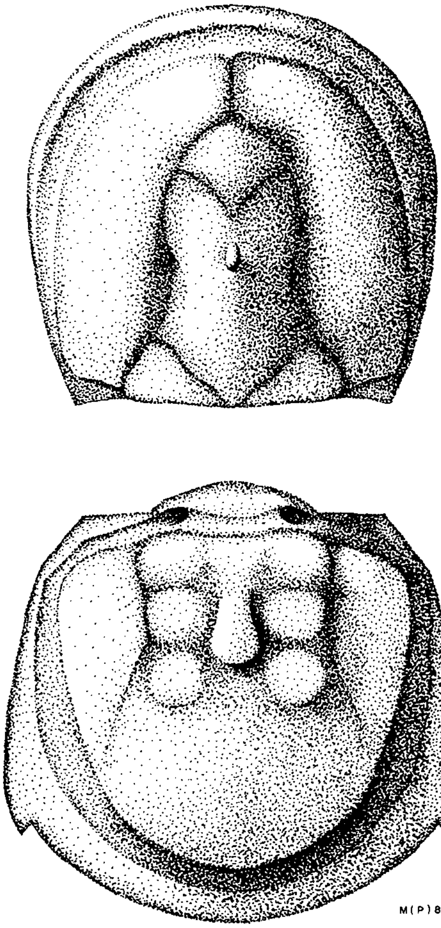


Fig. 20. ***Neoagnostus felix*** **sp. nov.; principal exoskeletal morphology, based on CPC 15092 (cephalon), x12, and CPC 15095 (pygidium), x14.**

Neoagnostus felix sp. nov.
(Pl. 8, figs. 1-9; Text-fig. 20)

Name. L. *felix,* happy; allusion of a smiling visage portrayed by the parietal glabellar morphology.

Types. Holotype, CPC 15092, exfoliated cephalon, Pl. 8, figs. 4-5; illustrated paratypes CPC 15089-15091, 15093-15096; non-illustrated paratypes CPC 17331-17336.

Material. The species is known from ten cephala measuring (Lc) between 1.40 and 4.80 mm, and five pygidia with lengths (Lp_2) from 2.70-4.20 mm.

Occurrence. Plains northwest of 'Chatsworth' at D124 and 669; section south of Horse Creek at K222, 223, and 225; and Lily Creek, at B54a, collected in 1957 from low in the sequence; BMR Boulia No. 6, 14.00-78.35 m.

Age. Late Cambrian, Assemblage-Zones of *Wentsuia iota - Rhaptagnostus apsis* and *Peichiashania secunda - Prochuangia glabella.*

Diagnosis. Externally partly effaced, deliquiate, non-plethoid *Neoagnostus* with strongly incised anterolateral and effaced median lateral glabellar furrows parietally.

Differential diagnosis. The morphology of *N. felix* is most closely comparable with that of members of the *clavus* species group (Shergold, 1975, 1977A), which have partly effaced test and strongly V-form anterolateral furrows defining the anterolateral muscle scar impressions parietally. Median lateral furrows defining the rear of these imptessions are mostly effaced, even parietally. *N. felix* has a subquadrate shield more anteriorly rounded than that of *N. clavus* (Shergold) (1972, pp. 31-4, pl. 3, figs, 1-8; 1975, pp. 84-5, pl. 8, figs. 6-12) from the Gola Beds at Momedah Creek and 'Chatsworth Limestone' at Black Mountain, and is further distinguished by the invariable presence of a median preglabellar furrow parietally, and a deuterolobe with higher relief. These latter features are shared with *Neoagnostus vulgaris* (Rosova) (1960, pp. 14-16, pl. 1, figs. 5-13) from the Orlina Mountains, Salair, USSR, and similar pygidial characteristics also occur in *N. cavernosus* (Rosova) (1960, pp. 12-14, pl. 1, figs. 1-4) from the same locality. In all three species the rear of the deuterolobe tends to become pointed. Cephalically, the specimen from the *Elvinia* Limestone of Mount Hunter, British Columbia, described by Kobayashi (1938, pp. 173-4, pl. XV, fig. 4) as *Homagnostus* cfr. *acutus,* is closely comparable to *N. felix.*

N. felix is distinguished by shield shape from members of the *araneavelatus* species group, by the style of its glabellar furrowing from the *bilobus* group, and by its non-plethoid accessory furrows from that of *N. canadensis.*

Description. The species is described mainly from exfoliated and partly exfoliated specimens. The latter are sufficient to assess the degree of effacement of the exoskeleton. Parietal morphology is mainly observed in the pygidium.

The cephalon is rounded subquadrate, with approximately equal length (Lc) and width (Wc), and is widest (tr.) across the middle of the anterior glabellar lobe. Cephalic borders occupy 10-12% of the total length (assessed on exfoliated specimens); marginal furrows are narrow (sag.) and deliquiate on both test and mould. The cephalic acrolobe is ovoid, unconstricted laterally, and sagittally is externally only proximally divided by a median preglabellar furrow. On the exoskeleton, glabellar furrowing and lobation are partly effaced. Parietally significant features are the deeply incised V-form anterolateral furrows defining the anterior margins of the anterolateral muscle scar impressions, and accordingly, the rhomboid anterior lobe. Furrows defining the rear of these muscle scar impressions are very faint. The posterior lobe is slightly constricted behind the anterolateral muscle impressions, and clearly separated from the basal lobes, which are laterally extensive. The axial glabellar node has a strongly spectaculate condition. Nothing is known of the extent of other muscle scar impressions, or of the caecal system of the cephalon.

The pygidium is rounded subquadrate to subrectangular, becoming apparently longer during holaspid morphogenesis; length (Lp_2) varies between 84 and 89% of the width (Wp) for four late holaspides. The maximum width (tr.) lies a little way in front of the posterolateral spines, which themselves lie on a transverse line across, or slightly in front of, the rear of the deuterolobe. Pygidial borders, which vary from 11-18% of the total length (Lp_2) and carry deliquiate marginal furrows, are particularly wide posterolaterally. The pygidial acrolobe is basically subtriangular with constricted flanks and bluntly pointed posterior. Axial and transverse segmental furrows are visible parietally but both tend to be effaced externally. Faint accessory furrows indicate a saccate, transversely narrow, tumid deuterolobe, often posteriorly pointed in late holaspides. Pleural lobes are exsagittally long and parietally scrobiculate. Eight metameres are indicated from a count of muscle scar impressions and notulae. As with other species of *Neoagnostus,* the third pair of muscle scar impressions is as large and clearly defined as those of the first two metameres. Articulating facets have high inclination, and the fulcra bear small points.

Species not assigned to species groups

Neoagnostus sp. I.
(Pl. 10, figs. 7-10)

Material. Four cephala and seven pygidia; cephala are insufficiently complete to measure, but pygidia vary in length (Lp_2) between 1.40 and 2.70 mm. Specimens CPC 15097-15100 are illustrated; CPC 15101, 17337-17342 are unfigured.

Occurrence. Lily Creek section, horizon K208, 144 m from the base of the measured section; and possibly B791c.

Age. Late Cambrian, Assemblage-Zone of *Peichiashania tertia* with *P. quarta.*

Comments. Neoagnostus sp. I represents an imperfectly known taxon which has subquadrate shields and is externally partly effaced. Parietal surfaces illustrated on Pl. 10 have reasonably narrow (sag.) borders with subdeliquiate marginal furrows; cephalic acrolobe divided by a median preglabellar furrow; glabella with more deeply incised anterolateral furrows; and pygidium with effaced deuterolobe. One fragment (CPC 15101, not illustrated) possesses long cephalic fulcral spines.

Neoagnostus sp. I probably belongs to the *clavus* species group, but is distinguished from *N. clavus* by the possession of a median preglabellar furrow and less quadrate pygidial shape. Cephalic shape, and the depressed deuterolobe, distinguish this species from *N. felix* sp. nov. described above.

Neoagnostus sp. II
(Pl. 10, figs. 11-12)

Material. A single cephalon, CPC 15102, length (Lc) 2.30 mm, and a pygidial fragment, CPC 15103, both illustrated.

Occurrence. Lily Creek section, horizon K212, 254 m from the base of the measured section.

Age. Late Cambrian, *Hapsidocare lilyensis* Assemblage-Zone.

Comments. This taxon represents an externally partly effaced, narrow bordered, non-deliquiate species of *Neoagnostus* with subquadrate cephalon. It lacks a median preglabellar furrow, and the glabellar furrowing is extremely weak. The shape of the pygidium is not known.

Neoagnostus sp. II presumably also belongs to the *clavus* group; its cephalon is similar to that of *N.*

clavus (Shergold) (1972, pp. 31-4, pl. 3, figs. 1-8), particularly to the exoskeletons described from Black Mountain (Shergold, 1975, pp. 84-5, pl. 8, figs. 6-12). Absence of a median preglabellar furrow separates the species from other *Neoagnostus* taxa described here. The vagueness of the glabellar furrowing prohibits accurate classification of this species.

Order **PTYCHOPARIIDA** Swinnerton, 1915
Suborder **PTYCHOPARIINA** Richter, 1933
Superfamily **PTYCHOPARIACEA** Matthew, 1887
Family **EULOMIDAE** Kobayashi, 1955
Subfamily **EULOMINAE** Kobayashi, 1955

Comment. Eulominae was proposed as a new subfamily of Ptychopariidae by Kobayashi (1955, p. 449), and was recognised as such by Rasetti (*in* Moore, 1959, p. 233). Öpik (1963, pp. 84-85) has argued that *Euloma* and its allies cannot be accommodated in Ptychopariidae without modifying the concept of that family. He has proposed that Kobayashi's Eulominae be regarded as a subfamily of Eulomatidae. This name is a corrected form of Eulominae based on grammatical construction derived from the Greek $\lambda\omega\mu\alpha,\text{-}\alpha\tau o\varsigma$. Following this reasoning the subfamilial name should be Eulomatinae. ICZN Article 29d, amended 1972, states, however, that family-group names proposed before 1961 based on incorrectly formed stems are not to be amended if the name is in general use, so that although Öpik was grammatically correct in his revision, I have reverted here to the form derived from Kobayashi's original subfamily name.

Genus **Plecteuloma** Shergold, 1975

Type species. Euloma (Plecteuloma) strix Shergold (1975, pp. 96-98, pl. 30, figs. 1-8), from the *Rhaptagnostus clarki patulus/Caznaia squamosa* Assemblage-Zone, Black Mountain, western Queensland, Australia; by original designation.

Comment. Originally conceived as a subgenus of *Euloma* Angelin, 1854, because of similarity to *Euloma (Proteuloma)* Sdzuy, 1955, *Plecteuloma* is now considered a distinct genus. *Plecteuloma* is thought to form with *Duplora* Shergold, 1972, and *Iveria* gen. nov., a generic complex which is localized in the Australian region during the Late Cambrian, and is geographically isolated from both a Siberian Late Cambrian complex represented by *Dolgeuloma (Dolgeuloma)* Rosova, 1963, *Pseudoacrocephalites* Maximova, 1962, *Lopeuloma* Rosova, 1968, and *Loparella* Rosova, 1968, and an Early Ordovician one comprising *Euloma (Euloma)* Angelin and *E. (Proteuloma)* Sdzuy in Europe.

Plecteuloma strix Shergold, 1975
(Pl. 13, figs. 11-13)

1975 *Euloma (Plecteuloma) strix* subgen. et sp. nov.: Shergold, 1975, pp. 96-8, pl. 30, figs. 1-8, text-fig. 42 [CPC 11835-41]

Types. The holotype is the cranidium, CPC 11835, figured Shergold, 1975, pl. 30, figs. 1-2; figured hypotypes are CPC 15324-15326; unfigured hypotypes CPC 17343, 17344.

Material. Additional material includes five cranidia with lengths, as far as can be assessed, between 4.50 and 5.70 mm, and a single librigena.

Occurrence. Additional material occurs at Lily Creek, horizon K212, 254 m from the base of the measured section.

Age. Late Cambrian, *Hapsidocare lilyensis* Assemblage-Zone.

Comments. As the new material is virtually indistinguishable from the type paradigm, falling well within the variation observed among previously illustrated material (Shergold, 1975, pl. 30), it is considered unnecessary to describe the hypotype material further herein.

Genus **Iveria** gen. nov.

Name. From the Parish of Iver, in the County of Windsor, western Queensland. *Iveria* has a feminine gender.

Type species. Iveria iverensis gen. et sp. nov. from the Chatsworth Limestone at Lily Creek, western Queensland; designated herein.

Diagnosis. Eulominae with elaborate anterior cranidial border, comprising a gently convex false border in front of a pitted marginal furrow, separated from an upturned anterior rim by a prominent, wide (sag.), shallow sulcus. The lateral librigenal border bears similar structures.

Comments. The morphology of the glabella, preglabellar field, ocular ridges, palpebral lobes and posterolateral limbs of *Iveria* is essentially comparable to that of *Plecteuloma* Shergold, 1975, the modified anterior cranidial and librigenal borders alone serving to distinguish cranidia of these genera. *Duplora* Shergold, 1972, has a similarly modified anterior cranidial border, but represents a more advanced condition in the duplication of a marginal cranidial rim (see Fig. 21 for comparisons). Insufficient pygidial material is available to permit an adequate comparison of pygidia of these genera. All,

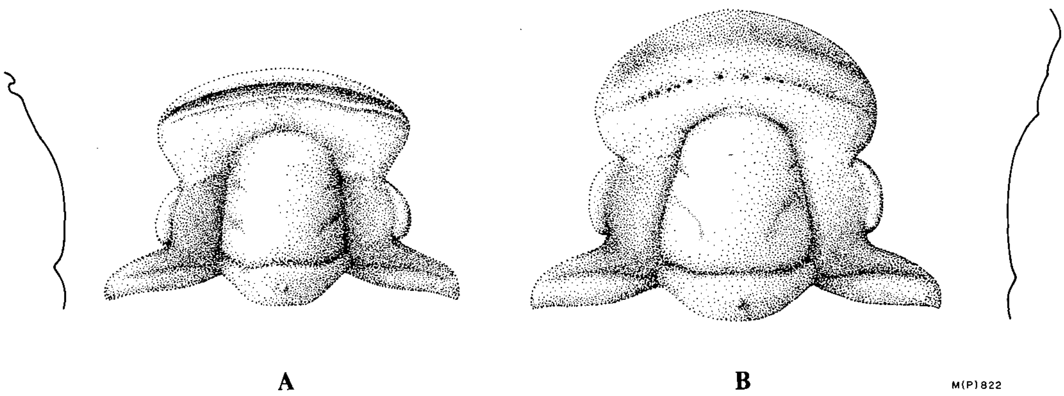


Fig. 21. Comparison of the cranidial morphology of A) *Duplora clara* **Shergold, 1972, based on CPC 9777a, x11, and B)** *Iveria iverensis* **gen. et sp. nov., based on CPC 15321, x7.5.**

however, appear to be micropygous. *Plecteuloma, Duplora* and *Iveria* are here classified together in the Subfamily Eulominae Kobayashi, 1955.

At first sight the anterior cranidial border, with its distinctive central transverse sulcus, resembles that of several previously described genera, e.g. *Maduiya* Rosova, 1963 (? = *Maspakites* Lazarenko, 1968), *Kaninia* Walcott & Resser, 1924, and various Pterocephaliinae (*sensu* Palmer 1965), but these lack the pitted anterior cranidial marginal furrow so prominent in *Iveria* and other Eulominae.

Iveria iverensis gen. et sp. nov.
(Pl. 13, figs. 1-10; Text-fig. 21B)

Name. Derived from the Parish of Iver, in the County of Windsor, western Queensland.

Types. The holotype is a silicified cranidium with attached thoracic segments, CPC 15317, Pl. 13, figs. 1-2; figured paratypes are CPC 15318-15323; unfigured paratypes CPC 17345-17392.

Material. Forty-one cranidia and cranidial fragments ranging in length between 2.70 and 7.30 mm; eight librigenae; four pygidia with lengths (Lp_2) from 1.30-1.90 mm.

Occurrence. Lily Creek, horizons K201, 204, 205, 206, 210, B50b, 50c, 51, 52, 53, and 54b, 49-186 m from the base of the measured section.

Age. Late Cambrian, Assemblage-Zones of *Peichiashania secunda - Prochuangia glabella* and *Peichiashania tertia - P. quarta.*

Diagnosis. The generic diagnosis is based on the characteristics of this species.

Differential diagnosis. As indicated above, *Iveria iverensis* sp. nov. is closely comparable with *Euloma (Plecteuloma) strix* Shergold (1975, pp. 96-8, pl. 30, figs. 1-8) in its glabellar and ocular characteristics. In *Iveria,* the anterior cranidial border is extended forwards and transversely furrowed in the centre, and this furrow continues along the lateral librigenal border, thus distinguishing the new genus from *Plecteuloma.* Pygidia of *I. iverensis* and *P. strix* are similarly small and transverse: that of *Plecteuloma* has a slightly more sinuous posterior margin, and the pygidium of *Iveria* is more evenly rounded.

Cranidially, *Iveria iverensis* is similar also to *Duplora clara* Shergold (1972, pp. 73-4, pl. 16, figs. 3-7), both having modified anterior cranidial borders. In *D. clara,* however, the central furrow which traverses this border is deep and wide (sag.), so that the anterior edge of the border appears dissociated from the remainder of the cranidium. The posterior edge of this furrow in *Duplora clara* is raised into a 'preglabellar rim' (Shergold 1972, p. 74).

Description. The articulated cephalon of *Iveria iverensis* (Pl. 13, figs. 1-6) is semicircular in plan view, and gently vaulted when observed anteriorly: in lateral aspect the genal spines lie parallel to the dorsal plane of the tagma.

The glabella is broad-based, tapers forwards, and is anteriorly gently rounded, occupying (G) 49-59% of the total cranidial length (Gn is 63-72%). Its furrows are totally effaced on silicified specimens, as they mostly are on specimens in which the shell is preserved. Exfoliated specimens, or those in which the shell is largely dissolved, show traces of three pairs of glabellar furrows: the preoccipital ones are curved adaxially and rearwards, and may be weakly bifurcated; the median lateral ones are transverse, gently curved, and very faint - often only pits or notches on the glabellar flanks; and the anterior lateral furrows, when seen, are similar to the median lateral ones, but shorter (tr.).

The occipital ring is of equal transverse width to the preoccipital glabellar lobes. Its leading edge is anteriorly bowed sagittally, and posteriorly bowed on either side. In lateral profile it lies at the same level as the dorsal surface of the glabella. A faint median occipital node is present.

The preocular sections of the facial suture are sigmoidal; initially they diverge forwards at angles between 40-80° (depending on preservation), then swing in a broad arch towards the sagittal line, which they would meet at about 100° if their courses were projected. The preocular facial sutures enclose a preglabellar area, 28-38% of the total cranidial length (sag.), which comprises a moderately convex (sag.) preglabellar field (32-55% of the length of the preglabellar area), a prominent marginal furrow which bears a variable number of pits which decrease in size abaxially, and an anterior cranidial border occupying 14-23% of the cranidial length (sag.). This border is itself divided into a gently convex posterior roll, a wide and shallow (sag.) transverse furrow which runs parallel to the normal anterior cranidial marginal furrow, and a narrow flat rim which is arched gently forwards. Postocular sections of the facial suture are transversely gently sigmoidal, and enclose blade-like posterolateral limbs. The palpebral lobes lie between the middle of the preoccipital glabellar lobes and the median lateral furrows, thus occupying 42-65% of the glabellar length (G) (33-51% of Gn). They are gently arcuate and somewhat elevated above flat or gently convex (tr.) palpebral areas. Posteriorly, the palpebral lobes are separated by a distance approximately two-thirds their length from the axial furrows. Anteriorly, they merge into faintly visible duplicated slightly oblique ocular ridges which contact the axial furrows just in front of the anterior lateral glabellar furrows. At the confluence, a pit is formed in the floor of the axial furrow in the posterior angle of intersection. A second pit forms at the anterior angle, at the anterolateral corner of the glabellar. On some specimens the anterior ocular ridge is seen to pass around the anterolateral edge of the glabella and reappear in the floor of the preglabellar furrow as a parafrontal band. Caeca radiate forwards from the ocular ridges across the preglabellar field and pass onto the posterior portion of the anterior cranidial border.

Specimens on which the librigena is attached bear an eye socle and visual surface. Unfortunately, these specimens are without exception silicified, and no details of the visual facets remain. The librigena has a narrow (tr.) genal field and short (tr.) posterior border. The lateral border bears a continuation of the transverse furrow which divides the anterior canidial border. On the librigena this continues for some distance into the base of the genal spine, which is broad-based, moderately long, and carries the curvature of the lateral cephalic margins straight backwards.

Several specimens have articulated thoracic segments: ten partly enrolled thoracic tergites are attached to CPC 15319 (Pl. 13, figs. 5-6). Thoracic pleurae are characterised by oblique pleural furrows and prominent articulating facets, and appear to have possessed blunt spines. The axial rings bear prominent median nodes (Pl. 13, fig. 6).

The pygidium is small, semielliptical, and gently vaulted, with length (Lp_2) 32-38% of the maximum width (tr.). The axis is short (sag.), bluntly rounded posteriorly, and fails to contact the posterior marginal furrow; there is no post-axial ridge. A single segment is well defined, but a second is apparently fused to the terminal piece. Only the anteriormost pair of pleural furrows is well defined although a second pair is faintly present. The distal ends of the first pair of pleural furrows become confluent with the marginal furrow at the sharply angled anterolateral corners of the shield. A flat posterior border with entire, but slightly sinuous, margins encircles the pygidium.

The external prosopon of *Iveria iverensis* is smooth, save for the presence of concentric terrace lines along the leading edges of the anterior cranidial border and lateral librigenal border, along the adaxial edge of the genal spine, and along the posterior margin of the pygidium.

Morphological variation. The specimens illustrated on Plate 13 show a range of variation in the morphology of their preglabellar areas. Specimens CPC 15317-19, figs. 1, 3, 5 (Lc 3.60-5.40 mm), have apparently shorter (sag.) anterior cranidial borders, and there is further variation in the extent of the transverse furrow which divides this border, particularly when compared to such specimens as CPC 15320-21, figs. 7-8 (Lc 5.50-6.60 mm). At least some of this variation can be attributed to preservation: specimens CPC 15317-19 are silicified replicas, whereas CPC 15320-21 are preserved as exfoliated and partly exfoliated exoskeletons respectively. The silicification process tends to obscure furrows, and generally obliterate relief. The material may represent two species, but since it is not possible to adequately differentiate them, the complete paradigm is regarded as a single taxon.

Superfamily **DIKELOCEPHALACEA** Miller, 1889
Family **DOKIMOCEPHALIDAE** Kobayashi, 1935
Subfamily **WUHUIINAE** subfam. nov.

Dokimocephalidae Kobayashi, 1935, is developed from Dokimocephalinae Kobayashi, 1935, originally proposed as a subfamily of Solenopleuridae Angelin, 1854. According to Kobayashi (1935C, p. 269), Dokimocephalinae comprised *Acrocephalites* Wallerius, 1895, *Burnetia* Walcott, 1924, *Dokimocephalus* Walcott, 1924, *Iddingsia* Walcott, 1924, and *Elkia* Walcott, 1924. These genera, spanning a considerable time interval, appear to be united by a long anterior cranidial border which may be drawn into a spine. More recently, Palmer (1965) has referred Dokimocephalinae to the family Elviniidae Kobayashi, 1935, which is regarded (Palmer, 1965, p. 33) as 'a group of trilobites logically related on the basis of stratigraphy, morphology, and biology'. Palmer's Dokimocephalinae are 'Elviniidae having glabella generally strongly rounded at front, posterior furrows generally well defined, directed obliquely backwards'. *Apachia* Frederickson, 1949, *Dokimocephalus* Walcott, 1924, *Iddingsia* Walcott, 1924, *Kindbladia* Frederickson, 1948, and *Pseudosaratogia* Wilson, 1951, are the included genera. Thus constituted, with the inclusion of *Burnetiella* Lochman, 1958 (=*Burnetia* Walcott, 1924), the Subfamily Dokimocephalinae has a late Dresbachian and early Franconian age in North America. Its genera are phylogenetically related.

In this paper, Dokimocephalinae is preserved as a subfamily of Dokimocephalidae (Superfamily Dikelocephalacea); dokimocephalid morphologies are thus removed from association with the Elviniidae, here considered referable to the Olenacea Burmeister, 1943.

Phylogenetic relationship also appears to exist between Australo-Asiatic trilobites formerly classified as Anomocaridae Poulsen, 1927, Conocephalinidae Walcott, 1913, Crepicephalidae Kobayashi, 1935, Dokimocephalidae Kobayashi, 1935, and Ptychaspididae Raymond, 1924, *viz, Lorrettina* Shergold, 1972, *Saimachia* Kobayashi, 1937, and *Wuhuia* Kobayashi, 1933. Species of this group, morphologically united by a common pattern of glabellar furrowing and shape, preglabellar area, and similarly shaped and segmented pygidium, form a phylogenetic lineage during late Idamean (Paishanian) to Paytonian (Fengshanian/Yenchouan) time. The new subfamily Wuhuiinae, with type genus *Wuhuia* Kobayashi, 1933, is therefore proposed for these genera in Australia and Asia, as a complement to the Dokimocephalinae (as constituted above) in North America. Genera such as *Protemnites* Whitehouse, 1939, and *Prismenaspis* Henderson, 1976, may represent early members of this subfamily.

Wuhuiinae are Australo-Asiatic Dokimocephalidae with anteriorly bluntly rounded or truncate glabellae; posteriorly directed and bifurcated preoccipital glabellar furrows; moderate to long (exsag.) palpebral lobes situated close to the axial furrows; generally sagittally anteriorly bowed anterior cranidial marginal furrows; and transverse subtrapezoidal to semicircular non-spinose pygidia of two or three segments, whose anteriormost pleural furrow is confluent with the pygidial marginal furrow.

Genus **Wuhuia** Kobayashi, 1933

Type species. Solenopleura belus Walcott (1905, p. 90, =*Conocephalina belus* (Walcott), Walcott 1913, p. 138, pl. 13, figs. 12, 12a), from the lower Chaumitien Limestone, 25ft below the top of Pagoda Hill, Tsinan, Shantung, China; designated Kobayashi (1933, p. 145).

Other species. See Shergold (1975, p. 105).

Comments. Opinions on the classification of *Wuhuia* have been given in an earlier paper (Shergold, 1975, p. 106). *Wuhuia* represents an Asian/Australian dokimocephalid closely related to *Saimachia* Kobayashi, 1937, from Manchuria, and the lineage of *Lorrettina* species in Australia. *Wuhuia* differs from *Lorrettina* because its glabella is not laterally swollen but is more or less straight-sided, tapering gently forwards; and because it possesses a wide, well defined evenly arcuate and sagittally non-interrupted anterior cranidial marginal furrow. Additionally, *Wuhuia* possesses a gently reflected anterior cranidial border, and its preglabellar field is only very gently convex (sag.) or flat, forward-sloping. *Saimachia* (as illustrated by Schrank, 1975, pl. 3, figs. 3-6) has a more anteriorly tapered glabella and longer (exsag.), more arcuate palpebral lobes which pass anteriorly into strong transverse ocular ridges. Pygidia referred to *Saimachia* (Schrank, 1975, pl. 3, figs. 4-5) are transverse, with poorly defined arcuate borders, and look different from that assigned by Walcott (1913, pl. 13, fig. 12a) to *W. belus* (Walcott). This specimen shows a poorly defined border only parietally: the overall impression is that it is a pagodiid pygidium, even though its granulose prosopon matches that of the holotype cranidium *(loc. cit.*, fig. 12).

Librigenal morphology closely resembles that of *Lorrettina,* and North American dokimocephalids such as *Kindbladia* and *Apachia* (see Palmer, 1965, pl. 3).

Wuhuia silex sp. nov.
(Pl. 16, figs. 1-10; Text - fig. 22)

Name. L. *silex,* silica, referring to the fact that the majority of specimens assigned to this species are silicified.

Types. The holotype is CPC 15289, an imperfect silicified cranidium illustrated on pl. 16, figs. 2, 6; CPC 15288, 15290 - 15294 are illustrated paratypes; CPC 17393 - 17411 are unfigured paratypes.

Material. Fragments of nineteen cranidia, those assessable measuring (Lc) between 4.30 and 6.70 mm, and seven librigenae.

Occurrence. Lily Creek, horizons K204, 205, 208, B50a, and B53, 69-144 m from the base of the measured section.

Age. Late Cambrian, Assemblage-Zones of *Peichiashania secunda - Prochuangia glabella* and *Peichiashania tertia - P. quarta.*

Diagnosis. An apparently non-granulose *Wuhuia* species with effaced glabellar furrows and gently convex (sag.) preglabellar field.

Differential diagnosis. Wuhuia silex sp. nov. differs from *W. belus* (Walcott), *W. belus* (Walcott) *sensu* Kobayashi (1933, p. 145, pl. XV, fig. 1), and *W.* sp. cf. *W. dryope* (Walcott) *sensu* Shergold (1975, p. 106, pl. 52, figs. 8-9) by its apparent lack of granulosity. Although external prosopon might be expected to be effaced due to silicification, some specimens from locality K208 preserved in limestone are also non-granulose. *Wuhuia dryope* (Walcott) (1905, p. 78; 1913, pp. 138-9, pl. 13, figs. 11, 11a, *non* fig. 11b) is said to be non-granulose, but is preserved as a mould. The effacement of the glabellar furrows in *W. silex* sets it apart from all previously described species. In terms of glabellar shape, arrangement of the preglabellar area, and palpebral morphology, it is comparable with *W. dryope* (Walcott).

Wuhuia silex also appears to closely resemble *Saimachia damesi* Kobayashi (1937A, p. 114, pl. 17, fig. 16; Schrank, 1975, pp. 596-7, pl. 3, figs. 3-6; =*Anomocare latelimbatum* Dames, 1883, pp. 14-5, pl. 2, fig. 16) in its cranidial organization and proportions. The cranidium of *Saimachia,* however, is *en grande tenue,* its palpebral lobes are a little larger (exsag.), and its ocular ridges are quite clearly visible. The pygidium of *S. damesi,* as interpreted by Schrank (1975, pl. 3, figs. 4-5), is scarcely distinguishable from that assigned here to *Lorrettina depressa* sp. nov.

Description. The glabella of *Wuhuia silex* is more or less straight-sided (some specimens bulge gently at the preoccipital lobes), evenly tapered forwards, and anteriorly truncate. It occupies 54-62% of the total cranidial length (sag.). Glabellar furrows are almost completely effaced on the exoskeleton, mere traces of sigmoidal preoccipital furrows remaining on some specimens, and occasionally extremely faint transverse median lateral furrows. A small notch occurs on each side of the glabella opposite the point at which the ocular ridge intersects the axial furrow.

The occipital ring is narrow (sag.), but transversely wider than the preoccipital glabellar lobes. In lateral profile it does not rise significantly above the dorsal surface of the glabella. The presence or absence of an occipital node cannot be confirmed.

The preglabellar area in anterior profile is nonvaulted. It comprises a very gently convex (sag.) forward-sloping preglabellar field, a wide shallow prominent and evenly arcuate cranidial marginal furrow, and a gently reflected anterior cranidial border, which has a similar length (sag.) to the preglabellar field. Preocular sections of the facial suture diverge forwards at angles of 70-80 degrees; postocular sections enclose long (tr.), strap-like posterolateral limbs. The palpebral lobes, occupying 55-66% of the glabellar length (G), are arcuate, relatively close to the axial furrows, and extend from the middle of the preoccipital glabellar lobes to the expected position of the anterior lateral glabellar furrows. The ocular ridges are very faint, short and oblique. The width (tr.) of the preglabellar area is approximately equal to that between the palpebral furrows.

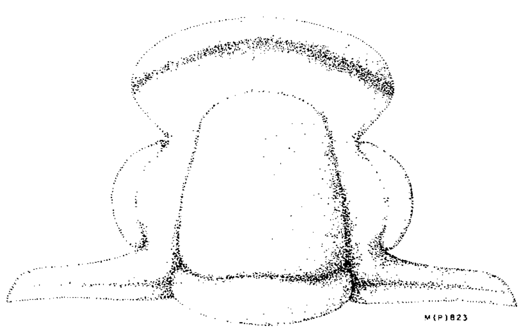


Fig. 22. Cranidial reconstruction of *Wuhuia silex* sp. nov., based on CPC 15288, x8.

Little is known of cranidial parietal morphology. Vague impressions of the muscle scars can be seen on non-silicified exfoliated material (Pl. 16, fig. 9), on which a prominent sagittal keel may also be observed. On one specimen at least, Pl. 16, fig. 1, a raised diverticular structure is observed lying sagittally in the anterior cranidial marginal furrow, but no caeca are associated.

Wuhuia silex has dokimocephalid librigena with short anterior prong, short deflected genal spine, appreciably convex (tr.) genal field, and prominent subocular groove and lateral marginal furrow. On most exfoliated specimens a principal caecal vein is observed, directed towards the genal angle. Caeca radiate from a presumed eye socle, cross the subocular groove, genal field, and lateral marginal furrow, and merge into the lateral border. The specimen illustrated, CPC 15292, is thick-shelled (Pl. 16, fig. 5).

The hypostoma and pygidium are presently unknown.

Genus **Lorrettina** Shergold, 1972

Type species. Lorrettina macrops Shergold (1972, pp. 68-9, pl. 17, figs. 1-4; 1975, pp. 104-5, pl. 53, figs. 1-8), *prolatus/sectatrix* through *bifax/denticulatus* Assemblage-Zones, 'Chatsworth Limestone', Black Mountain; *maximus/papilio* Assemblage-Zone, Gola Beds, Momedah Creek, western Queensland; by original designation.

Other species. Pagodia mina Endo (1944, p. 63, pl. 8, fig. 5), =*Wuhuia(?) mina* (Endo) (*in* Lu *et al.*, 1965, p. 437, pl. 85, fig. 17), Paishan formation?, Lashushan, Laohushan, Kuantung, Manchuria.

Comments. Based on four imperfectly preserved cranidia, the original diagnosis and concept of *Lorrettina* is in need of revision and amplification, as species are now known from Black Mountain, Momedah Creek and Lily Creek in western Queensland. It was originally stated (Shergold, 1972, p. 67) that the palpebral lobes are anteriorly sited, whereas in actual fact, as in *Wuhuia* and *Saimachia,* they are relatively long (exsag.), and situated close to the axial furrows about the mid-point of the glabella. *Lorrettina* has an anteriorly gently tapered glabella, bluntly rounded at the front, with a tendency to expand laterally at the preoccipital furrows. The glabellar furrows are generally well defined, especially the preoccipital ones, which are characteristically sigmoidal and bifurcated. The preocular facial sutures are widely divergent, as are the postocular ones which enclose long (tr.), strap-like posterolateral limbs. In lateral profile the preglabellar field may be gently convex (sag.) or flat, sloping appreciably forwards; the glabella has variable convexity (sag.). The pygidium of all species is similar; it is subtrapezoidal, the posterolateral margin more or less arcuate, and has a short axis with only two well defined segments (a third is poorly defined), and two pleural segments as indicated by pleural furrows. Posteriorly, the pygidium may be gently indented.

Species differ on the proportionate length of preglabellar field and cranidial border and the orientation of the latter, the course of the anterior cranidial marginal furrow, degree of glabellar inflation, and degree of pygidial transversality.

Lorrettina depressa sp. nov.
(Pl. 14, figs. 1-10, Text - fig. 23)

Name. L. *depressa,* f., depressed, flat, referring to the low degree of vaulting of the cranidium when viewed anteriorly.

Types. The holotype is cranidium CPC 15279, pl. 14, fig. 6; figured paratypes are CPC 15280 - 15287; unfigured paratypes are CPC 17412 - 17428.

Material. Twenty-three cranidial fragments with lengths (sag.) measuring 3.00 - 12.30 mm, one librigena, and 2 pygidia.

Occurrence. Chatsworth Plains, locality D124; Horse Creek, horizons K222 and D668; Lily Creek, horizons K201, 204, 206, 207, 208 and B53, 49-144 m from the base of the measured section; BMR Duchess No. 13, 35.50 - 36.70 m.

Age. Late Cambrian, Assemblage-Zones of *Wentsuia iota - Rhaptagnostus apsis, Peichiashania secunda - Prochuangia glabella,* and *Peichiashania tertia - P. quarta.*

Diagnosis. Lorrettina species with low degree of glabellar convexity when viewed laterally; subrectangular glabella not appreciably laterally expanded; externally partly effaced glabellar furrows; anterior cranidial marginal furrow bowed forwards sagittally on most specimens.

Differential diagnosis. Although its glabella is less inflated (tr., sag.), and its glabellar furrows more greatly effaced, *Lorrettina depressa* morphologically closely resembles *L. macrops* Shergold (1972, pp. 68-9, pl. 17, figs. 1-4; 1975, pp. 104-5, pl. 53, figs. 1-8), the type species. Cranidia also resemble that which Endo (1944, p. 63, pl. 8, fig.5) described as *Pagodia mina* (=*Wuhuia mina* (Endo), Lu *et al.*, 1965, p. 437, pl. 85, fig. 17) from Kuantung, Manchuria. *L. depressa* differs from both these species in that its palpebral lobes are situated further from the axial furrows. Its pygidium differs from

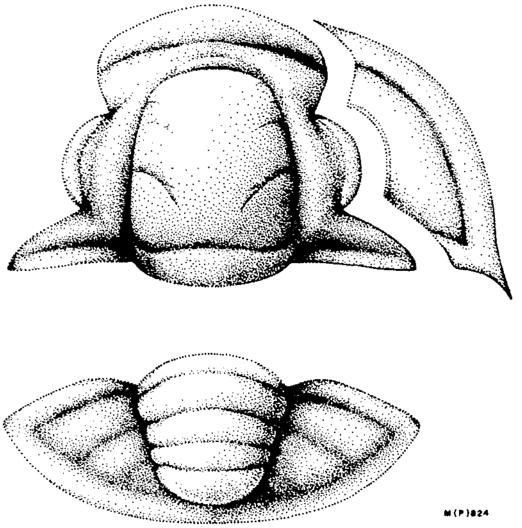


Fig. 23. ***Lorrettina depressa*** **sp. nov.; exoskeletal reconstruction based on CPC 15282 (cranidium), x4, CPC 15285 (librigena), x4, and CPC 15286 (pygidium), x16.**

that of *L. macrops* and *L. licina* sp. nov. in being shorter (sag.) and more transverse.

Description. The cranidium of *Lorrettina depressa* has an anteriorly bluntly rounded subovoid glabella, 57-67% (G) of the total cranidial length (sag.), and widest (tr.) at the preoccipital furrows. Two pairs of glabellar furrows are observed, but are generally not deeply incised; a third, anterior, pair is only faintly visible. The preoccipital furrows are posteriorly directed and sigmoidal on the exoskeleton, but sigmoidal and bifurcated on parietal surfaces.

The median lateral furrows are transverse or gently curved posteriorly, according to the convexity of the glabella. When visible, the anterior lateral furrows are similar to the preceeding. Definition of the glabellar furrows depends to a large extent on preservation: silicified replicas and specimens with thick dorsal exoskeleton are frequently partly effaced. On parietal surfaces (Pl. 14, fig. 8) the preoccipital furrows, in particular, are seen to be branched, outlining multiple muscle scar impressions. The median lateral furrows outline single muscle scars.

When viewed both anteriorly and laterally (Pl. 14, figs. 4-5), *L. depressa* has low convexity. The occipital ring is narrow (sag.), but slightly wider than the preoccipital glabellar lobes, and is not raised above the dorsal surface of the glabella. A faint occipital node is sometimes seen.

The preocular facial sutures diverge forwards at angles generally less than 40 degrees, and enclose a preglabellar area which comprises a gently convex (sag.) preglabellar field and similarly convex (sag.) anterior cranidial border, one-half to two-thirds the length (sag.) of the preglabellar area. Sagittally the anterior cranidial marginal furrow is characteristically bowed forwards. On the same specimens the preglabellar field is ridge-like, the plication presumably representing an underlying diverticulum or dorsal expression of the parafrontal band (Pl. 14, figs. 2-4). The width (tr.) of the preglabellar area is approximately equal to the cranidial width (tr.) between the palpebral furrows. The postocular facial sutures enclose long (tr.) narrow (exsag.) triangular posterolateral limbs. Arcuate palpebral lobes extend from near the middle of the preoccipital glabellar lobes to a point just in front of the the median lateral furrows, occupy some 45-65% of the glabellar length (G) depending on size, and are close to the axial furrows. The palpebral furrows are shallow but visible.

The librigena is narrow (tr.) with lateral borders almost as wide (tr.) as the genal field. The lateral and posterior marginal furrows meet at the genal angle; the genal spine is very short and laterally deflected. A subocular groove is present.

The pygidium is transverse with a semielliptical posterior margin, width (tr.) almost three times the length (Lp_2) in meraspides, a little less in early holaspides. The axis is short, squat, with two well defined segments, a poorly defined third, and a terminal piece. There is no postaxial ridge, the axis extending posteriorly to contact the pygidial marginal furrow. Two pleural furrows are clearly visible, and a third faintly, all merging into the marginal furrow which encircles the pleural zone. Interpleural furrows are effaced. The pygidial border is prominent; articulating facets are low-angled.

As far as can be judged the external prosopon of the holaspid cranidium is smooth, but the immature librigena illustrated herein (Pl. 14, fig 9) appears to be faintly granulose.

Lorrettina licina sp. nov.
(Pl. 15, figs. 1-7; Text-fig. 24)

Name. L. *licina*, bent or turned upwards, referring to the reflected anterior cranidial border in this species.

Types. Holotype, CPC 15295a, an imperfect cranidium, with counterpart, CPC 15295b, illustrated on Pl. 15, figs. 1-3; figured paratypes CPC 15296-15299; unfigured paratypes CPC 17429-17436.

Material. Four cranidial fragments, only one of which can be measured (Lc is 7.50 mm), four librigenae, and five pygidia with lengths (Lp_2) between 2.50 and 3.00 mm.

Occurrence. Lily Creek, horizon K214, 281 m from the base of the measured section.

Age. Late Cambrian, *Hapsidocare lilyensis* Assemblage-Zone.

Diagnosis. *Lorrettina* species with gently reflected anterior cranidial border equal in length (sag.) to the preglabellar field; no posterior librigenal border, the posterolateral limbs terminating at the genal spine base; pygidium with steeply inclined articulating facets.

Differential diagnosis. *Lorrettina licina* has similar glabellar shape and proportions to the original cranidial paradigm of *L. macrops* Shergold (1972, pp. 68-9, pl. 17, figs. 1-4) from the Gola Beds at Momedah Anticline, which have a more strongly convex (sag.) preglabellar field. Specimens referred to *L. macrops* from Black Mountain (Shergold, 1975, pp. 104-5, pl. 53, figs. 1-8) have more laterally swollen glabellae, a downsloping cranidial border, and in late holaspides, more greatly divergent preocular facial sutures (Fig. 25). *L. licina* has a gently reflected anterior crandial border. Librigenae from Black Mountain have a narrow (tr.) but distinct posterior border, and posterior and lateral marginal furrows which meet at the genal spine base. Those of *L. licina* have virtually no posterior librigenal border or posterior marginal furrow. In other respects librigenae of the two species are essentially similar, particularly in their possession of short, prong-like genal spines. No major difference can be recorded among pygidia of the two species. The strongly inclined articulating facets of *L. licina* are not preserved on any specimens of *L. macrops*. Possibly *L. licina* has a longer (tr.), more truncate, posterior margin.

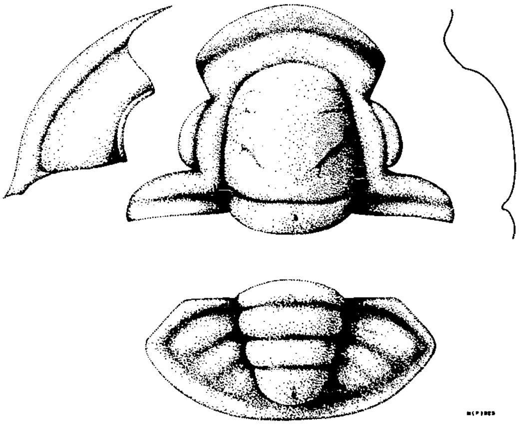


Fig. 24. ***Lorrettina licina*** **sp. nov.; exoskeletal reconstruction based on CPC 15295b (cranidium), x4, CPC 15297 (librigena), x4, and CPC 15299 (pygidium), x6.**

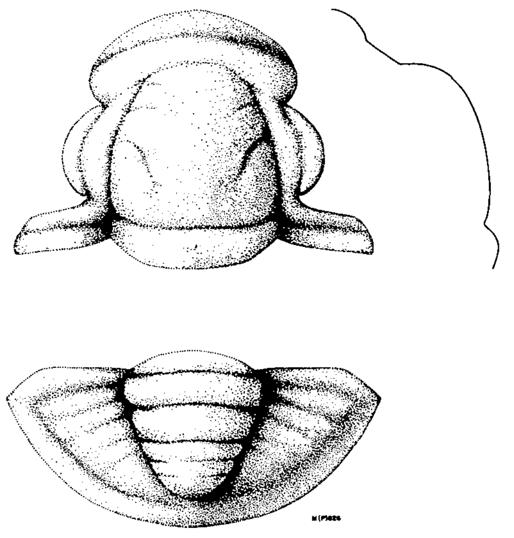


Fig. 25. ***Lorrettina macrops*** **Shergold, 1972; modified exoskeletal reconstruction superseding previous illustrations, based on CPC 11991 (cranidium), x4, and CPC 11989 (pygidium), x6.**

All specimens of *L. licina* are exfoliated, so that the prosopon of the exoskeleton cannot be adequately compared. The species appears not to have had the heavy granulation which characterises *L. macrops*.

Description. *Lorrettina licina* has an elongate glabella (G) occupying about two-thirds of the cranidial length (sag.). It is anteriorly gently rounded, has gently curved flanks, and is widest (tr.) at the level of the confluence of the preoccipital glabellar and axial furrows. It possesses three pairs of well-defined glabellar furrows: the preoccipital ones are sigmoidal and bifurcate, but the median and anterior lateral ones are transverse and gently arched forwards. In lateral profile the glabella has moderate convexity (sag.).

The occipital ring has the same transverse width as the preoccipital glabellar lobes, is sagittally narrow, and possesses an occipital node. In lateral profile it lies on the same level as the rear of the glabella.

The preocular facial sutures diverge forwards at 80-90 degrees, and enclose a gently vaulted preglabellar area comprising a flat forward-sloping preglabellar field and a gently reflected anterior cranidial border which are of approximately equal length (sag.). The anterior cranidial marginal furrow which separates these elements is wide and shallow, and slightly bowed forwards sagittally. The postocular facial sutures enclose long (tr.), strap-like posterolateral limbs. The palpebral lobes occupy a little over 50% of the glabellar length (sag.), extending between the middle of the preoccipital and the middle of the anterior lateral glabellar lobes. They are sited close to the axial furrows, and are separated by shallow palpebral furrows from narrow (tr.) strongly inclined palpebral areas. Ocular ridges are only weakly defined, but strongly oblique.

The librigena, like that of other dokimocephalids, has a short anterior prong, and small, thorn-like, laterally deflected genal spines. Its subocular groove and lateral marginal furrow are wide and shallow. There is no posterior border or marginal furrow, the posterolateral limbs extending into the genal spine base. An eye socle is observed (Pl. 15, fig. 7).

The pygidium is subtrapezoidal, wider than long with relatively long (tr.) truncate posterior margin which may be gently indented post-axially. It is characterised by steeply inclined articulating facets (Pl. 15, fig. 6) and a geniculation close to the axial furrows. The axis, which is almost as wide as long, is composed of two distinct rings and a poorly differentiated third, together with a terminal piece. There is no post-axial ridge, the axis terminating abruptly at the posterior marginal furrow. Two pleural segments are indicated by shallow pleural furrows, the first pair of which is apparently not confluent with the shallow and ill-defined marginal furrow. The pygidial margin is entire, non-spinose.

All specimens of *L. licina* are exfoliated, but the parietal morphology is generally indistinct. The bifurcated preoccipital glabellar furrows appear to encircle twin muscle scar impressions, as in *L. depressa* sp. nov. A fine caecal network radiates across the preglabellar field (Pl. 15, figs. 1-2), which is finely punctate, and obliquely directed diverticula appear to be associated with the ocular ridges near the intersection of the ridges, palpebral lobes and preocular facial sutures. The librigenal field has a typical caecal network radiating from the eye socle. A principal genal vein is not evident. The parietal morphology of the pygidium is obscure.

Family **IDAHOIIDAE** Lochman, 1956

Genus **Maladioidella** Endo, 1937

Type species. Maladioidella splendens Endo (*in* Endo & Resser, 1937, pp. 346-7, pl. 69, figs. 13-14, 15?, 16 *non* figs. 17-18), Daizanian, Daizan Formation, NE slope of Paichiashan, near Chinchiachengtzu, Fengtien, Manchuria; by original designation.

Other species. Crepicephalus chinchiaensis Endo (*in* Endo & Resser, 1937, p. 345, pl. 69, fig. 20), locality as for type species. *Maladioidella* cf. *chinchiaensis* (Endo) *sensu* Shergold (1975,pp. 152-3 pl. 51, figs. 4-6), pre-Payntonian, *maximus/papilio* Assemblage-Zone, 'Chatsworth Limestone', Black Mountain, western Queensland, Australia. *Maladioidella* sp. (Shergold, 1975, pp. 153-4, pl. 51, fig. 3), Payntonian, *quasibilobus/nomas* Assemblage-Zone, Dribbling Bore, western Queensland, Australia. *Maladioidella convexolimbata* Endo (*in* Endo & Resser, 1937, pp. 347-8, pl. 69, fig. 19) may represent *Pedinocephalus* Ivshin, 1956, and *M. elongata* Endo (1944, p. 84, pl. 8, fig. 12) is possibly a species of *Parachangshania* Chien, 1958.

Concept. Endo (1937, pl. 69, figs. 13-18) illustrated four cranidia and two pygidia under *Maladioidella splendens*. Three of the cranidia (figs. 13-14, 16), have short forward-tapering glabellae, gently convex (sag.) preglabellar fields, and flat forward-sloping or even gently concave cranidial borders of about equal length (sag.), straight obliquely directed ocular ridges, small arcuate palpebral lobes situated in front of the mid-point of the glabella and at some distance from the axial furrows, and long triangular posterolateral limbs. These are conspecific, and form the basis of the concept of *Maladioidella*. The fourth cranidium (fig. 15), which has a more conical glabella, shorter ocular ridges, and more anteriorly sited palpebral lobes, may represent a distinct species or belong to a related genus. The two pygidia (figs. 17-18), with subtrapezoidal shape, three axial rings and, perhaps, two pleural segments, resemble those currently (Palmer, 1962, 1965) referred to elviniid genera such as *Dunderbergia* and *Iddingsia*.

The cranidium of *Maladioidella*, as conceived herein, resembles many previously described and variously classified genera: *Cedarellus* Lazarenko, *Idahoia* Walcott, *Taenoria* Palmer, *Kujandina* Ivshin, *Blandicephalus* Palmer, *inter alia*. Similar cranidia may also have been illustrated by Walcott (1913) under *Anomocare* and *Anomocarella*. When its shell is preserved (Pl. 17, fig. 1; pl. 18, fig. 5), *Maladioidella* is evidently partly effaced and bears resemblance to the Tsinaniidae. It is impossible to assess how many of these genera are distinct, how many synonymous, and how many are homeomorphic, such uncertainty leading to classificatory indecision at familial level. Originally unclassified at this level by Endo (1937), he subsequently (1944, p. 84) placed *Maladioidella* in the

Crepicephalidae Kobayashi, 1935. Later, Lochman-Balk (1959) referred the genus to the Pterocephaliidae Kobayashi, 1935, and Kobayashi (1962) placed it in the Asaphiscidae, subfamily Elviniinae, the latter two assignations no doubt resulting from Endo's inclusion of elviniid pygidia in his original paradigm. More recently, Shergold (1975) has regarded *Maladioidella* as a representative of the Idahoiidae.

In summary, *Maladioidella* has morphological resemblance to various families: Anomocaridae, Asaphiscidae, Raymondinidae (Cedariinae), Elviniidae, Pterocephaliidae and Tsinaniidae. It occurs later than the late Middle Cambrian epibole of the anomocarids, and the Mindyallan (early Dresbachian) asaphiscids and cedariids, and earlier than the epibole of the latest Cambrian tsinaniids. Its morphology, however, suggests that it occupied a similar environmental situation to representatives of these families. Cranidial morphology could be derived by effacement of dokimocephalid (Dokimocephalinae) or pterocephaliid (Pterocephaliinae) stocks (*sensu* Palmer, 1965), but neither of these families can account for the morphology shown by pygidia of the Australian species described here, for which derivation by effacement from an idahoiid genus is suggested.

Maladioidella doylei sp. nov.
(Pl. 17, figs. 1-9; Pl. 18, figs. 1-5; Text-fig. 26)

Name. Named for H.M. Doyle Esq., who prepared the plates for this and earlier papers.

Holotype. CPC 15266, a partly exfoliated cranidium exhibiting details of both the exoskeleton and parietal surface, illustrated on Pl. 17, fig. 1; illustrated paratypes CPC 15268-15278; non-illustrated paratypes CPC 15267, 17437-17523.

Material. This species is based on fifty-nine cranidia and cranidial fragments, twelve librigenae, and twenty six pygidia and determinable pygidial fragments. Cranidia range in length (Lc) from 2.50 - 14.70 mm; pygidia (Lp_2) range from 3.60 to more than an estimated 27 mm.

Occurrence. Widespread: Chatsworth Plains, localities D124, 487, 489, 668, G41609; Horse Creek section, horizons K215, 217, 218, 219, 221, 222, 223, 224, 225, 226 and 227; Lily Creek section, K197, 198, 199, 200, 201, 202, B54a, 54b, and 790, 6-52 m from the base of the measured section; BMR Boulia No. 6, 45.85 - 81.55 m; BMR Duchess No. 13, 52.00 - 84.80 m.

Age. Late Cambrian, Assemblage-Zones of *Wentsuia iota - Rhaptagnostus apsis* and *Peichiashania secunda - Prochuangia glabella*.

Diagnosis. A *Maladioidella* species with proportionately long (exsag.) palpebral lobes whose mid-points lie opposite the mid-point of the glabella (G), and consequently narrow (exsag.), short (tr.), triangular posterolateral limbs; librigenae with broad-based, distally incurving genal spines and wide lateral borders; pygidium with posteriorly concave articulating facets, and narrow (exsag., sag.) circumscribing borders.

Differential diagnosis. The characteristics noted in the diagnosis distinguish cranidia of *Maladioidella doylei* from *M. splendens* Endo in particular. The latter has shorter (exsag.) palpebral lobes situated opposite the median lateral glabellar lobes, and broader, longer posterolateral limbs. Both species have similar glabellar shape, similarly orientated ocular ridges, and the proportionate relationship of preglabellar field to anterior cranidial border is comparable. Cranidial parietal morphology is apparently also similar, but as all Endo's specimens are to some degree exfoliated, comparisons of exoskeletal surfaces cannot be made.

The pygidium attributed by Endo (1937, pl. 69, figs. 17-18) to *M. splendens* is considered here to be representative of an elviniid trilobite, and is mismatched.

Maladioidella chinchiaensis (Endo) has a proportionately shorter preglabellar field, as does *M.* cf. *chinchiaensis* (Endo) *sensu* Shergold (1975, pl. 51, figs. 4-6). The latter appears to have similarly shaped posterolateral limbs, but differs further in that its librigena has only a short genal spine.

Maladioidella sp. (Shergold, 1975, pl. 51, fig. 3), based on an imperfect cranidium, has similarly long and similarly sited palpebral lobes, and similar triangular posterolateral limbs. The definition of its ocular ridges and muscle scar impressions suggests it was a more effaced species than *M. doylei*.

With taxa other than *Maladioidella*, *M. doylei* is best compared with *Cedarellus felix* Lazarenko (1966, pp. 48-9, pl. III, figs. 1-9), from the Kharaulakh Mountains (Chekurovka on the R. Lena), which occurs with the Russian *Irvingella* fauna. *C. felix* is less effaced, and has more transverse ocular ridges, slightly longer palpebral lobes, and longer (tr.) posterolateral limbs. Its assigned pygidium (Lazarenko, 1966, pl. III, figs. 6,8) is pterocephaliid in appearance. *Taenoria expansa* Palmer (1960, p. 84, pl. 7, figs. 20-23; 1965, p. 89, pl. 11, figs. 6, 10, 11), from the *Dunderbergia* Zone of Nevada, has similar, but less effaced, cranidium and librigena, but has also been assigned a pterocephaliid pygidium. The overall pygidial morphology of *M. doylei* is most closely comparable with that of certain Asaphiscidae, notably *Blountia (Mindycrusta)* Öpik (see 1967, pls. 11-13).

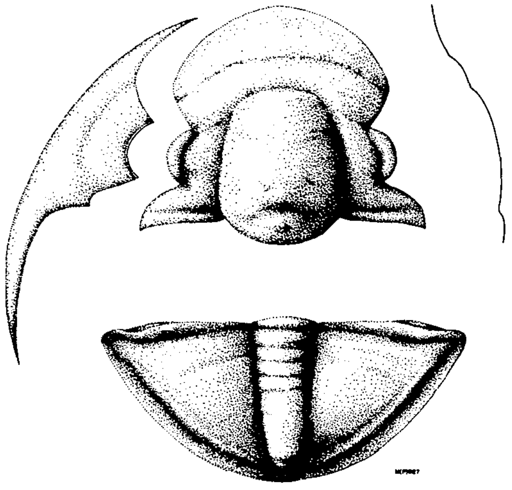


Fig. 26. ***Maladioidella doylei*** **sp. nov.; exoskeletal reconstruction based on CPC 15268 (cranidium), x3, CPC 15272 (librigena), x2, and CPC 15275a (pygidium), x2.**

Description. When shell is preserved, the features of the external surface of the cranidium are mostly effaced (Pl. 17, fig. 1), and in lateral profile there is little break in the convexity of the shield (Pl. 17, fig. 4). The anterior cranidial marginal furrow remains visible, however, in spite of effacement, separating an anterior cranidial border and preglabellar field of approximately equal lengths (sag.). Axial furrows faintly define a forward-tapering, anteriorly truncate glabella. On either side of the sagittal line the preglabellar furrow is pitted. Glabellar furrows are effaced, as are the palpebral furrows and ocular ridges. The occipital furrow is frequently anteriorly bowed, and a faint occipital node is invariably present. Posterior marginal furrows are well delineated.

The following cranidial proportions have been assessed: the glabella (G) occupies 45-54% of the total cranidial length, and with the occipital ring (Gn), 59-68% of the cranidial length. The anterior cranidial border (Lb) occupies 14-25% of the cranidial length depending on its morphogenetic development, small specimens having proportionately longer (sag.) borders. The length (sag.) of the preglabellar area varies between 34 and 42% of the cranidial length. The palpebral lobes occupy 25-45% of the glabellar length plus occipital ring (Gn), again varying with morphogenesis. The transverse glabellar width between the palpebral furrows and that across the preglabellar area are equal.

Cranidial parietal surfaces (Pl. 17, figs. 3, 5, 6, 7) show a wealth of morphological detail. Glabellar furrows, rarely seen on the exoskeleton, are effectively the anterior edges of muscle scar impressions (Pl. 17, figs. 3, 7). The posterior pair of cranidial muscle scar impressions lies across the occipital furrow so that it appears to bifurcate distally. A second, larger, pair is effectively represented on the exoskeleton by the preoccipital glabellar lobes, and a third pair, by the median lateral lobes. A third, anteriormost, pair of furrows is formed where the ocular ridges cross the axial furrows and merge with the frontal lobe of the glabella (Pl. 17, fig. 7). All three pairs of muscle scar impressions appear to be twinned. A sagittal keel divides the areas of muscle attachment. Raised palpebral lobes merge with the ocular ridges, which themselves merge into the frontal glabellar lobe, the combined structure presumably representing a single diverticulum. Caeca associated with this radiate across the preglabellar field. A small oval area lying across the sagittal line and partly in the floor of the preglabellar furrow appears to be related to a parafrontal band, as caeca seem to discharge from small nodes on this structure (Pl. 17, figs. 5-6). At the anterior cranidial marginal furrow a row of such nodes is formed at the extremity of each caeca. When the shell is completely exfoliated, the cranidial surface is finely and densely pitted.

On the external surface of the librigena (Pl. 17, fig. 9) only a wide and shallow lateral marginal furrow is readily discernible. Posteriorly this furrow curves around the base of the genal spine and merges with an indistinct posterior marginal furrow. The genal spine is long, distally incurved, and broad-based, and its inner edges bear terrace lines. Exfoliation of the shell reveals a punctate parietal surface (Pl. 17, fig. 8), and the caecal network of the genal field. This radiates from the eye socle at the base of the visual surface and terminates in pits at the lateral marginal furrow, in the same way as the caeca of the cranidium terminate at the anterior cranidial marginal furrow. A principal caecal vein is not evident.

Externally, the transverse furrows on the axis of the pygidium, the interpleural furrows, and the pleural furrows (apart from those of the first segment) are effaced, but the marginal furrows are clearly defined. Meraspid and early holaspid pygidia are basically subtriangular, but late holaspides tend towards a semicircular outline; length (Lp_2) varies between 40 and 53% of the width. Characteristic of pygidia here assigned to *Maladioidella doylei* is the posterior curvature of the articulating facets. In late holaspides (eg. Pl. 18, fig. 4) the facets become so strongly curved that the first pleural furrow is distally sigmoidal, and the anterolateral corners of the shield become acutely pointed. The articulating half-ring is a simple crescentic bar. This first pair of pleural furrows distally connects with the lateral marginal furrow at the anterolateral corners of the pygidium, meeting at angles of approximately 60°, to form an unbroken furrow peripheral to the pleural zone. The lateral and posterior borders are of equal width and form a distinctive rim. The pygidial margins are entire, non-spinose. Exfoliated material reveals 9-10 faint transverse furrows on the axis, and caecal diverticula related to 9 or 10 pairs of pleural segments. Faint impressions concentric to the marginal furrow (Pl. 18, figs. 1-4) appear to represent the traces of the doublure (see particularly fig. 4).

Family **SAUKIIDAE** Ulrich & Resser, 1930

Genus **Prosaukia** Ulrich & Resser, 1933

Type species. *Dikelocephalus misa* Hall, 1863, late Franconian, Franconia Formation, Wisconsin, USA; designated by Ulrich & Resser (1933, pp. 141-4, Pl. 24, figs. 1-9).

Other species. For comment see Shergold (1975, pp. 110-111).

Prosaukia sp. cf. **Prosaukia** sp. A? Shergold, 1975
(Pl. 19, figs. 1-4)

cf.? 1975 *Prosaukia* sp. A; Shergold, 1975, pp. 111-2, pl. 15, figs. 5-6, text-fig. 44 [CPC 11742].

Material. Material, generally heavily fragmented, includes pieces of three cranidia, two librigenae, and a single complete pygidium which has a length (Lp_2) of 7.90 mm. Specimens CPC 15385-8 are illustrated; CPC 17524 - 17525 are not illustrated.

Occurrence. Lily Creek, horizons K211, 212 and 214, 246-281 m from the base of the measured section; also at locality D144, adjacent to Coolibah Bore, on the western side of the Burke River Structural Belt, 29 km NW of 'Chatsworth' Homestead.

Age. Late Cambrian, *Hapsidocare lilyensis* Assemblage-Zone, at Lily Creek.

