The Pacoota Sandstone, Amadeus Basin, Northern Territory: stratigraphy and palaeontology

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J. H. Shergold (Compiler)

DEPARTMENT OF PRIMARY INDUSTRIES AND ENERGY
BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS

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Cover:
Aerial view to the east of the Pacoota Sandstone and immediately underlying "upper" Goyder Formation at the western closure of the Fergusson Syncline as exposed in Ross River Gorge. At the right hand side of the photograph is locality AS 315 (see text), Joklik's "east bank" locality, which yielded the first Amadeus Basin trilobites in 1951.

Photograph courtesy of R. J. Korsch (BMR)

Frontispiece:
Aerial view of the western MacDonnell Ranges between Ellery Creek and Glen Helen. The Pacoota Sandstone and other formations of the Larapinta Group occupies the central portion of the photograph; the late Proterozoic/ Early Cambrian Arumbera Sandstone forms the range in the foreground parallel to the Alice Springs–Glen Helen road; and the Mereenie Sandstone and formations of the Pertnjara Group from the ranges in the background.

Photograph courtesy of R. J. Korsch (BMR)

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PREFACE

The Pacoota Sandstone is a thick siliciclastic formation of Cambrian–Ordovician age, which crops out extensively in the Amadeus Basin, N.T. It contains important commercial hydrocarbon resources: gas and condensate are produced at the Palm Valley Gas Field, and oil at the Mereenie Oil Field. Until the research reported here, however, no satisfactory correlation between the detailed subsurface and outcrop observations had been made, so that a full resource evaluation of the formation was lacking. Furthermore, the age of the formation was also only known in general terms.

This bulletin represents the results of combined investigations by officers of the Bureau of Mineral Resources Amadeus Basin Project, Northern Territory Geological Survey, and Pancontinental Oil Company Pty. Ltd. between 1983–1988. Following detailed analysis of the trilobite biostratigraphy of the Pacoota Sandstone, it has been found possible to recognise four stratigraphic sequences within it, and there is now a possibility to correlate these from surface outcrop to well sections, which lack biostratigraphical control but are geophysically defined. Thereby, the basis for wide-ranging correlation of the lithofacies mosaics, which comprise the Pacoota Sandstone, is established.

The basic databank containing locality, lithological and palaeontological information is provided in the last section of this three-part publication.

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1. Bureau of Mineral Resources, Geology and Geophysics
G P O Box 378
CANBERRA ACT 2601

2. John D. Gorter Pty Ltd
P O Box 572
EPPING NSW 2121

3. Northern Territory Geological Survey
P O Box 2901
DARWIN NT 5794

4. Unknown

Stratigraphy of the Pacoota Sandstone (Cambrian–Ordovician), Amadeus Basin, N.T.

by

J.H. Shergold, J.D. Gorter, Robert S. Nicoll,
& P.W. Haines

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ABSTRACT

The Pacoota Sandstone is a thick (up to 850 m) deposit of siliciclastic rocks straddling the Cambrian–Ordovician boundary in the Amadeus Basin of central Australia. It is economically the most important hydrocarbon reservoir of the basin, contains a potentially significant reserve of phosphorite, and may be an important aquifer. The internal stratigraphy of the Pacoota Sandstone, not previously documented in detail on a basin-wide scale, is based here on a sequence of four informally defined sedimentary packages, separated by unconformity or disconformity. The age and stratigraphic distribution of these sequences is measured against a preliminary and equally informal biostratigraphic scheme, which involves body-fossil and ichnofossil assemblages. Although a late Cambrian–early Ordovician age has long been known, it is now possible to date the sequences, at least to stage-level of resolution. Sequence 1, characterised by channel-fill sediments at several localities, is Payntonian to early Datsonian (latest Cambrian). It overlies earlier Upper Cambrian (Mindyallan) formations with regional unconformity, and it, in turn, is overlain unconformably by Sequence 2. The latter is a tidal and storm-dominated sequence with concentrations of the *Skolithos* ichnocoenosis, but lacking age-diagnostic body fossils. It is separated by a further major unconformity from Sequence 3, comprising predominantly phosphatic and glauconitic clastic sediments of latest Warendian (late Tremadoc) age, which thus indirectly date Sequence 2 also. Sequence 4, which may be disconformable, at least in part on Sequence 3, again has storm and tidally dominated sandstones rich in ichnofossils, but impoverished in body fossils. The limited fauna that does occur dates this sequence at the Tremadoc/Arenig transition. The Pacoota Sandstone is in places unconformably overlain by the Horn Valley Siltstone, of early Arenig age.

INTRODUCTION

The Pacoota Sandstone is a formation of dominantly quartzose rocks, which forms the base of the Larapinta Group (Prichard & Quinlan, 1962) in the northern half of the Amadeus Basin. It extends over 700 km across the basin from Lake Hopkins in the west to Illogwa Creek in the east (Fig. 1), and underlies an estimated 25 000 km^2. The present southern and western limits of the Pacoota Sandstone equate closely with the margins of the Pacoota depositional basin, but the northern and eastern limits are erosional. The thinnest sequences (20 m) occur in the Lake Amadeus area and southeast of Mount Rennie (62 m) in the northwest. The most completely developed sections of Pacoota Sandstone are in the centre of the basin in a quadrangle defined by Mereenie Bluff, the Gardiner Range, the western James Ranges and Ellery Creek, where a maximum thickness of approximately 850 m occurs. However, the major depocentre appears to have existed in the northeast of the basin, where some 850 m of Pacoota Sandstone has been measured (see type-section, Fig. 2); but where the formation is incomplete, an unknown thickness of beds has been removed from the top of the Pacoota Sandstone by Rodingan diastrophism-caused erosion (Ordovician/pre-Middle Devonian) (see Wells & others, 1970; Kennard & others, 1986; Shergold, 1986).

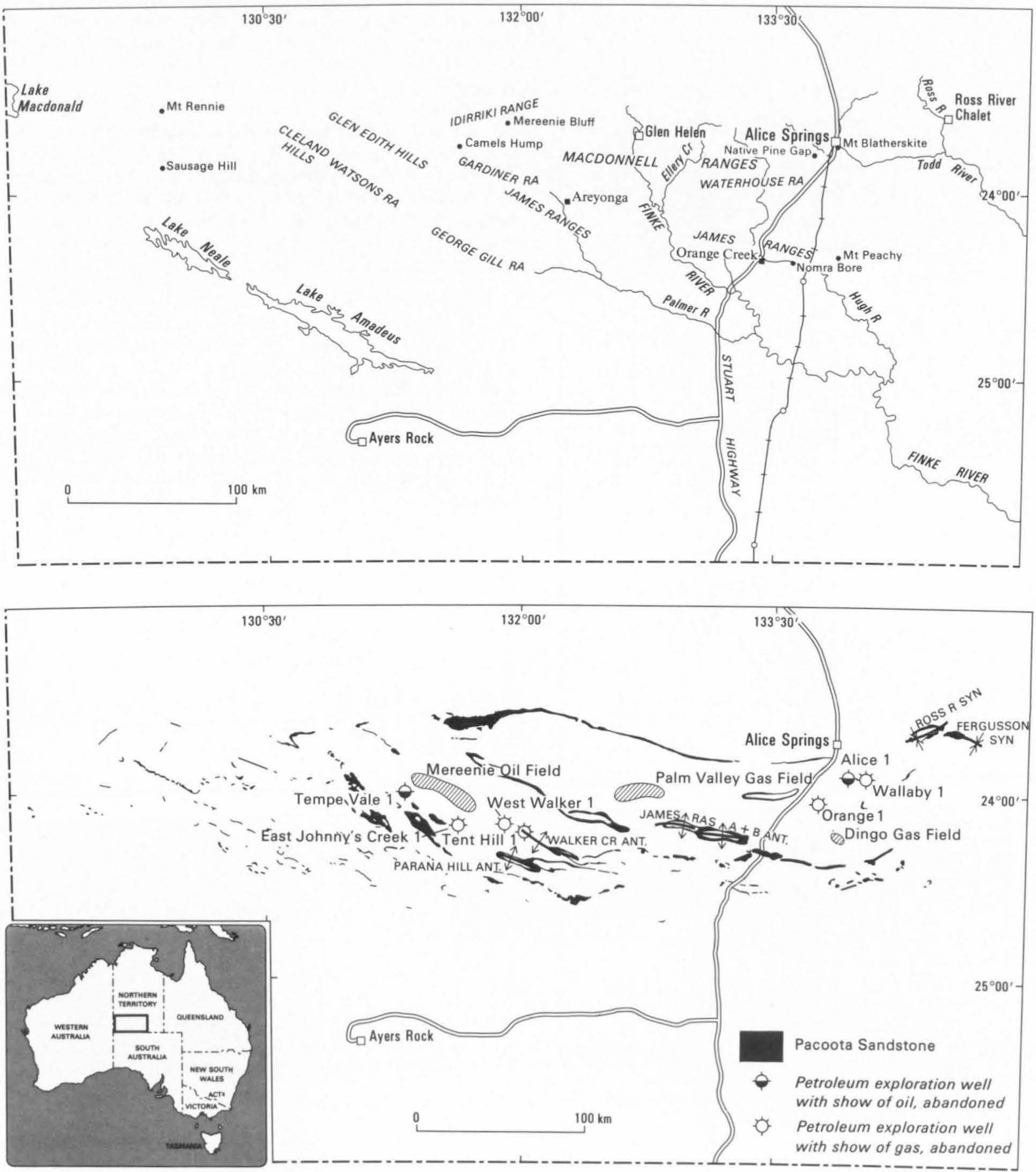

Fig. 1. Locality map showing distribution of Pacoota Sandstone in the Amadeus Basin.

An early published attempt to formally subdivide the formation into members at outcrop was not successful. The N'Dahla Member (Wells & others 1967), which was defined as lying within the top of the Pacoota Sandstone, has subsequently been shown to be Devonian (Young & others, 1987). All other attempts at subdivision have resulted from subsurface hydrocarbon investigations and have been informal. They were based on gross lithology and downhole electric log characteristics (Fig. 3), which have been related to surface geology with varying success. They have, nevertheless, proved formative in developing the four stratigraphic sequences used in this paper (see discussion below).

A detailed appraisal of the present state of knowledge of the internal stratigraphy of the Pacoota Sandstone is necessary, because of its economic importance as the major hydrocarbon reservoir in the Amadeus Basin, its potential as a source of phosphorite, and as an aquifer. Hydrocarbon shows have been reported from all subdivisions of the Pacoota Sandstone (Ozimic & others, 1986). Oil, currently being produced from the Mereenie Oil Field, is from Sequences 3 and 4 (P1 and P3 of Towler, 1986). In the Palm Valley Gas Field, gas and minor condensate occur in Sequences 2, 3 and 4 (P1–P3 of Pearson & Benbow, 1976). Additional oil shows are present in Sequences 1 and 4 in East Johnnys Creek No. 1 (McTaggart & Benbow, 1965) and in 3 and 4 in Tempe Vale No. 1 (Marsden & others, 1983). Gas also occurs in Sequence 4 in West Walker No. 1 (Schroder & Gorter, 1984).

The palaeontological data in this report have been compiled by J.H. Shergold (macrofossils), R.S. Nicoll (conodonts), and P.W. Haines (trace fossils). J.D. Gorter is responsible for the stratigraphic subdivision and lithological descriptions. Well data (electric logs, cores, cuttings), seismic data and measured sections have been re-examined and re-interpretated by J.D. Gorter (in prep.) and it is from this interpretation that the lithological correlation and depositional environments have been mostly derived. Shergold coordinated and compiled the manuscript.

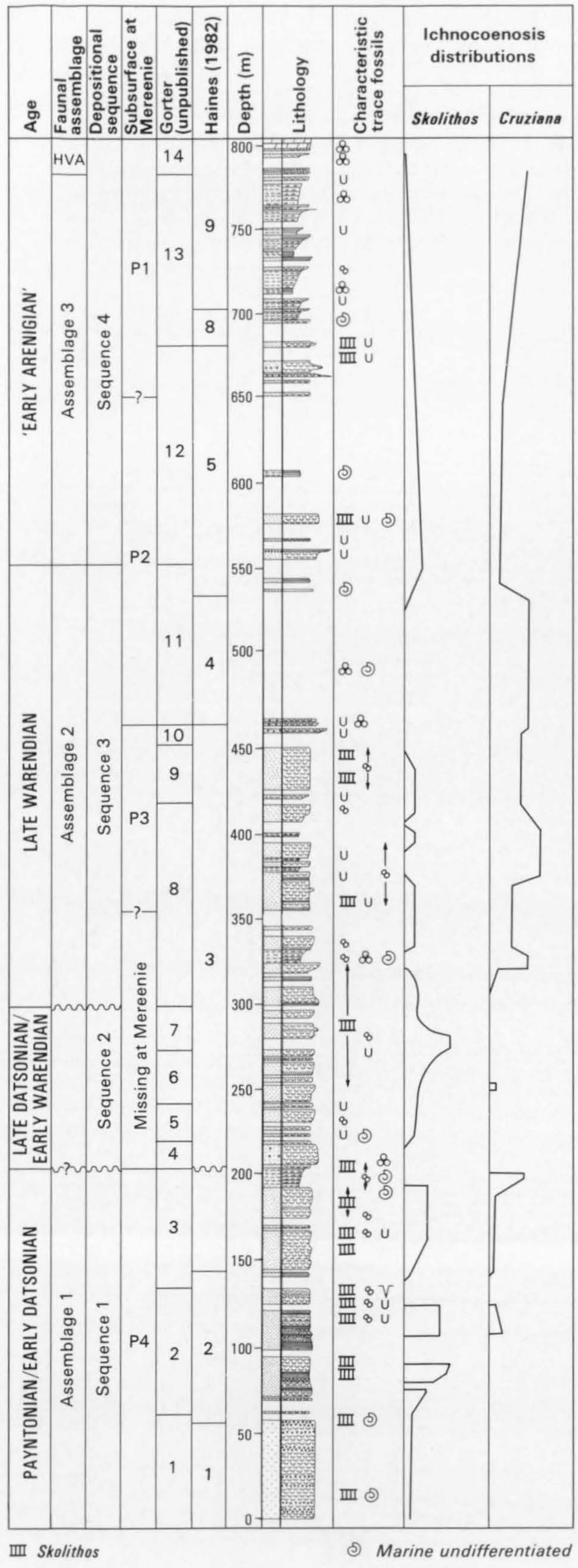

Fig. 2. The type section of the Pacoota Sandstone at Ellery Creek (after Haines, 1982), showing distribution of fossil collections, sedimentary sequences, and ages.

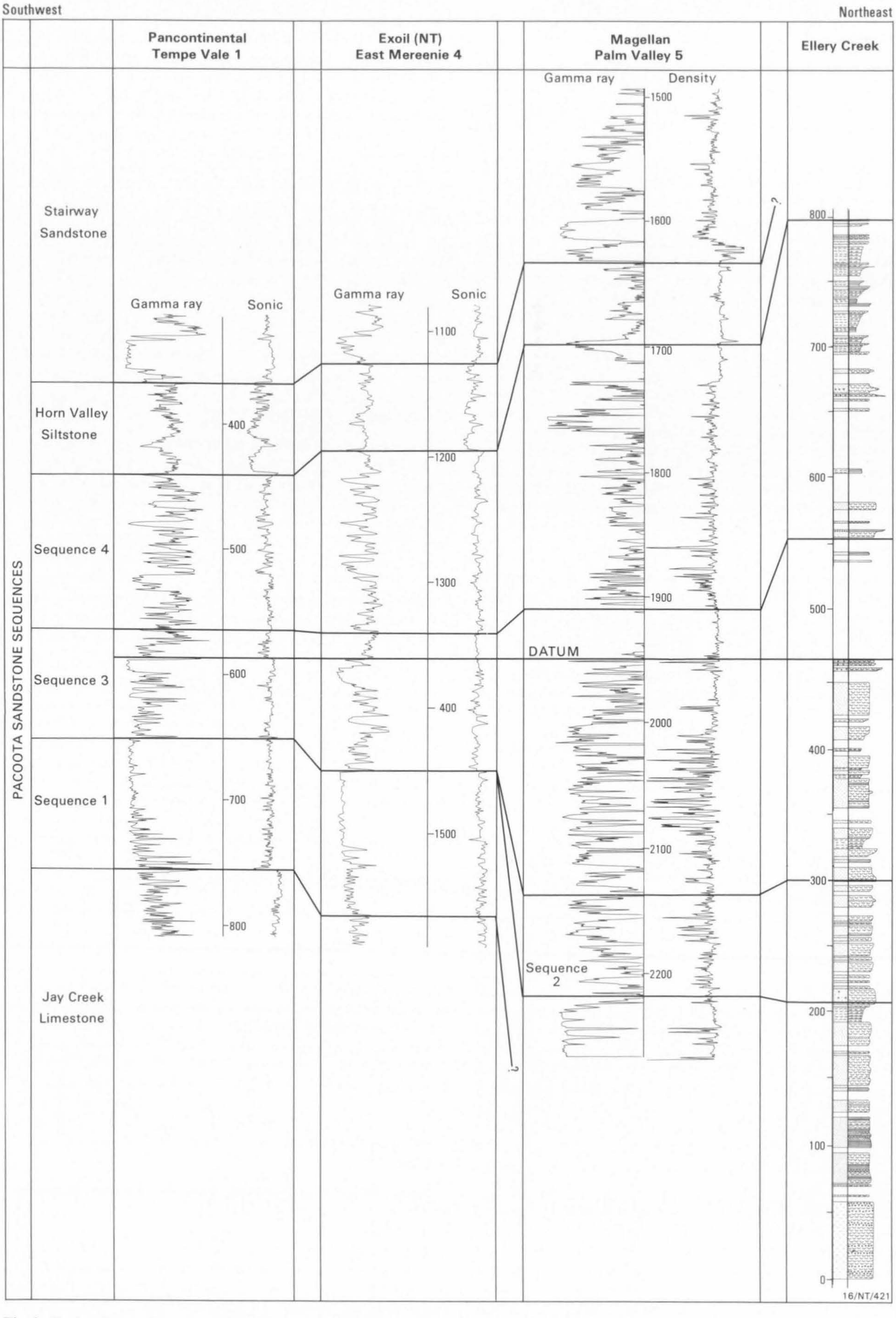

Fig. 3. Surface/subsurface correlations based on downhole wireline, gamma and sonic logs (after Gorter, in prep.).

LITHOSTRATIGRAPHY

Definitions

The Palaeozoic rocks of the Amadeus Basin were first described by Brown (1890, 1891, 1892). Etheridge (1891) described the first Ordovician fossils, but the presence of the Ordovician System in central Australia was to some degree obscured by the use of the, even then, out-moded Murchisonian term "Lower Silurian". Chewings (1894) proposed a three-fold series division of these Palaeozoic sediments; his Mareeno Bluff Series corresponding approximately to the Ordovician sequence. Subsequently, Tate (1896) introduced Lapworth's (1879) term Ordovician into central Australia, and inaugurated the Larapintine Series, the term Larapintine being derived from the Aranda name for the middle and upper reaches of the Finke River. Originally used as a title in Tate & Watt (1896), the Larapintine Series was not precisely defined, and probably excluded the Pacoota Sandstone, as presently understood, because there are no Pacoota fossils in Tate's collections (but see Prichard & Quinlan, 1962, p.18). Madigan (1932) considered Larapintine Series as the original name for the Ordovician in central Australia, and took his No.4 quartzite [Finke River quartzite(s)] as the base of this series. Chewings (1935) translated Larapintine as Larapinta, and a Larapinta Group was eventually formally defined by Prichard & Quinlan (1962). This group now consists of the Pacoota Sandstone, Horn Valley Siltstone, Stairway Sandstone, Stokes Siltstone, and Carmichael Sandstone, in ascending order.

The name Pacoota Quartzite was introduced by Mawson & Madigan (1930), conceived on the nature of quartzite developed at the Finke River Gorge Water Hole (Glen Helen). Pacoota is the Aboriginal name for Mount Blatherskite, 115 km east of Glen Helen, near Alice Springs, and composed of Heavitree Quartzite (Upper Proterozoic), which is repeated in a nappe structure. At Mount Blatherskite, the third quartzite formation recorded by Ward (1925) was correlated with Madigan's No. 4 quartzite at Glen Helen. In the absence of suitable fossils, the correlation of homotaxial sandstone/siltstone sequences could not be confirmed by Mawson & Madigan (1930), and was not firmly established until the discovery of trilobites by Joklik and Tomich in 1951 in the Ross River area (Joklik, 1952; Öpik, 1949, 1952, 1955).

Subsequently, Prichard & Quinlan (1962) changed Pacoota Quartzite to Pacoota Sandstone, defining it as a series of silicified quartz sandstones conformably overlying the Goyder Formation of the Pertaoorrta Group and succeeded conformably by the Horn Valley Siltstone, a generally accepted concept. Recent palaeontological analyses, and subsurface and field observations (Gorter, in prep.), however, have demonstrated an unconformable contact between the Pacoota Sandstone and the Horn Valley Siltstone at four locations: in the Waterhouse Range, the eastern James Ranges, and at the Orange and Dingo gas fields. Disconformity between the Pacoota Sandstone and the upper Goyder Formation can be demonstrated palaeontologically throughout the eastern Amadeus Basin (see below), and the presence of an unconformity can be demonstrated sedimentologically in the Ellery Creek region (Zaitlin, pers. comm.)

Boundaries

The boundary between the Goyder Formation (Pertaoorrta Group) and the Pacoota Sandstone (Larapinta Group) in the type area at Ellery Creek was picked at 'the change from dominant quartz greywacke, often calcareous, to the dominant quartz sandstone, silicified in many places, of the overlying Pacoota Sandstone' (Prichard & Quinlan, 1962, p.17). In the type section in Ellery Creek, the contact was selected originally at the first occurrence of *Skolithos*-bearing sandstone, but was later lowered to include in the Pacoota some supposedly non-*Skolithos*-bearing sandstone that is lithologically similar. *Skolithos* was subsequently described also from these lower beds by Haines (1982) (Fig. 2). The contact was regarded as conformable by Prichard & Quintan (1962), but in the type area around Ellery Creek a substantial palaeotopographical relief is demonstrable on the pre-Pacoota depositional surface, in places attaining 55 m (Zaitlin, pers. comm.)

In many other localities, the contact between the Pacoota Sandstone and Goyder Formation appears to be conformable (Wells *et al.*, 1970), but it is often poorly defined in outcrop and, therefore, sometimes impossible to identify (Stelck, 1960). In the eastern part of the basin, the base of the Pacoota Sandstone has traditionally been placed in a sandstone sequence that shows a gradational change from the poorly sorted kaolinitic, dolomitic and bioturbated sands of the Goyder Formation to the well-sorted and cleaner sands of the Pacoota Sandstone. In the west, it is usually picked at the top of a recessive interval that overlies the Cleland Sandstone (Haites, 1963). Here, the contact may be disconformable (Wells *et al.*, 1970).

The top of the Pacoota Sandstone is also poorly defined. Leslie (1959) restricted the term Pacoota Sandstone to the predominantly sandstone lithologies, and included Macleod's (1958) upper member (which contains shale, glauconite and calcareous material), in the overlying Horn Valley Siltstone. This view was followed to some extent by Haites (1963), who placed much sandstone-bearing strata in the Horn Valley Siltstone. At the type section, Prichard & Quinlan (1962) placed the base of the Horn Valley Siltstone at the top of a hard quartzite bed within the uppermost Pacoota Sandstone that is overlain by 55 m of siltstone, with thin beds or lenses of quartzose sandstone, some of which are glauconitic.

Subsequent workers have followed Prichard & Quinlan's choice of the top of the last outcropping quartzite bed for the base of the Horn Valley Siltstone. However, in the subsurface, any one of several thin sandstones below a prominent glauconitic and dolomitic limestone at or near the base of the Horn Valley Siltstone may be equivalent to the last outcropping quartzite of the Pacoota Sandstone. We prefer to place the contact at the base of this carbonate bed, which is found over a large area of the basin (see further discussion below).

Subsurface division of the Pacoota Sandstone

Benbow (1968) published the first informal subsurface division of the Pacoota Sandstone. His four-fold division comprised an Upper Pacoota Sandstone, including an Upper Zone, Middle Zone and Lower Zone, and a Lower Pacoota Sandstone. Huckaba (1970), in an unpublished report on the Mereenie Oil Field, also subdivided the Pacoota Sandstone into four subunits P1–P4 in descending order, based on gross lithology and wireline log characteristics. Unit P4 was directly correlated with the Lower Pacoota of Benbow (1968). Huckaba's divisions were published by Kurylowicz *et al.* (1976). We refer to a substantially modified version of Huckaba's subdivisions in this paper (Fig. 2), and recognise the absence of our Sequence 2 in the Mereenie area (Gorter, in prep).

In the Mereenie Oil Field, both Benbow (1968) and Huckaba (1970) placed the top of the Pacoota Sandstone at the top of prominent gamma ray and sonic log spikes, certainly correlatable in all the Mereenie Oil Field wells and also others in new parts of the Amadeus Basin where those logs were run. The unit that causes the spikes is generally a sandy, glauconitic and dolomitic limestone (Gorter, 1984). In other words, both workers placed the base of the Horn Valley

Siltstone at the top of the first major carbonate occurring above the uppermost quartzite of the Pacoota Sandstone. We prefer to place this marker bed in the Horn Valley Siltstone. Unfortunately, due to the effects of weathering in the Amadeus Basin and the ubiquitous scree slope above the top Pacoota, this basal Horn Valley marker is not always exposed.

Subdivision of outcropping Pacoota Sandstone

Formal subdivision of outcropping Pacoota Sandstone was attempted only in the Ross River area by Wells *et al.* (1967), who defined the N'Dahla Member in the Ross River Syncline. Recently, the N'Dahla Member has been shown to be Devonian, and is now considered to be a member of the Parke Siltstone of the Pertnjara Group (Young *et al.* 1987).

During field mapping east of the Mereenie oil field in the Walker Creek Anticline (Dee, 1983), the Glen Edith Hills (Webb, 1984; Watts, 1984), and James Ranges "A" and "B" Anticlines (Holden, 1985; Walton, 1985), the subsurface divisions of Huckaba (1970) were applied to outcrop sections of the Pacoota Sandstone with mixed success, often related to the incomplete sequence exposed at the surface and the lack of readily recognisable body fossils. However, detailed correlation (Gorter, in prep.) of over thirty measured sections, twenty-three electrical log suites from petroleum bores, core from petroleum wells (especially Tempe Vale No. 1 and Tent Hill No. 1), and eight BMR stratigraphic core holes, coupled with the re-appraisal of the biostratigraphy reported on here, has since allowed much better understanding of subsurface subdivisions and their correlation with outcropping Pacoota Sandstone. As a result, it is now possible to propose a provisional lithostratigraphic subdivision, which unites previous outcrop and subsurface observations equally. This scheme is demonstrated here by the type section of the Pacoota Sandstone in Ellery Creek (Prichard & Quinlan 1962), as subsequently revised by Haines (1982)

The nearly continuous exposure of the Pacoota Sandstone, along both banks of Ellery Creek, makes this an exceedingly informative type section (Fig. 2). It is also important because it is representative of sedimentation toward the depositional axis of the basin and thus contains a more complete record than do sections located at the depositional margins, such as those at Mereenie oil field. Furthermore, all of the P divisions of Huckaba (1970) can be recognised at Ellery Creek in addition to units that were not deposited in the southwest (Gorter, in prep.).

Haines (1982) recognised six informal lithological units at Ellery Creek, and Gorter (in prep.) has defined thirteen sedimentary units in the Pacoota Sandstone that can be correlated with the 800 m-section measured by Haines (1982) to the base of the Horn Valley Siltstone (Fig. 2).

Combining lithostratigraphic and biostratigraphic analysis of the section, we now describe four gross sedimentary sequences bounded by disconformity or unconformity surfaces. Each sequence has two or more of the sedimentary units described in detail by Gorter (in prep.). The four sequences described here may be regarded as interim informal members. It may be possible to promote them to more formal stratigraphic units, when they are more accurately described and dated. In the meantime, they are used as the framework for discussion of the litho- and biostratigraphic succession.

Sedimentary sequences

Sequence 1 equates with units 1 and 2, and the lowest part of unit 3 as recognised by Haines (1982) at Ellery Creek, and with units 2 and 3 of Gorter (1988, in prep.). In the type area, it represents a distinctive transgressive event, characterised by intervals with deeply incised sandstone channels with coarse-grained cross-stratified estuarine fill, interspersed with progradational tidal flat, barrier island, back barrier, and tidal inlet sediments, often dominated by trace fossil-bearing sandstones of the *Skolithos* ichnocoenosis. The channel deposits may cut down into the underlying Goyder Formation for up to 55 m (Zaitlin, pers comm.). Trilobites dominate the faunas of these deposits (particularly *Platysaukia tomichi* Shergold), whereas the barrier island/tidal inlet deposits have infrequently occurring rostroconch molluscs, conodonts, and inarticulate brachiopods, as well as trilobites similar to those found in the channels. The fossils belong to Assemblage 1 (see below), which are Payntonian or early Datsonian, implying a significant hiatus between the Pacoota Sandstone and the Goyder Formation (Fig. 4).

At Ellery Creek, Sequence 1 is 205 m thick (Haines, 1982). It extends from the type area west to the northwestern Glen Edith Hills and Watsons Range and east to Wallaby No. 1. Correlation from wells to outcrop suggests that the southern limit occurs just south of the James Ranges in the east and southwest of the George Gill Range in the west. The northern limit is marked by the overthrust of the monocline along the northern Idirriki Range and MacDonnell Range. Further work is required to determine the exact thickness and extent of Sequence 1 in the Ross River and Fergusson Syncline areas in the northeast Amadeus Basin, where no detailed measured sections are yet available.

In the subsurface, Sequence 1 was in part recognised in the Mereenie oil field by Benbow (1968) as a combined Lower Pacoota Sandstone and Goyder Formation. Huckaba (1970) regarded the upper part of this as his P4 lithofacies, characterised by the square shape of the gamma ray curve (Fig. 3).

Sequence 2 consists of heavily bioturbated sandstones, deposited as middle to outer shelf storm and tidally generated sand bars (Zaitlin, pers. comm.) At Ellery Creek, it is approximately 100 m thick. Three units have been recognised by

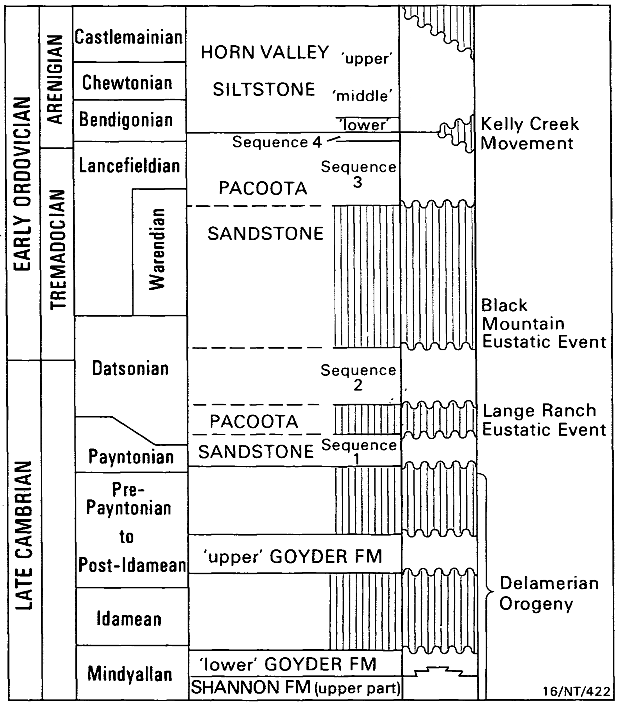

Fig. 4. Distribution of sea-level change events within the Pacoota Sandstone.