Comments. The present collection of fragments represents a species of *Prosaukia* similar to the type, *P. misa* (Hall), probably *Prosaukia* species A, illustrated previously (Shergold, 1975) from Black Mountain. However, the glabellar appears to taper forwards more strongly than in that species, this being responsible for the queried designation. Insufficient material is available to diagnose this species accurately. With the proliferation of species names attributed to *Prosaukia*, the species is, therefore, left under open nomenclature until its accurate affinity can be established.

The cranidium, apart from the degree of anterior taper noted above, resembles *Prosaukia* sp. A fairly closely. All material so far recovered possesses a very narrow preglabellar ridge (Shergold, 1975, p. 47). The position and size of the palpebral lobes, the extent of the posterolateral limbs, and the nature of the occipital ring, are unknown characteristics, although the librigenal fragments suggest a long palpebral lobe. That illustrated shows that, as in genera like *Anderssonella* and *Galerodaukia*, the lateral and posterior marginal furrows are not confluent.

The accompanying pygidium is about wide as wide (tr.) as long (sag.), with evenly curved posterior margin. Its axis is elevated, tapers gently rearwards, and is composed of four segments and a terminal piece. An indistinct post-axial ridge continues rearwards to the posterior margin. Four pairs of pleurae are indicated by deeply incised, posteriorly curving furrows. Interpleural furrows, nearly as well defined as the pleural ones, are distinguishable by a decided kink at the geniculation, at which the opisthopleuron of the preceeding segment commences to overlap the propleuron of that following. Both pleural and interpleural furrows terminate close to the margin of the shield, leaving only a very narrow unfurrowed border.

In the constitution of its preglabellar area, *Prosaukia* sp. cf. *P.* sp. A.? most closely resembles the fragment named *Ptychaspis campe* by Walcott (1913, p. 184, pl. 16, fig. 16). Walcott's specimen, however, would appear to have longer (exsag.) palpebral lobes. Pygidially, the present form more closely resembles *Prosaukia misa* (Hall) (see Ulrich & Resser, 1933, p. 141 *et seq.*; pl. 24, figs. 6, 8).

Family *INCERTAE SEDIS*
Subfamily **ATRATEBIINAE** subfam. nov.

The Atratebiinae is proposed for what are considered here to be dikelocephalacean trilobites whose morphology has remopleuridacean aspects. The new subfamily includes the genera *Atratebia* Shergold, 1975, as type genus, with *Mendosina* Shergold, 1975, and *Taishania* Sun, 1935, all of which occur during the post-Idamean but pre-Payntonian (Changshanian) interval in Australia and northern China.

Atratebiinae, as constituted here, are characterised cranidially by a cylindrical anteriorly bluntly rounded glabella, occipital ring wider (tr.) than the preoccipital glabellar lobes, and palpebral lobes situated adjacent to the axial furrows. Pygidially, Atratebiinae are transversely oval and characterised by sharply defined and elevated propleural leading edges, and interpleural furrows continuing close to

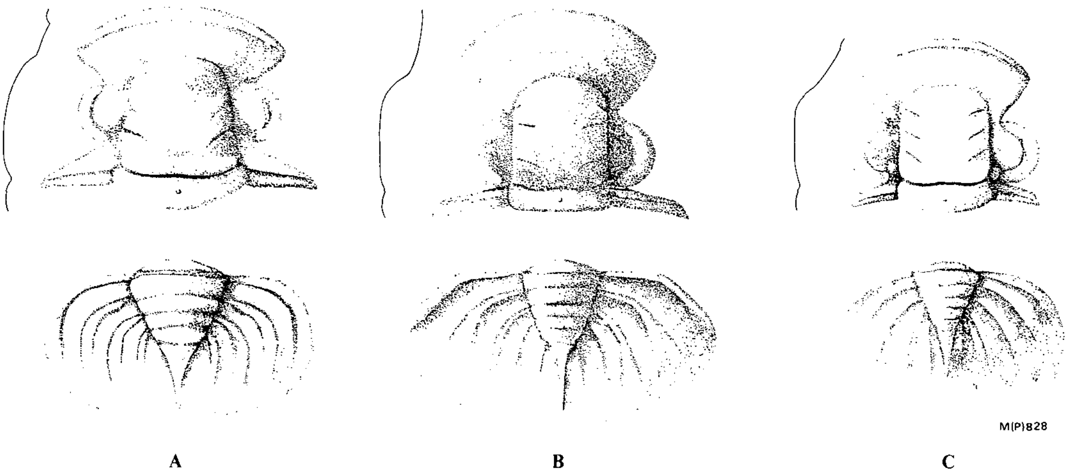


Fig. 27. Comparison of genera of the Atratebiinae subfam. nov.: (A) *Taishania platyfrons* **sp. nov.; based on CPC 15382 (cranidium), x5, and CPC 15379, 15380 (pygidium), x 5; (B)** *Atratebia nexosa* **Shergold, 1975, based on CPC 11868a (cranidium), x4, and CPC 11871 (pygidium), x4; (C)** *Mendosina laciniosa* **Shergold, 1972), based on CPC 9695 (cranidium), x4, and CPC 9703 (pygidium), x4.**

the margin of the shield, this combination giving rise to a fluted appearance; the axis is short and conical; four or five segments are present.

Whereas *Taishania* and *Mendosina* have preglabellar areas reminiscent of Kainellidae, that of *Atratebia* looks more like the Idahoiidae. All three genera have pygidia resembling such Dikelocephalacea as *Briscoia*, and certain Pterocephalidae, e.g. *Sigmocheilus*. Atratebiinae differ among themselves in degree of effacement of glabellar furrows, in the length of the palpebral lobes, in modifications of the preglabellar area, and in the varying development of pygidial spines. The three genera are compared in Text-fig. 27.

Although unclassified at the present time, the Atratebiinae seem likely to be members of the Pterocephaliidae (Dikelocephalacea).

Genus **Taishania** Sun, 1935

Type species. *Taishania taianensis* Sun (1935, p. 68, pl. 3, figs. 20-25), *Kaolishania pustulosa* Zone, Changshanian, Tawenkou Formation, Shantung, China; designated *in* Lu *et al.* (1965, p. 351).

Other species. Only the type species is certainly known, but Kobayashi (1962, p. 47) advocates the inclusion of the Paishanian *Elrathia yentaiensis* Endo (1944, p. 74, pl. 8, figs. 9-11), and *Anomocare persicum* King (1930, p. 320, pl. 17, figs. 3, 3a) in *Taishania*. If the latter is to be included, then *Anomocare subquadratum* (Dames) *sensu* King (1930, p. 319, pl. 17, fig. 5) could also be considered. *Mansuyia maladiformis* Kobayashi (1935C, pp. 302-303, pl. IV, fig. 1) from the *Eoorthis* Zone of Doten, South Korea, may also belong to *Taishania*.

Comments. Cranidia originally classified as *Mansuyia orientalis* by Sun (1924, p. 50, pl. 3, figs. 7a-d) were subsequently used to establish *Taishania* (see Sun, 1935, p. 68, pl. 3, figs. 20-25). Two pygidia, 'probably of this species' (Sun, 1935, p. 69), were included in the 1935 illustrations. Further cranidia and pygidia were illustrated by Endo (1939, p. 11, pl. 2, figs. 13-20) under *Mansuyia orientalis* (Sun). Whereas the cranidia conform to those referred to *Taishania taianensis* Sun, the pygidia differ slightly, having indented posterior margins. Resser (1942, p. 31) proposed the name *Mansuyia endoi* for the cranidia (Sun, 1924) which form the original types of *Taishania taianensis,* due to an erroneous concept of *Mansuyia orientalis*. *Taishania taianensis* Sun has been re-illustrated *in* Lu *et al.* (1965, p. 351, pl. 65, figs. 2-4). Sun's illustrations of the two pygidia assigned in 1935 are reproduced in this treatise, but the accompanying cranidium (fig. 2) cannot be positively identified as being from Sun's (1935) paradigm; it is conceivably from the 1924 collection. To my knowledge, no lectotype has yet been selected for *Taishania taianensis*. A cranidium should be chosen from one of the original 1924 suite. If the specimen illustrated *in* Lu *et al.* (1965, pl. 65, fig. 2) is representative of this collection, it could well serve in this capacity, the concept of *Taishania taianensis* being based on cranidial morphology.

Taishania appears to be characterised by a subcylindrical, somewhat elevated, poorly furrowed glabella; gently convex (sag.) preglabellar field of appreciable length (sag.); narrow (sag.) anterior cranidial border; short (exsag.) palpebral lobes, whose mid-points lie in front of the mid-point of the glabella, situated close to the axial furrows; triangular posterolateral limbs, and the presence of an occipital node.

Associated with cranidia possessing these characteristics in northern Australia, are pterocephalioid pygidia which differ considerably from those referred to *Taishania* by Sun (1935) and Endo (1939). These pygidia resemble others previously described as *Mendosina laciniosa* (Shergold) (1972, pp. 37-40, pl. 6, figs. 1-5; pl. 7, figs. 1-4) and *Atratebia nexosa* Shergold (1975, pp. 155-7, pl. 35, figs. 1-6), from Momedah Creek and Black Mountain, in western Queensland, respectively. Cranidia presented herein, previously referred to *Mendosina* sp. (Shergold, 1975, p. 158, pl. 51, figs. 1-2), are differentiated by their smaller palpebral lobes from *Mendosina laciniosa* and *Atratebia nexosa*, and from the latter also by the structure of their preglabellar areas. Thus *Taishania*, in Australia, appears to form a morphological cluster with *Mendosina* and *Atratebia*, which are united here in the new subfamily Atratebiinae.

Taishania platyfrons sp. nov.
(Pl. 19, figs. 5-10; Text-fig. 27A)

1975. *Mendosina* sp., Shergold, 1975, p. 158, pl. 51, figs. 1-2 [CPC 12874-5].

Name. Compounded from Gk πλατυς, broad, and *L. frons*, front, and refers to the transverse extent of the preglabellar area.

Types. The holotype is the cranidium, CPC 12875, from the *patulus/squamosa* Assemblage-Zone at Black Mountain, western Queensland, illustrated as *Mendosina* sp. by Shergold (1975, pl. 51, fig. 1), this specimen being the most complete. Illustrated paratypes are CPC 15379-15384.

Material. Besides the remaining cranidium from Black Mountain, CPC 12874, four others, with Lc measuring 5.50-7.20 mm, are known. Two pygidia, with estimated lengths (Lp_2) of 4.0 and 4.3 mm, are here referred to *Taishania*.

Occurrence. Black Mountain, horizons K106 and B507b, 51 m from the base of the measured section; Lily Creek, horizons B50c, 51, and 791a, which are not positively identified on the measured section, but are about 170-190 m from its base.

Age. Late Cambrian, *Peichiashania tertia - P. quarta* Assemblage-Zone (Lily Creek) and *patulus-squamosa* Assemblage-Zone (Black Mountain).

Diagnosis. *Taishania* species with broad (sag., tr.) preglabellar area; subtrapezoidal, non-spinose pygidium with slightly indented posterior margin, short axis, prominent post-axial ridge, and pleurae which are swept strongly backwards from a distinct geniculation.

Differential diagnosis. All interpretable published illustrations of *Taishania taianensis* Sun show cranidia with apprently narrow (tr.) preglabellar areas. *Mendosina* also has a relatively narrow (tr.) preglabellar area (Shergold 1972, pl. 6, figs. 1-5), but that of *Taishania platyfrons* sp. nov. is wide and remopleuridacean in appearance, resembling that of the kainelloid genus *Richardsonella*, particularly *R. elongata* Rasetti (1944, p. 256, pl. 39, fig. 52), *R. eurekensis* Kobayashi (1935A, p. 55, pl. 9, fig. 9) and *R. megalops* (Billings) (1860, p. 311, fig. 9; Rasetti, 1944, p. 255, pl. 39 figs. 48-49). Species of both *Mendosina* and *Richardsonella* are differentiated from those of *Taishania* by their considerably longer palpebral lobes, and consequently narrower (exsag.) strap-like posterolateral limbs.

Taishania species have a common glabellar shape (cf. Sun, 1935, pl. 3, figs. 20-22; Endo, 1939, pl. 2, figs. 13-17; Lu *in* Lu *et al.*, 1965, pl. 65, fig. 2) which closely resembles that of species of *Mendosina* and *Atratebia*, although the latter genus appears to be more effaced (see Shergold, 1975, p. 155, pl. 35, figs. 1-2). Some species of *Richardsonella* also have similarly shaped glabellae, but in these the glabellar furrows, particularly the preoccipital ones, are stronger.

Pygidia of *Taishania platyfrons* differ markedly from those assigned to *T. taianensis* by Sun (1935, pl. 3, figs. 24-5; Lu *et al.*, 1965, pl. 68, figs. 3-4), which are basically semicircular, with entire margins, narrow borders, and axes which reach close to the posterior margin. Pygidia figured by Endo (1939, pl. 2, figs. 19-20) are similar to Sun's, except for their indented posterior margins. Those illustrated here are more transverse, have short axes with prominent post-axial ridges, and prominent interpleural furrows which reach close to the margins. Such pygidia are morphologically essentially similar to those of *Atratebia nexosa* Shergold (see Shergold, 1975, pl. 35, figs. 4-6), but have a more transversely rectangular shape. Their lack of marginal spines differentiates them from pygidia of *Mendosina laciniosa* (Shergold) (1972, pl. 7, figs. 1-4). Similar pygidial morphologies are classified in North America among the Pterocephaliinae (*Sigmocheilus* Palmer and *Pterocephalia* Roemer), or when spinose, among the Kainellidae (eg. *Richardsonella arctostriata* (Raymond, 1937)).

Description. *Taishania platyfrons* has a gently tapered, anteriorly bluntly rounded glabella, which occupies (G) 54-62% of the cranidial length. Glabellar furrows are mainly effaced, even on parietal surfaces. The holotype (Shergold, 1975, pl. 51, fig. 1) has short faintly visible backwards directed preoccipital and transverse median lateral furrows.

The occipital ring is fractionally wider (tr.) than the preoccipital glabellar lobes, and in lateral profile is observed to have low convexity (sag.), similar to that of the glabella. An occipital node is carried medially.

The preglabellar area, occupying 20-30% of the cranidial length (sag.), is three to four times wider (tr.) than long (sag.), and comprises a gently convex (sag.) preglabellar field, and a relatively narrow (sag.) (8-12% of the cranidial length) convex (sag.) anterior cranidial border. The preocular facial sutures diverge considerably forwards. The palpebral lobes are arcuate, anteriorly sited between the preoccipital glabellar furrows and a position at which the anterior lateral furrows should be placed, and occupy 44-59% of the glabellar length (G) (33-46% of Gn). Palpebral furrows are effaced, and the palpebral areas narrow (tr.), so that the posterior edges of the palpebral lobes approach the axial furrows. The postocular facial sutures enclose long (tr.) broad triangular posterolateral limbs.

The pygidium is apparently transverse subrectangular, with entire, non-spinose, posteriorly indented margins, and estimated width twice the length. The maximum width appears to lie opposite the fourth axial segment, the anterolateral corners being more strongly rounded than in *Mendosina* or *Atratebia*. The axis is short, prominently conical, and composed of four 'rings' and a small triangular terminal piece. A post-axial ridge, almost as long as the segmented axis, continues to the posterior pygidial margin. The articulating half-ring is a simple narrow (sag.) crescent. There are three pairs of well defined pleural furrows, and a fourth is indistinctly indicated. Both pleural and interpleural furrows are distinguishable, sweeping strongly posteriorly from a well marked geniculation.

The cranidial exoskeletal prosopon is granulose on the glabella, individual granules, as in *Mendosina*, tending to coalesce to form a 'fingerprint' pattern. The pygidial axis has a similar prosopon. The anterior cranidial border, the rear edge of the occipital ring, and the margin and doublure of the pygidium bear a terrace-line prosopon. Cranidial caeca are preserved on the preglabellar field, and are observed to pass into a transverse diverticulum lying in the floor of the anterior cranidial marginal furrow (Pl. 19, fig. 8). Others are apparent on the holotype cranidium, diverging from the rear of the palpebral lobe and radiating across the posterolateral limb (Shergold 1975, pl. 51, fig. 1). The pygidial caecal network is observed, in part, associated with the distal ends of the pleurae (Pl. 19, fig. 7).

Superfamily **OLENACEA** Burmeister, 1843
Family **OLENIDAE** Burmeister, 1843
Subfamily **OLENINAE** Burmeister, 1843

Genus **Plicatolina** Shaw, 1951

Type species. *Plicatolina kindlei* Shaw (1951, pp. 103-4, pl. 22, figs. 11-17), Early Ordovician, Gorge Formation, Vermont, U.S.A.; by original designation.

Other species. *Plicatolina lucida* Lazarenko (1966, pp. 62-3, pl. VII, figs. 7-8), *Plicatolina perlata* Zone, Kyutyungdinsk Depression, below intersection of Khoyguollakh Stream and River Olenek, Yakutia, USSR. *Plicatolina perlata* Lazarenko (1966, pp. 60-62, pl. V, figs. 6-7; pl. VII, figs. 1-15), Kyutyungdinsk Depression, Khoyguollakh Stream, Khar-aulakh Mountains, below Chekurovka on Lena River, Yakutia, USSR. *Plicatolina quadrata* Pokrovskaya (1966, pp. 67-9, pl. 10, fig. 1), *Lotagnostus* Zone, Ogoniersk horizon, Tuora-Sis Ridge, along Neleger Brook, left bank of Lena River, 6 km below Chekurovka, Yakutia, USSR. *Plicatolina scalpta* Harrington & Leanza (1957, pp. 111-3, fig. 41/1-9), *Parabolina argentina* Zone, Jujuy Province. Salta Province, La Rioja Province, Argentina. *Plicatolina yakutica* Pokrovskaya (1966, pp. 69-71, pl. 10, figs. 2, 3), as for *P. quadrata* Pokrovskaya, above.

Comments. *Plicatolina* has been diagnosed by Shaw (1951, p. 103) and Henningsmoen (1957, pp. 152-3). The pygidial characteristics noted by the latter should be deleted as they are based on the spinose specimen Harrington (1938, p. 197) originally referred to *Parabolina pheidolopyge*, which is non-conspecific with cranidia referred to this taxon by Harrington & Leanza (1943, p. 348). These cranidia do, however, belong to *Plicatolina* (see Harrington & Leanza, 1957, p. 111). The association of cranidium and pygidium figured by Lazarenko (1966, pl. VII) closely resembles that found in the Chatsworth Limestone, and is assumed to be the correct combination. The pygidium of *Plicatolina*, therefore, is subtriangular, markedly pointed postaxially, non-spinose, and possesses three pairs of well defined pleural segments characterised by straight, oblique pleural furrows abaxially contacting the interpleural furrow, and thus bisecting the pleuron into two triangular segments. Three or four axial rings are evident. It resembles in shape and segmentation the pygidium illustrated by Westergaard (1922, pl. III, fig. 16) as *Olenus transversus* Linnarsson.

Originally diagnosed (Shaw, 1951, p. 103) to have four pairs of glabellar furrows, but the fourth pair is generally very faint and best seen on small compressed specimens (eg. those illustrated by Shaw and Harrington & Leanza). On Siberian and Australian species the anteriormost pair of furrows is invariably effaced. Glabellar characteristics aside, the cranidial characters of *Plicatolina* overlap with those of *Parabolina*, e.g. *P. acanthura* (Angelin, 1854) as figured by Henningsmoen (1957, p. 116, pl. 10, figs. 1-6) and *P. brevispina* Westergaard (1922, p. 133, pl. VI, figs. 9-13), which have spinose pygidia. They also overlap with *Simulolenus* Palmer, 1965, e.g. *S. quadrisulcatus* Palmer (1965, p. 56, pl. 8, figs. 1-4), which has a small transverse pygidium resembling that of *Parabolinites* Henningsmoen, 1957 (see *Parabolinella laticauda* Westergaard, 1922, pl. VIII, figs. 6-7) and some species of *Protopeltura* (e.g. *P. intermedia* Westergaard, 1922, p. 171, pl. XIV, figs. 21-22); and *Bienvillia,* of the *B. corax* (Billings) type (see Rasetti, 1944, p. 240, pl. 36, figs. 51-2).

Plicatolina sp. aff. **P. yakutica** Pokrovskaya, 1966
(Pl. 20, figs. 1-2)

aff. 1966. *Plicatolina yakutica* Pokrovskaya, sp. nov.; Pokrovskaya, 1966, pp. 69-71, pl. X, figs. 2-3.

Holotype. Cranidium, Geological Institute Novosibirsk GIN 3568/2, illustrated Pokrovskaya, 1966, pl. X, fig. 2.

Material. Present material comprises a single cranidium, CPC 15370, with length of 2.50 mm, and a single pygidial fragment, CPC 15371, with estimated length (Lp_2) of 4.5 mm.

Occurrence. Chatsworth Plains, locality D487; Horse Creek, horizon K216.

Age. Late Cambrian, *Wentsuia iota - Rhaptagnostus apsis* Assemblage-Zone.

Comments. The available material is inadequate for the diagnosis of a new species. Although the glabellar furrows are not as deeply incised, there is strong cranidial resemblance to *Plicatolina yakutica* Pokrovskaya. Glabellar shape, structure of the preglabellar area, and size and position of the palpebral lobes are comparable. A short preglabellar field relates *P.* aff. *yakutica, P. yakutica* and *P. quadrata* Pokrovskaya, and distinguishes these from *P. perlata* Lazarenko, *P. lucida* Lazarenko. *P. scalpa* Harrington & Leanza, and *P. kindlei* Shaw.

No pygidium has been assigned to *P. yakutica*. That associated herein resembles the pygidium of *P. perlata* Lazarenko, but is somewhat less pointed posteriorly and appears to possess at least an additional axial segment, and possibly also an additional pleural segment. The obliquely directed pleural furrows, which contact the interpleural furrows abaxially and divide the pleural 'rib' into two triangular areas, are essentially similar to the narrow pygidial border.

Subfamily **LEPTOPLASTINAE** Angelin, 1854

Genus **Leptoplastus** Angelin, 1854

Type species. *Leptoplastus stenotus* Angelin (1854, p. 47, pl. XXVI, fig. 1), *Leptoplastus stenotus* Subzone (4e of Westergaard, 1944), Alum Shale, Norway, Sweden and Denmark; designated Vodges (1890).

Other species. Other species of *Leptoplastus*, and species formerly placed in this genus but now referred elsewhere, are listed in Henningsmoen (1957, p. 161). Recently reillustrated material, found in the works of Henningsmoen (1957), Rushton *in* Taylor & Rushton (1971) and Schrank (1973), complements Angelin's (1854, 1878) original work, and that of Brögger (1882) and Westergaard (1922, 1940, 1944).

Leptoplastus? sp. nov.
(Pl. 20, figs. 3-4)

Material. Two cranidial fragments; CPC 15372 has an estimated length (Lc) of 4.3 mm, CPC 15373 is not assessable.

Occurrence. Horse Creek, horizon K216.

Age. Late Cambrian, *Wentsuia iota - Rhaptagnostus apsis* Assemblage-Zone.

Comments. *Leptoplastus* cranidia are typically characterised by a straight or posteriorly bowed anterior margin; narrow (sag.) anterior border; short (sag.) preglabellar field; an elevated, cylindrical glabella with two pairs of well defined furrows; an occipital node; small palpebral lobes situated opposite or a little in front of the mid-point of the glabella, and some distance from the axial furrows; narrow, obliquely directed ocular ridges; and relatively long, triangular posterolateral limbs. *Leptoplastus?* sp. nov. possesses these characteristics but has a diagnostic bigranulose prosopon differing from any previously described species. Morphologically closest, ignoring prosopon, is *L. rhaphidophorus* Angelin (1854, p. 47, pl. 26, fig. 2; see also Westergaard, 1922, p. 143, pl. 8, figs. 13-17 (*pars*), Henningsmoen, 1957, pp. 175-7, pl. 13, figs. 1-7).

Additional material is required to confirm this species as truly representative of *Leptoplastus*. If proven it would certainly represent a new species.

Family **ELVINIIDAE** Kobayashi, 1935
Subfamily **ELVINIINAE** Kobayashi, 1935

Genus **Wentsuia** Sun, 1935

Type species. Wentsuia granulosa Sun (1935, pp. 38-39, pl. 1, figs. 3-4; refigured *in* Lu *et al.*, 1965, p. 281, pl. 49, figs. 1-3), Late Cambrian, Changshanian, *Chuangia tawenkouensis* Zone, Tawenkou, Taian, Shantung, China; designated Kobayashi (1962, p. 65).

Other species. Elrathia(?) *munda* Resser & Endo (*in* Endo & Resser, 1937, p. 221), Late Cambrian, Yenchouan, Yenchou Formation, near Shangpingchou, 13 km east of Liaoyang, Manchuria, possibly also belongs to *Wentsuia* (see also Kobayashi 1962, p. 47). *Wentsuia iota* sp. nov. is described below.

Comments. Originally classified with the Dikelocephalinae (Sun, 1935, p. 36), the most recent classification (Kobayashi, 1962, pp. 64-5) places *Wentsuia,* together with *Changshania* and *Parachangshania,* in the Changshaniinae Kobayashi, 1935 (Emmrichellidae, Emmrichellacea, Ptychopariina). Whereas *Changshania* has affinity with genera such as *Lioparia,* and may be representative of the Pterocephaliidae (Dikelocephalacea) in Asia, *Wentsuia* seems to resemble *Dunderbergia* Walcott, 1924, a middle Late Cambrian elviniid genus (Elviniinae, Elviniidae) according to Palmer (1960, 1965). *Wentsuia* has the typical broad (tr.) preglabellar area of *Dunderbergia* with a narrow anteriorly pointed or arched cranidial border; its glabella is of similar shape to certain *Dunderbergia* species; and its posterolateral limbs have similar width (exsag.) and extent to those of *D. nitida* (Hall & Whitfield) (see Palmer, 1965, pl. 4, figs. 1-2, 5-6), the type species of *Dunderbergia*. The librigena of *Wentsuia,* which is characterised by the coalescence of lateral and posterior marginal furrows at the genal spine and, thus combined, their continuation a short distance into the spine base, resembles that of several *Dunderbergia* species. Finally, the pygidium here assigned to *Wentsuia,* which is elliptical, compares with species such as *D. brevispina* Palmer (1965, pp. 40-41, pl. 5, figs. 11-13, 15). *Wentsuia,* however, is significantly smaller than *Dunderbergia,* and is bacculate, which *Dunderbergia* never is; its occipital ring is constantly wider (tr.) than the maximum glabellar width (tr.); and its palpebral lobes are, in general, longer (exsag.). Nevertheless, *Wentsuia* could well be derived from a *Dunderbergia*-like source. In Australia the former post-dates the occurrence of *Irvingella*, whereas in North America, *Dunderbergia* predates *Irvingella*, disappearing, in the Great Basin at least, in earliest *Elvinia* time.

Wentsuia iota sp. nov.
(Pl. 21, figs. 1-10; Text-fig. 28)

Name. Gk*ιωτα*, ninth letter of the Greek alphabet, and pertaining to smallness.

Types. Holotype, CPC 15311, exfoliated cranidial fragment, Pl. 21, figs. 4-5; figured paratypes CPC 15308-15310 15312-15316; non-figured paratypes CPC 17526-17574.

Material. Forty-two cranidia, mostly incomplete, ranging in length between 1.15 and 3.50 mm; fourteen librigenae; and two pygidial fragments, one of which has a length (Lp_2) of 1.45 mm.

Occurrence. Chatsworth Plains, localities D124, 373, 487, and 669; Horse Creek, horizons K215, 216, 217, 218, 219, 220, 221, 222, 223, 224, 225, 226, 227 and D668; Lily Creek, horizons K201, 205 and B54b, 49-72 m from the base of the measured section; BMR Boulia No. 6, 18.40-98.90 m; BMR Duchess No. 13, 18.80-83.30 m.

Age. Late Cambrian, Assemblage-Zones of *Wentsuia iota - Rhaptagnostus apsis* and *Peichiashania secunda - Prochuangia glabella.*

Diagnosis. A small finely granulose partly effaced but bacculate species of *Wentsuia,* with ovoid glabella and elliptical pygidium.

Differential diagnosis. Sun's (1935, pl. 1, figs 3-4) illustrations of *Wentsuia granulosa* leave much to be desired, and those in Lu *et al.* (1965, pl. 49, figs. 1-3) are merely reproductions of the originals. All illustrated specimens are cranidia. *W. granulosa* and *W. iota* apparently share common glabellar and preglabellar characteristics. The preglabellar area in each has comparable convexity (sag.) when viewed laterally, and each has similarly extensive posterolateral limbs. The only differences which can be readily assessed are that *W. granulosa* has longer (exsag.) palpebral lobes, and its dorsal exoskeletal surface maybe more strongly granulose than that of *W. iota*. *W. granulosa* appears to be older than *W. iota*, occurring with species of *Chuangia* and *Changshanocephalus interalia* in the Lower Tawenkou Formation, Tawenkou, Taian, Shantung, China (Sun, 1935, p. 14).

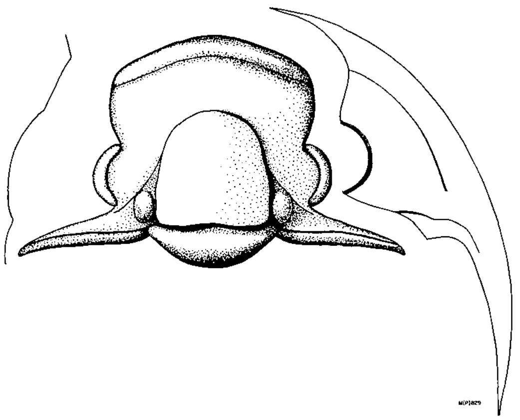


Fig. 28. ***Wentsuia iota* sp. nov.; exoskeletal reconstruction based on CPC 15310 (cranidium), x13, and CPC 15315 (librigena), x10.**

Wentsuia munda Resser & Endo (*in* Endo & Resser 1937, pl. 56, fig. 11), occurring in the Yenchou Formation of Manchuria, is probably younger than *W. iota*. Its type cranidium is about the same size as the larger cranidia of *W. iota*, but few detailed comparisons can be made because of the small size of its illustration and scant description.

As noted in the generic comments above, *W. iota* resembles species of *Dunderbergia*, particularly *D. bigranulosa* Palmer, 1960, and *D. nitida* (Hall & Whitfield, 1877) on cranidial characteristics, and on pygidial ones, *D. brevispina* Palmer, 1965.

Description. *Wentsuia iota* is a partly effaced species: glabellar furrows are totally effaced on the exoskeleton, and only the faintest traces — as notches on the flanks of the glabella adjacent to the axial furrows — remain parietally. The glabella is basically ovoid, but is more elongated in meraspides or early holaspides than in late holaspides, and is anteriorly rounded or even pointed when posteriorly tilted (Pl. 21, fig. 6). The glabellar length varies during morphogenesis, from 47-61% (G) of the total cranidial length (Gn, 62-75%); evidently the length (sag.) of the preglabellar area increases during morphogenesis.

The occipital ring is characteristically wider (tr.) than the maximum width of the glabella, does not rise above the dorsal level of the glabella when viewed laterally, and bears a faint median node. Anterolaterally, the occipital ring is vaguely connected to small, very prominent, oval bacculae which lie alongside the preoccipital glabellar lobes.

Some 60-80% of the preglabellar area is occupied by a gently convex preglabellar field which slopes forwards (Pl. 21, fig. 4). This preglabellar field is sagittally very gently elevated, and in front of the ocular ridges correspondingly depressed. The elevation is not sufficiently prominent, however, to form a boss. The anterior cranidial marginal furrow is distinct, and evenly arched forwards. The anterior cranidial border — a flat rim occupying 20-40% of the preglabellar area (sag.) —is often gently pointed anteriorly (Pl. 21, fig. 5). The preocular facial sutures diverge forwards at angles of 40-80°, being more greatly divergent in meraspides or early holaspides. Postocular facial sutures enclose long (tr.) triangular posterolateral limbs.

In general, ocular ridges are visible only on exfoliated specimens, in which they are short (tr.) and slightly oblique. The palpebral lobes are prominent, semicircular, and occupy between one-half and two-thirds the total glabellar length (G); their mid-points lie slightly behind the glabellar mid-point. Palpebral areas are about one-half as wide (tr.) as the length of the palpebral lobes, and gently inclined to the axial furrows.

The librigena has a rather flat genal field, prominent sharply incised lateral and posterior marginal furrows which connect at the base of the genal spine and run along the spine for a short distance and lateral borders which widen posteriorly. The genal spine is moderately long and stout, and often bears terrace lines on its adaxial edge. Eye socles and subocular grooves are preserved on some specimens.

The pygidium tentatively ascribed to this species is elliptical with length (Lp_2) approximately 44% of the width. It is characterised by rounded anterolateral corners with very short, almost vertically inclined, articulating facets, and entire posterior and posterolateral margins. The anterior margin is gently curved, and fulcral points are not well developed. The axis is composed of two segments, the second of which is fused to a terminal piece ending well in front of the posterior marginal furrow. There is no post-axial ridge. The articulating half ring is a mere arcuate replica of the first axial segment. The pleural zone, which is restricted in area by wide, shallow marginal furrows, also comprises two segments, as indicated by traces of pleural furrows. The first pair of pleural furrows runs concentric to the anterior margin of the shield and distally curves into the marginal furrow. The first pair of interpleural furrows is visible on all specimens. The pygidial border is a very narrow rim which is turned slightly addorsally.

Prosopon consists of fine granulation, most evident on the pygidial axis and the cranidial occipital ring. The posterior margin of the pygidium and the inner (adaxial) margin of the genal spine bear inosculating terrace lines. Details of the caecal system are observed rarely, presumably due to the small size of the species. That of the cranidium is best expressed on the holotype (CPC 115311, Pl. 21, fig. 5).

Family **PTEROCEPHALIIDAE** Kobayashi, 1935
Subfamily **APHELASPIDINAE** Palmer, 1960

Genus **Eugonocare** Whitehouse, 1939

Type species. *Eugonocare tessellatum* Whitehouse (1939, p. 226, pl. XXIII, figs. 15, 17, *non* figs. 16, 18; pl. XXV, fig. 7b [*fide* Henderson 1976]), Late Cambrian, Idamean, Georgina Limestone, Pomegranate Limestone, western Queensland; designated Whitehouse (1939, p. 224).

Other species. *Eugonocare* sp. indet., from the Glenormiston area of western Queensland, has been noted but not illustrated by Whitehouse (1939, p. 227). *Eugonocare* cf. *tessellatum* Whitehouse has been recorded from the O'Hara Shale of the Duchess area, also western Queensland (Öpik, 1967, p. 203, pl. 8, fig. 2). A species of *Eugonocare* has also been reported (Thomas & Singleton, 1956, p. 158) from the Dolodrook Limestone in central Victoria. More recently, Henderson has described the new species *Eugonocare quadratum* (1976, pp. 346-347, pl. 49, figs. 8-14) and *E. whitehousei* (1976, pp. 346-347, pl. 49, figs. 15-19), again from the Glenormiston region, and has used the holotype pygidium of *Eugonocare propinquum* Whitehouse (1939, p. 227, pl. XXIII, fig. 19) as the basis for *Prismenaspis* Henderson, 1976. The paratype cranidium of *E. propinquum* is by Whitehouse's own admission (1939, p. 227) identical to those referred by him to *E. tessellatum*.

Comments. The classificatory position of *Eugonocare* has been commented upon by Palmer (1962, pp. 31-32) and Öpik (1963, p. 75; 1967, pp. 202-203), both of whom have noted the similarity of the Aphelaspidinae to the Olenidae, and the probable synonymy of these groups. The Aphelaspidinae are here retained in the Pterocephaliidae (*sensu* Palmer 1962, 1965), but this is regarded as a family of the Olenacea. Henderson (1976, p. 243) has provided an updated diagnosis of *Eugonocare*.

Eugonocare? sp. undet.
(Pl. 35, fig. 7)

Material. A single exfoliated pygidium, CPC 15396, having a length (Lp_2) of 1.40 mm.

Occurrence. Chatsworth Plains, D373.

Age. Late Cambrian, *Wentsuia iota - Rhaptagnostus apsis* Assemblage-Zone.

Comments. The pygidium referred to *Eugonocare?* sp. undet. is lenticular in outline, with length 36% of maximum width. Its broad, short, elevated axis possesses three distinct segments, and a fourth may be fused with the terminal piece. Three pleural segments are also observed, the first two having strong oblique pleural furrows, and weaker, but nevertheless visible, interpleural furrows. The border is a narrow, slightly reflected rim.

The specimen is tentatively referred to *Eugonocare* by comparison with *E. quadrata* Henderson, whose pygidia (Henderson, 1976, pl. 49, figs. 13-14) have similar segmentation and similarly orientated pleural furrows. Pygidia of *E. quadrata* differ very slightly in possessing a more transverse shape.

Superfamily **CATILLICEPHALACEA** Raymond, 1938
Family **CATILLICEPHALIDAE** Raymond, 1938

Genus **Onchonotellus** Lermontova, 1956

Type species. *Solenopleura subcincta* Lermontova (1951, pp. 22-25, pl. 5, figs. 4-5, 5a), Late Cambrian, Shidertan Stage, Tortkuduk Effusive Suite, central Kazakhstan (Ivshin, 1962, p. 117); by designation of Lermontova (*in* Ivshin, 1956, p. 26) (See Öpik, 1967, p. 206 for discussion of validity).

Other species. *Onchonotellus abnormis* Ivshin (1956, pp. 28-31, pl. 9, figs. 9-16; 1962, pp. 118-119, pl. 7, fig. 12, text fig. 31), Late Cambrian, Kuyanda Stage, Tortkuduk Effusive Suite, Aksak - Kuyanda and Seletin horizons, Selety River basin and between the Shiderta and Olenta Rivers, central Kazakhstan. *Onchonotellus offula* Öpik (1967, p. 207, pl. 9, fig. 7), Late Cambrian, Mindyallan, Zone of *Erediaspis eretes*, Mungerebar Limestone, western Queensland. *Onchonotellus perlatus* Ivshin (1962, pp. 121-4, text fig. 33), Kuyanda Stage, Seletin horizon, Tortkuduk Effusive Suite, Selety River basin, central Kazakhstan. *Onchonotellus privus* Rosova (1968, pp. 66-68, pl. 1, figs. 1-9, text-fig. 9), Late Cambrian, Tuorian, Nganasan horizon, N.W. Siberian Platform. *Onchonotellus tchecurensis* Lazarenko (1966, p. 66, pl. 8, figs. 1-3), *Glyptagnostus stolidotus* Zone, Kharaulakh Mountains, River Lena below Chekurovka, Yakutia, North Siberian Platform, USSR. *Onchonotellus trisulcatus* Ivshin (1962, pp. 119-121, pl. 17, figs. 13-15, text-fig. 32), Kuyanda Stage, Seletin horizon, Tortkuduk Effusive Suite, Selety River basin and Alkamergeny Sea, central Kazakhstan.

Onchonotus ovoidea Kobayashi (1938, p. 188, pl. 15, figs. 35a-b), from the *Dunderbergia* Limestone in the vicinity of Mount Jubilee, west of Harrogate, British Columbia, may also be a representative of *Onchonotellus*. Furthermore, it is likely that the genus *Seletella* Ivshin, 1962, is a synonym of *Onchonotellus;* thus the species *S. choristos* Ivshin (1962, pp. 257-9, pl. 18, figs. 1-6, text-fig. 74), *S. conusoides* Ivshin (1962, pp. 259-262, pl. 17, figs. 6-10, text-fig. 75), *S. mirabilis* Ivshin (1962, pp. 262-4, pl. 18, figs. 8-14, text-fig. 76), *S. discreta* Ivshin (1962, pp. 264-6, pl. 18, fig. 7, text-fig. 77), and *S. parallela* Ivshin (1962, pp. 266-8, pl. 18, figs. 15-19, text-fig. 78), all from the Kuyanda Stage, Seletin horizon, of central Kazakhstan, can be assessed with *Onchonotellus*.

Comments. Öpik (1967, p. 206) has commented on the nomenclatorial problems surrounding the name *Onchonotellus,* and recommended the authority and date quoted above. He has also revised the suprageneric classification of *Onchonotellus*, transferring it from Solenopleuridae Angelin, 1854, to Catillicephalidae Raymond, 1938. This classification is accepted and followed here, in preference to that of Lu (*in* Lu *et al.*, 1965, p. 218) who has erected the Family Onchonotinidae for the genera *Onchonotina* Lu, 1961, *Onchonotus* Raymond, 1924, and *Onchonotellus* Lermontova, 1956.

As presently constituted, *Onchonotellus* consists of two groups. The earliest group, *O. offula, O. privus,* and *O. tchecurensis*, is of Mindyallan and equivalent age in Australia and Siberia. The remaining species are younger, occurring in the late Idamean and immediate post-Idamean on either side of the time span of *Irvingella*, in Australia, Kazakhstan and, possibly, British Columbia. Both groups can be encompassed within the current diagnosis (Öpik, 1967, p. 207).

Onchonotellus sp. undet.
(Pl. 20, figs, 5-7)

Material. A single partly exfoliated cranidium, CPC 15378, which has a length of 2.90 mm.

Occurrence. Horse Creek, locality K217.

Age. Late Cambrian, *Wentsuia iota - Rhaptagnostus apsis* Assemblage-Zone.

Comments. This species is left under open nomenclature because the available material is inadequate for the diagnosis of a new species. It is characterised by a swollen, ovoid glabella which rises high above the genae when viewed anteriorly, and which has considerable convexity when observed in lateral profile. Glabellar furrows are effaced. The occipital ring is broken, but appears to be wider (tr.) than the maximum glabellar width. The preglabellar area is short (sag.) and occupied mostly by a forward-sloping anterior cranidial border; thus the preglabellar field is considerably attenuated (sag.). Palpebral lobes are poorly defined, apparently sited well away from the axial furrows and anterior to the mid-point of the glabella. The condition of the posterolateral limbs is unknown. Under high power magnification the vestiges of shell remaining seem to be faintly granulose.

Onchonotellus sp. undet. appears to have a wider, more sphaerical glabella than other described species of the genus, and it is also wider than those of *Seletella*. Perhaps the most similar previously described species in this respect is *O. ovoidea* Kobayashi, from British Columbia. The preglabellar area is depressed below the level of the preglabellar furrow, and the preglabellar field, though short (sag.), is present, in this respect resembling *O. privus* Rosova, rather than those species in which the preglabellar field is breached sagittally. Palpebral lobes are similarly situated to those of *O. abnormis* Ivshin, being further removed from the axial furrows than those of *O. offula* Öpik, *O. tchecurensis* Lazarenko, and *O. privus* Rosova.

Of other related genera, *Quebecaspis,* as illustrated by Palmer (1968, p. 95, pl. 9, figs. 8-10), is most similar.

Superfamily *INCERTAE SEDIS*
Family **PARABOLINOIDIDAE** Lochman, 1956

Genus **Taenicephalites** Rasetti, 1961

Type species. *Taenicephalites macrops* Rasetti (1961, p. 118, pl. 25, figs. 1-11), *Dunderbergia* Zone, Frederick Limestone, Frederick, Maryland, USA; by original designation.

Comments. *Taenicephalites* closely resembles *Taenicephalus*, from typical members of which it is distinguished by somewhat longer palpebal lobes, and long (tr.), narrow (exsag.), blade-like posterolateral limbs. Long-eyed species assigned to *Taenicephalus*, e.g. *T. megalops* Kobayashi (1938, pp. 183-4, pl. XVI, figs. 7-10) from British Columbia, and *T. polyaricus* Rosova (1963, p. 12, pl. 1, fig. 12; 1968, p. 83, pl. 2, figs. 1-9) from the northwest Siberian Platform, although imperfectly preserved, appear not to belong to either *Taenicephalus* or *Taenicephalites*.

Taenicephalites also resembles *Amorphella* Rosova, 1963, which has slightly longer palpebral lobes, and more gently convex (sag.) preglabellar field. In dorsal view, cranidia of *Amorphella modesta* Rosova (1963, p. 14, pl. 2, figs. 1-2; 1968, p. 117-120, pl. VII, figs. 6-4; Lazarenko *in* Lazarenko & Nikiforov, 1968, pp. 54-55, pl. XIII, figs. 1-5) closely compare with the specimens illustrated here as *Taenicephalites plerus* sp. nov., but do not show the extent of the posterolateral limbs. Pygidia assigned to the Russian *Amorphella* and the Australian *Taenicephalites* differ: the Siberian pygidia are less transverse, have wider borders, and more axial and pleural segments. There is no guarantee however, that cranidia and pygidia from either region are correctly matched.

Taenicephalites has more or less transverse ocular ridges. Smooth species of *Dunderbergia*, e.g. *D. nitida* (Hall & Whitfield) *sensu* Palmer (1965, p. 41, pl. 4, fig. 5), and *D. simplex* Rasetti (1961, p. 112, pl. 24, figs. 1-5), which are similar to *Taenicephalites*, have sloping ocular ridges, and plane, forward-sloping preglabellar fields.

Several of Ivshin's (1962) genera appear comparable, e.g. *Elegantaspis*, *Petruninaspis*, and *Lochmanaspis*, but cannot be fully assessed at this time.

Taenicephalites plerus sp. nov.
(Pl. 22, figs. 1-9; Text-fig. 29)

Name. L. *plerus*, many, referring to the abundance of this species.

Types. Holotype, cranidium, CPC 15300, illustrated on pl. 22, figs. 1, 4; illustrated paratypes CPC 15301-15307; non-illustrated paratypes CPC 17575-17632.

Material. Fifty-nine cranidial fragments and seven pygidia. Cranidia range in length between 1.60 and 4.60 mm, measured pygidia (Lp_2) between 1.00 and 3.10 mm.

Occurrence. Chatsworth Plains, localities D124, 487, 489, G41609; Horse Creek, horizons K215, 216, 217, 218, 219, 220, 221, 222, 223, 224, 225, 226, 227, D668; Lily Creek, horizons B790, K199, 200, 15-24 m from the base of the measured section; BMR Boulia No. 6, 26.75 - 83.00 m; BMR Duchess No. 13, 30.90-83.05 m.

Age. Late Cambrian, Assemblage-Zones of *Wentsuia iota - Rhaptagnostus apsis* and *Peichiashania secunda - Prochuangia glabella*.

Diagnosis. *Taenicephalites* species with palpebral lobes situated about the mid-length of the glabella, and pitted anterior cranidial marginal furrow. The exoskeleton has mostly effaced furrows.

Differential diagnosis. *Taenicephalites plerus* sp. nov. has similarly long and narrow posterolateral limbs, glabella, and preglabellar area and similarly convex anterior and lateral profiles as the holotype, *T. macrops* Rasetti (1961, pl. 25, figs. 1-3). Both species have smooth exoskeletons, but parietal surfaces of *T. plerus* are punctate. The palpebral lobes of *T. macrops* are possibly sited further forwards and closer to the axial furrows than in *T. plerus*. No pygidial comparison is possible.

T. plerus has a more convex (sag.) preglabellar field than *Amorphella modesta* Rosova (1968, pl. VII, fig. 8), less divergent preocular facial sutures, and shorter (exsag.) palpebral lobes situated further away from the axial furrows. Its pygidium is considerably more transverse, and possesses only two axial segments, whereas *Amorphella* has four.

The illustrated parietal surface of *T. plerus* (Pl. 22, fig. 6) resembles that of *Camaraspoides berkeyi* (Resser) *sensu* Frederickson (1949, pp. 349-350, pl. 68, fig. 4) from the *Elvinia* Zone in Oklahoma.

Description. Generally, in early holaspides (e.g. Pl. 22, figs. 1, 3, 5) the glabella is narrow, cylindrical, and gently tapered forwards. In later holaspides (Pl. 22, figs. 2, 6), it appears to be proportionately shorter (sag.). Thus the glabellar length (G) varies between 47 and 61% of the cranidial length (Lc), and with the occipital ring added (Gn), 63-77%. Glabellar furrows are effaced on the exoskeleton (eg. Pl. 22, fig. 1), but parietal surfaces (fig. 6) show three pairs of furrows: the preoccipital furrows are gently curved, strongly inclined rearwards, and may open into the axial furrows; the median lateral furrows are gently curved, transverse; and the anterior lateral furrows similar, but much shorter and considerably fainter.

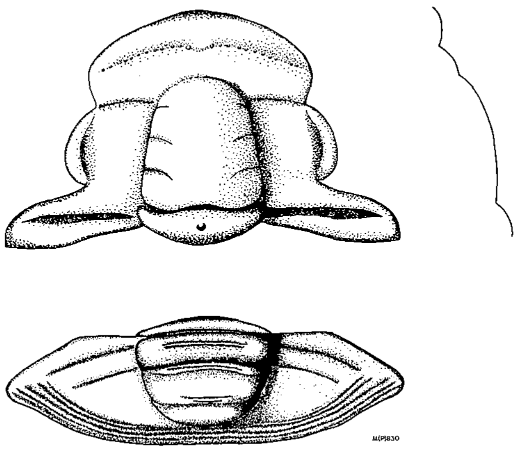


Fig. 29. ***Taenicephalites plerus*** **sp. nov.; exoskeletal reconstruction based on CPC 15300 (cranidium), x10, and CPC 15305 (pygidium), x4.**

The occipital ring is as wide (tr.) as the preoccipital glabellar lobes, and bears a median node. The lateral portions of the occipital ring are appreciably narrower (exsag.) than the central portion, and appear to connect laterally with the postocular fixigenae.

The preocular facial sutures diverge forwards at varying angles, depending on the degree of flattening of the preglabellar area. The anterior cranidial contour is rounded to slightly pointed, and the cranidial border occupies 50-70% of the preglabellar area (sag.). In lateral profile the preglabellar field is appreciably convex (Pl. 22, fig. 4), the anterior cranidial marginal furrow prominent and pitted. There is a tendency to form a plectrum sagittally. The postocular sections of the facial suture diverge widely, and enclose long (tr.) narrow (exsag.) posterolateral limbs which bear prominent posterior cranidial marginal furrows. The posterior cranidial margin is sigmoidal: most specimens in which it is preserved have a thickened posterior border distally, this starting at the central bend of the sigmoidal margin, directly behind the palpebral lobe.

The palpebral lobes are gently arcuate, externally bear faint palpebral furrows, and are scarcely differentiated from the gently convex weakly inclined palpebral areas. Parietal surfaces, however, bear fairly well defined palpebral furrows. The palpebral lobes are situated opposite the glabella, between the middle of the preoccipital glaellar lobes and the anterior lateral furrows, occupying between one-half and three quarters of the glabellar length (G), 40-54% of parameter Gn, this variation evidently being due to change in glabellar proportions during morphogenesis. The interocular width (tr.) is notable, although the posterior palpebral width (tr.) is less than the exsagittal length of the palpebral lobes. Gently curved and oblique ocular ridges are extremely faint on the exoskeleton, more strongly defined on parietal surfaces.

The pygidium attributed to *Taenicephalites plerus* is transverse, with length (Lp_2) approximately 30% of the maximum width. The axis is wide (tr.), short (sag.), and posteriorly truncate, terminating in front of the posterior border. There is no post-axial ridge. A single axial segment is clearly defined, a second exists on some specimens, partly fused to a terminal piece. A single pleural segment is also evident from the presence of a first pair of pleural furrows, which fade out before reaching the marginal furrow. Behind this segment, two further ones may be fused toether. The marginal furrow is faint and shallow, the border low. Articulating facets are prominent and steeply inclined for such a transverse structure. The articulating half-ring is a duplication of the first axial segment. Pygidia of *T. plerus* are characterised by the presence of four or five concentric terrace lines which parallel the margin of the shield. Transverse terrace lines also occur on the more elevated portions of the axial 'rings'.

The exoskeleton is smooth; parietal surfaces appear to be punctate. Other than that which can be observed on CPC 15304 and 15307 (Pl. 22, figs. 5, 9, respectively), little is known of the caecal system.

Family **SHUMARDIIDAE** Lake, 1907

Genus **Koldinioidia** Kobayashi, 1931

Type species. Koldinioidia typicalis Kobayashi (1931, pp. 187-8, pl. X, figs. 8b, 9), Chiushukou Shale, Chiushukou and Hualienchai, Manchuria; designated Kobayashi (1931).

Other species. See Shergold (1975, p. 99), who also comments on the concept of the genus.

Subgenus **Liriamnica** subgen. nov.

Name. Compounded from Gk λειριον, lily, and L. *amnis*, stream, and alluding to Lily Creek. A feminine gender is assigned.

Type species. *Liriamnica antyx* sp. nov., from Lily Creek, Chatsworth area, western Queensland; here designated; monotypical.

Diagnosis. *Liriamnica* represents *Koldinioidia*-like species whose cranidia are bacculate, and possess an anterior cranidial border throughout morphogenesis. They apparently have a facial suture, but lack palpebral lobes. Although the glabellar furrows are effaced, *Liriamnica* has a strong occipital node. Its posterolateral limbs are extended into a blunt point.

Differential diagnosis. Overall cranidial morphology closely resembles that of *Koldinioidia*: an anterior cranidial border, suspected during early holaspid morphogenesis of *Koldinioidia*, is present throughout the holaspid development of *Liriamnica*. Facial sutures, not readily interpreted on most species of *Koldinioidia*, also appear to be visible throughout *Liriamnica* morphogenesis. However, such similarity exists in glabellar, occipital, and fixigenal morphology that a subgeneric relationship is advocated here.

Liriamnica has a broad (tr.), short (sag.), forwards-tapering glabella which distinguishes it from other Shumardiidae such as *Hospes* and *Idiomesus*. Its frontal lobe lacks the lateral expansion seen in *Shumardia*, *Shumardops* and *Eoshumardia*.

Koldinioidia (Liriamnica) antyx subgen. et sp. nov.
(Pl. 18, figs. 6-12)

Name. L. *antyx*, f., rim or edge, referring to the presense of an anterior cranidial border.

Types. Holotype, cranidium, CPC 15375, pl. 18, figs. 6, 8; illustrated paratypes, CPC 15374, 15376, 15377; non-illustrated paratypes, CPC 17633-17639.

Material. Eleven cranidia with lengths (Lc) between 0.85 and 2.50 mm.

Occurrence. Lily Creek section, horizons K208, 210 and 211, between 144-246 m from the base of the measured section.

Age. Late Cambrian, Assemblage-Zones of *Peichiashania tertia - P. quarta* and *Hapsidocare lilyensis*.

Diagnosis. See subgeneric diagnosis above.

Differential diagnosis. *Koldinioidia (Liriamnica) antyx* sp. nov. resembles such previously described species as *Koldinioidia (K.) payntonensis* Shergold (1975, pp. 101-2, pl. 58, figs. 6-10) from the latest Cambrian (Payntonian) at Black Mountain, western Queensland, and *K. (K.) sulcata* Robison & Pantoja-Alor (1968, pp. 796-7, pl. 104, figs. 20-23) from the early Ordovician of Nochixtlán, Oaxaca Province, Mexico, in its glabellar and occipital morphology. However, its frontal lobe is less pointed than in the two cited species, and its occipital ring bears a prominent node lacking in the younger species, neither of which possess an anterior cranidial border. *K. (K.) cylindrica* (Shergold) (1972, pp. 65-66, pl. 18, figs. 7-8) and *K. (K.)* cf. *cylindrica* (Shergold) (1975, pp. 100-101, pl. 58, figs. 1-4) have a more totally effaced glabella which tends to merge anteriorly with the preglabellar field. The occipital ring of these species is only as wide as the preoccipital glabellar lobes, whereas in *K. (L.) antyx*, *K. (K.) sulcata* and *K. (K.) payntonensis* it is considerably wider (tr.). The combination of anterior cranidial border and more obvious facial sutures suggests the derivation of *Koldinioidia (Liriamnica)* from a ptychoparioid stock (possibly lonchocephaliid) possessing both palpebral lobes, hence eyes, and borders.

Description. The cranidium is broadly trapezoidal, with low lateral convexity but appreciable vaulting evident when viewed anteriorly.

The glabella is subcylindrical, tapers slightly forwards, particularly in small specimens, and is anteriorly rounded. It occupies (G) 53-69% of the cranidial length, 76-84% if the occipital ring is included (Gn). Glabellar furrows are effaced, being represented by two pairs of pits lying close to the axial furrows, and an anterior pair of very faint 'accessory furrows' (Robison & Pantoja-Alor, 1968, p. 796). The occipital furrow is sharply incised, and arches forwards sagittally. In lateral profile the occipital ring lies on the same plane as the dorsal surface of the glabella, and only the high point of the posteriorly sited median occipital node rises above this level (Pl. 18, fig. 10). In plan view the occipital ring is observed to be wider (tr.) than the glabella, and to merge laterally into the posterior borders of the cranidium.

The preglabellar area is composed of a short (sag.) preglabellar field which falls abruptly to a fairly prominent marginal furrow, apparently pitted, and a flat-lying anterior cranidial border. Palpebral lobes are apparently lacking, or are undifferentiated. Nevertheless, 'preocular' sections of the facial suture converge forwards, and 'postocular' sections diverge rearwards, from an area opposite the anteriormost pair of glabellar pits, which is about 0.75 of the glabellar width distant from the axial furrows, i.e. at a point from which palpebral lobes might be expected.

The 'postocular' sections of the facial suture apparently enclose broadly triangular posterolateral limbs which are bluntly pointed distally. At a prominent geniculation the posterolateral limbs slope strongly abaxially to give the high vaulting of the cranidial shield. Faint ovoid bacculae are developed (Pl. 18, fig. 7) on most specimens adjacent to the axial furrows, at the corners of the fixigenae.

The cranidial exoskeleton is smooth.

Family *INCERTAE SEDIS*

Genus **Guizhoucephalina** Chien, 1961

Type species. *Guizhoucephalina longispina* Chien (1961, p. 120, pl. IV, figs. 1-6; pl. V, fig. 1; text-fig. 2), Late Cambrian, Sandu Shale, Yangjiawan, Sandu, Kweichow, China; by monotypy.

Guizhoucephalina? sp.
(Pl. 20, fig. 8)

Material. Two cranidial fragments having lengths (sag.) of 3.50 and 4.10 mm: CPC 15389 is illustrated, CPC 17640 is not.

Occurrence. Chatsworth Plains, locality D124.

Age. Late Cambrian, *Wentsuia iota - Rhaptagnostus apsis* Assemblage-Zone.

Comments. The available material referred with query to *Guizhoucephalina* represents a nepeiform species with only the faintest traces of an incipient preglabellar boss and fixigenal bacculae. It is characterised by transverse ocular ridges which terminate in small elevated palpebral lobes, a broad (sag.) anterior cranidial marginal furrow, and gently reflected anterior cranidial border. No doubt the species also possessed extensive backward-directed falcate posterolateral limbs.

Guizhoucephalina? sp. possesses glabellar furrows, not seen in the type species *G. longispina* Chien, but very much reminiscent of *Crucicephalus ocellatus* Shergold (1972, pl. 16, figs. 1-2), and the Tremadocian *Amzasskiella mirabilis* Petrunina (1960, p. 432, pl. XX, figs. 19-20). *Guizhoucephalina?* sp. also has similar bigranulose prosopon and caecal network to these species, but lacks a pitted cranidial marginal furrow, and prominent boss and bacculae.

Superfamily **LEIOSTEGIACEA** Bradley, 1925
Family **LEIOSTEGIIDAE** Bradley, 1925
Subfamily **PAGODIINAE** Kobayashi, 1935.

Genus **Prochuangia** Kobayashi, 1935

Type species. *Prochuangia mansuyi* Kobayashi (1935C; pp. 186-7, pl. VIII, fig. 8, pl. X, figs. 1-7, = *Chuangia nais* Walcott *sensu* Mansuy, 1915, pp. 20-22, pl. II, fig. 14, *non* Walcott, 1911, pp. 84-5, pl. 15, fig. 5), Late Cambrian, Saisho-ri, South Korea, and Tonkin; designated Kobayashi (1935C, p. 185).

Other species. Some revision of the list previously given (Shergold *in* Shergold, Cooper *et al*., 1976, p. 277-8) is necessary following recent work:

Conocephalites quadriceps Dames (1883, p. 9, pl. 1, figs. 13-18) (referred to *Schantungia* by Lorenz, 1906, p. 94: to *Prochuangia* by Kobayashi, 1937A, pp. 75-6, pl. 17, figs. 2a-c; Lu *et al*., 1965, p. 416, pl. 79, figs. 2-4; and *Kaolishania?* by Schrank, 1975, pp. 597-8, pl. III, fig. 7, pl. IV, figs. 1-9; *non* pl. V, figs. 1-2), Liaotung, Manchuria. *Prochuangia angusta* Kobayashi (1935C, pp. 188-9; pl. IX, fig. 12), Saisho-ri, South Korea. *Prochuangia posterospina* Kobayashi (1935C, pp. 187-8, pl. X, fig. 8), as *P. angusta*. *Prochuangia imamurai* Endo (1944, pp. 69-70, pl. 10, fig. 12; refigured in Lu *et al*., 1965, p. 415, pl. 79, fig. 1), Paishan Formation, Fengtien, Manchuria. *Prochuangia granulosa* Lu (1956B, pp. 376-7, pl. 1, fig. 5, refigured with additional material in Lu *et al*., 1965, p. 414, pl. 78, figs. 22-23), Yüping, eastern Kweichow, China. *Prochuangia* sp., Henderson (1976, p. 354, pl. 5, fig. 19), Idamean, *Irvingella tropica/Agnostotes iconstans* Zone, Glenormiston, western Queensland, Australia. *Prochuangia* sp. aff. *P. granlosa* Lu (Shergold *in* Shergold, Cooper *et al*., 196, pp. 278-281, pl. 3, figs. 1-6), Bowers Group, Evans Névé, Northern Victoria Land, Antarctica.

Diangosis. Cranidium anteriorly transverse or gently curved, with reflected cranidial border, and prominent marginal furrow; glabella cylindrical or conical, generally laterally constricted; variably wide interocular fixigenae; palpebral lobes lying adjacent to glabellar midpoint; slightly advanced genal spines. Pygidium with rounded anterolateral corners; no marginal furrows externally; pair of posterolaterally or posteriorly directed spines. Prosopon may be smooth or granulose.

Comments. Cranidially, *Prochuangia* species fall into two inter-grading groups. Group 1, based on *P.*

mansuyi Kobayashi and including such forms as *P. angusta* Kobayashi, *P. glabella* sp. nov., and probably *P. granulosa* Lu, has a depressed or gently reflected anterior cranidial border, and cylindrical laterally constricted glabella. This group resembles species of *Iranochuangia* Kobayashi, *Pagodia (Oreadella)* Shergold, and later Leiostegiidae, and is related to *Chuangia* (type species *Batia* Walcott, 1911, p. 84, pl. 15, figs. 3, 3a) through intermediates such as *Prochuangia angusta* and *Chuangia nais* Walcott.

Group 2, consisting of *Prochuangia quadriceps* (Dames) and *P.* sp. aff. *granulosa* Lu (*sensu* Shergold, *in* Shergold, Cooper *et al.*, 1976), has a narrow strongly reflected anterior cranidial border, and an often conical glabella which may (*P.* sp. aff *granulosa*) or may not *(P. quadriceps)* be laterally constricted. This group closely resembles *Pagodia (Pagodia)* Walcott, *P. (Idamea)* Whitehouse, *P. (Wittekindtia)* Wolfart, and particularly *Lotosoides* Shergold, 1975. In fact, Schrank (1975, pls. 3-5) has illustrated material referrable to both *Prochuangia* and *Lotosoides* (see Pl. 5, figs. 3-4) under *Kaolishania?* cf. *quadriceps* (Dames). It may be significant that two cranidial species-groups exist also among species of *Chuangia* and *Pagodia,* although in the latter case they have been divided as subgenera.