Gorter (in prep.), and there is massive development of the *Skolithos* ichnofacies (Haines, 1982). Although age diagnostic fossils are lacking, overlying and underlying sequences have been dated, and a late Datsonian–early Warendian time span is proposed.

The contact between Sequences 1 and 2 is considered to represent a major erosional and transgressive event. An unconformity is indicated by lateral cutout and onlap visible on aerial photographs (Zaitlin, pers. comm.), and can be clearly seen in the Watsons Range. In the subsurface, Sequence 2 is missing at the Mereenie oil field and an unconformity is developed at the base of Sequence 3 (P3 of Huckaba). Deposition of Sequence 2 is considered here to represent the interval between the Lange Ranch and Black Mountain eustatic events (Miller, 1984, 1987) recognised in the Georgina Basin of western Queensland (see below).

Sequence 3 was deposited during a rapid series of transgressions. The base is defined by a ferruginised surface and phosphatic pebble lag, and by the presence of glauconitic and phosphatic sands, the latter derived from comminuted inarticulate brachiopod debris. At the type section, some 160 m of outer shelf storm and tidally deposited sandstones are overlain by about 70 m of green glauconitic shale with lensar dolostone layers, presumably representing maximum transgression. This third sedimentary cycle is dated as latest Warendian (latest Tremadocian) on the basis of trilobites, molluscs, and conodonts (Assemblage 2).

Sequence 3 essentially embraces units P3 and the lower part of P2 at the Mereenie oil field. The uppermost part of Sequence 3 (lower unit P2 of the Mereenie oil field) is readily recognised by the "hot" gamma ray response to the presence of abundant glauconite (Fig. 3). In the field this part of the sequence is usually recessive, owing to the occurrence of green shale and friable glauconitic sandstone.

The distribution of Sequence 3 is essentially the same as Sequence 1, but it onlaps the latter regionally, and unconformable contacts are recognised at Ellery Creek and in the Watsons Range, and are probably more extensive to the south and southwest. The upper shaly part thins rapidly westwards and south of latitude 24° 30′. It is difficult to draw a zero isopach, but this probably occurs south of 24° 30′ and near Mt Winter No. 1. Episodic Ordovician erosion has removed much of the unit from the area northeast of Alice No. 1 and in the Ross River area. The unit was also eroded from the eastern James Ranges before deposition of the Horn Valley Siltstone (Gorter, in prep.). At Ellery Creek, Sequence 3 is 230 m thick, but this thickness is exceeded at the western end of the Idirriki Range and in the subsurface at Palm Valley No. 5.

A good knowledge of the distribution of Sequence 3 is needed since it forms the primary reservoir at the Mereenie oil field. It is one of the few Pacoota subunits that contains consistently porous beds in the subsurface. In the Roe Creek area, it has been investigated as a possible water source for the Alice Springs township (Verhoeven & Knott, 1982).

An abrupt change from glauconitic to clean sandstone is readily identifiable in wells and many outcrop sections, and is here considered to define the base of Sequence 4, which consists of two transgressive cycles (Gorter, in prep.). The lowermost part of Sequence 4 represents a return to storm and tidally dominated sedimentary rocks. At its base, shales and heavily bioturbated sandstones, with a variety of ichnofossils, are interbedded. Basal contacts of the sandstone beds are often sharp, and the frequency of scoured contacts increases upwards. Shale clasts and phosphatic pellets are scattered throughout the unit. At Ellery Creek, several conglomeratic horizons occur.

The upper part of Sequence 4 is quite heterolithic. In the subsurface of the west-central part of the Amadeus Basin, it equates with lithofacies P1 of the Mereenie oil field. Gamma ray logs indicate the presence of coarsening upward cycles, which are also seen in outcrop. Each cycle records an upward transition from laminated shale with a few lenticular sandstone beds and minor bioturbation, through increasing sand content and bioturbation, to non-bioturbated low-angle cross-bedded sandstone. There may be some development of short vertical burrows in the upper part of the cycle. The top of the cycle is abruptly terminated and a new cycle is established with another shale.

The cycles are well developed at Ellery Creek, where they average 10–12 m in thickness. A typical cycle consists of several metres of bioturbated siltstone followed by a thicker interval of thin-bedded, sharp-based, rippled sandstone interbedded with siltstone. The cycles are capped by a few metres of cross-bedded and bioturbated sandstone. The uppermost sandstone often contains vertical and U-shaped burrows, arthropod traces such as *Phycodes*, and other trace fossils.

In some wells in the west-central part of the Basin, a coarsening upward cycle, present in the top 30 m of Sequence 4, terminates abruptly in bright red oolitic ironstone (Gorter, 1986). There is sometimes bioturbation (skolithids) in the top of the ironstone. Farther eastwards, such cycles may terminate in rusty red, iron-stained sandstone or are represented by a few scattered iron pisolites on bedding surfaces, as at Ellery Creek (Gorter, in prep.). Fossils derived from this unit are often preserved in laterite.

Sequence 4 yields a much impoverished fauna (Assemblage 3) of trilobites, molluscs, brachiopods, and ichnofossils, but conodonts are quite abundant and indicate an age intermediate between the latest Tremadoc (Warendian) and earliest Arenig, a very brief duration. Nevertheless, Sequence 4 is the most widespread division of the Pacoota Sandstone, being recorded as far west as "Sausage Hill" (western Mount Rennie sheet area), and as far south as the George Gill Range. In the east, it has been eroded from the area of the Dingo and Orange gas fields, the eastern James Ranges, and N'Dhala Gorge (Gorter, in prep.). It is thickest towards the MacDonnell Range, where 305 m has been measured at Glen Helen.

BIOSTRATIGRAPHY

The Pacoota Sandstone has three faunal assemblages, defined by characteristic trilobite, mollusc, brachiopod, and conodont associations, which were designated Pacoota I–III by Gilbert-Tomlinson (*in* Wells *et al.*, 1970). Since 1970, our comprehension of the biostratigraphy of central Australia, based mainly on research undertaken in the Georgina Basin, permits the application of local Australian stage nomenclature (Jones *et al.*, 1971) to the Pacoota I and II assemblages, which are late Payntonian–early Datsonian (Shergold, 1975; Druce *et al.*, 1982) and late Warendian (Jones *et al.*, 1971), respectively. Pacoota III refers to an as yet undefined assemblage at the Warendian/Arenig transition. These assemblages have not been previously defined in a biostratigraphic context, and taxonomic documentation of many fossil groups is not yet complete.

The body fossil assemblages are separated by, and in places occur with, ichnofossil assemblages, particularly of the *Skolithos* and *Cruziana* ichnocoenoses. The relationships between all the various fossil groups, as outlined below, allows us to make confident age determinations by comparison with other sedimentary basins, and, particularly, they permit us to draw significant palaeoenvironmental conclusions to test sedimentary models.

It is unlikely that an independent or highly resolved biostratigraphy can be established for the Pacoota Sandstone interval. This is a reflection of the prevalent sedimentary palaeoenvironments, interpreted as estuarine to shallow subtidal, and the dominantly siliciclastic sediments. There is a general paucity of body fossils, which occur infrequently in fossiliferous horizons often separated by large thicknesses of strata, which cannot be directly dated. Beds with fossils often contain the fragmented remains of a limited number of taxa. Owing to the deep weathering of these coarse clastic sediments, the macro-fossils are usually poorly preserved, invariably occurring only as internal moulds.

Observations made below on faunal distributions are based essentially on large collections of material from 215 localities. Deductions from thirty measured sections and thirty-one coreholes have been supplemented by spot locality material. The great bulk of the material is housed in the collections of the Bureau of Mineral Resources and was collected by officers of that organisation between 1951 and the present, but it also includes collections made by CSIRO (1956), Caltex (Queensland) (1957), Frome-Broken Hill Co Pty Ltd (Gillespie, 1959; Taylor, 1959), and material submitted for determination by the Magellan Petroleum Corporation and Pancontinental Petroleum Ltd.

Assemblage 1 (Pacoota I of Gilbert-Tomlinson, *in* Wells *et al.*, 1970) is characterised by the association of dikelocephalacean and leiostegiacean trilobites, and a molluscan fauna dominated by rostroconchs (Pojeta *et al.*, 1977). Seventeen taxa of trilobites are described below, but less than half (eight taxa) can be determined specifically. The assemblage is dominated by dikelocephalacean trilobites of the families Saukiidae and Ptychaspididae, of which nine taxa are described (Shergold, this volume); *Platysaukia jokliki* sp.nov., *P. tomichi* sp. nov., *Lichengia simplex* sp.nov., *Sinosaukia* cf. *S. impages* Shergold, *Eosaukia* cf. *E. walcotti* (Mansuy), *Mictosaukia* sp. undet., *Thailandium* sp. undet.; *Changia correcta* sp.nov., and *Quadraticephalus* cf. *Q. coreanica* Kobayashi; leiostegiaceans include: *Mansuyia* cf. *M. orientalis* Sun, *Shergoldia* sp. undet., and *Wanwanaspis* sp. undet. Additionally, assemblage 1 includes the shumardiid *Koldinioidia* aff. *K. sulcata* Robison & Pantoja-Alor, the probable hapalopleurid *Jegorovaia? arena* sp.nov., and undetermined specimens of *Plethometopus*?, *Micragnostus* and a pseudagnostinid. The agnostoid species occur very rarely.

Associated rostroconch molluscs (all described by Pojeta et al., 1977) include: *Cymatopegma semiplicatum*, *Kimopegma pinnatum*, *Pinnocaris robusta*, *P. wellsi*, *Ribeiria huckitta*, and *R. jonesi*. Undescribed monoplacophoran molluscs; *Hypseloconus*; gastropods; a hylothid; articulate and inarticulate brachiopods; cystoid debris; and ichnofossils at some localities, also occur in Assemblage 1. Only a single conodont species, *Oneotodus gallatini* Müller, *sensu* Druce & Jones, 1971, occurs rarely.

The association of the saukiid, tsinaniid and mansuyiinid trilobites with species of *Cymatopegma* and *Kimopegma*, permits correlation with the *Neoagnostus quasibilobus*/*Shergoldia nomas* and probably also *Mictosaukia perplexa* Assemblage-Zones, of late Payntonian and early Datsonian age in western Queensland (Jones *et al.*, 1971; Shergold, 1975; Druce *et al.*, 1982). Elements of this assemblage occur, at the same time, in the Clark Sandstone of the Bonaparte Basin (Öpik, 1969), and are also found in the Cambrian/Ordovician boundary sections of the Bancannia Trough (Webby, 1981; Shergold *et al.*, 1982, 1985). Similar faunas occur in western and southern Tasmania (Jago *in* Shergold *et al.*, 1985) and northern Victorian Land, Antarctica (Wright *et al.*, 1984). Further afield, very similar trilobite associations occur on Tarutao Island, Peninsular Thailand (Kobayashi, 1957; Shergold *et al.*, 1988), in western Yunnan (Sun & Szetu, 1947) and throughout the Sino-Korean Platform (Kobayashi, 1966, 1967; Zhou & Zhang, 1978, 1983, 1985; Kuo *et al.*, 1982: Chen *et al.*, 1985; Qian, 1986; Duan *et al.*, 1986).

The fauna of Assemblage 1 is widespread in the Amadeus Basin, and has been identified at some sixty-five localities. These, however, are mostly in the northeastern portion of the basin, around the Ross River and Fergusson synclines in the eastern MacDonnell Ranges.

Characteristically, Assemblage 1 occurs in the basal Pacoota Sandstone (Sequence 1), where, in the eastern part of the Amadeus Basin it is estimated to be 200 m thick, as for example south of Ross River Chalet. At localities in the west of the Waterhouse Range, however, elements of Assemblage 1 occur also in what has been regarded as an upper, clastic, portion of the Goyder Formation. This is now regarded as the basal channel-bearing unit of the Pacoota Sandstone.

Between Assemblages 1 and 2 is an interval (Sequence 2), about 100 m thick at Ellery Creek, which lacks both body-fossils and conodonts. It has an abundant ichnocoenosis, especially *Skolithos*. Comminuted phosphatic brachiopod shell material is also abundant in some beds. No age dating can be applied to this interval, but, depositionally, it probably represents nearshore, inner shelf deposits. From Ellery Creek, this interval extends east to Native Pine Gap, and to the western Waterhouse Range. Southeastwards, it extends to Mt Peachy, thence westward to Nomra Bore, and the James Range 'A' anticline.

Assemblage 2 (Pacoota II), known in some early Bureau of Mineral Resources reports (e.g. Öpik, 1955) as the "Owen Springs Road Fauna", is a varied and distinctive association of molluscs (gastropods, bivalves, nautiloid cephalopods, rostroconchs) and trilobites. Articulate and inarticulate brachiopods and ostracodes also occur, but to date only the bivalved and rostroconch molluscs have been adequately described (Pojeta & Gilbert-Tomlinson, 1977; Pojeta *et al.*, 1977, respectively): *Colpantyx wooleyi*, *Deceptryx*? sp. *A*, *Pharcidoconcha raupi*, and *Xestoconcha kraciukae* form a quite distinctive bivalve association, while the rostroconchs are dominated by species of *Technophorus*, e.g. *T. nicolli*, and *T. walteri*. The cephalopod fauna contains undescribed ellesmeroceroids, and there are at least two genera of gastropods (aff. *Euconia*?, aff. *Lecanospira*? spp.).

Conodonts from Assemblage 2 represent species that are poorly understood, in that most apparatuses have not yet been adequately described. The fauna is relatively abundant, but not very diverse, consisting of five species of *Drepanodus*, which generally have cusps with smooth lateral surfaces; *Scolopodus* aff. *S. iowensis*; and elements probably assignable to other species of *Scolopodus*. These indicate a latest Warendian (latest Tremadoc) age, when compared to the conodont-dominated Ninmaroo Formation of the eastern Georgina Basin.

A large, elongated, triangular, inarticulate brachiopod is provisionally identified as *Leptembolon* and is associated with a more typical linguloid form similar to *Lingulepis*, both normally occurring in coarse quartzite layers, in association with species of *Skolithos* and *Cruziana*, but no age diagnostic fossils.

Nine species of trilobites (Shergold, this volume) characterise assemblage 2. Described are: *Apatokephalus* cf. *A. hyotan* Kobayashi, *Koraipsis* cf. *K. taiziheensis* Kuo & Duan, *Psilocephalina* cf. *P. lubrica* Hsu, *Asaphellus* cf. *A. trinodosus* Chang, *Hystricurus* cf. *H. eurycephalus* Kobayashi, *Kayser-*

aspis? *belli* sp. nov., *Pacootella collativa* gen. et sp. nov., and undetermined species of *Shumardia* and *Asaphellus*?

The trilobites of Assemblage 2 have not been described elsewhere in Australia. They post-date the assemblage of the Digger Island Formation, Victoria (Jell, 1985), but predate those of the Caroline Creek Sandstone of Tasmania (Jell & Stait, 1985b) and Nora Formation of the Georgina Basin (Fortey & Shergold, 1984). They are unlike the presumed contemporaneous, but as yet undescribed faunas of the upper Ninmaroo Formation of western Queensland; however, they may be compared in some aspects to elements of the Florentine Valley Formation, Tasmania (Jell & Stait, 1985a), although dikelocephalinids are absent. Internationally, elements of the faunas from south-central China described by Lu (1975) are similar. Species of *Shumardia*, *Asaphellus*, *Kayseraspis*, *Hystricurus* and *Psilocephalina* occur together in the terminal Tremadoc *Acanthograptus-Tungtzuella* Zone in Sichuan, Hubei, and Guizhou Provinces. Other elements of assemblage 2 (e.g. the combination *Apatokephalus*, *Asaphellus*, *Hystricurus*, *Kayseraspis* and *Koraipsis*), however, are common in North China (Shanxi, Hebei, Liaoning, Jilin Provinces) (Chang, 1966; Kuo *et al.*, 1982; Zhou & Fortey, 1986; Duan *et al.*, 1986; Qian, 1986) and South Korea (Kobayashi, 1934, 1960, 1966) in equivalents of the *Koraipsis- Hystricurus* Zone of Kuo *et al.* (1982).

Within the Pacoota Sandstone, Assemblage 2 trilobites are found most commonly in association with the comminuted phosphatic brachiopod sands and glauconitic bioclastic sands of Sequence 3. Conodonts are most abundant in shaly intervals near the top of this sequence. The inarticulate brachiopods and certain elements of the molluscan fauna are often commonly associated with ichnofossil-bearing sands, and, accordingly, also occur in the upper part of Sequence 3. No trilobites have yet been recovered from the lowest part of Sequence 3, in which inarticulate brachiopod debris and ichnofossils mostly occurs. The presence of *Leptembolon* in this part of the Pacoota Sandstone, and in Sequence 2, is equivocal.

Assemblage 2 has a much wider geographic distribution than Assemblage 1, from the eastern part of the Fergusson Syncline in the east to localities south-southeast of Mount Rennie in the west, and extending from the western MacDonnell Range in the north, southwards to Nomra Bore and Mount Peachy. Material has been studied from 118 localities.

Assemblage 3 (Pacoota III) is the most spatially and temporally restricted of the Pacoota Sandstone body fossil assemblages. It is characterised by molluscs, articulate brachiopods, conodonts and trilobites, which have little in common with those of Assemblage 2, but are related to the succeeding faunas of the Horn Valley Siltstone. It is an assemblage of low diversity: a single undescribed species of the trilobite *Asaphellus*?; the bivalved mollusc *Cyrtodonta* sp.; undescribed gastropods; and ichnofossils. Conodonts from Assemblage 3 represent a succession of faunas derived from Assemblage 2, including species of *Drepanodus* with well-developed lateral costae. However, in the upper part of Sequence 4, *Bergstroemognathus extensus* (Graves & Ellison) and an early form of *Protoprionodus* occur, and may indicate an earliest Arenig age.

Assemblage 3 is limited to the uppermost Pacoota Sandstone, lying above or interbedded with *Skolithos* and *Cruziana* ichnocoenoses in the middle part of Sequence 4. Assemblage 3 has been found at only a limited number of localities in the western James Range, western Gardiner Range, at Ellery Creek, and in the Idirriki Range. The eastward limits of the assemblage are controlled by removal of the upper part of the Pacoota Sandstone by erosion associated with the Kelly Creek or Rodingan Movements. As far as is known, the trilobite characterising assemblage 3 is endemic to the Amadeus Basin, but associated conodonts have a wider distribution.

Ichnocoenoses

The Pacoota Sandstone contains an abundant and diverse assemblage of trace fossils, most belonging to the *Skolithos* and *Cruziana* ichnofacies of Seilacher (1964; 1967). The *Skolithos* ichnofacies, characterised by the dominance of vertical burrows of suspension feeders, is considered indicative of sandy littoral environments, while the *Cruziana* ichnofacies is characteristic of the sub-littoral to neritic zones. In the Pacoota Sandstone, these ichnofacies are often superimposed, reflecting the complexity of environmental factors within shallow-marine waters.

The Pacoota Sandstone *Skolithos* ichnofacies is generally characterised by an abundance of simple vertical tubes which may be densely packed to form spectacular "pipe rock" horizons, often with few or no other trace fossils. Where *Skolithos* is less-densely packed, U-shaped burrows of *Diplocraterion*, *Arenicolites* and *Corophioides* may also be present. Funnel-shaped tubes of *Monocraterion* may be associated with sparse *Skolithos* and other burrows in the upper part of Sequence 3.

The most notable members of the *Cruziana* ichnofacies in the Pacoota Sandstone are the variety of trace fossils attributable to trilobites or similar arthropods, including *Cruziana* itself, but most characteristically, *Rusophycus*. *Rusophycus* is particularly abundant near the top of Sequence 1 and throughout Sequence 3 in the north of the Amadeus Basin. Of especial note is the large ichnospecies *R. latus* Webby, up to 20 cm in length which occurs in the upper part of Sequence 1 and within Sequence 3.

Other arthropod trace fossils common in the Pacoota Sandstone include *Diplichnites*, *Dimorphichnus*, *Monomorphichnus* and *Isopodichnus*. In Sequence 4, arthropod trace fossils are relatively uncommon and the presence of the *Cruziana* ichnofacies is frequently indicated by the abundance of such forms as *Phycodes*, including *P. cincinatum*.

The vertical distribution of ichnocoenoses in the Pacoota Sandstone has been studied in some detail in three sections in the northeastern part of the Amadeus Basin (Haines, 1982). In the vicinity of Ellery Creek, Sequence 1 is characterised by the abundance of the *Skolithos* ichnofacies, particularly in the central part of the unit, where the densely packed *Skolithos* beds are devoid of other trace fossils. In the upper part of Sequence 1, less densely packed *Skolithos* may be associated with *Diplocraterion*, *Corophioides* and *Rusophycus*, indicating superposition of the *Skolithos* and *Cruziana* ichnofacies.

Sequence 3 is characterised by cyclic ichnofacies and sedimentary facies. The thinner bedded and recessively weathered lower portions of cycles are typified by the dominance of the *Cruziana* ichnofacies trace fossils. *Skolithos*-rich intervals usually include only one other inhabitant – the inarticulate brachiopod refered to as *Leptembolon*. The *Cruziana* ichnofacies is most prevalent in the middle part of Sequence 3. *Cruziana* becomes common for the first time, but *Rusophycus* is still the dominant arthropod trace fossil. *Isopodichnus*, and various arthropod walking trails are also common in locally developed fine-grained sandstone and shale interbeds. Other distinctive trace fossils include *Scolicia* and (?) *Chondrites*.

Thin sandstones within the upper part of Sequence 3 in the Ellery Creek area contain a diversity of distinct trace fossils, mostly referable to the *Cruziana* ichnofacies, with a total absence of the *Skolithos* ichnofacies. Most of the ichnospecies present appear to be endemic to this unit. The characteristic forms include *Teichichnus*, *Phycodes*, *Palaeophycus* (including *P. striatus*), *Tomaculum* and *Cruziana* (including *C. warrisi* Webby). Unlike in lower parts of the Pacoota Sandstone, *Rusophycus* is rare.

Members of the *Skolithos* ichnofacies, including *Skolithos*, *Monocraterion* and *Diplocraterion*, and some members of the *Cruziana* ichnofacies, such as *Phycodes* cf. *P. cincinatum*, occur in the lower part of Sequence 4. Trilobite trace fossils, however, are rare.

The uppermost part of Sequence 4, characterised by coarsening-upward cycles, is often strongly bioturbated, but few of the traces are characteristic of a specific ichnofacies. Diagnostic trace fossils are generally members of the *Cruziana* ichnofacies, such as *Phycodes*, including *P.* cf. *P. cincinatum*, except for sparse vertical burrows, including *Diplocraterion* and other U-shaped burrows in sandstones at the top of cycles. As in the lower part of Sequence 4, trilobite trace fossils are rare, but there is an overall increase in bioturbation towards the top of the unit.

Where the Pacoota Sandstone thins laterally, the whole sequence may be represented by bioturbated sands, e.g. *Skolithos* sandstone in otherwise unfossiliferous sequences at measured sections LAR3, LAC8, and LAC12 in the Lake Amadeus 1:250 000 Sheet area (Wells *et al.*, 1963). Significantly, where the formation thickens, e.g. at sections in the Parana Hill Anticline (Wells *et al.*, op. cit.), *Skolithos* and *Cruziana* ichnocoenoses may be interbedded.

The precise age of the Pacoota Sandstone where body fossils are lacking, particularly Sequence 2, has been considered problematical (Shergold, 1986), and stratigraphical breaks have been sought to account for the absence of body fossils diagnosing the early Datsonian–late Warendian interval. The main development of *Skolithos* occurs exactly in this interval, which is a period of low sea-level stand between the early Datsonian Lange Ranch Eustatic Event and the Warendian Black Mountain Eustatic Event, recognised on a global scale by Miller (1984, 1987).

SEA-LEVEL EVENTS

In the Amadeus Basin, overwhelmingly clastic sediments were deposited in a broad, shallow epeiric shelf which lay astride, or within 10°, of the Cambrian–Ordovician equator (Smith *et al.*, 1973, 1981; Scotese, 1986; Scotese *et al.*, 1979; Burrett, 1983) in at least four disconformity or unconformity-bound sequences. Deposition of the Sequence 1 is interpreted as the product of erosion associated with the Delamarian Orogeny, which was most intensive during the latest Cambrian (Milnes *et al.*, 1977; Cas 1983), at 515–500 Ma. It rests with unconformity on the Upper Cambrian Goyder Formation, representing the initial Pacoota Sandstone transgression. This event can be widely recognised across the Australian–Antarctic–Asian sector of Gondwanaland. It is followed by three further transgressive events, which can be related to tectonic movements or eustatic sea-level events, some having global significance.

Miller (1984, 1987), for example, has recognised two global eustatic sea-level events during the latest Cambrian and earliest Ordovician (Tremadoc). Both events have been recorded in Australia, in the carbonate environments of the Burke River Structural Belt, eastern Georgina Basin. These may be correlated with the Pacoota Sandstone, and are possibly related to pulses of the Delamerian Orogeny.

In the eastern Georgina Basin, the Lange Ranch Eustatic Event (LREE) (Miller, 1984) is recorded within the Ninmaroo Formation, of earliest Datsonian age. Predating this event, the late Cambrian (early Payntonian) trilobite faunas of the upper Chatsworth Limestone (Shergold, 1975) correlate directly with those of Assemblage 1 characterising Sequence 1 of the Pacoota Sandstone in the Amadeus Basin. The LREE is, therefore, expressed in the Amadeus Basin by the unconformity reported here between Sequences 1 and 2. In the carbonate deposits of the Ninmaroo Formation (Unbunmaroo and Jiggamore Members), extensive evidence of peritidal conditions has been documented by Radke (1981, *in* Druce *et al.*, 1982), during and immediately following the LREE. These conditions persisted during the early Datsonian *Cordylodus proavus* and *Oneotodus bicuspatus*/*Drepanodus simplex* conodont zones. Age-diagnostic macrofauna was extremely sparse at this time in the carbonate environments. If contemporaneous sedimentation occurred in the Amadeus Basin, it must be represented by the basal layers of Sequence 2. Notably, neither conodonts nor trilobites have been found in this sequence.

The second sea-level event documented by Miller (1984) is the Black Mountain Eustatic Event (BMEE), named after Black Mountain in the Burke River Structural Belt, western Queensland. This occurs within the early Warendian (Tremadoc) conodont zone of *Cordylodus angulatus*/*C. rotundatus* and is documented in the Corrie Member of the Ninmaroo Formation. The event cannot be dated by either conodonts or trilobites in central Australia, but it is probably represented by the unconformity recognised here between Sequences 2 and 3.

Current evidence seems to suggest that the Pacoota Sandstone Sequence 2 was deposited during the period of slightly rising sea-level between the Lange Ranch and Black Mountain Eustatic Events, perhaps within the late Datsonian/early Warendian, *Cordylodus oklahomensis*/*C. lindstromi* and *C. prion*/*Scolopodus* conodont zones by comparison with the Georgina Basin. Subsequent to the Black Mountain event, rapid subsidence in the Amadeus Basin was responsible for the deeper water transgressive phosphatic and glauconitic deposits of Sequence 3, which are characterised by Assemblage 2 fossils, indicating a latest Warendian (latest Tremadoc) age.

A third episode of sea-level perturbation may also be recorded in the Pacoota Sandstone at the base of and within Sequence 4. Evidence for extreme shallowing in the lower part of this sequence (upper and initial part of the cyclic sequence) is recognised by the occurrence at some localities in the central-western part of the Amadeus Basin (e.g. Tempe Vale No. 1, Tent Hill No. 1, etc.) of oolitic hematitic ironstone (Gorter, 1986). It seems likely that this event was followed by the onset of the Horn Valley transgression as shown on Fig. 4. It is likely also to represent the Kelly Creek Movement, recognised by Webby (1978) in the Georgina Basin, during the earliest Arenig. Emergence at this time caused subaerial weathering of the Ninmaroo Formation and formation of the regolith known as the Swift Formation (Shergold, 1986) (Fig. 4).

CONCLUSIONS

The Pacoota Sandstone is a demonstrable hydrocarbon reservoir. Where fully developed, it contains four stratigraphic sequences separated by datable events. These sequences can be recognised and correlated widely in the subsurface, but their significance has not yet been adequately exploited. The events documented within the Pacoota Sandstone are also recognisable outside the Amadeus Basin, and some are global. Further work, however, is required to plot the accurate distribution of the sequences throughout the basin and document lateral facies changes within them. Sequence 2 in particular requires more precise dating. It may eventually be possible to further subdivide Sequences 3 and 4.

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Late Cambrian and Early Ordovician trilobite faunas of the Pacoota Sandstone, Amadeus Basin, Central Australia

by

J.H. Shergold

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PLATE EXPLANATIONS

ABSTRACT

Twenty-seven trilobite species of twenty-four genera and subgenera are described from the Pacoota Sandstone, eastern Amadeus Basin, Northern Territory. Nine taxa are referred to existing species, eleven are left under open nomenclature, and seven are new: *Lichengia simplex* sp. nov., *Platysaukia jokliki* sp. nov., *P. tomichi* sp. nov., *Changia correcta* sp. nov., *Jegorovaia*? *arena* sp. nov., *Kayseraspis*? *belli* sp. nov., and *Pacootella collectiva* gen. et sp. nov. Three trilobite assemblages are recognised and informally referred to: Assemblage 1 — of terminal Cambrian, Payntonian to early Datsonian age, is dominated by saukiid, tsinaniid and mansuyiinid trilobites widely distributed in the Australasian-Chinese region. Assemblage 2 — of Early Ordovician, terminal Tremadoc, late Warendian age and characterised by the occurrence of species of *Apatokephalus*, *Hystricurus*, *Asaphellus*, *Psilocephalina* and *Koraipsis inter alia*,is also widely distributed in China. Assemblage 3 - has a single species of *Asaphellus*? and is restricted geographically to the Amadeus Basin, and stratigraphically, on the basis of conodont correlations, to the Tremadoc–Arenig transition.

INTRODUCTION

Trilobites are described here for the first time from the Cambrian–Ordovician Pacoota Sandstone, a coarse clastic formation up to 850 m thick, which occurs over more than 25 000 km² in the northern part of the Amadeus Basin (see Shergold *et al.*, i.e. Chapter 1, for detailed description and stratigraphy).

Although Madigan (1932) reported fossils from what is now known to be Pacoota Sandstone, datable material was not collected until October 1951, when G. F. Joklik and S. A. Tomich (Bureau of Mineral Resources) reinvestigated Madigan's localities along the Ross River, 62 km east of Alice Springs. These localities are on both the eastern and western banks, about 8 km south of Ross River Tourist Camp (Loves Creek Homestead); shown as localities AS304 and AS194, respectively, on contemporary maps (e.g. the Alice Springs District 1:100000 Special Geological Sheet, 1983).

Age-diagnostic trilobites, rostroconch and gastropod molluscs, and ichnofossils were first reported by Öpik (1952, 1955, 1956, *in* Joklik, 1955), but only the rostroconchs have been described until now (Pojeta *et al.*, 1977). The trilobites were originally considered to represent two distinct horizons of 'middle Upper Cambrian' age, but here both faunas are demonstrated to be representative of Assemblage 1, which has a terminal Cambrian age.