The pygidium assigned to *Prochuangia* is laterally spinose, and closely resembles that of *Lotosoides. Pagodia, Chuangia, Chuangioides* Chu and *Szechuanella (in* Lu *et al.*, 1965) are non-spinose, and *Eochuangia* Kobayashi has a single post-axial spine. Among *Prochuangia* species the position of the lateral spines is variable; they may be posterolaterally or posteriorly directed, and the amount of margin between the spine bases varies, imparting apparently different shield shapes.

All the genera noted (Table 2) have intergrading characteristics and can be distinguished only by particular combinations of characters. The combination of degree of lateral constriction of the glabella, orientation of the anterior cranidial border, and presence or absence of pygidial spines, appears to be reliable in discriminating most of these genera. Basically, *Prochuangia* can be regarded as a *Chuangia* with lateral pygidial spines, just as *Lotosoides* is a *Pagodia* with such spines.

Prochuangia glabella sp. nov.
(Pl. 23, figs. 1-8; Text-fig. 30)

Name. L. *glabella*, dim. from *glaber*, smooth, referring to the exoskeletal prosopon of this species.

Types. Holotype, CPC 15242, cranidium, illustrated on Pl. 23, fig. 2; illustrated paratypes, CPC 15243-15248; non-illustrated paratypes, CPC 17641-17663.

Material. The species is based on the remains of thirteen cranidia, seven librigenae, and ten pygidia; cranidia range in length between 3.70 and 6.70 mm, and pygidia (Lp_2) from 1.50-2.90 mm.

Occurrence. Lily Creek, horizons K199, 200, 202, 203, 204, 205, B54a, 54b, and 790, 15-72 m from the base of the measured section.

Age. Late Cambrian, Assemblage-Zones of *Wentsuia iota - Rhaptagnostus apsis* and *Peichiashania secunda - Prochuangia glabella.*

Diagnosis. A smooth, thick-shelled *Prochuangia* species, whose anterior cranidial border is depressed and flat-lying; whose palpebral lobes lie mainly to the rear of the glabellar mid-point; and whose pygidial spines are directed posteriorly from the flanks of the shield.

Differential diagnosis. Cranidially, *Prochuangia glabella* most closely resembles *P. mansuyi* Kobayashi (1935C, pp. 186-7, pl. VIII, fig. 8; pl. X, figs. 1-7), the type species of *Prochuangia,* having a similarly shaped glabella, palpebral lobes of similar size and situation, and similarly orientated anterior border. Kobayashi *(op. cit.)* assigned a librigena with non-advanced genal spine to *P. mansuyi;* that of *P. glabella* is slightly advanced, as in other Pagodiinae.

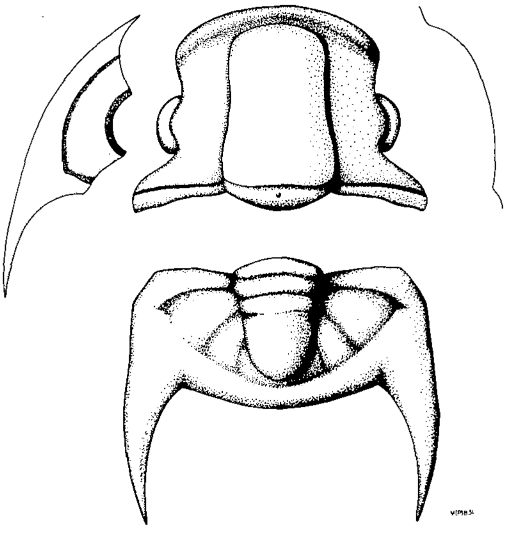


Fig. 30. ***Prochuangia glabella*** **sp. nov.; exoskeletal reconstruction based on CPC 15242 (cranidium), x8, CPC 15245a (librigena), x4, and CPC 15248a (pygidium), x7.**

TABLE 2

RELATIONSHIPS AMONG PAGODIID GENERA.

CHARACTER / TAXON	Orientation of cranidial margin	Orientation of anterior cranidial border	Condition of anterior cranidial marginal furrow	Shape of glabella	Interocular fixigenae	Palpebral lobes	Condition of pygidial margin	Condition of pygidial marginal furrows	Prosopon
Chuangia batia (Walcott) group	gently arched forwards	upraised, near vertical	wide (sag.), shallow, equals concave preglabellar furrow	truncatoconical/ laterally constricted	wide	behind midpoint of glabella	entire	externally effaced	
Chuangia nitida Walcott group	gently arched forwards	gently reflected	narrow (sag.) prominent groove	conical / straight sided	wide	adjacent to glabellar midpoint	entire	externally effaced	
Chuangia transversalis Kobayashi group	transverse or concave posteriorly	upraised, near vertical	narrow (sag.) medianly shallow	conical / straight sided	moderately wide	adjacent to glabellar midpoint	entire	externally effaced	
Prochuangia Kobayashi, 1935	curved gently forwards anteriorly	depressed, flat, or gently reflected	narrow (sag.) prominent groove	subrectangular / laterally constricted	moderately wide	behind midpoint of glabella	posteriorly or posterolaterally deflected spines	externally effaced	granulose and smooth
Pagodia (Pagodia) Walcott, 1905	anteriorly curved	depressed or gently reflected	narrow (sag.) deep prominent groove	subrectangular / straight sided	moderately narrow	behind midpoint of glabella	entire	externally present	
Pagodia (Idamea) Whitehouse, 1939	curved gently forward	upraised overfolded	narrow (sag.) deep prominent groove	truncatoconical/ laterally constricted	wide	behind midpoint of glabella	entire	externally effaced	
Pagodia (Oreadella) Shergold, 1975	anteriorly curved	depressed flat	shallow but prominent	cylindrical / laterally constricted	narrow	adjacent to glabellar midpoint	entire	parietally weak, externally effaced	granulose
Pagodia (Datsonia) Shergold, 1975	anteriorly curved	depressed wirelike	shallow (sag.) partly effaced	subrectangular/ laterally constricted	narrow	behind midpoint of glabella	entire	externally effaced	granulose
Pagodia (Wittekindtia) Wolfart, 1974	anteriorly gently curved	upraised overfolded	narrow (sag.) deep prominent	subrectangular/ laterally constricted	moderately wide	behind midpoint of glabella	entire	laterally present	
Lotosoides Shergold, 1975	anteriorly gently curved	upraised overfolded	narrow (sag.) deep prominent groove	conical/laterally constricted	wide	behind midpoint of glabella	posteriorly directed spines	externally effaced	granulose
Eochuangia Kobayashi, 1935	anteriorly gently curved			subrectangular / straight sided	narrow	adjacent to glabellar midpoint	single postaxial spine	externally effaced	
Iranochuangia Kobayashi, 1960	anteriorly gently curved	depressed flat	shallow prominent groove	subrectangular / laterally constricted	wide	behind midpoint of glabella	entire	externally effaced	
Chuangioides Chu, 1959							entire	externally effaced	granulose
Szechuanella Lu, 1959	anteriorly very gently curved	upraised vertical?	deep narrow (sag.)	subrectangular / laterally constricted	narrow	adjacent to glabellar midpoint	entire	present?	granulose

M(P) 843

The posterior orientation of the pygidial spines of *P. glabella* is somewhat similar to that of *P. posterospina* Kobayashi (1935C, pp. 187-8, pl. X, fig. 8), from Korea, but *P. glabella* has a considerably wider (tr.) posterior margin between the spine bases. *P. granulosa* Lu (1956B, pp. 376-7, pl. 1, fig. 5; *in* Lu *et al.* 1965, p. 414, pl. 78, figs. 22-23), *Prochuangia* sp. aff. *granulosa* Lu (Shergold *in* Shergold, Cooper *et al.*, 1976, pp. 278-281, pl. 3, figs. 4-5), *P. quadriceps* (Dames, 1883) (see Kobayashi, 1937A, pp. 75-6, pl. 17, figs. 2a-c), *P. mansuyi*, and *Prochuangia* sp. (Henderson, 1976, p. 354, pl. 5, fig. 79) all have posterolaterally deflected spines, but the extent of posterior margin between the spine bases varies, giving rise to slight variation in shield appearance. Hence, the pygidium of *P. glabella* is basically transverse while that of *P. granulosa* might be described as subtriangular.

The smooth exoskeleton of *P. glabella* readily differentiates it from *P. granulosa* Lu and *P.* sp. aff. *P. granulosa* Lu (Shergold, *in* Shergold, Cooper *et al.*, 1976).

Description. The anterior cranidial outline is curved gently forwards. The glabella is long (sag.), cylindrical, somewhat truncate anteriorly, with constricted lateral flanks and externally effaced furrows. The external effacement of the occipital furrow and consequent apparent fusion of the occipital ring with the glabella exaggerates the glabellar length. Exfoliated material indicates the presence of an occipital ring bearing an occipital node, and the extent of the glabella (G:Lc is 74-80% for mainly exfoliated specimens: Gn:Lc is 89-93% for mainly external surfaces). Parietal surfaces (Pl. 23, fig. 3) also indicate the distribution of muscle scar impressions.

The palpebral lobes are gently arcuate, approximately one-third of the length of the glabella and occipital ring combined. Their mid-points are set one-half of the preoccipital glabellar width (tr.) from the axial furrows, and posterior to the mid-point of the glabella. Preocular facial sutures enclose a preglabellar area slightly less wide (tr.) than the interocular width, comprising a shallow but prominent marginal furrow, and flat, ledge-like anterior cranidial border which in lateral profile lies well below the level of the dorsal surface of the glabella. This border occupies 7-14% of the total cranidial length (sag.). Ocular ridges are externally effaced, but visible on exfoliated specimens (Pl. 23, fig. 3). Postocular facial sutures enclose short (tr.) triangular posterolateral limbs.

The librigena referred to this species (Pl. 23, fig. 1) has a prominent but narrow (tr.) genal field bearing a subocular groove, and is bounded by shallow, but definite, lateral and posterior marginal furrows, which are confluent at the genal angle. The genal spine is short, stout, and broad-based. A short anterior prong is preserved.

If the lateral spines are ignored, the pygidium of *Prochuangia glabella* is transversely rectangular, with length (Lp_2) 46-53% of the width. Fulcral points are wide-spaced, but not prominent, and the anterolateral pygidial corners are gently rounded. A short axis is composed of two well defined segments, a poorly indicated third, and a bluntly rounded terminal piece. The articulating half-ring is a bar approximating half the sagittal length of the first segment. Externally, transverse furrows are effaced, but parietally they are prominent, and confluent with the axial furrows laterally. There is no post-axial ridge. A single pair of pleural furrows is generally visible externally, but exfoliated specimens indicate the presence of at least another pair, and possibly a third. Parietally, and faintly externally, the furrowed pleural zone is seen to be restricted to a narrow (tr.) triangular area delineated by a faint marginal furrow, possibly representing the trace of the edge of the doublure impressed on the dorsal surface of the specimen. Pygidial spines, drawn from the lateral borders, are relatively short and stout, distally incurved, and posteriorly directed. Between the spine bases the posterior pygidial margin is wide (tr.) and gently curved backwards, the shield having a shallow 'bowl'.

Prochuangia glabella has a smooth external prosopon save for the possession of terrace lines along the anterior edge of the cranidial and posterior fixigenal borders, the lateral edge of the librigena, lateral edges of the genal spines, and doublure (Pl. 23, fig. 8). Exfoliated surfaces are finely and densely punctate. The shell is thick (Pl. 23, figs. 6, 8).

Genus **Lotosoides** Shergold, 1975
[= *Pagodia (Lotosoides)* Shergold, 1975]

Type species. *Pagodia (Lotosoides) calcarata* Shergold (1975, pp. 174-6, pl. 37, figs. 1-6), Late Cambrian, *Rhaptagnostus clarki prolatus*/*Caznaia sectatrix* and *Rhaptagnostus bifax*/*Neoagnostus denticulatus* Assemblage-Zones, at Black Mountain, Boulia area, western Queensland; by original designation.

Other species. *Pagodia (Lotosoides) turbinata* Shergold (1975, pp. 176-7, pl. 36, figs. 4-7), Late Cambrian, assemblage-zones and locality as for type species. *Kaolishania?* cf. *quadriceps* (Dames, 1883) *sensu* Schrank (1975, p. 598, pl. 5, figs. 3-4), Saimaki, Liaotung, Manchuria.

Diagnosis. See Shergold (1975, pp. 173-4).

Comments. Originally conceived as a subgenus of *Pagodia, Lotosoides* is now considered to represent a district genus of the Pagodiinae. By virtue of its pygidial spines, it stands with regard to *Pagodia* and its subgenera, as *Prochuangia* stands to *Chuangia*.

Meraspides of *Prochuangia* and *Lotosoides* apparently have similar glabellar and pygidial characteristics, and the meraspid pygidium of *Kaolishania* is also very close (compare herein pl. 24, fig. 6, with *K. australis* Shergold, 1972, pl. 12, figs. 1, 3-4). As in *Pagodia (Pagodia)* Walcott (see *P. (P.) lotos* Walcott, 1913, pl. 15, fig. 12), holaspid cranidia of *Lotosoides* invariably have anteriorly tapered glabellae, which may be gently constricted about the median lateral glabellar lobes. They also have narrow, upraised cranidial borders. One characteristic, previously overlooked, which is well illustrated by the present material, is the lateral interconnection of the occipital lobe with the postocular fixigenae. Presumably these bridging features are the surface expressions of caecal diverticula. Similar features linking the anterolateral corners of the glabella to the preocular areas have been commented upon before (Shergold, 1975, p. 175). Both diverticular expressions are also noted in *Kaolishania australis* Shergold (1972, p. 49, pl. 12, figs. 5-8), and *Pagodia (Idamea) baccata* Öpik.

In general, the pygidium of *Lotosoides* has a deeper 'bowl' (Shergold, 1972, p. 15) than that of *Prochuangia,* although some species of the latter genus, eg. *P. granulosa* Lu (1956B, pp. 376-7, pl. 1, fig. 5; *in* Lu *et al.*, 1965, pl. 78, fig. 22), *P.* sp. aff. *P. granulosa* Lu (Shergold *in* Shergold, Cooper *et al.*, 1976, pl. 3, fig. 4) have pygidia virtually indistinguishable from those of *Lotosoides*.

Lotosoides bathyora sp. nov.
(Pl. 24, figs. 2-8)

Name. Gk $\beta\alpha\theta\upsilon\varsigma$, deep, and L. *ora*, f., border, referring to the depth of the pygidial bowl.

Types. Holotype, CPC 15255, pygidium illustrated on Pl. 24, fig. 8; figured paratypes, CPC 15249-15254; unfigured paratypes CPC 17664-17671.

Material. Five cranidia plus several fragments, having estimated lengths (Lc) of 2.4 - 7.9 mm; one librigena; and ten pygidia with estimated lengths (Lp_2) 1.6 - 5.0 mm.

Occurrence. Lily Creek, horizons K200, 201, B54b, and possibly K203, 206, 24-52 m and possibly extending to 92 m from the base of the measured section; Horse Creek, K222; Chatsworth Plains, D124, G41609.

Age. Late Cambrian, Assemblage-Zones of *Wentsuia iota - Rhaptagnostus apsis* and *Peichiashania secunda - Prochuangia glabella*.

Diagnosis. *Lotosoides* species with deep holaspid pygidial 'bowl' and wide (sag.) posterior border.

Differential diagnosis. The cranidium of *Lotosoides bathyora* is indistinguishable from that of *L. calcarata* Shergold, as far as comparisons can be made between exoskeletons and parietal moulds. The pygidium, however, has greater posterior curvature between the spine bases, and wider (sag., exsag.) borders distinguished from the pleural zone by stronger marginal furrows, both externally and parietally. *L. bathyora* has a similar finely granulose prosopon to *L. calcarata,* which is sufficient to distinguish it from the coarsely granulose *L. turbinata*. Pygidia of *L. turbinata* are additionally differentiated by their lack of well developed spines. It is not possible to readily distinguish the cranidia which Schrank (1975, pl. V, figs. 3-4) has illustrated as *Kaolishania?* cf. *quadriceps* (Dames) from those of *Lotosoides bathyora*.

Description. Meraspid cranidia have a more or less rectangular, anteriorly bluntly rounded glabella (Pl. 24, fig. 4), whereas in late holaspides (Pl. 24, fig. 3) it is distinctly forward tapered, and noticeably constricted adjacent to the median lateral glabellar lobes. When shell is preserved, the glabellar furrows are effaced or extremely faint. Exfoliation of the shell, however, reveals the existence of three pairs of furrows.

The axial furrows, which are well incised adjacent to the glabellar lobes, shallow appreciably at the occipital ring, which appears to be laterally connected by an underlying diverticulum to the postocular fixigenae. Accordingly, the proximal extremities of the posterior cranidial marginal furrows seem to pass below the occipital ring. Distally these furrows terminate before reaching the posterolateral margin of the cranidium.

Anteriorly, the glabella abuts a forward-arched cranidial border which in lateral profile is seen to be an upraised ridge. Anterolaterally, the glabella is connected to the preocular areas by faint ridges (diverticula) which obstruct the anterior course of the axial furrows. They seem to be related to, but offset from, faint obliquely orientated ocular ridges.

The palpebral lobes are not well preserved on any of the available material, but nevertheless appear to have been short (exsag.), gently arcuate, and mostly situated behind the mid-point of the glabella (G), between the middle of the preoccipital and middle of the median lateral glabellar lobes. The posterior palpebral width (tr.) is equal to the length (exsag.) of the palpebral lobes.

The librigena associated with this species (Pl. 24, fig. 5) is incomplete, but appears to conform to the general pagodiid style in having a thickened lateral border and distinct eye socle. It cannot be determined whether this specimen had an advanced genal spine.

The meraspid pygidium is transverse, with only a gently curved posterior margin between the spine bases. In the holaspid condition, however, the pygidium is subtriangular, with appreciable posterior bowing of the margin. Distinct fulcral points are developed, and together with strongly sloping articulating facets give the shield a distinctly 'shouldered' appearance. Holaspid lateral spines are slender. Both meraspides and holaspides appear to have similar segmentation, with four axial and three pleural divisions evident. In holaspides the axis tapers gently rearwards and terminates bluntly, well in front of the posterior margin and distinct wide posterior and posterolateral borders.

Meraspid cranidial prosopon comprises a sparse bigranulosity (Pl. 24, figs. 4, 6), but in holaspides both cranidia and pygidia have a fine dense granulation. On the preocular areas the granules appear to radiate from the ocular ridges, presumably following caecal lines.

Lotosoides sp. cf. **L. calcarata** Shergold, 1975. (Pl. 23, figs. 9-10; Pl. 24, fig. 1)

cf. 1975. *Pagodia (Lotosoides) calcarata* subgen. et sp. nov. Shergold, 1975, pp. 174-6, pl. 37, figs. 1-6, CPC 11879-11884.

Material. Fragments of a cranidium and a pygidium, CPC 15256-15257, illustrated but not sufficiently complete to measure.

Occurrence. Lily Creek, horizon K212, 254 m from the base of the measured section.

Age. Late Cambrian, *Hapsidocare lilyensis* Assemblage-Zone.

Comments. What is known of the cranidium suggests close comparison with *Lotosoides calcarata*. Certainly the prosopon is identical, and the only difference which can be suggested, the width of the palpebral areas, may be dependant on preservation in this instance. The exfoliated pygidium cannot be differentiated from the similarly preserved specimen illustrated previously (Shergold, 1975, pl. 37, fig. 6) as *L. calcarata*.

Subfamily **MANSUYIINAE** Hupé, 1955

Genus **Peichiashania** Chang, 1957

Type species. Eymekops rectangularis Endo (*in* Endo & Resser, 1937, p. 334, pl. 68, fig. 21), Daizan Formation, Paichiashan, near Chinchiachengtzu, Manchuria; designated Chang (1957, p. 31).

Other species. Paramansuyella planilimbata Endo (*in* Endo & Resser, 1937, pp. 359-360, pl. 70, figs. 16-19), Daizan Formation, Paichiashan, near Chinchiachengtzu, Manchuria. *Peichiashania prima, P. secunda, P. tertia* and *P. quarta* spp. nov. are described from the Chatsworth Limestone at Lily Creek and Horse Creek, Chatsworth Station, western Queensland. *Peichiashania? lunatula* Öpik (1967, pp. 222-3, pl. 16, fig. 8) and *P.? pelta* Öpik (1967, p. 223, pl. 16, fig. 7), from the Mindyallan *Glyptagnostus stolidotus* Zone of western Queensland, are not congeneric with the species listed above; together with *Proceratopyge polita* Whitehouse (1939, p. 251, pl. XXV, fig. 14), which *Peichiashania? lunatula* closely resembles, they could be placed in a new auritamid genus.

Diagnosis. Mansuyiinae with short (sag.), strongly concave, anteriorly rounded preglabellar area, lacking a definite anterior cranidial border; and long (tr.), narrow (exsag.), blade-like posterolateral limbs.

Differential diagnosis. Like other Mansuyiinae, *Peichiashania* has a concave preglabellar area, long palpebral lobes posteriorly sited with regard to the mid-point of the glabella, and weakly furrowed glabella with interconnected lateral bacculae; pygidia bear a single pair of lateral spines. *Peichiashania* is differentiated from all other Mansuyiinae except *Paramansuyella* by a short (sag.) preglabellar area. In holaspides at least, it lacks a well-defined anterior cranidial border, which differentiates it from *Paramansuyella*. The long bladed posterolateral limbs are quite distinct; *Hapsidocare* has triangular ones and both *Mansuyites* and *Mansuyia* narrow strap-like ones.

Peichiashania pygidia are 'shallow-bowled', as are meraspid pygidia of most other Mansuyiinae presently recognised in Australia. One species, *P. quarta* sp. nov., develops anterolateral shoulders similar to *Mansuyia*, a characteristic carried to its extreme development in *Kaolishaniella*. Posterolateral spines are developed from the opisthopleuron of

TABLE 3
DIFFERENTIAL DIAGNOSIS OF *Peichiashania* SPECIES

SPECIES \ CHARACTER	Glabellar length (G:Lc) %	Relative length of palpebral lobes (A:G) %	L:W of preglabellar area %	Relationship of anterior glabellar margin to preocular areas	Orientation of ocular ridges	Condition of anterolateral pygidial corners	Orientation of lateral spines	Number of axial segments	Condition of posterior pygidial margin	Development of marginal furrow
P. rectangularis *	69	58	18	behind	oblique					
P. planilimbata **	69		19	on line						
P. prima	64	73	15-20	behind	transverse	c.130^{o}	deflected	5 (6)	gently rounded	none
P. secunda	66-68	56	15-20	on line or in front	transverse	115-125^{o}	straight back	6	gently rounded	none
P. tertia	68-75	59-65	14-16	on line	oblique/ transverse	130-140^{o}	deflected	5 (6)	straight	none
P. quatra	66	48-56	15	on line	oblique	c.130^{o}	deflected	6	very gently rounded	present

* type specimen only (Endo, 1937, pl.68, fig.21) ** two cotypes only (Endo, 1937, pl.70, figs 16-17, non 18-19)

(Correction: for *P. quatra* read *P. quarta*)

the first and propleuron of the second pygidial segments as in other Mansuyiinae. The posterior margin between the spine bases has greater curvature than *Hapsidocare*, but less than *Mansuyites* or *Mansuyia*, being most similar to the condition shown by *Paramansuyella* and *Kaolishaniella*.

Comment. *Peichiashania* was erected by Chang (1957, p. 31) for the cranidial fragment described by Endo (*in* Endo & Resser, 1937, p. 334) as *Eymekops rectangularis*. Only a rudimentary diagnosis was given (Chang, 1959, p. 223) based on Endo's specific description. The type specimen is re-illustrated in Lu *et al.* (1965, p. 232, pl. 40, fig. 14).

Although they are in general somewhat more effaced, Australian specimens here described are classified *Peichiashania* because their glabellar, ocular, preglabellar and preocular characteristics are comparable with those of the type species. *Peichiashania*is placed the Family Kaolishaniidae, Subfamily Mansuyiinae, account of cranidial similarity with previously described genera such as *Mansuyia* Sun, 1924, *Taipaikia* Kobayashi, 1960, *Mansuyites* Shergold, 1972, and *Hapsidocare* Shergold, 1975.

In view of the association of cranidia and pygidia comprising the Australian species, it is probable that Asian pygidia not previously ascribed to *Peichiashania* have been described under names such as *Mansuyella lilia* Endo (*in* Endo & Resser, 1937, p. 356, pl. 67, figs. 16, 17, 19) and *M. tokunagai* (Kobayashi) (*sensu* Endo *in* Endo & Resser, 1937, p. 354, pl. 69, figs. 5-6). The latter's cranidia have since been referred to *Shirakiella* (Kobayashi, 1960, p. 390).

The relationship of species assigned to *Peichiashania* is summarised in Table 3.

Peichiashania prima sp. nov.
(Pl. 25, figs. 1-5; Text-fig. 31)

Name. L. *prima*, f., the first.

Types. Holotype, cranidium CPC 15205, illustrated on Pl. 25, fig. 2; illustrated paratypes CPC 15204, 15206-15208; non-illustrated paratypes CPC 17672-17683.

Material. The species is based on fragments of seven cranidia, of which the smallest complete specimen has a length of 4.90 mm and the largest an estimated 18.4 mm; four librigenae; and six pygidia ranging in length (Lp_2) between 5.50 and an estimated 10.5 mm.

Occurrence. Lily Creek, horizons K201, 202, and B790, 24-52 m from the base of the measured section; Horse Creek, horizons K215, 218, 221, 222, 223, 225; Chatsworth Plains, D124. BMR Boulia No. 6, 42.55-43.85 m; BMR Duchess No. 13, 82.55-82.80 m.

Age. Assemblage-Zones of *Wentsuia iota* - *Rhaptagnostus apsis* and *Peichiashania secunda* - *Prochuangia glabella*.

Diagnosis. *Peichiashania* species in which the front of the glabella lies to the rear of a transverse line drawn across the front of the preocular areas, even in meraspides; a distinct convex boss lies at the confluence of the lateral and posterior librigenal furrows, resulting in sigmoidal posterior marginal furrows; the posterior pygidial margin is gently and evenly rounded between the spine bases; the posterolateral spines are laterally deflected from the pygidial margins.

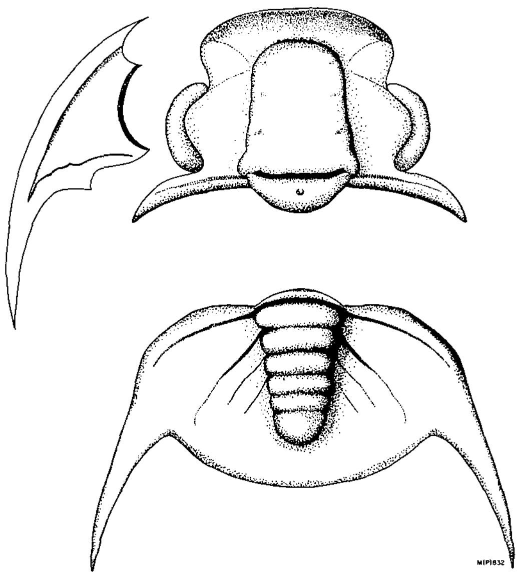


Fig. 31. ***Peichiashania prima*** **sp. nov.; exoskeletal reconstruction based on CPC 15205 (cranidium), x6, CPC 15208a (librigena), x6, and CPC 15207 (pygidium), x2.5.**

Description. The cranidium possesses a subrectangular glabella whose flanks are constricted adjacent to the median lateral lobes. The glabella occupies some two-thirds of the cranidial length (sag.), is anteriorly obtusely rounded, and its furrows are mostly effaced, being represented externally only by weak ovoid depressions, of which three pairs can be counted. At the posterolateral corners of the preoccipital lobes, diverticula pass across the axial furrows and merge into small bacculae.

The palpebral lobes are strongly arcuate, long, about 75% of the glabellar length (G), and posteriorly sited, closely approaching the posterior cranidial marginal furrow. They pass anteriorly into wide (exsag.), faintly duplicated ocular ridges which continue the curvature of the palpebral lobes, becoming almost transverse, to terminate at the axial furrows.

Sigmoidal preocular facial sutures enclose a narrow (sag.) preglabellar area, composed of gently convex (sag.) preocular areas which extend anteriorly in front of the glabella, and an upturned cranidial border with terrace-lined rim. Marginal furrows are developed only laterally, dividing the preocular areas from the border. In front of the glabella the furrows pass into a flat or gently concave preglabellar field interposed as a platform between the frontal glabellar lobe and the cranidial border. The length (sag.) of the preglabellar area of the holotype is almost 20% of its width (tr.). At least three pairs of prominent diverticula issue from the frontal glabellar lobe and cross the preocular areas and preglabellar field.

The occipital ring is as wide (tr.) as the preoccipital glabellar lobes, has a low lateral profile, and on the exoskeleton bears a small median node.

The librigena has a moderately convex genal field, a gently concave anterolateral border, and gently convex posterior and posterolateral borders. A wide, shallow anterolateral marginal furrow becomes more deeply incised towards the genal angle. Lateral and posterior marginal furrows do not meet at the genal angle, but are separated by a low boss which is confluent with both the genal field and genal spine base. Distally the posterior marginal furrow curves sigmoidally around the base of this boss before passing into the genal spine base.

The pygidium is shallow - 'bowled' with length (sag.) less than 60% of the width, arcuate posterior curve between the spine bases, and obtusely rounded anterolateral corners. The axis is conical, with 5-6 segments, the axial furrows tapering rearwards adjacent to segments 1-3, becoming less tapered to the rear of segment 3. The terminal piece is bluntly rounded posteriorly. There are four pleural segments as indicated by defined pleural furrows: interpleural furrows are effaced. The first pleural furrow is sigmoidal, curving distally and posterolaterally into the lateral spine base. Pleural furrows 2-4 are short, oblique and posterolaterally directed. A faint marginal furrow is represented by a slight break in the convexity across the pleural zone and border. Lateral spines are developed from the opisthopleuron of the first and propleuron of the second pygidial segments. Spine bases are defined posteriorly by an ovoid depression at the termination of the marginal furrow opposite the opisthopleuron of the second segment. The condition of the articulating facets and half-ring are inadequately known in this species.

Both cranidium and librigena of *Peichiashania prima* bear a densely granulose prosopon; in places the granules coalesce to give a squamose appearance. Terrace lines run along the anterior facing edge of the cranidial border, the lateral edge of the librigena, and the inner (adaxial) edge of the genal spine. Such lines are also found on the pygidial doublure and edges of the pygidial spines. All known pygidia are exfoliated or else retain only thin vestiges of shell. Where preserved the external prosopon appears less dense than that of the cranidium or librigena. In general, furrowed areas of all carapace parts are only lightly dotted with granules, or are devoid of these altogether.

Peichiashania secunda sp. nov.
(Pl. 25, figs. 6-11; Pl. 26, figs. 1-3; Text-fig. 32)

Name. L. *secunda*, f., second: the second species observed in the sequences studied.

Types. Holotype, cranidium CPC 15214, illustrated on Pl. 25, fig. 11; illustrated paratypes, CPC 15209 - 15213, 15215 - 15217; non-illustrated paratypes, CPC 17684 - 17695.

Material. The species is known only from fragments, of which there are ten identifiable cranidia ranging in length between 1.95 and 14.40 mm; six librigenae; and five pygidia, two measurable specimens having lengths (Lp_2) of 9.34 and 11.10 mm.

Occurrence. Lily Creek, horizons K201, 202, 204,205 and B53, 49 - 72 m from the base of the measured section.

Age. Late Cambrian, Assemblage-Zone of *Peichiashania secunda - Prochuangia glabella*.

Diagnosis. Peichiashania species with edge of frontal lobe lying slightly in front of or on a transverse line drawn across the front of the preocular areas in late holaspides, and angulate shouldered pygidium whose lateral spines are orientated straight backwards.

Differential diagnosis. The cranidium of *Peichiashania secunda* closely resembles that of *P. prima*, differing only in the late holaspid extent of the glabella anteriorly: in *P. secunda* it mostly lies on the same transverse line as the front of the preocular areas. Librigenae, as far as can be assessed, are indistinguishable from those of *P. prima*. Pygidia of *P. secunda* are more deeply 'bowled'

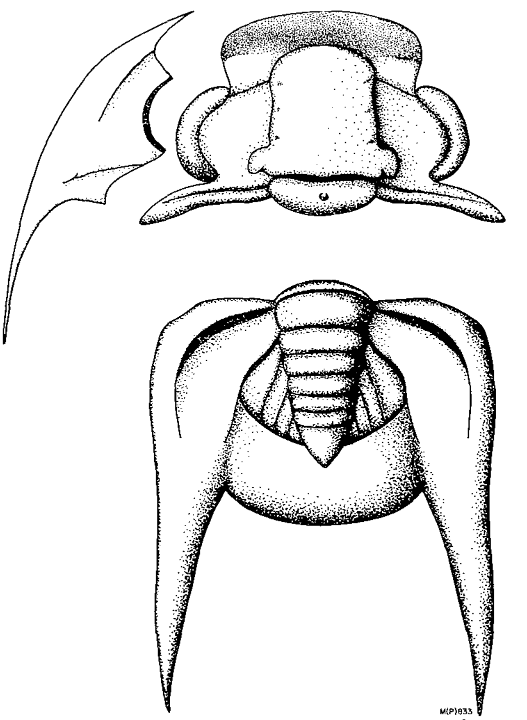


Fig. 32. ***Peichiashania secunda*** **sp. nov.; exoskeletal reconstruction based on CPC 15214 (cranidium), x2, CPC 15215 (librigena), x1.5, and CPC 15216 (pygidium), x3.**

than those of *P. prima*, with lengths (sag.) in excess of two-thirds the widths for the former, and less than 60% for the latter. *P. secunda* has a slightly greater posterior pygidial curvature between the spine bases; wider posterolateral and posterior borders; more acutely angulate anterolateral corners; lateral spines orientated straight backwards rather than deflected laterally from the sides of the pygidium; and pleural furrows less transversely and more obliquely directed posteriorly.

Both *P. prima* and *P. secunda* are apparently more effaced than the type species, *P. rectangularis* (Endo) (see Endo *in* Endo & Resser, 1937, pl. 68, fig. 21), which seems to have more definite palpebral and anterior cranidial marginal furrows. The relationship of the frontal glabellar lobe to the preocular areas is similar in *P. prima, P. rectangularis*, and one of the cranidia which Endo assigned to *Paramansuyella planilimbata* (see Endo, *op. cit.*, pl. 70, fig. 18). In *P. secunda* and the two remaining cranidia assigned to *P. planilimbata* (Endo, *loc. cit.*, figs. 16-17), the glabella extends further forwards to the transverse line joining the anterior edges of the preocular areas. Pygidia placed by Endo (*op. cit.*, pl. 67, figs. 16, 17, 19) with *Mansuyella lilia* are most similar to those associated here with cranidia of *Peichiashania prima:* they have the similar laterally deflected spines, the same degree of posterior curvature between the spine bases, and similarly angulate anterolateral corners. The pygidium of *P. secunda* most closely resembles that associated by Endo (*op. cit.*, pl. 69, figs. 21-22) with the cranidium of *Taipaikia glabra* (Endo).

Description. Apart from the details specifically noted in the diagnoses, cranidia and librigenae can be described in similar terms to those of *P. prima*. Attention is therefore drawn to individual specimens which can amplify the description of the previous species. All illustrated cranidia of *P. secunda* are to some extent exfoliated, or are silicified, and surface prosopon cannot be described as fully as for *P. prima*. Available surfaces, both external and parietal, are somewhat less densely granulose than the former species; many silicified specimens are quite smooth, the silicification process being considered primarily responsible for this effacement of external prosopon.

Cranidia of *P. secunda* have similar glabellar, ocular and preglabellar proportions to those of *P. prima*. One cranidium, CPC 15209 (Pl. 25, fig. 6), shows the form of the posterolateral limb to be long (tr.), narrow (exsag.), and strap-like, and to possess a distinct geniculation. The posterior marginal furrow terminates within the posterolateral limb. Like *P. prima, P. secunda* is bacculate in late holaspides (Pl. 25, fig. 11), bacculae being connected to the posterolateral corners of the preoccipital glabellar lobes by a short diverticulum. This specimen also shows that the ocular ridges of exfoliated cranidia are faintly duplicated; the anterior section of the ocular ridge crosses the axial furrow and passes, at the anterolateral corner of the glabella, into an indistinct parafrontal band. This band is inferred to run around the anterior periphery of the frontal lobe, but cannot be recognised as a distinct feature. At least three pairs of diverticula issue from the postulated position of the parafrontal band, one very prominent pair emanating from the points on the axial furrows at which the anterior sections of the ocular ridges merge with the band. This pair of diverticula crosses the preocular areas obliquely. Two other pairs cross the preglabellar furrow, forming miniature bridges to connect the frontal glabellar lobe and preglabellar area. A further diverticulum appears to encircle the posterior end of the palpebral lobe and link with the fixigenal baccula (Pl. 25, fig. 11).

Morphology of the librigena is virtually identical with that of *P. prima,* saving perhaps that the posterior marginal furrows are less sigmoidal in *P. secunda*. The caecal system of the librigena is well displayed on CPC 15215 (Pl. 26, fig. 3). Caeca, including the principal caecal vein (Öpik, 1967, p. 60), radiate across the genal field from an eye socle which surmounts a shallow subocular groove. The principal caecal vein passes into the low boss-like area which separates the lateral and posterior marginal furrows. Caeca cross the lateral marginal furrows and fade into the lateral border. The librigenal doublure (Pl. 25, fig. 9) has a decided flat flange along its lateral edge. This, and the remainder of the doublure, bears terrace lines. The genal spine was evidently short and stout.

As detailed above, the pygidium differs appreciably on several points from that of *P. prima*. The axis is evenly tapered posteriorly and composed of six well delineated segments; a seventh may also be included in the terminal piece. Transverse furrows 4-6 are not confluent with the axial furrows. Five, possibly six, pairs of pleural furrows are directed obliquely rearwards: the first pair curves strongly into the spine base; the second defines the rear of the spine base and has similar curvature to the first; the remainder are short and straight. The lateral spines are apparently drawn from the whole of the first pleural segment and the propleuron of the second. These spines are directed straight backwards, and as the anterolateral corners of the pygidium are almost right-angled, the shield assumes a rectangular appearance. The pygidial prosopon on CPC 15216 (Pl. 26, fig. 2) is finely and densely granulose, and closely resembles the external prosopon of the cranidium of *P. prima*.

Peichiashania tertia sp. nov.
(Pl. 26, figs. 4-7; Pl. 27, figs. 1-7; Text-fig. 33)

Name. L. *tertia*, f., the third : the third species occurring on the Lily Creek section.

Types. Holotype, cranidium CPC 15218, illustrated on Pl. 27, figs. 1-3; figured paratypes, CPC 15220-15227; unfigured paratypes, CPC 15219, 17696-17707.

Material. The species is based on fragments of ten cranidia, varying in length from 2.50 - 12.30 mm; five librigenae; and seven pygidia with lengths (Lp_2) between 1.20 and 9.50 mm.

Occurrence. Lily Creek section, horizons K206, 207, 208, B50b and B52, 92-162 m from the base of the measured section.

Age. Late Cambrian, Assemblage-Zones of *Peichiashania secunda - Prochuangia glabella* and *Peichiashania tertia - P. quarta*.

Diagnosis. *Peichiashania* species with anterior margin of frontal glabellar lobe lying just behind or on a transverse line drawn across the front of the preocular areas; narrow (tr.) preglabellar area; and pygidium with straight transverse or very gently curved posterior margin; narrow (sag.) postaxial doublure, wide posterolateral doublure; and very long, slender, laterally deflected lateral spines.

Differential diagnosis. Cranidially, late holaspides resemble those of *P. prima*, differing only by a narrower preglabellar area (L:W less than 15%), and a denser external granulation — on the glabella, in particular, granules unite to form a Bertillon pattern. Meraspides are similar to that illustrated for *P. secunda*, having a rectangular, anteriorly truncate glabella, and a significant short (sag.) preglabellar area with a wire-like anterior cranidial border. Both meraspides and early holaspides have glabellar segmentation indicated by pits rather than furrows. Proportions of the preglabellar area distinguish *P. tertia* from *P. rectangularis* (Endo) and *P. planilimbata* (Endo).The straight transverse posterior pygidial margin differentiates *P. tertia* from all others yet assigned to the genus. The strong lateral deflection of the pygidial spines separates it from *P. secunda*, which it would otherwise most closely resemble, but allies it to *P. prima*.

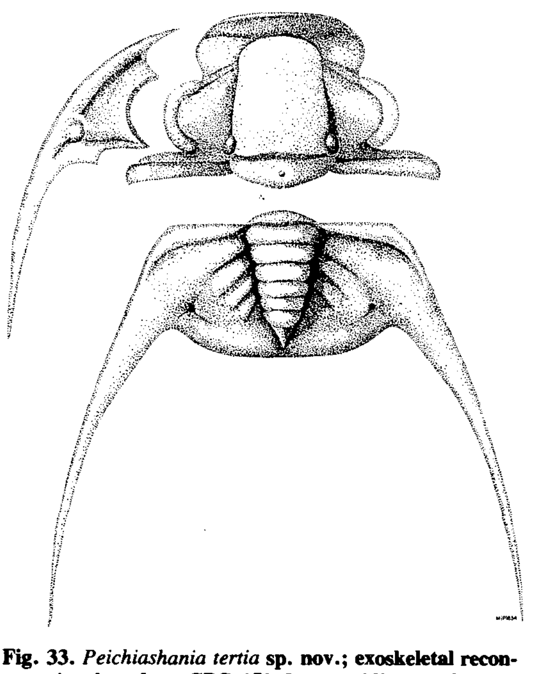


Fig. 33. ***Peichiashania tertia* sp. nov.; exoskeletal reconstruction based on CPC 15218a (cranidium), x3, CPC 15223 (librigena), x5, and CPC 15225 (pygidium), x3.**

Description. The holaspid cranidial description is basically that applying to *P. prima* and *P. secunda*.

The positioning of the frontal margin of the glabella with respect to the preocular areas is intermediate between these species. Late holaspid glabellar furrows are effaced on the exoskeleton, as are the ocular ridges. Glabellar length is similar to that documented for other species of the genus, being 68-75% of the total cranidial length; palpebral lobes attain 59-65% of the glabellar length (G); and the length (sag.) of the preglabellar area is generally less than 15% of its width (tr.).

Librigenal morphology is essentially similar to other species of *Peichiashania*, but the genal spine appears to be substantially longer (non-illustrated specimens).

The pygidium, like *P. prima*, is transverse, with length (Lp_2) 55-60% of the width. The axis is conical, composed of five, possibly six, segments and a pointed terminal piece; a short post-axial ridge reaches close to the posterior margin. Up to five pairs of pleural furrows are indicated, with orientation as for *P. prima*. The anterolateral pygidial corners are obtusely angled, again as in *P. prima*, and long slender spines are laterally deflected (Pl. 26, fig. 4). Due to the roughly trapezoidal configuration of the posterior margin between the spine bases, the posterolateral border is substantially wider than the posterior one. A marginal furrow is present, but indistinct.

More meraspides are assigned to *P. tertia* than other species recognised here, and their morphology is better displayed. The meraspid glabella is quite distinctly parallel-sided, anteriorly truncate, and shows traces of three, possibly four, pairs of glabellar furrows, observed as pits. As in late holaspides, bacculae are associated with the preoccipital lobes. The occipital furrow is very narrow (sag.) and sharply incised. The occipital ring is considerably wider (tr.) than the preoccipital glabellar lobes, but equal to the width (tr.) across these lobes together with the bacculae. The palpebral areas are quite convex (tr.), and the palpebral lobes so spaced from the axial furrows that the posterolateral limbs are transversely shorter than those of holaspides (non-figured specimens). The late meraspid pygidium (Pl. 26, fig. 6) is well segmented, having six axial rings and five pleural segments indicated by deeply incised pleural furrows. Laterally deflected spines are derived from the opisthopleuron of the first and propleuron of the second segments. The posterior margin between the spine bases is gently curved in contradistinction to the straight margin of late holaspides.

Peichiashania quarta sp. nov.
(Pl. 27, figs. 8-9; Pl. 28, figs. 1-8; Text-fig. 34)

Name. L. *quarta*, f., the fourth: the fourth species of this genus occurring on the Lily Creek section.

Types. Holotype, cranidium CPC 15228, illustrated on Pl. 28, fig. 1; figured paratypes, CPC 15229-15236; unfigured paratypes, CPC 17708-17715.

Material. Four cranidia, of which only the holotype (length 16.7 mm) is sufficiently complete to measure; five librigenae; eight pygidia with lengths (Lp_2) 10.35-14.80 mm.

Occurrence. Lily Creek, horizon K209, 210 and B50c, 151-182 m from the base of the measured section.

Age. Late Cambrian, *Peichiashania tertia* - *P. quarta* Assemblage-Zone.

Diagnosis. *Peichiashania* species with the front of the glabella lying on the same transverse line as the anterior margins of the preocular areas; relatively short (sag.) palpebral lobes, and thus obliquely directed ocular ridges; pygidium with angulate anterolateral corners, laterally deflected spines, faint but discernible marginal furrow.

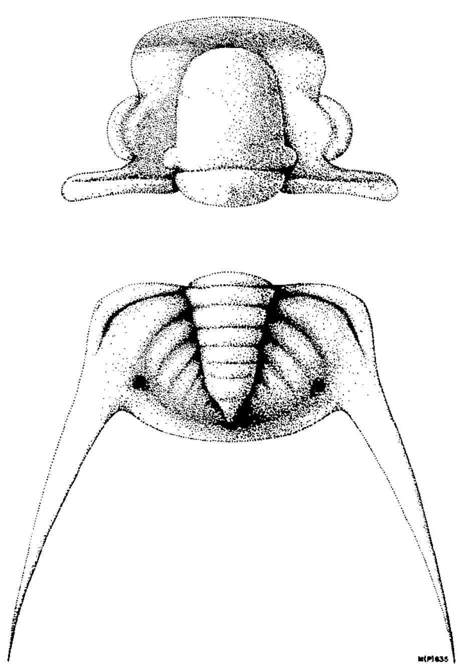


Fig. 34. ***Peichiashania quarta*** **sp. nov.; exoskeletal reconstruction based on CPC 15228 (cranidium), x1.5, and CPC 15235 (pygidium), x2.**

Differential diagnosis. The relationship of the frontal glabellar lobe to the anterior margins of the preocular areas is similar to that of *P. secunda* and *P. planilimbata* (Endo), differing by degree from *P. prima, P. tertia,* and *P. rectangularis* (Endo). *P. quarta* has a similar degree of effacement to *P. rectangularis,* which is less than any of the other species assigned to the genus, retaining traces of glabellar furrows and having more obvious ocular ridges. Palpebral lobes are shorter than those of other Australian species, and in their situation most closely resemble those of *P. rectangularis*. Cranidial prosopon is most similar to that of *P. tertia*. The posterior pygidial margin is somewhat truncate, as in *P. tertia,* but the anterolateral corners are slightly less obtusely angled, similar to *P. prima*. The presence of a weak marginal furrow differentiates the pygidia from those of *P. prima* in particular.

Description. Like *P. tertia,* the general descriptive features of *P. quatra* are similar to those of *P. prima* and *P. secunda,* and are not repeated here. Characteristic differences are noted in the diagnosis and differential diagnosis.

P. quarta shows the same features of the caecal system as *P. secunda:* the pair of diverticula which cross the preocular areas from points close to the intersections of the anterior branches of the ocular ridges with the axial furrows, is well preserved on CPC 15229 (Pl. 28, fig. 2) and CPC 15230a (Pl. 28, fig. 4); other pairs of diverticula can be seen around the periphery of the frontal lobe on the former. CPC 15229 and 15230b show the parafrontal band lying within the axial furrows at the anterolateral corners of the glabella, and intimately related to the preocular and preglabellar diverticula and ocular ridges. Caeca also radiate from the eye socle of the librigena, cross the subocular groove, genal field and marginal furrow, and pass into a gently upturned border. A principal caecal vein is only faintly distinguished from the remainder of the caecal lines in this species. The ventral surface of the librigena is figured on Pl. 27, fig. 8.

Several well preserved pygidia have length to width ratios of 58-63%, and anterolateral corners with angles of 130-136 degrees. The pygidial axis is evenly tapered posteriorly, and is composed of six segments and a terminal piece. Transverse furrows 4-6 are not confluent with the axial furrows. Five pairs of pleural furrows are indicated; interpleural furrows are effaced. Lateral spines are deflected from the pygidial margins, and are apparently derived from the anterior two segments together with the propleuron of the third, judging from the positions of the pleural furrows. Between the spine bases a gently curved posterior margin is seen to straighten slightly post-axially. A faint marginal furrow is developed. The extent of the doublure is illustrated on CPC 15234 (Pl. 28, fig. 6). Little is seen of the caecal system, apart from the opisthopleural diverticulum of the first segment, and a posterior marginal diverticulum running immediately behind the marginal furrow between the spine bases. Several small caeca pass from the pleural zone into this posterior diverticulum.

Genus **Hapsidocare** Shergold, 1975

Type species. *Hapsidocare chydaeum* Shergold (1975, pp. 185-7, pl. 40, figs. 1-6, pl. 41, figs. 1-3), 'Chatsworth Limestone', Black Mountain, Boulia sheet area, western Queensland; by original designation.

Other species. *Hapsidocare grossum* Shergold (1975, pp. 187-8, pl. 41, figs. 4-7, pl. 42, figs. 1-5), 'Chatsworth Limestone', locality as above. *H. lilyensis* sp. nov. is described below.

Comment. Diagnosis and differential diagnosis have been given previously (Shergold, 1975, p. 184).

Hapsidocare lilyensis sp. nov.
(Pl. 29, figs. 1-7; Text-fig. 35)

Name. L. *lilyensis*, derived from Lily Creek, a tributary of the Mort River, near Chatsworth, County of Windsor, western Queensland.

Types. Holotype, cranidium CPC 15237, illustrated on Pl. 29, fig. 1; figured paratypes, CPC 15238-15241, 15395; un-figured paratypes, CPC 17716-17720.

Material. Five cranidial fragments with lengths (Lc) 4.50-10.10 mm; two librigenae; and four pygidial fragments with lengths (Lp_2) between 3.00 and 9.70 mm.

Occurrence. Lily Creek, horizons K211, 212, and 214, 246-281 m from the base of the measured section.

Age. Late Cambrian, *Hapsidocare lilyensis* Assemblage-Zone.

Diagnosis. *Hapsidocare* species with long, strongly tapered and anteriorly narrowed glabella, and relatively short (sag.) preglabellar area.

Differential diagnosis. Cranidial proportions of the three species of *Hapsidocare* now recognised are tabulated in Table 4. *H. lilyensis* obviously has a considerably longer (sag.) glabella and consequently shorter (sag.) preglabellar area than the type species, *H. chydaeum,* and probably also *H. grossum*. Palpebral lobes of the three species are similar in size; they may be slightly closer to the glabella in *H. lilyensis*, but more material is required to substantiate this observation. Anteriorly the glabella of *H. lilyensis* is narrower than that of *H. chydaeum*, resembling that of *H. grossum*, and it is more effaced than other species; even the occipital furrow is obliterated.

The narrow (tr.) librigena is indistinguishable from those of either *H. chydaeum* or *H. grossum*.

The pygidium, like the cranidium, is more effaced externally than that of other species, only the first pair of pleural furrows being clearly defined. It is transverse, similar to that of *H. chydaeum* in its proportions and in the shape of the posterior margin between the spine bases. As in the type species, the pygidial spines are laterally deflected and apparently derived from several pleural segments. As far as can be ascertained, segmentation is similar to *H. chydaeum*. Prosopon is also more similar to the type species, being composed of a heavy granulation, individual granules combining to give the appearance of overlapping scales. A more finely granulose prosopon is evident on *H. grossum*.

TABLE 4
CRANIDIAL PROPORTIONS OF *Hapsidocare* SPECIES

	chydaeum	grossum	lilyensis
G/Lc	49-56%	57%	68%
Gn/Lc	61-66%	71%	79%
Lpga/Wpga	30-41%	30%	20%
A/G	44-50%	42-52%	46%
A/Gn	37-41%	37-43%	40%

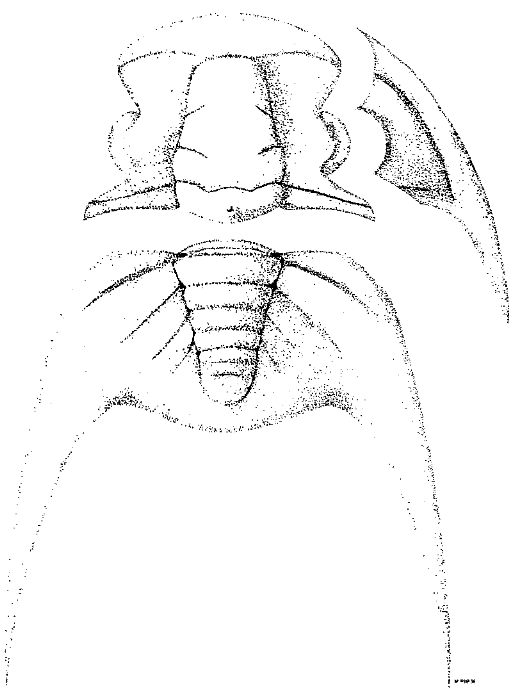


Fig. 35. ***Hapsidocare lilyensis*** **sp. nov.; reconstruction based on CPC 15237 (cranidium), x3, CPC 15239 (librigena), x3, and CPC 15241b (pygidium), x11.**

Description. The glabella (G) of the holotype occupies some 68% of the total cranidial length; it is concave-sided, and strongly tapered anteriorly, and its furrows are effaced, their positions being marked only by vague depressions. The occipital furrow is similarly effaced. The glabella does not quite reach a transverse line drawn across the front of the preocular areas.

The palpebral lobes of *H. lilyensis* are gently arcuate; occupy about 46% of the glabellar length (G) (40% of Gn); and posteriorly are situated about half a preoccipital glabellar width from the axial furrows, with centre-points to the rear of the mid-point of the glabella.

The preocular sections of the facial suture diverge at angles of 55-60 degrees, and enclose a short (sag.) preglabellar area which comprises a concave preglabellar-cum-marginal furrow and an upturned cranidial border pointed sagittally. On exfoliated specimens two, or perhaps three, pairs of diverticula issue from the front of the glabella, cross the preglabellar furrow, and merge into the cranidial border. The postocular facial sutures appear to enclose short (tr.) triangular posterolateral limbs.

The librigena is transversely narrow, and characterised by a gently convex genal field, deeply incised marginal furrows, and moderately wide border. The posterior marginal furrow is slightly sigmoidal, and meets the lateral marginal furrow at the base of the genal spine. A long genal spine is evident.

The pygidium is transverse, with gently arcuate posterior margin between the spine bases, and obtusely angled anterolateral corners. The axis, which reaches close to the posterior margin, is composed of six segments, a possible seventh, and a very small terminal piece. Exfoliated material indicates that all transverse furrows are discontinuous with the axial furrows. Only the anterior pair of pleural furrows is not effaced externally. Parietally, at least two pairs, and possibly four, are indicated by diverticula. Lateral spines, deflected from the pygidial margins, are formed from an indeterminate number of pleural segments. There is no posterior marginal furrow.

The prosopon of all known parts of the exoskeleton is heavy and squamose. Individual granules link together to form scales, e.g. on the preocular areas and genal fields. Scales link together to form terrace lines on the preglabellar area, and along the genal and pygidial spines. Exfoliated surfaces are punctate.

Family **MISSISQUOIIDAE** Hupé, 1955

Genus **Parakoldinioidia** Endo, 1937

Type species. *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, Manchuria; by original designation.

Other species. See Shergold (1975, pp. 195-6).

Parakoldinioidia sp. aff. **P. bigranulosa** Shergold, 1975
(Pl. 30, figs. 1-10; Text-fig. 36)

aff. 1975. *Parakoldinioidia bigranulosa* sp. nov. Shergold, 75, pp. 195-6, pl. 45, figs. 2-5.

Material. Eight cranidial and twelve pygidial fragments. Two assessable cranidia have estimated lengths (sag.) of 3.5 and 4.0 mm, and ten pygidia lengths (Lp_2) of 2.00 - 3.90 mm. Specimens CPC 15258-15265 are illustrated. Supplementary material is CPC 17721-17731.

Occurrence. Lily Creek, horizons K201, 214 and B791, 49 - 281 m from the base of the measured section.

Age. Late Cambrian, Assemblage-Zones of *Peichiashania secunda - Prochuangia glabella* and *Peichiashania tertia - P. quarta*.

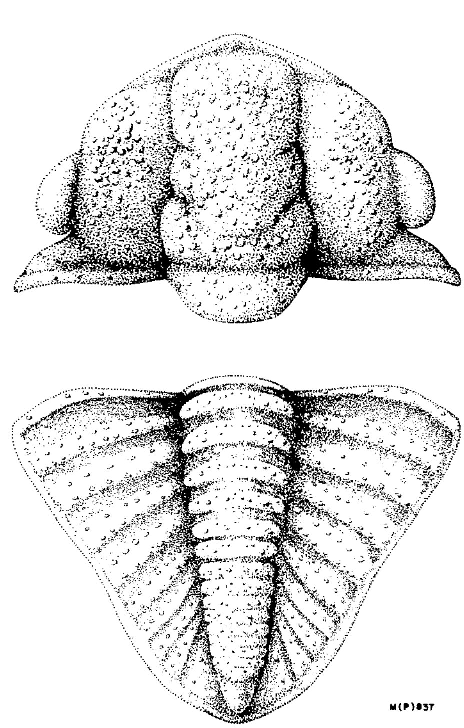


Fig. 36. *Parakoldinioidia* **sp. aff.** *bigranulosa* **Shergold, 1975; reconstruction based on CPC 15258a (cranidium), x10, and CPC 15262a (pygidium), x12.**

Comments. The available material is generally poorly preserved, highly variable in its morphology, and occurs at the end points of the Lily Creek section. In all possibility two species are present, but the material is inadequate to effectively diagnose them, and, because the range of morphological variation is so great, it is not possible to adequately distinguish them from *Parakoldinioidia bigranulosa* Shergold.

The best preserved of the cranidia, CPC 15258, Pl. 30, fig. 2, has a narrow (tr.) frontal lobe, slightly constricted median lateral glabellar lobes, and preoccipital lobes which are wider than the remainder of the glabella. In these characteristics it resembles the paratype specimen earlier referred to *P. granulosa* (see Shergold, 1975, pl. 45, fig. 3). However, its pointed anterior cranidial border is not as anteriorly extended as that of the Black Mountain specimen, and its bigranulation not as distinctive. Cranidium CPC 15259, Pl. 30, fig. 3, has a more or less parallel-sided anteriorly truncate glabella, resembling those referred by Endo (*in* Endo & Resser, 1937, pl. 71, figs. 17-21) to *P. typicalis*. The anterior cranidial border of this specimen is not adequately preserved for detailed comparison with other species. Specimens CPC 15260 and 15261 (Pl. 30, fig 4 and 1 respectively) have frontal lobes laterally expanded to an extent similar to the holotype of *P. bigranulosa* (see Shergold, 1975, pl. 45, fig. 2), and similarly shaped and orientated anterior cranidial borders. Possibly the differences in glabellar morphology detailed here could relate to morphogenesis, a cylindrical glabella representing the latest holaspid development.

Two kinds of pygidia occur together at the top of the Lily Creek section (horizons K214 and B791a). One form (Pl. 30, figs. 9-10) is long, narrow, and highly vaulted when viewed posteriorly. It possesses 8 or 9 pleural segments and up to 10 identifiable axial ones. The posterior termination of this form is bluntly pointed and apparently connected by an ill-defined post-axial ridge to the axis. A narrow, poorly defined border is present, posterolaterally at least. The second form is more transversely triangular in shape, considerably less vaulted, and composed of 6 or 7 pleural and 8 axial segments (Pl. 30, figs. 6-7). There is no post-axial ridge and the posterior margin is bluntly rounded. A lateral border is present. Of these morphologies, the narrow pointed pygidium most closely resembles that previously assigned to *P. bigranulosa* (see Shergold, 1975, pl. 45, fig. 4). The observed differences may be the result of preservation, but could also be ascribed to morphogenesis — the wider, flatter specimens seem to be the largest.

Suborder **ASAPHINA** Salter, 1864
Superfamily **ASAPHACEA** Burmeister, 1843
Family **ASAPHIDAE** Burmeister, 1843
Subfamily *INCERTAE SEDIS*

Genus **Atopasaphus** Shergold, 1972

Type species. *Atopasaphus petasatus* Shergold (1972, pp. 81-2, pl. 9, fig. 5), from the Gola Beds, Momedah Creek, Boulia area, western Queensland; by original designation.

Other species. *Atopasaphus stenocanthus* Shergold (1975, pp. 218-9, pl. 54, figs. 1-6), Late Cambrian, *Rhaptagnostus clarki patulus* - *Caznaia squamosa* through *R. bifax* - *Neoagnostus denticulatus* Assemblage-Zones; 'Chatsworth Limestone', Black Mountain, western Queensland.

Comments. The material described below is in accord with that previously known (Shergold, 1975, pp. 217-9) from Black Mountain, in that the preglabellar areas of all three taxa recognised below are a little narrower (tr.) than that of the type species, *A. petasatus* Shergold, 1972. As with the Black Mountain material, all that presented here is representative of large specimens. The type specimen of *A. petasatus* is considerably smaller than the smallest specimen known from the Chatsworth area, and its wider preglabellar area may be attributable to an early holaspid condition.

Atopasaphus stenocanthus Shergold, 1975
(Pl. 31, figs. 6-7)

1975. *Atopasaphus stenocanthus* sp. nov., Shergold, 1975, pp. 218-9, pl. 54, figs. 1-6; text-fig. 72.

Holotype. CPC 12886, cranidium, see Shergold (1975, pl. 54, fig. 6).

Material. Supplementary material includes two cranidial fragments, too incomplete to assess quantitatively (CPC 15361, 17732); and one pygidium (CPC 15362) which has a length (Lp_2) of 8.75 mm. Specimens CPC 15361-2 are illustrated.

Occurrence. Lily Creek, horizons K210 and 211, 182-246 m from the base of the measured section.

Age. Late Cambrian, Assemblage-Zones of *Peichiashania tertia* - *P. quarta* and *Hapsidocare lilyensis*.

Comments. The supplementary material adds no new morphological information to that already published (Shergold, 1975). The cranidium, CPC 15361 (Pl. 31, fig. 7), has small palpebral lobes sited close to the axial furrows and, as far as can be ascertained, about the mid-point of the glabella. The preglabellar area is slightly wider (tr.) than the maximum palpebral width (tr.), as in the holotype of *Atopasaphus stenocanthus*.

Preserved as a parietal surface, the pygidium, CPC 15362 (Pl. 31, fig. 6), looks somewhat different from those earlier figured, in which the exoskeleton is preserved. However, the basic shape is identical, and the doublure similarly wide (sag., tr.), as wide as the furrowed pleural zone. About seven axial and pleural segments characterise this species, at both Lily Creek and Black Mountain. The estimated length of the Lily Creek pygidium is 63% of its width, which falls within the range of variation noted for the Black Mountain material (Shergold, 1975, p. 219).

Atopasaphus sp. cf. **A. stenocanthus** Shergold, 1975
(Pl. 31, figs. 1-5; Pl. 35, fig. 9)

cf. 1975. *Atopasaphus stenocanthus* sp. nov., Shergold, 1975, 218-9, pl. 54, figs. 1-6; text-fig. 72.