Joklik's discovery in 1951 and Öpik's subseqeunt interpretation resulted in the much-needed clarification of Madigan's informal stratigraphic nomenclature, and permitted the subsequent definition of the Pacoota Sandstone by Prichard & Quinlan (1962). Öpik (1956) gave an account of the early development of the stratigraphic nomenclature of the Cambrian and early Ordovician in the eastern Amadeus Basin.

For the present study, trilobites have been examined from 215 localities in the Pacoota Sandstone, representative of measured sections and spot collecting sites. Trilobites have been prepared from 61 of these collections (see Owen *et al.*, this Bulletin) for all locality data pertinent to the Pacoota Sandstone. As indicated earlier (Shergold *et al.*, this Bulletin), these collections have been assembled between 1951 and the present mainly by officers of the Bureau of Mineral Resources, but also by CSIRO (1956), Caltex (Queensland) (1957), Frome Broken Hill Pty Ltd (Gillespie, 1959; Taylor, 1959), Magellan Petroleum Corporation, and Pancontinental Petroleum Ltd.

Material described here occurs in abundance only at specific stratigraphic horizons in sections and at certain spot localities. The horizons generally have low species diversity, and may be represented by coquinas of a single taxon. Invariably the material is not well preserved, occurring only as moulds. Accordingly, a conservative approach has been taken to the taxonomy: approximately 40% of the species are left under open nomenclature, and only eight new taxa are described. Although trilobite assemblages can be readily recognised and correlated, often over wide areas within and outside Australia, a formal biostratigraphy based on trilobites is not contemplated at this time, and reference is made to the most appropriate zones and stages recognised previously in the Georgina Basin, western Queensland.

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BIOSTRATIGRAPHY

Twenty-seven trilobite species, including seven newly described, nine previously known, and eleven left under open nomenclature, are assigned to 24 genera and subgenera, one of which is new. These species occur in three discrete assemblages of body fossils.

Assemblage 1 is dominated by dikelocephalacean trilobites of the families Saukiidae and Ptychaspididae. It contains 17 species of 16 genera and subgenera: *Micragnostus* sp. indet., pseudagnostinid gen. et sp. undet., *Eosaukia* sp. cf. *E. walcotti* (Mansuy), *Lichengia simplex* sp. nov., *Mictosaukia* sp. undet., *Platysaukia jokliki* sp. nov., *Sinosaukia* sp. cf. *S. impages* Shergold, *Thailandium* sp. undet., *Changia correcta* sp. nov., *Quadraticephalus* sp. cf. *Q. coreanicus* Kobayashi, *Mansuyia* sp. cf. *M. orientalis* Sun, *Shergoldia* sp. undet., *Wanwanaspis* sp. undet., *Plethometopus*? sp. undet., *Koldinioidia* sp. cf. *K. sulcata* Robison & Pantoja-Alor, and *Jegorovaia*? *arena* sp. nov.

Besides trilobites, Assemblage 1 has rostoconch, monoplacophoran and gastropod molluscs, *Hypseloconus*,articulate and inarticulate brachiopods, a hyolithid, pelmatozoan debris, and ichnofossils (generally *Skolithos* and *Cruziana*). To date, only the rostoconch molluscs have been described (Pojeta *et al.*, 1977).

The assemblage is widespread in the eastern Amadeus Basin, occurring in channel fill deposits (Sequence 1 of Shergold *et al.*, this Bulletin) at the base of the Pacoota Sandstone. Assemblage 1 has been recognised in 73 collections, 30 of which have been prepared for this study. The localities are concentrated in the Fergusson, Ross River and Waterhouse Range Synclines, and at Native Pine Gap. Owing to sporadic occurrence in stratigraphic sections, previously measured, it is not possible to give an accurate account of the stratigraphic distribution of Assemblage 1. It ranges with certainty over 43 m at Native Pine Gap, and 109 m in the southwestern part of the Waterhouse Range. In the Ross River Syncline, where up to 190 m of basal Pacoota Sandstone has been considered to represent the Upper Goyder Formation, it may range over as much as 200 m of section.

In **Assemblage 2**, the trilobite fauna of *Assemblage 2* includes eight genera, including one newly described, and ten species, of which two are new, three left under open nomenclature, and five previously described. This assemblage is dominated by leiostegiacean, remopleuridacean, hystricurid, pilekiine and asaphacean trilobites: *Apatokephalus* sp. cf. *A. hyotan* Kobayashi, *Asaphellus* sp. cf. *A. trinodosus* Chang, *Asaphellus*? species undetermined 1, *Hystricurus* sp. cf. *H. eurycephalus* Kobayashi, *Kayseraspis*? *belli* sp. nov., *Koraipsis* sp. cf. *K. taiziheensis* Kuo & Duan, *Pacootella collativa* genus et species nov., *Psilocephalina* sp. cf. *P. lubrica* Hsu, and *Shumardia* species undetermined.

The trilobites are associated with a variety of rostroconch, gastropod, bivalved and nautiloid molluscs, articulate and inarticulate brachiopods, ostracodes, conodonts, and trace fossils. Of these, Pojeta & Gilbert-Tomlinson (1977) have described the bivalved molluscs.

Assemblage 2 is very distinctive, and is recognisable across the Amadeus Basin from Mount Rennie in the west to the Fergusson Syncline in the east. Trilobites have been collected at 116 localities, and material prepared from 27. In the eastern Amadeus Basin, in the vicinity of Ross River, Assemblage 2 may range over a minimum of 254 m and maximum of 421 m of section, but the sequence is demonstrably incomplete in this area (Young *et al.*, 1987), an unknown thickness of Pacoota Sandstone having been removed by Rodingan diastrophism (Wells *et al.*, 1970). Assemblage 2 is recognised over 102 m of section at Native Pine Gap, 210 m at Ellery Creek, and 48 m in the Waterhouse Range, but is found only in a 3 m interval at Areyonga, and elsewhere only in single horizons within measured sections.

Nowhere in the Amadeus Basin has the contact between the trilobite faunas of Assemblages 1 and 2 been seen. Along the northern margin of the present basin, where the Pacoota Sandstone is most fully and most thickly developed, inarticulate brachiopod and ichnolite-bearing sandstones (Sequence 2 of Shergold *et al.*) (which cannot be accurately biochronologically dated at this time) intervene between age-diagnostic trilobite assemblages. These brachiopod/ichnolite associations may dominate considerable thicknesses of section, particularly in the Ross River area, where a thickness of 300 m is estimated. Elsewhere, such associations may dominate the entire Pacoota Sandstone, as along the southern margin of the Amadeus Basin, where tidal sand flat environments were maintained throughout the deposition of the Pacoota Sandstone.

The trilobites of Assemblage 2 first occur at the base of Sequence 3 (Shergold *et al.*) and they dominate the phosphatic/glauconitic sandstone in the upper part of this sequence. In the shallower (as interpreted from the rocks), trilobites are replaced by inarticulate brachiopod and ichnolite associations similar to those separating Assemblages 1 and 2 at the base of Sequence 4.

Assemblage 3 contains a single trilobite referable to an undetermined species of *Asaphellus*?, associated with undescribed articulate brachiopods, conodonts, molluscs and ichnofossils. This assemblage is restricted to the uppermost 75 m of the Pacoota Sandstone (Sequence 4) at six localities, extending from the Idirriki Range in the west of the basin to the western Gardiner Range, western James Range, and Ellery Creek.

BIOCHRONOLOGY AND CORRELATION

The trilobites of Assemblage 1 are characterised by the predominance of Saukiidae in association with Tsinaniidae and Mansuyiinae. This association is essentially the same as that in the Upper Chatsworth Limestone in the Burke River Structural Belt of western Queensland (Shergold, 1975). There, it is diagnostic of the *Neoagnostus quasibilobus*/*Shergoldia nomas* and probably *Mictosaukia perplexa* Assemblage Zones, of latest Cambrian, Payntonian and initial Datsonian ages (Jones *et al.*, 1971; Shergold, 1975; Druce *et al.*, 1982). That age is therefore correlated with the lowermost Pacoota Sandstone of the eastern Amadeus Basin. Differences between the trilobite associations in the two areas are considered to be ecological: those of the Chatsworth Limestone are from the seaward margin of a peritidal carbonate belt, whereas those of the Pacoota Sandstone occur in sandstones and siltstones deposited on the landward side of this carbonate belt, i.e. in an inner detrital clastic zone. Morphologically, the trilobites in the Pacoota Sandstone have a greater proportion of effaced forms than those of the Chatsworth Limestone.

Elements of the Payntonian–early Datsonian trilobite assemblage (Assemblage 1) are widespread. In Australia, they occur in the upper Clark Sandstone of the Bonaparte Basin (Öpik, 1969; Shergold *et al.*, 1982), Nootumbulla Sandstone of western New South Wales (Webby, Editor, 1981), and in the Misery Conglomerate and its correlatives in northwestern and southern Tasmania (Jago *in* Shergold *et al.*, 1985). A similar assemblage may also occur in northern Victoria Land, Antarctica (Wright *et al.*, 1984; Cooper & Shergold, in press).

Assemblage 1 is also common in Asia, its elements having been recorded in some combination or another in the Southern Shan States of Burma (Thein, 1973; Wolfart *et al.*, 1984), peninsular Thailand (Kobayashi, 1957; Shergold *et al.*, 1988), and in the belt extending from northern Vietnam (Mansuy, 1915, 1916) through western Yunnan (Sun & Szetu, 1947; Sun & Xiang, 1979; Zhu, 1982; Luo, 1983) into Sichuan, Gansu and eastern Qinghai Provinces of China. Lithological similarities with central Australia extend to the dominance of clastic sediments throughout this area.

In addition, correlation can, as in western Queensland, be made with the carbonate-dominated environments of the Sino-Korean Platform (Kobayashi, 1931, 1933, 1935, 1960b; Zhou & Zhang, 1978, 1983, 1985; Kuo *et al.*, 1982; Chen *et al.*, 1985; Qian, 1986; Duan *et al.*, 1986).

Together, the occurrences listed here, extending from Antarctica to Jilin, China, form the nucleus of the saukiid/tsinaniid biofacies of the North China faunal province described by Shergold (1988), and they permit a range of terminal Cambrian correlations across this region (Shergold, 1988).

The trilobites from Assemblage 2 have a generally similar geographic distribution although they have not yet been described from elsewhere in Australia. They possibly correlate with elements of the Florentine Valley Formation of Tasmania (Jell & Stait, 1985a), but the composition of the assemblages is somewhat different.

Various combinations of the components of Assemblage 2 occur in China, in the latest *Acanthograptus–Tungtzuella* Zone in Sichuan, Hubei and Guizhou Provinces of south-central China, and in the *Koraipsis–Hystricurus* Zone (Kuo *et al.*, 1982) and its equivalents in North China (Shanxi, Hebei, Liaoning, Jilin) described by Chang, 1966; Kuo *et al.*, 1982; Qian, 1986; Zhou & Fortey, 1986; Duan *et al.*, 1986) and South Korea (Kobayashi, 1934, 1960a, 1966). It is essentially the fauna of Horizon 1 in the Upper Yehli Formation in Liaoning, as described by Zhou & Fortey (1986), which, on their authority, may be correlated with the *Scolopodus quadraplicatus–S. opimus* conodont zone of An *et al.* (1983), thence to the *Chosonodina herfurthi–Acodus* Zone (Druce & Jones, 1971) of northern Australia, of late Warendian age (Jones *et al.*, 1971). This age, therefore, is assumed by the trilobites of Assemblage 2.

The trilobite which occurs in Assemblage 3 has not been recognised outside of the Amadeus Basin, and is therefore not age-diagnostic. Associated conodonts (Nicoll, pers. comm.), however, indicate an earliest Arenig age.

A large interval, essentially from the latest Cambrian to the latest Tremadoc (early Datsonian to late Warendian in Australian terminology), is not recognised on the trilobite biochronological scale in the Amadeus Basin. This interval, however, may contain up to 350 m of clastic sediment dominated by ichnofacies and inarticulate brachiopods, which are not yet known to be age-diagnostic. As described earlier (Shergold *et al.*, this Bulletin), stratigraphical breaks of varying magnitude may occur particularly in the ichnolite sequence. Although they may be speculated upon, with the currently available degree of biochronological resolution, their durations cannot yet be adequately determined.

SYSTEMATIC PALAEONTOLOGY

Descriptive terminology used here is basically that in earlier monographs by Öpik (1961a, 1961b, 1963, 1967) and Shergold (1972, 1975, 1980, 1982). Symbols in the text for dimensional parameters are defined in the last four works. Only the following are used here:

Lc — maximum length (sag.) of cephalon or cranidium,
L_{p1} — maximum pygidial length (sag.) including the articulating half-ring, and
L_{p2} — pygidial length (sag.) excluding the articulating half-ring.

All the Australian material described here is deposited in the Commonwealth Palaeontological Collection, Bureau of Mineral Resources, Canberra, and is prefixed CPC.

Order **Agnostida** Salter, 1864
Family **Agnostidae** M'Coy, 1849
Subfamily **Agnostinae** M'Coy, 1849

Genus ***Micragnostus*** Howell, 1935
Subgenus ***Micragnostus*** Howell, 1935

Type species: *Agnostus calvus* sp. nov.; Lake 1906, p. 23, pl. 2, fig. 18; designated Howell (1935, p. 233); Nant Rhosddu, Arenig, North Wales, UK; Early Ordovician, Tremadoc.

Micragnostus (Micragnostus) species indeterminate
(Pl. 1, Figs 1–4)

Material: Three cephala, CPC26606, 26607, 26610, approximately 1.7 mm long; and three pygidia, CPC26608, 26609, 26611, up to 2.3 mm long (L_{p2}).

Distribution: This species has been found only at AS355 in the Ross River Syncline, eastern Amadeus Basin.

Age: Late Cambrian, Payntonian/Early Datsonian, Assemblage 1.

Comments: This material is both too impoverished and too poorly preserved to be determined at specific level. It is illustrated here to demonstrate some of the difficulties in attempting to systematically describe Amadeus Basin material. On the cephala, little detailed morphology can be described. All available specimens are convex (tr., sag.), have unconstricted, undivided acrolobes, narrow (sag.) borders and border furrows. The anterior glabellar lobe has significant length (sag.), and is divided from the posterior lobe by a transverse furrow. The position of the axial node is unknown. Associated pygidia have wider (sag.) borders and border furrows, and in addition constricted acrolobes. The pygidial axis is relatively short (sag.), and the posterior lobe occupies about one-half the axial length. There is no postaxial furrow.

Family **Diplagnostidae** Whitehouse 1936,
emend. Öpik, 1967
Subfamily **Pseudagnostinae** Whitehouse, 1936
Pseudagnostinid genus et species undetermined
(Pl. 1, Fig. 5)

Material: A single pygidium, CPC26612, about 3.2 mm long (L_{p2}).

Distribution: Found only at locality AS355 in the eastern part of the Ross River Syncline, eastern Amadeus Basin.

Age: Late Cambrian, Payntonian/Early Datsonian, Assemblage 1.

Comments: This specimen, undoubtedly a pseudagnostinid, cannot be determined at either specific or generic level with any degree of confidence. It appears to have a narrow (sag.) border, and border furrow, and to have a weakly constricted, tumid deuterolobe which swells above the posterior border furrow. It could possibly represent the genus *Rhaptagnostus* Whitehouse.

Order **Ptychopariida** Swinnerton, 1915
Suborder **Ptychopariina** Swinnerton, 1915

Superfamily **Dikelocephalacea** Miller, 1889
Family **Saukiidae** Ulrich & Resser, 1930

Saukiid trilobites dominate Assemblage 1, representing almost half the genera recorded here. *Eosaukia* Lu, *Mictosaukia* Shergold, *Platysaukia* Kobayashi, *Lichengia* Kobayashi, *Sinosaukia* Sun and *Thailandium* Kobayashi are all genera of Asian origin, having been previously described from peninsular Thailand, Vietnam, China and South Korea. These genera represent several different saukiid lineages. Close to the basic *Prosaukia* is *Thailandium*, differentiated principally by its long (sag.) preglabellar area, readily differentiated into a preglabellar field and border. In *Platysaukia*, on the other hand, the preglabellar area is created by the effacement of the anterior cranidial border furrow, although a very faint trace of this may remain on some specimens. *Lichengia* is also derived from a prosaukioid stock, possibly similar to *Caznaia* Shergold. It retains a distinctive border and preglabellar field, and, additionally, is characterised by preoccipital glabellar furrows which are not continuous across the sagittal line-unusual among saukiids. *Lichengia* also shows a tendency to widen (tr.) the glabella at the preoccipital lobes at the expense of the palpebral areas. *Sinosaukia* and *Saukia* have a common origin, and form the basis of a generic group, also containing *Lophosaukia* Shergold and *Linguisaukia* Peng (not represented in the present faunas). *Eosaukia* and *Mictosaukia* also share a common origin, and are basically only differentiated by palpebral morphology and pygidial segmentation. Like *Platysaukia*, they have an undifferentiated preglabellar area, but in this case it is separated from the preocular areas by transverse or oblique preocular furrows. *Eosaukia* has previously been regarded as representative of *Calvinella* Walcott in eastern Asia, and *Mictosaukia* as *Tellerina* Ulrich & Resser, but it now seems unlikely that these typically North American genera occur in the Australian/Asian region.

Genus *Eosaukia* Lu, 1954

Type Species: *Eosaukia latilimbata* Lu (sp. nov.); Lu, 1954, pp. 145-146, pl. 1, figs. 5-6; by original designation; Sandu Shale, Sandu, southeastern Guizhou, China; Late Cambrian, Fengshanian.

Comments: *Eosaukia latilimbata* Lu is known from two imperfect, but fully articulated, specimens. One of these, the holotype, is from southeastern Guizhou (Lu, 1954, 1957; Lu *et al.*, 1965; Lu & Chien, 1978), and the other from Yunnan (Luo, 1983). Both specimens have damaged preglabellar areas. However, an external mould of the holotype is available (Nanjing Institute of Geology and Palaeontology 7227) and is figured herein (Pl. 5, Figs. 20–22).

This specimen shows the holotype to have been sagittally compressed (foreshortened). The preglabellar area on the external mould is more or less complete, but has been driven addorsally (i.e. pushed upwards) and does not retain its original convexity (sag.). It seems likely that it would have been simply convex (sag.), as for example in "*Calvinella*" *walcotti* (Mansuy) (see below). The preglabellar area is granulose, as is the glabella and occipital ring which bears a prominent node or vestigial spine. The palpebral lobes are relatively small (exsag.), and spaced well away from the axial furrows. Palpebral areas are both striate and faintly granulose.

The articulated librigena of the holotype is prosaukioid in appearance, but the posterior border furrow terminates at the genal spine base. The genal spines seem to be characteristically curved both outwards and addorsally. The genal field is concentrically striate. *Eosaukia latilimbata* has eleven thoracic segments, which have short terminal spines laterally. A small transverse triangular pygidium has three axial segments, the first slightly wider (tr.) than the others. Traces of a narrow border are apparent. *Eosaukia* seems, therefore, to be an eminently interpretable genus, having the advantage of fully articulated tagmata.

Because they frequently possess an occipital spine, at least during early morphogenesis, trilobites referred here to *Eosaukia* Lu (1954), have commonly been assigned by Chinese geologists (e.g. Lu *et al.*, 1957; Lu *et al.*, 1965; Li & Yin, 1973; Sun & Xiang, 1979; Nan, 1980; Zhu, 1982, *inter alia*) to the genus *Calvinella* Walcott, 1914. Similar material from northeastern China has also been identified as *Saukioides* Kobayashi, 1952 (Kobayashi, 1951; Duan *et al.*, 1986). Others, e.g. Zhu (1982), have even applied the generic name *Mictosaukia* Shergold, 1975 to such forms. *Calvinella* was applied to Asian saukiids for the first time by Kobayashi (1933, p. 129). *Ptychaspis walcotti* Mansuy, 1915 from Vietnam was assigned, together with unfigured specimens from Liaoning, to this typically North American genus. Use of *Calvinella* was perpetuated by Lu (1957) and Lu *et al.* (1965), Li & Yin (1973), Sun & Xiang (1979) and Nan (1980). The name *Calvinella*, either qualified or unqualified, has been applied in particular to Mansuy's (1915) cranidium (pl. 3, fig. 1a), pygidium (pl. 3, fig. 1x), and librigena (pl. 3, fig. 1r). This is an appropriate combination, which can be matched in peninsular Thailand, Guizhou, and central Australia. However, the smaller, wide-spaced palpebral lobes, and small, transverse triangular pygidium distinguish Australian and Asian material from all species assigned to *Calvinella* in North America.

The same cranidial characteristics are also apparent on the holotype of *Saukioides* Kobayashi (1951, pl. 7, fig. 8), although the structure of the preglabellar area is not clearly visible. Associated pygidia contain only three segments, as in *Eosaukia*. The paratype cranidium (Kobayashi, 1951, pl. 7, fig. 11) used in the cephalic reconstruction (1951, p. 78, text fig. 2) appears to be more like *Platysaukia*, as interpreted herein, and this similarity may also extend to the larger palpebral lobes situated adjacent to the axial furrows. While *Saukioides* seems to be a composite genus, its designated holotype cranidium can be interpreted. It seems to be essentially the same as that of *Eosaukia*, but the resemblances can only be reassessed by comparison of the type material. Should no real difference be found, *Eosaukia* will become a synonym of *Saukioides*, which has priority. In the meantime, *Eosaukia* is retained, having the advantage of the completeness of its type specimen.

Eosaukia embraces older concepts based on *Ptychaspis*/ *"Calvinella" walcotti* (Mansuy) and associated species in China and Vietnam, as well as concepts based on *Saukioides suni* (Kobayashi, 1951), as for example, revived by Duan *et al.* (1986), and those derived from species assigned to *Eosaukia* and *"Eosaukia"* in south-central China, Yunnan and Thailand. The relationship of many of these taxa has been concealed by erroneously applied concepts, poor illustration, and inadequate type materials.

Besides the type species, *Eosaukia latilimbata* Lu, 1954, three others can be diagnosed. All species are linked by preglabellar, palpebral and pygidial morphology, and the presence at some stage during morphogenesis of an occipital spine. Accordingly, other species include *"Eosaukia" buravasi* Kobayashi (1957, pp. 376–378, pl. 5, figs 3?, 4, 5, 16–18) from Tarutao Island, peninsular Thailand; ?*Calvinella solitaria* Shergold (1975, pp. 141–142, pl. 23, figs 1–7), from the late Payntonian of western Queensland, Australia; and *Calvinella micropora* Qian (1985, pp. 81–82, pl. 18, figs 1–9), from the late Fengshanian, Jilin Province, northeastern China. All species occur in close proximity to the Cambrian–Ordovician boundary.

Eosaukia **sp. cf.** ***E. walcotti*** **(Mansuy, 1915)**

(Pl. 5, Figs 10-19)

Synonymy: For references prior to 1965, see Lu *et al.* (1965, p. 451). Selected synonymy below refers to *E. walcotti* (Mansuy) only.

cf. 1915 *Ptychaspis walcotti* nov. sp.; Mansuy, 1915, pp. 22–25, pl. 3, figs 1a, 1c, 1d, 1f, 1g–q?, 1r–u, 1x–z (*non* fig. 1e = *Lophosaukia*?).

cf. ? 1915 *Ptychaspis walcotti* nov. sp.; Mansuy, 1915, pp. 22–25, pl. 2, figs 16a–b.

cf. ? 1916 *Ptychaspis walcotti* Mansuy; Mansuy, 1916, p. 33, pl. 5, figs 10a–j.

cf. 1965 *Calvinella walcotti* (Mansuy); Lu *et al.* 1965, pp. 451–452, pl. 88, figs 13–16.

cf. ? 1973 *Calvinella striata* Resser et Endo; Li & Yin, 1973, p. 31, pl. 2, figs 1–2.

cf. ? 1973 *Calvinella walcotti* (Mansuy); Li & Yin, 1973, p. 30, pl. 2, fig. 3.

cf. 1977 *Calvinella striata* Resser et Endo; Zhou, 1977, p. 206, pl. 61, figs 3–5.

cf. ? 1978 *Calvinella striata* Resser et Endo; Lu & Chien, 1978, p. 517, pl. 171, fig. 3.

cf. ? 1978 *Calvinella walcotti* (Mansuy); Lu & Chien, 1978, p. 517, pl. 171, fig. 4.

cf. 1979 *"Calvinella" walcotti* (Mansuy); Sun & Xiang, 1979, p. 11, pl. 3, fig. 11.

cf. 1980 *Calvinella callisto* (Walcott); Nan, 1980, p. 508, pl. 208, figs 20–21.

cf. 1982 *"Calvinella" walcotti* (Mansuy); Zhu, 1982, p. 295, pl. 1, figs 7–8; pl. 2, fig. 6; pl. 3, fig. 1.

cf. 1982 *Mictosaukia? batangensis* Zhu (sp. nov.); Zhu, 1982, pp. 294-295, pl. 1, figs 3–6; pl. 2, fig 1-3.

cf. 1982 *Mictosaukia*? sp.; Zhu, 1982, p. 295, pl. 3, fig. 2.

non 1956 *Eosaukia*(?) *walcotti* (Mansuy); Kobayashi, 1956, p. 281, pl. 40, figs 1–4.

non 1957 *Calvinella walcotti* (Mansuy); Lu, 1957, p. 285, pl. 148, fig. 5.

non 1980 *Calvinella walcotti* (Mansuy); Nan, 1980, p. 508, pl. 209, fig. 4.

Material: Selected prepared material includes 38 cranidia CPC26613–26650, within the size range 5–10.5 mm; three librigenae, CPC26651–26653; eight pygidia (Lp$_2$, 2–7 mm), CPC26654–26661.

Distribution: All the prepared material is from the Ross River and Fergusson Synclines in the eastern Amadeus Basin, at localities AS13, AS147, AS193, AS197, AS270, AS351 and AS354. Additional material from AS198, AS199, AS350, AS352, NT606 and Hy276 extends this distribution to the Waterhouse Range Anticline.

Age: Late Cambrian, Payntonian/Early Datsonian, Assemblage 1.

Description: The glabella is widest (tr.) at the preoccipital lobes, thence forwards rectangular, obtusely rounded anteriorly. The preoccipital glabellar furrows are sagittally connected, and abaxially confluent with the axial furrows; median and anterior lateral furrows are short (tr.), sagittally discontinuous, and only faintly developed. The occipital ring is marginally wider (tr.) than the preoccipital lobes, from which it is separated by a sinuous laterally overdeepened occipital furrow. An addorsally and posteriorly curving occipital spine or prominent node is present throughout morphogenesis.

The palpebral lobes are barely arcuate, short (exsag.), extending from the preoccipital glabellar furrows to the anterior lateral furrows. They are situated well away from the axial furrows, the palpebral areas being as wide (tr.) as the length (exsag.) of the palpebral lobes. The former are gently convex (tr.); the latter raised significantly above the palpebral areas (Pl. 5, Fig. 12).

Postocular sections of the facial suture enclose moderately long (tr.), broad-based triangular posterolateral limbs, which bear narrow (exsag.) posterior borders and wide (exsag.) border furrows. Preocular sections of the facial suture run directly to the anterolateral margins of the cranidium and enclose an anteriorly broadly rounded preglabellar area, which is not differentiated into a preglabellar field and border. The preglabellar area has a gentle convexity (sag.), and is divided from the preocular areas by deep anterolaterally directed preocular furrows, which are confluent with the preglabellar furrow. A pair of pits may develop in the floor of the axial furrows on the posterior side of this confluence (Pl. 5, Figs 14, 15).

The associated librigena is recognised by a characteristic flattening of its lateral margin at the beginning of the genal spine base. The genal field has low convexity; the lateral border furrows may be quite weakly developed; and the lateral borders may be of unequal width (exsag.). The posterior borders are short (tr.), but weak posterior border furrows continue into the base of the genal spine, but are not confluent with the lateral furrows. The genal spine is often adaxially incurved distally.

The pygidium is small and triangular, wider (tr.) than long (sag.). The axis contains two, possibly three, segments, of which the anterior-most is the widest (tr.). The axis continues to the posterior pygidial margin. The pleural areas are differentiated into only a single segment by a poorly defined pleural furrow. All other furrows, pleural and interpleural, are effaced. Very narrow, poorly defined, posterolateral borders appear to be present. The margins are non-spinose.

The whole of the surface of the cranidium, and probably also the librigena, is granulose. The prosopon of the pygidium is unknown. No trace of the concentric striations observed on the type species of *Eosaukia* is preserved on the central Australian material.

Relationships: *Eosaukia* cf. *walcotti* (Mansuy) differs little from specimens included by Mansuy (1915, 1916) in his *Ptychaspis walcotti*. This species is, however, composite. No type specimen was designated, and so the concept of the species is not clearly understood. Furthermore, the Vietnamese material is variously deformed. For these reasons the confer is added to the present determination.

As is indicated by the synonymy list, this or a similar species occurs widely in southwestern China (Guizhou, Yunnan, Sichuan), Vietnam and Thailand, and extends into northern Australia. Material from Guizhou, referred by Li & Yin (1973, pp. 30-31, pl. 2, figs 1-3) to *Calvinella striata* Resser & Endo and *C. walcotti* (Mansuy), has smaller (exsag.) palpebral lobes situated closer to the axial furrows, but only a small number of specimens is available and the degree of variation cannot be readily assessed. In other respects, these cranidia, and those referred by Zhou (1977, p. 206, pl. 61, figs 3-5) to *C. striata* Resser & Endo, appear very similar to Mansuy's (1915) material. It seems unlikely that *C. striata sensu stricto*, which is representative of the genus *Mictosaukia*, occurs outside northern China.

Specimens illustrated from Yunnan (Sun & Xiang, 1979) and western Sichuan (Zhu, 1982) appear to represent variously distorted versions of a single species similar to that described by Mansuy (1915).

Of the other species of *Eosaukia* listed above, *E.* cf. *walcotti* (Mansuy) closely resembles the type species *E. latilimbata* Lu, illustrated herein (Pl. 5, Figs 20-22). It is differentiated from this species, and from *E. buravasi* Kobayashi, by retention of its occipital spine longer during morphogenesis. So similar are these species that they may eventually prove to be synonyms. *E. solitaria* (Shergold), previously described from northern Australia, also loses its occipital spine early during morphogenesis, but this species has longer (exsag.) palpebral lobes closer to the axial furrows. *E. micropora* (Qian) retains its occipital spine, but also has narrow (tr.) palpebral areas. In addition, its librigena appears to be characterised by an effaced lateral border furrow.

Genus *Mictosaukia* Shergold, 1975

Type species: *Tellerina orientalis* Resser & Endo *in* Endo, 1931, p. 89, figs 1-7; *in* Endo & Resser, 1937, pp. 293-294, pl. 57, figs 1-7; designated Shergold (1975, p. 143); Wanwan Formation, Tawenkou, Liaoning, China; Late Cambrian, late Fengshanian, *Mictosaukia orientalis* Zone.