Material. Three cranidial fragments, only one of which can be measured for length (11.80 mm); and ten pygidia varying in length (Lp_2) between 2.00 and an estimated 33.5 mm. Specimens CPC 15363-68 are illustrated hypotypes; CPC 17733-17739 are unfigured hypotypes.

Occurrence. Chatsworth Plains, locality D124; Lily Creek, horizons K200, 203, B54b and 790, 24-66 m from the base of the measured section; Horse Creek, horizon K227; BMR Duchess No. 13, 16.47-17.22 m.

Age. Late Cambrian, Assemblage-Zones of *Wentsuia iota - Rhaptagnostus apsis* and *Peichiashania secunda - Prochuangia glabella.*

Comments. Cranidia assigned to this species are poorly preserved in calcareous sandstone; all represent fragments of large specimens. Confident determination as *Atopasaphus stenocanthus* is not possible because of the condition of the material. Cranidial fragments have a preglabellar area which is slightly wider than the palpebral cranidial width, and small palpebral lobes situated close to the mid-point of the glabella, in accordance with the holotype (Shergold, 1975, p. 218, pl. 54, fig. 6). None of the cranidial fragments yet found in western Queensland shows the position of the glabellar node clearly. Rather long (tr.), narrow (exsag.) posterolateral limbs are shared with the holotype. Pygidia, ranging to almost 3.50 cm in length (Lp_2), are preserved in both calcareous sandstone and limestone. They are characterised by wide doublures, six or seven axial segments and perhaps six pleural ones, and the lack of a post-axial ridge — characteristics which are shared with *A. stenocanthus.* Whereas the smaller pygidia (eg. Pl. 35, fig. 9) are rather transverse and evenly rounded posteriorly, the largest ones (eg. Pl. 31, fig. 2) are more elongate and have straighter posterior margins. No specimens of *A. stenocanthus* of similar size have been observed.

In summary, it is likely that the specimens here classified as *Atopasaphus* cf. *stenocanthus* belong to *A. stenocanthus,* but in general their condition of preservation prevents positive determination.

Atopasaphus sp. undet.
(Pl. 35, fig. 8)

Material. A single cranidium, CPC 15369, having an estimated length of 29.4 mm.

Occurrence. Horse Creek, horizon K215.

Age. Late Cambrian, *Wentsuia iota - Rhaptagnostus apsis* Assemblage-Zone.

Comments. This cranidium is not complete enough for adequate determination. The preglabellar area and posterolateral limbs resemble those of *Atopasaphus stenocanthus.* The glabella, however, appears to have substantial convexity (sag.), taper anteriorly, and lack the lateral constriction observed on the holotype (Shergold, 1975, p. 218, pl. 54, fig. 6).

Subfamily **NIOBINAE** Jaanusson, 1959

Genus **Norinia** Troedsson, 1937

Type species. Norinia convexa Troedsson (1937, pp. 52-53, pl. III, fig. 8; pl. V, figs. 3-5), *ex situ,* assigned to basal Ordovician (Troedsson, *op. cit.,* p. 51), western Quruq-tagh, eastern Tien-shan, China; designated Troedsson (1937, p. 51).

Other species. Norinia sp. ind. 1 Troedsson (1937, p. 53, pl. V, fig. 6), locality as for type species. *Norinia* (?) sp. ind. 2 Troedsson (*loc. cit.,* pl. III, figs. 9-10), locality as above. *Norinia* (?) sp. ind. 3 Troedsson (*loc. cit.,* pl. V, fig. 7), locality as above. *Norinia* (?) spp. ind. 4 and 5 Troedsson (*op. cit.,* p. 54, pl. III, figs. 11-12), locality as above. *Norinia* (?) sp. ind. 6 Troedsson (*loc. cit.,* pl. III, figs. 13-14), locality as above.

Comments. The concept of the genus *Norinia* is not well defined. The holotype cranidium of the type species, *N. convexa,* is the most complete cranidium available, and it differs from the other figured cranidia (compare Troedsson 1937, pl. V, fig. 3 with pl. V, figs. 4-5, pl. III, fig. 8). Furthermore, it is the only cranidium of the type series to show the position of the glabellar node, which is between the glabellar mid-point and the occipital ring, as in the Iwayaspidinae (above). Other cranidia assigned by Troedsson to *Norinia* have preglabellar areas which resemble *Yuepingia* Lu (see *Y. niobiformis* Lu 1956B, pp. 378-379, pl. 1, figs. 6-13). According to V. Jaanusson (pers. comm. July 1977) the type material of *Norinia* has been returned to China and is available for comparative study at the Nanjing Institute of Geology and Palaeontology.

Based on the holotype of *N. convexa, Norinia* is seen to be an asaphine genus with an elongate, subparallel-sided, anteriorly rounded and faintly furrowed glabella which bears a subcentrally sited median node. Its preocular facial sutures diverge forwards at low angles and enclose a short (sag.) concave preglabellar field and small, flat, possibly triangular, anterior cranidial border. The palpebral lobes are short and situated well in front of the median glabellar node. Posterolateral limbs are broad and triangular.

Troedsson drew cranidial comparisons with *Niobe*, and classified *Norinia* with the Ogygiinae. Excepting the position of its glabellar node, *Norinia* could be classified cranidially with a variety of asaphaceans having a short (sag.) preglabellar area, e.g. *Megalaspides, Asaphellus, Notopeltis,* and particularly *Megalaspidella*. It can also be compared to *Yuepingia* Lu, from which it differs in having a more posteriorly sited median glabellar node, and shorter (exsag.) palpebral lobes.

All of Troedsson's specimens are 'isolated on separate rock specimens and are never associated with the wealthy Upper Cambrian fauna at the same locality' (p. 51). Accordingly, Troedsson referred them to the Ordovician, although there is no reason to think that they cannot have a Late Cambrian age, particularly as the 'wealthy Upper Cambrian fauna' referred to contains *Irvingella*, a genus characterising the middle portion of the Upper Cambrian. *Norinia convexa* and *Norinia* sp. ind. 1 are known from cranidial fragments, *Norinia* spp. ind. 2-5 are pygidia, and *Norinia* sp. ind. 6 is based on two hypostomata.

Norinia? sp. undet.
(Pl. 34, figs. 1-2)

Material. Fragments of two cranidia (CPC 15346, 17839) with lengths (sag.) of 2.40 and 4.40 mm. Specimen CPC 15346 is illustrated.

Occurrence. Chatsworth Plains, locality D487.

Age. Late Cambrian, *Wentsuia iota-Rhaptagnostus apsis* Assemblage-Zone.

Comments. Norinia? sp. undet. is left under open nomenclature until adequate material becomes available for proper description.

The cranidial fragments presently available show an elongate, anteriorly expanding and rounded, but poorly defined, glabella with effaced furrows. The occipital furrow is also effaced; Gn is 81-83% of the cranidial length. The glabella plus fused occipital ring is gently constricted laterally, adjacent to a median node which lies 33-36% of the cranidial length from the rear of the cranidium. Small crescentic palpebral lobes lie close to the axial furrows, forward of the median node. The preocular facial sutures diverge forwards at low angles, then close rapidly to contain a gently concave preglabellar field and a small flat-lying triangular anterior cranidial border poorly delineated from the preglabellar field. The postocular facial sutures are gently sigmoidal and enclose reasonably broad (exsag.) triangular posterolateral limbs.

Available material shows greatest similarity with the paratype fragments of *N. convexa* Troedsson rather than the holotype cranidium, as the latter appears to have a convex (sag.) preglabellar field and anteriorly rounded cranidial outline. The paratypes, however, have a triangular frontal contour. As far as can be judged, the glabella of *N. convexa* tapers gently forwards whereas that of *N.*? sp. undet. has a tendency to expand slightly.

Superfamily **CERATOPYGACEA** Linnarsson, 1869
Family **CERATOPYGIDAE** Linnarsson, 1869
Subfamily **PROCERATOPYGINAE** Wallerius, 1895

Genus **Haniwoides** Kobayashi, 1935

Type species. Haniwoides longa Kobayashi (1935C, p. 243, pl. XVII, figs. 2-3), '*Olenoides* Zone of Neietsu', South Korea; by original designation.

Other species. Haniwoides concava Kobayashi (1935C, pp. 243-4, pl. XVII, figs. 1, 6-7), '*Olenoides* Zone of Neietsu', South Korea. *Haniwoides longissima* Kobayashi (1962, p. 116, pl. II, fig. 7), *Eochuangia* Zone, Machari, Pukmyon, Noltari, South Korea. *Haniwoides tenuis* Kobayashi (1962, p. 116, pl. II, figs. 8-9), *Eochuangia* Zone, west of Kokkol, Pukmyon, north-northeast of Chungsan, South Korea. *Haniwoides* (?) *puteolata* Kobayashi (1962, pp. 116-7, pl. II, figs. 18-19; pl. III, figs. 18-22), *Eochuangia* Zone, various localities around Mohari and Machari, Pukmyon, South Korea.

Haniwoides(?) sp. nov. Kobayashi (1961, pp. 232-3, pl. XIII, fig. 16), Middle Cambrian, Sampo-san Formation, cannot be interpreted.

Comment. The concept of *Haniwoides* is based on cranidial characteristics: a long concave preglabellar area, oblong almost entirely effaced glabella, and semi-circular palpebral lobes located close to the glabella (Kobayashi, 1935C, p. 242). These characteristics are shared by many Asaphina. *Haniwoides*, however, also possesses a median glabellar node situated on a transverse line which passes across the rear of the palpebral lobes. This can be inferred from Kobayashi's 1935C illustrations, but cannot be confirmed on those given in

1962. A node in this position seems to indicate relationship with ceratopygids such as *Proceratopyge* and the recently described *Aplotaspis* Henderson, 1976. The meraspid cranidium here referred to *Haniwoides* is not readily distinguishable from meraspides of *Proceratopyge*, while early holaspid cranidia have a definite anterior border closely relating them to early holaspides of *Aplotaspis*, and through this genus to *Proceratopyge* species of the type referrable to *P.(P.) chuhsiensis* Lu, 1956A (see Öpik, 1963, pl. 5, fig. AA, designated *Proceratopyge* cf. *chuhsiensis* Lu; referred to *Yuepingia* sp. nov. by Henderson, 1976, pl. 48, fig. 12). Late holaspides do not have a definite anterior cranidial border, and can possess prominent paradoublural lines, characteristics which relate *Haniwoides* to earlier described Ceratopygidae. Cranidially, species of *Proceratopyge, Aplotaspis* and *Haniwoides* are interpreted as forming a morphologically- and time-related series.

Pygidia, however, are disparate. Within *Haniwoides,* for instance, Kobayashi (1935C, 1962) has identified at least three different kinds of pygidium. For example, one of those referred to *H. concava* Kobayashi (1935C, pl. XVII, fig. 16) seems identical with those presently referred in Australia to *Aplotaspis,* and in combination with the cranidium (*op. cit.*, pl. XVII, fig. 1) may in fact represent this genus in South Korea. Those referred to *Haniwoides*(?) *puteolata* Kobayashi (1962; pp. 116-7, pl. III, figs. 20-22) appear to be posteriorly divided, and similar to specimens referred here to *H. varia*. A posterior bifurcation of the pygidial margin is common to the early meraspid morphogenesis of both *Proceratopyge* and *Haniwoides,* and some species of *Proceratopyge,* e.g. *P.(P.) lata* Whitehouse, retain a flattened or slightly bifurcated posterior margin throughout holaspid morphogenesis. The holaspid pygidium of *Haniwoides varia* sp. nov. is apparently an enlarged version of that of the stage 4 meraspid of *P.(P.) lata,* but lacks the development of the spines which have appeared in *Proceratoyge* by this meraspid stage. A case can therefore be made for the inclusion of *Proceratopyge, Aplotaspis,* and *Haniwoides* within a single subfamily: Proceratopyginae Wallerius, 1895. Morphological similarity during the pygidial morphogenesis of *Haniwoides* and olenids such as *Hedinia* (see *Hedinia regalis* Troedsson, 1937, pl. VII, figs. 1-12; pl. VIII, figs. 3-8) should, however, be noted.

Haniwoides varia sp. nov.
(Pl. 32, figs. 1-8; Pl. 33, figs. 1-10; Text-fig. 37)

Name. L. *varia,* f., variable, referring to the illustrated morphogenetic variation.

Types. Holotype cranidium, CPC 15331, illustrated on Pl. 32, fig. 5; figured paratypes, CPC 15327-15330, 15332-15345; unfigured paratypes, CPC 17740-17808.

Material. Thirty two cranidia with lengths between 0.95 and 16.45 mm; eleven librigenae; and forty seven pygidia with lengths (Lp_2) measuring 0.70-5.30 mm.

Occurrence. Chatsworth Plains, localities D124, 373, 487 and 489; Horse Creek, horizons K215, 216, 218, 219, 221, 223, 224, 225, 227, B1; Lily Creek, horizons K197, 198, 199 and B54b, documented between 6 and 52 m from the base of the measured section; BMR Boulia No. 6, 41.30 - 86.00 m; BMR Duchess No. 13, 35.50-84.30 m.

Age. Late Cambrian, Assemblage-Zones of *Wentsuia iota - Rhaptagnostus apsis* and *Peichiashania secunda - Prochuangia glabella.*

Diagnosis. Haniwoides with anterior cranidial border apparent throughout early holaspid morphogenesis, and long (tr.), narrow (exsag.), distally expanded posterolateral limbs; pygidium with posteriorly bifurcated posterior margin.

Differential diagnosis. There is little to differentiate the cranidia of any species assigned to *Haniwoides*. A morphogenetic series is required to follow the changes of preglabellar proportions and glabellar parameters. In general appearance, especially the long effaced glabella, *H. varia* resembles the type cranidium of *H. longa* Kobayashi (1935C, p. 243, pl. XVII, fig. 3). Librigenae assigned to *H. longa* and *H. varia* are virtually identical. No pygidium has been assigned to the type species of *Haniwoides*. Comparison is not made with *H. concava* Kobayashi (1935C, p. 243, pl. XVII, figs. 1, 16-17) because it is felt that the cranidium (fig. 1) of this taxon, combined with the pygidium (fig. 2), represents a species of *Aplotaspis* Henderson, 1976. Little comparison can be made with *H. longissima* Kobayshi (1962, p. 116, pl. II, fig. 7) or *H. tenuis* Kobayashi (1962, p. 116, pl. II, figs. 8-9), although the palpebral lobes of the latter may be somewhat shorter (exsag.) than those of *H. varia*. *Haniwoides* (?) *puteolata* Kobayashi (1962, pp. 116-7, pl. II, figs. 18-19; pl. III, figs. 18-22), however, can be compared. Glabellar parameters are similar to those of *H. varia,* as are those concerned with the palpebral lobes. *H. puteolata* preserves traces of glabellar furrows and may have a more strongly reflected anterior cranidial border. One of the pygidia, in particular, (Kobayashi, 1962, pl. II, fig. 19) has the indented posterior margin and wide posterolateral doublure typical of *H. varia*. The remaining pygidia (Pl. III, figs. 20-22) are fragmentary and considerably larger than any of the Australian specimens.

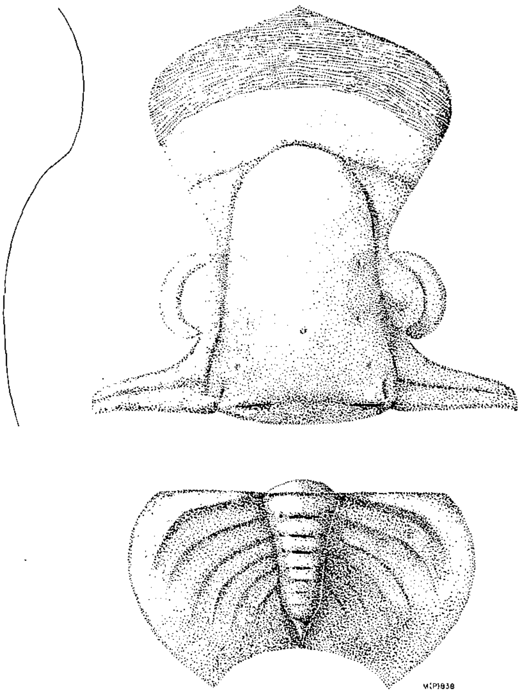


Fig. 37. *Haniwoides varia* **sp. nov.; late holaspid exoskeletal morphology reconstructed from CPC 15333 (cranidium), x3, and CPC 15343 (pygidium), x10.**

Three pygidia from the Kushan Formation in Fengtien, Manchuria, illustrated as *Koptura quadrata* Endo (*in* Endo & Resser, 1937, p. 345, pl. 65, figs. 10-12) are homeomorphs of those here assigned to *Haniwoides varia* sp. nov. *Koptura biloba* Kobayashi (1935C, p. 281, pl. XIX, fig. 10) from the '*Solenoparia* Zone of Doten', South Korea, is similar but more elongate. *Temnura granulosa* Kobayashi (1935C, p. 278, pl. XXIV, fig. 14; =*Temnoura granosa* Resser & Endo *In* Endo & Resser, 1937, p. 295, pl. 57, fig. 8; Lu *et al.*, 1965; p. 541, pl. 113, fig. 11), from an erratic block assigned to the Wanwan Formation, near Huolienchai, Manchuria, is a pygidium essentially similar to those of *H. varia*, but has the posterior tips of the bifurcation drawn out into short spines or prongs.

Description. The meraspid cranidium has a cylindrical, anteriorly rounded, effaced glabella which bears a prominent axial node about 25% of the glabellar and occipital length combined (Gn) from the rear of the cranidium; smallish palpebral lobes placed anterior to the mid-point of the glabella, some distance from the axial furrows; narrow (sag.) reflected concave preglabellar area; and narrow band-like occipital ring strongly differentiated from the glabella.

Holaspid cranidia retain the long cylindrical anteriorly rounded and effaced glabella, but at this morphogenetic stage it becomes slightly constricted adjacent to the palpebral areas, and occupies 70-85% of the total cranidial length (sag.). In holaspides the occipital furrow is obliterated and the occipital ring fused with the glabella, as in the Asaphacea. The axial node lies about 20-27% of the cranidial length (sag.) from the rear of the cranidium.

Early holaspid cranidia, to lengths of about 7.00 mm, possess a concave (sag.) preglabellar field and a differentiated pointed anterior cranidial border (Pl. 32, figs. 2-5). Late holaspides merely have a long (sag.) concave preglabellar area which is also anteriorly pointed (Pl. 32, fig. 7). The length of the preglabellar area varies between 25 and 40% of its width (tr.). Transverse paradoublural lines separate small triangular preocular areas from the preglabellar field. The palpebral lobes occupy 42-53% of the parameter Gn, and lie adjacent to the axial furrows, with their posterior ends more or less on a transverse line lying through the axial glabellar node; their mid-points, however, lie opposite the mid-point of the combined glabella and occipital ring. The palpebral lobes are semicircular, their palpebral furrows are only faintly discernible, and the palpebral areas are only gently inclined to the axial furrows. The post-ocular sections of the facial suture enclose very long (tr.) strap-like posterolateral limbs which expand slightly distally, and bear gently sinuous posterior marginal furrows.

The librigena is characterised by extremely narrow lateral and posterior borders, and a wide (exsag.) anterior doublure. *Haniwoides* lacked a rostral plate, the librigenae meeting anteriorly and ventrally at a median suture, as in the Asaphidae. The visual surface of the eye was mounted on an eye socle, which is differentiated from the genal field merely by a break in convexity of the exoskeleton. A short delicate genal spine is present.

A range of meraspid pygidial morphogenesis is illustrated on Pl. 33; specimens range in size (Lp_2) between 0.90 and 1.30 mm. The largest pygidium with unliberated thoracic segments has a total length of 1.75 mm. The earliest meraspides (Pl. 33, figs. 1-3) have up to eight unliberated segments which may represent the full complement of thoracic segments in this species. Spines are absent at all stages of the meraspid development.

Holaspid pygidia have a length (Lp_2) 40-50% of the maximum width. They are characterised by arcuate lateral margins, obtusely rounded anterolateral corners, and strongly indented posterior margins. Up to seven axial segments are observed on a narrow rearwards-tapering axis, which fails to reach the posterior margin. Five or six pleural segments are indicated by pleural furrows. Interpleural furrows are also faintly preserved anteriorly. The pygidium of *Haniwoides varia* is weakly fulcrate, with wide geniculation, and wide posterior doublure.

Cranidial prosopon is visible on the preglabellar area as a series of transverse terrace lines. The glabella remains smooth. The entire outer surface of the pygidium bears similar terrace lines, which are also present on the pygidial and librigenal doublures.

Traces of the cranidial caecal network are seen sagittally on the preglabellar field, where a cluster of caeca cross to the anterior cranidial border. The so-called paradoublural lines appear to represent diverticula which pass on to the librigena, run parallel to the marginal librigenal furrow and lateral border, and join the posterior border at its intersection with the postocular section of the facial suture. Nothing is known of the pygidial caecal system.

Subfamily **IWAYASPIDINAE** Kobayashi, 1962

The concept of Iwayaspidinae (Kobayashi 1962, p. 122) is expanded herein to include the genera *Iwayaspis* Kobayashi, 1962, *Pseudoyuepingia* Chien, 1961, and *Cermatops* gen. nov. *Pseudohysterolenus* Harrington & Leanza, 1957, previously included in the subfamily by Kobayashi *(loc. cit.)* is rejected because the posterior position of its glabellar node and the morphological arrangement of its preglabellar area are not compatible with the other listed genera.

The subfamily Iwayaspidinae, as conceived here, is intermediate morphologically between the Asaphacea (Niobinae), as interpreted by Jaanusson (*in* Moore, 1959), and the Ceratopygacea (Ceratopyginae, Proceratopyginae). Its genera are characterised by the possession of a preglabellar field, a shallow anterior cranidial marginal furrow, reflected anterior cranidial border, and glabellar node situated between the mid-point of the glabella and the occipital furrow. Iwayaspid pygidia are variable in their pleural and border morphologies, but in general are transverse or semicircular, and none have holaspid lateral spines.

As presently understood the subfamily has a distribution in Korea, central China (Kweichou), northern Siberia (Olenek River, Yakutia), and northern Australia.

Genus **Cermatops** gen. nov.

Type species. *Cermatops vieta* sp. nov., from the Chatsworth Limestone of Lily Creek, western Queensland; designated herein.

Name. Gk κερμα n., small, combined with Gk ωψ, f., eye.

Diagnosis. Ceratopygacean with small anteriorly sited palpebral lobes, close to the axial furrows and well forwards of a subcentral glabellar node; preglabellar area comprising a narrow forward-sloping preglabellar field, wide shallow anterior marginal furrow, and addorsally reflected anterior cranidial border; prominent paradoublural lines; grooved lateral librigenal border; transverse pygidium with wide-spaced fulcral points, delicate fluted pleurae with opisthopleurae overlapping the propleurae and pleural furrows of following segments so that the posterior edges of pygidial pleural segments are gently sigmoidal; broad doublure.

Differential diagnosis. *Cermatops* cannot readily be compared to *Pseudoyuepingia* Chien which is known only from three flattened specimens, one a hypostoma *(P. modesta* Chien, 1961, pp. 126-127, pl. III, figs. 5-7). The most nearly complete specimen of *P. modesta* has a similar glabellar and preglabellar morphology to that of *Cermatops vieta* sp. nov., but its palpebral lobes are slightly longer (exsag.). Its pygidium is transversely triangular, and lacks the delicate fluted pleurae of *Cermatops*. Furthermore, there is also a distinct and different border.

The Korean species of *Iwayaspis (I. asaphoides* Kobayashi, 1962, p. 122, pl. VI, figs. 1-10, pl. VIII, fig. 24) also has longer (exsag.) palpebral lobes than *C. vieta*, and its preglabellar area is less well differentiated, as far as can be judged from the illustrations presented. Its pygidium is also more triangular, and again has a differentiated border. Species of *Iwayaspis* from northern Siberia for which the cranidium is known, e.g. *I. caelata* Lazarenko (*in* Datsenko *et al.*, 1968, pp. 184-185, pl. XVI, figs. 6-13), have a wider (tr.) preglabellar area, less well differentiated preglabellar field, and longer (exag.) palpebral lobes than *Cermatops*. Pygidia of the Siberian species *I. curta* Lazarenko (*op. cit.*, pp. 185-186, pl. XVI, figs. 14-15) and *I. longa* Lazarenko (*op. cit.*, 186-187, pl. XVI, fig. 16) are remarkably similar to those of *C. vieta* (below) in all respects.

Pygidia of *Cermatops*, by virtue of their fluted pleurae, resemble those of certain anomocarids, e.g.

Anomocarina Lermontova, 1940 (see Rosova 1964, pl. 1), in that traces of the intersegmental furrows continue to within a short distance of the margin. The distal overlapping of pleural segments seen in *Cermatops*, Siberian species of *Iwayaspis*, and anomocarids is strongly reminiscent of late Cambrian dikelocephalaceans such as *Briscoia* (see *B. hartti* in Walcott, 1914, p. 368, pl. 63, fig. 6, and *B. septentrionalis* in Palmer, 1968, p. 59, pl. 15, figs. 3-4) and *Tellerina* (see Ulrich & Resser, 1933, for various examples).

Cermatops vieta sp. nov.
(Pl. 34, figs. 3-11; Text-fig. 38)

Name. L. *vieta*, wrinkled, referring to the folded appearance of the preglabellar area and lateral librigenal border.

Types. In spite of its lacking a preglabellar area, the cranidial fragment CPC 15347a is selected as holotype because it shows the positions of the palpebral lobes and glabellar node to advantage, the latter being important in determining the classificatory position of *Cermatops*. Figured paratypes CPC 15348-15354; unfigured paratypes, CPC 17809-17823.

Material. Seven cranidial fragments, none complete enough for a full estimation of cranidial length, although two specimens have glabellar lengths (Gn) of 22.50 and 23.50 mm; six librigenae; and ten pygidia with lengths (Lp_2) 2.60-12.50 mm.

Occurrence. Horse Creek, horizons K216, 223, 225, 226 and D668; Lily Creek, horizons K197, 198, 199, 200, 203, B54a, 54b and 790, 6-66 m from the base of the measured section; *Cermatops* fragments also occur in BMR Boulia No. 6, 57.80-86.00 m; and Duchess No. 13, 16.47-57.53 m.

Age. Late Cambrian, Assemblage-Zones of *Wentsuia iota - Rhaptagnostus apsis* and *Peichiashania secunda - Prochuangia glabella*.

Diagnosis. *Cermatops* with suboval pygidia having gently angled anterolateral corners, and six pleural segments.

Differential diagnosis. See generic diagnosis, and comments on *Cermatops* sp. undet., following.

Description. The description of the cranidium has been pieced together from ten fragments, the illustrated specimens covering more or less the complete cranidial morphology with the exception of the posterolateral limbs, whose shape is deduced from the librigena. As the material is badly fragmented no quantitative descriptions can be given.

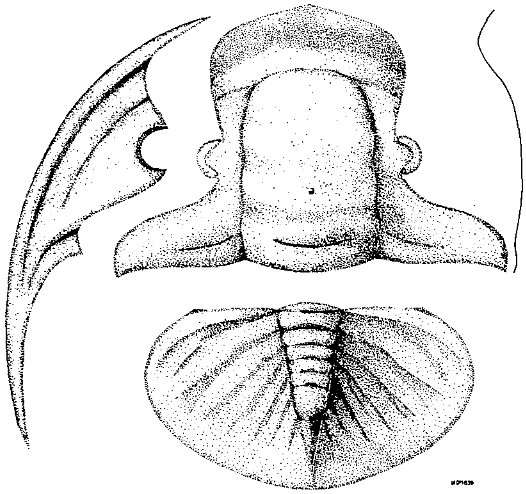


Fig. 38. ***Cermatops vieta*** **gen. et sp. nov.; reconstruction based on CPC 15347a and 15348b (cranidium), CPC 15350a (librigena), and CPC 15354 (pygidium), x2.5.**

The glabella appears to be rectangular, anteriorly rounded, mostly effaced — traces of glabellar furrows being not readily distinguished from the impressions of muscle scars — and fused with the occipital ring. A gentle lateral constriction is evident along the axial furrows opposite the glabellar node, which lies a little over a third (38%) of the combined length of the glabella plus occipital ring (Gn) from the rear of the cranidium.

Small semicircular palpebral lobes, about 17% of the glabellar plus occipital length (Gn), lie forward of the glabellar node, close to the axial furrows. Palpebral furrows are poorly defined.

The preocular facial sutures run more or less straight, or with low angle of divergence, forwards. In general they enclose a gently forward-sloping preglabellar field, shallow but wide marginal furrow, and upturned, poorly differentiated border which is anteriorly slightly pointed. The preglabellar field is invariably separated by well marked paradoublural lines or preocular furrows from narrow (tr.), elongate (exsag.) preocular areas. In some specimens, however, there is little differentiation of the components of the preglabellar area, the preglabellar field merging with the marginal furrow to form a concave depression which passes imperceptibly into a poorly differentiated anterior cranidial border. The postocular facial sutures enclose broad-based triangular posterolateral limbs, evident from the posterior margin of the librigena.

The librigena is characterised by a lateral border morphology which resembles that of the preglabellar area of the cranidium. A transversely narrow genal field is sharply delineated from the lateral border by a rather prominent marginal furrow, and the lateral border itself is divided by a shallow sulcus, a continuation of the anterior cranidial marginal furrow. The posterior marginal furrow continues into the genal spine base, and is unconnected with the lateral marginal furrow. The genal spine is long and stout. Although there is no definite evidence, it is likely that the two librigenae connected anteriorly at an asaphoid median suture.

The pygidium is suboval, with gently rounded anterolateral corners and entire margins. Among measured specimens the length (Lp_2) is 49-53% of the width. The axis is conical, tapers evenly rearwards, and is continued to the posterior margin as a post-axial ridge about half the length of the axis proper. Only the anterior 3-4 segments are well defined by transverse furrows, but probably three more are fused together behind these: six pleural segments are apparent from a count of pleural furrows. The latter widen distally and continue close to the pygidial margin. The opisthopleuron of each pleural segment overlaps the propleuron of that behind, the overlap commencing at a weak geniculation which is located closer to the axial furrows than to the pygidial margin. Abaxially from this geniculation, the pygidium is gently concave. Anteriorly, the articulating half-ring is a narrow crescent, fulcral points are undeveloped, and the articulating facets have a gentle inclination to the anterior pygidial edge. The doublure is evidently wide (sag; exsag; tr.).

Cranidial and librigenal exoskeletal prosopon has not been observed. The pygidial exoskeleton, however, bears terrace lines on all areas with relief (Pl. 34, figs. 9-11). Details of musculature are observed on the cranidial fragment illustrated on Pl. 34, figs. 3, 6, but cannot be adequately interpreted. No details of the caecal network are presrved.

Cermatops sp. undet.
(Pl. 35, figs. 1-5)

Material. Twenty pygidia with lengths (Lp_2) between 2.90 and 9.90 mm. Specimens CPC 15355-59 are illustrated; supplementary material CPC 17824-17838.

Occurrence. Horse Creek, horizons K215, 217, 223, 224, 225, 226 and B1; Lily Creek, horizons K198, 199 and B54a, 10-24 m from the base of the measured section.

Age. Late Cambrian, Assemblage-Zones of *Wentsuia iota-Rhaptagnostus apsis* and *Peichiashania secunda - Prochuangia glabella*.

Comments. The pygidia referred to *Cermatops* sp. undet. are subtrapezoidal in shape, in contrast to the suboval pygidia of *C. vieta*. Accordingly, their proportions differ slightly, length (Lp_2) varying between 44 and 51% of the maximum width (tr.), and the inclination of the articulating facets is apparently greater. *Cermatops* sp. undet. has comparable pleural morphology to *C. vieta,* but has one fewer segment. Its axis and post-axial ridge are shorter (sag.), but have a similar number of segments. The position of the geniculation is similar and a wide doublure is postulated.

As most of the specimens assigned to *Cermatops* sp. undet. are early holaspides, it may be considered that they represent juveniles of *C. vieta*. However, their size range is overlapped by pygidia of *vieta*, so they are differentiated here as an unnamed variant, possibly a new species. No obvious differences can be observed among associated cranidial fragments or librigenae, so that if this taxon does represent a new species it is likely that its cephalon was identical with that of *C. vieta*. As far as can be ascertained, the time spans of *C. vieta* and *Cermatops* sp. undet. overlap slightly.

Genus et species undet. A
(Pl. 35, fig. 6)

Material. A single incomplete and slightly distorted pygidium, CPC 15360, measuring (Lp_2) 9.50 mm.

Occurrence. Lily Creek, horizon K199, 15 m from the base of the measured section.

Age. Late Cambrian, *Wentsuia iota - Rhaptagnostus apsis* Assemblage-Zone.

Comments. Genus et species undet. A appears to represent a *Cermatops* with at least one pair of lateral pygidial spines. As far as can be ascertained, the general pleural and axial morphology closely resemble that of *Cermatops* sp. undet.; the articulating facets appear more strongly inclined than in *C. vieta*, but the doublure is similarly wide (sag., exsag.). The lateral spines are developed as triangular points on the anterolateral margin behind the articulating facets, and are related to the first pair of pleurae. They are quite unlike the spines of previously described Ceratopygidae, resembling those of dikelocephalacean genera such as *Elkia* Walcott, 1924 — with particular reference to the pygidium of *Parabriscoia dolichorachis* Kobayashi (1935A, p. 54, pl. X, fig. 11), now assigned to *Elkia nasuta* Walcott by Lochman-Balk (1959, p.0254) and Palmer (1968, p. 60). The *Cermatops*/Genus A relationship within the Ceratopygacea evidently parallels, but predates, that of *Briscoia/Elkia* among Dikelocephalacea.

UNDETERMINED HYPOSTOMATA

Hypostoma type 1
(Pl. 20, fig. 10)

Material. Five specimens are known: CPC 15394 is illustrated, CPC 17840-17843 are non-illustrated supplementary material.

Occurrence. Hypostoma type 1 is found at localities K216, 218, 221, 225, and 226 on the Horse Creek section.

Age. Late Cambrian, *Wentsuia iota - Rhaptagnostus apsis* Assemblage-Zone.

Description. Hypostoma type 1 is an elongate (sag.) sternite with prominent convex median body and maculae. The anterior and lateral borders are narrow upturned rims, but the posterior border is flat, the convexity of the posterior lobe sloping gradually to the posterior margin of the hypostoma. Gently concave triangular areas are interposed antero-laterally between the median body and the anterior hypostomal border, and a depression lies on the sagittal line at their adaxial confluence. The nature of the anterolateral wings is not known. The median body is ovoid and swollen, the posterior lobe short (sag.) crescentic and less concave (sag.). Maculae are prominent and bean-shaped. An overall 'fingerprint' prosopon is observable.

Comment. Judging from its basic morphology, Hypostoma type 1 belongs to an asaphine trilobite, and in view of its characteristic prosopon and temporal distribution probably belongs to the ceratopygid taxon *Haniwoides varia* sp. nov., described above. Resemblance, in the form of the median body and the position of the maculae, exists with the earlier described hypostomata of *Golasaphus* (see Shergold, 1972, pl. 11, figs. 8-9 for *G. momedahensis*, and Shergold, 1975, pl. 55, fig. 7 for *G. simus*).

Hypostoma type 2
(Pl. 20, fig. 9)

Material. A single incomplete specimen, CPC 15393.

Occurrence. Lily Creek, horizon B791a, unlocated on the measured section.

Age. Late Cambrian, *Peichiashania tertia - P. quarta* Assemblage-Zone.

Description. A small rectangular hypostoma with gently upturned lateral and posterior borders, and an anteriorly curved posterior margin. The nature of the anterior border and anterolateral wings is not known. The median body is gently convex, more so at the front than the back, with indistinct lateral boundaries. The posterior lobe is crescentic, has similar convexity, and is separated from the posterior border by a distinct furrow. Maculae are prominent. A granulose prosopon is observed.

Comment. The only granulose trilobite commonly occurring at locality B791a is *Parakoldinioidia* cf. *bigranulosa*, whose hypostoma has not previously been described. Hypostoma type 2 is of sufficient size to be assigned perhaps to this taxon.

Hypostoma type 3
(Pl. 12, fig. 13)

Material. A single partly exfoliated specimen, CPC 15392.

Occurrence. Lily Creek, horizon B54c, equivalent to K208, 144 m from the base of the measured section.

Age. Late Cambrian, *Peichiashania tertia - P. quarta* Assemblage-Zone.

Description. Hypostoma type 3 is an elongate shield with narrow lateral and posterior borders and prominent anterolateral wings. The borders are narrow (tr.) and wirelike, flattening anterolaterally to pass into broad, triangular wings. The anterior border is assumed to be broadly arcuate. The median body is long (sag.) ovoid, with maximum convexity about its centre. The posterior lobe is equally convex, and possibly overhangs the posterior margin of the hypostoma. The maculae are elongate bodies, perforated at their posterior ends. Where the exoskeleton is preserved, a coarse striation is observed along the borders and on the bases of the anterolateral wings.

A distinct caecal node is observed where the shell is exfoliated at the front of the median body. Caeca radiate from this, principally anteriorly, but also around the convexity of the anterolateral portions of the median body.

Hypostoma type 4
(Pl. 12, figs. 11-12)

Material. Three specimens: CPC 15390-15391, both silicified and incomplete, are illustrated; CPC 17844, another incomplete silicified specimen, is unfigured.

Occurrence. Lily Creek, horizons K204 and 205, 69-72 m from the base of the measured section.

Age. Late Cambrian, *Peichiashania secunda* - *Prochuangia glabella* Assemblage-Zone.

Description. An elongate (sag.) hypostoma with subrectangular median body, and very broad lateral borders. None of the available specimens has the anterior border preserved, but the two illustrated hypostomata indicate that the anterolateral wings may have projected strongly addorsally in life, probably orientated normal to the horizontal plane of the structure, and were separated by a short (tr.) anterior margin. Anterolaterally, the borders are very narrow, but they expand (tr.) rapidly posteriorly so that opposite the maculae they are as wide as half the transverse dimension of the median body. Thence, they narrow posteriorly around the posterior lobe of the hypostoma. The median body is subrectangular, pear-shaped, with relatively low convexity (tr. & sag.). The posterior lobe, more or less crescentic and with similar convexity, is separated from the posterior border by a furrow. The maculae are elongate, almost effaced by the silicification process. The prosopon of the borders is preserved as inosculating ridges, but that of the median body is obliterated.

Comments. These hypostomata could belong to either of the dokimocephalid genera *Wuhuia* or *Lorrettina*, or to the mansuyiinid *Peichiashania*. Hypostomata have not previously been attributed to any of these genera.

REFERENCES

ANGELIN, N.P., 1851-1878 — *Palaeontologica Scandinavica:* Acadamiae Regiae Scientarium Suecanae (Holmiae); *Pars I, Crustacea formationis transitionis,* pp. 1-24, pls. 1-24 [1851]; *Pars II, idem,* pp. i-ix, 25-92, pls. 25-41 [1854]; republished in combined and revised form (LINDSTRÖM, G., ed.), pp. i-ix, 1-96, pls. 1-42 [1878].

BANKS, M.R., 1962 — Cambrian System. *In* SPRY, A., & BANKS, M. R., (eds), The geology of Tasmania. *J. geol. Soc. Aust.,* 9 (2), 127-145.

BELL, W.C., & ELLINGWOOD, H. L., 1962 — Upper Franconian and Lower Trempealeauan Cambrian trilobites and brachiopods, Wilberns Formation, central Texas. *J. Paleont.,* 36 (3), 385-423, pls. 51-64.

BOROVIKOV, L.I., & KRYSKOV, L. N., 1963 — Cambrian deposits in the Kendyktas Mountains (south Kazakhstan). *Trudy vses. nauchno-issled. Inst. Geol.,* 94, 266-280, pl. 1 [in Russian].

BRADLEY, J.H., 1925 — Trilobites of the Beekmantown in the Philipsburg region of Quebec. *Can. Fld Nat.,* 39, 7-8.

BRÖGGER, W.C., 1882 — *Die silurischen Etagen 2 und 3 im Kristianiagebiet und auf Eker, ihre Gliederung, Fossilien, Schichtenstörungen und Kontaktmetamorfosen.* Univ.-Programm (Christiania), 1-376, pls. 1-12.

BURMEISTER, H., 1843 — *Die Organization der Trilobiten.* xii + 148 pp., pls. I-IV, Berlin.

CARTER, E.K., & ÖPIK, A. A., 1963 — Duchess, Qld: 4-mile Geological Series Sheet SF/54-6. *Explan. Notes Bur. Miner. Resour. Geol. Geophys. Aust.,* 23, 29 pp.

CASEY, J.N., 1959 — New names in Queensland stratigraphy (part 5). *J. Aust. Oil Gas,* 5, 31-36.

CASEY, J.N., 1968 — Boulia, Qld - 1:250 000 Geological Series Sheet SF/54-10. *Explan. Notes Bur. Miner. Resour. Geol. Geophys. Aust.,* 30 pp.

CASEY, J.N., REYNOLDS, M. A., DOW, D. B., PRITCHARD, P.W., VINE, R. R., & PATEN, R. J., 1960 — The geology of the Boulia area, western Queensland. *Rec. Bur. Miner. Resour. Geol. Geophys. Aust.,* 1960/12, 132 pp. [unpubl.].

CHANG, W. T.. 1957 — Preliminary note on the Lower and Middle Cambrian stratigraphy of Poshan, central Shantung. *Acta palaeont. sinica,* 5 (1), 13-28 [in Chinese], 29-31 [Engl.], pls. 1-2.

CHANG, W.T., 1959 — New trilobites from the Middle Cambrian of north China. *Acta palaeont. sinica,* 7 (3), 193-212 [in Chinese], 213-236 [Engl.], pls. 1-4.

CHEETHAM, A.H., & HAZEL, J. E., 1969 — Binary (presence-absence) similarity coefficients. *J. Paleont.,* 43 (5), 1130-1136.

CHIEN, Yi-yuan, 1958 — Ontogeny of a new Upper Cambrian trilobite from Penchi, Liaoning. *Acta palaeont. sinica,* 6 (4), 453-466 [in Chinese], 466-477 [Engl.], pls. 1-4.

CHIEN, Yi-yuan, 1961 — Cambrian trilobites from Sandu and Duyun, southern Kweichow. *Acta palaeont. sinica,* 9 (2), 91-129 [in Chinese], 130-139 [Engl.], pls. 1-5.

COOK, H.E., & TAYLOR, M.E., 1975 — Early Palaeozoic continental margin sedimentation, trilobite biofacies, and the thermocline, western United States. *Geology,* 3 (10), 559-562.

CORBETT, K.D., 1975 — The late Cambrian to early Ordovician sequence in the Denison Range, southwest Tasmania. *Papers Proc. Roy. Soc. Tasm.,* 109, 111-120.

DAMES, W., 1883 — Cambrische Trilobiten von Liautung. *In* von RICHTHOFEN, F.F., pp. 1-33, pls. I-II.

DATSENKO, V.A., & LAZARENKO, N.P., 1968 — Biostratigraphy of the Cambrian deposits of the northwest Siberian Platform. *In* DATSENKO, V.A., ZHURAVLEVA, I.T., LAZARENKO, N.P., POPOV, Yu. N., & TCHERNYSHEVA, N.E., pp. 7-117 [in Russian].

DATSENKO, V.A., ZHURAVLEVA, I.T., LAZARENKO, N.P., POPOV, Yu. N., & TCHERNYSHEVA, N.E., 1968 — Biostratigraphy and fauna of the Cambrian deposits of the northwest Siberian Platform. *Trudy nauchno-issled. Inst. Geol. Arktik,* 155, 213 pp., 23 pls. [in Russian].

de KEYSER, F., 1968 — The Cambrian of the Burke River outlier. *Rec. Bur. Miner. Resour. Geol. Geophys. Aust.,* 1968/67, 48 pp. [unpubl.].

DRUCE, E.C., & JONES, P.J., 1971 — Cambro-Ordovician conodonts from the Burke River Structural Belt, Queensland. *Bull. Bur. Miner. Resour. Geol. Geophys. Aust.,* 110, 158 pp., 20 pls.

DRUCE, E.C., RADKE, B.M.; & DRAPER, J.J., 1976 — Southern Burke River Structural Belt, Queensland, 1:100 000 Geological Series Sheet, provisional edition. *Bur. Miner. Resour. Geol. Geophys. Aust.*

DUNHAM, R.J., 1962 — Classification of carbonate rocks according to depositional texture. *In* HAM, W.E. (ed.), pp. 108-121.

ENDO, R., 1928 — The Cambro-Ordovician strata in south Manchuria (preliminary report). *Manchur. Teachers' Coll. Res. Ser.,* 3, 1-98 [in Japanese].

ENDO, R., 1931 — The Cambrian Period. *In* Iwanami Lecture Series, section on geology, palaeontology, mineralogy and petrology, pp. 1-94 [in Japanese].

ENDO, R., 1937 — Introduction; Stratigraphic geology; and Addenda to Parts I and II. *In* ENDO, R. & RESSER, C. E., pp. 1-102, 302-365, pls. 58-73.

ENDO, R., 1939 — Cambrian fossils from Shantung. *Jubilee Publ. Comm. Prof. Yabe's 60th Birthday,* 1-18, pls. 1-2.

ENDO, R., 1944 — Restudies on the Cambrian formations and fossils of southern Manchukuo. *Bull. cent. nat. Mus. Manchukuo,* 7, 1-100, pls. 1-10.

ENDO, R., & RESSER, C.E., 1937 — The Sinian and Cambrian formations and fossils of southern Manchukuo. *Bull. Manchur. Sci. Mus.,* 1, 474 pp., pls. 14-73.

FREDERICKSON, E.A., 1948 — Upper Cambrian trilobites from Oklahoma. *J. Paleont.,* 22 (6), 798-803, pl. 123.

FREDERICKSON, E.A., 1949 — Trilobite fauna of the Upper Cambrian Honey Creek Formation. *J. Paleont.,* 23 (4), 341-363, pls. 68-72.

GRANT, R.E., 1965 — Faunas and stratigraphy of the Snowy Range Formation (Upper Cambrian) in southwestern Montana and northwestern Wyoming. *Mem. geol. Soc. Amer.*, 96, pp. i-ix, 1-171, pls. 5-15.

HALL, J. & WHITFIELD, R.P., 1877 — Palaeontology, part II. *In* KING, C., pp. 198-302, pls. I-VIII.

HAM, W.E. (ed.), 1962 - Classification of carbonate rocks. *Mem. Amer. Assoc. Pet. Geol.*, 1, 279 pp.

HARRINGTON, H.J., 1938 — Sobre las faunas del Ordoviciano inferior del norte argentino. *Rev. Mus. de La Plata (Buenos Aires), n. s.*, 1, *Paleont.*, 4, 109-289, pls. I-XIV.

HARRINGTON, H.J., & LEANZA, A.F., 1957 — Ordovician trilobites of Argentina. *Spec. Publ. Univ. Kansas Dept Geol.*, 1, 276 pp., 104 figs.

HAZEL, J.E., 1970 — Binary coefficients and clustering in biostratigraphy. *Bull. geol. Soc. Amer.*, 81, 3237-3252.

HAZEL, J.E., 1971 — Ostracode biostratigraphy of the Yorktown Formation (upper Miocene and lower Pliocene) of Virginia and North Carolina. *Prof. Pap. U. S. geol. Surv.*, 704, 1-13.

HENDERSON, R.A., 1976 — Upper Cambrian (Idamean) trilobites from western Queensland, Australia. *Palaeontology*, 19 (2), 325-364, pls. 47-51.

HENDERSON, R.A., 1977 — Stratigraphy of the Georgina Limestone and a revised zonation for the early Upper Cambrian Idamean Stage. *J. geol. Soc. Aust.*, 23 (4), 423-433.

HENNINGSMOEN, G., 1957 — The trilobite family Olenidae. *Norske Videnskapsakad, (Oslo), mat.-naturv. Kl., Skr.*, 1, 303 pp., 31 pls.

HOWELL, B.F., 1935 — Cambrian and Ordovician trilobites from Hérault, southern France. *J. Paleont.*, 9 (3), 222-238, pls. 22-23.

HOWELL, B.F., 1937 — Cambrian *Centropleura vermontensis* fauna of northwestern Vermont. *Bull. geol. Soc. Amer.*, 48, 1147-1210, pls. 1-6.

HSIANG, L.W., 1963 — See JEGOROVA, L.I., HSIANG, L.W., LEE, S.C., NAN, J.S., & KUO, C.M., 1963.

HUPÉ, P., 1955 — Classification des trilobites. *Ann. Paléont.*, 41, 93-325, figs. 93-247.

IVSHIN, N.K., 1956 — Upper Cambrian trilobites of Kazakhstan, 1. *Trudy Inst. geol. Nauk, Akad. Nauk Kazakh. SSR, Alma-Ata*, 3-98, pls. I-IX [in Russian].

IVSHIN, N.K., 1960A — New biostratigraphic scale for the Upper Cambrian of the Altai-Sayan geosynclinal region. *Trudy Inst. geol. Nauk, Akad. Nauk Kazakh. SSR, Alma-Ata*, 3, 3-62 [in Russian].

IVSHIN, N.K., 1960B — See KHALFIN, L.L. (ed.) 1960.

IVSHIN, N.K., 1962 — Upper Cambrian trilobites of Kazakhstan, 2. *Trudy Inst. geol. Nauk, Akad. Nauk Kazakh. SSR, Alma-Ata*, 3-412, pls. I-XXI [in Russian].

IVSHIN, N.K., & POKROVSKAYA, N.V., 1968 — Stage and zonal subdivision of the Upper Cambrian. *23rd Sess. int. geol. Congr. Prague*, 9, 97-108.

JAANUSSON, V., 1959 — See MOORE, R.C. (ed.) 1959.

JAEKEL, O., 1909 — Uber die Agnostiden. *Z. dt. geol. Ges.*, 61, 380-401.

JASKOVICH, B.V., 1968 — Cambrian of the southern Tien-shan. *Izdat. FAN Uzbek. SSR, Min. Geol. Uzbek. SSR, Tashkent*, 3-76 [in Russian].

JEGOROVA, L.I., HSIANG, L.W., LEE, S.E., NAN, J. S., & KUO, C.M., 1963 — The Cambrian trilobite faunas of Kueichou and western Hunan. *Spec. Pap. Inst. Geol. Miner. Resour. Peking, [B] Stratigraphy and Palaeontology*, 3(1), 117 pp., 15 pls.

JONES, P.J., 1971 — Lower Ordovician conodonts from the Bonaparte Gulf Basin and Daly River Basin, northwestern Australia. *Bull. Bur. Miner. Resour. Geol. Geophys. Aust.*, 117, 80 pp., 9 pls.

JONES, P.J., SHERGOLD, J.H., & DRUCE, E.C., 1971 — Late Cambrian and early Ordovician Stages in western Queensland. *J. geol. Soc. Aust.*, 18(1), 1-32.

KAULBACK, J.A., & VEEVERS, J.J., 1969 — The Cambrian and Ordovician geology of the southern part of the Bonaparte Gulf Basin, and the Cambrian and Devonian geology of the ouliers, Western Australia. *Rept Bur. Miner. Resour. Geol. Geophys. Aust.*, 109, 55 pp., 4 appendices.

KENNARD, J., & DRAPER, J.J., 1977 — BMR stratigraphic drilling in the Burke River Structural Belt, southeast Georgina Basin, 1974. *Rec. Bur. Miner. Resour. Geol. Geophys. Aust., 1977/19 [unpubl.]*.

KHALFIN, L.L. (ed.), 1960 — Palaeozoic biostratigraphy of the Altai-Sayan mining region. Part 1, Lower Palaeozoic. *Trudy sib. nauchno-issled. Inst. Geol. Geofiz. Min. Syr'ya (SNIIGGIMS)*, 19, 3-498, 53 pls [in Russian].

KING, C., 1877 — Report of the geological exploration of the fortieth parallel, IV. *Prof. Pap. Engineer Dept, U.S. Army*, 18 [extracts only seen].

KING, W.B.R., 1930 — Notes on the Cambrian fauna of Persia. *Geol. Mag.*, 67, 316-327, pl. XVII.

KOBAYASHI, T., 1931 — Studies on the stratigraphy and palaeontology of the Cambro-Ordovician formation of Hualienchai and Niuhsintai, south Manchuria. *Jap. J. Geol. Geogr.*, 8(3), 131-189, pls. XVI-XXII.

KOBAYASHI, T., 1933 — Upper Cambrian of the Wuhutsui Basin, Liaotung, with special reference to the limit of the Chaumitien (or Upper Cambrian) of eastern Asia, and its subdivision. *Ibid.*, 11 (1-2), 55-155, pls. IX-XV.

KOBAYASHI, T., 1935A — The *Briscoia* fauna of the late Upper Cambrian in Alaska with descriptions of a few Upper Cambrian trilobites from Montana and Nevada. *Ibid.*, 12 (3-4), 39-57, pls. 8-10.

KOBAYASHI, T., 1935B — On the *Kainella* fauna of the basal Ordovician age found in Argentina. *Ibid.*, 12 (3-4), 59-67, pl. 11.

KOBAYASHI, T., 1935C — The Cambro-Ordovician formations and faunas of South Chosen. Palaeontology, pt III. Cambrian faunas of South Chosen with special study on the Cambrian trilobite genera and families. *J. Fac. Sci. Imp. Univ. Tokyo*, [2], 4 (2), 49-344, pls. I-XXIV.

KOBAYASHI, T., 1937A — Restudy of the Dames' types of the Cambrian trilobites from Liaotung. *Trans. Proc. palaeont. Soc. Japan*, 12 (7), 70-86, pl. 17, reprinted from *J. geol. Soc. Japan*, 44 (523-525), 421-437, pl. 6.

KOBAYASHI, T., 1937B — The Cambro-Ordovician shelly faunas of South America. *J. Fac. Sci. Imp. Univ. Tokyo,* [2], 4 (4), 369-522, pls. I-VIII.
KOBAYASHI, T., 1938 — Upper Cambrian fossils from British Columbia with a discussion on the isolated occurrence of the so-called *'Olenus'* Beds of Mount Jubilee. *J. Jap. Geol. Geogr.,* 15, 149-192, pls. XV-XVI.
KOBAYASHI, T., 1955 — The Ordovician fossils of the McKay Group in British Columbia, western Canada, with a note on the early Ordovician palaeogeography. *J. Fac. Sci. Univ. Tokyo,* [2], 9 (3), 355-493, pls. I-IX.
KOBAYASHI, T., 1956 — The Cambrian of Korea and its relation to the other Cambrian Territories. *In* Symposium sobre el Sistema cambrico su Paleogeografia y el Problema de su Base, 1, 343-362. *20th Sess. int. geol. Congr. Mexico.*
KOBAYASHI, T., 1960 — The Cambro-Ordovician formations and faunas of South Korea, part VII. Palaeontology, VI. *J. Fac. Sci. Univ. Tokyo,* [2], 12 (2), 329-420, pls. XIX-XXI.
KOBAYASHI, T., 1961 — *Idem,* part VIII. Palaeontology, VII. Cambrian faunas of the Mun'gyong (Bunkei) district and the Samposan Formation of the Yongwol (Neietsu) district. *Ibid.,* [2], 13 (2), 181-241, pls. IX-XIII.
KOBAYASHI, T., 1962 — *Idem,* part IX. Palaeontology, VIII. The Machari fauna. *Ibid.,* [2], 14 (1), 1-152, pls. I-XII.
KOBAYASHI, T., 1966A — *Idem,* part X. Stratigraphy of the Chosen Group in Korea and south Manchuria and its relation to the Cambro-Ordovician formations of other areas. Section A. The Chosen Group of South Korea. *Ibid.,* [2], 16 (1), 1-84.
KOBAYASHI, T., 1966B — *Idem,* Section B. The Chosen Group of North Korea and northeast China. *Ibid.,* [2], 16 (2), 209-311.
KOBAYASHI, T., 1967 — *Idem,* Section C. The Cambrian of eastern Asia and other parts of the continent. *Ibid.,* [2], 16 (3), 381-534
KOBAYASHI, T., 1971 — *Idem,* Section E. The Cambro-Ordovician faunal provinces and the interprovincial correlation. *Ibid.,* [2], 18 (1), 129-299.

LAKE, P., 1906 — A monograph of the British Cambrian trilobites, part 1. *Monogr. Palaeontogr. Soc. Lond.,* 60 (1906), 1-28, pls. 1-2
LAKE, P., 1907 — A monograph of the British Cambrian trilobites, part 2. *Monogr. Palaeontogr. Soc. Lond.,* 61 (1907), 29-48, pls. 3-4.
LANDING, E., & TAYLOR, M.E., 1977 — Correlation of the Cambro-Ordovician Boundary between the Acado-Baltic and North American faunal provinces. *Abstracts, Geol. Soc. Amer. N-Central Sectn, Illinois* pp. 618-619.
LAZARENKO, N.P., 1966 — Biostratigraphy and some new trilobites from the Upper Cambrian of the Olenek Uplift and Kharaulakh Mountains. *Uchen. Zap. Paleont. Biostratigr., nauchno-issled. Inst. Geol. Arktik,* 11, 33-78, pls. I-VIII [in Russian]. trilobites, part 1, *Monogr. Palaeontogr. Soc. Lond., 60 (1906), 1-28, pls. 1-2.*
LAZARENKO, N.P., 1968 — New trilobites from the Cambrian deposits of northern Siberia. *In* DATSENKO, V.A., ZHURAVLEVA, I.T., LAZARENKO, N.P., POPOV, Yu. N., & TCHERNYSHEVA, N.E., pp. 176-203, pls. XV-XIX [in Russian].
LAZARENKO, N.P., & DATSENKO, V.A., 1967 — Upper Cambrian bistratigraphy of the northwest Siberian Platform. *Uchen. Zap. Paleont. Biostratigr., nauchno-issled. Inst. Geol. Arktik,* 20, 13-32 [in Russian].
LAZARENKO, N.P., & NIKIFOROV, N.I., 1968 — Trilobite complexes from Upper Cambrian deposits on the River Kulyumbe (northwestern Siberian Platform). *Ibid,* 23, 20-80, pls. I-XV [in Russian].
LAZARENKO, N.P., & NIKIFOROV, N.I., 1972 — Middle and Upper Cambrian of the northern Siberian Platform and adjoining mountain regions. *In* Stratigraphy, palaeogeography and mineral resources of the Soviet Arctic. *Nauchno-issled. Inst. Geol. Arktik,* 4-9 [in Russian].

LERMONTOVA, E.V., 1940 — Arthropoda. *In* VOLOGDIN, A.G. (ed.), pp. 112-157, pls. XXXV-XLIX [in Russian].
LERMONTOVA, E.V., 1951 — Upper Cambrian trilobites and brachiopods from Boshche-Kul (northeast Kazakhstan). *Trudy vses. nauchno-issled. Inst. Geol.,* 1-49, pls. I-VI [in Russian].
LERMONTOVA, E.V., 1956 — See NIKITIN, I.F., 1956.

LINNARSSON, J.G.O., 1869 — Om Vestergötlands kambriska och siluriska aflagringar. *Handl. K. svenska Vetenskapsakad.,* 8 (2), 3-89.

LOCHMAN, Christina, 1956 — The evolution of some Upper Cambrian and Lower Ordovician trilobite families. *J. Paleont.,* 30 (3), 445-462, pl. 47.
LOCHMAN, Christina, 1958 — *Sulcocephalus* Wilson, 1948 to replace *Berkeia* Resser, 1937, and *Burnetiella* to replace *Burnetia* Walcott, 1924. *J. Paleont.,* 32 (1), 247.
LOCHMAN, Christina, & HU, Chung-hung, 1959 — A *Ptychaspis* faunule from the Bear River Range, southeastern Idaho. *J. Paleont.,* 33 (3), 404-427, pls. 57-60.
LOCHMAN-BALK, Christina, 1959 — See MOORE, R.C. (ed.), 1959.
LONGACRE, Susan A., 1970 — Trilobites of the Upper Cambrian Ptychaspid biomere, Wilberns Formation, central Texas. *Mem. paleont. Soc.,* 4, *J. Paleont.,* 44 (1), *suppl.,* 1-70, pls. 1-6.
LORENZ, Th., 1906 — Beiträge zur Geologie und Palaeontologie von Ostasien unter besonderer Berucksichtigung der Provinz Schantung in China, II. Palaeontologischer Teil. *Z. dt. geol. Ges.,* 58, 67-122, pls. IV-VI.

LU, Yen-hao, 1956A — On the occurrence of *Lopnorites* in northern Anhwei. *Acta palaeont. sinica,* 4 (3), 267-277 [in Chinese], 278-283 [Engl.], pl. I.
LU, Yen-hao, 1956B — An Upper Cambrian trilobite faunule from eastern Kueichou. *Acta palaeont. sinica,* 4 (3), 365-372 [in Chinese], 373-380 [Engl.], pl. I.
LU, Yen-Hao, 1961 — New Lower Cambrian trilobites from eastern Yunnan. *Inst. Geol. Palaeont., Acad. sinica,* 9 (4), 300-321, pls. I-III.

LU, Yen-hao, CHANG, W.T., CHU, Chao-ling, CHIEN, Yi-yuan, & HSIANG, Lee-wen, 1965 — *Chinese fossils of all groups. Trilobita*. Vol. 1, 362 pp., 66 pls; vol. 2, pp. 363-766, pls. 67-135 [in Chinese]. Science Publ. Co., Peking.

LU, Yen-hao *et al.*, 1957 — Trilobites. *In Chung-kuo piao chun hua shih* [Index fossils of China], part 3. *Inst. Palaeont., Acad sinica*, 249-298, pls. 137-155 [in Chinese].

LU, Yen-hao *et al*, 1974 — Bio-environmental control hypothesis and its application to the Cambrian biostratigraphy and palaeozoogeography. *Mem. Nanking Inst. Geol. Palaeont.*, 5, 27-110, pls. I-IV [in Chinese].

M'COY, F., 1849 — On the classification of some British fossil Crustacea, with notices of new forms in the University collection at Cambridge. *Ann. Mag. nat. Hist*, [2], 4, 161-179, 392-414.

MANSUY, H., 1915 — Faunes cambriennes du Haut-Tonkin. *Mém. Serv. géol. Indochine*, 4, *fasc.* II, 1-35, pls. 1-3.

MATTHEW, G.F., 1887 — Illustrations of the fauna of the St John Group, No. IV, pt. I. Description of new species of *Paradoxides (Paradoxides regina)*. Pt II. The smaller trilobites with eyes (Ptychoparidae and Ellipsocephalidae). *Trans. Proc. Roy. Soc. Can.*, 5, 115-166, pls. 1-2.

MAXIMOVA, Z.A., 1962 — Ordovician and Silurian trilobites of the Siberian Platform. *In* Biostratigraphy of the Palaeozoic of the Siberian Platform, Ordovician and Silurian. *Trudy vses. nauchno-issled. Inst. Geol.*, 76, 215 pp., 18 pls. [in Russian].

MELO, J.F., & BUZAS, M.A., 1968 — An application of cluster analysis as a method of determining biofacies. *J. Paleont.*, 42 (3), 747-758.

MILLER, S.A., 1889 — *North American geology and palaeontology for the use of amateurs, students and scientists*. 718 pp., 1265 figs. Cincinnati, Ohio.

MOORE, R.C. (ed.), 1959 — *Treatise on invertebrate Paleontology*. Part O, Arthropoda, 1, xix + 560 pp. Geol. Soc. Amer. & Univ. Kansas Press.