Other species: Since the genus *Mictosaukia* was erected in 1975, a considerable amount of new information has been published in China pertinent to its distribution and speciation (e.g. Zhang & Jell, 1987). Some species originally included by Shergold (1975, p. 143) in *Mictosaukia* are now considered to belong elsewhere. A revised concept of the genus might include the following species, regardless of synonymy: *Ptychaspis acamus* Walcott (1913, p. 179, pl. 16, fig. 18), Shandong, China; *Mictosaukia angustilimbata* Qian (*in* Chen, 1986, pp. 276-278, pl. 71, figs 8-11; pl. 72, figs 1-5, 8), Jilin, China; *Ptychaspis bella* Walcott (1913, p. 180, pl. 17, fig. 9), Liaoning, China; *Ptychaspis callisto* Walcott (1913, pp. 183-184, pl. 16, figs 14, 14a), Shandong, China; *Ptychaspis chinhsiensis* Sun (*pars*) (1924, pp. 64-66, pl. 4, figs 8b, 8c, 8f, *non* figs 8a, 8e = *Lophosaukia*? or 8d?), Liaoning, China; *Tellerina coreanica* Kobayashi (1935, p. 316, pl. 4, figs 12-14, *non* fig. 5?), Doten, South Korea; *Mictosaukia dayangchaensis* Kuo & An (in Kuo *et al.*, 1982, pp. 17-18, pl. 1, figs 18-19; Duan *et al.*, 1986, p. 49, pl. 7, figs 15-17), Jilin, China; *Calvinella diversa* Endo (*in* Endo & Resser, 1937, p. 363, pl. 73, fig. 10), Liaoning, China; *Saukia globosa* Robison & Pantoja-Alor (1968, pp. 795-796, pl. 104, figs 12-19), Oaxaca, Mexico; *Mictosaukia luanhensis* Zhou & Zhang (1978, p. 8, pl. 1, figs 18-21; 1983, p. 29, pl. 2, figs 5-6; 1985, pp. 104-106, pl. 7, figs 8-9; pl. 26, figs 10-14; pl. 28, fig. 11; Duan *et al.*, 1986, pp. 48-49, pl. 7, figs 11-14; pl. 8, fig. 4), Hebei, Shanxi, Jilin, China; *Tellerina paichiaensis* Kobayashi (1933, p. 130, pl. 13, fig. 9), Liaoning, China; *Mictosaukia perplexa* Shergold (1975, pp. 144-146, pl. 24, figs 1-9), western Queensland, Australia; *Saukia rotunda* Kushan (1973, pp. 157-159, pl. 33, figs 9-13; pl. 34, figs 1-7), Iran; *Saukia* cf. *S. rotunda* Kushan (Dean, 1982, p. 91, pl. 1, figs 9, 11, 14), southeastern Turkey; *Calvinella striata* Resser & Endo (*in* Endo & Resser, 1937, p. 189, pl. 56, figs 24-25); Peng (1983, p. 51, pl. 2, figs 7-8; 1984, pp. 350-351, pl. 8, figs 1-3, 4a; Qian *in* Chen *et al.*, 1985, p. 81, pl. 16, figs 3-6; pl. 17, figs 1-4; Zhou & Zhang, 1985, p. 104, pl. 1, fig. 12; pl. 4, fig. 13; pl. 7, figs 1-3; pl. 11, fig. 4; pl. 12, figs 4-7; pl. 28, figs 9-10; *in* Chen, 1986, pp. 278-281, pl. 71, figs 1-7), Liaoning, Jilin, Shanxi, Nei Monggol, Guizhou, China; *Saukia wirtzi* Wolfart (1970, pp. 43-47, pl. 8, figs 8-9; pl. 9, figs 2, 3?, 4-7; pl. 10, figs 1-2, 3?, 4-6, 7?, pl. 11, figs 1–3), Afghanistan. In addition, specimens referable to *Mictosaukia* have been included among the type material of *Ptychaspis walcotti* (Mansuy, 1915), and possibly *"Eosaukia" buravasi* Kobayashi (1957), respectively from Vietnam and peninsular Thailand.

Comments: *Mictosaukia* is shown to have an extremely wide spatial distribution, occurring throughout NE and SW China (Jilin, Liaoning, Nei Monggol, Hebei, Shanxi, Shandong, Guizhou, Yunnan), Vietnam, Thailand, South Korea, Afghanistan, Iran, SE Turkey, central Mexico, and northern Australia. Stratigraphically, the genus is restricted to a relatively narrow interval at the close of the Late Cambrian, *M. orientalis* Assemblage-Zone in China (*M. perplexa* Assemblage Zone in Australia), which according to Miller (1984) overlaps the initial *Cordylodus proavus* Zone on the conodont biochronological scale.

As presently conceived, *Mictosaukia* is diagnosed by an undifferentiated convex (sag.) preglabellar area, separated from narrow (tr.) preocular areas by transverse or anterolaterally directed preocular furrows confluent with the axial and preglabellar furrows; long (exsag.) palpebral lobes situated posteriorly to the mid-length of the glabella and close to the axial furrows; long (tr.), narrow posterolateral limbs; characteristic librigena in which the lateral and posterior border furrows become confluent at the genal spine base, but do not extend into it, and in which the lateral borders are crenulated when the shell is exfoliated; a subelliptical pygidium with up to five segments, parallel pleural and interpleural furrows, and poorly defined border; non spinose.

Mictosaukia species undetermined
(Pl. 5, Figs 2–9)

Material: Nine cranidia, CPC26662–26666, 26671, 26673–26675, within the size range 4–22 mm; three librigenae, CPC26667–26668, 26672; and two pygidia, CPC26669–26670, with lengths (Lp_2) up to 10.5 mm.

Distribution: *Mictosaukia* sp. undet. is restricted to the Ross River sections of the eastern Amadeus Basin, occurring at localities AS197, AS199 and AS302.

Age: Late Cambrian, Payntonian/Early Datsonian, Assemblage 1.

Description: *Mictosaukia* sp. undet. has all the diagnostic characteristics of this genus. It is, however, distinctive in possessing an evenly narrow (sag., exsag.), almost ridge-like preglabellar area, separated from narrow (tr.) preocular areas by deep anterolateral preocular furrows; proportionately short (exsag.), arcuate palpebral lobes; and palpebral areas which are relatively wide (tr.) for this genus. The glabella is subrectangular, only slightly wider (tr.) at the preoccipital lobes than at the frontal lobe. Only the preoccipital furrows are distinctively developed. The degree of anterior taper of the glabella and degree of definition of the glabellar furrows appears to vary with cranidial length (cf. Pl. 5, Figs 4, 9). The occipital ring is wider (tr.) than the glabellar lobes, and bears a trace of a median node.

The associated librigena typically has only a short genal spine, a wide lateral border, and quite convex (tr.) genal field. The lateral and posterior border furrows are confluent at the genal angle.

The pygidium is attributed with confidence to *Mictosaukia* sp. undet. This is semielliptical, non-spinose, and contains five segments. The axis bears a long terminal piece which continues to the posterior pygidial margin. Pleurae are divided by deep furrows, and separated by concentric, weaker interpleural furrows. These furrows terminate distally at a narrow (tr.) indistinct border.

Relationships: *Mictosaukia* sp. undet. has a shorter (sag.) preglabellar area, and wider palpebral areas than *M. chinhsiensis* (Sun), *M. dayangchaensis* Kuo & An, *M. diversa* (Endo), and *M. striata* (Resser & Endo). It has some similarity with Walcott's (1913) species *Ptychaspis acamus* and *Ptychaspis callisto*, subsequently referred (Lu *et al.*, 1965) to *Saukia* and *Tellerina* respectively, both from Shandong Province, China. Late holaspides of *Mictosaukia* sp. undet. (e.g. Pl. 5, Figs 8–9) particularly resemble the specimen which Kobayashi (1933, pl. 13, fig. 9) described as *Tellerina paichiaensis* from Liaoning, where earlier holaspides (e.g. figs. 2–4) resemble *Tellerina coreanica* Kobayashi (1935, pl. 4, figs 12–14, *non* fig. 5), from South Korea. Similarity with this last species may also extend to the pentameric pygidium.

Outside eastern Asia, *Saukia rotunda* Kushan (1973, pl. 33, figs 9–13; pl. 34, figs 1–7) may be the most similar species in terms of preglabellar and palpebral morphology of the cranidium, and the pygidium. The librigena assigned to this species, however, is quite unlike that typical of *Mictosaukia*, as, for example, those illustrated on Pl. 5, Figs 5–6.

Genus *Sinosaukia* Sun, 1935

Type species: *Sinosaukia pustulosa* Sun (sp. nov.), Sun, 1935, pp. 52–53, pl. 5, figs 1, 3–4, 6–7 (*non* figs 2a–b, 5a–b = *Lophosaukia*); by original designation; Upper Wolungshan Formation, Huolu, and Kaolishan Formation, Taian, Shandong; Late Cambrian, Fengshanian, *Quadraticephalus walcotti* Zone of Kaolishan.

Comments: *Sinosaukia* Sun is similar to *Saukia* Walcott, 1914 in its glabellar shape and furrowing, and size and position of the palpebral lobes. The glabella is frequently laterally constricted and the frontal lobe expanded. The palpebral lobes are long (exsag.) and adjacent to the axial furrows. The preglabellar area is undifferentiated into a preglabellar field and a border, and there are no preocular furrows or lateral continuations of the preglabellar furrow, as in *Saukia* and *Lophosaukia* Shergold, 1975. There is often a gently angulate anterior cranidial marginal contour, but not emphasised to the extent observed in either *Lophosaukia* or *Linguisaukia* Peng, 1983. Only the degree of cranidial morphology distinguishes all of these genera: the preglabellar area of *Lophosaukia* is drawn out into a quite definite apex, while that of *Linguisaukia* is formed into a distinctive spine. The degree of projection is then reflected in the morphology of the anterior prong of the librigena. Associated pygidia are semi-elliptical or semicircular, non-spinose, and have up to seven segments and an indefinite border. Pleural and interpleural furrows are concentric, the former bisecting the pleura equally. While the possible synonymy of *Sinosaukia*, *Lophosaukia* and *Linguisaukia* cannot be ruled out, these genera are considered here distinct. No type specimen was designated for *Sinosaukia*, and the whereabouts of Sun's original material is presently not known.

Sinosaukia sp. aff. *S. impages* Shergold, 1975
(Pl. 5, Fig. 1)

aff. 1975 *Sinosaukia impages* sp. nov.; Shergold, 1975, pp. 133–134, pl. 17, figs. 1–7.

Material: A single cranidium is here referred to *Sinosaukia*, CPC26676, length approximately 8 mm.

Distribution: Fergusson Syncline, locality AS354.

Age: Late Cambrian, Payntonian/Early Datsonian, Assemblage 1.

Comments: CPC26676 is referred to *Sinosaukia* on account of its glabellar and palpebral morphology. The glabella is laterally constricted at the median lateral lobes, and the frontal lobe is laterally slightly expanded. The palpebral lobes are almost semi-circular, situated adjacent to the axial furrows, and extend from the occipital furrow to the anterior lateral glabellar furrows.

Sinosaukia sp. undet. has a simple preglabellar area, which is gently convex (sag.), narrow (sag.) and only very slightly angulate anteriorly. It lacks the highly pustulose condition which Kobayashi (1960b, p. 405) considered to be diagnostic of *Sinosaukia*, and in this respect closely resembles *S. impages* Shergold (1975, pp. 133-134, pl. 17, figs 1-7), previously described from the *Sinosaukia impages* and *Neoagnostus quasibilobus*/*Shergoldia nomas* Assemblage-Zones of western Queensland. Insufficient material from the Amadeus Basin prevents firm identification with *S. impages*, which may have even longer (exsag.) palpebral lobes (see Shergold, 1975, pl. 17, fig. 2).

Genus *Platysaukia* Kobayashi, 1960

Type species: *Platysaukia euryrachis* Kobayashi, new species; Kobayashi, 1960b, p. 407, pl. 19, fig. 12, cranidium, by original designation; upper Kasetzu Formation, Sodo-ri, Ch'ongori district, South Korea; Late Cambrian, Fengshanian, *Shergoldia* Zone.

Comments: *Platysaukia* is a saukiid genus characterised by a broad (tr.) rectangular glabella; broad (tr.), gently convex (sag.) or flat preglabellar area only very faintly differentiated into a border and preglabellar field; long (exsag.) palpebral lobes, situated close to the axial furrows.

Kobayashi (1960b) based *Platysaukia* on a single cranidial fragment having the above characteristics. Similar cranidia occur commonly in the sandy sediments of the eastern Amadeus Basin, where two further species, differentiated by occipital, palpebral and pygidial criteria, are recognised.

Öpik (1952, 1955) originally determined these species as *Dikelocephalus*, with which they are almost homeomorphic, differing in a convex (sag.) rather than concave preglabellar area, less extensive posterolateral limbs, frequently a broad occipital ring (tr.), and pygidium without marginal spines. Nevertheless, there is a striking similarity in general size range, convexity (tr. and sag.) and hypostomal morphology; effaced pygidial interpleural furrows, and occasionally similar prosopon.

Australian species of *Platysaukia* are also similar in size and convexity to some species of *Tellerina*, e.g. *T. leucosia* (Walcott, 1914) and *T. convexa* Ulrich & Resser, 1933, which also have wide (tr.) occipital rings, effaced preocular furrows, and similar pygidial furrowing. Comparison may also be made with *Saukia enshiensis* Chu (1974: p. 107, pl. 42, figs 11-14; also Zhou, 1977, p. 205, pl. 60, figs 13-16), which appears to represent *Platysaukia* in central and southwestern China. *Saukia distincta* Zhou (1977, p. 204, pl. 60, figs 9-11) and *Saukia jinxianensis* Chien (*in* Lu *et al.*, 1974, pp. 99-100, pl. 4, fig. 10) may be other species of a similar age. Both have long (exsag.) palpebral lobes situated close to the axial furrows and appropriate preglabellar areas.

Platysaukia jokliki sp. nov.
(Pl. 3, Figs 1-22; Pl. 4, Fig. 15)

1952 *Dikelocephalus* sp.; Öpik, 1952, p. 1 (listed)
1955 *Dikelocephalus* sp.; Öpik *in* Joklik 1955, p. 30 (listed)

Name: This species is named after G. F. Joklik, who first collected Late Cambrian trilobites in the Ross River Gorge in October 1951.

Types: Holotype, CPC26677, cranidium (Pl. 3, Fig. 5); paratypes, CPC26678-26742.

Material: The description is based on a selected paradigm of 37 cranidia, CPC26677-26692, 26701-26705, 26711-26716, 26720-26723, 26725-26728, 26739-26741, with approximate lengths 2.8-35.5 mm; ten librigenae, CPC 26706-26708, 26718, 26729-26734; six hypostomata, CPC26693-26696, 26717, 26724; and thirteen pygidia, CPC26697-26700, 26709-26710, 26719, 26735-26738, 26742, lengths (Lp_2) 1.15-35 mm.

Distribution: The selected material is from collections AS8, AS13, AS196, AS197, AS198, AS199, AS300, AS350 and Hy276. Other material occurs in collections AS3, AS12, AS51, AS85, AS125, AS198, AS247, AS301, AS302, AS314, AS351 and Rd204. The species is thus very common in the Ross River Syncline, the western portion of the Fergusson Syncline, and the adjacent Todd River Anticline. From the Ross River Gorge, the species extends southwestwards to Mount Peachy, and westwards to the Waterhouse Range.

The two Australian species of *Platysaukia* described here are considered to have a similar age. They do, however, have a different geographic and probably stratigraphic, and thus palaeoenvironmental, distribution. *P. jokliki* occurs throughout the basal Pacoota Sandstone in the eastern part of the Amadeus Basin, where tidal sedimentation appears to have predominated. *P. tomichi* is more restricted in its distribution and occurs only in both the Waterhouse Range Anticline and at Ellery Creek in coarse channel-fill deposits and associated clean saccharoidal quartz sandstones, which, prior to the present study, were considered to constitute the "Upper" Goyder Formation (now Sequence 1 of the Pacoota Sandstone).

Age: Late Cambrian, Payntonian/Early Datsonian, Assemblage 1.

Diagnosis: A species of *Platysaukia* Kobayashi characterised by an occipital ring which is, in holaspides, wider (tr.) than the glabellar lobes; preglabellar area with a faint indication of differentiation into a cranidial border and preglabellar field; lacking any trace of preocular or laterally continuous preglabellar furrows; pygidium semicircular to subtriangular.

Description: In early holaspides, the glabellar is rectangular, narrowing (tr.) very slightly forwards, but the shape becomes more evenly rectangular during holaspid morphogenesis; preoccipital glabellar furrow is defined at all growth stages, is sagittally continuous and contacts the axial furrows laterally; discontinuous median lateral furrows are also transverse; indications of anterior lateral furrows are rarely preserved. The glabella is slightly wider (tr.) at the preoccipital lobes. It is anteriorly truncate or obtusely rounded. The occipital furrow is strongly defined, separating a relatively narrow (sag.) occipital ring, which is invariably wider (tr.) than any of the glabellar lobes. A faint occipital node may be indicated in early holaspides.

In early holaspides, the palpebral lobes are long (exsag.), almost semicircular, and lie adjacent to the axial furrows, but in subsequent holaspid morphogenesis they appear proportionately shorter (exsag.) and arcuate, and narrow (tr.) gently inclined palpebral areas are developed. In late holaspides, the palpebral lobes extend from near the middle of the preoccipital lobe to a point at or slightly in front of the median lateral furrow.

Postocular sections of the facial suture enclose short (tr.) triangular posterolateral limbs with well-defined posterior cranidial furrows. Preocular sections of the facial suture diverge significantly, curve anterolaterally, and unite to form a transversely truncate anterior cranidial contour. They enclose confluent preocular and preglabellar areas. However, the latter may retain a trace of an equidimensional anterior border and preglabellar field. Combined, the preglabellar area is very gently convex (sag.) or even flat; but, occasionally, a trace of a flatter border and slightly more convex preglabellar field is apparent.

The hypostome is characteristically saukiid, with a rectangular median body and expansive anterolateral wings turned addorsally. Posterolaterally, the corners of the median body are chopped off, and the lateral and posterior margins are very slightly curved inwards. The anterior lobe is gently convex (sag., tr.), ovoid and long (sag.); the posterior lobe is U-shaped and quite restricted by the long anterior lobe and its constraining furrows. A pair of pits lies at the anterior end of these furrows; a second pair forms at the posterolateral border; and a third very faint and shallow pair of pits lies immediately adjacent to the sagittal line in the posterior border.

The librigena is broad and relatively flat. It bears evenly wide lateral and posterior borders, the latter having a deeper furrow. The border furrows combine at the genal angle and continue for a short distance into the genal spine base. A relatively long, sometimes curved, delicate genal spine is observed.

Associated pygidia are semicircular or subtriangular, according to size. They have an axis which does not reach the posterior border and has only a weak postaxial ridge. Up to seven segments, according to size, are clearly defined. Up to seven pleural segments may also be defined by strongly developed pleural furrows, which sweep posterolaterally to terminate at a narrow border. Interpleural furrows are not well defined; distally, they cut across the propleuron of the following segment. The border is reflected; the geniculation is narrow (tr.); the doublure is wide (tr., sag.); and the margins are entire, non-spinose at all morphogenetic stages.

Although preserved in sediments with various grain sizes, *Platysaukia jokliki* sp. nov. exhibits a good range of proposon. The glabella, occipital ring, palpebral lobes and areas, and the axial and pleural segments of the pygidium are all finely and densely granulose. Concentric striae are found on the preglabellar area and across the whole of the librigena; and all doublures, where these are preserved. None of the hypostomata have any characteristic prosopon.

Comments: The presently illustrated species, *Platysaukia jokliki* sp. nov., is distinguished from the type species, *P. euryrachis* Kobayashi, on account of its more arcuate, less semi-circular palpebral lobes, development of narrow (tr.) palpebral areas, and its characteristically wide (tr.) occipital ring.

A degree of variation exists in the morphology of the material studied. This is observed in the definition of the components of the preglabellar area, as detailed above. Two kinds of pygidium may be included in the present paradigm. However, insufficient specimens are available to form a continuous morphogenetic sequence. Differences among the smaller and larger specimens illustrated here are in shape (compare Pl. 3, Figs 13 and 18) and segmentation. The smaller specimens are less subtriangular and have consistently fewer segments, five as against seven for the larger specimens.

Hypostomata, possibly, 'may also not have been correctly assigned here'. That illustrated (Pl. 3, Fig. 11) does not differ significantly from the one assigned to *Lichengia absona* (Shergold). However, the size of the hypostomata recovered suggests preferential assignation to *Platysaukia*.

Platysaukia tomichi sp. nov.
(Pl. 4, Figs 8–14, 24)

Name: After S. A. Tomich, who collected the first Late Cambrian trilobites with G. F. Joklik in 1951.

Types: Holotype, CPC26743, the cranidial mould illustrated on Pl. 4, Figs 10–11; paratypes, CPC26744–26770, 26803–26804.

Material: The species is based on six cranidial fragments, CPC26743–26745, 26754–26755, 26762, ranging up to a length (sag.) of 16 mm; eight librigenae, CPC26763–26770; a possible hypostome, CPC26746; and fifteen pygidia, CPC26747–26753, 26756–26761, 26803–26804, with lengths (Lp_2) 5.6–15.9 mm.

Distribution: Material assigned to this species has been recognised in only a small number of collections in the Waterhouse Range, Hy265, Hy266, Hy277, NT183, 87/002, 003, 004, and at Ellery Creek, 87/005, 006.

Age: Late Cambrian, Payntonian/Early Datsonian, Assemblage 1.

Diagnosis: A species of *Platysaukia* with relatively, but consistently, narrow (tr.) occipital ring and preglabellar area; palpebral lobes adjacent to the axial furrows; ovoid or cordate prosaukioid pygidium.

Differential diagnosis: *Platysaukia tomichi* sp. nov. is based on material which is generally not well preserved, nor is it by any means as abundant as *P. jokliki* sp. nov. Hence, the same degree of descriptive resolution is not possible. Accordingly, morphology of a comparative nature is included here.

Cranidially, *Platysaukia tomichi* resembles *P. jokliki* described above. In general appearance, it resembles the early holaspid morphology of the latter in terms of glabellar shape and size and position of the palpebral lobes (compare Pl. 4, Figs 12 and 15). In these, it also resembles the type species *P. euryrachis* Kobayashi. However, no comparably large specimens are available to confirm the constancy of this morphology with growth. Most cranidial fragments so far observed retain a suggestion of a poorly differentiated preglabellar area. The occipital ring appears to be substantially narrower (tr.) than that of *P. jokliki*. Librigenae are essentially similar to those of *P. jokliki*, as far as can be ascertained from the poor preservation. Similarly, an associated hypostoma (Pl. 4, Fig. 14) has the same basic morphological elements as those of *P. jokliki*, but the whole structure is narrower (tr.), as, correspondingly, is the glabella of *P. tomichi*.

If they do in fact belong to *P. tomichi*, associated pygidia are quite distinct. As in the case of *P. jokliki*, these pygidia are prosaukioid in that their pleurae are swept posterolaterally backwards; the pleural furrows are strongly defined and bisect the pleura equally; the interpleural furrows are weaker and cut across the propleura of the following segment; and the opisthopleurae merge distally with a narrow border. Pygidia referred to *P. tomichi* are ovoid or cordate rather than transverse subtriangular. The variation in pygidial segmentation observed in *P. jokliki* is also seen in *P. tomichi*. In both species, specimens over 7 mm long (sag.) have six or seven segments, whereas smaller specimens (cf. Pl. 4, Figs 8 and 24) have only five segments. There does not seem to be a readily discernible shape difference between the smaller and larger specimens of *P. tomichi*. In both species of *Platysaukia* described here, the pygidial axis is quite short (sag.) and a post-axial ridge negligible. Prosopon cannot be compared, since so little is preserved in the case of *P. tomichi*.

Genus ***Lichengia*** Kobayashi, 1942

Type species: *Lichengia onigawara* Kobayashi, new genus and species; Kobayashi, 1942, pp. 297–298, fig. 1 [= *Prosaukia brizo* Sun (*non* Walcott), 1935, pp. 43–44, pl. 4, figs 22, 23; refigured Lu *et al.*, 1965, p. 453, pl. 89, figs 1–2]; Licheng Formation, Shangyaochen, Licheng, Shanxi, China; Late Cambrian, Fengshanian.

Comments: *Lichengia* is not easy to assess: Sun's original material of *Prosaukia brizo* (1935, pl. 4, figs 22–23) was not well illustrated. The cranidium used by Kobayashi (1942, p. 298, fig. 1) to illustrate *Linchengia* [*sic*] *onigawara* seems to differ from that used by Sun, and there is also some difficulty in reconciling that used by Lu *et al.* (1965, pl. 89, fig. 1), because the specimen has been tilted backwards, thereby exaggerating the preglabellar appearance. From a combination of all sources, it would appear that the type cranidium has a glabella which is considerably widened (tr.) at the preoccipital furrows, thence tapers gently forwards and is obtusely rounded anteriorly. The occipital ring is not as wide (tr.) as the maximum glabellar width. A distinct preglabellar field is present, but the anterior cranidial border furrow may be deflected around an anteriorly thickened cranidial border (sag.). The palpebral lobes are posteriorly situated, opposite the maximum glabellar width, and ocular ridges are faintly indicated. Sun (1935) and Lu *et al.* (1965) illustrated the same associated pygidium, which is prosaukioid, trapezoidal, posteriorly possibly gently emarginate, composed of four segments, which have posterolaterally swept back pleurae and pleural furrows extending almost to the margin.

Significant characteristics appear to be the laterally expanded glabella, preoccipital glabellar furrows, which are either only faintly connected across the sagittal line or may be disconnected, and posteriorly situated palpebral lobes. These apart, the cranidium of *Lichengia* is not much different from that of *Prosaukia* as redefined by Ludvigsen & Westrop (1983).

Until now a single species has been recognised. However, comparable material occurs in peninsular Thailand, where a single cranidium was described by Kobayashi (1957, p. 378, pl. 5, fig. 12) as *Saukiella tarutaoensis* Kobayashi. Possibly, this should be combined with the pygidium from the same collection, which Kobayashi (1957, p. 379, pl. 4, figs 16–17) described as *Coreanocephalus planulatus* Kobayashi (see Shergold *et al.*, 1988).

Material newly described here from central Australia shares many of the characteristics of the type species of *Lichengia*, although, like the Thai species and *Lichengia absona* (Shergold, 1975, pp. 117–118, pl. 15, Figs. 1–4), previously described from northern Australia, exhibits less swelling of the preoccipital glabellar lobes.

Lichengia simplex sp. nov.
(Pl. 4, Figs 1-7)

Name: L. *simplex*, simple, alluding to the more simple morphology compared to the type species.

Types: Holotype, cranidium, CPC26771, illustrated on Pl. 4, Fig. 1; paratypes CPC26772-26862.

Material: This species is based on ten cranidia, CPC26771-26772, 26776-26778, 26789-26793, 26799-26800, and 26802, 5–14.5 mm in length (Lc); hypostomata, CPC26773, 26774, 26787; seven librigenae, including a yolked pair (Pl. 4, Fig. 4), CPC26779-26784, 26798; and nine pygidia, CPC26775, 26785, 26788, 26794-26797 and 26801, with lengths (Lp_2) 6.6 - 22.5 mm.

Distribution: This species occurs in the Fergusson and Ross River Synclines of the eastern Amadeus Basin, and extends as far west as the Waterhouse Range. Described material is from AS147, AS193, AS197, AS270, AS354, Hy265 and NT183. Other material occurs in collection AS8.

Age: Late Cambrian, Payntonian/Early Datsonian, Assemblage 1.

Diagnosis: A species of *Lichengia* Kobayashi, 1942 with up to four pairs of sagittally discontinuous glabellar furrows, preoccipital lobes only gently expanded laterally, anteriorly truncate or gently indented frontal lobe; combined lateral and posterior librigenal border furrows extended a considerable way along the genal spine; ovoid or subtrapezoidal pygidium with five segments, lacking discrete border furrow; non-spinose.

Description: Compared to the type species, *Lichengia simplex* sp. nov. has an unmodified glabella. Although widest (tr.) at the preoccipital lobes, the extreme pear-shape seen on the holotype of *L. onigawara* Kobayashi does not develop. Accordingly, there is only a slight anterior taper from the preoccipital glabellar furrows forwards. Anteriorly, the frontal lobe is obtusely rounded and often sagittally posteriorly indented. The preoccipital furrows are deeply incised, posterosagittally directed, and unconnected sagittally. They may or may not open into the axial furrows. Median lateral furrows are less well developed and more transverse; anterior lateral furrows may be slightly anterosagittally directed; and a fourth pair of faint glabellar furrows may be developed anterior to these.

The occipital furrow is transverse, always prominent, overdeepened slightly abaxially. It separates a proportionately narrow (sag.) occipital ring, which is marginally narrower (tr.) than the preoccipital glabellar lobes.

The palpebral lobes are arcuate, posteriorly situated, extending from the rear of the preoccipital glabellar lobes to the middle of the median lateral lobes or median lateral furrows in holaspides. The width of the palpebral area is approximately the same dimension as the length (exsag.) of the palpebral lobe.

Postocular sections of the facial suture diverge rapidly, and enclose long (tr.) blade-like posterolateral limbs, which bear straight strongly incised posterior border furrows. The preocular facial sutures are subparallel. They enclose a preglabellar area consisting of a narrow (sag.), flat or anteriorly sloping preglabellar field and a gently reflected cranidial border, thickened sagittally so that the border furrow is better defined laterally. The anterior margin of the cranidium is evenly rounded.

Librigenae assigned to *Lichengia simplex* are anteriorly fused (Pl. 4, Fig. 4). They are characterised by a relatively narrow (tr.) genal field; a lateral border, gradually widening (exsag.) anterolaterally before developing into an anterior prong; very long posterior border furrows which extend for a considerable way into the genal spine, where they combine with the lateral border furrows; and long genal spines.

A typically subquadrate dikelocephalacean hypostoma is associated (Pl. 4, Fig. 7). It resembles that assigned here to *Platysaukia* (Pl. 3, Fig. 11), but has less expansive anterior wings and, conversely, more extensive lateral borders, widest (tr.) at the maculae. The median body therefore has an elongated pentagonal shape. The lateral margins are gently curved, the posterolateral margins straight and truncate, and the posterior borders are narrow (sag., exsag.), particularly the sagittally. A pair of transversely ovoid pits lies on either side of the sagittal line in the posterior border furrow, and an ovoid pair lies in the posterolateral border furrows. The anterior lobe of the median body is convex (tr., sag.) and oval, and is separated by prominent maculae and associated pits from a laterally narrow (tr.), U-shaped posterior lobe. The arrangement of the lobes of the median body is thus anchor-shaped.

The pygidium is subtrapezoidal, slightly wider (tr.) than long (sag.), slightly emarginate posteriorly, but non-spinose. Anterolaterally, it has steeply inclined articulating facets, and the geniculation is narrow (tr.). The axis is characteristically short (sag.), comprising four segments and a terminal piece, and a long post-axial ridge runs almost to the posterior pygidial margin. Four pleural segments are strongly swept posterolaterally, so that, distally, they become almost parallel with the sagittal line. Pleural furrows equally bisect the pleurae, but the interpleural furrows cut across the propleurae of succeeding segments. Distally, the propleurae merge into a poorly defined border, which lacks a discrete border furrow.

Lichengia simplex sp. nov. has a combined granulose and striate prosopon. The glabella and segmented regions of the pygidium are finely and equally granulose, while the cranidial, librigenal and pygidial borders are concentrically striate.

Relationships: *Lichengia simplex* sp. nov. is quite distinct from the type species, *L. onigawara* Kobayashi, 1942 by virtue of its simpler glabellar shape and sagittally discontinuous preoccipital glabellar furrows. However, both species share a common palpebral and preglabellar morphology. Pygidia are also essentially similar, differing only in shape.

Cranidia of *Lichengia tarutaoensis* (Kobayashi, 1957) from peninsular Thailand are very similar to those from central Australia. They do, however, appear to have a narrower (sag.) preglabellar field and deeper, wider (sag.) cranidial border furrow. Like the Australian species, they too bear sagittally unconnected preoccipital glabellar furrows. Pygidially, they have similar segmentation, and a similar long post-axial ridge, but may be more ovoid than trapezoidal.

Lichengia absona (Shergold, 1975), from the upper part of the Chatsworth Limestone at Black Mountain in western Queensland, also has a more ovoid pygidium (*op. cit.*, pl. 15, fig. 3). It is further differentiated by the absence of a preglabellar field.

Lichengia may also be represented in northern Victoria Land, Antarctica, where Wright *et al.* (1984) have reported saukiid fragments (*op. cit.* p. 303, figs A-B) from the Robertson Bay terrane. The cranidium they figure has been sagittally compressed, thus exaggerating the preglabellar morphology. If it belongs to *Lichengia*, this specimen is related to those species having the more simple glabellar shape. An appropriate short-axis pygidium is associated.

Lichengia simplex is unusual among Saukiidae in that the preoccipital glabellar furrows are not connected across the sagittal line. It shares this characteristic with the stratigraphically earlier genus *Caznaia* Shergold, 1975. The holotype of *C. squamosa* Shergold (1975, p. 129, pl. 25, fig. 1) further resembles the type species of *Lichengia* in its glabellar shape, the width (tr.) being exaggerated at the preoccipital glabellar furrows, in having an anteriorly truncate or indented frontal lobe, and, to a large extent, in the structure of the preglabellar area. Species of *Caznaia*, however, have smaller (exsag.) palpebral lobes, wider (tr.) occipital rings, and different librigenal and pygidial morphologies. Nevertheless, a direct evolutionary relationship seems possible.

Genus *Thailandium* Kobayashi, 1957

Type species: *Thailandium solum* Kobayashi, new gen. and sp.; Kobayashi, 1957, pp. 374–375, pl. 4, figs 9–12; original designation; Tarutao Island, Thailand; Late Cambrian, Fengshanian.

Comments: *Thailandium solum* Kobayashi is a saukiid trilobite closely related to *Prosaukia* Ulrich & Resser, 1933. The holotype cranidium of *T. solum* (see Kobayashi 1957, pl. 4, fig. 9) has a subparallel-sided, anteriorly obtusely rounded glabella with sagittally continuous preoccipital glabellar furrows; a preglabellar area consisting of a forward-sloping preglabellar field and flat-lying anterior cranidial border of equal dimensions; wide palpebral areas, and small (exsag.) palpebral lobes situated about the mid-length of the glabella. The cranidium of *T. solum* may therefore be interpreted as a small-eyed *Prosaukia*. It is difficult to judge from the original illustrations if the associated tagmata confirm this interpretation. However, similar cranidia are associated with prosaukioid librigenae and pygidia in central Australia. These show substantial morphological variation.

Thailandium species undet.
(Pl. 4, Figs 16–23)

1952 *Prosaukia* (Fam. Dikelocephalidae) sp.; Öpik, 1952, p. 1 (listed).

1955 *Prosaukia* (Fam. Dikelocephalidae) sp.; Öpik, *in* Joklik, 1955, p. 30 (listed).

Material: Eleven cranidia, CPC26805–26813, 26825, 26827, ranging in length from 4.5 to approximately 40 mm; four librigenae, CPC26817, 26824, 26826, 26828; three hypostomata, CPC26814–26816; and six pygidial fragments, CPC26818–26823, measuring 4–8 mm.

Distribution: Eastern Amadeus Basin, extending from the Fergusson Syncline and Ross River Syncline to the Waterhouse Range Anticline, at localities AS3, AS8, AS351, AS355, NT183, and, possibly, Hy265, Hy266 and Hy277.

Age: Late Cambrian, Payntonian/Early Datsonian, Assemblage 1.

Description: This taxon demonstrates a fairly consistent glabellar format, which is subrectangular, tapering very gently forwards, and anteriorly truncate or obtusely rounded. Preoccipital glabellar furrows are sagittally continuous and open into the axial furrows; median lateral furrows are sagittally unconnected, but parallel to the abaxial ends of the preoccipital furrows; and anterior lateral furrows are very short and faint. In all but one of the specimens, the smallest, CPC26809, the occipital ring is narrow (sag., exsag.) and wider (tr.) than the glabellar lobes.

The palpebral lobes are arcuate and situated between the middle of the preoccipital lobes and the median lateral furrows, well apart from the axial furrows. Postocular sections of the facial suture diverge rapidly and enclose very narrow (exsag.), but long (tr.), posterolateral limbs bearing prominent posterior cranidial border furrows. The preocular sections diverge little, and enclose a variable preglabellar area, which apparently increases in length (sag.) during morphogenesis. There is a general increase in the dimensions of both the downsloping preglabellar field and the flat-lying anterior cranidial border. Also variable is the definition of the anterior border furrow.

Librigenae resemble those of *Lichengia simplex* sp. nov. in their narrowness (exsag.), but the lateral border furrow is generally weakly impressed. The posterior border furrow, however, is sinuous, short, and extends into the base of the genal spine, which is long and delicate.

The associated hypostomata are decidedly saukiid, but are characterised by a significant lateral expansion at the level of the maculae, and constriction posterior to the anterior wings. The lateral and posterolateral margins and borders are reflected. Characteristic pits occur in the posterior and posterolateral border furrows. The median body is anchor-shaped, even pointed posteriorly.

A transverse semicircular pygidium is attributed to the Australian species of *Thailandium*. This has up to six segments, an entire, non-spinose margin, and indefinite border. The pleural segments bear strong furrows equally bisecting the segment, and are separated by weak interpleural furrows, having probable parallel courses. The pleural bands grade imperceptibly into a shallow concave border zone.

The surfaces of the glabella and pygidial axis are granulose. The cranidial librigenal, hypostomal and pygidial borders are striate.

Comments: Australian material assigned to *Thailandium* is left under open nomenclature, pending revision of the Thai material. Cranidia conform to the concept of this genus established by Kobayashi (1957), but only a single specimen (the holotype) was illustrated originally. Variation observed among the Australian cranidia needs to be confirmed in other collections. The status of the attributed librigenae appears consistent with the observed cranidial morphology, but that of the hypostomata and pygidia is uncertain. Pygidia originally assigned by Kobayashi (1957) are not readily interpretable. Possibly, *Thailandium* sp. undet. as presently construed is bicomposite.

Family **Ptychaspididae** Raymond, 1924

Ptychaspididae constitutes a family of dikelocephalaceans in which the preglabellar area has been simplified and the size of the librigena reduced to permit a compact, convex (tr., sag.) body plan. Frequently, pygidia have adventrally sloping margins, thus enhancing the relief of the exoskeleton.

Ludvigsen (1982a), Ludvigsen & Westrop (1983, 1986) and Westrop (1986) have diagnosed three subfamilies: Ptychaspidinae Raymond, 1924; Euptychaspidinae Hupé, 1953; and Macronodinae Westrop, 1986.

Subfamily **Ptychaspidinae** Raymond, 1924

Ludvigsen & Westrop (1986) have diagnosed Ptychaspidinae on the basis of broad, semi-elliptical pygidia, with few segments, and with narrow, concave borders; and have the palpebral morphology of the cranidium.

Ptychaspidinae generally have an undifferentiated or poorly differentiated preglabellar area, adventrally strongly sloping; mostly small palpebral lobes, variably situated with regard to the glabellar mid-point and axial furrows. The librigena is often reduced to a narrow sliver, which bears a poorly developed border furrow.

The following genera, with their suggested synonyms are referred to Ptychaspidinae: *Ptychaspis* Hall, 1863 (= *Asioptychaspis* Kobayashi, 1933); *Changia* Sun, 1924 (= *Fengshania* Sun, 1935; = *Coreanocephalus* Kobayashi, 1935); *Quadraticephalus* Sun, 1924; *Alborsella* Kushan, 1973; *Iranaspis* King, 1937; *Keithiella* Rasetti, 1944; *Keithia* Raymond, 1924; *Eoptychaspis* Nelson, 1951; *Idiomesus* Raymond, 1924; *Proricephalus* Westrop, 1986.

Genus ***Changia*** Sun, 1924
[= ***Fengshania***, Sun, 1924; = ***Coreanocephalus*** Kobayashi, 1935]

Type species: *Changia chinensis* Sun (sp. nov.); Sun, 1924, pp. 60–61, pl. 4, figs 5a–g; by original designation; upper Chaumitien Limestone, Shandong, China; Late Cambrian, Fengshanian.

Comments: Other species assigned to *Changia* are listed by Zhou & Zhang (1985, p. 100). They should also include *Changia acuta* An (*in* Duan *et al.*, 1986). *C. planilimbata* Zhou (*in* Zhou *et al.*, 1977) and *C. pulchra* Guo & Duan (1978) do not seem to be congeneric with other assigned species.

Earlier predicted synonymy (Shergold, 1975) of *Changia* Sun, 1924 and *Coreanocephalus* Kobayashi, 1935 has been confirmed by Zhang & Jell (1987) (see also Zhou & Zhang, 1985, p. 99). The synonymy of *Changia*/*Coreanocephalus* with *Quadraticephalus* Sun, 1924 seems likely, but cannot be confirmed (but see Zhang & Jell, 1987). According to Zhou & Zhang (*loc. cit.*), Sun's types are lost, so that the essential morphological data required for confirmation cannot currently be supplied.

Resser (1942, p. 48) originally synonymised *Changia* with *Quadraticephalus*, arguing preference for the latter, in spite of the fact that the former has page priority in Sun's (1924) publication, because of the confusion possible with similar names (*Changia*, *Changhia*), a confusion demonstrated by Sun (1924, p. 62) himself. As the first reviser, Resser's right to nominate the generic priority must be respected. Accordingly, if the synonymy is upheld, then the nine species currently assigned to *Coreanocephalus*, together with the seven belonging to *Changia*, will be transferred to the eighteen presently included in *Quadraticephalus*. Considerable synonymy exists amongst these species, which is quite beyond the scope of this study to resolve.

The *status quo* is therefore maintained here with the recognition of both *Quadraticephalus* and *Changia*/*Coreanocephalus*. Kobayashi (1933, 1935) differentiated them by the size and position of the palpebral lobes, but the shape of the glabella and posterolateral limbs and definition of the glabellar and occipital furrows may also be of value. In general, the palpebral lobes of *Quadraticephalus* are small and placed anteriorly adjacent to the axial furrows at the level of the anterior lateral glabellar lobes, and the posterolateral limbs are broadly triangular based. Glabellar furrows are not well defined, and the occipital ring is frequently poorly differentiated. *Changia* has longer (exsag.) palpebral lobes and the posterolateral limbs are narrower (exsag.) at the base. Glabellar furrows are often more firmly impressed, and an occipital ring is generally well delineated. Various pygidia have been assigned to these genera. Those illustrated here are based on associations found at several localities.

Changia correcta sp. nov.
(Pl. 2, Figs 17–23)

1975 *Quadraticephalus* cf. *teres* Resser & Endo *in* Endo & Resser 1937; Shergold, 1975, pp. 149–152, pl. 28, figs 1–9.

Name: L., *correcta*, f., correct, referring to the corrected generic determination of this species.

Types: Holotype, cranidial fragment, CPC11827a, figured by Shergold, 1975, pl. 28, fig. 1; paratypes, CPC11826–11834; plesiotype material, CPC26829–26848.

Material: Supplementary type material from the Amadeus Basin includes 12 cranidia, CPC26829–26837, 26840–26841, 26848, measuring 3.5–11.5 mm; six pygidia, CPC26838–26839, 26844–26847, with lengths (L_{p2}) 3–4.5 mm; and two hypostomata, CPC26842–26843.

Distribution: Known only in the eastern Amadeus Basin, in the Ross River Syncline, at localities AS193, AS196 and AS355.

Age: Late Cambrian, Payntonian, Assemblage Zones of *Neoagnostus quasibilobus*/*Shergoldia nomas* and *Mictosaukia perplexa* at the *locus typicus*, Mount Nimaroo in the Georgina Basin; Assemblage 1 in the Amadeus Basin.

Description: Early holaspid cranidia, with lengths less than about 6 mm (e.g. Pl. 2, Figs 17 and 20), have relatively consistent cranidial morphology. The glabella is proportionately long (sag.), rectangular, obtusely rounded anteriorly and faintly constricted laterally at the level of the anterior lateral glabellar furrows. Preoccipital glabellar furrows are postero-sagittally directed and unconnected sagittally; median and anterior lateral furrows are mostly effaced. An occipital furrow is invariably present, separating an occipital ring, which is only slightly wider (tr.) than the greatest width of the glabella.

Palpebral lobes are prominent, being wide (tr.) and arcuate, and well defined by palpebral furrows. They are situated close to the axial furrows, between the preoccipital glabellar furrows and at a level coinciding with the greatest width (tr.) of the frontal lobe. Palpebral areas are restricted to half-moon pads.

The postocular sections of the facial suture enclose triangular posterolateral limbs. Preocular sections diverge appreciably forwards and a little adventrally, enclosing an undifferentiated convex (sag.) preglabellar area, which is confluent laterally with narrow (tr.) preocular areas.

Late holaspid cranidia, greater than 6 mm long (Pl. 2, Figs 12, 13), appear to be narrower (tr.) overall. While the glabella retains its rectangular shape, the preglabellar area is longer (sag.) and narrower (tr.) than in early holaspides. The palpebral lobes remain arcuate, but are also narrower (tr.).

No librigena definitely assignable to *Changia* has been identified as yet in the collections. Two hypostomata are too poorly preserved to illustrate, and may not be correctly associated. They resemble to some extent saukiid hypostomata described above as *Platysaukia tomichi* sp. nov. (Pl. 4, Fig. 14), but are less laterally expanded.

Associated pygidia, from localities AS196 and AS355, are semi-elliptical, non-spinose, and partly effaced. They contain five axial and four pleural segments. Interpleural furrows are effaced: pleural furrows are prominent, terminating at a broad, slightly concave border. Prominent oblique articulating facets overlap this border anterolaterally.

Relationships: Material originally described from the Georgina Basin (Shergold, 1975) as *Quadraticephalus* cf. *teres* Resser & Endo, 1937 is here combined with additional specimens from the Amadeus Basin. The earlier-figured material demonstrates all the characteristics listed above as diagnostic of *Changia*. In particular, the morphology of the palpebral lobes, the well-defined occipital furrow, and the morphology of the pygidium suggest classification with *Changia* rather than *Quadraticephalus*, as presently conceived. Material from the Georgina and Amadeus Basins is united on the basis of a common cranidial morphology: the early holaspid morphology of the Amadeus Basin specimens cannot be easily distinguished from the Georgina Basin cranidia. Pygidia from the two basins are essentially inseparable.

Outside Australia, most of the sixteen species constituting the genus *Changia* are from a narrow stratigraphic interval of latest Cambrian age on the Sino-Korean Platform. Specific relationships are difficult to assess among these taxa, because of highly variable preservation and its effect on morphology. Many of these species are considered to be likely synonyms. Comparisons are therefore facilitated through the genotype, *Changia chinensis* Sun.

The full extent of the preglabellar area on the holotype specimen of the type species cannot be assessed, because the specimen has been trimmed to remove photographic background. Nevertheless, it appears to be wider (tr.) and larger (sag.), and this condition seems to be typical of several other species of *Changia*. The exceptions, to which *C. correcta* sp. nov. is related, include *Changia fungosa* (Yao & Wang) (1978, p. 121, pl. 3, fig. 13, pl. 2, figs 4, 8), particularly as illustrated by Zhou & Zhang (1985, pp. 100–101, pl. 5, figs 1–4, pl. 6, fig. 1); and *Changia acuta* (*in* Duan *et al.*, 1986, pp. 47–48, pl. 6, figs 1–12). Qian (*in* Chen, 1986, p. 273) synonymised *Changia fungosa* (Yao & Wang) *sensu* Zhou & Zhang (1985) with *Changia* [*Coreanocephalus*] *planulata* (Kobayashi) (1957, p. 379, pl. 4, figs 13–17). His specimens (*op. cit.*, pl. 74, figs 2, 5, 6, 8–10; pl. 75, fig. 1) are quite comparable with central Australian cranidia. However, as in the case of Kobayashi's holotype cranidium, they have more anteriorly situated palpebral lobes and the possibility of their belonging to *Quadraticephalus* cannot be dismissed.

Changia correcta further differs from the type species in its less laterally constricted glabella, and more effaced glabellar and occipital furrows. There is no comparison between the associated pygidia. Pygidia essentially similar to those described here are associated with the species *C. brevica* Zhou (*in* Chen *et al.* 1980, p. 131, pl. 4, figs 1–7), *C. hebeiensis* (Zhou) (*loc. cit.*, figs 8–11) and *C. latilimbata* (Zhou) (*loc. cit.*, figs 12, 13), all from northern China. These species may be discriminated on cranidial details from *Changia* sp. undet.

Genus ***Quadraticephalus*** Sun, 192

Type Species: *Quadraticephalus walcotti* Sun (sp. nov.); Sun, 1924, p. 63, pl. 4, figs 6a–d; by original designation; Kaolishan Formation, Taianfu, Shandong, China; Late Cambrian, Late Fengshanian, *Dictyella* Zone.

Comments: Some eighteen species of *Quadraticephalus* have been described.

Since those listed by Kobayashi (1960b, p. 402) and Shergold (1975), four further species, all from Yunnan, have been published by Sun & Xiang (1979) and Luo (1983): *Q. latus* Sun, 1979; *Q. expansus* Xiang, 1979, *Q. depressus* Luo, 1983; and *Q. latilimbatus* Luo, 1983. Like *Changia*, species of *Quadraticephalus* are mainly distributed on the Sino-Korean Platform, where they also have a latest Cambrian age. Species occurring in southwestern China are most often tectonised and of little use for morphological comparison. With the possibility that *Coreanocephalus planulata* Kobayashi, 1957 from peninsular Thailand may also represent *Quadraticephalus*, the range of the genus is extended in Asia. The single species, *Q.* cf. *teres* Resser & Endo, previously described from northern Australia (Shergold, 1975), is now referred to *Changia* Sun, 1924 and forms the basis of the new species *Changia correcta*.

Quadraticephalus sp. cf. ***Q. coreanicus*** Kobayashi, 1960
(Pl. 2, Figs 11–16)

cf. 1935 *Quadraticephalus manchuricus* Kobayashi; Kobayashi, 1935, p. 320, pl. 6, figs 1–5, *non* figs 6–7, = *Q. elongatus* Kobayashi, 1960.

cf. 1960 *Quadraticephalus coreanicus* Kobayashi, new species; Kobayashi, 1960b, p. 402, pl. 20, figs 2–6, pl. 21, fig. 13.

Material: Four cranidia, CPC26849-26852, measuring 9-13 mm in length; eight librigenae, CPC26853-26865; and five pygidia, CPC26861-26865, with lengths 7-14 mm.

Distribution: This species occurs at two localities in the Ross River and Fergusson Synclines, eastern Amadeus Basin: AS199, AS354.

Age: Late Cambrian, Payntonian/Early Datsonian, Assemblage 1.

Description: Australian material compared to *Quadraticephalus* cf. *coreanicus* Kobayashi is characterised by a proportionately obtusely rounded glabella, which is gently constricted at the level of the anterior lateral glabellar furrows.

Glabellar furrows are invariably poorly defined, as is the occipital furrow sagittally. Abaxially, however, the latter opens out and truncates slightly the posterolateral margins of the preoccipital lobes. The occipital ring is wider (tr.) than the preoccipital glabellar lobes.

The palpebral lobes are short (exsag.), arcuate and close to, but not contacting, the axial furrows, enclosing small slightly raised palpebral areas. The palpebral lobes extend from about the median lateral glabellar furrows to a position a little in advance of the glabellar constriction at the anterior lateral furrows.

The postocular facial sutures enclose long (tr.) broad-based posterolateral limbs, which bear shallow posterior border furrows. The preocular facial sutures are relatively short (exsag.) and divergent, enclosing an undifferentiated, gently convex (sag.), adventrally sloping preglabellar area.

The associated librigena has low convexity (tr., exsag.). Border furrows are effaced, but a very narrow (tr.) flange extends along the lateral margin and down the genal spine for a considerable distance. The latter is long, stout, and distally incurved.

Pygidia associated at both localities are transverse subtriangular and have entire margins and wide, poorly defined borders. The axis is relatively short (sag.), comprising three segments. A post-axial ridge is not apparent. Pleurae are poorly defined by furrows, which terminate at the indistinct border. The first pair of pleural furrows, however, continues to the anterolateral margin. Long (tr.), flat articulating facets are developed from very narrow (exsag.) propleura.

The wide preglabellar area and pygidial doublure may display a striate prosopon. Otherwise the species is smooth.

Relationships: Australian material is referred to *Q.* cf. *coreanicus* Kobayashi because of the proportions of the glabella and preglabellar area, the shape of the glabella, and the size and position of the palpebral lobes. The species differs slightly in the definition of the glabellar furrows. Kobayashi (1935, pl. 6, fig. 4) associated a pygidium similar in shape and segmentation to those found in the Pacoota Sandstone.

The species is, however, obviously related cranidially to a group of Chinese species from Liaoning Province and from South Korea: *Quadraticephalus walcotti* Sun, 1924, *Q. fengshanensis* (Sun, 1935), *Q. pyrus* Kobayashi, 1933; *Q. quadratus* Kobayashi, 1935; *Q. elongatus* Kobayashi, 1960b; and *Q. teres* Resser & Endo, 1931. In general, appropriate librigenae have been associated, but a variety of pygidia, those of *Q. manchuricus* Kobayashi (1933, pl. 13, fig. 7) and *Q. coreanicus* Kobayashi (1935, pl. 6, fig. 4) being the most similar to those found in central Australia. These species differ in glabellar and preglabellar proportions and shape, and in the size and position of the palpebral lobes.

Superfamily **Leiostegiacea** Bradley, 1925
Family **Tsinaniidae** Kobayashi, 1933
Genus ***Shergoldia*** Zhang & Jell, 1987

Type species: *Tsinania nomas* Shergold, 1975, 202–203, pl. 47, figs 1–7; designated Zhang & Jell (1987, p. 196); Chatsworth Limestone, western Queensland, Australia; Late Cambrian, Payntonian, *Neoagnostus quasibilobus*/*Shergoldia nomas* Assemblage-Zone.

Comments: Asian and Australian Tsinaniidae have been reviewed at length by Shergold (1975) and Zhang & Jell (1987). *Shergoldia* has been proposed by the latter to replace an earlier concept based on many species referred to *Dictyites* Kobayashi, 1936 (pro *Dictya* Kobayashi, 1933). This is because the type specimens of *Illaenurus dictys* Walcott, 1905, on which *Dictyites* was based, have been found to be the same as those of *I. canens* Walcott, 1905, the type species of *Tsinania* Walcott, 1914, and, furthermore, all material has been found to come from the same locality. Zhang & Jell (1987) now differentiate *Tsinania* from *Shergoldia* by the effacement of the axial and border furrows of the former, and the presence of a prominent plectrum in the latter. *Shergoldia* (*Dictyites sensu* Shergold, 1975) is further characterised by wide depressed borders in both cranidium and pygidium, more angulate cranidial outline, and the faint indication of a median preglabellar furrow separating the preocular areas.

Species now included by Zhang & Jell (1987) in *Shergoldia* include: *Dictya dolichocephala* Kobayashi (1933, 138–139, pl. 14, fig. 12), Liaoning, China; *Dictya trigonalis* Kobayashi (1933, 139, pl. 14, figs 10–11, 13–15), Liaoning, China; *Dictya dictys* (Walcott) *sensu* Kobayashi (1933, 138, pl. 14, figs 7–9) [= *Shergoldia tianfuensis* (Endo)], Liaoning, China; *Dictya longicauda* Kobayashi (1935, 307–308, pl. 6, fig. 15), Kasetsu-ji, South Korea; *Dictya depressa* Kobayashi (1935, 307, pl. 6, figs 16–19), Kasetsu-ji, South Korea; *Dictya tianfuensis* Endo (1939, 11–12, pl. 2, figs 21–23), Shandong, China; *Tsinania* (*Dictyites*) *antidictys* Shergold (1975, 207–209, pl. 49, figs 1–8), western Queensland, Australia; *Tsinania* (*Dictyites*) cf. *trigonalis* (Kobayashi, 1933) *sensu* Shergold (1975, 209–210, pl. 50, figs 3–9), western Queensland, Australia; *Tsinania* (*Tsinania*) cf. *pagoda* (Sun, 1924) *sensu* Shergold (1975, 201–202, pl. 50, figs 1–2), western Queensland, Australia; *Tsinania* (*Tsinania*) *nomas* Shergold (1975, 202–203, pl. 47, figs 1–7), western Queensland, Australia; *Tsinania* (*Tsinania*) *necopina* Shergold (1975, 204–206, pl. 48, figs 1–8, pl. 49, figs 9–10), western Queensland, Australia. Another species, compared to *S. nomas* (Shergold) also occurs in the latest Cambrian of Tarutao Island, Thailand (Shergold *et al.*, 1988).

Shergoldia species undetermined
(Pl. 1, Figs 12–17)

Material: Four cranidia, CPC26866, 26867, 26871, 26873, 6.5–16.75 mm long (sag.); two librigenae, CPC26868, 26869; and two pygidia, CPC26870, 26872, 6–7 mm (Lp_1) long, have been prepared.

Distribution: Eastern Amadeus Basin, western end and southern limb of the Fergusson Syncline at AS197, AS198, AS315, AS354, AS355, AS356, NT606; Ross River Syncline, southern limb, AS350, and western closure, AS147; Native Pine Gap measured section, 20 km SW of Alice Springs railway station, NT320.

Age: Late Cambrian, Payntonian/Early Datsonian, Assemblage 1.

Comments: Present material is not good enough for precise determination. Reference is made to *Shergoldia* because of the presence of borders in both cranidium and pygidium, the faint presence of a median preglabellar furrow bisecting the preglabellar field in the former, and the rather narrow (exsag.) librigenae. One cranidium, CPC26871, Pl. 1, Fig. 14, demonstrates a very wide (sag.) cranidial border in addition. Degree of angulation of the anterior cranidial margin is less than that observed in material previously described from the Chatsworth Limestone of western Queensland (Shergold, 1975).

Since the preservation is mostly inadequate and no morphogenetic sequence is available, comparison with previously described species is not attempted.

Family **Kaolishaniidae** Kobayashi, 1935
Subfamily **Mansuyiinae** Hupé, 1955

Comments: The concept of Kaolishaniidae followed here is essentially that published earlier (Shergold, 1972). However, subsequent research has led to a re-evaluation of the generic content of the constituent subfamilies of Kaolishaniidae. Currently attributed to the Subfamily Mansuyiinae are the genera *Mansuyia* Sun, 1924, *Mansuyites* Shergold, 1972, *Hapsidocare* Shergold, 1975, *Peichiashania* Chang, 1957 (*sensu* Shergold, 1980), *Shidiania* Luo, 1983 and *Taipakia* Kobayashi, 1960. Of formerly included taxa, species of *Paramansuyella* Endo, 1937 are divided amongst several genera. *Kaolishaniella* Sun, 1935 is now regarded as a shirakiellid.

Genus ***Mansuyia*** Sun, 1924

Type species: *Mansuyia orientalis* (Grabau) Sun; Sun, 1924, pp. 50–52, pl. 3, figs 7i–j *non* figs 7a–d [= *Taishania taianensis* Sun, 1935]; *non* figs 7f–h [= *Mansuyia chinensis* (Endo, 1939)]; by original designation; Yehli Limestone, Liaoning, China; Late Cambrian, Fengshanian.

Comments: The composition and concept of *Mansuyia* have been discussed previously (Shergold, 1972, 1975). Subsequently described species include: *Mansuyia laevigata* Zhou, *in* Zhou *et al.* (1977, p. 203, pl. 60, fig. 3), Jingxixian, Guangxi; *Mansuyia pulchra* Zhou, *in* Zhou *et al.* (1977, p. 203, pl. 60, fig. 7), Jingxixian, Guangxi; *Mansuyia zhuitunensis* Liu, *in* Liu *et al.* (1982, p. 322, pl. 219, fig. 29), Fenghuangxian, Hunan; and *Mansuyia granosa* Zhang, *in* Qiu *et al.* (1983, p. 189, pl. 63, figs 11–12), Suxian, Anhui, China.

Mansuyia sp. cf. ***M. orientalis*** Sun, 1924
(Pl. 2, Figs 1–10)

1975 *Mansuyia* cf. *orientalis* Sun, 1924; Shergold, 1975, pp. 180–182, pl. 38, figs 1–11, pl. 39, figs 1–2 (earlier, but not exhaustive synonymy quoted: this species also described in Lu *et al.* (1965), Nan (1980), Sun & Xiang (1979), and Qiu *et al.* (1983)).

Material: Six cranidia, CPC26874–26879, length (sag.) 6–9 mm; one librigena, CPC26880; three hypostomata, CPC26881, 26889, 26890; and six pygidia, CPC26882–26888, 26891, varyingly deformed, but 5–10.5 mm long (Lp_2).

Distribution: Western end of the Fergusson Syncline at Ross River, AS193, AS199 and AS315, eastern Amadeus Basin.

Age: Late Cambrian, Payntonian/Early Datsonian, Assemblage 1.

Comments: *Mansuyia* cf. *orientalis* Sun has been described previously from the Chatsworth Limestone at Black Mountain in western Queensland (Shergold, 1975, pp. 180–182), where it occurs in the *Sinosaukia impages* and *Neoagnostus quasibilobus* with *Shergoldia nomas* Assemblage-Zones. Taking into account difference in preservation between the Burke River Structural Belt and the eastern Amadeus Basin, the species occurring cannot be adequately differentiated. Cranidia are characterised by a relatively long (sag.), poorly furrowed glabella, which extends very close to the exsagittal limit of the preocular areas; i.e. the anterior limit of these and the glabella lie almost on the same transverse line. Palpebral lobes are the same shape, size and position in specimens from the two areas, being long (exsag.), arcuate, and well removed from the axial furrows. The preglabellar area is broadly rounded anteriorly, concave, and has only a poorly differentiated border.

A librigena and three hypostomata are associated with such cranidia in the Pacoota Sandstone. The former is quite characteristic, being much restricted in extent laterally by the large palpebral lobes, and expanded anterolaterally to take account of the wide doublure beneath the expansive preglabellar area. Posterolaterally, there is a short genal spine.

The hypostome is subrectangular, with narrow (tr., sag.) lateral and posterior borders, and only short anterolateral wings. The median body is expansive and the maculae well impressed and distinct.

Pygidia are variably deformed. No morphogenetic sequence is available. All holaspid specimens are spinose, the spine deriving from the anterolateral pygidial border. A distinctive border extends between the spine bases; six axial segments and four or five pleural ones appear to be present, but are rarely clearly defined. Number of pygidial segments is the only criterion on which Georgina Basin and Amadeus Basin pygidia might be separated. In this respect, the latter more closely resemble those of northern China.