NIKITIN, I.F., 1956 — Cambrian and Lower Ordovician brachiopods from northeastern central Kazakhstan. *Trudy Inst. geol. Nauk, Akad. Nauk Kazakh. SSR, Alma-Ata*, 143 pp., 15 pls. [in Russian].

ÖPIK, A.A., 1956A — Cambrian geology of Queensland. *In* Symposium sobre el Sistema cambrico su Paleogeografia y el Problema de su Base, 2, 1-24 *20th Sess. int. geol. Congr., Mexico*.

ÖPIK, A.A., 1956B — Cambrian geology of the Northern Territory. *Ibid.*, 25-54. *20th Sess. int. geol. Congr., Mexico*.

ÖPIK, A.A., 1960 — Cambrian and Ordovician geology [of Queensland]. *J. geol. Soc. Aust.*, 7, 91-103.

ÖPIK, A.A., 1961A — Alimentary caeca of agnostids and other trilobites. *Palaeontology*, 3 (4), 410-438, pls. 68-70.

ÖPIK, A.A., 1961B — The geology and palaeontology of the headwaters of the Burke River, Queensland. *Bull. Bur. Miner. Resour. Geol. Geophys. Aust.*, 53, 249 pp., 24 pls.

ÖPIK, A.A., 1963 — Early Upper Cambrian fossils from Queensland. *Ibid.*, 64, 133 pp., 9 pls.

ÖPIK, A.A., 1967 — The Mindyallan fauna of northwestern Queensland. *Ibid.*, 74, vol. 1, 404 pp.; vol. 2, 166 pp., 67 pls.

ÖPIK, A.A., 1968 — Early Ordovician at Claravale in the Fergusson River area, Northern Territory. *Ibid.*, 80 (9), 163-165.

ÖPIK, A.A., 1969 — Appendix 3. The Cambrian and Ordovician sequence, Cambridge Gulf area. *In* KAULBACK, J.A., & VEEVERS, J.J., 1969, pp. 74-77.

PALMER, A.R., 1955 — Upper Cambrian Agnostidae of the Eureka District, Nevada. *J. Paleont.*, 29 (1), 86-101, pls. 19-20.

PALMER, A.R., 1960 — Trilobites from the Upper Cambrian Dunderberg Shale, Eureka district, Nevada. *Prof. Pap. U. S. geol. Surv.*, 334-C, 109 pp., 11 pls.

PALMER, A.R., 1962 — *Glyptagnostus* and associated trilobites in the United States. *Prof. Pap. U. S. geol. Surv.*, 374-F, 49 pp., 6 pls.

PALMER, A.R., 1965 — Trilobites of the late Cambrian pterocephaliid biomere in the Great Basin, United States. *Prof. Pap. U. S. Geol. Surv.*, 493, 105 pp., 23 pls.

PALMER, A.R., 1968 — Cambrian trilobites of east-central Alaska. *Prof. Pap. U. S. geol. Surv.*, 559-B, 115 pp., 13 pls.

PETRUNINA, Z.E., 1960 — See KHALFIN, L.L., 1960.

PHILLIPS PETROLEUM CO. LTD., 1963 — Phillips-Sunray stratigraphic drilling, Boulia area, ATP 54P, Queensland. Well completion report by GREEN, D.C., HAMLING, D.D., & KYRANIS, N. [unpubl.].

POKROVSKAYA, N.V., 1966 — Trilobites of the Family Olenidae from the Upper Cambrian of Yakutia. *Paleont. Zh.*, 1966 (2), 67-80, pl. X [in Russian].

POULSEN, C., 1927 — The Cambrian, Ozarkian and Canadian faunas of northwest Greenland. *Meddel. om Grønland*, 70 (2), 233-343, pls. 14-21.

RADKE, B.M., 1976 — See SHERGOLD, J.H., DRUCE, E.C., RADKE, B.M., & DRAPER, J.J., 1976.

RASETTI, F., 1944 — Upper Cambrian trilobites from the Lévis conglomerate. *J. Paleont.*, 18 (3), 229-258, pls. 36-39.

RASETTI, F., 1961 — Dresbachian and Franconian trilobites of the Conococheague and Frederick Limestone of the central Appalachians. *J. Paleont.*, 35 (1), 104-124, pls. 21-25.

RAYMOND, P.E., 1924 — New Upper Cambrian and Lower Ordovician trilobites from Vermont. *Proc. Boston Soc. Nat. Hist.*, 37, 389-466, pls. 12-14.

RAYMOND, P.E., 1937 — Upper Cambrian and Lower Ordovician Trilobita and Ostracoda from Vermont. *Bull. geol. Soc. Amer.*, 48, 1079-1146, 4 pls.

RAYMOND, P.E., 1938 — Corrections and emendations. *Bull. geol. Soc. Amer.*, 48 (suppl.), p. xv.

REPINA, L.N., JASKOVICH, B.V., AKSARINA, N.A., PETRUNINA, Z.E., PONYKLENKO, I.A., RUBANOV, D.A., BOLGOVA, G.V., GOLYKOV, A.N., HAJRULLINA, T.I., & POSOKHOVA, M.M., 1975 — Stratigraphy and fauna of the Lower Palaeozoic of the northern submontane belt of the Turkestan and Alai Ridges

(southern Tien-shan). *Trudy Inst. Geol. Geofiz.*, 278, 351 pp., 48 pls. [in Russian].
RESSER, C.E., 1938 — Cambrian System (restricted) of the southern Appalachians. *Spec. Pap. geol. Soc. Amer.*, 15, 140 pp., 16 pls.
RESSER, C.E., 1942 — New Upper Cambrian trilobites. *Smithson. misc. Coll.*, 103 (5), 1-136, 21 pls.
RESSER, C.E., & ENDO, R., 1931 — See ENDO, R., 1931.
RESSER, C.E., & ENDO, R., 1937 — See ENDO, R., & RESSER, C.E., 1937.
ROBISON, R.A., 1972 — Mode of life of agnostid trilobites. *24th Sess. intn. geol. Congr., Montreal,* 7, 33-40.
ROBISON, R.A., & PANTOJA-ALOR, J., 1968 — Tremadocian trilobites from the Nochixtlán region, Oaxaca, Mexico. *J. Paleont.*, 42 (3), 767-800, pls. 97-104.
ROSOVA, A.V., 1960 — Upper Cambrian trilobites from Salair (Tolstochikhinsk Suite). *Trudy Inst. Geol. Geofiz.*, 5, 116 pp., 8 pls. [in Russian].
ROSOVA, A.V., 1963 — Biostratigraphical scheme for the Upper and top of the Middle Cambrian and new Upper Cambrian trilobites. *Ibid.*, 9, 3-19, pls. 1-2 [in Russian].
ROSOVA, A.V., 1964 — Biostratigraphy and description of Middle and Upper Cambrian trilobites from the north-west Siberian Platform. *Trudy inst. Geol. Geofiz.*, 106 pp., 19 pls. [in Russian].
ROSOVA, A.V., 1968 — Biostratigraphy and Upper Cambrian and Lower Ordovician trilobites from the northwest Siberian Platform. *Ibid.*, 36, 196 pp., 27 pls. [in Russian].
ROWELL, A.J., McBRIDE, D.J., & PALMER, A.R., 1973 — Quantitative study of Trempealeauian (latest Cambrian) trilobite distribution in North America. *Bull. geol. Soc. Amer.*, 84, 3429-3442.
SALTER, J.W., 1864 — A monograph of the British trilobites. *Palaeontogr. Soc.* [*Monogr.*], 1-80, pls. 1-6.
SCHRANK, E., 1973 — Trilobiten aus Geschieben der oberkambrischen Stufen 3-5. *Paläont. Abh.*, [A] *Paläozool.*, 2, 805-857, pls. I-XV.
SCHRANK, E., 1974 — Kambrische Trilobiten der China-Kollektion v. Richthofen. 1. Die *Chuangia*-Zone von Saimaki. *Z. geol. Wiss.*, 2 (1974) (5), 617-643, pls. I-V.
SCHRANK, E., 1975 — *Idem*, 2. Die Fauna mit *Kaolishania? quadriceps* von Saimaki. *Ibid.*, 3 (1975) (5), 591-619, pls. I-VIII.
SDZUY, K., 1955 — Die Fuana der Leimnitz-Schiefer (Tremadoc). *Abh. Senck. naturf. Ges.*, 492, 74 pp., 8 pls.
SHAW, A.B., 1951 — Paleontology of northwestern Vermont, 1. New late Cambrian trilobites. *J. Paleont.*, 25 (1), 97-114, pls. 21-24.
SHAW, A.B., 1952 — *Idem*, II. Fauna of the Upper Cambrian Rockledge Conglomerate near St Albans. *J. Paleont.*, 26 (3), 458-483, pl. 57.
SHERGOLD, J.H., 1972 — Late Upper Cambrian trilobites from the Gola Beds, western Queensland. *Bull. Bur. Miner. Resour. Geol. Geophys. Aust.*, 112, 126 pp., 19 pls.
SHERGOLD, J.H., 1975 — Late Cambrian and early Ordovician trilobites from the Burke River Structural Belt, western Queensland, Australia. *Ibid.*, 153, vol. 1 (text), 251 pp., vol. 2, 58 pls.
SHERGOLD, J.H., 1977A — Classification of the trilobite *Pseudagnostus*. *Palaeontology,* 20 (1), 69-100, pls. 15-16.
SHERGOLD, J.H., 1977B — See KENNARD, J., & DRAPER, J.J., 1977.
SHERGOLD, J.H., COOPER, R.A., MacKINNON, D.I., & YOCHELSON, E.L., 1976 — Late Cambrian Brachiopoda, Mollusca, and Trilobita from northern Victoria Land, Antarctica. *Palaeontology,* 19 (2), 247-291, pls. 38-42.
SHERGOLD, J.H., DRUCE, E.C., RADKE, B.M., & DRAPER, J.J., 1976 — Cambrian and Ordovician stratigraphy of the eastern portion of the Georgina Basin, Queensland and eastern Northern Territory. *25th Sess. intn. geol. Congr., Sydney, Excur. Guide* 4C, 54 pp.
SMITH, K.G., 1972 — Stratigraphy of the Georgina Basin. *Bull. Bur. Miner. Resour. Geol. Geophys. Aust.*, 111, 156 pp., 6 pls.
SPRY, A., & BANKS, M.R., 1962 — The geology of Tasmania. *J. geol. Soc. Aust.*, 9 (2), 107-362.
STITT, J.H., 1977 — Late Cambrian and earliest Ordovician trilobites, Wichita Mountains area, Oklahoma. *Bull. geol. Surv. Oklahoma,* 124, 79 pp., 6 pls.
SWINNERTON, H.H., 1915 — Suggestions for the revised classification of trilobites. *Geol. Mag.*, [*Dec. 6*] 2, 487-496, 538-545.
SUN, Yun-chu, 1924 — Contribution to the Cambrian faunas of China. *Palaeont. sinica,* [B] II, *Fasc.* 4, 1-109, pls. I-V.
SUN, Yun-chu, 1935 — The Upper Cambrian trilobite faunas of north China. *Palaeont. sinica,* [B] VII, *Fasc.* 2, 1-69, pls. I-VI.
TAYLOR, D.J., 1959 — Report on the examination of fossils collected from the Georgina Basin, Queensland-Northern Territory 1958. *Frome-Broken Hill Co. Pty Ltd Rept* 4400-G-12, 18 pp. [unpubl.].
TAYLOR, K., & RUSHTON, A.W.A., 1971 — The pre-Westphalian geology of Warwickshire Coafield. *Bull. geol. Surv. U. K.*, 35, 152 pp., 12 pls.
TAYLOR, M.E., 1976 — Indigenous and redeposited trilobites from late Cambrian basinal environments of central Nevada. *J. Paleont.*, 50 (4), 668-700, pls. 1-3.
TAYLOR, M.E., & COOK, H.E., 1976 — Continental shelf and slope facies in the Upper Cambrian and lowest Ordovician of Nevada. *Brigham Young Univ. Geol. Studies,* 23 (2), 181-214.
TCHERNYSHEVA, N.E., 1960 — *Osnovy paleontologii; spravochnik dlya paleontologov i geologov SSSR.* 8, Chlenistonogie, trilobitoobraznye i rakoobraznye. 515 pp. *Akad. Nauk SSSR, Moscow.*
THOMAS, D.E., & SINGLETON, O.P., 1956 — The Cambrian stratigraphy of Victoria. *In* Symposium sobre el Sistema cambrico su Paleogeografia y el Problema de su Base, 2, 149-163. *20th Sess. intn. geol. Congr., Mexico.*
TROEDSSON, G.T, 1937 — On the Cambro-Ordovician faunas of western Quruq Tagh, eastern Tien-shan. *In* Report of the scientific expedition to the northwestern provinces of China under the leadership of Dr Sven Hedin. The Sino-Swedish Expedition Publ. 4.

V. Invertebrate Palaeontology, 1. *Palaeont. sinica, n. s.*, [B] 2 (*whole ser.* 106), 1-74, pls. 1-10.

TULLBERG, S.A., 1880 — *Agnostus*-arterna i de Kambriska afflagringarne vid Andrarum. *Sver. geol. Unders.*, [C], 42, 37 pp., 2 pls.

ULRICH, E.O., & RESSER, C.E., 1930 — The Cambrian of the Upper Mississippi Valley. Pt 1, Trilobita; Dikelocephalinae and Osceolinae. *Bull. Milwaukee publ. Mus.*, 12 (1), 1-122, pls. 1-23.

ULRICH, E.O., & RESSER, C.E., 1933 — *Idem*, Pt 2, Trilobita; Saukiinae. *Ibid.*, 12 (2), 123-306, pls. 24-45.

VOGDES, A.W., 1890 — A bibliography of Palaeozoic Crustacea from 1698 to 1889, including a list of North American species and a systematic arrangement of genera. *Bull. U. S. geol. Surv.*, 63, 177 pp. [not seen].

VOLOGDIN, A. (ed.) 1940 — *Atlas of the leading forms of the fossil faunas of the USSR*. Vol. 1, Cambrian, 191 pp., XLIX pls. Coun. Peoples Commissars USSR - Geol. Comm. All-Union Sci. Prospect. Inst. (VSEGEI).

VON RICHTHOFEN, F.F., 1883 — *China*. Ergebnisse einiger Reisen und darauf gegründeter Studien. 4, Palaeontologischer Teil. vi + 288 pp., 54 pls., Berlin.

WALCOTT, C.D., 1905 — Cambrian faunas of China. *Proc. U. S. natn. Mus.*, 29, 1-106.

WALCOTT, C.D., 1911 — Cambrian geology and palaeontology, II. No. 4, Cambrian faunas of China. *Smithson. misc. Coll.*, 57 (4), 69-108, pls. 14-17.

WALCOTT, C.D., 1913 — The Cambrian faunas of China. In *Research in China*. Vol. 3, Publs. Carnegie Instn, 54, 1-375 pls. 1-24.

WALCOTT, C.D., 1914 — Cambrian geology and palaeontology, II. No. 13, *Dikelocephalus* and other genera of Dikelocephalinae. *Smithson. misc. Coll.*, 57 (13), 345-412, pls. 60-70.

WALCOTT, C.D., 1924 — *Idem*, V. No. 2, Cambrian and Lower Ozarkian trilobites. *Ibid.*, 75 (2), 53-60, pls. 9-14.

WALCOTT, C.D., & RESSER, C.E., 1924 — Trilobites from the Ozarkian sandstones of the island of Novaya-Zemlya. *In Report of the scientific results of the Norwegian expedition to Novaya-Zemlya 1921*, 24, 3-14, pls. I-II. Soc. Arts Sci. Kristiania.

WALLERIUS, I.D., 1895 — *Undersökninga öfver zonen med Agnostus laevigatus i Vestergötland jämte en inledande öfversikt af Vestergötlands samtliga Paradoxides-lager*. Akademisk afhandl., Lund, 72 pp. [not seen].

WEBBY, B.D., 1974 — Lower Palaeozoic rocks of the craton of Australia. *Unpubl. Rept geol. Sci. Univ. Sydney*, 1974/3, 95 pp. [unpubl.].

WELLS, A.T., FORMAN, D.J., RANFORD. L.C., & COOK, P.J., 1970 — Geology of the Amadeus Basin, central Australia. *Bull. Bur. Miner. Resour. Geol. Geophys. Aust.*, 100, 222 pp., 40 pls.

WESTERGAARD, A.H., 1922 — Sveriges Olenidskiffer. *Sver. geol. Unders.*, [Ca] 18, 1-188 [in Swedish], 189-205 [Engl.], pls. I-XVI.

WESTERGAARD, A.H., 1940 — Nya djupborrningar genom aldsta ordovicium och kambrium i Östergötland och Närke. *Sver. geol. Unders.*, [C] 437, 1-72.

WESTERGAARD, A.H., 1944 — Borrningar genom Skaanes Alunskiffer, 1941-2. *Ibid.*, [C] 459, *Aarsb.*, 38 (1), 3-37 [in Swedish], 38-45 [Engl.], pls. 1-3.

WESTERGAARD, A.H., 1947 — Supplementary notes on the Upper Cambrian trilobites of Sweden. *Ibid.*, [C] 489, *Aarsb.*, 41 (8), 3-34, pls. 1-3.

WHITEHOUSE, F.W., 1936 — The Cambrian faunas of northeastern Australia. Pt 1. Stratigraphic outline. Pt 2. Trilobita (Miomera). *Mem. Qd Mus.*, 11 (1), 59-112, pls. VIII-X.

WHITEHOUSE, F.W., 1939 — *Idem*, Pt 3. The polymerid trilobites. *Ibid.*, 11 (3), 179-282, pls. XIX-XXV.

WILSON, J.L., 1951 — Franconian trilobites of the central Appalachians. *J. Paleont.*, 25 (5), 617-654, pls. 89-95.

APPENDIX 1: INDEX OF SECTIONS AND LOCALITIES

Trilobite faunas are listed from sections and localities in three areas: Lily Creek (on the Boulia 1:250 000 Geological Series Sheet, SF/54-10), Horse Creek and Chatsworth Plains (on the Duchess 1:250,000 Sheet area, SF/54-6).

Horizons on sections, and localities, are listed under field prefixes B, D, K, G, and BMR:

B — prefix collections were made by the 1957-60 Bureau of Mineral Resources Georgina Basin Field Party (Casey, *et al.*, 1960), during the mapping of the Boulia 1:250 000 Geological Series Sheet.

D — prefix collections were made in 1958, during the mapping of the Duchess 1:250 000 Geological Series Sheet (Carter & Öpik, 1963), and in 1967 by members of the Northwest Queensland Phosphate Party (F. de Keyser, J.H. Shergold, C.E. Murray, R. Thieme *in* de Keyser, 1968).

G — prefix samples were collected by Frome-Broken Hill Co. Pty Ltd in 1958, from basal Chatsworth Limestone around 'Chatsworth' (Taylor 1959).

K — prefix collections were made by Shergold in 1969, on both Duchess and Boulia Sheet areas.

BMR — collections refer to those of B.M. Radke, and were made during the course of 1974-75 1 100 000 scale mapping by the Bureau of Mineral Resources Georgina Basin Project.

Eight-figure numbers following the field numbers refer to the Bureau of Mineral Resources internal computing system.

Most of the samples yielding trilobites have been thin-sectioned: the resulting petrological determinations, based on the Dunham (1962) classification, were made by J.A. Kennard (BMR).

LILY CREEK SECTION

See Figures 3 (p. 4) and 4 (p. 6).

K197 74713014. 6 m from base of measured section.
A 5 cm layer of sandy pelletal grainstone locally cross-laminated, with elongate clumps of *Girvanella*, dolomite-filled vugs, and scattered pyrite.

Asaphacean undet., *Cermatops vieta, Haniwoides varia, Maladioidella doylei,* undet. pygidium.

K198 74713015. 10 m.
Sampled from top of a 60 cm sandy pelletal? grainstone/calcareous sandstone unit.

Cermatops vieta, Cermatops sp. undet., *Haniwoides varia, Maladioidella doylei,* pseudagnostid indet.

K199 74713016. 15 m.
An 8 cm layer of clean sandy pelletal skeletal grainstone with mud laminae, localised dolomite-filled vugs, and pyrite patches.

Cermatops vieta, Cermatops sp. undet., *Haniwoides varia, Maladioidella doylei, Prochuangia glabella, Pseudagnostus aulax, Pseudagnostus parvus, Pseudagnostus* sp. V, *Pseudagnostus* sp. VII, *Taenicephalites plerus,* gen. et sp. undet. A; Brachiopoda undet.

K200 74713017. 24 m.
A one-metre unit comprising sandy skeletal pelletal packstone overlying a lithified surface of interlaminated sandy pelletal grainstone and pelletal wackestone. The thin section contains moderately compacted ooids, local dolomite veins and patches, and dusty pyrite or limonite laminae.

Atopasaphus sp. cf. *stenocanthus, Cermatops vieta, Connagnostus* sp. undet., *Lotosoides bathyora, Maladioidella doylei, Prochuangia glabella, Pseudagnostus aulax, Pseudagnostus parvus, Pseudagnostus* sp. VI, *Taenicephalites plerus;* Brachiopoda undet., pelmatozoan debris.

K201 74713018. 49 m.
A 6 cm layer of imbricated skeletal grainstone with infiltered pellets and mud? (recrystallised).

Iveria iverensis, Lorrettina depressa, Lotosoides bathyora, Maladioidella doylei, Parakoldinioidia sp. cf. *bigranulosa, Peichiashania prima, Peichiashania secunda, Pseudagnostus parvus, Wentsuia iota,* hypostomata undet.; Brachiopoda undet., pelmatozoan debris.

K202 74713019. 52 m.
From the uppermost layers of a 30 cm unit; silty pelletal skeletal packstone.

Maladioidella doylei, Peichiashania prima, Peichiashania secunda, Prochuangia glabella, Pseudagnostus parvus, Pseudagnostus sp. VI; Brachiopoda undet., monoplacophoran? mollusc undet., pelmatozoan debris.

K203 74713020. 66 m.
A 12 cm layer of cross-laminated sandy pelletal skeletal grainstone, with partial silicification of pelmatozoan grains.

Atopasaphus sp. cf. *stenocanthus, Cermatops vieta, Lotosoides bathyora?, Prochuangia glabella, Pseudagnostus* sp. VI; Brachiopoda undet., pelmatozoan debris.

K204 74713021. 69 m.
From within a 4 m unit of thin-bedded limestone: pelletal grainstone containing rare ooids, *Girvanella* fragments and calcispheres; silicified skeletal grains.

Connagnostus sp. undet., *Iveria iverensis, Lorrettina depressa, Peichiashania secunda,* *Prochuangia glabella, Pseudagnostus parvus, Pseudagnostus* sp. VI, *Wuhuia silex,* hypostoma 4; Brachiopoda undet., eocrinoid aff. *Macrocystella* sp. undet., monoplacophoran mollusc aff. *Proplina* sp. undet., gasteropod undet., sponge spicules, burrows.

K205 74713022. 72 m.
From within a 3 m unit of thin-bedded limestone: cross-laminated silty recrystallised limestone grading into silty pelletal grainstone; dolomitic laminae; silicified skeletal fragments.

Iveria iverensis, Peichiashania secunda, Prochuangia glabella, Wentsuia iota, Wuhuia silex, hypostoma 4; pelmatozoan debris.

K206 74713023. 92 m.
From a 3 m thick cross-laminated sandy limestone: skeletal grainstone with skeletal packstone laminae, rare pellets; infiltered mud and silt.

Iveria iverensis, Lorrettina depressa, Lotosoides bathyora?, Peichiashania tertia, Pseudagnostus sp. VI; linguloid brachiopod undet.

K207 74713024. 140 m.
From a 0.6 m unit of sandy limestone: sandy pelletal skeletal packstone; scattered pyrite.

Lorrettina depressa, Peichiashania tertia, Pseudagnostus parvus.

K208 74713025. 144 m.
From a 12 m sandy limestone and siltstone unit: recrystallised silty pelletal grainstone.

Koldinioidia (Liriamnica) antyx, Lorrettina depressa, Neoagnostus sp. I, *Peichiashania tertia, Wuhuia silex.*

K209 74713026. 151 m.
A 0.3 m layer of sandy pelletal grainstone and skeletal wackestone.

Peichiashania quarta.

K210 74713027. 182 m.
From a 0.6 m unit of sandy limestone: sandy pelletal skeletal packstone; geopetal mud-filled skeletal grains.

Atopasaphus stenocanthus, Iveria iverensis, Koldinioidia (Liriamnica) antyx, Peichiashania quarta.

K211 74713028. 246 m.
From a 3 m cross-laminated sandy/silty limestone unit: silty pelletal grainstone; scattered pyrite.

Atopasaphus stenocanthus, Hapsidocare lilyensis, Koldinioidia (Liriamnica) antyx, Prosaukia sp. cf. sp. A?

K212 74713029. 254 m.
From a 0.6 m cross-laminated silty limestone unit: silty skeletal pelletal packstone overlying very silty pelletal skeletal grainstone; rare ooids; partly silicified fossil fragments.

Connagnostus sp. cf. *conspectus, Hapsidocare lilyensis, Lotosoides* sp. cf. *calcarata, Neoagnostus* sp. II, *Plecteuloma strix, Prosaukia* sp. cf. sp. A; Brachiopoda undet.

K213 74713030. 266 m.
From a 3 m unit of thin-bedded and cross-laminated limestones: silty pelletal skeletal ooid grainstone; partial silicification of fossil fragments; scattered pyrite.

Brachiopoda undet., *Coelocerodontus?* sp.

K214 74713031. 281 m.
Topmost limestone bench on the section: intraclastic limestone — silty pelletal clast grainstone in which the clasts are aligned and consist of laminated silty pelletal grainstone and mudstone.

Connagnostus sp. cf. *conspectus, Hapsidocare lilyensis, Lorrettina licina, Parakoldinioidia* sp. aff. *bigranulosa, Prosaukia* sp. cf. sp. A?

B50a 74713032. Probably equivalent to K208.
Silty pelletal skeletal packstone and minor sandy pelletal grainstone.

Pseudagnostus parvus, Wuhuia silex; Brachiopoda undet., eocrinoid fragments, gasteropod undet., hylothid undet.

B50b 74713033. Probably from a 2 m thick sandy limestone unit at 162 m on measured section.
Sandy pelletal skeletal packstone; contains calcispheres and scattered pyrite.

Iveria iverensis, Peichiashania tertia; Brachiopoda undet.

B50c 74713034. Unlocated exactly on measured section, but probably about 173 m.
Sandy pelletal packstone; scattered pyrite.

Iveria iverensis, Peichiashania quarta, Taishania platyfrons; Brachiopoda undet.

B51 74713035. Likely equivalent of BMR 201/14 at 186 m.
Sandy pelletal packstone.

Iveria iverensis, Peichiashania sp. indet., *Taishania platyfrons;* Brachiopoda undet.

B52 74713036. Equivalent to K206 at 92 m on measured section.
Skeletal pelletal grainstone.

Iveria iverensis, *Peichiashania tertia*, *Pseudagnostus* sp. indet.; Brachiopoda undet., eocrinoid fragments.

B53 74713037. Equivalent to K204 on measured section.
Pelletal grainstone with rare ooids, calcispheres, and partial silicification of skeletal grains; widespread recrystallisation.

Iveria iverensis, *Lorrettina depressa*, *Peichiashania secunda*, *Pseudagnostus parvus*, *Wuhuia silex;* Brachipoda undet., eocrinoid aff. *Macrocystella* sp. undet., hyolithid undet., sponge spicules, burrows.

B54a 74713038. Equivalent to K200, B790, and BMR 201/1 at 24 m on measured section.
Interlaminated sandy pelletal grainstone and shaly limestone; minor disseminated pyrite and some muscovite.

Cermatops vieta, *Cermatops* sp. undet., *Connagnostus aversus*, *Maladioidella doylei*, *Neoagnostus felix*, *Prochuangia glabella*, *Pseudagnostus aulax*, *Pseudagnostus parvus*, *Pseudagnostus tricanthus*, hypostoma 3.

B54b 74713039. Equivalent to K202 and BMR 201/5 on measured section at 52 m.
Sandy pelletal grainstone with mudstone? laminae; *Girvanella* clasts, calcispheres, and minor disseminated pyrite; hand specimen is oolitic and contains abraded brachiopods.

Atopasaphus sp. cf. *stenocanthus*, *Cermatops vieta*, *Connagnostus aversus*, *Haniwoides varia*, *Iveria iverensis*, *Lotosoides bathyora*, *Maladioidella doylei*, *Prochuangia glabella*, *Pseudagnostus aulax*, *Pseudagnostus parvus*, *Wentsuia iota;* Brachiopoda undet., eocriniod fragments, gasteropod undet., monoplacophoran mollusc aff. *Proplina* sp. undet.

B790 74713127. Equivalent to K200, B54a and BMR 201/1 at 24 m on measured section.
Sandy pelletal grainstone; no thin section.

Atopasaphus sp. cf. *stenocanthus*, *Cermatops vieta*, *Maladioidella doylei*, *Peichiashania prima*, *Prochuangia glabella*, *Pseudagnostus* sp. VI, *Taenicephalites plerus;* pelmatozoan debris.

B791a 74713041. Not accurately located on measured section, but presumed within interval 180 — 190 m.
Sandy/silty skeletal packstone with interlaminated skeletal wackestone and silty pelletal skeletal grainstone; common pyrite and scattered dolomite.

Parakoldinioidia sp. aff. *bigranulosa*, *Peichiashania* sp. indet., *Pseudagnostus parvus*, *Rhaptagnostus auctor*, *Taishania platyfrons*, hypostoma 2; Brachiopoda undet., pelmatozoan debris.

B791b 74713128. Unlocated on measured section, but lies one metre above B791a.
Specimen not sectioned.

Indeterminate trilobite fragments; Brachiopoda undet., pelmatozoan debris.

B791c 74713129. Unlocated on measured section, but lies about 7 m above B791a.
Silty or sandy pelletal grainstone; no thin section.

Connagnostus sp. cf. *conspectus*, *Neoagnostus* sp. I?

B791d 74713130. Very likely equivalent to K213 and BMR 201/17 at 266 m on measured section.
Specimen not sectioned.

Billingsella sp. undet.

B754 74713134. About 10 km south-southwest of 'Chatsworth', to the east of faults bounding the Lily Creek outcrop, in the core of a plunging anticlinal structure.

Pale recrystallised medium-grained silty skeletal limestone.

Undetermined inarticulate brachiopods, *Billingsella* sp. undet.

HORSE CREEK AREA

See Figure 3 (p. 4).

K215 74713042. Confluence of Horse Creek and Mort River: 6-9 m of limestone in low bank, southeast side of confluence.
Sample from 3 m above base of outcrop; silty pelletal peloidal skeletal grainstone; disseminated pyrite.

Acmarhachis hybrida, *Atopasaphus* sp. undet., *Cermatops* sp. undet., *Haniwoides varia*, *Innitagnostus medius*, *Maladioidella doylei*, *Neoagnostus greeni*, *Peichiashania prima*, *Pseudagnostus aulax*, *Pseudagnostus mortensis*, *Pseudagnostus tricanthus*, *Pseudagnostus* sp. V, *Rhaptagnostus apsis*, *Taenicephalites plerus*, *Wentsuia iota;* Brachiopoda undet., gasteropod undet.

K216 74713043. Eastern tributary of gully 0.8 km east of confluence of Horse Creek and Mort River; head of tributary.

Pale sandy ripple-marked limestone; silty pelletal skeletal grainstone with random silty recrystallised clasts; disseminated pyrite.

Cermatops vieta, Haniwoides varia, Innitagnostus medius, Leptoplastus? sp. nov., *Neoagnostus greeni, Plicatolina* sp. cf. *P. yakutica, Pseudagnostus aulax, Pseudagnostus mortensis, Pseudagnostus tricanthus, Pseudagnostus* sp. VII, *Rhaptagnostus apsis, Taenicephalites plerus, Wentsuia iota,* hypostoma 1; Brachiopoda undet.

K217 74713044. Same tributary as K216, west bank, last outcrop below Mesozoic rubble cover.
Intraclastic limestone; elongate pyritic mudstone laths in pelletal skeletal silty grainstone matrix; patchy recrystallisation.

Cermatops sp. undet., *Maladioidella doylei, Onchonotellus* sp. undet., *Pseudagnostus aulax, Pseudagnostus* sp. V, *Pseudagnostus* sp. VII, *Taenicephalites plerus, Wentsuia iota;* Brachiopoda undet.

K218 74713045. Same gully, immediately succeeding layer to K217.
Fine silty pelletal skeletal grainstones.

Connagnostus aversus, Haniwoides varia, Innitagnostus medius, Maladioidella doylei, Neoagnostus greeni, Peichiashania prima, Pseudagnostus mortensis, Pseudagnostus tricanthus, Pseudagnostus sp. V, *Rhaptagnostus apsis, Taenicephalites plerus, Wentsuia iota,* hypostoma ; Brachiopoda undet.

K219 74713046. Western tributary south of K217.
Silty pelletal skeletal grainstone; infiltered mud.

Connagnostus sp. indet., *Haniwoides varia, Maladioidella doylei, Pseudagnostus mortensis, Taenicephalites plerus, Wentsuia iota;* Brachiopoda undet., pelmatozoan debris, sponge spicules.

K220 74713048. Small east-west tributary south of K219.
Intraclastic limestone — elongate clasts of mudstone and fine silty pelletal grainstone.

Connagnostus aversus, Neoagnostus greeni, Pseudagnostus aulax, Taenicephalites plerus, Wentsuia iota; Brachiopoda undet.

K221 74713049. Approximately 0.6 km due south of K220.
Intraclastic limestone — clast skeletal and pelletal grainstone — contains mudstone, pelletal skeletal grainstone and skeletal clasts.

Haniwoides varia, Maladioidella doylei, Neoagnostus greeni, Peichiashania prima, Taenicephalites plerus, Wentsuia iota, hypostoma 1; Brachiopoda undet., pelmatozoan debris.

K222 74713050. A further 0.2 km south of K220.
Intraclastic limestone — clast skeletal peloidal grainstone — with elongated current-aligned silty mudstone, silty pelletal grainstone and skeletal clasts; shell material comminuted.

Connagnostus aversus, Lorrettina depressa, Lotosoides bathyora, Maladioidella doylei, Neoagnostus felix, Peichiashania prima, Pseudagnostus parvus, Taenicephalites plerus, Wentsuia iota; pelmatozoan debris.

K223 74713051. South bank of small tributary of east-west flowing creek, 1 km south of K220.
Silty skeletal grainstone.

Cermatops vieta, Cermatops sp. undet., *Connagnostus aversus, Haniwoides varia, Maladioidella doylei, Neoagnostus felix, Neoagnostus greeni, Peichiashania prima, Pseudagnostus parvus, Rhaptagnostus apsis, Rhaptagnostus* sp. cf. *impressus, Taenicephalites plerus, Wentsuia iota;* Brachiopoda undet., pelmatozoan debris.

K224 74713052. Approximately 0.2 km south-southwest of K223.
Silty clayey limestone with remnant pelletal structures; laminae rich in mica and skeletal debris.

Cermatops sp. undet., *Connagnostus* sp. indet., *Haniwoides varia, Maladioidella doylei, Pseudagnostus mortensis, Pseudagnostus parvus, Pseudagnostus tricanthus, Rhaptagnostus apsis, Rhaptagnostus* sp. cf. *impressus, Taenicephalites plerus, Wentsuia iota;* Brachiopoda undet.

K225 74713053. Approximately 0.2 km south-southwest of K224.
Silty pelletal skeletal grainstone with micaceous laminae.

Cermatops vieta, Cermatops sp. undet., *Connagnostus aversus, Haniwoides varia, Maladioidella doylei, Neoagnostus felix, Neoagnostus greeni, Peichiashania prima, Pseudagnostus aulax, Psuedagnostus mortensis, Pseudagnostus parvus, Pseudagnostus tricanthus, Rhaptagnostus apsis, Rhaptagnostus* sp. cf. *impressus, Taenicephalites plerus, Wentsuia iota,* hypostoma 1; Brachiopoda undet., pelmatozoan debris

K226 74713054. *Ex situ* blocks of limestone at fence about 0.2 km southwest of D668.
Intraclastic limestone — silty mudstone, fine recrystallised limestone, and skeletal clasts in clear pelletal silty grainstone matrix.

Cermatops vieta, Cermatops sp. undet., *Connagnostus* sp. indet., *Maladioidella doylei, Rhaptagnostus apsis, Taenicephalites plerus, Westsuia iota,* hypostoma 1; obolid brachiopod.

K227 74713055. Approximately 1.2 km northwest of K226 along fence line.
Intraclastic limestone — clast skeletal ooid grainstone — with clasts of mudstone and elongate finely laminated silty pelletal grainstone; vugs, bored clasts and patches of recrystallisation.

Atopasaphus sp. cf. *stenocanthus, Haniwoides varia, Maladioidella doylei, Taenicephalites plerus, Wentsuia iota;* Brachiopoda undet.

D668 74713056. Approximately 4 km due east of 'Chatsworth', and 0.2 km northeast of the boundary fence of Lily Paddock.
Silicified ooid skeletal grainstone.

Cermatops vieta, Lorrettina depressa, Maladioidella doylei, Rhaptagnostus apsis, Taenicephalites plerus, Wentsuia iota; Brachiopoda undet., pematozoan debris, sponge spicules.

B1 74713133. Trackside exposure, 5.6 km northwest of 'Burnham' on the 'Chatsworth' road.
Silty pelletal grainstone?

Cermatops sp. undet., *Haniwoides varia, Neoagnostus* sp. aff. *felix;* Brachiopoda undet.

CHATSWORTH PLAINS

See Figure 2 (p. 2)

D124 74713131. On Duchess road out of 'Chatsworth': exposures at gate in fence, 5 km northwest of homestead; collected horizons are northeast from gate along fence, and several different horizons appear to be lumped under this locality number, previously referred to in Öpik (1963, p. 22).

Atopasaphus sp. cf. *stenocanthus, Connagnostus aversus, Guizhoucephalina?* sp., *Haniwoides varia, Lorrettina depressa, Lotosoides bathyora, Maladioidella doylei, Neoagnostus felix, Peichiashania prima, Pseudagnostus aulax, Pseudagnostus parvus, Pseudagnostus tricanthus, Rhaptagnostus apsis, Rhaptagnostus* sp. cf. *impressus, Taenicephalites plerus, Wentsuia iota;* Brachiopoda undet.

D373 74713060. Southern margin of pediment outcrop 10 km due north of 'Chatsworth', beside old track between Eight Mile and Mount Merlin Bores.
Recrystallised grainstone with pelletal ghosts.

Eugonocare? sp. undet., *Haniwoides varia, Pseudagnostus* sp. indet., *Wentsuia iota;* Brachiopoda undet.

D487 74713057. Northern margin of same pediment, about 11 km due north of 'Chatsworth' and 0.8 km north of D373.
Intraclastic limestone — silty pelletal skeletal grainstone, mud patches, and skeletal pelletal grainstone.

Acmarhachis hybrida, Connagnostus aversus, Connagnostus sp. indet., *Haniwoides varia, Maladioidella doylei, Norinia?* sp. undet., *Peratagnostus* sp. cf. *nobilis, Plicatolina* sp. cf. *yakutica, Pseudagnostus mortensis, Taenicephalites plerus, Wentsuia iota;* Brachiopoda undet.

D489 74713058. Northeastern tip of pediment outcrop 6.5 km due north of 'Chatsworth' and 4.8 km west of Mount Merlin Bore.
Sandy ripple-marked limestone and intraclastic limestone; silty clast skeletal grainstone with elongate clasts of silty mudstone.

Haniwoides varia, Maladioidella doylei, Pseudagnostus mortensis, Taenicephalites plerus; obolid brachiopod.

D669 74713059. Rubble strips of limestone 4 km northwest of 'Chatsworth' at the meeting-point of three fences, 1.75 km northeast of D124.
Ripple-marked sandy limestone; silty pelletal skeletal grainstone.

Neoagnostus felix, Pseudagnostus aulax, Wentsuia iota; obolid brachiopod, *Billingsella* sp. undet., gasteropod undet., pelmatozoan debris.

G41609 Stated by Taylor (1959, p. 7) merely as 'to the west of the homestead'.
Purplish-grey silty grainstone.

Lotosoides bathyora, Peichiashania sp., *Maladioidella doylei, Taenicephalites plerus;* obolid brachiopod.

G41610 One kilometre northeast of locality D124 (see above)
Sample represented in the collections by dissolved-out brachiopod shells.

Billingsella sp. undet.

APPENDIX 2: CATALOGUE OF TYPE MATERIAL

The use of the letters *a* and *b* in the following lists of CPC numbers refers to the presence in the collections of specimens and their counterparts, *a* representing the former and *b* the latter. Where useful information can be gained, the counterpart has been treated with rubber latex and the resulting mould, which may replicate the external surface of the exoskeleton or the parietal surface, is also given the suffix *b*.

1. Figured Specimens

CPC No.	*Taxon*	*Type*	*Plate*	*Fig.*	*Locality*
15007	**Pseudagnostus (P.) mortensis** sp. nov.	Paratype	1	1	K225
15008		Paratype	1	2	K216
15009		Paratype	1	3	K216
15010		Paratype	1	5	K215
15011		Paratype	1	4	K216
15012		Paratype	1	6, 7	K216
15013		Paratype	1	8	K216
15014		Paratype	2	3	K216
15015		Paratype	2	2	K216
15016		Paratype	2	1	K216
15017		Paratype	2	4	K215
15018		Paratype	2	5	K216
15019		Paratype	2	6	K225
15020		Paratype	2	7	K216
15021		Paratype	2	8	K216
15022		**Holotype**	2	9, 10	K218
15023	**Rhaptagnostus apsis** sp. nov.	Paratype	6	1	K216
15024		Paratype	6	2	K226
15025		Paratype	6	3	K216
15026		Paratype	6	4, 5	K226
15027		Paratype	6	6	D124a
15028		Paratype	6	7	K226
15029		**Holotype**	6	8, 9	D668
15030		Paratype	6	10	K226
15031		Paratype	6	11	K225
15032	**Pseudagnostus (P.) parvus** sp. nov.	**Holotype**	3	1	K204
15033a		Paratype	3	2	B54a
15033b		Plastoparatype	3	5	B54a
15034		Paratype	3	3	B791a
15035		Paratype	3	4	B54b
15036		Paratype	3	6	K224
15037		Paratype	3	7, 8	B54b
15038		Paratype	3	9	D124
15039		Plastoparatype	3	10	B54a
15040		Paratype	3	11	B54a
15041		Paratype	3	12	K200
15042	**Pseudagnostus (P.) tricanthus** sp. nov.	Paratype	4	6	D124
15043		**Holotype**	4	7, 11	K218
15044		Paratype	4	8	D124a
15045		Paratype	4	9	K216
15046		Paratype	4	10	K218
15047		Paratype	4	12	K224
15048	**Rhaptagnostus** sp. cf. **R. impressus** (Lermontova)	Figured specimen	10	1	K225
15049		Figured specimen	10	2	D124
15050		Figured specimen	10	3	K223
15051a		Figured specimen	10	4, 6	K223
15051b		Figured specimen	10	5	K223
15052	**Pseudagnostus (P.) aulax** sp. nov.	Paratype	5	1	D124

CPC No.	*Taxon*	*Type*	*Plate*	*Fig.*	*Locality*
15053		**Holotype**	5	2, 3	D124
15054		Paratype	5	4	D124
15055		Paratype	5	6	D669
15056		Paratype	5	7	B54b
15057		Paratype	5	8, 12	D124
15058		Paratype	5	9	D124
15059		Paratype	5	5	K216
15060		Paratype	5	11	D124
15061		Paratype	5	10	K215
15062	**Pseudagnostus (P.?)** sp. VI	Figured specimen	4	1	B790
15063		Figured specimen	4	2	K200
15064		Figured specimen	4	3	K203
15065		Figured specimen	4	4	K202
15066		Figured specimen	4	5	K200
15067	**Rhaptagnostus auctor** sp. nov.	Paratype	7	7	B791a
15068		Paratype	7	5,6	B791a
15069		Plastoparatype	7	8	B791a
15070		**Holotype**	7	1	B791a
15071		Paratype	7	2, 3	B791a
15072		Paratype	7	4	B791a
15073	**Pseudagnostus (P.)** sp. VII	Figured specimen	7	9	K217
15074		Figured specimen	7	10	K216
15075	**Pseudagnostus (P?)** sp. V	Figured specimen	8	10	K218
15076		Figured specimen	8	11	K215
15077		Figured specimen	8	12	K217
15078	**Neoagnostus greeni** sp. nov.	**Holotype**	9	3	K215
15079		Paratype	9	1, 2	K216
15080		Paratype	9	4	K216
15081		Paratype	9	5	K225
15082		Paratype	9	6	K216
15083		Plastoparatype	9	7	K223
15084		Paratype	9	8	K216
15085		Paraype	9	9	K216
15086		Paratype	9	10	K216
15087		Paratype	9	11	K216
15088		Paratype	9	12	K216
15089	**Neoagnostus felix** sp. nov.	Paratype	8	1	D124
15090		Paratype	8	3	D124
15091		Paratype	8	2	D124
15092		**Holotype**	8	4, 5	D124
15093		Paratype	8	8	D124
15094		Paratype	8	7	D124
15095		Paratype	8	6	D124
15096		Paratype	8	9	K225
15097	**Neoagnostus** sp. I	Figured specimen	10	7	K208
15098		Figured specimen	10	8	K208
15099		Figured specimen	10	9	K208
15100		Figured specimen	10	10	K208
15102	**Neoagnostus** sp. II	Figured specimen	10	11	K212
15103		Figured specimen	10	12	K212
15104	**Acmarhachis hybrida** sp. nov.	Paratype	11	1	D487
15105		Paratype	11	3	K215
15106		Paratype	11	2	K215
15107a		**Holotype**	11	4	D487
15107b		**Plastoholotype**	11	5	D487
15108		Paratype	11	6	K215
15109	**Innitagnostus medius** sp. nov.	**Holotype**	11	8	K218
15110		Paratype	11	7	K218
15111		Paratype	11	9	K218
15112		Paratype	11	10	K216
15113		Paratype	11	11	K218
15114	**Peratagnostus** sp. cf. **P. nobilis** Öpik, 1967	Figured specimen	11	12	D487

CPC No.	*Taxon*	*Type*	*Plate*	*Fig.*	*Locality*
15115	**Connagnostus aversus** sp. nov.	**Holotype**	12	2	D124
15116		Paratype	12	3	D124
15117		Paratype	12	4	D124
15118		Paratype	12	1	K220
15119	**Connagnostus** sp. cf. **C. conspectus** Shergold, 1975	Figured specimen	12	5	B791c
15120a		Figured specimen	12	7, 8	K212
15120b		Figured specimen	12	9	K212
15122		Figured specimen	12	6	K212
15123	**Connagnostus** sp. undet.	Figured specimen	12	10	K200
15204	**Peichiashania prima** sp. nov.	Paratype	25	1	K201
15205		**Holotype**	25	2	K201
15206		Paratype	25	3	K222
15207		Paratype	25	4	D124
15208		Paratype	25	5	K201
15209	**Peichiashania secunda** sp. nov.	Paratype	25	6	K204
15210		Paratype	25	7	B53
15211		Paratype	25	8	K204
15212		Paratype	25	9	B53
15213		Paratype	25	10	K205
15214		**Holotype**	25	11	K205
15215		Paratype	26	3	K205
15216		Plastoparatype	26	2	K205
15217		Paratype	26	1	K204
15218a	**Peichiashania tertia** sp. nov.	**Holotype**	27	1, 2	K206
15218b		**Plastoholotype**	27	3	K206
15220		Paratype	27	6	B52
15221		Paratype	27	4	K208
15222		Paratype	27	5	K208
15223		Paratype	27	7	K208
15224		Paratype	26	4	K207
15225		Paratype	26	7	K206
15226		Paratype	26	5	K208
15227		Paratype	26	6	K208
15228	**Peichiashania quarta** sp. nov.	**Holotype**	28	1	K209
15229		Plastoparatype	28	2	K210
15230a		Paratype	28	4	K210
15230b		Plastoparatype	28	3	K210
15231		Paratype	27	9	K209
15232		Paratype	27	8	K210
15233		Paratype	28	8	K210
15234		Paratype	28	6	K210
15235		Paratype	28	7	K210
15236		Paratype	28	5	K209
15237	**Hapsidocare lilyensis** sp. nov.	**Holotype**	29	1	K212
15238		Paratype	29	2	K211
15239		Paratype	29	4	K212
15240		Paratype	29	7	K212
15241a		Paratype	29	5	K214
15241b		Plastoparatype	29	6	K214
15242	**Prochuangia glabella** sp. nov.	**Holotype**	23	2	B54a
15243		Paratype	23	3, 4	B790
15244		Plastoparatype	23	5	K200
15245		Paratype	23	1	K200
15246		Paratype	23	7	B54b
15247		Paratype	23	8	B54b
15248		Paratype	23	6	B54b
15249	**Lotosoides bathyora** sp. nov.	Paratype	24	3	K201
15250		Paratype	24	2	K201
15251		Paratype	24	4	K222
15252		Paratype	24	5	K222
15253		Paratype	24	6	K200
15254		Paratype	24	7	B54b

CPC No.	*Taxon*	*Type*	*Plate*	*Fig.*	*Locality*
15255		**Holotype**	24	8	D124
15256	**Lotosoides** sp. cf. **L. calcarata** Shergold, 1975	Figured specimen	24	1	K212
15257a		Figured specimen	23	9	K212
15257b		Figured specimen	23	10	K212
15258	**Parakoldinioidia** sp. aff. **P. bigranulosa** Shergold, 1975	Figured specimen	30	2, 5	K201
15259		Figured specimen	30	3	B791a
15260		Figured specimen	30	4	B791a
15261		Figured specimen	30	1	B791a
15262b		Figured specimen	30	6	B791a
15263		Figured specimen	30	7	B791a
15264		Figured specimen	30	8, 9	K214
15265		Figured specimen	30	10	K214
15266a	**Maladioidella doylei** sp. nov.	**Holotype**	17	1	B54a
15266b		**Plastoholotype**	**17**	**2**	**B54a**
15268		Paratype	**17**	**3, 4**	**K215**
15269		Plastoparatype	**17**	**5**	**K200**
15270		Paratype	**17**	**6**	**K222**
15271		Plastoparatype	**17**	**7**	**K200**
15272		Plastoparatype	**17**	**8**	**K200**
15273		Paratype	**17**	**9**	**K222**
15274		Paratype	**18**	**1**	**K225**
15275		Paratype	**18**	**2**	**K226**
15276		Paratype	**18**	**3**	**B54a**
15277		Paratype	**18**	**4**	**B54a**
15278		Paratype	**18**	**5**	**B54b**
15279	**Lorrettina depressa** sp. nov.	**Holotype**	14	6	K204
15280		Paratype	14	2	D124
15281		Paratype	14	1	D124a
15282		Paratype	14	3, 4	K204
15283		Paratype	14	5	K204
15284		Paratype	14	7	K206
15285		Paratype	14	8	D124
15286		Paratype	14	9	D124
15287		Paratype	14	10	D124
15288	**Wuhuia silex** sp. nov.	Paratype	16	1	K204
15289		**Holotype**	16	2, 6	K204
15290		Paratype	16	3	K204
15291		Paratype	16	4, 5	K204
15292		Paratype	16	8	K205
15293		Paratype	16	7	K204
15294		Paratype	16	9, 10	K208
15295a	**Lorrettina licina** sp. nov.	**Holotype**	15	3	K214
15295b		**Plastoholotype**	15	1, 2	K214
15296		Paratype	15	4	K214
15297		Paratype	15	5	K214
15298		Paratype	15	6	K214
15299		Paratype	15	7	K214

CPC No.	*Taxon*	*Type*	*Plate*	*Fig.*	*Locality*
15300	**Taenicephalites plerus** sp. nov.	**Holotype**	22	1, 4	K226
15301		Paratype	22	2	D124
15302		Plastoparatype	22	3	K223
15303		Paratype	22	5	K224
15304		Paratype	22	6	K200
15305		Paratype	22	7	D124
15306		Paratype	22	8	B54a
15307		Paratype	22	9	B790
15308	**Wentsuia iota** sp. nov.	Paratype	21	1	K225
15309		Paratype	21	2	K220
15310		Paratype	21	3	K223
15311		**Holotype**	21	4, 5	K215
15312		Paratype	21	6	K215
15313		Paratype	21	7	K222
15314		Paratype	21	8	K201
15315		Paratype	21	9	K221
15316		Paratype	21	10	K201
15317	**Iveria iverensis** sp. nov.	**Holotype**	13	1, 2	K204
15318		Paratype	13	3, 4	K204
15319		Paratype	13	5, 6	B53
15320a		Paratype	13	7	B50c
15321		Paratype	13	8	K210
15322		Paratype	13	9	K205
15323		Paratype	13	10	B53
15324	**Plecteuloma strix** Shergold, 1975.	Hypotype	13	11	K212
15325		Plastohypotype	13	12	K212
15326		Hypotype	13	13	K212
15327	**Haniwoides varia** sp. nov.	Paratype	32	1	K215
15328		Paratype	32	2	K216
15329		Paratype	32	3	K225
15330		Paratype	32	4	K225
15331		**Holotype**	32	5	B54b
15332		Paratype	32	6	D373
15333		Paratype	32	8	K215
15334		Paratype	32	7	K199
15335		Paratype	33	1	K218
15336		Paratype	33	2	D487
15337		Paratype	33	3	K216
15338		Paratype	33	6	K216
15339		Paratype	33	5	K216
15341		Paratype	33	4	K225
15342		Paratype	33	7	K216
15343		Paratype	33	8	D489
15344		Paratype	33	9	K225
15345		Paratype	33	10	K215
15346	**Norinia?** sp. undet.	Figured specimen	34	1, 2	D487
15347a	**Cermatops vieta** sp. nov.	**Holotype**	34	3	K199
15347b		**Plastoholotype**	34	6	K199
15348b		Plastoparatype	34	5	K216
15349		Paratype	34	7	K223
15350		Paratype	34	4	B54b
15351		Paratype	34	11	K203
15352		Paratype	34	8	K199
15353		Paratype	34	9	B790
15354		Plastoparatype	34	10	B54b
15355	**Cermatops** sp. undet.	Figured specimen	35	1	K225
15356		Figured specimen	35	5	K217
15357		Figured specimen	35	4	K225
15358		Figured specimen	35	3	K199
15359		Figured specimen	35	2	B54a
15360	Genus et sp. undet. A	Figured specimen	35	6	K199
15361	**Atopasaphus stenocanthus** Shergold, 1975	Hypotype	31	6	K211

CPC No.	Taxon	Type	Plate	Fig.	Locality
15362		Hypotype	31	7	K210
15363b	**Atopasaphus** sp. cf. **A. stenocanthus**	Figured specimen	31	1	K203
15364		Figured specimen	31	3	K203
15365b		Figured specimen	31	2	K203
15366		Figured specimen	31	4	D124
15367		Figured specimen	31	5	D124
15368		Figured specimen	35	9	K200
15369	**Atopasaphus** sp. undet.	Figured specimen	35	8	K215
15370	**Plicatolina** sp. aff. **P. yakutica** Pokrovskaya, 1966	Figured specimen	20	1	D487
15371		Figured specimen	20	2	K216
15372	**Leptoplastus?** sp. nov.	Figured specimen	20	3	K216
15373		Figured specimen	20	4	K216
15374	**Koldinioidia (Liriamnica) antyx** sp. nov.	Paratype	18	7	K211
15375		**Holotype**	18	6, 8	K210
15376		Paratype	18	11, 12	K208
15377		Paratype	18	9, 10	K208
15378	**Onchonotellus** sp. undet.	Figured specimen	20	5, 6, 7	K217
15379	**Taishania platyfrons** sp. nov.	Plastoparatype	19	5	B791a
15380		Paratype	19	6	B791a
15381		Plastoparatype	19	7	B791a
15382		Paratype	19	8	B791a
15383		Paratype	19	9	B791a
15384		Paratype	19	10	B50c
15385	**Prosaukia** sp. cf. **P.** sp. A? Shergold, 1975	Figured specimen	19	1	K214
15386		Figured specimen	19	2	K212
15387		Figured specimen	19	3	K211
15388		Figured specimen	19	4	K214
15389	**Guizhoucephalina?** sp. undet.	Figured specimen	20	8	D124
15390	Hypostoma undet. 4	Figured specimen	12	12	K204
15391		Figured specimen	12	11	K204
15392	Hypostoma undet. 3	Figured specimen	12	13	B54c
15393	Hypostoma undet. 2	Figured specimen	20	9	B791a
15394	Hypostoma undet. 1	Figured specimen	20	10	K226
15395	**Hapsidocare lilyensis** sp. nov.	Paratype	29	3	K214
15396	**Eugonocare?** sp. undet.	Figured specimen	35	7	D373

2. Unfigured Supplementary Material

All listed specimens of new species are paratypes.

CPC. No.	Taxon
15101	*Neoagnostus* sp. I
15121	*Connagnostus* sp. cf. *C. conspectus* Shergold, 1975
15219	*Peichiashania tertia* sp. nov.
15267	*Maladioidella doylei* sp. nov.
15340	*Haniwoides varia* sp. nov.
15397-15399	*Acmarhachis hybrida* sp. nov.
15400-15401	*Innitagnostus medius* sp. nov.
15402-15407	*Connagnostus aversus* sp. nov.
15408	*Connagnostus* sp. undet.
15409-15459 17225-17246	*Pseudagnostus* (P.) *mortensis* sp. nov.
17247-17263	*Pseudagnostus* (P.) *parvus* sp. nov.
17264-17267	*Pseudagnostus* (P.) *tricanthus* sp. nov.
17268-17279	*Pseudagnostus* (P.) *aulax* sp. nov.
17280	*Pseudagnostus (Pseudagnostus?)* sp. V
17281-17285	*Pseudagnostus (Pseudagnostus?)* sp. VI
17286-17298	*Rhaptagnostus apsis* sp. nov
17299-17303b	*Rhaptagnostus* sp. cf. *R. impressus* (Lermontova)

17304-17313	*Rhaptagnostus auctor* sp. nov.
17314-17330	*Neoagnostus greeni* sp. nov.
17331-17336	*Neoagnostus felix* sp. nov.
17337-17342	*Neognostus* sp. I
17343-17344	*Plecteuloma strix* Shergold, 1975
17345-17392	*Iveria iverensis* sp. nov.
17393-17411	*Wuhuia silex* sp. nov.
17412-17428	*Lorrettina depressa* sp. nov.
17429-17436	*Lorrettina licina* sp. nov.
17437-17523	*Maladioidella doylei* sp. nov.
17524-17525	*Prosaukia* sp. cf. *P.* sp. A? Shergold, 1975
17526-17574	*Wentsuia iota* sp. nov.
17575-17632	*Taenicephalites plerus* sp. nov.
17633-17639	*Koldinioidia (Liriamnica) antyx* sp. nov.
17640	*Guizhoucephalina?* sp. undet.
17641-17663	*Prochuangia glabella* sp. nov.
17664-17671	*Lotosoides bathyora* sp. nov.
17672-17683	*Peichiashania prima* sp. nov.
17684-17695	*Peichiashania secunda* sp. nov.
17696-17707	*Peichiashania tertia* sp. nov.
17708-17715	*Peichiashania quarta* sp. nov.
17716-17720	*Hapsidocare lilyensis* sp. nov.
17721-17731	*Parakoldinioidia* sp. aff. *P. bigranulosa* Shergold, 1975
17732	*Atopasaphus stenocanthus* Shergold, 1975
17733-17739	*Atopasaphus* sp. cf. *A. stenocanthus* Shergold, 1975
17740-17808	*Haniwoides varia* sp. nov.
17809-17823	*Cermatops vieta* sp. nov.
17824-17838	*Cermatops* sp. undet.
17839	*Norinia?* sp. undet.
17840-17843	Hypostoma type 1
17844	Hypostoma type 4

APPENDIX 3: CHATSWORTH LIMESTONE IN BOREHOLES

Chatsworth Limestone was cored during the 1974 Bureau of Mineral Resources Georgina Basin Project drilling programme, in BMR Boulia No. 6 and BMR Duchess No. 13. The lithologies encountered in these boreholes have been described by Kennard, their geochemistry has been analysed by Draper, and faunal determinations have been made by Shergold (see Kennard & Draper 1977). Lithological sections and abridged descriptions are reproduced here, together with ranges of trilobite taxa described in this Bulletin (Figs. 39-41).

BMR Boulia No. 6

This hole was sited on Lily Creek (at latitude 22°S, longitude 140° 18'E) at the base of the exposed type section of the Chatsworth Limestone, about 3.5 km south of 'Chatsworth' Homestead (Figs. 2, 3). Drilling reached a depth of 98.90 m, with continuous coring from 12 m. Lithological sequence and analysis of the trilobite fauna is summarised on Fig. 40. As far as can be ascertained, the whole sequence was deposited during the interval of the *Wentsuia iota - Rhaptagnostus apsis* Assemblage-Zone.

BMR Duchess No. 13

BMR Duchess No. 13 was drilled to a depth of 84.80 m, with continuous coring from 15.30 m. It was sited approximately 1.5 km northwest of 'Chatsworth' Homestead (at latitude 21° 58'S, longitude 140° 17'E) in an area of poor outcrop between the Lily Creek section, the Horse Creek section, and the bulk of the exposures on Chatsworth Plains (Fig. 2). The lithological sequence (Fig. 41) appears to contain less micrite and more grainstone than in BMR Boulia No. 6, suggesting perhaps an overlap and upward extension of that sequence. Analysis of the trilobites, however, indicates the certain presence of only the *Wentsuia iota - Rhaptagnostus apsis* Assemblage-Zone.