Superfamily **Remopleuridacea** Hawle & Corda, 1847
Family **Kainellidae** Ulrich & Resser, 1930
Genus ***Apatokephalus*** Brögger, 1896
[= ***Diplapatokephalus*** Raymond, 1937]

Type species: *Trilobites serratus* Boeck, 1838, p. 139; subsequently designated, Bassler, 1915; Ceratopyge Limestone, Norway; Early Ordovician, late Tremadoc, Zone of *Apatokephalus serratus.*

Comments: *Apatokephalus* Brögger is a cosmopolitan genus, which occurs in Norway, Sweden, central England, South Wales, Germany (Bavaria), ČSSR (Bohemia), USA (Texas), Argentina, Bolivia, Canada (British Columbia), South Korea, China (Liaoning, Jilin, Shaanxi, Sichuan, Hunan), and the Soviet Union (southern Siberian Platform, Salair, Kazakhstan).

Characteristically, the type species has an urceolate glabella, is laterally expanded at the preoccipital glabellar furrows, but constricted or subparallel-sided in front of the median lateral furrows. The lateral glabellar expansion occupies all the space normally formed by the palpebral areas, and is enveloped by long arcuate palpebral lobes, which extend from the occipital furrow to the anterior lateral furrows. The occipital ring is narrower (tr.) than the maximum glabellar width (tr.), equal to that between the posterior ends of the palpebral lobes.

Preocular sections of the facial suture diverge very rapidly to enclose a very wide (tr.), short (sag.) preglabellar area, comprising an equidimensional cranidial border and preglabellar *cum* anterior border furrow, which may unite into a preglabellar field. A densely granulose prosopon occupies the glabella, occipital ring and palpebral lobes.

A large number of species have been assigned to *Apatokephalus*, among them forms in which the glabella is not fully expanded laterally so that small palpebral areas are retained, and/or lacking altogether a preglabellar field, thus exhibiting some morphological overlap with *Pseudokainella* Harrington, 1938, *Fatocephalus* Duan & An, 1982, or even some species of *Kainella* Walcott, 1924. However, they are younger than species of these genera, of late rather than early Tremodoc age.

Apatokephalus sp. cf. ***A. hyotan*** Kobayashi, 1953
(Pl. 6, Figs 19–21)

cf. 1953 *Apatokephalus hyotan* Kobayashi, new species; Kobayashi, 1953, pp. 52–54, pl. 3, figs 17–23

cf. 1960 *Apatokephalus hyotan* Kobayashi, 1953; Kobayashi, 1960a, p. 248, figs 6d–f (line drawings).

Material: Five cranidia, CPC26919–26923, 3.5–5 mm long (sag.).

Distribution: Central Amadeus Basin, at the Ellery Creek measured section (NT252, 85/3061) and in the Gardiner Range (A1/26, 85/3058). Unprocessed material is also recorded in the Ross River Syncline (AS9, AS260, AS304, NT191), at Native Pine Gap (NT237c), and at Hy80 on section HyR4 in the Gardiner Range, south of Areyonga.

Age: Early Ordovician, Late Warendian, Assemblage 2.

Comments: *Apatokephalus hyotan* Kobayashi is not a typical species of the genus. Its cranidium is not fully expanded into the palpebral areas laterally, so that small arcuate palpebral areas are retained. Accordingly, the palpebral lobes are also arcuate. The occipital ring is wider (tr.) than the preoccipital glabellar lobes, and about as wide (tr.) as the maximum glabellar width (tr.), which is at the level of the median lateral lobes. Glabellar furrows are not strongly defined. The frontal glabellar lobe is obtusely rounded anteriorly, approximately as wide (tr.) as the preoccipital glabellar lobes. The preglabellar area is very short (sag.), and no preglabellar field is apparent. The width (tr.) of the preglabellar area is equivalent to the interocular width (tr.).

Material from the Pacoota Sandstone has all the cranidial characteristics illustrated by Kobayashi (1953, pl. 3, figs 17–20) for *A. hyotan*. Korean and Australian cranidia share common glabellar, preglabellar and palpebral morphologies, and both lack granulation. The Korean species, however, is associated with other tagmata not yet found in the Pacoota Sandstone. Accordingly, the Australian species is determined with qualification.

Other species having similar cranidial characteristics are *Apatokephalus angustilimbatus* Kuo & An (in Kuo et al., 1982, pp. 21–22, pl. 1, fig. 11) from the *Koraipsis–Hystricurus* Zone, late Tremadoc, at Benxi, Liaoning, which is probably synonymous with *A. hyotan* Kobayashi, *A.? invalidus* Liu (1977, p. 208, pl. 61, fig. 15) from northwestern Hunan — but this species has less effaced glabellar furrows and is granulose — and *A. exiguus* Harrington & Leanza (1957, p. 139, figs 57, 58/1–5) from the Early Tremadoc of Salta Province, Argentina, which has a more fully expanded glabella laterally.

All other described species have various combinations of density of granulation, extent of the preglabellar area, convexity of preocular areas, lateral expansion and genal proportions of the glabella and degree of effacement of its furrows, and width (tr.) of the occipital ring.

Superfamily **Catillicephalacea** Raymond, 1938

Family **Hystricuridae** Hupé, 1953

The obvious cranidial morphological similarity between hystricurids and solenopleurids has led traditionally to their inclusion within the same superfamily in spite of the large age discrepancy between their constituent genera. Many families originally placed in Solenopleuracea by Hupé (1955) were reclassified by Harrington *et al.* (1959), and subsequently by Öpik (1961b, 1963, 1967). The latter remarked on the synonymy between Solenopleuracea and Ptychopariacea, and observed that only the Solenopleuridae could confidently be assigned to Solenopleuracea as envisaged by Harrington *et al.* (1959). Accordingly, Öpik (1967) revived the concept of Catillicephalacea Raymond, 1938 to include the families Catillicephalidae Raymond, 1938 and Lonchocephalidae Hupé, 1953 (including Lonchocephalinae and Avoninae Lochman, 1936). Dokimocephalidae, formerly classified with Solenopleuracea, are now better considered as an olenacean (*sensu lato*) family — a subfamily of Elviniidae according to Westrop (1986). Acrocephalitidae appear also to be related to this superfamily through Elviniidae. The composition of many of these familial taxa, however, needs to be reinvestigated in detail.

Öpik (1967) implied a similar phylogenetic origin for some Lonchocephalidae and Catillicephalidae during the Late Cambrian, and it seems possible that Hystricuridae Hupé, 1953 could have a similar origin. Fortey (1983, pp. 182–183) has drawn attention to the similarity between *Hystricurus* and the Late Cambrian genus *Onchopeltis*, an elviniid olenacean (Westrop, 1986; Shergold & Webers, *in press*). A derivation of Hystricuridae from Eulomidae (Ptychopariacea), involving the loss of the pits which lie in the floor of the anterior cranidial border furrow, could also be postulated. A degree of cranidial homeomorphy exists between *Hystricurus* and the morphological complex from southern Kazakhstan assigned by Apollonov & Chugaeva (1983, p. 68 *et seq.*) to *Ketyna* Rosova, 1963.

Hystricuridae are here regarded *pro tem* as a third family of Catillicephalacea. Hystricuridae and many lonchocephalines have similar cranidial and pygidial architecture, and, when developed, similar cranidial spines. *Onchonotellus* Lermontova, 1956 is a similar catillicephalid genus cranidially.

The structure of the hystricurid librigena, however, with its prominent genal diverticulum, cannot be compared with Catillicephalidae or Lonchocephalidae. This characteristic allows comparison with some dokimocephalinids (Elviniidae, Olenacea). Hystricurids have about 11 thoracic segments, lonchocephalids 7–10. The number in Catillicephalidae is not known.

Genus ***Hystricurus*** Raymond, 1913

Type species: *Bathyurus conicus* Billings, 1859, p. 366, fig. 12C; refigured Raymond, 1913, p. 60, pl. 7, fig. 9; designated Raymond, 1913, p. 60; Beekmantown Formation, Quebec, Canada; Early Ordovician, Canadian.

Comments: *Hystricurus* has been most recently described and discussed by Fortey (1983) and Zhou & Fortey (1986, p. 172). All significant previous references to species of this genus are listed in these publications. The former has listed the essential diagnostic characteristics.

Hystricurus sp. cf. ***H. eurycephalus*** Kobayashi, 1934
(Pl. 6, Figs 10–18)

cf. 1934 *Hystricurus eurycephalus*, new species; Kobayashi, 1934, p. 542, pl. 6, fig. 10.

Material: Twenty cranidia, CPC26924–26928, 26931, 26933–26935, 26938–26948; length (sag.) 2.5–8 mm; six librigenae, CPC26929–26930, 26936–26937, 26949–26950, and two pygidial fragments, CPC26932, 26951.

Distribution: Species of *Hystricurus* are recorded from the N'Dahla Gorge region in the eastern part of the Ross River Syncline (AS257); the southern limb of the Waterhouse Range Anticline, section HyR5/6 (Hy269, 85/3101); southern and northern flanks of the Gardiner Range Anticline (Hy77, Hy233, FBH A1/26); and the southern limb of the Parana Hill Anticline, section LAR2 (LA36).

Age: Early Ordovician, Late Warendian, Assemblage 2.

Comments: *Hystricurus* cf. *H. eurycephalus* Kobayashi has a transverse, anteriorly gently rounded cranidium with appreciable convexity (sag.). It has a proportionately short (sag.), semi-ovoid, anteriorly well-rounded glabella, which is widest (tr.) at the preoccipital lobes and has effaced furrows. The occipital ring is as wide (tr.) as the maximum glabellar width, depressed in profile (sag.), and non-spinose. Palpebral lobes are arcuate and situated with mid-points in advance of the mid-point of the glabella. The palpebral areas are not quite as wide (tr.) as the length (exsag.) of the palpebral lobes. Faint ocular ridges are present. Preocular sections of the facial suture are not greatly expansive (exsag.), but enclose a relatively long (sag.) forward-sloping preglabellar field, a significantly deepened anterior border furrow, and a narrow (sag.) border. The postocular facial sutures are considerably more extensive, embracing wide (tr.) blade-like posterolateral limbs.

Characteristically, the librigena of *H.* cf. *eurycephalus* has a major upraised genal diverticulum separating the lateral and posterior border furrows, and continuing well into the genal spine. The latter are abaxially pitted. The borders are narrow in accord with the dimension of the cranidial border furrows.

Only two pygidial fragments have been recovered with certainty, and these show no diagnostic characteristics.

Most specimens in the prepared paradigm have a smooth or, at best, only faintly granulose prosopon. Possibly, this results from style of preservation and degree of secondary silicification, because at one locality (AS257) densely granulose hystricurine fragments occur with the smooth ones. Possibly, a similar situation exists to that previously described (Shergold, 1982) for the leiostegiacean *Pagodia (Idamea)* cf. *baccata*, in which granulose and smooth specimens occur on the same pieces of rock. If this is the case, then granulosity has little specific meaning for the discrimination of species of *Hystricurus*.

Specimens from the Pacoota Sandstone are referred here to the Korean species *H. eurycephalus* Kobayashi (1934, p. 542, pl. 6, fig. 10), described from the *Clarkella* Zone of Saisho-ri, South Korea, on a single smooth cranidium. This has a similar transverse shape and appropriate glabellar and preglabellar morphology. If granulosity has no meaning among species of *Hystricurus*, then the species could be equally well assigned to *H. megalops* Kobayashi (1934, p. 541, pl. 6, figs 8–9) from the same locality.

More densely granulose specimens may even be determined as *H. penchiensis* Lu (*in* Lu *et al.*, 1976, p. 54, pl. 7, figs 10–13; or Zhou & Fortey, 1986, pp. 172–173, pl. 1, figs 5, 8, 12) from the Upper Yehli Formation, in Liaoning Province, China, or even *H. genalatus* Ross (1951, pp. 40–42, pl. 8, figs 1–13, pl. 9, figs 1–13, 17–19) or *H. oculilunatus* Ross (1951, pl. 10, figs 1–3, 5, 8, 9, 12) from the Garden City Formation of northeastern Utah. Previously described Australian species of *Hystricurus*, referred to *H. penchiensis* Lu, *H. lewisi* (Kobayashi, 1940) and *H.* sp. cf. *H. robustus* Ross by Jell & Stait (1985a, p. 4 *et seq.*) from the Florentine Valley, Tasmania, are all granulose. *H. lewisi* (Kobayashi) (Jell & Stait a *loc. cit.*, pl. 2) is perhaps the most similar in terms of palpebral and preglabellar morphology to the present species.

Superfamily **Incertae sedis**
Family **Shumardiidae** Lake, 1907

Shumardiidae are characterised by genera having considerable morphological variation. The nominal genus *Shumardia* Billings, 1862, for example, which ranges through the Ordovician and has a global distribution, has so far defied attempts to reduce its great many species into more closely defined taxonomic entities. Latterly, Přibyl & Vaněk (1980) have attempted to revive *Conophrys* Calloway, 1877 as a subgenus of *Shumardia*, but according to their diagnosis it is necessary to have complete exoskeletons to identify it, even though many of the species they include in *Conophrys* are only known from disarticulated tagmata. Dean (1973) and Fortey (1980) have also commented on the elusive agreement for subdivision of *Shumardia*. Overlapping and intergrading morphological variation, often caused by preservation, prevent taxa being strictly diagnosed.

Currently, similar problems have arisen among Cambrian shumardiids. Zhou & Zhang (1983, 1985) have attempted to divide *Koldinioidia* Kobayashi, 1931 and essentially they restricted that name to shumardiids with an effaced preglabellar furrow, wide (tr.) occipital ring and stout genal spines, as in Kobayashi's type species, *K. typicalis* and *K. infrequens* (Resser & Endo) (*in* Endo, 1931, p. 86, fig. 14; *in* Endo & Resser, 1937, p. 229, pl. 57, fig. 14). Zhou & Zhang (*op. cit.*) contend that *Koldinioidia* so defined also possesses a laterally expanded frontal glabellar lobe, and consider it to be a subgenus of *Shumardia*. For species, formerly included in *Koldinioidia*, which have a well-defined preglabellar furrow and tapering or parallel-sided glabella, the new genus *Akoldinioidia* was proposed (Zhou & Zhang, 1983; 1985, p. 73), with type species *A. pustulosa* Zhou & Zhang, 1983. The revised concept of *Koldinioidia* has been followed by Qian (1986) and An & Duan (*in* Duan *et al.*, 1986).

This procedure seems unnecessary, however. Too much weight appears to be placed on the definition of the preglabellar furrow and the shape of the frontal glabellar lobe, which is normally highly variable in Shumardiidae. Shergold (1972, 1975) previously demonstrated a range of morphology in *Koldinioidia cylindrica* (Shergold, 1972), *K.* cf. *cylindrica* and *K. payntonensis* (Shergold, 1975). The first species has a variably defined preglabellar furrow (Shergold, 1972, pl. 18, figs 7-8), and variably expanded frontal glabellar lobe. In *K.* cf. *cylindrica* (see Shergold, 1975, pl. 58, figs 1-4), internal moulds and exoskeletons show different morphology. *K. payntonensis* (Shergold, 1975, pl. 58, figs 5-10) has a considerably broadened (tr.) occipital ring, supposedly as in the type species of *Koldinioidia*, but an anteriorly tapering glabella, more like that thought to characterise *Akoldinioidia*.

Accordingly, the concept of *Kolinioidia* adopted here is that of Shergold (1975), and *Akoldinioidia* is regarded as a junior subjective synonym. *Koldinioidia* is regarded as a distinct genus. A former subgenus of *Koldinioidia*, *Lyriamnica* Shergold, 1980, with palpebral lobes and an anterior cranidial border, is here raised to full generic rank. It is considered to be the ancestor of *Koldinioidia*; it is also the senior subjective synonym of *Elaphraella* Lu & Qian, 1983. This ancestral shumardiid existed early during the post-Idamean/pre-Payntonian interval in northern Australia and at an equivalent time (*Shirakiella xiaoshiensis* and *Kaolishania pustulosa* Assemblage Zones) in Liaoning, northeastern China.

In central Australia, the cephalic morphologies of both *Kolinioidia* and *Akoldinioidia sensu* Zhou & Zhang (1983, 1985) occur together in the Pacoota Sandstone and are considered to represent a single species of *Koldinioidia*.

Genus ***Koldinioidia*** Kobayashi, 1931
[= ***Akoldinioidia*** Qian, 1986]

Type species: *Kolinioidia typicalis* gen. et sp. nov.; Kobayashi, 1931, pp. 187–188, pl. 22, figs 8b, 9; original designation; Chiushukuo Shale, Qiushuguo, Hualienchai, Liaoning; Late Cambrian, late Fengshanian. This species also occurs in northern Shanxi, northern and eastern Hebei, Jilin, and north-western Hunan.

Other species: To the species listed in Shergold (1975) should be added those assigned to *Koldinioidia* or *Akoldinioidia* by Přibyl & Vaněk (1980), Q. Z. Zhang *in* Qiu *et al.* (1983), Zhou & Zhang (1983, 1985), Lu & Lin (1984), Qian (1986), and Lu *et al.* (1986).

Koldinioidia sp. aff. *K. sulcata* Robison & Pantoja-Alor, 1968
(Pl. 3, Figs 23–24)

aff. 1968 *Koldinioidia sulcatus*, n. sp.; Robison & Pantoja-Alor, 1968, pp. 796–797, pl. 104, figs 20–23

Material: Three cephala, CPC26916–26918, lengths (sag.) 1.75–2.6 mm.

Age: Late Cambrian, Payntonian/Early Datsonian, Assemblage 1.

Occurrence: Confined to locality AS193, at the western end of the Fergusson Syncline, Ross River, Amadeus Basin.

Comments: The available material (Pl. 3, Figs 23–24) is insufficiently well preserved to warrant detailed description. All specimens are internal moulds in a sand/silt matrix, and are from the same locality (AS193). CPC26916 (Fig. 23) has a poorly defined preglabellar furrow, and the frontal lobe of the glabella appears to merge with the preglabellar area, as in moulds of *Kolinioidia* cf. *cylindrica* (Shergold, 1972) (see Shergold, 1975, pl. 58, fig. 1). In CPC26917 (Fig. 24), a preglabellar furrow is defined, and the frontal lobe apparently is pointed. Neither specimen has the laterally expanded occipital ring characteristic of *K. payntonensis* Shergold, 1975. However, both do have a gently sulcate preglabellar area, similar to the specimens from Mexico described by Robison & Pantoja-Alor (1968, pl. 104, figs 20–23) as *K. sulcata.*

Genus *Shumardia* Billings, 1862

Type species: *Shumardia granulosa* (N. sp.); Billings, 1862, pp. 92–93, fig. 83; by original designation; Shumardia Limestone, Lévis, Quebec; Middle Ordovician, Early Llanvirnian.

Comments: Numerous species of *Shumardia* have been described, and some difficulties with their revised classification alluded to above. Concepts of *Shumardia* have been discussed previously by Whittington (1965), Dean (1973) and Fortey (1980) and their conclusions are followed here. The present material adds no new information to these earlier discussions.

Shumardia species undetermined
(Pl. 1, Figs 25–26)

Material: A single specimen, CPC27158, known from both external and internal moulds, about 1.8 mm long (sag.).

Occurrence: Confined to locality AS9, eastern end of Ross River Syncline, eastern Amadeus Basin.

Comments: The available cranidium is appreciably convex (tr., sag.). The glabella is long (sag.), slightly club-shaped, anteriorly broadly rounded, and the occipital ring is only marginally wider (tr.) than the preoccipital glabellar lobes. Faint glabellar furrows are apparent.

Given the variation noticed among species of *Shumardia* by all recent observers, this specimen cannot be assigned to a particular species. Possibly close morphologically is *Shumardia erquensis* Kobayashi, 1937 *sensu* Jell (1985, p. 60, pl. 19, figs 15–19) from the Digger Island Formation, Waratah Bay, Victoria, of probable early Tremadocian age.

Age: Early Ordovician, Late Warendian, Assemblage 2.

Superfamilia **Incertae sedis**
Family **Plethopeltidae** Raymond, 1925
Genus *Plethometopus* Ulrich, *in* Bridge, 1931

Type species: *Bathyurus armatus* Billings, 1860, p. 319, fig. 23; designated Ulrich, *in* Bridge, 1931, p. 221; Lévis Formation, Lévis, Quebec; Late Cambrian, *Hungaia* assemblage.

Comments: Plethopeltidae as currently conceived is a homeomorphic family comprising entirely effaced or partly effaced genera: e.g. *Plethopeltis* Raymond, 1913, *Stenopilus* Clark, 1924, *Leiocoryphe* Clarke, 1924, and *Paraplethopeltis* Bridge & Cloud, 1947, mostly of North American provenance, but all of Late Cambrian, Franconian and Trempealeauan ages.

Of these genera, only *Plethopeltis* has been recorded in Asia. Material previously recorded as *Stenopilus* by Kobayashi (1933, p. 279) is now referred to *Wanwanoglobus* Kobayashi (1966, p. 265). The relationships between North American plethopeltids and effaced genera of similar age in Asia and Australia, which have been traditionally determined as kingstoniids, are not clear. Similarly, the relationships between these and Soviet effaced genera referred originally to *Kingstonia*, Walcott, 1924, *Koldinia* Walcott & Resser, 1924 or *Parakoldinia* Rosova, 1960 are equally unclear. Rosova (1960) originally classified the Russian material within the family Plethopeltidae. Pertinent Late Cambrian effaced trilobite families like the Kingstoniidae, Illaenuridae and Plethopeltidae within specific geographical biofacies succeed each other in time stratigraphic order (Shergold & Sdzuy, 1984, pp. 100–101), and their constituent genera are not necessarily genetically related. In North America, Plethopeltidae are themselves succeeded in the early Ordovician by other similarly constituted families, commencing with early nileids.

Comments on the distinction between plethopeltid genera were published by Longacre (1970), Stitt (1971) and Taylor & Halley (1974). Asian material was considered by Kobayashi (1933, 1943, 1960a, 1962, 1966). Longacre (1970, pp. 19–21) separated *Plethopeltis* and *Plethometopus* on the basis of degree of effacement of the axial, preglabellar and anterior border furrows. *Plethopeltella*, created for Asian species of *Plethopeltis* by Kobayashi (1943, p. 319), but regarded by Lu *et al.* (1965) as a leiostegiid genus, actually most closely resembles *Plethopeltis* on Longacre's criteria.

Australian material at hand consists of two effaced genera, one of which may be classified as *Wanwanaspis* Kobayashi, 1966. The other illustrates characteristics shared by *Plethopeltis*, *Plethometopus* and *Plethopeltella.* Asian material previously assigned to these genera is generally poorly preserved, has been poorly prepared and indifferently illustrated. Thus, a definitive determination of this material from the Amadeus Basin cannot be made and is, accordingly, left under open taxonomic nomenclature.

Plethometopus? species undetermined
(Pl. 1, Figs 18–22)

Material: Three cranidia, CPC26892, 26896–26897, length (sag.) 6–13 mm, certainly belong to this taxon; whereas two librigenae, CPC26893–26894; and two pygidia, 5.5–7.5 mm long (Lp_1), CPC26895, 26899, are less confidently assigned.

Distribution: This species occurs at localities AS147 and AS350 in the Ross River Syncline, eastern Amadeus Basin. It may also occur at locality AS197 in the same region, and at NT183 on the northern limb of the Waterhouse Range Anticline, SW of Alice Springs.

Age: Late Cambrian, Payntonian/Early Datsonian, Assemblage 1.

Comments: This species is assigned to *Plethometopus*, because its axial, preglabellar and border furrows are effaced, and only a trace of the occipital furrow is present sagittally.

Characteristically, the palpebral lobes are short (exsag.), situated in advance of the mid-point of the glabella and close to it. Quite distinct pits lie at the anterolateral margins of the glabella.

The size and position of the palpebral lobes is comparable with the majority of species of *Plethometopus*, as is the degree of effacement of the cranidial furrows. Pits similar to those described here anterolateral to the glabella have been illustrated previously in *Plethometopus obtusus* Rasetti (1945, p. 472, pl. 62, figs 2) from the Lévis Formation, Quebec. The Australian cranidia do not have the triangular, sagittally pointed, occipital ring so characteristic of North American species of *Plethometopus* (e.g. Westrop, 1986, pls 36–38) and even some of the species assigned to *Plethopeltis* (e.g. Longacre, 1901, pl. 4). The occipital ring does resemble species such as *Plethopeltis shantungensis* Lu (Lu 1957, p. 270, pl. 140, figs 18, 19; Lu *et al.*, 1965, p. 585, pl. 123, figs 9–10), which Kobayashi (1962, p. 68) would classify as *Plethopeltella*. The last, however, may have a differentiated anterior cranidial border furrow (see Kobayashi, 1933, pl. 6, figs 5a–b). The only previous species of *Plethometopus* described from Asia, *P. longispinus* Kobayashi (1958, p. 214, fig. 3; 1962, pl. 10, fig. 19) from the Tangyang district of South Korea, has an occipital spine.

Australian cranidia are associated with librigenae which retain only faint traces of border furrows, and have expansive genal fields and short genal spines. These are reminiscent of species referred once more to both *Plethometopus* (e.g. Westrop, *loc. cit.*) and *Plethopeltis* (e.g. *Plethopeltis saurini* Kobayashi, 1956, pp. 281–282, pl. 40, figs 5–7) from Vietnam.

Associated pygidia could also belong to either genera. Those at hand are small, semicircular, have a broad axis (tr.), consisting of only three segments, and a basically effaced pleural zone. The border furrow is effaced, and the margins entire, non-spinose. Previously described species are quite variable in their degree of effacement.

Superfamily et Family Incertae sedis
Genus ***Wanwanaspis*** Kobayashi, 1966

Type species: *Kingstonia semicircularis*, new species; Kobayashi, 1933, p. 278, pl. 6, figs 7-8; by original designation; Wanwankou Dolomite, Wanwankou, Liaoning, China; Late Cambrian, Fengshanian.

Comments: *Wanwanaspis* was previously classified within the Family Kingstoniidae (see Shergold, 1975, p. 107), a typically North American early Late Cambrian (Dresbachian) family of unknown derivation. Iterative morphology among latest Cambrian and even earliest Ordovician trilobites has led also to their unquestioned classification within Kingstoniidae. Considering previous discussion (Shergold & Sdzuy, 1984), such trilobites are best left unclassified at suprageneric level until their various evolutionary lineages can be investigated. Composed mostly of externally effaced cranidial genera, they are often poorly preserved and poorly illustrated. Exfoliated material is required for their classification and tagmata other than cranidia are required for the proper assessment of their relationships.

Wanwanaspis species undetermined
(Pl. 1, Figs 23–24)

Material: Two cranidia, CPC26900, 26902, length (sag.) 8–14 mm; a possible librigena, CPC26903; and a possible pygidium, CPC26901.

Distribution: Confined to the southern limb of the Fergusson Syncline, eastern Amadeus Basin, at localities AS354 and AS355.

Age: Late Cambrian, Payntonian/Early Datsonian, Assemblage 1.

Comments: The present material is insufficiently well preserved to warrant detailed description.

The two cranidia are significantly convex (tr.) (sag.) and totally effaced. Small (exsag.) palpebral lobes are situated anterior to the mid-point of the glabella, and are widely spaced.

The associated librigena is narrow (exsag.), sliver-like. Its lateral border furrow is faintly impressed; the posterior border is much reduced, and lacks a furrow. A stout genal spine is present. It is possible that this type of librigena may belong to *Quadraticephalus* cf. *coreanicus*, found in the same samples.

A single subcircular pygidium with effaced segmental furrows, and retaining only a hint of a border furrow, may belong to *Wanwanaspis* sp. undet.

Suborder **Asaphina** Salter, 1864
Superfamily **Asaphacea** Burmeister, 1843
Family **Asaphidae** Burmeister, 1843
Subfamily **Isotelinae** Angelin, 1854
Genus ***Asaphellus*** Callaway, 1877

Type species: *Asaphus (Isotelus?) homfrayi* Salter, 1866a, p. 311, pl. 8, figs 11–14; 1866b, pp. 165–166, pl. 24, figs 6–12; designated Callaway (1877, p. 664); Tremadoc Series, Garth, North Wales.

Comments: Synonymy, distribution and composition of *Asaphellus* species have been reviewed by Zhou & Fortey (1986, p. 186), whose concept is followed here. Comparison below is confined to previously described Australian, Chinese and Korean species, including: *Asaphellus acutulus* Zhou & Zhang (1978, pp. 16–17, pl. 4, figs 12–20), from northeastern Hebei; *A. aristous* Liu (*in* Lu *et al.*, 1982, p. 325, pl. 233, fig. 4; pl. 235, fig. 12), from Hunan; *A. bellus* Lu *in* Zhou *et al.* (1977, p. 213, pl. 62, fig. 7), from Hunan and southeastern Sichuan; *A. changi* Sheng (1958, p. 188, pl. 2, figs 3a–e), from Guizhou; *A. conoideus* Kuo & Duan *in* Kuo *et al.* (1982, pp. 22–23, pl. 1, fig. 6), from Hebei; *A. coreanicus* Kobayashi (1934, pp. 552–553, pl. 4, fig. 12), from South Korea; *A? hunghuanyuanensis* Sheng (1958, pp. 188–189, pl. 3, fig. 4), from Guizhou; *A. inflatus* Lu (1962, p. 43, pl. 13, figs 2–4), from western Hubei, southern and southeastern Sichuan; *A. nanchuanensis* Lu (1975, pp. 134–135, pl. 13, figs 16–19), from southern Sichuan; *A. planus* Zhang *in* Qiu *et al.* (1983, p. 204, pl. 68, figs 5–7), from *A. praetrinodosus* Lu *in* Lu *et al.* (1976, pp. 55–56, pl. 8, figs 9–10), from eastern Liaoning; *A? pricensis* Legg (1976, p. 12, pl. 4, figs 1, 8, 12, 13, 17–19, 24), from the Canning Basin, Western Australia; *A. tomkolensis* Kobayashi (1934, pp. 549–551, pl. 4, figs 1–7), from South Korea; *A. trinodosus* Chang (1949, p. 119, pl. 1, fig. 12; pl. 2, figs 7–10), from western Hebei; *A? tungtzuensis* (Sheng) (Sheng 1958, pp. 173–174, pl. 1, figs 3a–g), from Guizhou; *A. verus* Zhou *in* Chen *et al.* (1980, pp. 135–136, pl. 4, figs 18–21), from Hebei; and *A. yansheensis* Yin (in Yin & Li 1978, pl. 532, pl. 175, figs 6–10), from Guizhou.

Asaphellus sp. cf. ***A. trinodosus*** Chang, 1949
(Pl. 9, Figs 9–18)

cf. 1949 *Asaphellus trinodosus* Chang (sp. nov.); Chang, 1949, p. 119, pl. 1, fig. 12; pl. 2, figs 7–10. [Further synonymy of this species given by Zhou & Fortey (1986, pp. 186–187)]

1985 *Asaphellus* sp. cf. *A. trinodosus* Chang, 1949; Jell & Stait, 1985a, pp. 13–14, pl. 4, fig. 12; pl. 6, figs 1–12.

Material: Five cranidia, CPC26977–26980, 26993, length (sag.) 11–17.5 mm; eight librigena, CPC26981–26987, 26994; and six pygidia, CPC26988–26992, 26995, length (Lp_1) 4.5–20 mm.

Distribution: Confined to localities in the Gardiner Range, 85/3055 and 85/3058, central-western Amadeus Basin.

Age: Early Ordovician, Late Warendian, Assemblage 2.

Comments: *Asaphellus trinodosus* Chang is characterised by the occurrence of bacculae immediately posterior to the palpebral lobes. In Australian material from the Amadeus Basin described here, and possibly also that from the Florentine Valley, Tasmania (Jell & Stait, 1985a), which is compared to this species, a median glabellar node lies on a transverse line connecting the bacculae. Characteristically, the palpebral lobes are short (exsag.), with mid-lengths coinciding approximately with the mid-length of the glabella, and adjacent to the weakly defined axial furrows. Material from the Pacoota Sandstone has a relatively narrow (tr.) interocular width and an undifferentiated shallow and concave (sag.) preglabellar area. The interocular width and the maximum width (tr.) of the preglabellar area coincide.

Typically, central Australian librigenae associated with the cranidia have long delicate genal spines, a narrow lateral border gently reflected in front of the spine base, and effaced posterior border furrows.

Pygidia are elongate, subovoid, slightly flattened in outline posteriorly. Pleural and interpleural furrows are effaced, as are the transverse furrows of the axis. Axial furrows, however, are weakly defined, but there is a fairly significant border.

The present material is comparable to a group of Chinese and Korean species referred previously to *A. trinodosus* Chang, *A. tomkolensis* Kobayashi, *A. changi* Sheng, *A. praetrinodosus* Lu, *A. acutulus* Zhou & Zhang and *A. verus* Zhou. These species, amongst which there are probably several synonyms, lack the glabellar convexity of *A. inflatus* Lu and related species, have longer (sag.) preglabellar areas, and retain pygidial borders. They differ among themselves, basically by the proportions of the preglabellar area, the course of the preocular sections of the facial suture, depth of the preglabellar furrow, and degree of definition of the pygidial furrows.

Compared to the typical species of *Asaphellus* occurring in its type area (see Lake 1942, pl. 45; Zhou & Fortey, 1986, text-fig. 2), the cranidium of *A.* cf. *trinodosus*, and related species, has proportionately a more slender glabella and wider (tr.), shorter (sag.) preglabellar area, and possibly longer (exsag.) palpebral lobes. Pygidia are essentially similar.

Asaphellus? species undetermined 1
(Pl. 9, Figs 1-8)

Material: Six cranidial fragments, CPC27000, 27002, 27012–27014, 27028, up to about 12 mm long (sag.); one hypostome?, CPC27017; seven librigenae, CPC26999, 27003–27004, 27015–27016; and twenty-five pygidia, CPC26996–26998, 27001, 27007–27011, 27018–27027, 27029–27034, length (Lp_1) 3.5–13.5 mm.

Distribution: As presently conceived, this species has a wide distribution across the Amadeus Basin from the N'Dhala Gorge and Williams Bore areas of the Ross River Syncline (AS231A, AS265, AS267, NT195) in the east, through Native Pine Gap (AS128, NT331) and the southern Waterhouse Range (Hy268) in the east-central part of the Basin, as far as the southern Idirriki Range (ML4) in the west.

Age: Early Ordovician, Late Warendian, Assemblage 2

Comments: *Asaphellus*? species undetermined 1 is likely to be a composite taxon. Although the combination of librigena and pygidium recurs in collections across the basin, only fragmentary and poorly preserved cranidia are known. That assigned here has a very short (sag.) preglabellar area, as dictated by the morphology of the librigena, and could possibly equally well be identified as *Kayseraspis*. Thus, it may not be correctly identified.

Pygidia are quite characteristic, being semicircular, but variously effaced. Mostly they show evidence of four pleural furrows and up to six axial segments. All specimens conserve a faint, but definite, border at which the axis terminates abruptly posteriorly. This type of pygidium is never spinose.

At localities AS265, NT331 and Hy268, an associated librigena is characterised by a narrow lateral border which is quite distinctly reflected, and a prominent lateral border furrow terminating in front of the genal spine base. The posterior border furrow is effaced. The librigena indicates association with a cranidium-bearing anteriorly situated palpebral lobes and an equally narrow (sag.) anterior cranidial border and narrow (sag.) preglabellar furrow. The cranidium illustrated here (Pl. 9, Fig. 2) appears to represent a likely morphological combination, because its preglabellar area is very short (sag.), and its palpebral lobes lie in front of the mid-point of the glabella. This type of cranidium is non-bacculate, but possesses a posteriorly situated axial node lying just in front of the occipital structure.

Few previously described species of *Asaphellus* share this combination of morphologies; hence the queried generic determination. *A. praetrinodosus* Lu (*in* Lu *et al.*, 1976, pl. 8, figs 9–10) has a similar pygidium (fig. 10), but the cranidium associated with it (fig. 9) has a considerably more extensive preglabellar area, and the glabella is constricted at the interocular width.

Specimens assigned by Harrington & Leanza (1957, fig. 75) to *Megalaspidella kayseri* Kobayashi (1937, p. 499, pl. 5, figs 7–8) may have comparable cranidia. The pygidium, however, has many more visible axial segments (up to 12) and pleural furrows (6–7). Nevertheless, its shape may be similar. This Argentinian species is likely to be younger than that described here.

The pygidium of *Niobella obsoleta* (Linnarsson) (see Tjernvik, 1956, p. 229, pl. 5, fig. 2) has an appropriate age (Zone of *Apatokephalus serratus* in Västergötland, Sweden), comparable shape and segmentation, but is less effaced. Its cranidium (*loc. cit.* fig. 1) also has a short preglabellar area, but it shows more obvious traces of an occipital ring.

Asaphellus? species undetermined 2
(Pl. 9, Figs 19–24)

Material: Fragments of three cranidia, CPC27043, 27049–27050, the most complete (illustrated on Pl. 9, Figs 19–20, mould and counterpart) having a length (sag.) of 34.5 mm; and two librigenae, CPC27039, 27048; and eleven pygidia, CPC27035–27038, 27040–27042, 27044–27047, length (Lp_1) 4–13.5 mm.

Distribution: West-central Amadeus Basin, on the Ellery Creek measured section at NT614, about 700 m above the base of the Pacoota Sandstone; and in the Deering Hills, Mount Liebig 1:250 000 geological series sheet area, at ML18, ML30A and ML30E within the uppermost 70 m of Pacoota Sandstone on measured section MLW5.

Age: Early Ordovician, initial Arenigian?, Assemblage 3.

Comments: Cranidia and librigenae are partly effaced, but pygidia retain axial, pleural and border furrows. On the cranidium, the shape of the glabella, which is typically isoteline and similar to *Asaphellus* or *Isoteloides* Raymond, 1910, can be made out to be broadly pear-shaped.

Neither glabellar furrows nor bacculae are observed. Short (exsag.) palpebral lobes lie adjacent to vestigial axial furrows opposite the point at which the glabella is laterally constricted. The preglabellar area is proportionately wide (tr., sag.), concave (sag.), and distinctly ogival. The trace of the posterior margin of the doublure is indicated on the internal mould (Pl. 9, Fig. 20). Posterior fixigenal border furrows are only faintly impressed. The associated librigenal fragments (not illustrated) are convex (tr.), and lack both lateral and posterior border furrows, thereby becoming essentially featureless.

Pygidia, which occur with the cephalic tagmata, are elongate (sag.), display up to 10 axial segments and 8-9 pleural furrows, of which the initial 7 are most prominent, and have prominent borders, particularly laterally, whose margins are flexed addorsally towards the posterior. Since they lack the same degree of effacement shown by the cranidium and librigena, they may not be conspecific or even congeneric. Most likely, however, the associated tagmata do represent a single taxon, but no such combination has been described previously. As the present material is not well preserved, no attempt is made here to create a new taxon.

Cranidia most closely resemble *Asaphellus*, but there is insufficient material to assess variation or make adequate comparison with existing species. The pygidia, on the other hand are not really typical of *Asaphellus*. They could conceivable be classified among a number of genera: *Basiliella* Kobayashi, 1934; *Megistaspis* Jaanusson, 1953; *Ptychopyge* Angelin, 1854; or *Plesiomegalaspis* Jaanusson, 1953, perhaps. They very closely resemble species of the first, especially *Basiliella carinata* Harrington, 1938 (see Harrington & Leanza, 1957, pp. 145-146, fig. 62, 1-9) from the late Tremadocian of northwestern Argentina, and *B. chinkoutzuensis* Endo, 1944 (see Lu *et al.*, 1965, pl. 94, figs 11-12) from Jilin Province, China. No cranidia of the *Basiliella* type have been found in the present collections, at this stratigraphical level.

A general combination of cranidium and pygidium could be representative, however, of *Isoteloides*. Considerable cranidial similarity exists between *Asaphellus*? sp. undet. 2 and *Isoteloides flexa* Hintze (1952, p. 172, pl. 17, fig. 4), and the pygidium of this species has an appropriate shape and border morphology, although more effaced. Since an associated hypostome is not available, the presence of *Isoteloides* cannot be confirmed. *Isoteloides* is typically a North American genus, which occurs later than the Australian species from the top of the Pacoota Sandstone. Determination of the last is accordingly constrained.

Genus *Kayseraspis* Harrington, 1938

Type species: *Kayseraspis asaphelloides* gen. et sp. nov., Harrington, 1938, pp. 228-230, pl. 10, figs 1, 2, 6, 7, 10, 14, 15, 18; by original designation; Santa Victoria Group, Salta Province, northwestern Argentina; Early Ordovician, Arenigian.

Comments: The concept of *Kayseraspis* is discussed in the papers of Harrington (1938), Kobayashi (1955), Harrington & Leanza (1957) and Zhou & Fortey (1986), and the last have also documented the distribution of the genus. All previously described species appear to have been assigned an Arenig age. Essentially similar, but considerably less effaced pygidia occur in the late Tremadoc of northern China (Lu *in* Lu *et al.*, 1976; Zhou & Fortey, 1986), but have been referred to *Penchiopsis* Lu (*in* Lu *et al.*, 1976) on the basis of association with a strongly posteriorly emarginate hypostome: that found articulated with the cranidium of *Kayseraspis brackesbuschi* (Kayser) (Harrington & Leanza, 1957, fig. 78.3) is posteriorly broadly rounded, as in *Asaphellus* or *Xenostegium*.

Kayseraspis? *belli* sp. nov.
(Pl. 7, Figs 13-22)

Name: Named for A. D. M. Bell, first resident geologist, Alice Springs, 1950-1954.

Types: Holotype, cranidium and associated counterpart, CPC27066; paratypes CPC27051-27065, 27067-27073.

Material: Ten cranidia, CPC27051-27053, 27058-27061, 27066, 27072-27073, length (sag.) 5-14 mm; one librigena, CPC27063; and twelve pygidia, CPC27054-27057, 27062, 27064-27065, 27067-27071, 2.5-16 mm long (Lp_1), excluding the terminal spine.

Distribution: Wide-ranging across the sampled Amadeus Basin; prepared collections have been obtained from the eastern Ross River Syncline in the vicinity of N'Dhala Gorge (NT194, AS260, AS262, AS264, AS265), and from the western end of this syncline in the vicinity of Willaims Bore (AS231A, 231B); in the vicinity of Jay Creek Native Settlement (AS126, 127); on the measured section at Ellery Creek (85/3062), and Native Pine Gap (NT333); the southern flank of the James Range Anticline (Hy211); in the Deering Hills (ML18); and Idirriki Range, southern flank (ML4), in the western-central part of the Basin.

Age: Early Ordovician, Late Warendian, Assemblage 2.

Diagnosis: A species tentatively assigned to *Kayseraspis* Harrington, 1938 with proportionately wide (tr.), subrectangular glabella, anteriorly situated palpebral lobes, vestigial occipital ring, short (sag.) preglabellar area, posteriorly situated axial glabellar node; and pygidium with effaced furrows on the axis, pleural zone and border.

Description: The cranidium is proportionately short (sag.), convex (tr. & sag.), anteriorly markedly ogival in early holaspides.

The glabella is subrectangular, barely constricted laterally, broadly rounded laterally, only slightly longer (sag.) than wide (tr.). Glabellar furrows are effaced, but a faint occipital furrow is characteristic, separating a distinct occipital ring. An axial node lies on the glabella immediately in front of the occipital furrow.

Palpebral lobes are moderately long (exsag.), considering the shortness of the glabella, situated adjacent to the axial furrows in advance of the midpoint of the glabella. Preocular facial sutures diverge towards the anterior, unite sagittally at an angle more distinctive in early holaspides, and enclose a short (sag.) preglabellar area composed of a narrow (sag.), concave preglabellar furrow, and narrow (sag.), reflected anterior cranidial border. Postocular sections of the facial suture enclose, blade-like posterolateral limbs bearing faint posterior border furrows.

Associated librigenal fragments have narrow (exsag.) lateral borders, deep border furrows, and delicate genal spines.

Pygidia are typically largely effaced, essentially subtriangular, and with a delicate posterior spine. Only the articulating furrow is usually defined on the axis, which is distinguished by vestigial axial furrows. Pleural furrows, apart from the first, and interpleural furrows are effaced, as are the border furrows. However, a faint hint of a narrow border remains. Posteriorly, this forms the base of the pygidial terminal spine.

Comments: The holotype of *Kayseraspis asaphelloides* (Kayser) is a complete exoskeleton, with, unfortunately, a damaged glabella. However, the cranidium does show a narrow (sag.) preglabellar area, comprising a deep and narrow preglabellar furrow and equally narrow (sag.) anterior border. The glabellar furrows are effaced, and an axial node is posteriorly sited. Palpebral lobes are short (exsag.), close to the axial furrows, and anteriorly situated. Librigenae show narrow (exsag.) lateral borders and border furrows, in keeping with the morphology of the preglabellar area. The pygidium has effaced pleural furrows, but retains the segmentation of the axis and border furrows. The assigned hypostome is similar to that of *Asaphellus*.

Material from the Pacoota Sandstone, tentatively assigned to *Kayseraspis*, shares many of the characteristics of the type specimen. However, it is distinguished from all other species currently assigned to the genus by its glabellar shape and retention of an occipital ring. Furthermore, its pygidial effacement is more advanced. In many respects, the morphology of the preglabellar area more closely resembles that of *Xenostegium*, particularly the type species *X. belemnurum* (White), as illustrated by Walcott (1925, pl. 24, figs 3–4), than most species of *Kayseraspis*. Similar cranidia were also described by Harrington (1938, pp. 241–242, pl. 12, figs 12–14) from the late Tremadoc of northwestern Argentina as *Megalaspidella pumila* Harrington. Essentially, *K? belli* sp. nov. is a more effaced spinose variation of *Asaphellus?* sp. undet. 1 described above. Occasionally, pygidia can only be distinguished by the presence or absence of the terminal spine. That the combination of cranidium and pygidium is correct seems assured by the association illustrated in Pl. 7, Fig. 19. All the fragments found at locality NT194 are representative of a single taxon. The close relationship between *Kayseraspis* and *Asaphellus* noted by Zhou & Fortey (1986) would seem to be supported.

The stratigraphic occurrence of *K.? belli* is earlier than other described species of *Kayseraspis*, but similar to that of *Penchiopsis* Lu (*in* Lu *et al.*, 1976; Zhou & Fortey, 1986). The latter is known only from pygidia, and an associated posteriorly emarginate hypostome, which may or may not belong to *Penchiopsis*. Unfortunately, no hypostomata have been identified for *K? belli*. If they exist in the collections, they are indistinguishable most likely from those of *Asaphellus*. If *K? belli* is considered to represent *Penchiopsis*, then its pygidium is considerably more effaced. In view of the current lack of resolution that can be applied to these problems, a firm generic determination is left in abeyance.

Subfamily **Incertae sedis**
Genus ***Psilocephalina*** Hsu, 1948

Type species: *Psilocephalina lubrica* Hsu, 1948, pp. 24–27, pl. 7, figs 8–15; pl. 8, figs 1–14; by original designation; Fenhsiang Formation, western Hubei, and Sichuan Provinces, China; Early Ordovician, late Tremadocian, *Acanthograptus-Tungtzuella* Zone.

Other species: *Psilocephalina sinuata* Hsu (1948, p. 27, pl. 8, figs 15–24); *Psilocephalina lubrica transversa* Hsu, 1948; *Psilocephalina hsui* Sheng (1958, p. 174, pl. 2, figs 1a–e); *Psilocephalina kuoi* Sheng (1958, p. 174, pl. 2, figs 4a–h); *Psilocephalina hsui* var. *tungtzuensis* Sheng (1958, p. 174, pl. 2, figs 2a–f); *Psilocephalina lata* Lu (1975, p. 338, pl. 17, figs 3–8); *Psilocephalina sinuata brevica* Lu (1975, p. 339, pl. 17, fig. 15); *Psilocephalina strangosinuata* Lee (*in* Lu *et al.*) (1978, p. 244, pl. 104, figs 6–9); *Psilocephalina qijiangensis* Li (1978, p. 244, pl. 104, figs 3–4); *Psilocephalina latiformis* Li (1978, pp. 244–245, pl. 104, fig. 5); *Psilocephalina bayuensis* Lee (1978, p. 245, pl. 103, fig. 9). These species occur in Yunnan, Sichuan and W. Hubei Provinces of south-central China, where they have a latest Tremadoc age, *Acanthograptus — Tungtzuella* Zone.

Comments: The confusion over the nomenclature of *Psilocephalina* has been discussed at length by previous authors (Stubblefield, 1951a and b; Kobayashi, 1951; Lu *in* Lu *et al.* 1965; Lu, 1975). Although classified in the Family Asaphidae by Hsu (1948), Sheng (1958) and Lu (1975), other authors have referred it to the Family Nileidae although the frontal glabellar lobe is not laterally expanded. The generic concept published by Lu (1975) is followed here.

Psilocephalina sp. cf. ***P. lubrica*** Hsu, 1948
(Pl. 8, Figs 1–20)

cf.	1948	*Psilocephalina lubrica* Hsu (sp. nov.); Hsu, 1948, pp. 24–27, pl. 7, figs 8–15, pl. 8, figs 1–14.
cf.	1948	*Psilocephalina carinata* Hsu (sp. nov.); Hsu, 1948, pp. 27–28, pl. 9, figs 8–12.
cf.	1965	*Psilocephalina lubrica* Hsu; Lu *et al.*, 1965, pp. 523-524, pl. 109, figs 2–8.
cf.	1965	*Psilocephalina carinata* Hsu; Lu *et al.*, 1965, pp. 524-525, pl. 109, figs 9–10.
cf.	1974	*Psilocephalina lubrica* Hsu; Lu & Zhang *in* Lu *et al.*, 1974, pp. 126–127, pl. 50, figs 3–4.
cf.	1975	*Psilocephalina lubrica* Hsu; Lu 1975, p. 139, pl. 16, figs 4–24; pl. 17, figs 1–2.
cf.	1978	*Psilocephalina lubrica* Hsu; Li, 1978, p. 243, pl. 104, figs 1–2.
cf.	1979	*Psilocephalina lubrica* Hsu; Ju, 1979, pl. 1, figs 16–17.

Material: Twenty cranidia, CPC27112, 27116, 27118–27124, 27129–27133, 27145, 27149–27151, 27155–27156, length (sag.) 4–24 mm; two hypostomata, CPC27117, 27135; nine librigenae, CPC27104–27105, 27111, 27113–27114, 27125–27134, 27152; and twenty-three pygidia, CPC27106–27110, 27115, 27127–27128, 27136–27144, 27146–27148, 27153–27154, 27157, length (Lp_1) 4–20 mm, comprise the studied paradigm.

Distribution: Extensive across the basin; eastern Ross River Syncline (NT195); southern flank of Waterhouse Range on the "Owen Springs Road" (NT237a–c, A1/26); and at section HyR5/6, southern flank of Waterhouse Range Anticline, approximately 395 m above the base of the measured section (Hy 269, 85/3101, 85/3102). Native Pine Gap, approximately 363 m above the base of the measured section (NT335); Ellery Creek, approximately 480 m above the base of the Pacoota Sandstone (NT252 85/3061); Gardiner Range Anticline, southern flank (85/3058); Walker Creek Anticline, Walker Pass (Hy233); Mount Peachy section RdC8 (Rd202); southern flank of James Range Anticline (Hy209, Hy260).

Age: Early Ordovician, Late Warendian, Assemblage 2.

Description: All tagmata have effaced furrows, and may be large, but of relatively low convexity (tr., sag.).

On the cranidium, a glabella is not differentiated, and only a hint of a wide occipital structure is preserved by pits on the posterior cranidial margin at its abaxial extremities, as in the type species. No border is differentiated anteriorly (Pl. 8, Figs 12, 13). The preocular facial sutures are not appreciably divergent. Postocular sections enclose expansive (tr., exsag.) posterolateral limbs, which may possess a hint of a narrow articulating facet on their posterolateral margins. Palpebral lobes are small (exsag.) and lie in advance of the middle of the cranidium, presumably close to the glabella. An axial glabellar node lies in close proximity to the occipital structure.

Two indifferently preserved hypostomata demonstrate little definitive morphology. They have weak maculae, weak border furrows and an almost saukioid median body.

The librigena closely mirrors the shape of the cranidium. Specimens figured here (Pl. 8, Figs 10, 11) have a faintly depressed lateral border furrow, but no posterior border furrow, and a short genal spine.

Pygidia are subtriangular, smooth, and non-spinose. The axis, like the occipital ring, is defined only anteriorly, by abaxial pits. The remainder is effaced, as is the pleural zone — apart from a faint indication of the first pair of pleural furrows — and the anterolateral articulating facets. The number of segments cannot be ascertained.

Although no border furrow is preserved, some specimens have broken margins and show the extent of the doublure (e.g. Pl. 8, Fig. 18).

Comments: In degree of effacement, convexity, shape and proportion, Australian cranidia and pygidia are virtually identical to those of *Psilocephalina lubrica* Hsu. They differ, however, in respect to the position of the glabellar node, which lies much farther forward in the Chinese species, almost just behind the middle of the glabella. Librigenae also differ (cf. Pl. 8, Fig. 11 with Lu, 1975, pl. 16, fig. 8, pl. 17, fig. 1 for example), but this may represent an artefact of preparation. Essentially, the two groups of species are morphologically very close.

Family **Taihungshaniidae** Sun, 1931
Genus ***Pacootella*** gen. nov.

Name: Derived from Pacoota, traditional name for Mount Blatherskite, adjacent to the Todd River, south of Heavitree Gap, Alice Springs; feminine gender assigned.

Type species: *Pacootella collativa* gen. et sp. nov.; Upper Pacoota Sandstone (Sequence 3), Amadeus Basin; Early Ordovician, late Tremadoc, Warendian, Assemblage 2; designated herein; illustrated Pl. 7, Figs 1-12.

Diagnosis: Cranidium with characteristically subrectangular glabella, with effaced furrows, weakly defined posteriorly situated axial node; traces of occipital ring; short (exsag.) palpebral lobes close to middle of glabella, adjacent to axial furrows; very short (sag.) preglabellar area, no more than a narrow ledge; hypostoma characteristically with broad anterolateral wings, steeply inclined, convex median body with effaced maculae; lateral borders distinctively deflected anteriorly; pygidium with pair of lateral spines, posteriorly directed, four segments, and trace of border.

Comments: *Pacootella* gen. nov. may eventually prove to be a composite taxon having an asaphine cranidium and librigena, a non-asaphine hypostome of presently unknown affinity, and a ceratopygacean or leiostegiacean pygidium with long, posteriorly directed lateral spines. However, at the localities where *Pacootella* occurs, this combination of tagmata is prevalent: for example, it is the only combination occurring at AS306.

Initially, the combination of tagmata described here as *Pacootella*, was considered to represent *Chosenia* Kobayashi, 1934, which also has a spinose pygidium (e.g. as listed by Shergold, 1987). The concept of *Chosenia*, a late Tremadoc to Arenig trilobite, has been discussed by Lu (1975) and Zhou & Fortey (1986), and is currently considered by these authors as a leiostegiid. Certainly, the lectotype cranidium of the type species, *C. laticephala* Kobayashi (1934, pl. 8, fig. 8), that assigned to the same species by Zhou & Fortey (1986, pl. 1, fig. 6), and that referred to a second species, *C. divergens* Lu (Lu, 1975, pl. 2, fig. 27), appear to represent a leiostegiid, with posteriorly sited palpebral lobes and wide (tr.) interocular areas, synonymous with *Leiostegioides* Kobayashi, 1934 (Zhou & Fortey, 1986, pp. 175, 176). The further synonymy of *Wutingia* Endo, 1935 and *Endoaspis* Lochman, 1956 refers to pygidia, which may or may not be congeneric. Pygidia heavily outnumber the cranidial fragments in all collections of *Chosenia* from northeastern China. *Pacootella* is also known mostly from pygidia and hypostomata. If its combination of parts is correctly assembled, then *Pacootella* cannot represent a leiostegiid genus, because of the structure of its cranidium and non-leiostegiid hypostome. The possibility of its ceratopygacean provenance cannot be discounted, because of close pygidial resemblance with *Proceratopyge* Wallerius, 1895.

Here, *Pacootella* is regarded as a new genus of Taihungshaniidae developed from an ancestral morphology similar to that of *Bellefontia* Ulrich (*in* Walcott, 1924), e.g. *B. chamberlaini* Clark (see Hintze, 1952, pl. 4, figs 9-13). *Bellefontia*, with its tendency to anterior glabellar expansion and reduction of the preglabellar area, requires only the development of pygidial spines to become recognisably taihungshaniid.

Taihungshaniidae have been discussed at length by Lu (1975), and its constituent genera listed: *Taihungshania* Sun, 1931, *Asaphellina* Munier-Chalmas & Bergeron, 1889, *Omeipsis* Kobayashi, 1951, and *Tungtzuella* Sheng, 1958. *Ruapyge* Wright, 1979 [= *Dionide* Reed, 1926, = *Taihungshania* Kobayashi, 1940, = *Hectoria* Lu, 1975], considered a taihungshaniid by Lu (1975) is now a proven ceratopygid (Wright, 1979). Taihungshaniidae, as conceived by Lu, has a restricted Arenig-Llanvirn age.

Of taihungshaniid genera, *Tungtzuella* retains a more or less subrectangular glabella and very narrow (sag.) preglabellar area similar to that of *Pacootella*. *Asaphellina* shares a more typically asaphine cranidium, which has a posteriorly situated axial glabellar node. All genera of Taihungshaniidae possess variably expressed pygidial spines. Little, however, is known of the hypostomal morphology.

Pacootella collativa sp. nov.
(Pl. 7, Figs 1-12)

Name: L., *collativa*, collected together, referring to the gathering together of apparently disparate tagmata.

Types: Holotype, external mould of cranidial fragment, CPC27074, illustrated on Pl. 7, Fig. 2; paratypes, CPC27075-27103.

Material: Eight cranidial fragments, CPC27074-27078, 27090-27092, measuring (Lc) between 9.5-21 mm; seven hypostomata, CPC27083-27086, 27095-27097; six librigenae, CPC27079-27082, 27093-27094; and nine pygidia, CPC27087-27089, 27098-27103, lengths (Lp_1) 8-26 mm.

Distribution: Material unquestionably assigned to this taxon is confined to the Ross River Syncline, eastern Amadeus Basin (AS9 and AS306). Similar hypostomata have also been found in collection A1/26, which is from Areyonga, Gardiner Range, west-central Amadeus Basin.

Age: Early Ordovician, Late Warendian, Assemblage 2.

Diagnosis: See generic diagnosis.

Description: Undeformed cranidia have a proportionately long (sag.), anteriorly obtusely rounded, laterally unconstricted, subrectangular glabella, and a poorly defined occipital ring.

The palpebral lobes are short (exsag.), situated close to faint axial furrows and in front of the mid-point of the glabella. Postocular branches of the facial suture, therefore, enclose broadly triangular posterolateral limbs bearing weak posterior border furrows. Preocular branches are not appreciably divergent and meet at a gentle angle sagittally. They enclose a short, band-like preglabellar area composed of a shallow, narrow (sag.) preglabellar furrow and equally narrow (sag.) anterior border. Occasionally, the preglabellar furrow is almost effaced and the cranidial border poorly differentiated from the glabella.

Librigenae are characterised by broad lateral borders narrowing rapidly and becoming reflected anterolaterally, and variably effaced lateral border furrows. The posterior border furrow is invariably effaced; the genal field has low convexity; and the genal spine is long and delicate.

Hypostomata have a gently arcuate anterior margin, and conspicuous, triangular, steeply sloping (addorsally) anterolateral wings. The median body has moderate convexity and is generally fused by the effacement of the maculae. Lateral and posterior border furrows are clearly incised. The borders broaden posterolaterally and are only gently upraised. Anteriorly, however, they become narrow and ridge-like. Posterior borders are also narrow (sag.) and reflected above the border furrow.

Pygidia are transverse, semicircular, approximately twice as wide (tr.) as long (sag.). A pair of long, delicate, posteriorly directed lateral spines is drawn from the lateral border adjacent to the anterior three pairs of pleural segments. Between the spine bases, the posterior margin is evenly rounded. An appreciably wide (tr., sag.) border is developed, but a border furrow is only faintly discernible. The axis is partly effaced: it could contain six segments, but only the articulating half ring is clearly defined. There is no post-axial ridge, the terminal piece of the axis ending abruptly at the posterior border. Four or five pleural segments are indicated by pleural furrows, of which only the first three pairs are well defined; interpleural furrows are effaced.

Comments: The cranidium of *Pacootella collativa*, characterised especially by its very narrow (sag.) preglabellar area and vestigial occipital ring resembles that assigned here to *Kayseraspis*? *belli* sp. nov. These cranidia may otherwise be distinguished by the proportionately larger palpebral lobes, greater convexity, and proportions of the glabella in the latter. Resemblance to certain species of *Bellefontia* has been indicated in the generic discussion. In general, however, species of *Bellefontia* have longer (exsag.) palpebral lobes, and a more centrally situated axial glabellar node. Species of *Megalaspidella* Kobayashi, 1937, *sensu* Harrington & Leanza (1957, p. 161 *et seq.*) are essentially similar, and the hypostome, although maculate, may be comparable. *Niobides* Harrington & Leanza, 1957, may also be cranidially related (*op. cit.* fig. 91.2).

Pygidia have lateral spines, posteriorly directed. They closely resemble specimens assigned previously to *Proceratopyge*, on the one hand, and *Chosenia*, on the other, particularly *C. divergens* Lu (1975, pl. 2, figs 28–31, pl. 3, figs 1–2), which also has a comparable age. Specimens referred to *C. laticephala* Kobayashi by Zhou & Fortey (1986, pl. 1, figs 7, 9, 10) have laterally directed spines and are less effaced. *Chosenia adamsensis* Jell & Stait (1985), from Tasmania, appears to represent an undisputed leiostegiid.

Suborder **Trinucleina** Swinnerton, 1915

Family **Hapalopleuridae** Harrington & Leanza, 1957

[= **Jegorovaiidae** Lu, 1965]

Genus ***Jegorovaia*** LU, 1964

Type species: *Jegorovaia expansa* Lu 1964a, p. 34, pl. 7, fig. 3, refigured in Lu *et al.*, 1965, p. 472, pl. 93, fig. 10; by original designation; uppermost Siyangshan Formation, western Zhejiang, China; Late Cambrian, Fengshanian, *Lotagnostus punctatus* Zone.