SYMBOLS USED ON LITHOLOGICAL LOGS

LITHOLOGIES

limestone

dolomitic limestone

dolostone

sandstone

siltstone

shale, mudstone

calcareous

dolomitic

conglomeratic

sandy

silty

shaly, muddy

brecciated

SEDIMENTARY STRUCTURES

lamination

cross-lamination

thin bedding

cross-bedding

ripple, symmetrical

desiccation cracks

bioturbation, burrows

ABBREVIATIONS USED ON LITHOLOGICAL LOGS

As per list of standard abbreviations used by BMR

( ) parentheses denote poor, weakly developed, or rare

—— underlining denotes good, well developed, or abundant

CARBONATE ROCKS

Grnst	*grainstone*
Mdst	*mudstone*
Pckst	*packstone*
Wckst	*wackestone*

GRAIN TYPES

clast	*intraclast*
ooid	*ooid*
pel	*peloid*
skltl	*skeletal*

SEDIMENTARY STRUCTURES

bd	*bed*
biotrbtd	*bioturbated*
bnd	*band*
grdg	*grading*
intlamd	*interlaminated*
lam, lamd	*laminae (ated)*
Xlamd	*cross-laminated*

DIAGENETIC FEATURES

repl	*replacement*
sol	*solution*

M(P)806

Fig. 39. Symbols and abbreviations used on the lithological logs of BMR drill holes Boulia No. 6 (Fig. 40) and Duchess No. 13 (Fig. 41)

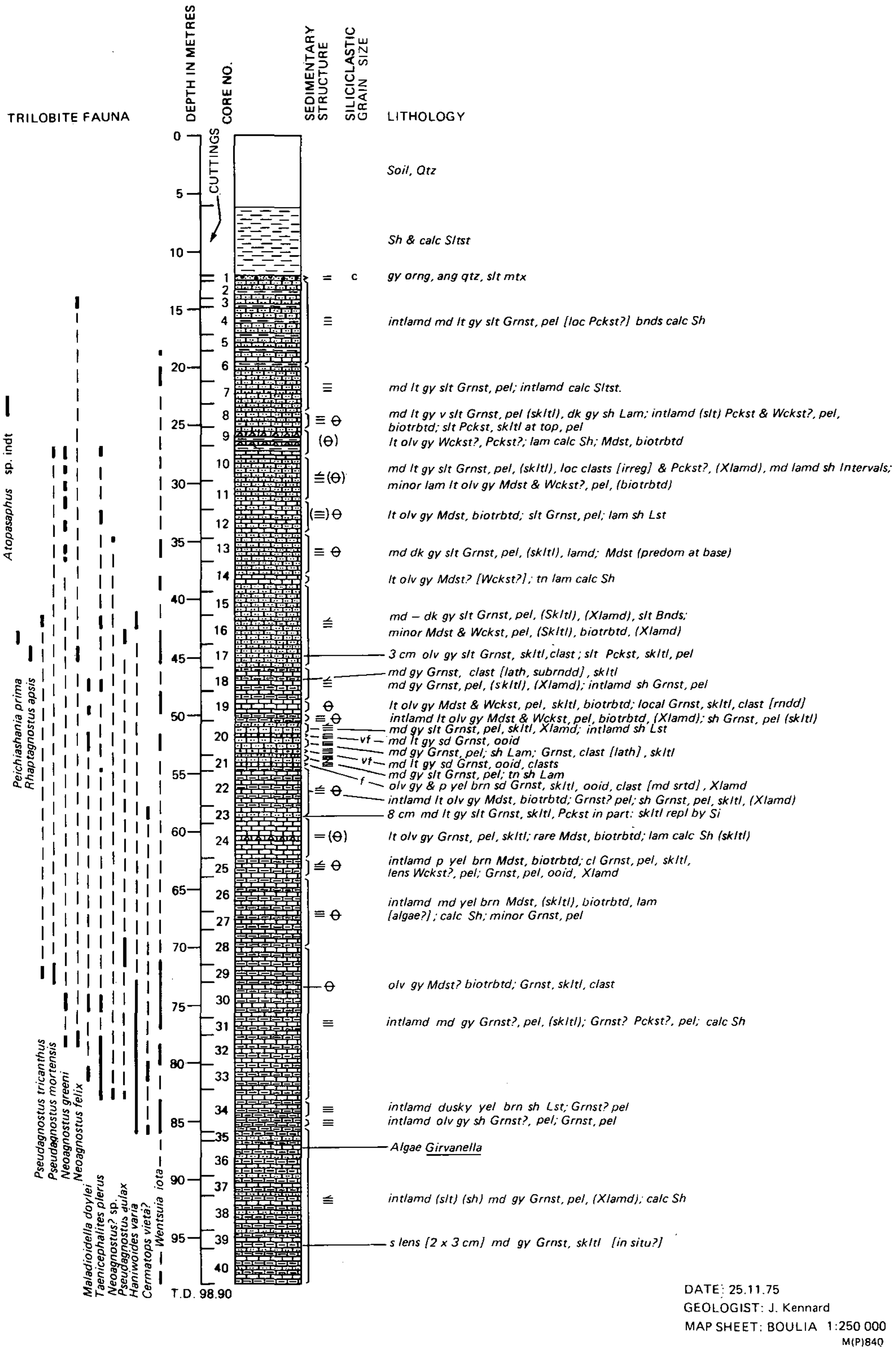


Fig. 40. Preliminary faunal analysis and abridged lithological description of BMR drill hole Boulia No. 6 (following Kennard *in* Kennard & Draper, 1977)

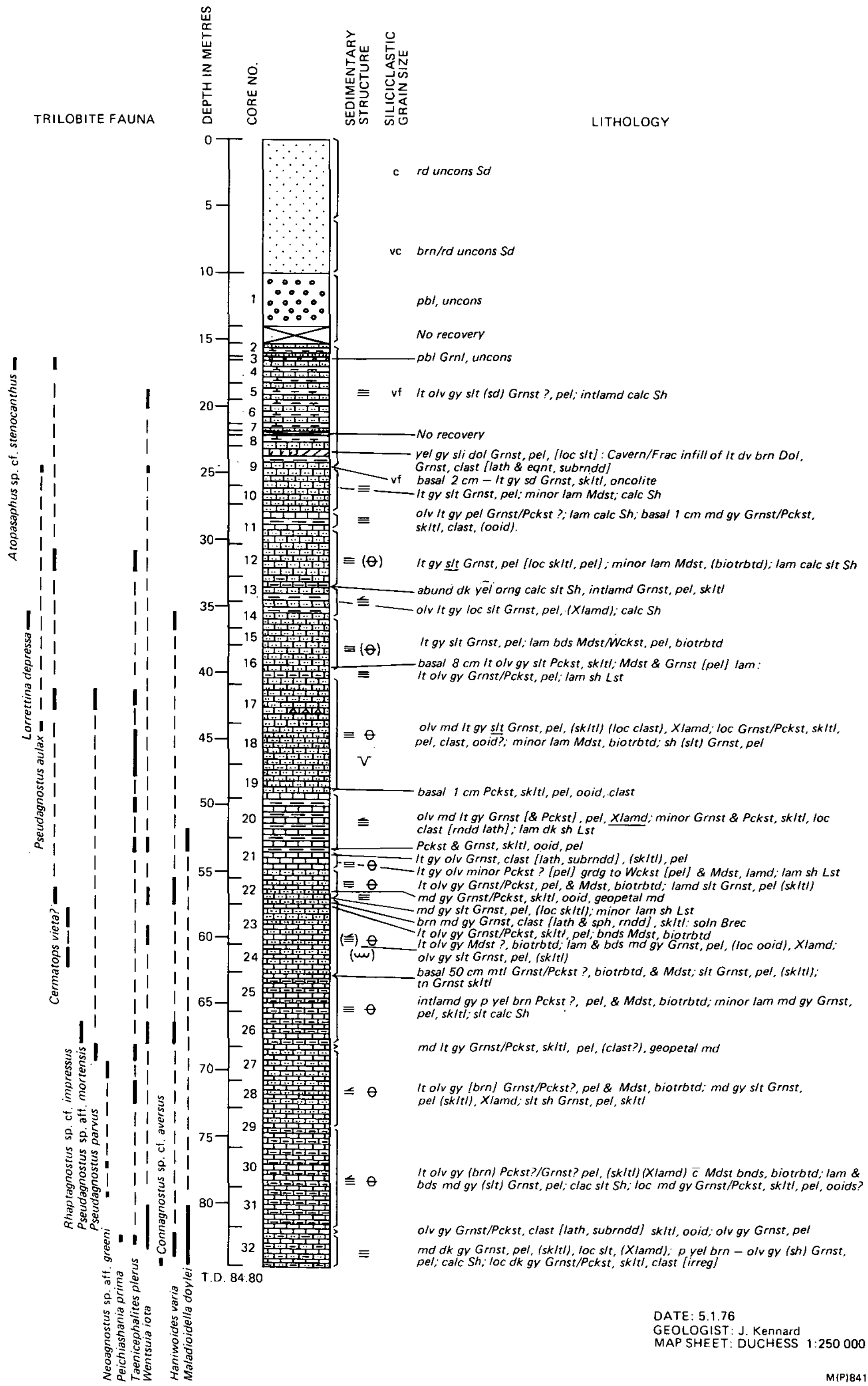


Fig. 41. Preliminary faunal analysis and abridged lithological description of BMR drill hole Duchess No. 13 (following Kennard *in* Kennard & Draper, 1977).

PLATE 1

Pseudagnostus (Pseudagnostus) mortensis sp. nov.

(p. 27)

Fig. 1 CPC 15007, early holaspid cephalon, length 1.40 mm; Horse Creek, K225; x 25.

Fig. 2 CPC 15008, cephalic exoskeleton, length 2.60 mm; Horse Creek, K216; x 20.

Fig. 3 CPC 15009, cephalic exoskeleton, length 2.55 mm; Horse Creek, K216; x 16.

Fig. 4 CPC 15011, cephalic exoskeleton, length 2.80 mm; Horse Creek, K216; x 16.

Fig. 5 CPC 15010, cephalic exoskeleton, length 2.70 mm; Horse Creek, K215; x 16.

Fig. 6 CPC 15012, cephalic exoskeleton, length 3.05 mm; Horse Creek, K216; x 16.

Fig. 7 CPC 15012, lateral aspect; x 16.

Fig. 8 CPC 15013, cephalic exoskeleton, length 3.50 mm; Horse Creek, K216; x 16.

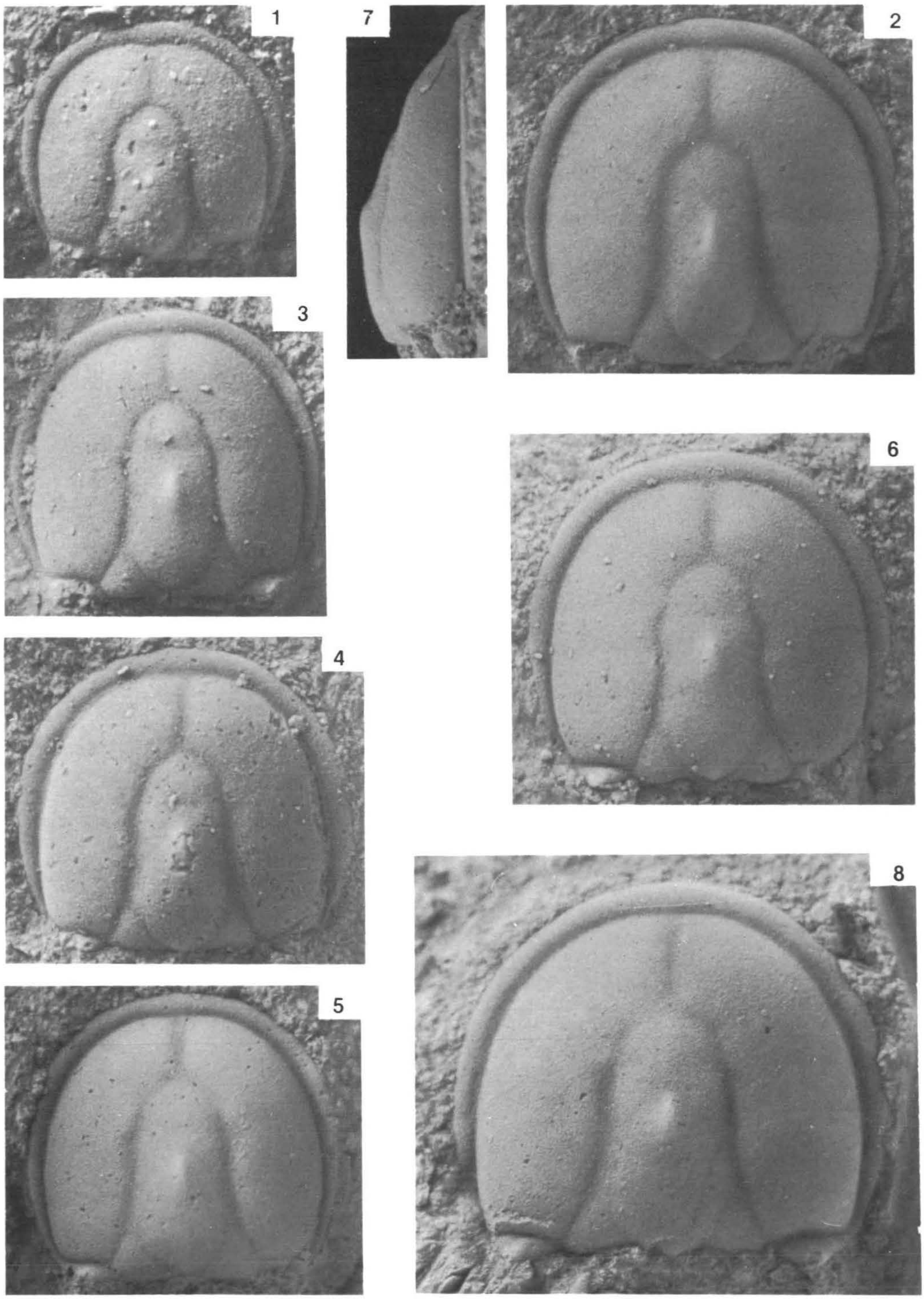

1
7
2
3
6
4
8
5

PLATE 2

Pseudagnostus (Pseudagnostus) mortensis sp. nov.

(p. 27)

Fig. 1 CPC 15016, pygidial exoskeleton, length (Lp_2) 1.90 mm; Horse Creek, K216; x 21.

Fig. 2 CPC 15015, pygidial exoskeleton, length (Lp_2) 2.50 mm; Horse Creek, K216; x 15.

Fig. 3 CPC 15014, early holaspid pygidial exoskeleton, length (Lp_2) 1.75 mm; Horse Creek, K216; x 15.

Fig. 4 CPC 15017, pygidial exoskeleton, length (Lp_2) 3.00 mm; Horse Creek, K215; x 15.

Fig. 5 CPC 15018, pygidial exoskeleton, length (Lp_2) 2.60 mm; Horse Creek, K216; x 16.

Fig. 6 CPC 15019, pygidial exoskeleton, length (Lp_2) 2.90 mm, Horse Creek, K225; x 16.

Fig. 7 CPC 15020, pygidial exoskeleton, length (Lp_2) 3.00 mm; Horse Creek, K216; x 16.

Fig. 8 CPC 15021, pygidial exoskeleton, length (Lp_2) 3.00 mm; Horse Creek, K216; x 17.

Fig. 9 CPC 15022, **holotype,** lateral aspect of partly exfoliated pygidium; Horse Creek, K218; x 13.

Fig. 10 CPC 15022, **holotype,** dorsal view, length (Lp_2) 3.60 mm; x 13.

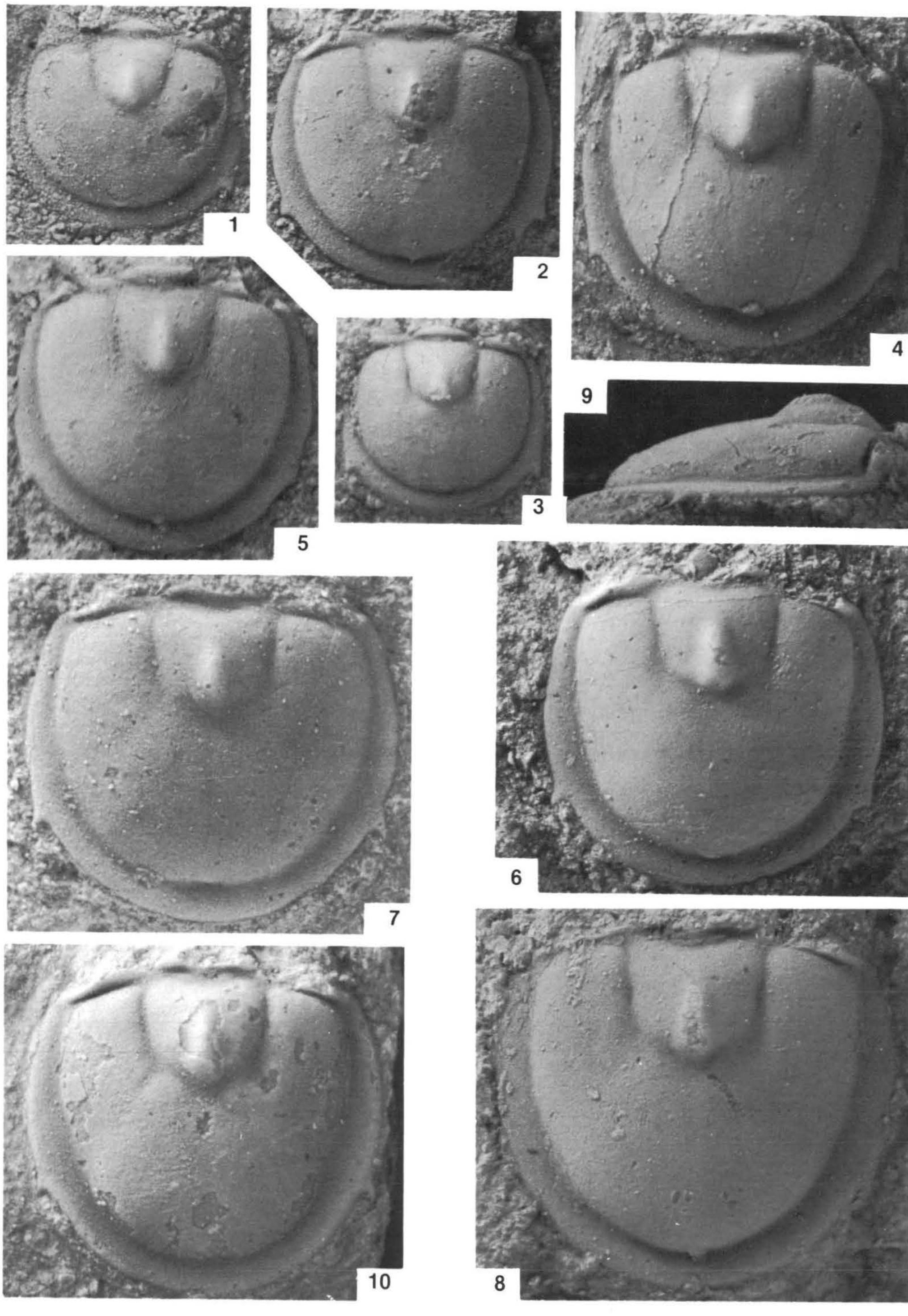

1
2
4
9
5
3
6
7
10
8

PLATE 3

Pseudagnostus (Pseudagnostus) parvus sp. nov.

(p. 29)

Fig. 1 CPC 15032, **holotype,** silicified cephalon, length 3.85 mm; Lily Creek, K204; x 12.

Fig. 2 CPC 15033a, exfoliated cephalon, length 2.40 mm; Lily Creek, B54a; x 16.

Fig. 3 CPC 15034, cephalic exoskeleton, partly effaced, length 2.85 mm; Lily Creek, B791a; x 11.

Fig. 4 CPC 15035, exfoliated cephalon, length 1.70 mm; Lily Creek, B54b; x 20.

Fig. 5 CPC 15033b, latex cast from external mould, as fig. 2; x 16.

Fig. 6 CPC 15036, exfoliated cephalon, length 1.70 mm; Horse Creek, K224; x 25.

Fig. 7 CPC 15037, pygidial exoskeleton, length (Lp_2) 2.40 mm, Lily Creek, B54b; x 20.

Fig. 8 CPC 15037, lateral aspect, x 20.

Fig. 9 CPC 15038, partly exfoliated pygidium, length (Lp_2) 3.60 mm; Chatsworth Plains, D124; x 12.

Fig. 10 CPC 15039, latex cast from external mould of pygidial exoskeleton, length (Lp_2) 3.30 mm; Lily Creek, B54a; x 12.

Fig. 11 CPC 15040, exfoliated pygidium, estimated length (Lp_2) 2.05 mm; Lily Creek, B54a; x 21.

Fig. 12 CPC 15041, pygidial exoskeleton, length (Lp_2) 2.05 mm; Lily Creek, K200; x 21.

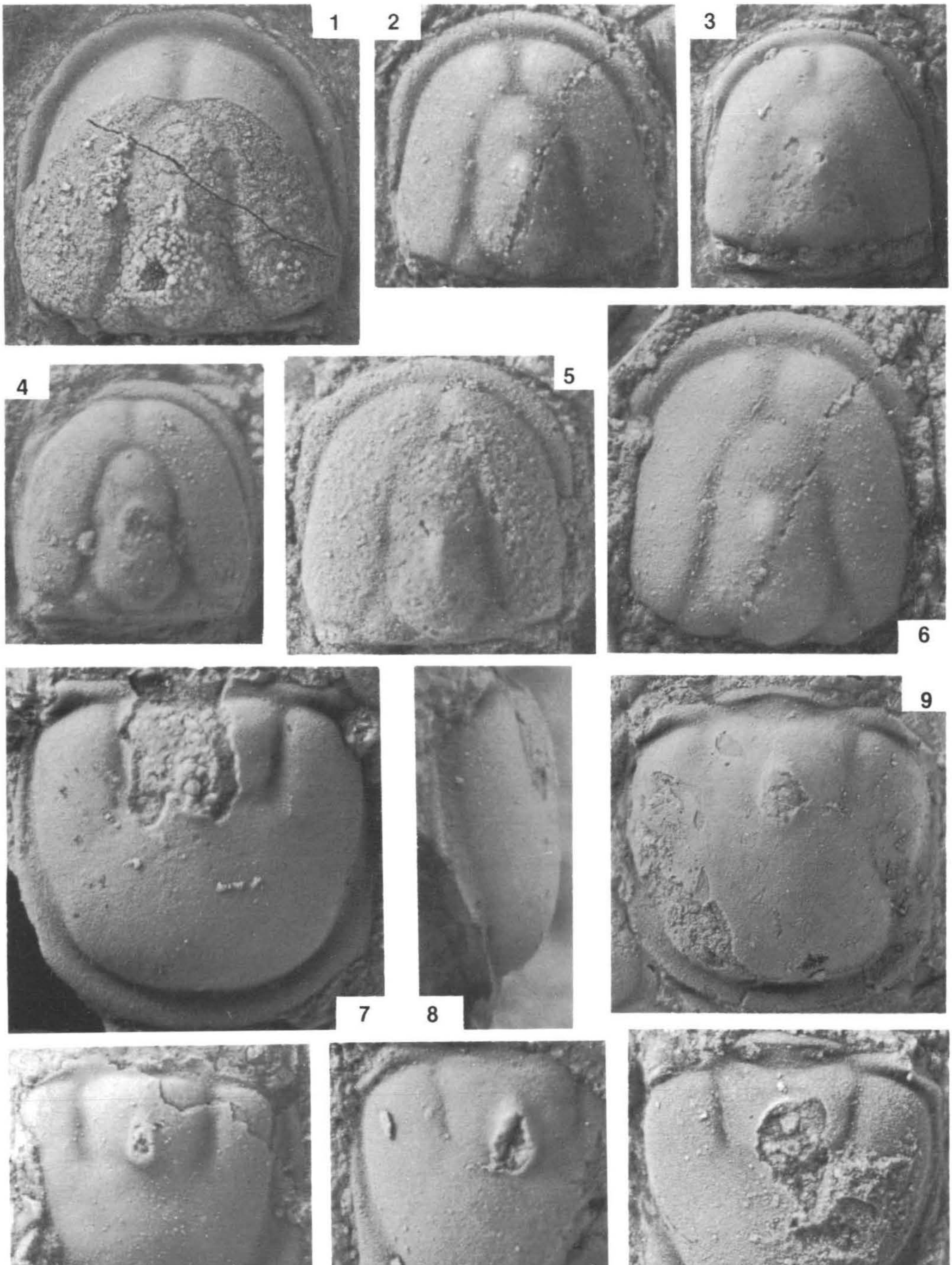

1
2
3
4
5
6
7
8
9
10
11
12

PLATE 4

Pseudagnostus (Pseudagnostus?) sp. VI

(p. 33)

Fig. 1 CPC 15062, exfoliated cephalon showing parietal morphology, length 6.40 mm; Lily Creek, B790; x 8.

Fig. 2 CPC 15063, exfoliated cephalic fragment showing parietal morphology; Lily Creek, K200; x 8.

Fig. 3 CPC 15064, effaced pygidial exoskeleton, length (Lp_2) 7.50 mm; Lily Creek, K203; x 4.

Fig. 4 CPC 15065, exfoliated pygidium, estimated length (Lp_2) 4.5 mm; Lily Creek, K202; x 8.

Fig. 5 CPC 15066, exfoliated pygidium showing parietal morphology, which includes 10 pairs of muscle scar impressions; Lily Creek, K200; x 6.

Pseudagnostus (Pseudagnostus) tricanthus sp. nov.

(p. 30)

Fig. 6 CPC 15042, incomplete cephalic exoskeleton, length 3.45 mm; Chatsworth Plains, D124; x 12.

Fig. 7 CPC 15043, **holotype,** exfoliated cephalon, length 2.55 mm; Horse Creek, K218; x 16.

Fig. 8 CPC 15044, exfoliated cephalon, length 3.50 mm; Chatsworth Plains, D124a; x 12.

Fig. 9 CPC 15045, detail of anterior cephalic shape, typically triangular; Horse Creek, K216; approx. x 16.

Fig. 10 CPC 15046, exfoliated cephalon, length 2.75 mm; Horse Creek, K218; x 16.

Fig. 11 CPC 15043, **holotype,** lateral aspect, x 16.

Fig. 12 CPC 15047, exfoliated pygidium, length (Lp_2) 2.35 mm; Horse Creek, K224; x 25.

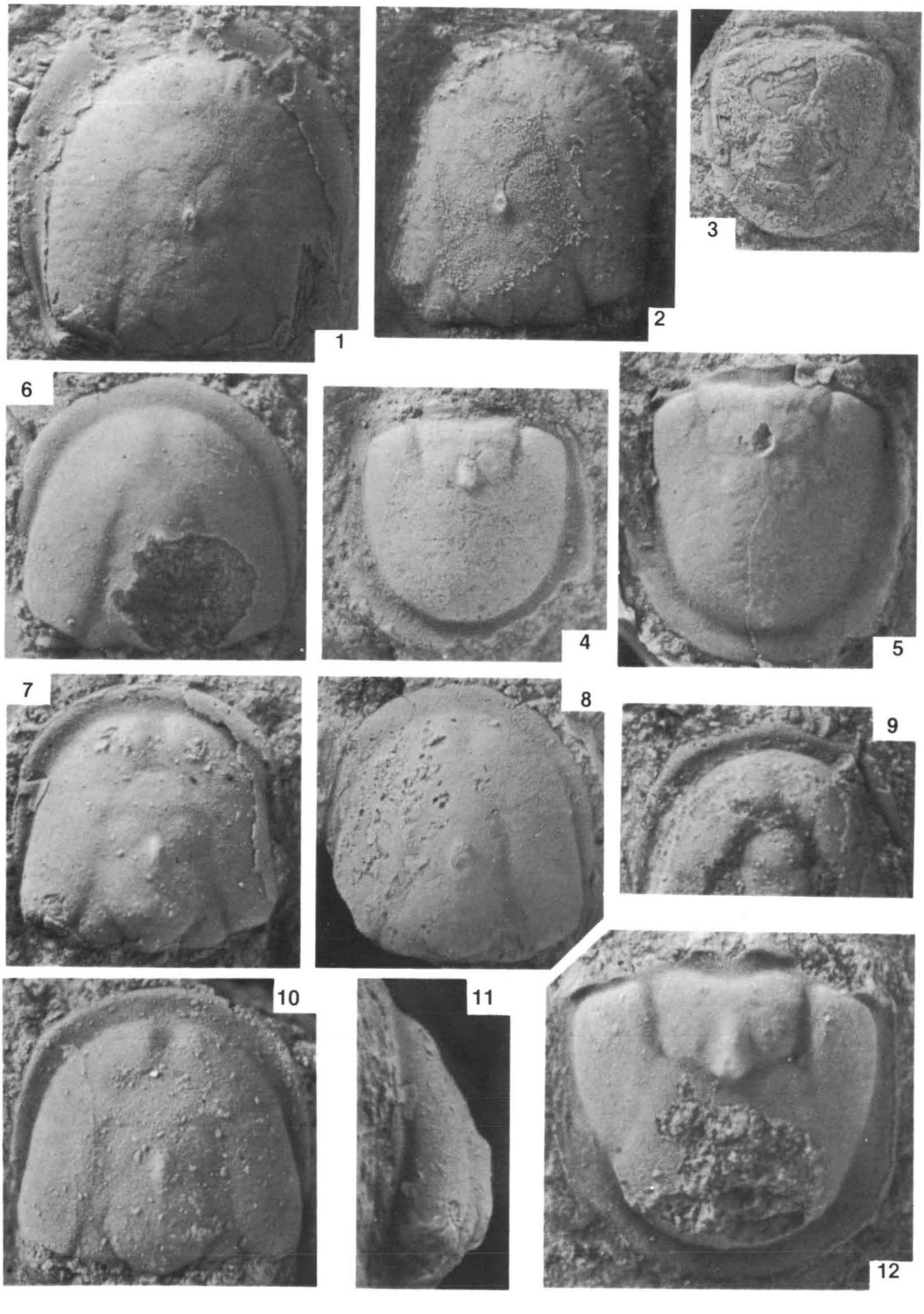

1
2
3
4
5
6
7
8
9
10
11
12

PLATE 5

Pseudagnostus (Pseudagnostus) aulax sp. nov.

(p. 31)

Fig. 1 CPC 15052, cephalic parietal surface showing details of musculature, length 5.70 mm; Chatsworth Plains, D124; x 8.

Fig. 2 CPC 15053, **holotype,** cephalic parietal surface showing scrobiculate acrolobe and glabellar musculature, length 5.35 mm; Chatsworth Plains, D124; x 8.

Fig. 3 CPC 15053, **holotype,** lateral aspect; x 8.

Fig. 4 CPC 15054, cephalic parietal surface as above, length 5.80 mm; Chatsworth Plains, D124; x 8.

Fig. 5 CPC 15059, fragment of cephalic parietal surface; Horse Creek, K216; x 8.

Fig. 6 CPC 15055, partly exfoliated pygidium showing parietal muscle scar impressions, length (Lp_2) estimated at 5.20 mm; Chatsworth Plains, D669; x 8.

Fig. 7 CPC 15056, pygidial exoskeleton, length (Lp_2) 5.05 mm; Lily Creek, B54b; x 8.

Fig. 8 CPC 15057, pygidial exoskeleton, length (Lp_2) 4.85 mm; Chatsworth Plains, D124; x 8.

Fig. 9 CPC 15058, partly exfoliated pygidial exoskeleton, length (Lp_2) 4.80 mm; Chatsworth Plains, D124; x 8.

Fig. 10 CPC 15061, incomplete cephalic parietal surface, estimated length 3.9 mm; Horse Creek, K215; x 12.

Fig. 11 CPC 15060, pygidial parietal surface showing muscle scar impressions, scrobiculations, and extent of deuterolobe, length (Lp_2) 4.30 mm; Chatsworth Plains, D124; x 12.

Fig. 12 CPC 15057, lateral aspect of pygidial exoskeleton showing orientation of spines; x 8.

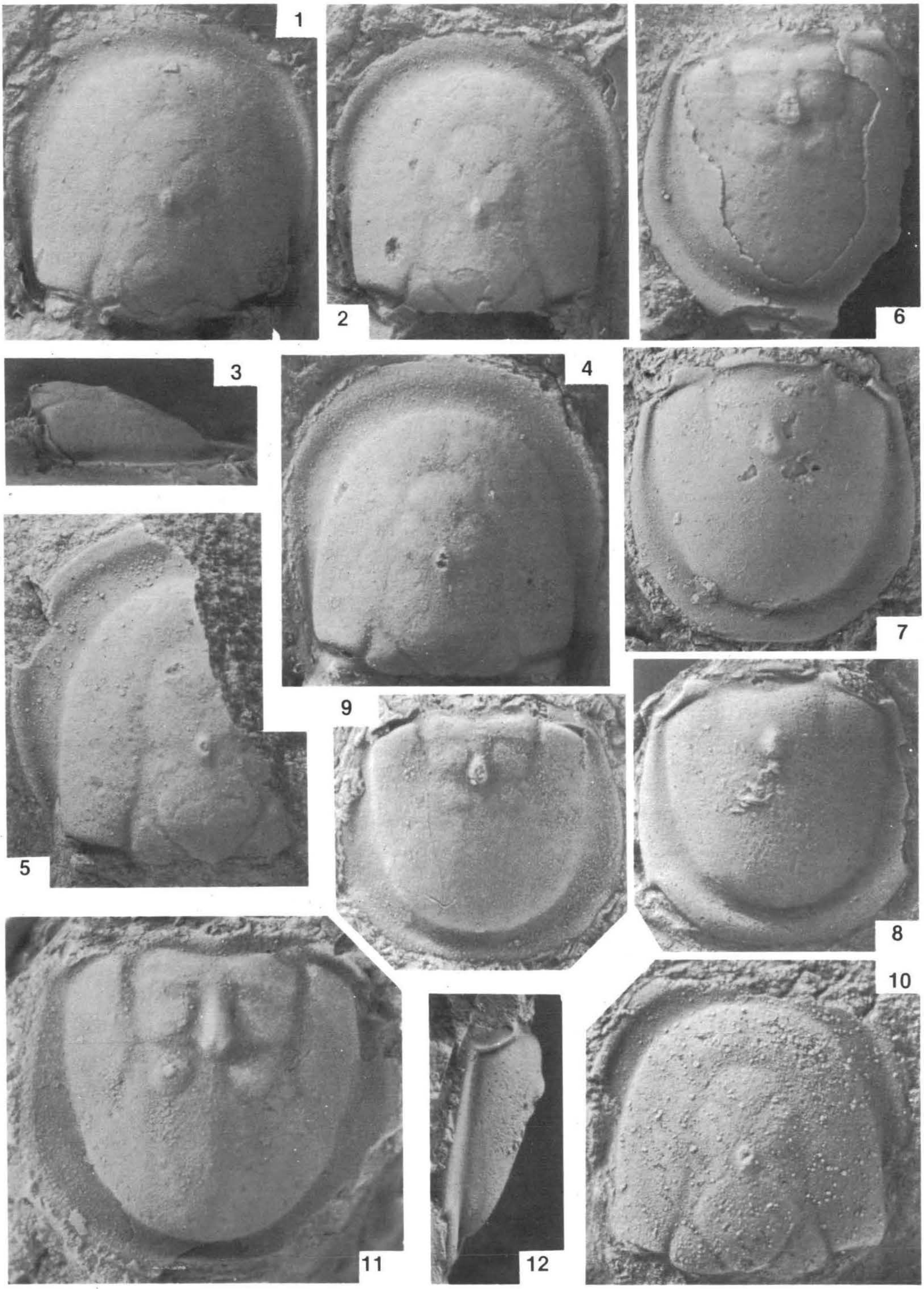

1
2
6
3
4
7
5
9
8
10
11
12

PLATE 6

Rhaptagnostus apsis sp. nov.

(p. 35)

Fig. 1 CPC 15023, cephalic exoskeleton showing degree of glabellar effacement, length 4.20 mm; Horse Creek, K216; x 12.

Fig. 2 CPC 15024, partly exfoliated cephalon showing parietal glabellar relief, length 3.50 mm; Horse Creek, K226; x 12.

Fig. 3 CPC 15025, incomplete pygidial exoskeleton; Horse Creek, K216; approx. x 8.

Fig. 4 CPC 15026, exfoliated cephalon, length 4.20 mm; Horse Creek, K226; x 12.

Fig. 5 CPC 15026, as above, lateral aspect; approx. x 12.

Fig. 6 CPC 15027, partly exfoliated pygidium, length (Lp_2) 4.50 mm; Chatsworth Plains, D124a; x 8.

Fig. 7 CPC 15028, pygidial exoskeleton, length (Lp_2) 3.30 mm; Horse Creek, K226; x 12.

Fig. 8 CPC 15029, **holotype,** pygidial exoskeleton, length (Lp_2) 3.50 mm; Horse Creek, D668; x 12.

Fig. 9 CPC 15029, **holotype,** as above, lateral aspect, x 12.

Fig. 10 CPC 15030, partly exfoliated cephalon, length 4.70 mm; Horse Creek, K226; x 12.

Fig. 11 CPC 15031, partly exfoliated pygidium, length (Lp_2) 4.00 mm; Horse Creek, K225; x 12.5.

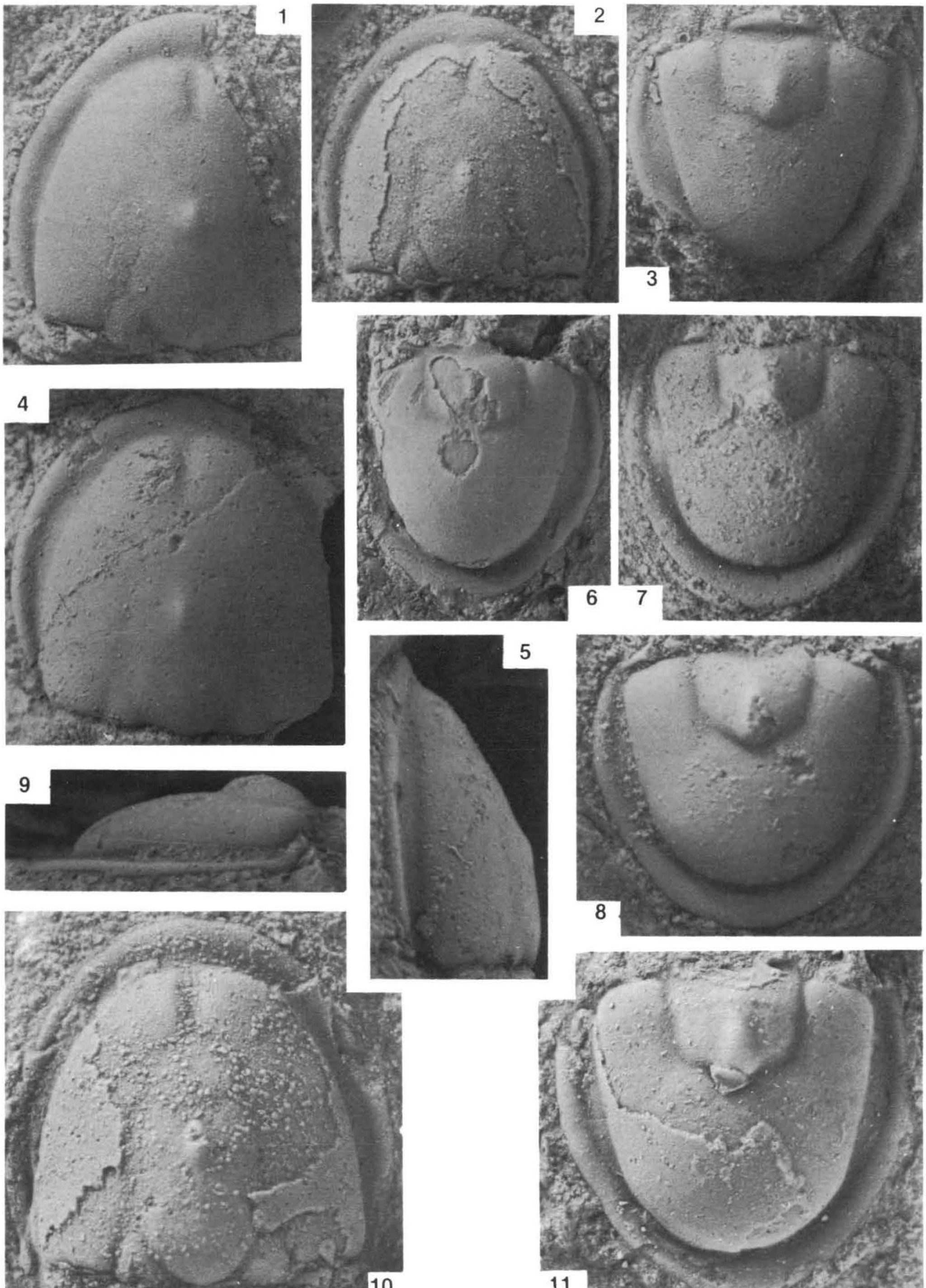

1
2
3
4
5
6
7
8
9
10
11

PLATE 7

Rhaptagnostus auctor sp. nov.

(p. 38)

Fig. 1 CPC 15070, **holotype,** partly exfoliated cephalon, length 3.10 mm; Lily Creek, B791a; x 12.

Fig. 2 CPC 15071, exfoliated cephalon showing parietal morphology of glabella, length 4.20 mm; Lily Creek, B791a; x 12.

Fig. 3 CPC 15071, lateral aspect, x 12.

Fig. 4 CPC 15072, partly exfoliated cephalon, estimated length 4.85 mm; Lily Creek, B791a; x 8.

Fig. 5 CPC 15068, exfoliated pygidium showing parietal morphology of anterior axis, length (Lp_2) 3.50 mm; Lily Creek, B791a; x 12.

Fig. 6 CPC 15068, lateral aspect, approx. x 12.

Fig. 7 CPC 15067, exfoliated pygidium showing parietal morphology, particularly scrobiculate deuterolobe margins and segmental diverticula associated with the anterior two segments and axial node, length (Lp_2) 3.80 mm; Lily Creek, B791a; x 12.5.

Fig. 8 CPC 15069, latex cast from pygidial exoskeleton exhibiting high degree of effacement, estimated length (Lp_2) 3.5 mm; Lily Creek, B791a; x 10.

Pseudagnostus (Pseudagnostus) sp. VII

(p. 33)

Fig. 9 CPC 15073, exfoliated pygidium with retrally sited spines, estimated length 4.6 mm; Horse Creek, K217; x 8.

Fig. 10 CPC 15074, latex cast from parietal mould of pygidium with retral spines, estimated length 4.6 mm; Horse Creek, K216; x 6.

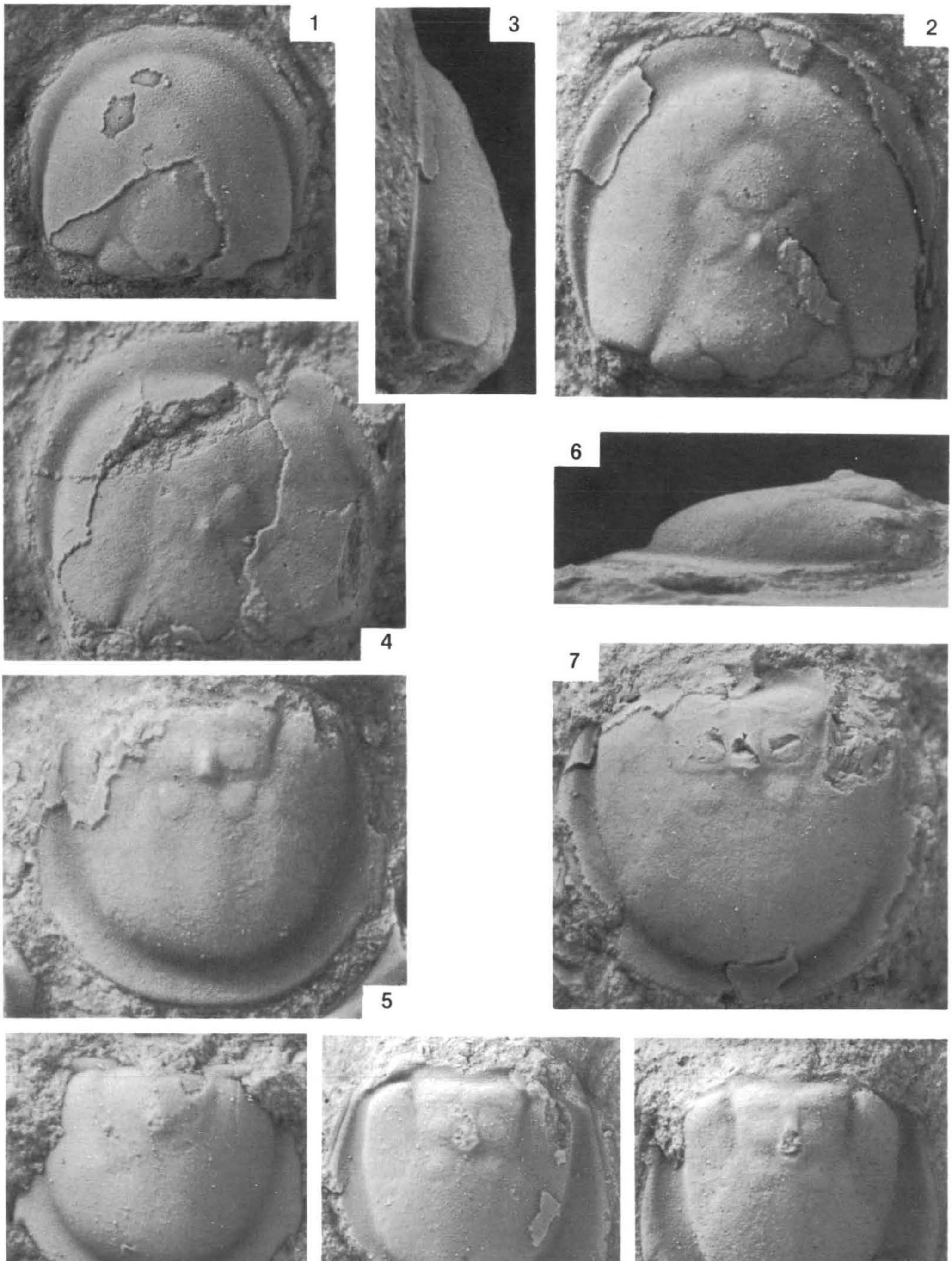

1
3
2
6
4
7
5
8
9
10

PLATE 8

Neoagnostus felix sp. nov.

(p. 41)

Fig. 1 CPC 15089, partly exfoliated cephalon, length 4.10 mm; Chatsworth Plains, D124; x 10.

Fig. 2 CPC 15091, partly exfoliated cephalon, length 3.70 mm; Chatsworth Plains, D124; x 10.

Fig. 3 CPC 15090, exfoliated cephalon, length 3.80 mm; Chatsworth Plains, D124; x 10.

Fig. 4 CPC 15092, **holotype,** exfoliated cephalon showing extent of anterolateral muscle scar impressions, length 4.80 mm; Chatsworth Plains, D124; x 12.

Fig. 5 CPC 15092, **holotype,** lateral aspect, x 12.

Fig. 6 CPC 15095, exfoliated pygidium showing extent of deuterolobe, length (Lp_2) 4.20 mm; Chatsworth Plains, D124; x 10.

Fig. 7 CPC 15094, exfoliated pygidium showing deuterolobe scrobiculation, length (Lp_2) 3.65 mm; Chatsworth Plains, D124; x 12.

Fig. 8 CPC 15093, exfoliated pygidium, length (Lp_2) 3.20 mm; Chatsworth Plains, D124; x 12.

Fig. 9 CPC 15096, partly exfoliated pygidium showing parietal musculature, length (Lp_2) 3.60 mm; Horse Creek, K225; x 12.

Pseudagnostus (Pseudagnostus?) sp. V.

(p. 33)

Fig. 10 CPC 15075, exfoliated quadrate pygidium with retral spines, length (Lp_2) 1.70 mm; Horse Creek, K218; x 24.

Fig. 11 CPC 15076, exfoliated pygidium as Fig. 10, length (Lp_2) 2.50 mm; Horse Creek, K215; x 20.

Fig. 12 CPC 15077, incomplete exfoliated pygidium showing extent of deuterolobe and muscle scar impressions; Horse Creek, K217; x 12.

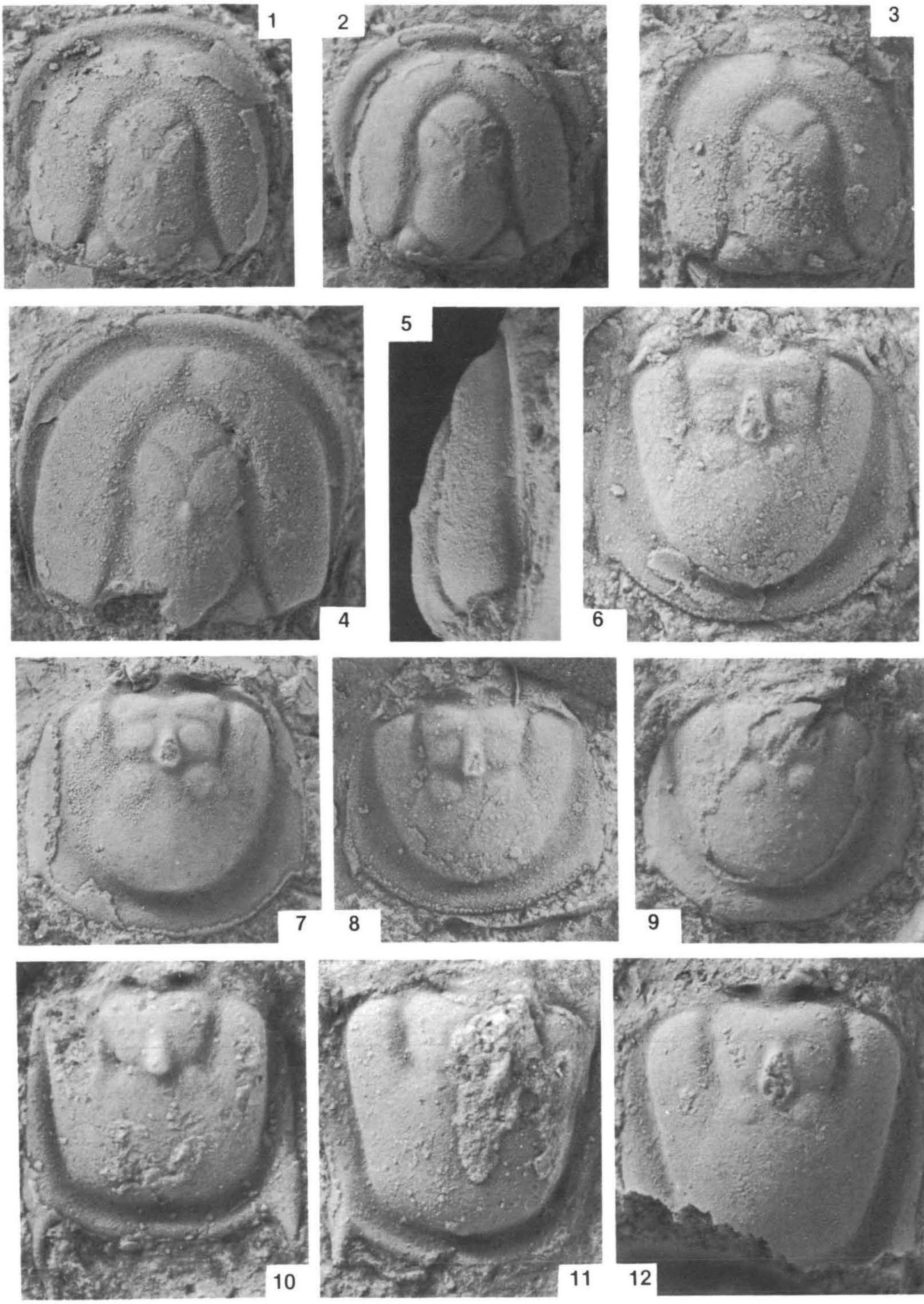

1
2
3
4
5
6
7
8
9
10
11
12

PLATE 9

Neoagnostus greeni sp. nov.

(p. 39)

Fig. 1 CPC 15079, exfoliated cephalon showing extent of fulcral spines, length 2.40 mm; Horse Creek, K216; x 20.

Fig. 2 CPC 15079, as above, lateral view, x 20.

Fig. 3 CPC 15078, **holotype,** cephalic exoskeleton, shell mainly dissolved, length 2.30 mm; Horse Creek, K215; x 23.

Fig. 4 CPC 15080, exfoliated cephalon showing scrobiculation of acrolobe, length 2.45 mm; Horse Creek, K216; x 16.

Fig. 5 CPC 15081, early holaspid cephalon, length 1.60 mm; Horse Creek, K225; x 24.

Fig. 6 CPC 15082, cephalon, shell mostly dissolved, length 1.85 mm; Horse Creek, K216; x 25.

Fig. 7 CPC 15083, latex cast from partly exfoliated cephalon, length 3.25 mm; Horse Creek, K223; x 12.

Fig. 8 CPC 15084, late meraspid pygidium with retral spines, length (Lp_2) 1.30 mm; Horse Creek, K216; x 16.

Fig. 9 CPC 15085, pygidium showing extent of fulcral points, length (Lp_2) 2.15 mm; Horse Creek, K216; x 16.

Fig. 10 CPC 15086, exfoliated pygidium, length (Lp_2) 2.55 mm; Horse Creek, K216; x 16.

Fig. 11 CPC 15087, late meraspid pygidium with retral spines, length 1.30 mm; Horse Creek, K216; x 17.

Fig. 12 CPC 15088, pygidium, length (Lp_2) 2.90 mm; Horse Creek, K216; x 16.

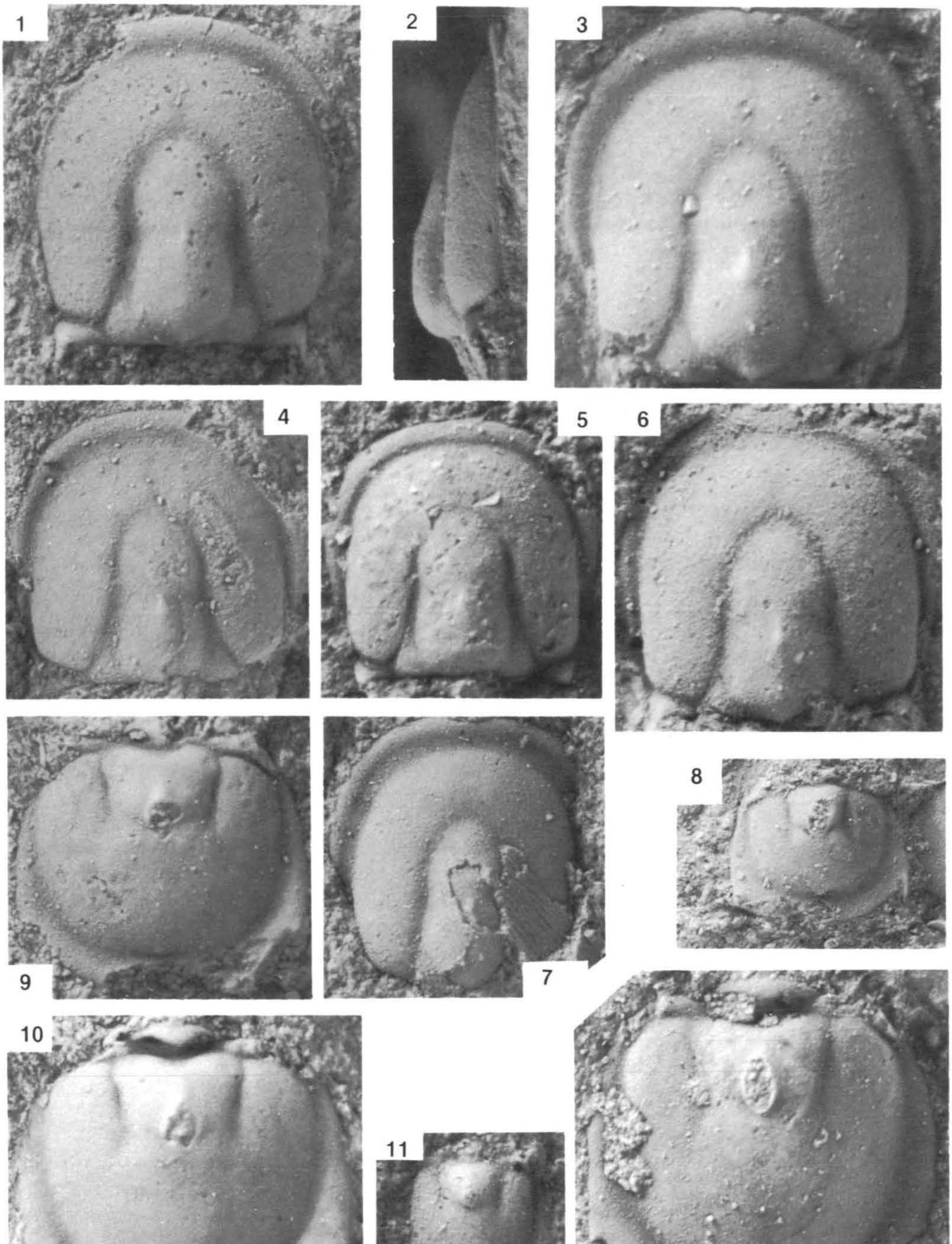

1
2
3
4
5
6
8
9
7
10
11
12

PLATE 10

Rhaptagnostus sp. cf. *R. impressus* (Lermontova, 1940)

(p. 36)

Fig. 1 CPC 15048, exfoliated cephalon, length 3.30 mm; Horse Creek, K225; x 16.

Fig. 2 CPC 15049, incomplete exfoliated cephalon, length 3.20 mm; Chatsworth Plains, D124; x 16.

Fig. 3 CPC 15050, detail of exfoliated glabella showing extent of known parietal morphology, length estimated 2.6 mm; Horse Creek, K223; approx. x 20.

Fig. 4 CPC 15051a, effaced, deuterolobate, narrow-bordered pygidial exoskeleton, length (Lp_2) 3.60 mm; Horse Creek, K223; x 12.5.

Fig. 5 CPC 15051b, latex cast from external mould, approx. x 12.

Fig. 6 CPC 15051a, as above, lateral aspect, x 12.5.

Neoagnostus sp. I.

(p. 42)

Fig. 7 CPC 15097, exfoliated subquadrate cephalon; Lily Creek, K208; x 16.

Fig. 8 CPC 15098, exfoliated cephalon; Lily Creek, K208; x 16.

Fig. 9 CPC 15099, exfoliated late meraspid? pygidium, length (Lp_2) 1.50 mm; Lily Creek, K208; x 18.

Fig. 10 CPC 15100, partly exfoliated pygidium, length (Lp_2) 2.60 mm; Lily Creek, K208; x 16.

Neoagnostus sp. II.

(p. 42)

Fig. 11 CPC 15102, weathered cephalic mould, estimated length 2.3 mm; Lily Creek, K212; x 16.

Fig. 12 CPC 15103, pygidial fragment; Lily Creek, K212; x 16.

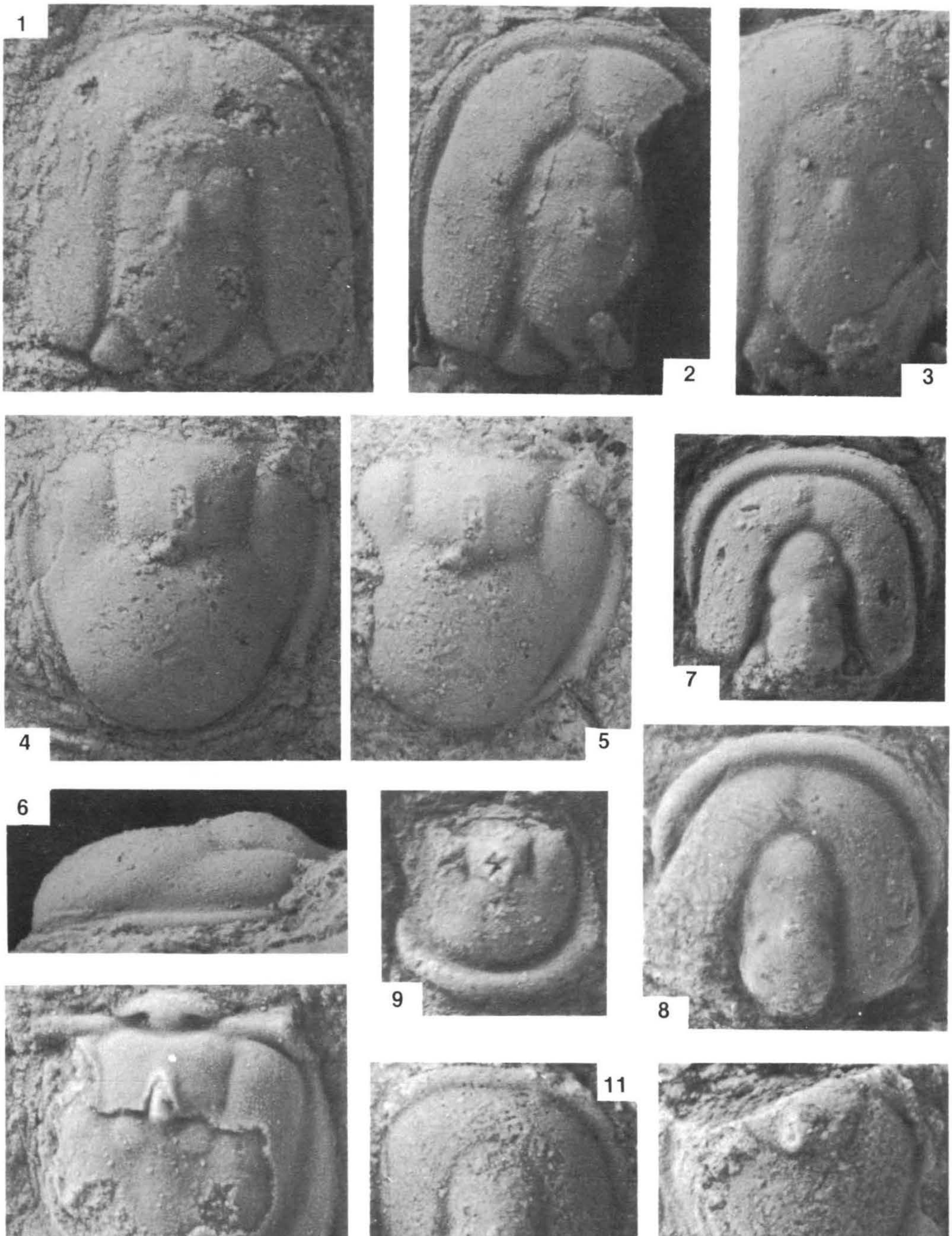

1
2
3
4
5
6
7
8
9
10
11
12

PLATE 11

Acmarhachis hybrida sp. nov.

(p. 20)

Fig. 1 CPC 15104, exfoliated cephalon, length 2.20 mm, showing prominent median preglabellar furrow; Chatsworth Plains, D487; x 20.

Fig. 2 CPC 15106, exfoliated cephalon, estimated length 2.2 mm, with effaced median preglabellar furrow; Horse Creek, K215; x 20.

Fig. 3 CPC 15105, exfoliated cephalon, length 1.40 mm, with effaced median preglabellar furrow; Horse Creek, K215; x 29.

Fig. 4 CPC 15107a, **holotype,** exfoliated pygidium, typical of *Acmarhachis,* length (Lp_2) 2.00 mm; Chatsworth Plains, D487; x 20.

Fig. 5 CPC 15107b, **holotype,** latex cast from external mould; x 20.

Fig. 6 CPC 15108, exfoliated early holaspid pygidium, length (Lp_2) 1.60 mm; Horse Creek, K215; x 21.

Innitagnostus medius sp. nov.

(p. 22)

Fig. 7 CPC 15110, early holaspid cephalon, length 1.80 mm; Horse Creek, K218; x 23.

Fig. 8 CPC 15109, **holotype,** partly exfoliated cephalon, length 2.00 mm; Horse Creek, K218; approximately x 20.

Fig. 9 CPC 15111, partly exfoliated pygidium, length (Lp_2) 1.50 mm; Horse Creek, K218; x 25.

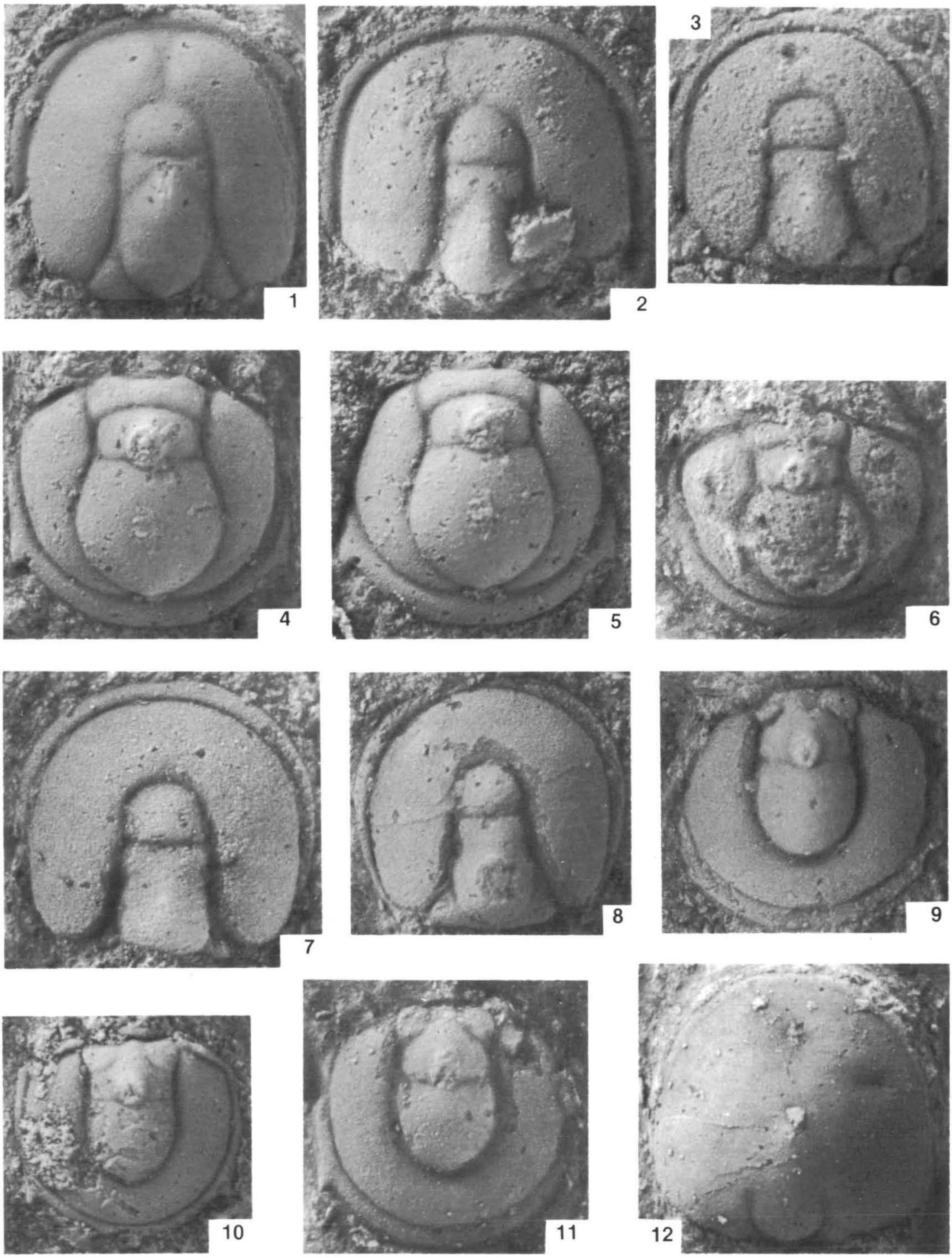
Fig. 10 CPC 15112, partly exfoliated pygidium, length (Lp_2) 1.90 mm; Horse Creek, K216; x 16.

Fig. 11 CPC 15113, incomplete pygidium, partly exfoliated, length (Lp_2) 1.50 mm; Horse Creek, K218; x25.

Peratagnostus sp. cf. *P. nobilis* Öpik, 1967

(p. 24)

Fig. 12 CPC 15114, cephalon retaining exoskeleton, length 3.00 mm; Chatsworth Plains, D487; x 14.



1
2
3
4
5
6
7
8
9
10
11
12

PLATE 12

Connagnostus aversus sp. nov.

(p. 24)

Fig. 1 CPC 15118, exfoliated cephalon; length 2.20 mm; Horse Creek, K220; x 19.

Fig. 2 CPC 15115, **holotype,** exfoliated pygidium; length (Lp_2) 1.90 mm; Chatsworth Plains, D124; x 21.

Fig. 3 CPC 15116, exfoliated pygidium, with posteriorly pointed acrolobe and vague indications of muscle scar impressions on the posterior lobe; length (Lp_2) 1.85 mm; Chatsworth Plains, D124; x 21.

Fig. 4 CPC 15117, exfoliated pygidium with narrower (tr.) posterior lobe; estimated length 1.65 mm; Chatsworth Plains, D124; x 23.

Connagnostus sp. cf. *C. conspectus* Shergold, 1975

(p. 26)

Fig. 5 CPC 15119, partly exfoliated cephalon; length 4.30 mm; Lily Creek, B791c; x 9.

Fig. 6 CPC 15122, incomplete pygidium; estimated length (Lp_2) 2.9 mm; Lily Creek, K212; x 14.

Fig. 7 CPC 15120a, exfoliated pygidium; length (Lp_2) 2.60 mm; Lily Creek, K212; x 14.

Fig. 8 CPC 15120a, lateral aspect; x 14

Fig. 9 CPC 15120b, latex cast; x 16.

Connagnostus sp. undet.

(p. 26)

Fig. 10 CPC 15123, incomplete pygidium, length (Lp_2) 1.80 mm; Lily Creek, K200; x 21.

Hypostoma undet. 4.

(p. 89)

Fig. 11 CPC 15391, silicified hypostoma; Lily Creek, K204; x 4.

Fig. 12 CPC 15390, incomplete silicified specimen showing extent of lateral border; Lily Creek, K204; x 4.

Hypostoma undet. 3

(p. 89)

Fig. 13 CPC 15392, exfoliated specimen showing details of caecal network of the anterior portion of the median body; Lily Creek, B54c; x 8.

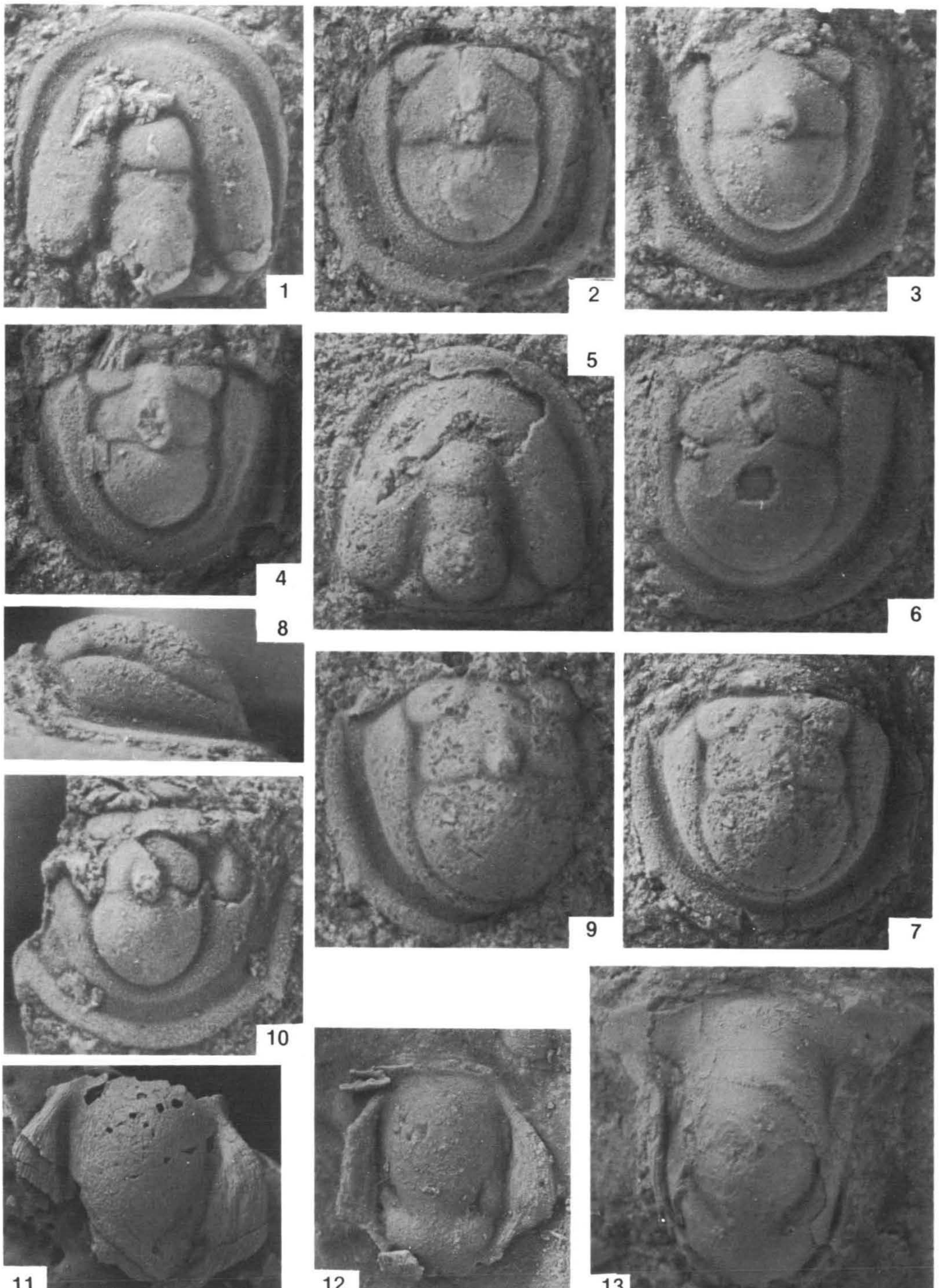

1
2
3
4
5
6
7
8
9
10
11
12
13

PLATE 13

Iveria iverensis gen. et sp. nov.

(p. 44)

Fig. 1 CPC 15317, **holotype,** silicified cephalon with four attached thoracic segments, cephalic length 5.40 mm; Lily Creek, K204; x 3.5.

Fig. 2 CPC 15317, **holotype,** anterior view; x 3.5.

Fig. 3 CPC 15318, silicified cephalon with remnants of six attached thoracic segments, estimated cephalic length 5.1 mm; Lily Creek, K204; x 4.

Fig. 4 CPC 15318, lateral view; x 4.

Fig. 5 CPC 15319, silicified cephalo-thorax including ten attached thoracic segments, cephalic length 3.60 mm; Lily Creek, B53; x 4.

Fig. 6 CPC 15319, as above, lateral view showing thoracic axial spines; x 4.

Fig. 7 CPC 15320a, large exfoliated cranidium with possibly more extensive anterior border, and showing traces of the caecal network, length 6.60 mm; Lily Creek, B50c; x 8.

Fig. 8 CPC 15321, partly exfoliated cranidial exoskeleton showing parafrontal band, estimated length 5.5 mm; Lily Creek, K210; x 8.

Fig. 9 CPC 15322, small transverse pygidium ascribed to this species, length (Lp_2) 1.20 mm; Lily Creek, K205; x 16.

Fig. 10 CPC 15323, small silicified pygidial fragment, estimated length (Lp_2) 1.4 mm; Lily Creek, B53; x 18.

Plecteuloma strix Shergold, 1975

(p. 43)

Fig. 11 CPC 15324, fragment of cranidial exoskeleton, estimated glabellar length 3.0 mm; Lily Creek, K212; x 8.

Fig. 12 CPC 15325, latex cast from exoskeletal surface, estimated length 5.7 mm; Lily Creek, K212; x 8.

Fig. 13 CPC 15326, librigenal exoskeleton; Lily Creek, K212; x 10.

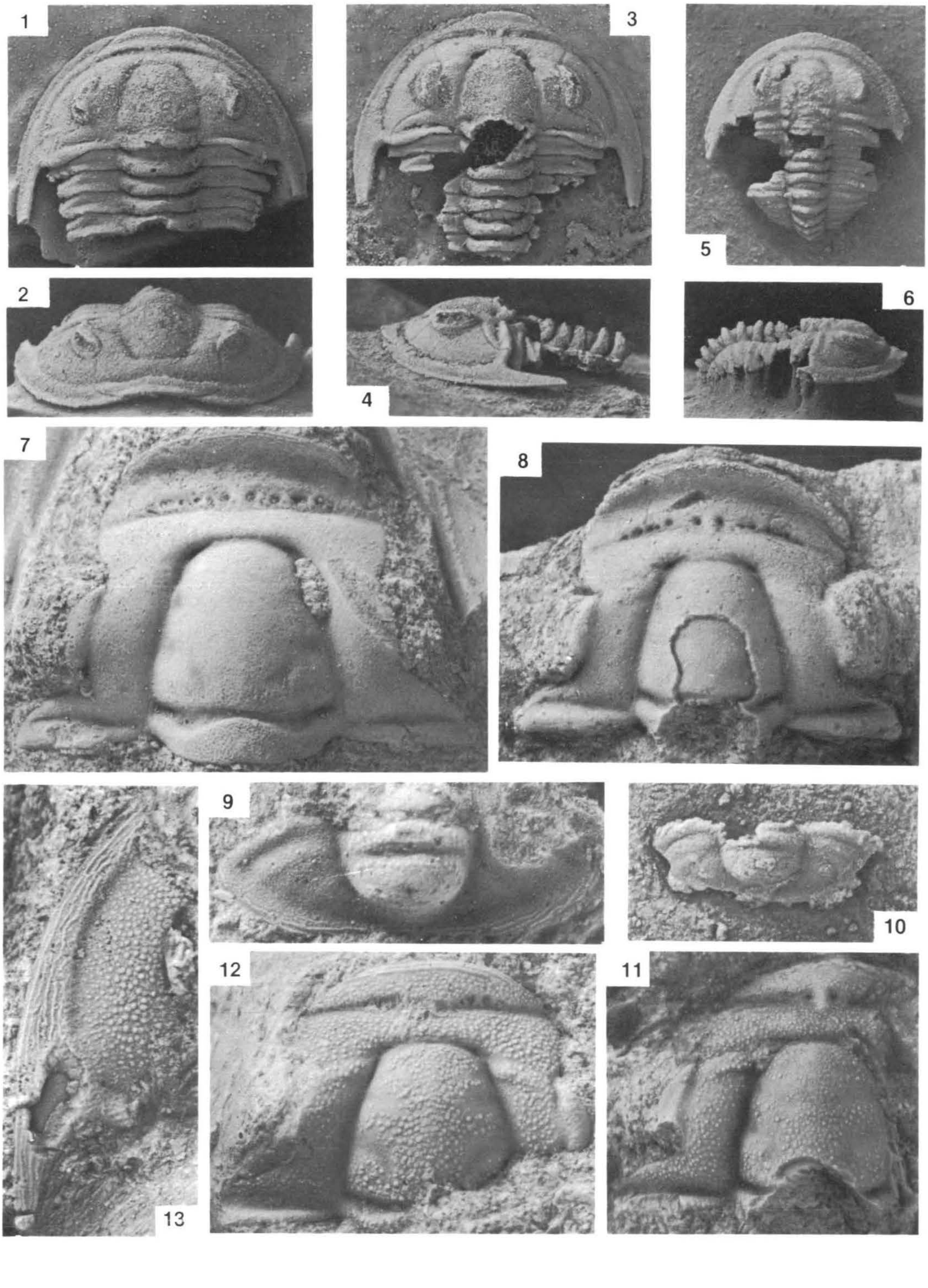

1
2
3
4
5
6
7
8
9
10
11
12
13

PLATE 14

Lorrettina depressa sp. nov.

(p. 48)

Fig. 1 CPC 15281, incomplete exfoliated cranidium in grainstone matrix, showing glabellar muscle scar impressions, length 7.50 mm; Chatsworth Plains, D124a; x 4.

Fig. 2 CPC 15280, partly exfoliated cranidium, length 7.90 mm; Chatsworth Plains, D124; x 4.

Fig. 3 CPC 15282, silicified cranidium with prominent parafrontal band, length 9.00 mm; Lily Creek, K204; x 4.

Fig. 4 CPC 15282, lateral aspect, x 4.

Fig. 5 CPC 15283, silicified cranidium, length 8.60 mm; Lily Creek, K204; x 4.

Fig. 6 CPC 15279, **holotype,** silicified cranidium, length 7.00 mm; Lily Creek, K204; x 8.

Fig. 7 CPC 15284, partly exfoliated cranidium showing parietal glabellar morphology, length 12.30 mm; Lily Creek, K206; x 4.

Fig. 8 CPC 15285, librigenal fragment; Chatsworth Plains, D124; x 20.

Fig. 9 CPC 15286, incomplete pygidium preserved in limestone; Chatsworth Plains, D124; x 20.

Fig. 10 CPC 15287, incomplete exfoliated pygidium; Chatsworth Plains, D124; x 16.

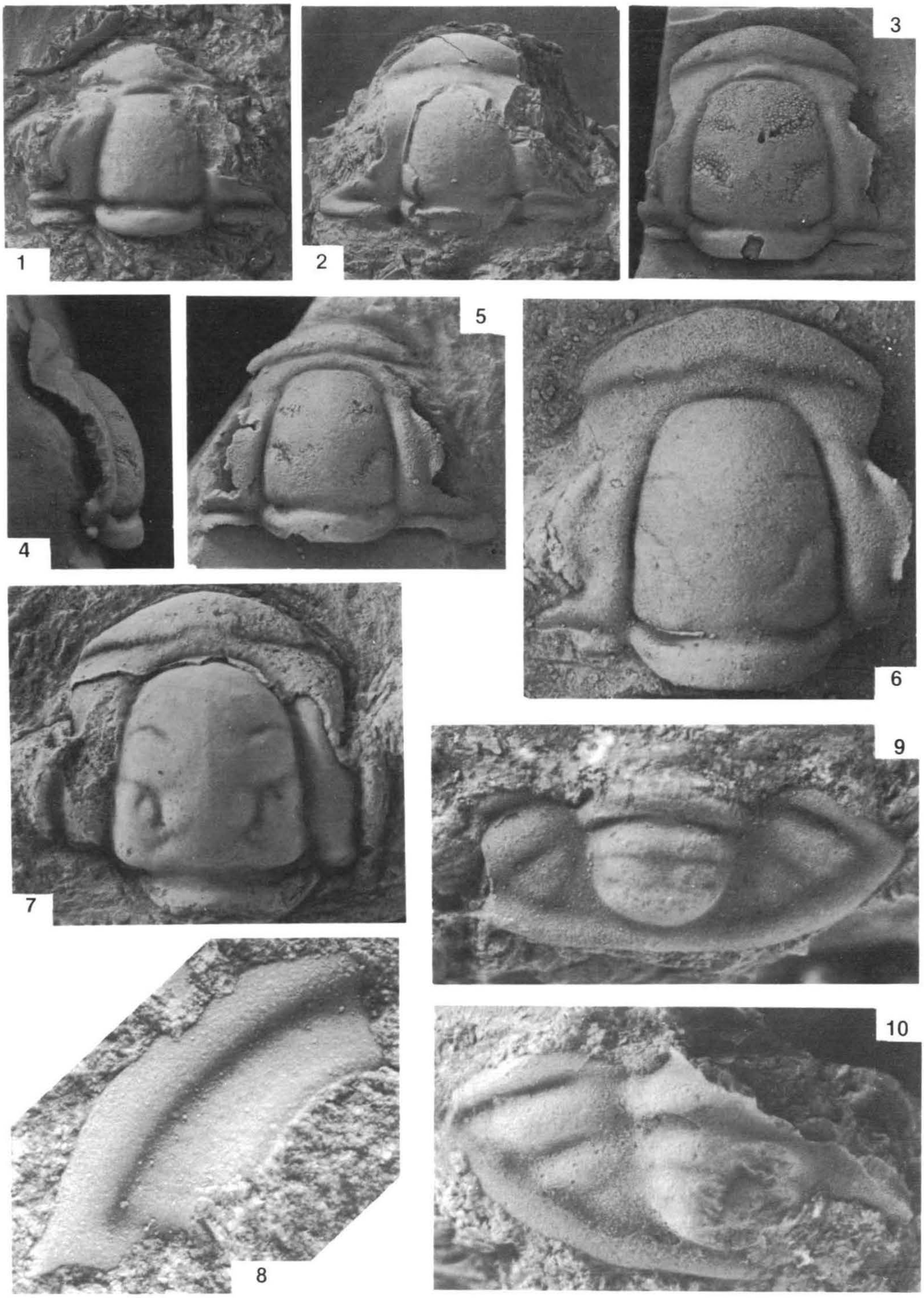


PLATE 15

Lorrettina licina sp. nov.

(p. 49)

Fig. 1 CPC 15295b, latex cast from parietal surface of **holotype,** showing punctation, glabellar muscle scar impressions and, faintly, the caecal system of the preglabellar area, length 7.30 mm; Lily Creek, K214; x 8.5.

Fig. 2 CPC 15295b, as above, lateral aspect, x 8.5.

Fig. 3 CPC 15295a, **holotype,** incomplete exfoliated cranidium; Lily Creek, K214; approx. x 8.

Fig. 4 CPC 15296, incomplete exfoliated cranidium, glabellar length 4.80 mm; Lily Creek, K214; x 8.

Fig. 5 CPC 15297, complete exfoliated librigena, demonstrating caecal morphology; Lily Creek, K214; x 8.

Fig. 6 CPC 15298, exfoliated pygidium, length (Lp_2) 2.70 mm; Lily Creek, K214; x 10.6.

Fig. 7 CPC 15299, exfoliated pygidium, estimated length (Lp_2) 3.0 mm; Lily Creek, K214; x 11.5.

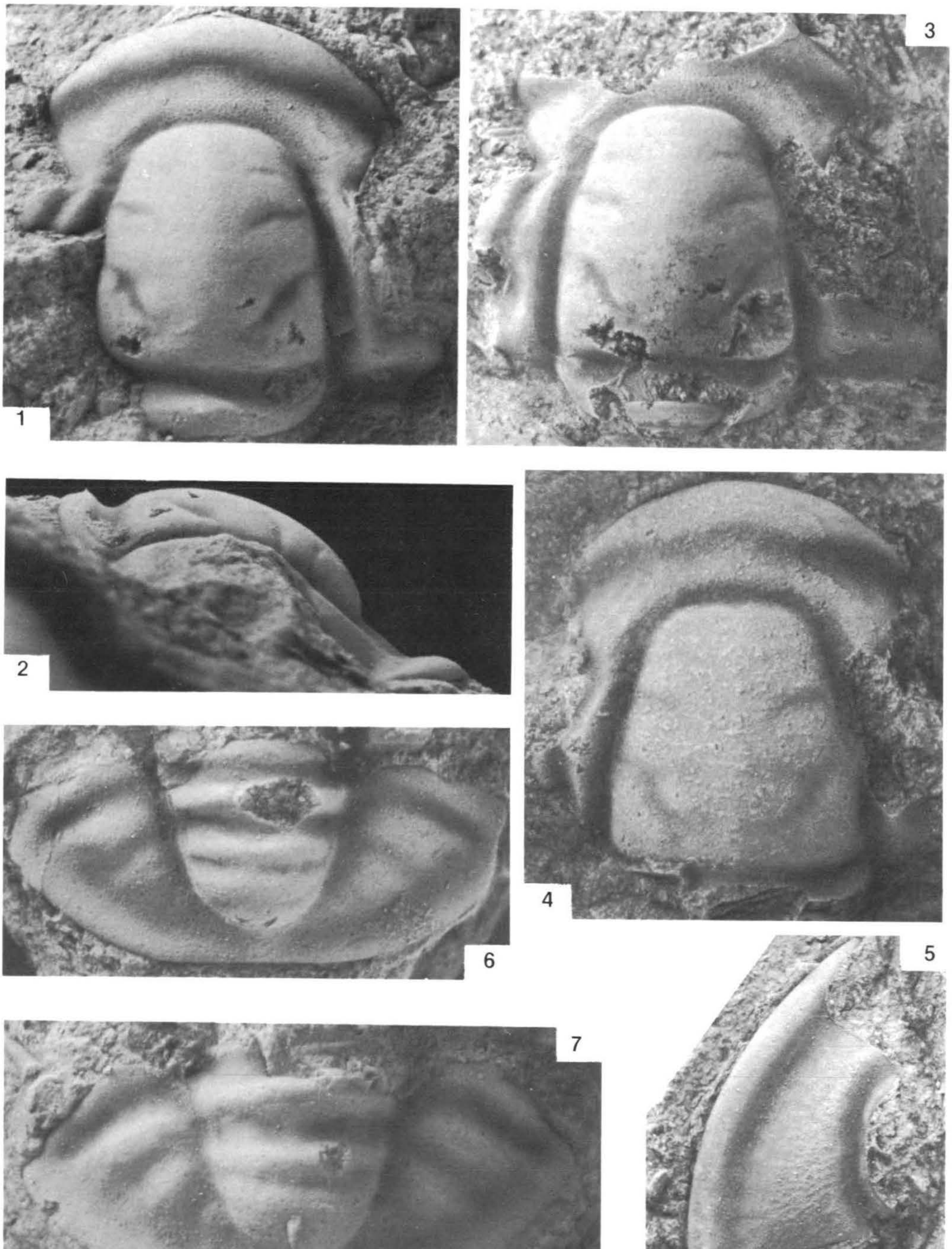

1
2
3
4
5
6
7

PLATE 16

Wuhuia silex sp. nov.

(p. 47)

Fig. 1 CPC 15288, incomplete silicified cranidium, length 5.50 mm; Lily Creek, K204; x 8.

Fig. 2 CPC 15289, **holotype,** silicified cranidium, length 6.70 mm; Lily Creek, K204; approx. x 8.

Fig. 3 CPC 15290, incomplete silicified cranidium, estimated length 5.8 mm; Lily Creek, K204; x 8.

Fig. 4 CPC 15291, incomplete silicified cranidium; Lily Creek, K204; x 8.

Fig. 5 CPC 15291, as above, anterior aspect, x 8.

Fig. 6 CPC 15289, **holotype,** lateral view, x 8.

Fig. 7 CPC 15293, incomplete silicified cranidium, length 5.25 mm; Lily Creek, K204; x 8.5.

Fig. 8 CPC 15292, partly exfoliated librigena; Lily Creek, K205; x 8.

Fig. 9 CPC 15294, incomplete exfoliated cranidium preserved in limestone; Lily Creek, K208; x 12.

Fig. 10 CPC 15294, as above, lateral aspect, x 12.

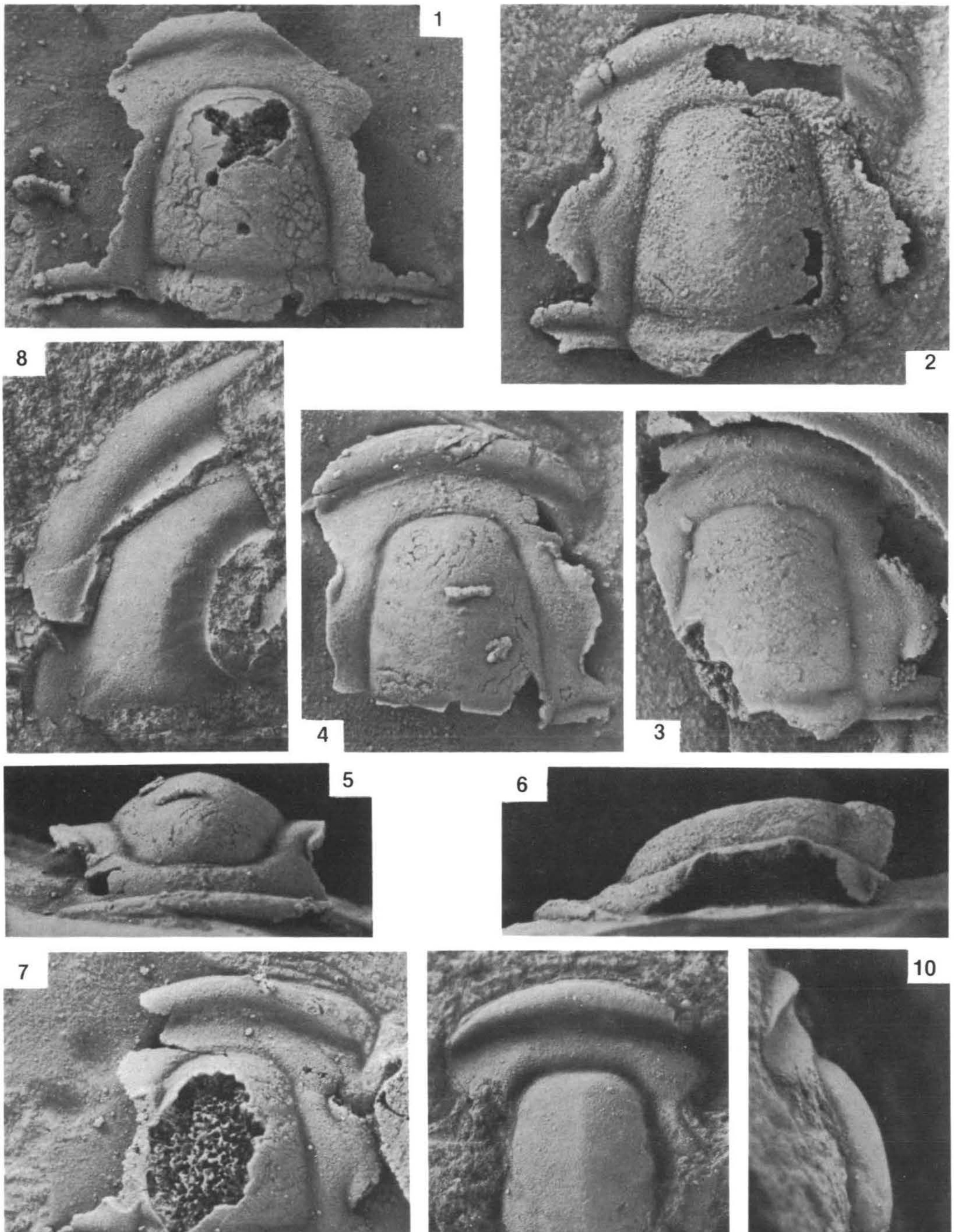

1
2
3
4
5
6
7
8
9
10

PLATE 17

Maladioidella doylei sp. nov.

(p. 52)

Fig. 1 CPC 15266a, **holotype,** partly exfoliated cranidium showing contrasting definition of ocular ridges on exoskeleton and parietal surface, length 12.30 mm; Lily Creek, B54a; x 4.

Fig. 2 CPC 15266b, latex replica of **holotype,** x 4.

Fig. 3 CPC 15268, exfoliated cranidium showing punctation, parietal morphology of glabella, and caecal system of preglabellar area, length 9.90 mm; Horse Creek, K215; x 4.

Fig. 4 CPC 15268, as above, lateral profile, x 4.

Fig. 5 CPC 15269, latex replica of parietal surface of cranidium, estimated length 12.1 mm; Lily Creek, K200 x 4.

Fig. 6 CPC 15270, incomplete exfoliated cranidium, estimated length 11.0 mm; Horse Creek, K222; x 4.

Fig. 7 CPC 15271, latex replica of cranidial parietal surface showing distribution of muscle scar impressions, estimated length 10.1 mm; Lily Creek, K200; x 8.

Fig. 8 CPC 15272, latex replica of librigenal parietal surface showing caeca and punctation; Lily Creek, K200; x4.

Fig. 9 CPC 15273, librigenal exoskeleton, showing terrace lines on genal spine; Horse Creek, K222; x 4.

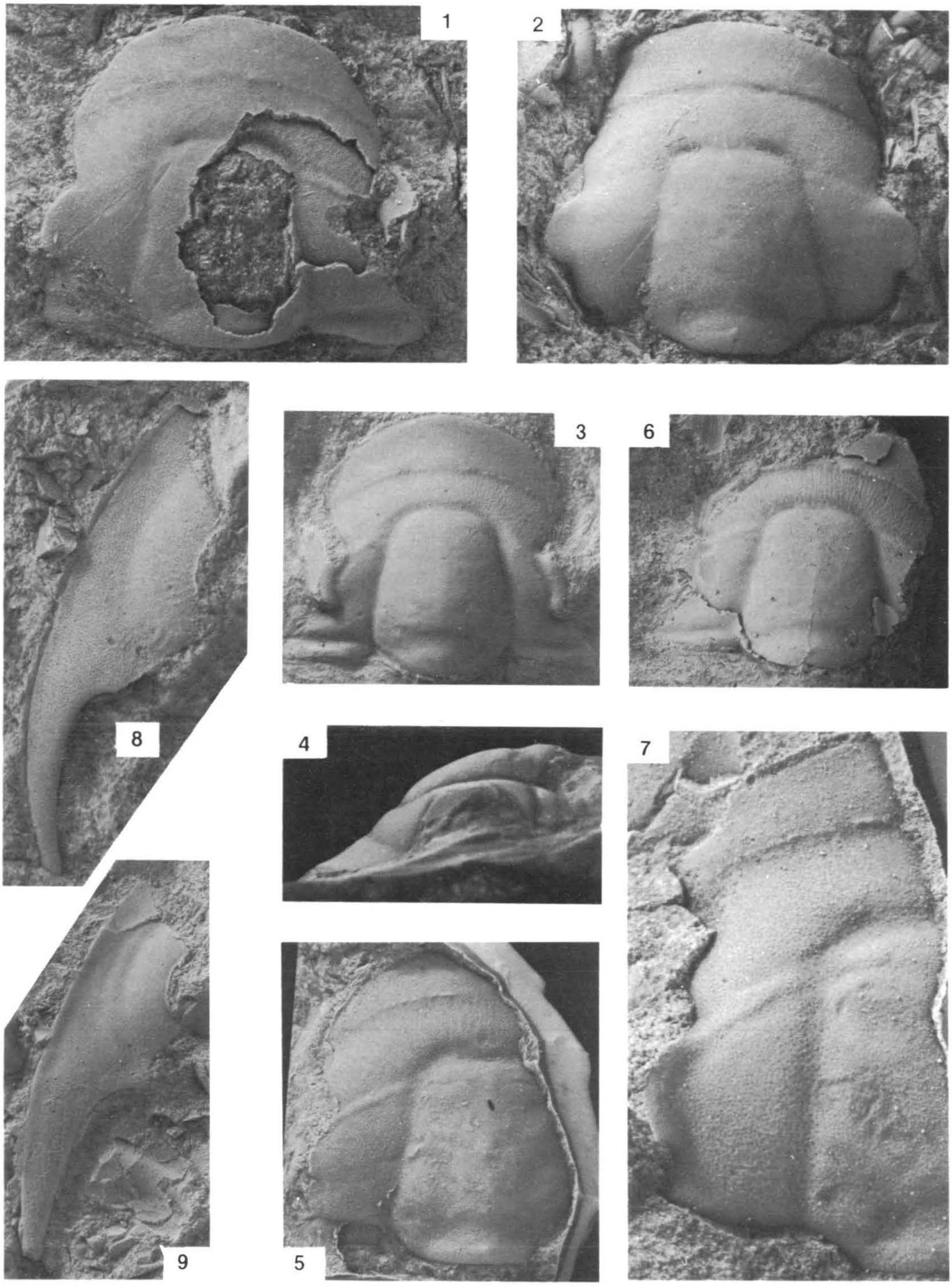

1
2
3
6
8
4
7
9
5

PLATE 18

Maladioidella doylei sp. nov.

(p. 52)

Fig. 1 CPC 15274, pygidial exoskeleton, length (Lp_2) 6.00 mm; Horse Creek, K225; x 4.

Fig. 2 CPC 15275, exfoliated pygidium, length (Lp_2) 3.70 mm; Horse Creek, K226; x 8.

Fig. 3 CPC 15276, incomplete partly exfoliated pygidium; Lily Creek, B54a; x 2.

Fig. 4 CPC 15277, incomplete partly exfoliated pygidium showing diverticula; Lily Creek, B54a; x 2.

Fig. 5 CPC 15278, incomplete partly exfoliated pygidium with estimated length (Lp_2) of 23.5 mm; Lily Creek, B54b; x 2.

Koldinioidia (Liriamnica) antyx subgen. et sp. nov.

(p. 65)

Fig. 6 CPC 15375, **holotype,** exfoliated cranidium showing glabellar pits, bacculae, and traces of an anterior cranidial border, length 2.20 mm; Lily Creek, K210; x 15.

Fig. 7 CPC 15374, exfoliated cranidium, length 2.50 mm; Lily Creek, K211; x 14.

Fig. 8 CPC 15375, **holotype,** lateral aspect, x 15.

Fig. 9 CPC 15377, cranidial fragment with traces of anterior broder, glabellar length 0.80 mm; Lily Creek, K208; x 24.

Fig. 10 CPC 15377, as above, lateral view, x 24.

Fig. 11 CPC 15376, exfoliated cranidium with anterior border, length 0.85 mm; Lily Creek, K208; x 20.

Fig. 12 CPC 15376, as above, lateral aspect, x 20.

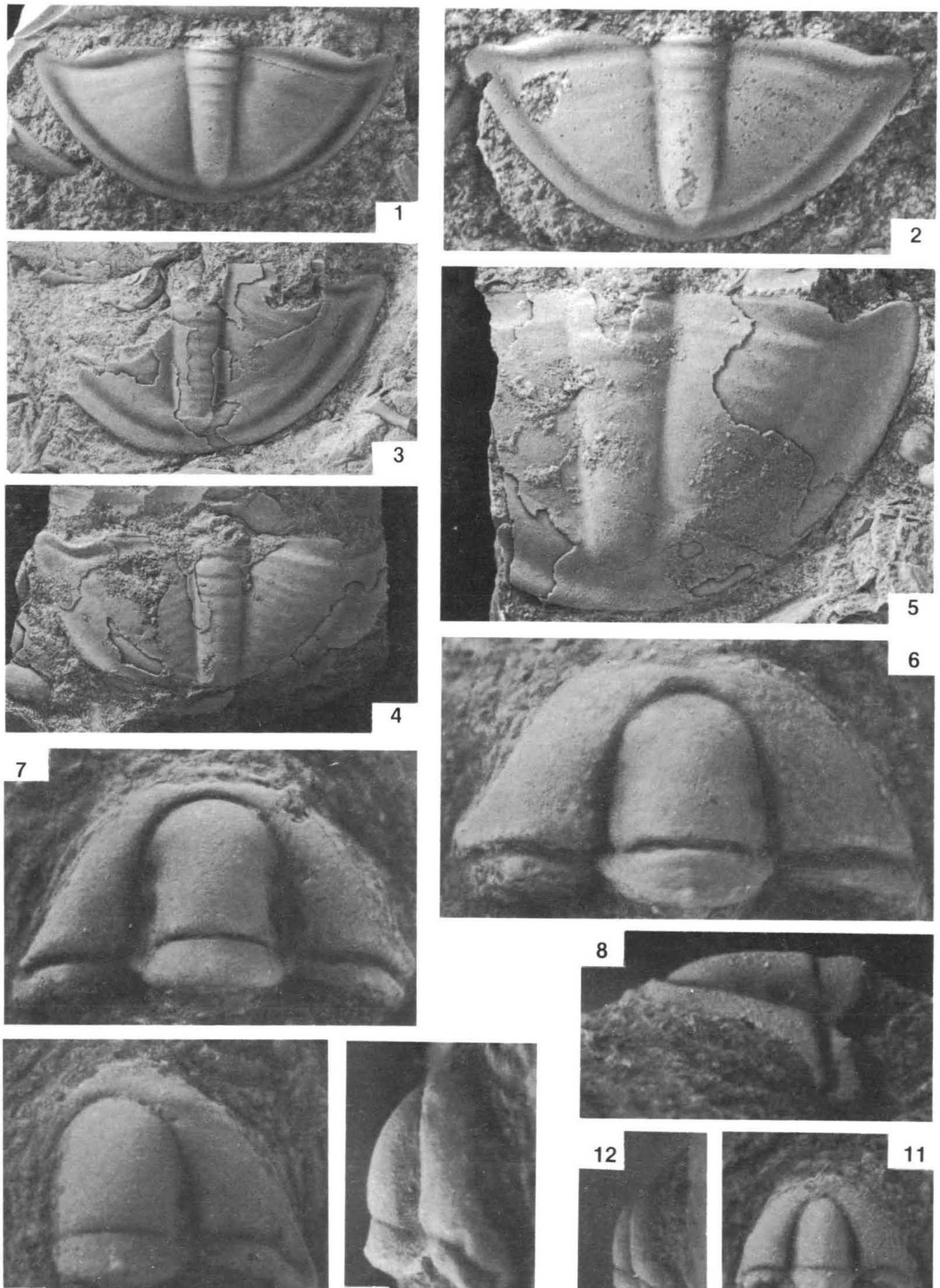

1
2
3
5
4
6
7
8
9
10
12
11

PLATE 19

Prosaukia sp. cf. *Prosaukia* sp. A? Shergold, 1975.

(p. 54)

Fig. 1 CPC 15385, latex replica of exfoliated cranidial fragment; Lily Creek, K214; x 8.

Fig. 2 CPC 15386, partly exfoliated cranidial fragment; Lily Creek, K212; x 4.

Fig. 3 CPC 15387, exfoliated librigenal fragment; Lily Creek, K211; x 8.

Fig. 4 CPC 15388, partly exfoliated pygidium, estimated length (Lp_2) 7.9 mm; Lily Creek, K214; x 4.

Taishania platyfrons sp. nov.

(p. 56)

Fig. 5 CPC 15379, latex replica of partly exfoliated pygidial fragment, estimated length (Lp_2) 4.0 mm; Lily Creek, B791a; x 10.

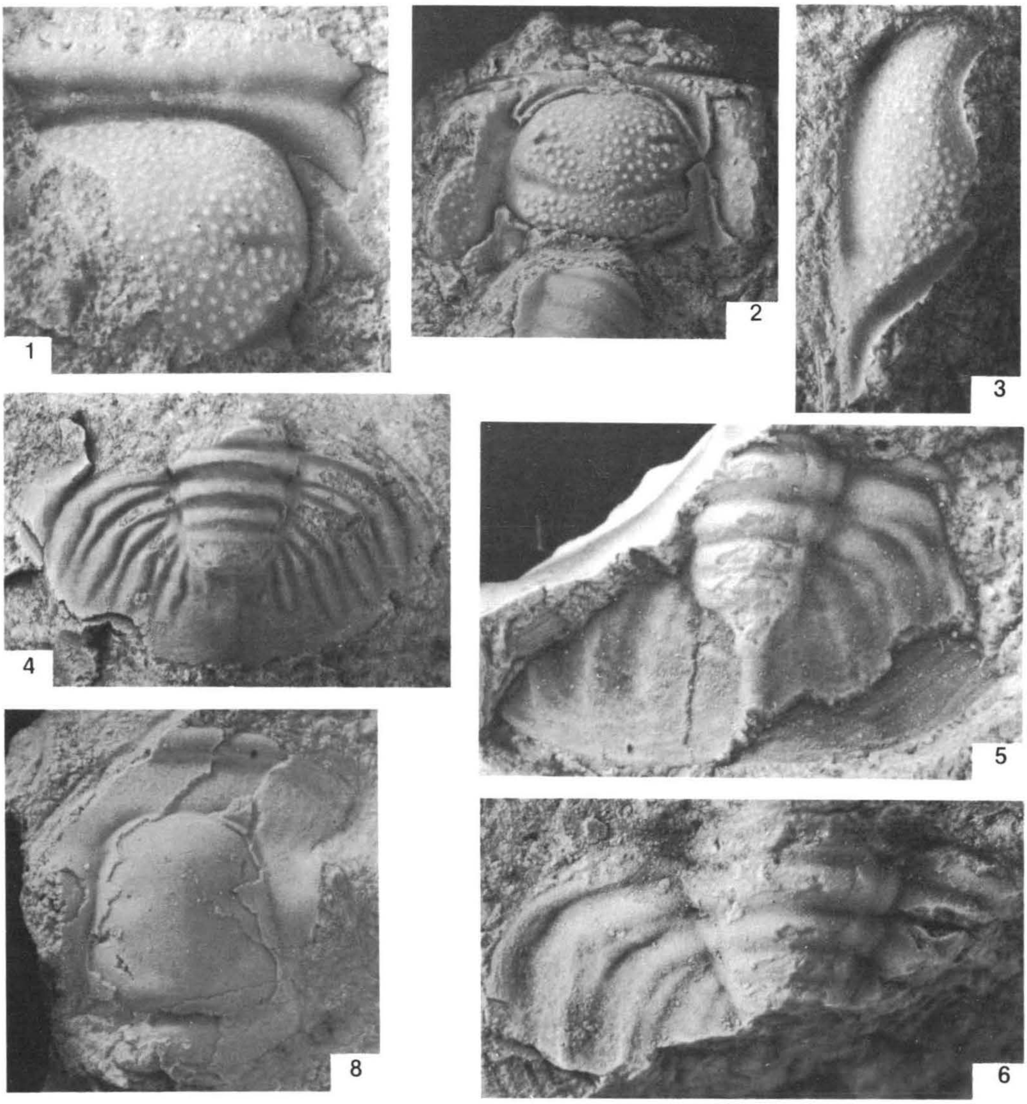
Fig. 6 CPC 15380, exfoliated pygidial fragment; Lily Creek, B791a; x 12.

Fig. 7 CPC 15381, latex replica of exfoliated pygidial fragment, estimated length (Lp_2) 4.3 mm; Lily Creek, B791a; x 8.

Fig. 8 CPC 15382, partly exfoliated cranidium, length 5.50 mm; Lily Creek, B791a; x 8.

Fig. 9 CPC 15383, incomplete exfoliated cranidium, length 7.20 mm; Lily Creek, B791a; x 8.

Fig. 10 CPC 15384, exfoliated cranidial fragment; Lily Creek, B50c; x 20.



1
2
3
4
5
8
6
9
10
7

PLATE 20

Plicatolina sp. aff. *P. yakutica* Pokrovskaya, 1966

(p. 58)

Fig. 1 CPC 15370, incomplete exfoliated cranidium, length 2.50 mm; Chatsworth Plains, D487; x 20.

Fig. 2 CPC 15371, latex replica of incomplete exfoliated pygidium; Horse Creek, K216; x 8.

Leptoplastus? sp. nov.

(p. 58)

Fig. 3 CPC 15372, exfoliated cranidial fragment, length 4.30 mm; Horse Creek, K216; x 11.

Fig. 4 CPC 15373, exfoliated cranidial fragment; Horse Creek, K216; x 4.

Onchonotellus sp. undet.

(p. 62)

Fig. 5 CPC 15378, partly exfoliated cranidium, estimated length 2.9 mm; Horse Creek, K217; x 12.

Fig. 6 CPC 15378, as above, anterior view, x 12.

Fig. 7 CPC 15378, as above, lateral aspect, x 12.

Guizhoucephalina? sp. undet.

(p. 66)

Fig. 8 CPC 15389, incomplete exfoliated cranidium; Chatsworth Plains, D124; x 12.

Hypostoma undet. 2

(p. 89)

Fig. 9 CPC 15393, incomplete exfoliated hypostoma, characteristically granulose; Lily Creek, B791a; x 12.

Hypostoma undet. 1

(p. 89)

Fig. 10 CPC 15394, hypostoma with Bertillon-pattern prosopon and prominent maculae; Horse Creek, K226; x 12.

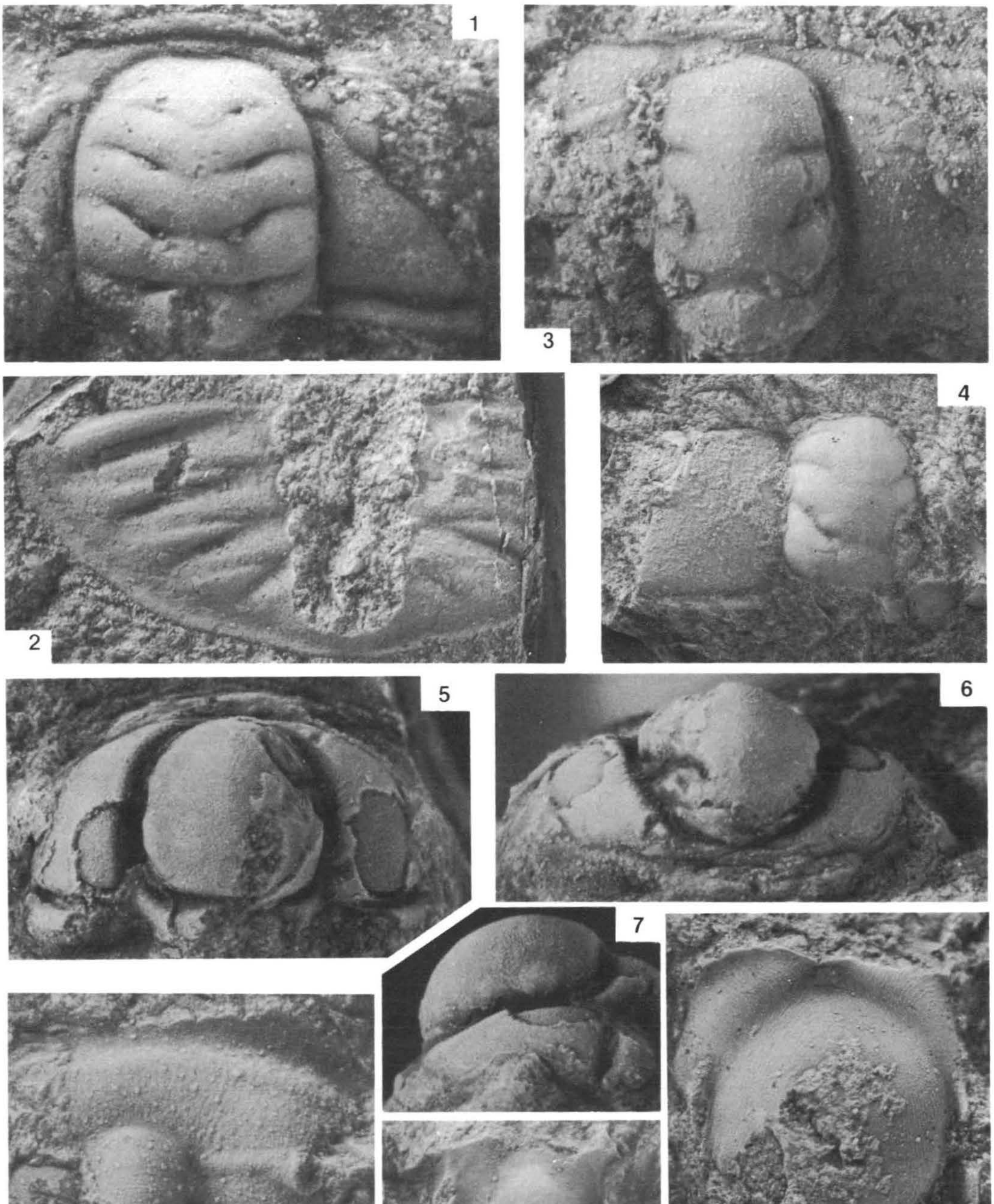

1
3
4
2
5
6
7
8
9
10

PLATE 21

Wentsuia iota sp. nov.

(p. 59)

Fig. 1 CPC 15308, exfoliated probable late meraspid cranidium, length 1.15 mm; Horse Creek, K225; x 38.

Fig. 2 CPC 15309, exfoliated early holaspid cranidium, length 2.00 mm; Horse Creek, K220; x 24.

Fig. 3 CPC 15310, exfoliated holaspid cranidium with traces of glabellar musculature and bacculae, length 2.50 mm; Horse Creek, K223; x 20.

Fig. 4 CPC 15311, **holotype**, lateral view of mostly exfoliated holaspid cranidium, length 3.30 mm; Horse Creek, K215; x 16..

Fig. 5 CPC 15311, **holotype,** dorsal aspect showing caecal network of preglabellar field and diverticulum associated with baccula to left of photograph; locality as above; x 16.

Fig. 6 CPC 15312, exfoliated holaspid cranidium, length 2.20 mm; Horse Creek, K215; x 20.

Fig. 7 CPC 15313, partly exfoliated holaspid cranidium, length 3.50 mm; Horse Creek, K222; x 12.

Fig. 8 CPC 15314, exfoliated holaspid cranidium, length 2.20 mm; Lily Creek, K201; x 20.

Fig. 9 CPC 15315, librigena; Horse Creek, K221; x 20.

Fig. 10 CPC 15316, finely granulose pygidial exoskeleton, length (Lp_2) 1.45 mm; Lily Creek, K201; x 21.

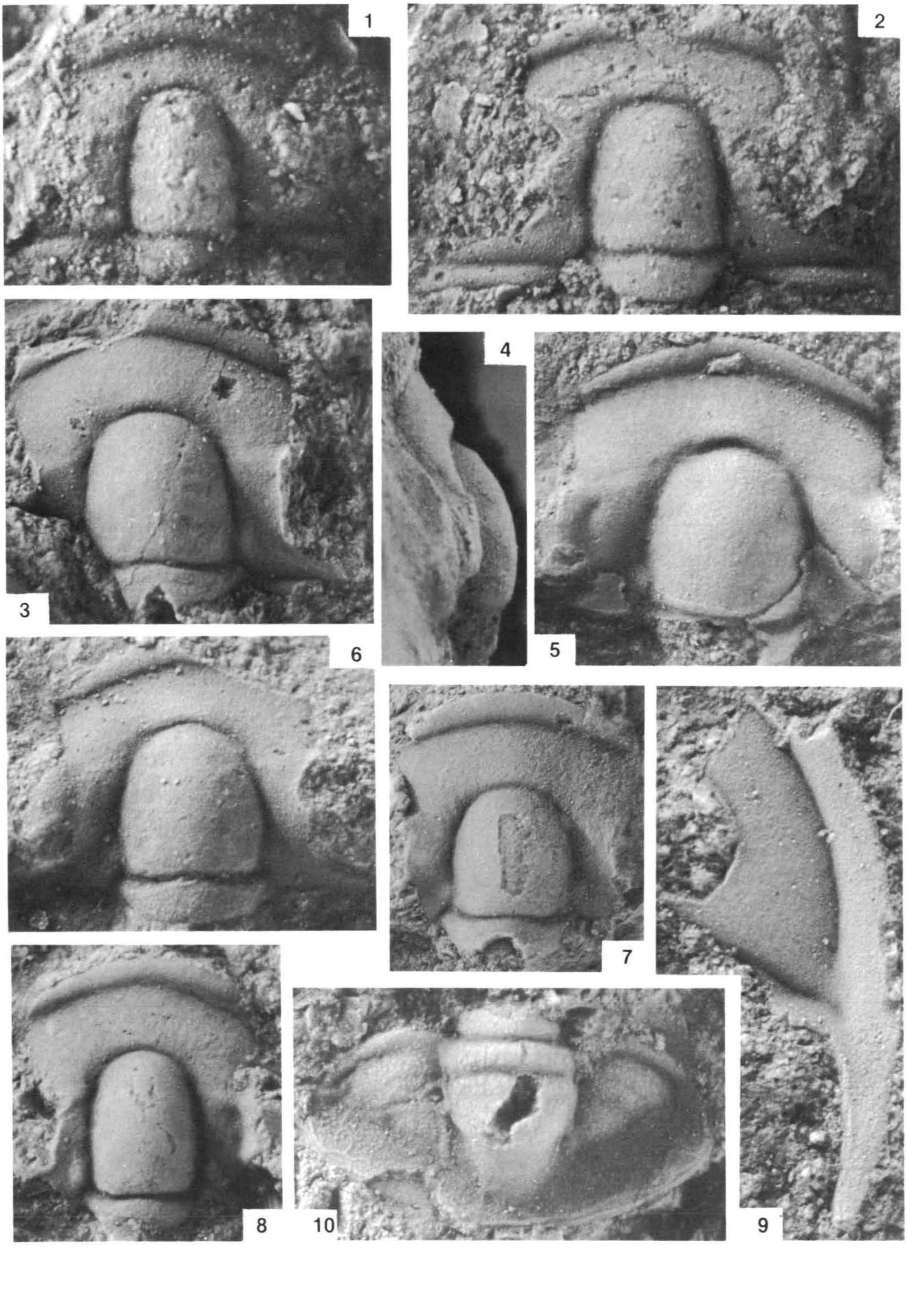

1
2
3
4
5
6
7
8
9
10

PLATE 22

Taenicephalites plerus sp. nov.

(p. 63)

Fig. 1 CPC 15300, **holotype**, exfoliated cranidium, length 3.10 mm; Horse Creek, K226; x 16.

Fig. 2 CPC 15301, cranidial exoskeleton, length 4.60 mm; Chatsworth Plains, D124; x 8.

Fig. 3 CPC 15302, latex replica of cranidial parietal surface, length 2.50 mm; Horse Creek, K223; x 20.

Fig. 4 CPC 15300, **holotype**, lateral aspect, x 16.

Fig. 5 CPC 15303, exfoliated cranidium, length 2.50 mm; Horse Creek, K224; x 20.

Fig. 6 CPC 15304, cranidial parietal surface illustrating punctation and glabellar musculature, estimated length 4.3 mm; Lily Creek, K200; x 12.

Fig. 7 CPC 15305, pygidial exoskeleton, length (Lp_2) 2.60 mm; Chatsworth Plains, D124; x 10.

Fig. 8 CPC 15306, pygidial exoskeleton, length (Lp_2) 2.30 mm; Lily Creek, B54a; x 8.

Fig. 9 CPC 15307, exfoliated pygidial fragment, length (Lp_2) 2.20 mm; Lily Creek, B790; x 15.

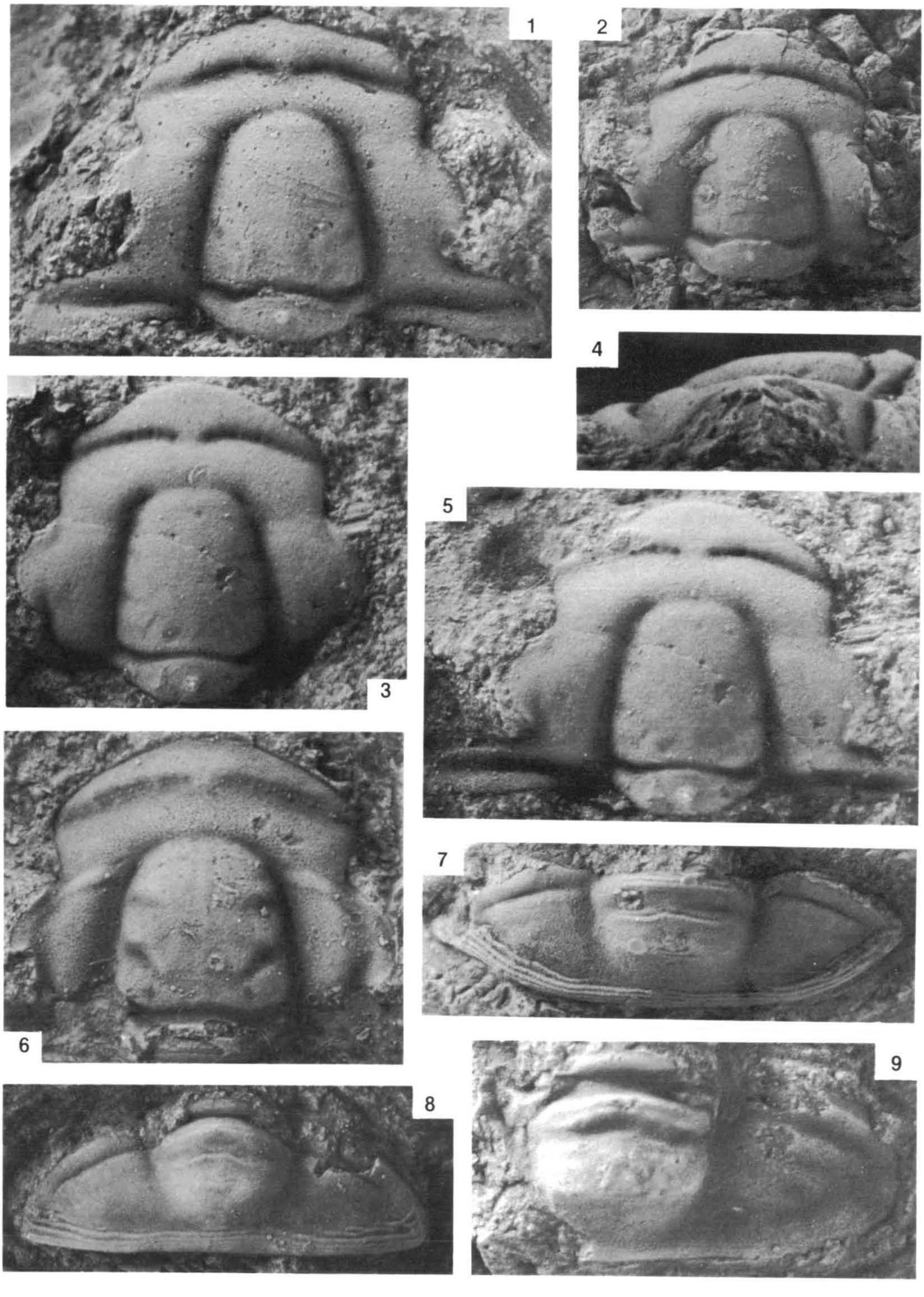


PLATE 23

Prochuangia glabella sp. nov.

(p. 67)

Fig. 1 CPC 15245, exfoliated librigena; Lily Creek, K200; x 12.

Fig. 2 CPC 15242, **holotype,** cranidial exoskeleton with effaced glabellar and occipital furrows, length 3.75 mm; Lily Creek, B54a; x 9.

Fig. 3 CPC 15243, incomplete exfoliated cranidium showing traces of glabellar musculature and ocular ridges, length 5.30 mm; Lily Creek, B790; x 9.

Fig. 4 CPC 15243, as above, lateral view, x 9.

Fig. 5 CPC 15244, latex replica of cranidial fragment showing morphology of anterior border; Lily Creek, K200; x 20.

Fig. 6 CPC 15248, pygidial exoskeleton, showing thickness of test, effaced pleural furrows, length (Lp_2) 2.90 mm; Lily Creek, B54b; x 6.

Fig. 7 CPC 15246, pygidial exoskeleton, estimated length 2.7 mm; Lily Creek, B54b; x 12.

Fig. 8 CPC 15247, pygidial exoskeleton, estimated length 2.8 mm; Lily Creek, B54b; x 8.

Lotosoides sp. cf. *L. calcarata* Shergold, 1975

(p. 71)

Fig. 9 CPC 15257a, incomplete exfoliated pygidium; Lily Creek, K212; x 8.

Fig. 10 CPC 15257b, latex replica from pygidial parietal surface; Lily Creek, K212; x 8.

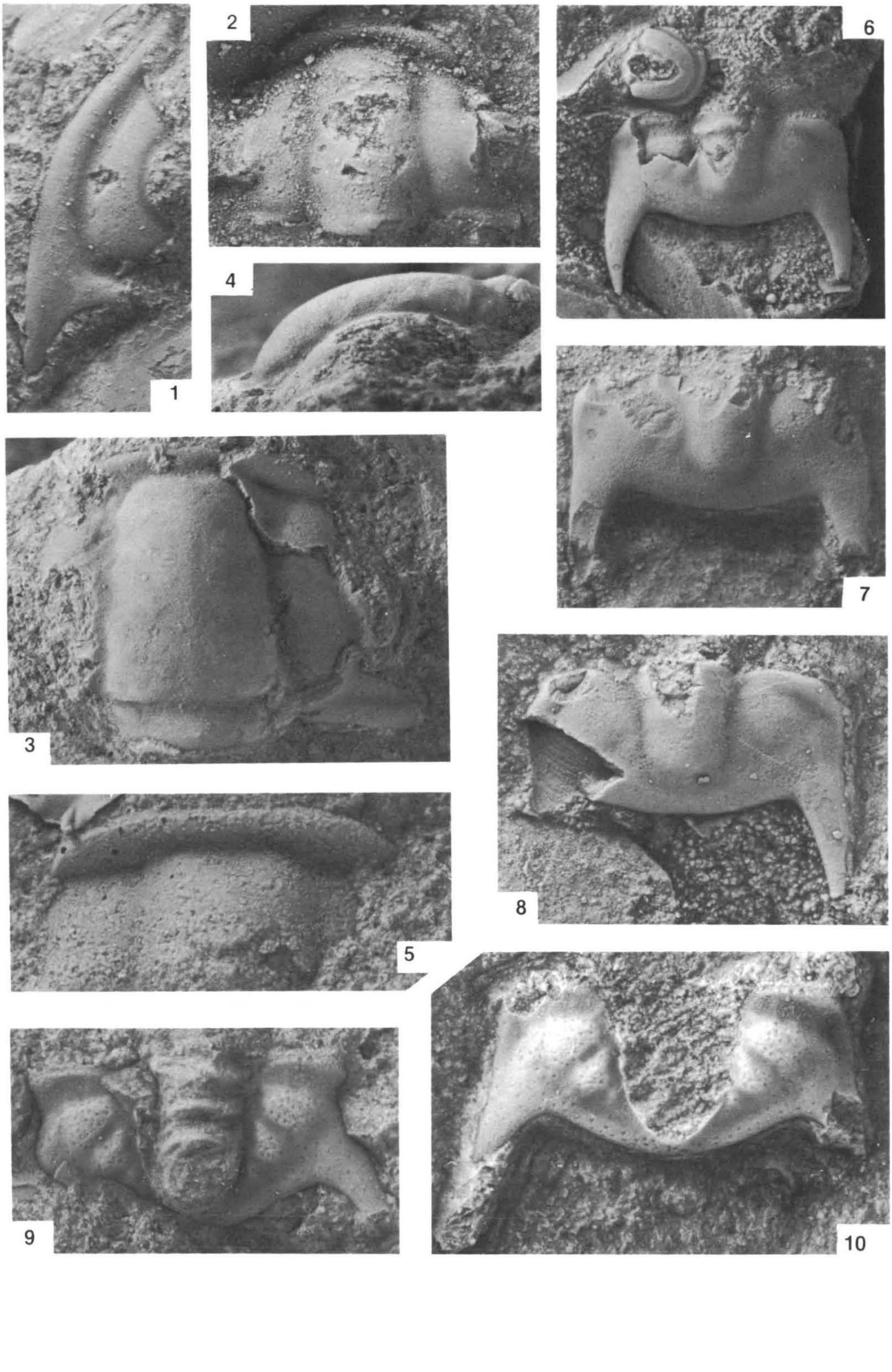

1
2
3
4
5
6
7
8
9
10

PLATE 24

Lotosoides sp. cf. *L. calcarata* Shergold, 1975

(p. 71)

Fig. 1 CPC 15256, incomplete partly exfoliated cranidium; Lily Creek, K212; x 8.

Lotosoides bathyora sp. nov.

(p. 70)

Fig. 2 CPC 15250, incomplete exfoliated cranidium; Lily Creek, K201; x 6.

Fig. 3 CPC 15249, mostly complete cranidial exoskeleton, estimated length 7.0 mm; Lily Creek, K201; x 5.

Fig. 4 CPC 15251, mostly complete late meraspid or early holaspid cranidium with bigranulose prosopon, length 2.45 mm; Horse Creek, K222; x 20.

Fig. 5 CPC 15252, librigenal fragment illustrating prosopon; Horse Creek, K222; x 20.

Fig. 6 CPC 15253, incomplete partly exfoliated pygidium, length (Lp_2) 1.65 mm; Lily Creek, K200; x 18.

Fig. 7 CPC 15254, exfoliated pygidium, length (Lp_2) 3.40 mm; Lily Creek, B54b; x 8.

Fig. 8 CPC 15255, **holotype,** pygidial exoskeleton, estimated length (Lp_2) 5.0 mm; Chatsworth Plains, D124; x 9.

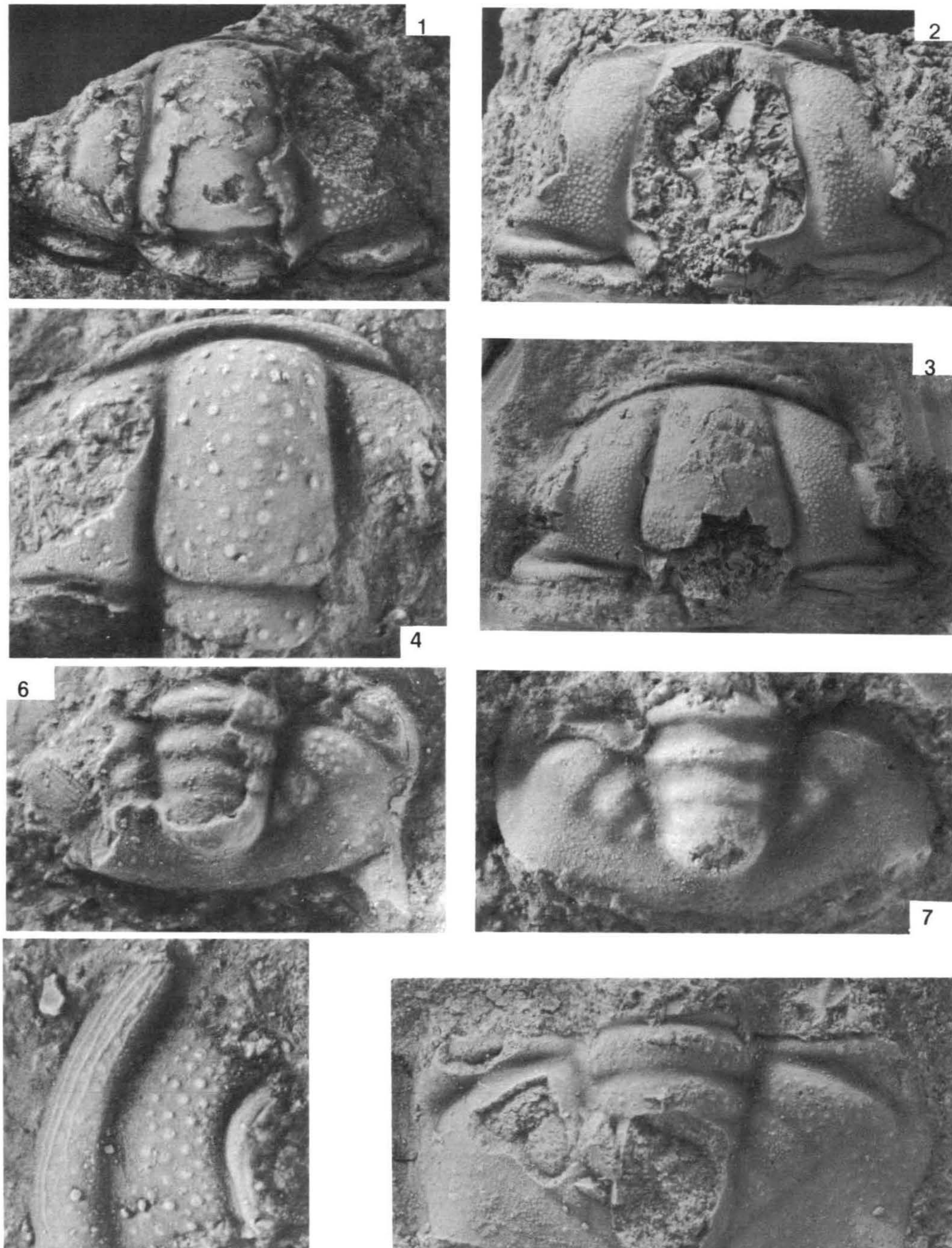


PLATE 25

Peichiashania prima sp. nov.

(p. 73)

Fig. 1 CPC 15204, enlargement of librigenal exoskeleton showing deflection of posterior marginal furrow and associated diverticulum passing into genal spine base; Lily Creek, K201; x 4.

Fig. 2 CPC 15205, **holotype,** cranidial exoskeleton with characteristic prosopon, length 4.90 mm; Lily Creek, K201; x 8.

Fig. 3 CPC 15206, incomplete partly exfoliated pygidium, estimated length (Lp_2) 6.1 mm; Horse Creek, K222; x 4.

Fig. 4 CPC 15207, exfoliated pygidial fragment, estimated length 10.5 mm; Chatsworth Plains, D124; x 3.

Fig. 5 CPC 15208, librigenal exoskeleton exhibiting prosopon; Lily Creek, K201; x 4.

Peichiashania secunda sp. nov.

(p. 74)

Fig. 6 CPC 15209, silicified cranidium, estimated length 13.9 mm; Lily Creek, K204; x 2.

Fig. 7 CPC 15210, silicified meraspid cranidial fragment, estimated length 1.9 mm; Lily Creek, B53; x 20.

Fig. 8 CPC 15211, fragment of silicified cranidial ventral surface; Lily Creek, K204; x 4.

Fig. 9 CPC 15212, ventral surface of silicified librigena illustrating extent of doublure and inclined facet at lateral leading edge; Lily Creek, B53; x 4.

Fig. 10 CPC 15213, cranidial fragment showing caecal structures associated with preocular area and preglabellar field; Lily Creek, K205; x 8.

Fig. 11 CPC 15214, **holotype,** exfoliated cranidium showing diverticula associated with the glabella and preglabellar field, length 14.40 mm; Lily Creek, K205; x 4.

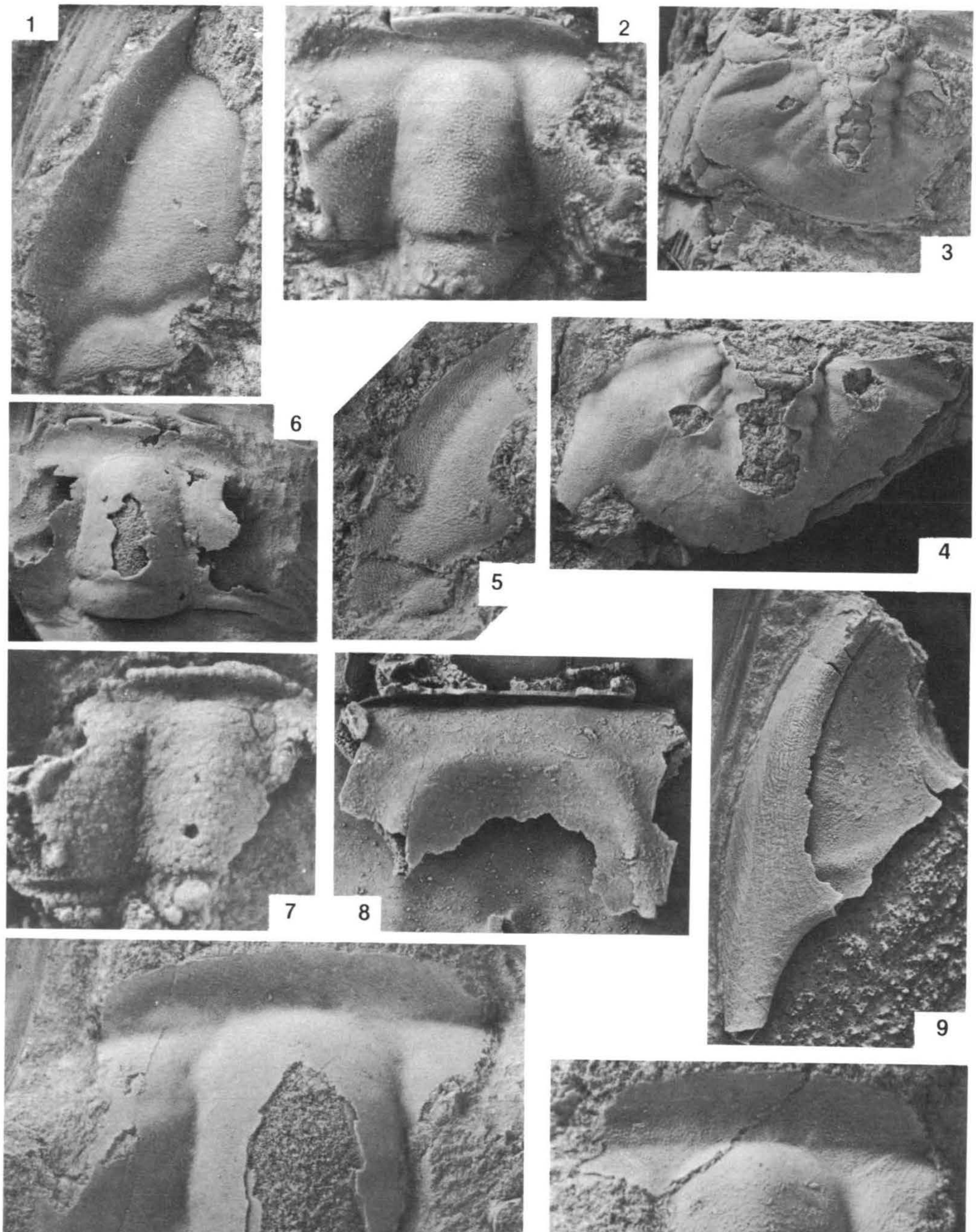

1
2
3
4
5
6
7
8
9
10
11

PLATE 26

Peichiashania secunda sp. nov.

(p. 74)

Fig. 1 CPC 15217, incomplete silicified pygidial exoskeleton; Lily Creek, K204; x 4.

Fig. 2 CPC 15216, latex replica of incomplete pygidial exoskeleton, estimated length (Lp_2) 11.1 mm; Lily Creek, K205; x 4.

Fig. 3 CPC 15215, exfoliated librigenal fragment showing caecal network; Lily Creek, K205; x 4.

Peichiashania tertia sp. nov.

(p. 76)

Fig. 4 CPC 15224, exfoliated incomplete pygidium showing extent of lateral spine and straight posterior margin; Lily Creek, K207; x 4.

Fig. 5 CPC 15226, exfoliated meraspid pygidium, length (Lp_2) 1.20 mm; Lily Creek, K208; x 16.

Fig. 6 CPC 15227, fragment of pygidial exoskeleton; Lily Creek, K208; x 8.

Fig. 7 CPC 15225, incomplete exfoliated pygidium; Lily Creek, K206; x 4.

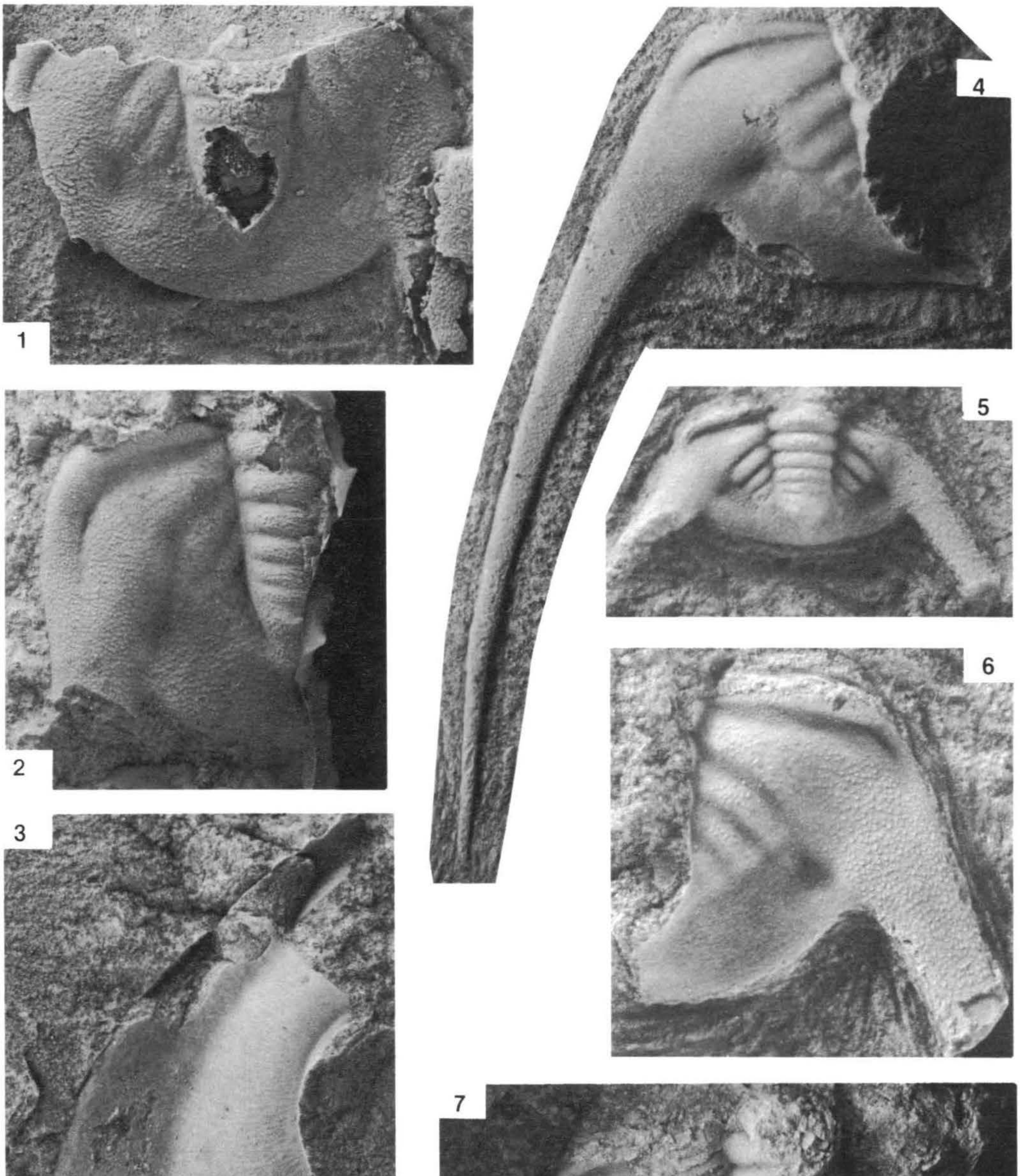

1
2
3
4
5
6
7

PLATE 27

Peichiashania tertia sp. nov.

(p. 76)

Fig. 1 CPC 15218a, **holotype,** cranidial exoskeleton exhibiting bacculae and prosopon, length 8.45 mm; Lily Creek, K206; x 4.

Fig. 2 CPC 15218a, **holotype,** lateral aspect, x 4.

Fig. 3 CPC 15218b, latex replica from external mould of **holotype,** as above, x 4.

Fig. 4 CPC 15221, incomplete late meraspid (?) exoskeleton showing wire-like cranidial border and cylindrical glabella, length 2.50 mm; Lily Creek, K208; x 17.

Fig. 5 CPC 15222, fragment of cranidial exoskeleton; Lily Creek, K208; x 12.

Fig. 6 CPC 15220, incomplete cranidial exoskeleton exhibiting bacculae and prosopon; Lily Creek, B52; x 12.

Fig. 7 CPC 15223, librigenal exoskeleton; Lily Creek, K208; x 16.

Peichiashania quarta sp. nov.

(p. 77)

Fig. 8 CPC 15232, ventral morphology of librigena showing extent of doublure and facet on lateral leading edge; Lily Creek, K210; x 3.

Fig. 9 CPC 15231, dorsal morphology of librigenal exoskeleton; Lily Creek, K209; x 2.

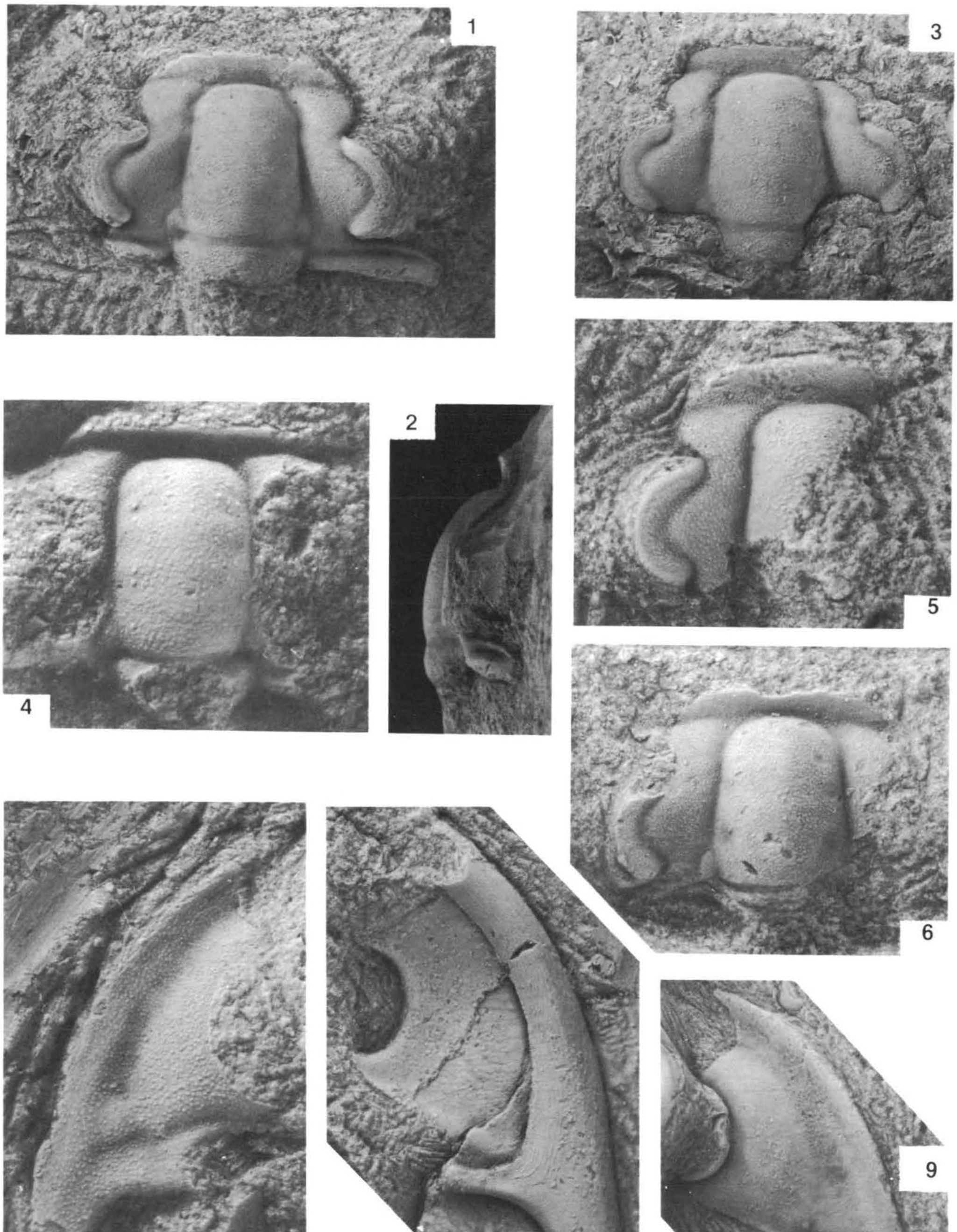

1
2
3
4
5
6
7
8
9

PLATE 28

Peichiashania quarta sp. nov.

(p. 77)

Fig. 1 CPC 15228, **holotype,** exfoliated cranidium showing diverticular structures associated with glabella, length 16.70 mm; Lily Creek, K209; x 2.

Fig. 2 CPC 15229, latex replica from exfoliated cranidial fragment showing caeca associated with the preglabellar field; Lily Creek, K210; x 3.

Fig. 3 CPC 15230b, latex replica of exfoliated cranidial fragment; Lily Creek, K210; x 3.

Fig. 4 CPC 15230a, partly exfoliated cranidium; Lily Creek, K210; x 3.

Fig. 5 CPC 15236, pygidial exoskeleton, length (Lp_2) 14.80 mm; Lily Creek, K209; x 2.

Fig. 6 CPC 15234, ventral morphology of pygidial exoskeleton; Lily Creek, K210; x 2.

Fig. 7 CPC 15235, pygidial exoskeleton, length (Lp_2) 10.35 mm; Lily Creek, K210; x 3.

Fig. 8 CPC 15233, partly exfoliated pygidium, length (Lp_2) 12.30 mm; Lily Creek, K210; x 2.

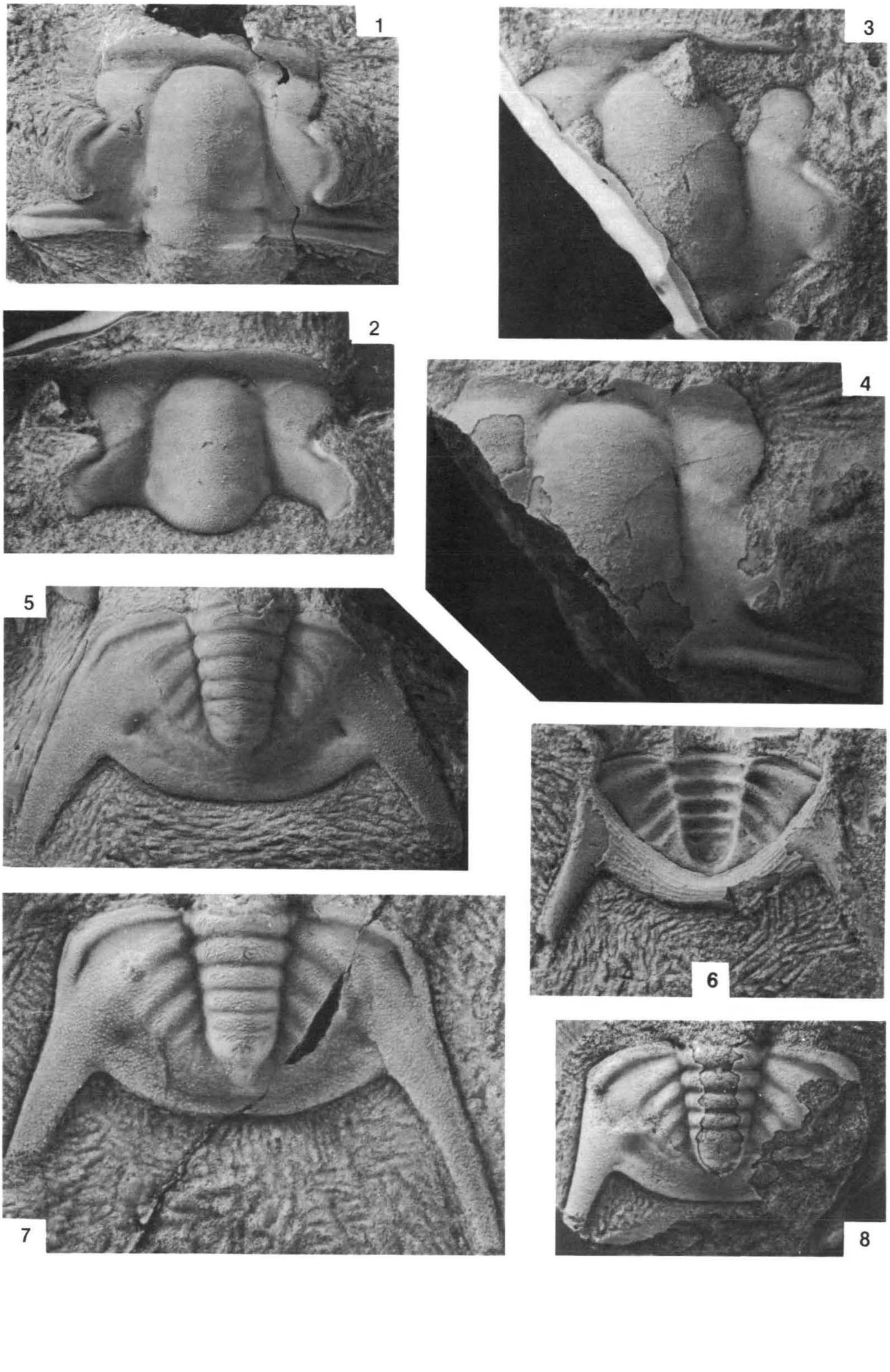

1
2
3
4
5
6
7
8

PLATE 29

Hapsidocare lilyensis sp. nov.

(p. 78)

Fig. 1 CPC 15237, **holotype,** cranidial exoskeleton showing prosopon, length 10.10 mm; Lily Creek, K212; x 6.

Fig. 2 CPC 15238, exfoliated cranidial fragment showing diverticula crossing preglabellar field; Lily Creek, K211; x 6.

Fig. 3 CPC 15395, exfoliated cranidial fragment; Lily Creek, K214; x 7.

Fig. 4 CPC 15239, librigenal exoskeleton; Lily Creek, K212; x 6.

Fig. 5 CPC 15241a, exfoliated pygidial fragment lacking spines, showing punctation, length (Lp_2) 3.00 mm; Lily Creek, K214; x 12.

Fig. 6 CPC 15241b, latex replica from exfoliated pygidial fragment, as above; x 12.

Fig. 7 CPC 15240, fragment of pygidial exoskeleton; Lily Creek, K212; x 6.

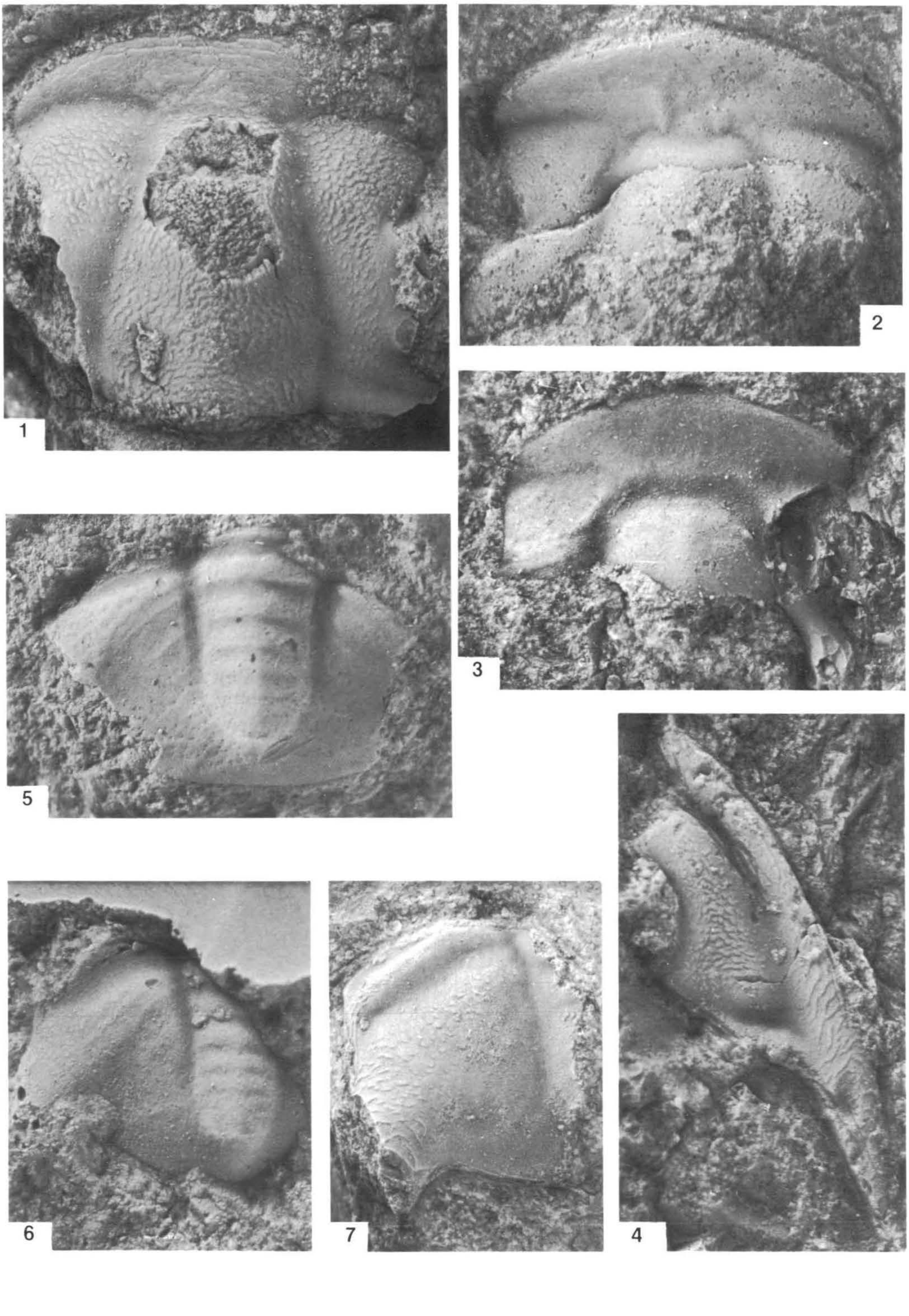

1
2
3
4
5
6
7

PLATE 30

Parakoldinioidia sp. aff. *P. bigranulosa* Shergold, 1975.

(p. 80)

Fig. 1 CPC 15261, latex replica of partly exfoliated cranidial fragment which illustrates the extent of the anterior cranidial border; Lily Creek, B791a; x 16.

Fig. 2 CPC 15258, cranidial exoskeleton, length 3.50 mm; Lily Creek, K201; x 12.

Fig. 3 CPC 15259, partly exfoliated cranidium; Lily Creek, B791a; x 12.

Fig. 4 CPC 15260, latex replica of exfoliated cranidial fragment well illustrating bigranulose prosopon; Lily Creek, B791a; x 20.

Fig. 5 CPC 15258, lateral aspect of cranidial exoskeleton showing adventrally directed cranidial border; Lily Creek, K201; x 12.

Fig. 6 CPC 15262b, latex replica of fragment of pygidial exoskeleton, estimated length (Lp_2) 2.6 mm; Lily Creek, B791a; x 18.

Fig. 7 CPC 15263, exfoliated pygidial fragment showing portion of lateral border; Lily Creek, B791a; x 12.

Fig. 8 CPC 15264, latex replica of exfoliated pygidial fragment, estimated length (Lp_2) 3.9 mm; Lily Creek, K214; x 11.

Fig. 9 CPC 15264, as above, lateral aspect, x 11.

Fig. 10 CPC 15265, latex replica of exfoliated pygidial fragment; Lily Creek, K214; x 15.

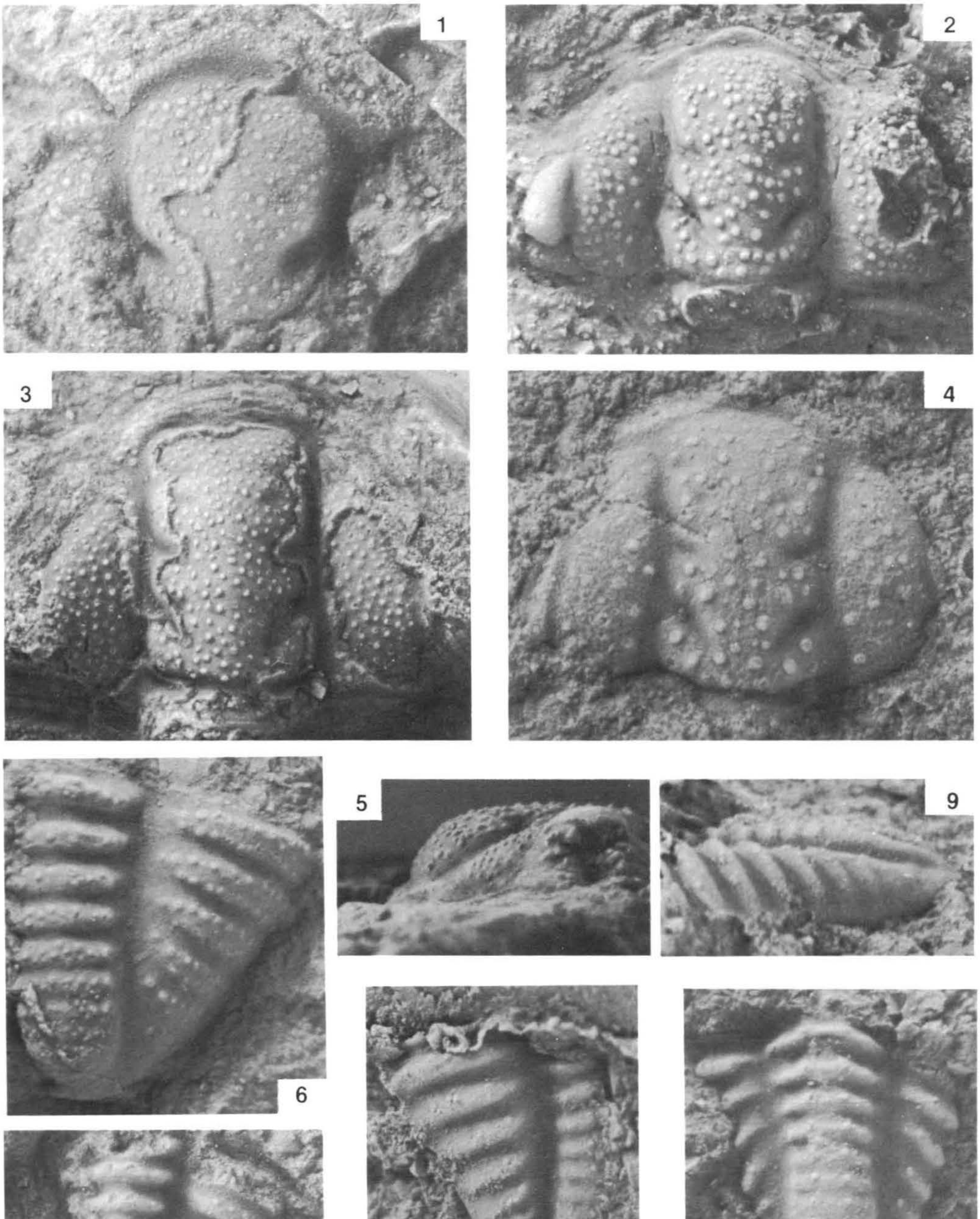

1
2
3
4
5
6
7
8
9
10

PLATE 31

Atopasaphus sp. cf. *A stenocanthus* Shergold, 1975

(p. 81)

Fig. 1 CPC 15363b, latex replica of fragment of cranidial parietal surface showing traces of muscle scar impressions and extent of preglabellar area; Lily Creek, K203; x 2.

Fig. 2 CPC 15365b, latex replica of pygidial exoskeleton, estimated length (Lp_2) 26.5 mm; Lily Creek, K203; x 2.

Fig. 3 CPC 15364, partly complete cranidium, estimated length 11.8 mm; Lily Creek, K203; x 4.

Fig. 4 CPC 15366, exfoliated pygidial fragment, extimated length (Lp_2) 18.5 mm; Chatsworth Plains, D124; x 3.

Fig. 5 CPC 15367, exfoliated pygidium, estimated length (Lp_2) 16.8 mm; Chatsworth Plains, D124; x 3.

Atopasaphus stenocanthus Shergold, 1975

(p. 81)

Fig. 6 CPC 15361, partly exfoliated cranidial fragment; Lily Creek, K211; x 6.

Fig. 7 CPC 15362, exfoliated pygidium, estimated length (Lp_2) 8.8 mm; Lily Creek, K210; x 4.

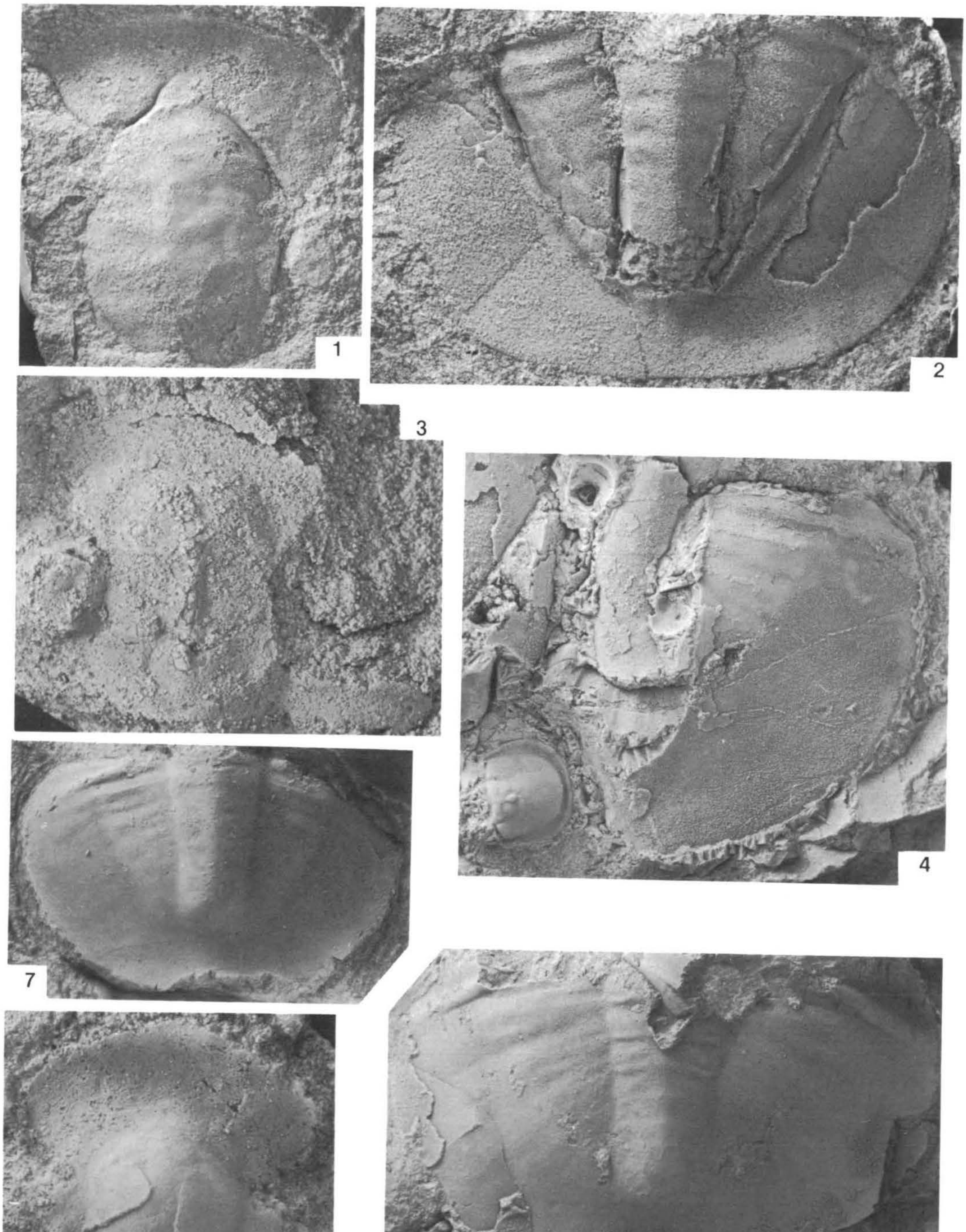

1
2
3
4
7
6
5

PLATE 32

Haniwoides varia sp. nov.

(p. 84)

Fig. 1 CPC 15327, exfoliated meraspid cranidium, length 1.15 mm; Horse Creek, K215; x 35.

Fig. 2 CPC 15328, early holaspid cranidial exoskeleton, length 2.40 mm; Horse Creek, K216; x 20.

Fig. 3 CPC 15329, exfoliated holaspid cranidium showing distribution of muscle scar impressions, length 4.40 mm; Horse Creek, K225; x 13.

Fig. 4 CPC 15330, exfoliated holaspid cranidium showing caecal morphology of preglabellar area, length 4.40 mm; Horse Creek, K225; x 12.

Fig. 5 CPC 15331, **holotype,** holaspid cranidial exoskeleton, length 5.40 mm; Lily Creek, B54b; x 8.

Fig. 6 CPC 15332, exfoliated holaspid cranidium showing caecal morphology of preglabellar area, length 6.90 mm; Chatsworth Plains, D373; x 8.

Fig. 7 CPC 15334, librigena broken to reveal extent of doublure; Lily Creek, K199; x 4.

Fig. 8 CPC 15333, late holaspid cranidial exoskeleton, length 16.45 mm; Horse Creek, K215; x 4.

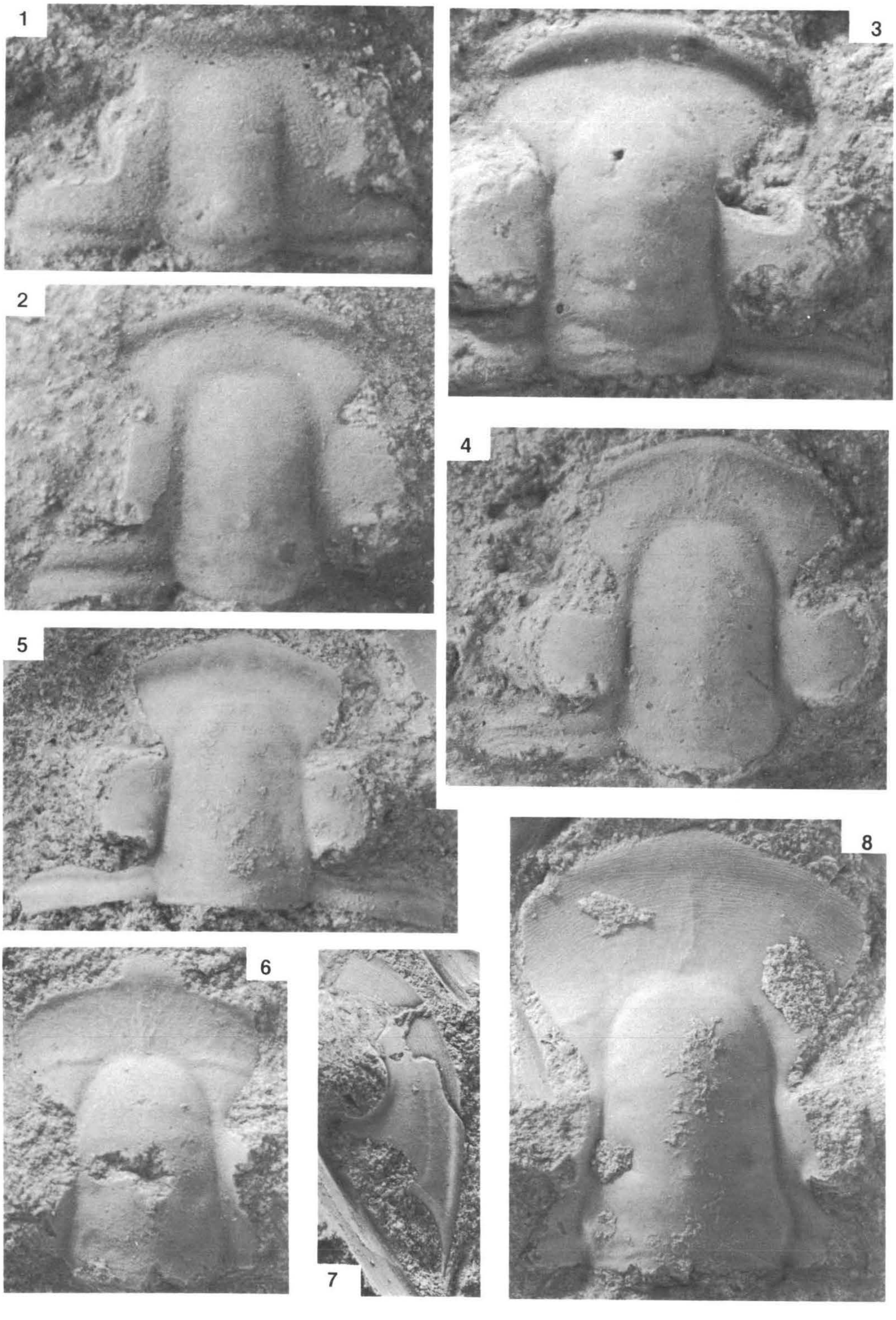

1
2
3
4
5
6
7
8

PLATE 33

Haniwoides varia sp. nov.

(p. 84)

Fig. 1 CPC 15335, meraspid pygidial exoskeleton with five unliberated thoracic segments; estimated length 0.9 mm; Horse Creek, K218; x 28.

Fig. 2 CPC 15336, meraspid pygidial exoskeleton with five unliberated thoracic segments; estimated length (Lp_2) 0.9 mm; Chatsworth Plains, D487; x 28.

Fig. 3 CPC 15337, meraspid pygidial exoskeleton with three unliberated thoracic segments; length (Lp_2) 1.20 mm; Horse Creek, K216; x 26.

Fig. 4 CPC 15341, exfoliated meraspid pygidium with two unleberated thoracic segments; length (Lp_2) 1.30 mm; Horse Creek, k225; x 21.

Fig. 5 CPC 15339, meraspid pygidial exoskeleton with three unliberated thoracic segments; length (Lp_2) 1.20 mm; Horse Creek, K216; x 16.

Fig. 6 CPC 15338, incomplete exfoliated meraspid pygidium with three unliberated thoracic segments; estimated length (Lp_2) 1.1 mm; Horse Creek, K216; x 24.

Fig. 7 CPC 15342, merapid pygidial exoskeleton with a single unliberated thoracic segment; estimated length (Lp_2) 1.15 mm; Horse Creek, K216; x 26.

Fig. 8 CPC 15343, early holaspid pygidial exoskeleton, length (Lp_2) 1.85 mm; Chatsworth Plains, D489; x 16.

Fig. 9 CPC 15344, exfoliated holaspid pygidium, length (Lp_2) 1.70 mm; Horse Creek, K225; x 15.

Fig. 10 CPC 15345, broken pygidium showing extent of doublure and exoskeletal prosopon, length (Lp_2) 3.60 mm; Horse Creek, K215; x 9.

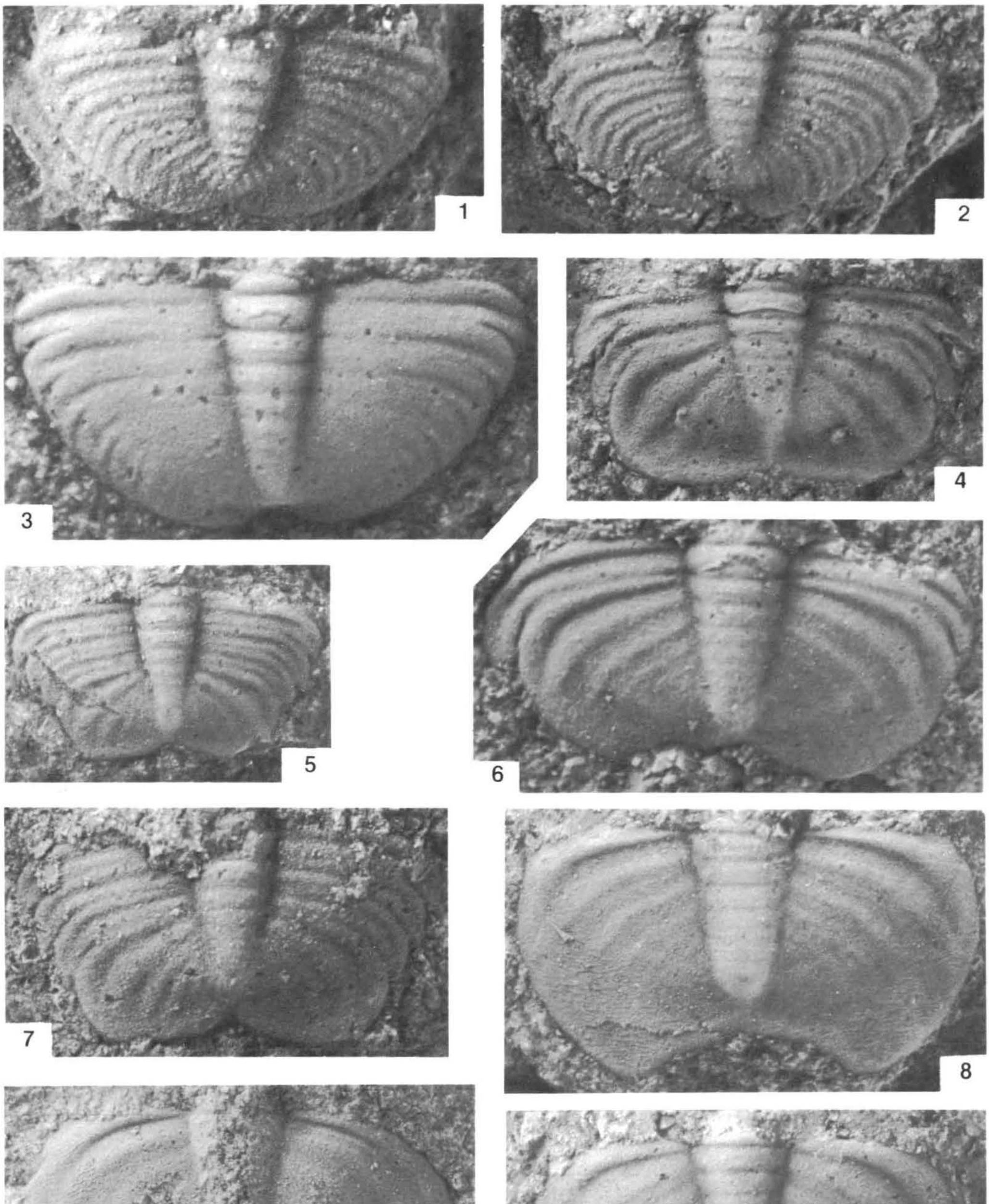

1
2
3
4
5
6
7
8
10
9

PLATE 34

Norinia? sp. undet.

(p. 83)

Fig. 1 CPC 15346, incomplete partly exfoliated cranidial exoskeleton, length 4.40 mm; Chatsworth Plains, D487; x 8.

Fig. 2 CPC 15346, as above, lateral profile, x 8.

Cermatops vieta gen. et sp. nov.

(p. 87)

Fig. 3 CPC 15347a, **holotype,** exfoliated cranidial fragment showing position of glabellar node, palpebral lobes and glabellar muscle scar impressions, length (Gn) 23.50 mm; Lily Creek, K199; x 2.

Fig. 4 CPC 15350, exfoliated librigena showing characteristic border morphology; Lily Creek, B54b; x 2.5.

Fig. 5 CPC 15348b, latex replica of partly exfoliated cranidial fragment showing morphology of preglabellar area; Horse Creek, K216; x 4.

Fig. 6 CPC 15347b, **holotype,** latex replica of exfoliated cranidial fragment, counterpart to fig. 3; x 2.

Fig. 7 CPC 15349, fragment of cranidial exoskeleton; Horse Creek, K223; x 2.

Fig. 8 CPC 15352, fragment of pygidial exoskeleton, estimated length 9.2 mm; Lily Creek, K199; x 4.

Fig. 9 CPC 15353, fragment of pygidial exoskeleton showing characteristic prosopon, length (Lp_2) 7.30 mm; Lily Creek, B790; x 6.

Fig. 10 CPC 15354, latex replica of pygidial exoskeleton, length (Lp_2) 10.00 mm; Lily Creek, B54b; x 4.

Fig. 11 CPC 15351, pygidial exoskeleton, length (Lp_2) 3.50 mm; Lily Creek, K203; x 8.

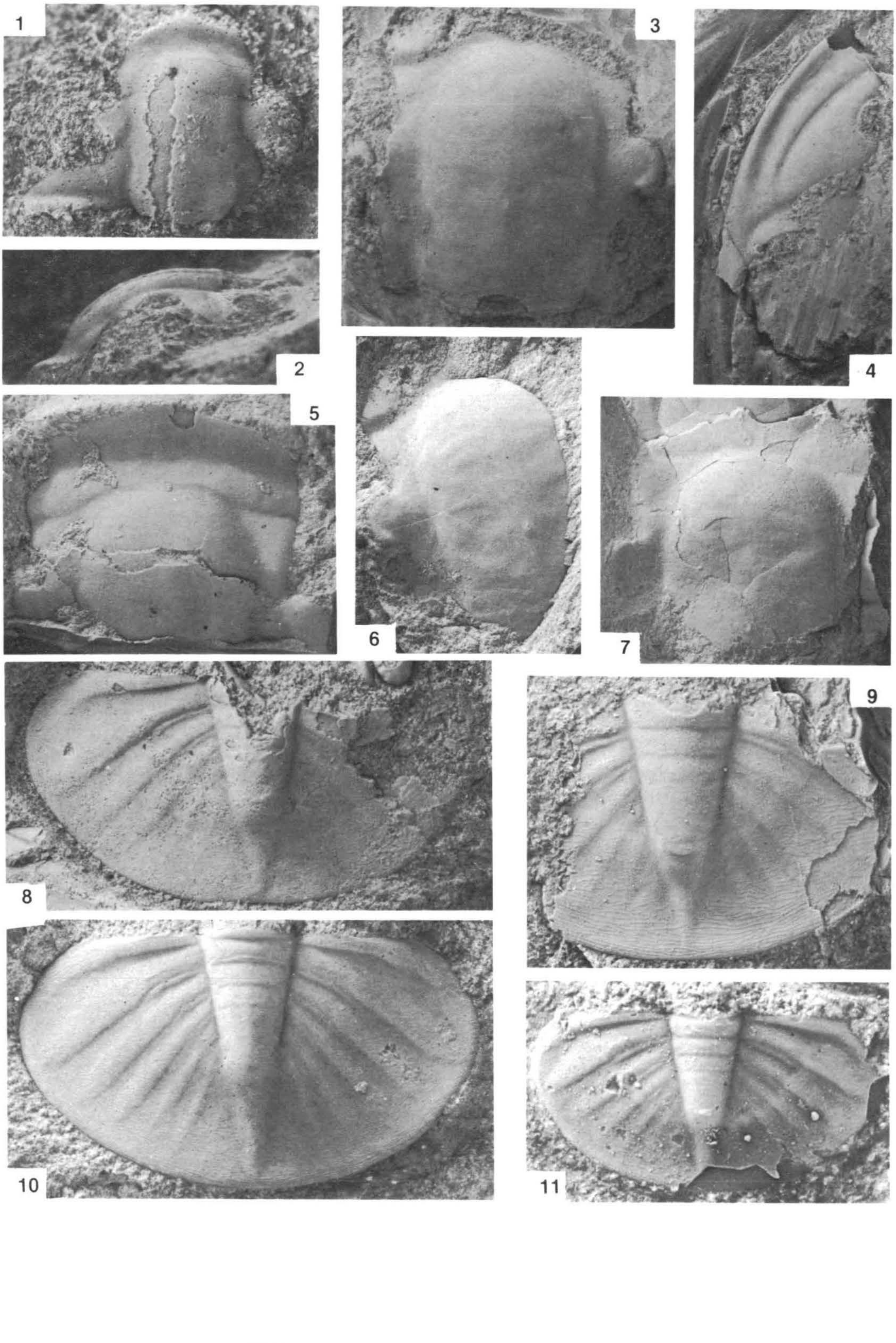

1
2
3
4
5
6
7
8
9
10
11

PLATE 35

Cermatops sp. undet.

(p. 88)

Fig. 1 CPC 15355, pygidial exoskeleton, length (Lp_2) 2.90 mm; Horse Creek, K225; x 13.

Fig. 2 CPC 15359, incomplete pygidial exoskeleton, length (Lp_2) 9.90 mm; Lily Creek, B54a; x 4.

Fig. 3 CPC 15358, latex replica of exfoliated pygidium, length (Lp_2) 4.60 mm; Lily Creek, K199; x 8.

Fig. 4 CPC 15357, pygidial exoskeleton, length (Lp_2) 3.80 mm; Horse Creek, K225; x 8.

Fig. 5 CPC 15356, exfoliated pygidium, length (Lp_2) 3.00 mm; Horse Creek, K217; x 12.

Genus et species undet. A

(p. 88)

Fig. 6 CPC 15360, partly exfoliated pygidium with lateral spine; Lily Creek, K199; x 4.

Eugonocare? sp. undet.

(p. 61)

Fig. 7 CPC 15396, exfoliated pygidium, length (Lp_2) 1.40 mm; Chatsworth Plains, D373; x 14.5.

Atopasaphus sp. undet

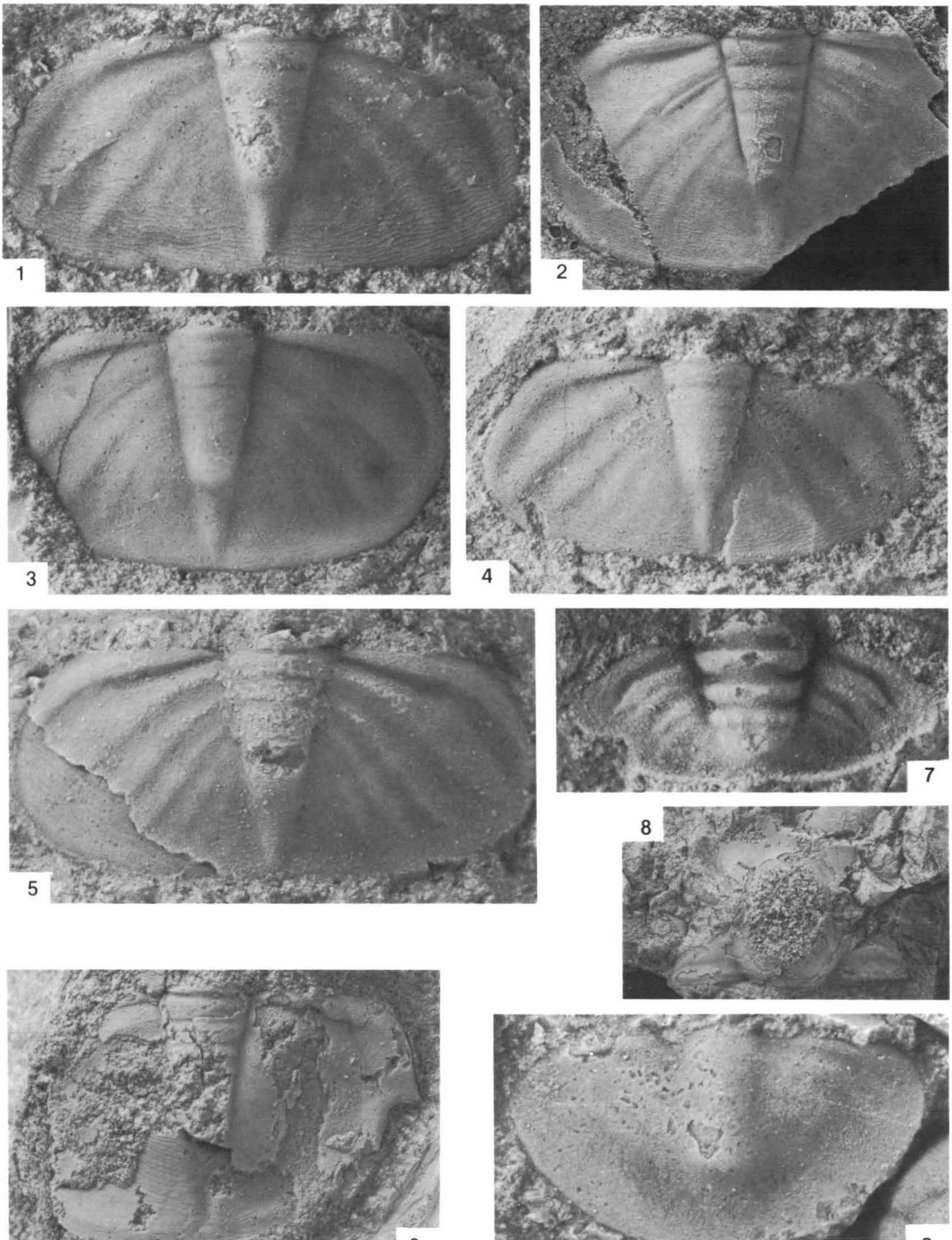
(p. 82)

Fig. 8 CPC 15369, partly exfoliated cranidium, estimated length 29.4 mm; Horse Creek, K215; x 1.

Atopasaphus sp. cf. *A. stenocanthus* Shergold, 1975

(p. 81)

Fig. 9 CPC 15368, early holaspid pygidial exoskeleton, length (Lp_2) 2.00 mm; Lily Creek, K200; x 16.5.


1
2
3
4
5
7
8
6
9