Comments: Chinese palaeontologists assign *Jegorovaia* to Lu (1964a, p. 34), but at that time no discrete generic diagnosis was provided, although the species *J. expansa* Lu was described and illustrated. This is regarded as the type species by Lu (*in* Lu *et al.*, 1965, p. 472, and *in* Lu *et al.*, 1974, p. 90) even though a second species, from the eastern Tianshan, Xinjiang, *J. tenuis* Lu (1964b, p. 28, pl. 3, fig. 2), was contemporaneously described. The last is dated 1963 by Xiang (1986, p. 135). Subsequently, *J. convexa* was described by Lu & Chien (*in* Lu *et al.*, 1974, p. 91, pl. 2, figs 6a–b, 7) from the Sandu Formation, Guizhou; and Xiang (1986, p. 135, pl. 49, figs 4–5) described *J*? *jiangjunguoensis* from the *Glyptagnostus reticulatus* Zone of northwestern Xinjiang Province. Xiang (1986) is followed here in the interpretation of *Jegorovaia* as a genus of Hapalopleuridae. However, one could also argument for the inclusion of the Cambrian members of this family within Olenacea. It seems that iterative development of an essentially nepeiform morphology appears in different family groups throughout the Middle and Late Cambrian. Material other than cranidia is required to establish relationships more firmly.

Jegorovaia*? *arena sp. nov.

Pl. 1, Figs 6–11)

Name: L., *arena*, f., from the sand, referring to the occurrence of this species in sandy inner detrital-type sedimentary rocks.

Types: Holotype, cranidium, CPC26904, an internal mould illustrated on Pl. 1, Fig. 10; paratypes CPC26905–26915.

Material: Twelve cranidia or cranidial fragments within the range 1.5–4 mm (sag.), CPC26904–26915.

Distribution: Material assigned to this species has been identified in five collections, two at the western end of the Fergusson Range Syncline on the Ross River (AS197, AS198), and three from the base of the measured section at Native Pine Gap (NT320A, 320B, 326), 20 km SW of Alice Springs railway station.

Age: Late Cambrian, Payntonian/Early Datsonian, Assemblage 1.

Diagnosis: A species tentatively assigned to *Jegorovaia* Lu with the following features: an anteriorly tapering glabella; glabellar furrows anterolaterally directed and opening widely into the axial furrows; and preglabellar area which comprises a convex (sag.) preglabellar field, wide (sag., exsag.) and deep border furrow, and narrow (sag.) upraised border.

Differential diagnosis: Australian material appears to be closely related to that described by Xiang (1986, p. 135) from northwestern Xinjiang Province, China, as *Jegorovaia*? *jiangjungouensis*. Both Chinese and Australian cranidia have wide preoccipital and median lateral glabellar furrows opening abaxially into diffuse axial furrows; a tendency to thicken the occipital ring sagittally; a differentiated preglabellar area; anterolaterally directed curved ocular ridges terminating at very small palpebral lobes perched at the highest points of the convex fixigenae almost in line (tr.) with the front of the glabella; and narrow (exsag.) transverse posterior borders and border furrows, distally curving strongly adventrally. These characteristics are also seen in part on cranidia of *Jegorovaia tenuis* Lu (1964b, p. 28, pl. 3, fig. 2). Adequate comparison cannot be made with the type species, *J. expansa* Lu (1964a, p. 34, pl. 7, fig. 3).

J.? arena sp. nov. differs from Chinese species in its glabellar shape, convexity of the preglabellar field, and orientation of the anterior cranidial border.

Elsewhere, *Zacompsus clarki* Raymond (1924, pp. 401–402, pl. 12, fig. 13) possibly representing Hapalopleuridae in Vermont, USA, lacks a preglabellar field and has effaced glabellar furrows. *Z? levisensis* Rasetti (1944, p. 258, pl. 39, fig. 6), from Quebec, Canada has a broad preglabellar area, similar to that of *Proaraiopleura* Zhang, 1981, as conceived by Xiang (1986, pp. 133–134). Glabellar shape and segmentation differentiates *J.? arena* from species of these two genera.

Ulrichaspis paradoxa Rasetti (1945, p. 474, pl. 62, figs 9, 10, 15), also from Quebec, has similar glabellar furrows and glabellar shape, and similarly orientated ocular ridges. It is differentiated by its longer (sag.) preglabellar area, and particularly thicker (sag.) border. *Asilluchus nanus* Öpik (1963, p. 67, pl. 6, fig. 8) from the Idamean of western Queensland, Australia, has appropriate glabellar furrows and perched palpebral lobes. However, it has a considerably narrower (tr.) interocular width and less well-differentiated preglabellar area.

Description: *Jegorovaia*? *arena* sp. nov. is known only from moulds of diminutive cranidia not exceeding 4 mm in length (sag.). These are transverse, especially across the posterolateral limbs, gently arcuate anteriorly, and significantly convex (sag., tr.).

The glabella is relatively short (sag.), basically conical, tapering forwards, and anteriorly obtusely rounded. Its lateral margins are indented by deep preoccipital and median lateral glabellar furrows, which widen abaxially, as do the abaxial ends of the occipital furrow. Furrows in advance of the median lateral glabellar furrows are not well developed, if at all. The occipital ring is not as wide (tr.) as the preoccipital glabellar lobes. It is thickened sagittally and may even be drawn out into a short, broad-based spine on some specimens. Adverse preservation, however, prevents confirmation.

The preglabellar area is composed of a convex (sag.) ridge-like preglabellar field, sometimes depressed below the level of the preocular areas, other times at the same elevation. On some specimens, the preglabellar field and preocular areas are differentiated by weak anterolateral extensions of the axial furrows.

A deep and relatively wide (sag., exsag.) border furrow lies anterior to the preglabellar field and preocular areas and separates them from a narrow (sag.) upturned border.

Variably defined ocular ridges run anterolaterally from the frontal glabellar lobe up the convexity of the fixigenae, terminating in very small palpebral lobes situated on the highest points. The postocular fixigenae are wide (exsag.), bacculate adjacent to the preoccipital glabellar lobes, and bear relatively narrow (exsag.) transverse border furrows and borders. Distally, the fixigenae curve sharply adventrally.

Order **Phacopida** Salter, 1864
Suborder **Cheirurina** Harrington & Leanza, 1957
Family **Pliomeridae** Raymond, 1913
Subfamily **Pilekiinae** Sdzuy, 1955
Genus ***Koraipsis*** Kobayashi, 1934

Type species: *Koraipsis spinus*, new species; Kobayashi, 1934, pp. 574–575, pl. 8, fig. 1; by original designation; Chiktong Limestone, South Korea; Early Ordovician, *Clarkella* Zone, late Tremadoc-Arenig.

Comments: Species of *Koraipsis* have been most recently discussed by Chang (1966), Kuo *et al.* (1982) and Zhou & Fortey (1986). Besides the type species, only *K. shansiensis* Chang (1966, pp. 6–7, pl. 1, figs 1–4; Zhou & Fortey, 1986, pp. 200–201, pl. 12, figs 6, 13, 15, 16, 19) from eastern Shanxi, China; and *K. taiziheensis* (Kuo, *et al.*, 1982, p. 24, pl. 1, figs 21–24), from Liaoning, China, have been described.

Kobayashi's (1934) type cranidium is incomplete, but shows a typically anteriorly tapering glabella with three pairs of posterosagittally orientated furrows, and a frontal spine derived from the anterior cranidial border.

Subsequently illustrated material (Kobayashi, 1960a, p. 262, pl. 13, fig. 16) and that also referred to *Protopliomerops punctatus* Kobayashi (*loc. cit.*, figs 14–15) and *Metapilekia* sp. nov. (*loc. it.*, fig. 26) remains fragmentary, but seems to represent a single pilekiid taxon. Chang's (1966) material includes a complete cranidium, which demonstrates the palpebral morphology. *K. taiziheensis* Kuo, *et al.*, 1982 is a likely synonym of Kobayashi's *K. spinus*, but the latter's material is inadequate for detailed comparison.

Koraipsis sp. cf. ***K. taiziheensis et al.***, 1982
(Pl. 6, Figs 1–9)

cf. 1982 *Koraipsis taiziheensis* Kuo *et al.*, sp. nov.; in Kuo, *et al.*, 1982, p. 24, pl. 1, figs 21–24.

Material: Eighteen cranidial fragments, CPC26952–26959, 26961–26964, 26966–26971, up to about 10 mm long (sag.) excluding the frontal spine; and six pygidial fragments, CPC26960, 26965, 26972–26976, up to about 6 mm (Lp_1) long.

Distribution: Confined to the central portion of the Amadeus Basin: Waterhouse Range Anticline, both northern and southern limbs (85/3061); Gardiner Range (A1/26, 85/3055, 85/3058, Hy77, Hy33) and southern limb Parana Hill Anticline, southern limb (LA36).

Age: Early Ordovician, Late Warendian, Assemblage 2.

Description: Cranidium of low convexity (tr., sag.) with short anterior spine (sag.) developed from the anterior cranidial border and very long obliquely directed and curved genal spines. Small pygidium with long curved macrospine associated with the second pleural segment.

In the cranidium, the glabella tapers gently forwards, is anteriorly obtusely rounded, and narrowest at the anterior lateral furrows. Three pairs of glabellar furrows are equally deeply incised, subparallel, posterosagittally directed, and adaxially gently curved. The glabella is sharply separated from a narrow (sag.) occipital ring, which bears a faint median node.

The palpebral lobes are very small, arcuate, situated anteriorly adjacent to the axial furrows, and extend from the median to the anterior lateral glabellar furrows. The preocular branches of the facial suture meet sagittally to form a short, stout, broad-based spine derived from the anterior cranidial border. The postocular sections are proparian and separate extensive postocular fixigenae, which bear sinuous border furrows and narrow borders. Lateral and posterior border furrows meet at an acute angle at the genal spine base. A long, delicate, oblique, curved genal spine is present.

Associated pygidia are strongly furrowed. Four axial and pleural segments are discerned. The axis tapers strongly rearwards and terminates at the posterior margin. A post-axial ridge is not formed. The pleural segments bear deep, sharply incised furrows which extend to the bases of distal free spines. They are separated by wider interpleural furrows, which extend to the margins of the pygidium. The free spine of the second segment is significantly longer than that of the other three segments.

Both cranidium and pygidium are frequently finely and densely granulose, and the cranidial fixigenae may be coarsely pitted.

Comments: *Koraipsis* sp. cf. *K. taiziheensis* Kuo & Duan very closely resembles the species from Liaoning Province, China. It does not, however, have a median furrow along the frontal preglabellar spine; it is a characteristic having an unknown taxonomic significance.

K. cf. *taiziheensis* differs from *K. shansiensis* Chang in that the latter is said to have pygidial spines decreasing in length rearwards, thus implying that the spines of the first pleural segment are the longest. In *K. taiziheensis* and *K.* cf. *taiziheensis*, the second segment bears the macrospine. Cranidially, the species are similar. Comparisons cannot be made directly with the fragmentary type species.

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APPENDIX
SPECIMEN INDEX

Number	*Classification*	*Illustration*	*Locality*
***Micragnostus (Micragnostus)* sp. undet.**			
CPC 26606	Figured specimen	Pl. 1, fig. 1	AS 355
26607	Figured specimen	Pl. 1, fig. 2	AS 355
26608	Figured specimen	Pl. 1, fig. 3	AS 355
26609	Figured specimen	Pl. 1, fig. 4	AS 355
26610	Cited specimen	unfigured	AS 355
26611	Cited specimen	″	AS 355
***Pseudagnostinid gen.* et sp. undet.**			
26612	Figured specimen	Pl. 1, fig. 5	AS 355
***Eosaukia* sp. cf. *E. walcotti* (Mansuy, 1915)**			
26613	Figured specimen	Pl. 5, figs 10-12	AS 354
26614	Figured specimen	Pl. 5, fig. 13	AS 354
26615	Figured specimen	Pl. 5, fig. 14	AS 351
26616	Figured specimen	Pl. 5, fig. 15	AS 13
26617	Cited specimen	unfigured	AS 354
26618	″ ″	″	AS 354
26619	″ ″	″	AS 354
26620	″ ″	″	AS 354
26621	″ ″	″	AS 354
26622	″ ″	″	AS 354
26623	″ ″	″	AS 354
26624	″ ″	″	AS 354
26625	″ ″	″	AS 354
26626	″ ″	″	AS 354
26627	″ ″	″	AS 354
26628	″ ″	″	AS 354
26629	″ ″	″	AS 354
26630	″ ″	″	AS 354
26631	″ ″	″	AS 354
26632	″ ″	″	AS 354
26633	″ ″	″	AS 354
26634	″ ″	″	AS 354
26635	″ ″	″	AS 354
26636	″ ″	″	AS 354
26637	″ ″	″	AS 354
26638	″ ″	″	AS 354
26639	″ ″	″	AS 354
26640	″ ″	″	AS 354
26641	″ ″	″	AS 354
26642	″ ″	″	AS 354
26643	″ ″	″	AS 193
26644	″ ″	″	AS 193
26645	″ ″	″	AS 193
26646	″ ″	″	AS 193
26647	″ ″	″	AS 193
26648	″ ″	″	AS 193
26649	″ ″	″	AS 147
26650	″ ″	″	AS 270B
26651	Figured specimen	Pl. 5, fig. 16	AS 354
26652	Cited specimen	unfigured	AS 354
26653	″ ″	″	AS 354
26654	Figured specimen	Pl. 5, fig. 17	AS 193
26655	″ ″	Pl. 5, fig. 19	AS 13
26656	″ ″	Pl. 5, fig. 18	AS 354
26657	Cited specimen	unfigured	AS 354
26658	″ ″	″	AS 354
26659	″ ″	″	AS 13
26660	″ ″	″	AS 193
26661	″ ″	″	AS 197
***Mictosaukia* sp. undet.**			
26662	Figured specimen	Pl. 5, fig. 2	AS 199
26663	″ ″	Pl. 5, fig. 3	AS 199
26664	″ ″	Pl. 5, fig. 4	AS 199
26665	Cited specimen	unfigured	AS 199
26666	″ ″	″	AS 199
26667	Figured specimen	Pl. 5, fig. 5	AS 199
26668	″ ″	Pl. 5, fig. 6	AS 199
26669	″ ″	Pl. 5, fig. 7	AS 199
26670	Cited specimen	unfigured	AS 199
26671	″ ″	″	AS 197

Number	*Classification*	*Illustration*	*Locality*
CPC 26672	″ ″	″	AS 197
26673	Figured specimen	″	AS 302
26674	″ ″	″	AS 302
26675	Cited specimen	″	AS 302
Sinosaukia sp. undet. aff. ***S. impages*** Shergold, 1975			
26676	Figured specimen	Pl. 5, fig. 1	AS 354
Platysaukia jokiliki sp. nov.			
26677	Holotype	Pl. 3, fig. 5	AS 197
26678	Paratype	Pl. 3, fig. 3	AS 197
26679	″	Pl. 3, fig. 4 AS 197	
26680	″	Pl. 3, fig. 7	AS 197
26681	″	Pl. 3, fig. 8	AS 197
26682	″	unfigured	AS 197
26683	″	″	AS 197
26684	″	″	AS 197
26685	″	″	AS 197
26686	″	″	AS 197
26687	″	″	AS 197
26688	″	″	AS 197
26689	″	″	AS 197
26690	″	″	AS 197
26691	″	″	AS 197
26692	″	″	AS 197
26693	″	Pl. 3, fig. 11	AS 197
26694	″	unfigured	AS 197
26695	″	″	AS 197
26696	″	″	AS 197
26697	″	Pl. 3, Figs 13-16	AS 197
26698	″	unfigured	AS 197
26699	″	″	AS 197
26700	″	″	AS 197
26701	″	″	AS 196
26702	″	″	AS 196
26703	″	″	AS 196
26704	″	″	AS 196
26705	″	″	AS 196
26706	″	″	AS 196
26707	″	″	AS 196
26708	″	″	AS 196
26709	″	Pl. 3, fig. 20	AS 196
26710	″	unfigured	AS 196
26711	″	Pl. 3, fig. 1	AS 199
26712	Paratype	unfigured	AS 199
26713	″	″	AS 199
26714	″	″	AS 199
26715	″	″	AS 199
26716	″	Pl. 3, fig. 6	AS 199
26717	″	unfigured	AS 199
26718	″	″	AS 199
26719	″	″	AS 199
26720	″	Pl. 3, fig. 12	AS 300
26721	″	Pl. 3, fig. 2	AS 350
26722	″	unfigured	AS 350
26723	″	″	AS 350
26724	″	″	AS 350
26725	″	Pl. 3, fig. 10	AS 13
26726	″	Pl. 3, fig. 9	AS 13
26727	″	unfigured	AS 13
26728	″	″	AS 13
26729	″	Pl. 3, fig. 22	AS 13
26730	″	Pl. 3, fig. 21	AS 13
26731	″	unfigured	AS 13
26732	″	″	AS 13
26733	″	″	AS 13
26734	″	″	AS 13
26735	″	Pl. 3, fig. 17	AS 13
26736	″	Pl. 3, fig. 18	AS 13
26737	″	Pl. 3, fig. 19	AS 13
26738	″	unfigured	AS 13
26739	″	Pl. 4, fig. 12	AS 198
26740	″	unfigured	AS 8B
26741	″	″	HY 276
26742	″	″	HY 276

Number	*Classification*	*Illustration*	*Locality*
Platysaukia tomichi sp. nov.			
CPC 26743	Holotype	Pl. 4, figs 10-11	NT 183
26744	Paratype	unfigured	NT 183
26745	″	″	NT 183
26746	″	Pl. 4, fig. 14	NT 183
26747	″	unfigured	NT 183
26748	″	″	NT 183
26749	″	″	NT 183
26750	″	Pl. 4, fig. 8	NT 183
26751	″	unfigured	NT 183
26752	″	″	NT 183
26753	″	″	NT 183
26754	″	Pl. 4, fig. 12	HY 266
26755	″	unfigured	HY 266
26756	″	″	HY 266
26757	″	″	HY 265
26758	″	″	HY 265
26759	″	″	HY 265
26760	″	″	HY 265
26761	″	″	HY 265
26762	″	″	HY 265
26763	″	″	HY 277
26764	″	″	HY 277
26765	″	″	HY 277
26766	″	″	HY 277
26767	″	″	HY 277
26768	″	″	HY 277
26769	Paratype	unfigured	HY 277
26770	″	″	HY 277
Lichengia simplex sp. nov.			
26771	Holotype	Pl. 4, fig. 1	AS 147
26772	Paratype	Pl. 4, fig. 3	AS 147
26773	″	Pl. 4, fig. 7	AS 147
26774	″	unfigured	AS 147
26775	″	Pl. 4, fig. 5	AS 147
26776	″	Pl. 4, fig. 2	AS 19
26777	″	unfigured	AS 193
26778	″	″	AS 193
26779	″	Pl. 4, fig. 4	AS 193
26780	″	unfigured	AS 193
26781	″	″	AS 193
26782	″	″	AS 193
26783	″	″	AS 193
26784	″	″	AS 193
26785	″	″	AS 193
26786	″	″	AS 193
26787	″	″	AS 197
26788	″	Pl. 4, fig. 6	AS 197
26789	″	unfigured	AS 354
26790	″	″	AS 354
26791	″	″	AS 354
26792	″	″	AS 354
26793	″	″	AS 354
26794	″	″	AS 354
26795	″	″	AS 354
26796	″	″	AS 354
26797	″	″	AS 354
26798	″	″	AS 270A
26799	″	″	NT 183
26800	″	″	NT 183
26801	″	″	NT 183
26802	″	″	HY 265
Platysaukia tomichi sp. nov.			
26803	Paratype	Pl. 4, fig. 24	HY 277
26804	″	unfigured	HY 277
Thailandium sp.undet.			
26805	Figured specimen	Pl. 4, fig. 16	AS 355
26806	″ ″	Pl. 4, fig. 17	AS 355
26807	″ ″	Pl. 4, fig. 18	AS 355
26808	Cited specimen	unfigured	AS 355
26809	″ ″	″	AS 355
26810	″ ″	″	AS 355
26811	″ ″	″	AS 355
26812	″ ″	″	AS 355
26813	″ ″	″	AS 355

Number	*Classification*	*Illustration*	*Locality*
CPC 26814	″ ″	″	AS 355
26815	″ ″	″	AS 355
26816	″ ″	″	AS 355
26817	″ ″	″	AS 355
26818	″ ″	″	AS 355
26819	″ ″	″	AS 355
26820	″ ″	″	AS 355
26821	″ ″	″	AS 355
26822	″ ″	″	AS 355
26823	Figured specimen	Pl. 4, fig. 19	AS 351
26824	Cited specimen	unfigured	AS 351
26825	Figured specimen	Pl. 4, figs 21-22	AS 8A
26826	Cited specimen	unfigured	AS 3
26827	″ ″	″	NT 183
26828	Figured specimen	Pl. 4, fig. 23	NT 183
Changia correcta sp. nov.			
26829	Figured specimen	Pl. 2, fig. 17	AS 196
26830	″ ″	Pl. 2, fig. 18	AS 196
26831	″ ″	Pl. 2, fig. 19	AS 196
26832	″ ″	Pl. 2, fig. 20	AS 196
26833	″ ″	Pl. 2, fig. 21	AS 196
26834	Cited speciman	unfigured	AS 196
26835	″ ″	″	AS 196
26836	″ ″	″	AS 196
26837	″ ″	″	AS 196
26838	″ ″	″	AS 196
26839	Figured specimen	Pl. 2, fig. 22	AS 196
26840	Cited specimen	unfigured	AS 355
26841	″ ″	″	AS 355
26842	″ ″	″	AS 355
26843	″ ″	″	AS 355
26844	Figured specimen	Pl. 2, fig. 23	AS 355
26845	Cited specimen	unfigured	AS 355
26846	″ ″	″	AS 355
26847	″ ″	″	AS 355
26848	″ ″	″	AS 193
Quadraticephalus sp. cf. **coreanicus** Kobayashi, 1960			
26849	Figured specimen	Pl. 2, fig. 11	AS 354
26850	″ ″	Pl. 2, fig. 12	AS 354
26851	″ ″	Pl. 2, fig. 13	AS 354
26852	Cited specimen	unfigured	AS 354
26853	Figured specimen	Pl. 2, fig. 14	AS 354
26854	″ ″	Pl. 2, fig. 15	AS 354
26855	Cited specimen	unfigured	AS 354
26856	″ ″	″	AS 354
26857	″ ″	″	AS 354
26858	″ ″	″	AS 354
26859	″ ″	″	AS 354
26860	″ ″	″	AS 354
26861	Figured specimen	Pl. 2, fig. 16	AS 354
26862	Cited specimen	unfigured	AS 354
26863	″ ″	″	AS 354
26864	″ ″	″	AS 354
26865	″ ″	″	AS 199
Shergoldiasp. undet.			
26866	Figured specimen	Pl. 1, figs 12-13	AS 315A
26867	Cited specimen	unfigured	AS 315A
26868	Figured specimen	Pl. 1, fig. 15	AS 315A
26869	Cited specimen	unfigured	AS 315A
26870	Figured specimen	Pl. 1, fig. 17	AS 197
26871	″ ″	Pl. 1, fig. 14	AS 193
26872	″ ″	Pl. 1, fig. 16	AS 193
26873	Cited specimen	unfigured	NT 320
Mansuyia sp. cf. ***orientalis*** Sun, 1924			
26874	Figured specimen	Pl. 1, figs 1, 4	AS 193
26875	″ ″	Pl. 1, fig. 2	AS 193
26876	″ ″	Pl. 1, fig. 3	AS 193
26877	Cited specimen	unfigured	AS 193
26878	Cited specimen	unfigured	AS 193
26879	″ ″	″	AS 193
26880	Figured specimen	Pl. 1, fig. 9	AS 193
26881	Cited specimen	unfigured	AS 193
26882	Figured specimen	Pl. 1, fig. 6	AS 193
26883	″ ″	Pl. 1, fig. 7	AS 193
26884	″ ″	Pl. 1, fig. 8	AS 193

Number	*Classification*	*Illustration*	*Locality*
CPC 26885	Cited specimen	unfigured	AS 193
26886	″ ″	″	AS 193
26887	″ ″	″	AS 193
26888	″ ″	″	AS 315A
26889	Figured specimen	Pl. 1, fig. 10	AS 196
26890	Cited specimen	unfigured	AS 196
26891	Figured specimen	Pl. 1, fig. 5	AS 199
***Plethometopus*?** sp. undet.			
26892	Figured specimen	Pl. 1, fig. 18	AS 147
26893	″ ″	Pl. 1, fig. 20	AS 147
26894	Cited specimen	unfigured	AS 146
26895	Figured specimen	Pl. 1, fig. 22	AS 147
26896	″ ″	Pl. 1, fig. 19	AS 350
26897	Cited specimen	unfigured	AS 350
26898	″ ″	″	AS 350
26899	Figured specimen	Pl. 1, fig. 21	AS 350
Wanwanaspis sp. undet.			
26900	Figured specimen	Pl. 1, figs 23-24	AS 355
26901	Cited specimen	unfigured	AS 355
26902	″ ″	″	AS 354
26903	″ ″	″	AS 354
Jegorovaia? *arena* sp. nov.			
26904	Holotype	Pl. 1 fig. 10	AS 197
26905	Paratype	Pl. 1, fig. 6	AS 197
26906	″	Pl. 1, fig. 7	AS 197
26907	″	Pl. 1, fig. 8	AS 197
26908	″	Pl. 1, fig. 9	AS 197
26909	″	unfigured	AS 197
26910	″	″	AS 198
26911	″	″	AS 198
26912	″	″	AS 198
26913	″	Pl. 1, fig. 11	AS 198
26914	″	unfigured	NT 320
26915	″	″	NT 320
Koldinioidia sp. aff. ***K. Sulcata*** Robison & Pantoja-Alor, 1968			
26916	Figured specimen	Pl. 3, fig. 23	AS 193
26917	″ ″	Pl. 3, fig. 24	AS 193
26918	Cited specimen	unfigured	AS 193
Apatokephalus sp. cf. ***A. hyotan*** Kobayashi, 1953			
26919	Figured specimen	Pl. 6, fig. 21	NT 252
26920	″ ″	Pl. 6, fig. 19	NT 252
26921	″ ″	Pl. 6, fig. 20	A1/26
26922	Cited specimen	unfigured	85/3058
26923	″ ″	″	85/3058
Hystricurus sp. cf. ***H. eurycephalus*** Kobayashi, 1934			
26924	Figured specimen	Pl. 6, fig. 11	85/3101
26925	″ ″	Pl. 6, figs 12-13	85/3101
26926	″ ″	Pl. 6, figs 14-15	85/3101
26927	Cited specimen	unfigured	85/3101
26928	″ ″	″	85/3101
26929	Figured specimen	Pl. 6, fig. 16	85/3101
26930	Figured specimen	PL. 6, fig. 17	85/3101
26931	″ ″	Pl. 6, fig. 10	A1/26
26932	″ ″	Pl. 6, fig. 18	HY 77
26933	Cited specimen	unfigured	HY 77
26934	″ ″	″	HY 77
26935	″ ″	″	HY 77
26936	″ ″	″	HY 269
26937	″ ″	″	LA 36
26938	″ ″	″	AS 257
26939	″ ″	″	AS 257
26940	″ ″	″	AS 257
26941	″ ″	″	AS 257
26942	″ ″	″	AS 257
26943	″ ″	″	AS 257
26944	″ ″	″	AS 257
26945	″ ″	″	AS 257
26946	″ ″	″	AS 257
26947	″ ″	″	AS 257
26948	″ ″	″	AS 257
26949	″ ″	″	AS 257
26950	″ ″	″	AS 257
26951	″ ″	″	AS 257

Number	*Classification*	*Illustration*	*Locality*
Koraipsis sp. cf. ***K. taiziheensis*** Kuo & Duan, 1982			
CPC 26952	Figured specimen	Pl. 6, fig. 1	A1/26
26953	″ ″	Pl. 6, figs 2-3	A1/26
26954	Cited specimen	unfigured	A1/26
26955	″ ″	″	HY 77
26956	″ ″	″	HY 77
26957	″ ″	″	HY 77
26958	″ ″	″	HY 77
26959	″ ″	″	HY 77
26960	″ ″	″	HY 77
26961	Figured specimen	Pl. 6, fig. 6	85/3058
26962	Cited specimen	unfigured	85/3058
26963	″ ″	″	85/3058
26964	″ ″	″	85/3058
26965	Figured specimen	Pl. 6, fig. 7	85/3058
26966	Cited specimen	unfigured	85/3101
26967	″ ″	″	NT 252
26968	″ ″	″	NT 252
26969	″ ″	″	NT 252
26970	″ ″	″	NT 252
26971	″ ″	″	NT 252
26972	Figured specimen	Pl. 6, fig. 9	NT 252
26973	″ ″	Pl. 6, fig. 8	NT 252
26974	Cited specimen	unfigured	NT 252
26975	″ ″	″	85/3055
26976	Figured specimen	Pl. 6, fig. 5	LA 36
Asaphellus sp. cf. ***A. trinodus*** Chang, 1949			
26977	Figured specimen	Pl. 9, figs 9-10	85/3058
26978	″ ″	Pl. 9, fig. 11	85/3058
26979	″ ″	Pl. 9, fig. 12	85/3058
26980	Cited specimen	unfigured	85/3058
26981	Figured specimen	Pl. 9, fig. 15	85/3058
26982	Cited specimen	unfigured	85/3058
26983	″ ″	″	85/3058
26984	″ ″	″	85/3058
26985	″ ″	″	85/3058
26986	Cited specimen	unfigured	85/3058
26987	″ ″	″	85/3058
26988	Figured specimen	Pl. 9, fig. 16	85/3058
26989	″ ″	Pl. 9, fig. 17	85/3058
26990	Cited specimen	unfigured	85/3058
26991	″ ″	″	85/3058
26992	″ ″	″	85/3058
26993	Figured specimen	Pl. 9, figs 13-14	85/3055
26994	Cited specimen	unfigured	85/3055
26995	Figured specimen	Pl. 9, fig. 18	85/3055
Asaphellus? sp. undet. 1			
26996	Figured specimen	Pl. 9, fig. 4	AS 265
26997	Cited specimen	unfigured	AS 265
26998	″ ″	″	AS 265
26999	Figured specimen	Pl. 9, fig. 1	AS 265
27000	″ ″	Pl. 9, fig. 1	AS 265
27001	″ ″	Pl. 9, fig. 8	NT 195
27002	Cited specimen		NT 331
27003	″ ″		NT 331
27004	″ ″		NT 331
27005	″ ″		NT 331
27006	″ ″		NT 331
27007	Figured specimen	Pl. 9, fig. 6	NT 331
27008	Cited specimen	unfigured	NT 331
27009	″ ″	″	NT 331
27010	″ ″	″	NT 331
27011	″ ″	″	NT 331
27012	Figured specimen	Pl. 9, fig. 2	HY 268
27013	Cited specimen	unfigured	HY 268
27014	″ ″	″	HY 268
27015	″ ″	″	HY 268
27016	″ ″	″	HY 268
27017	″ ″	″	HY 268
27018	Figured specimen	Pl. 9, fig. 5	HY 268
27019	Cited specimen	unfigured	HY 268
27020	″ ″	″	HY 268
27021	″ ″	″	HY 268
27022	″ ″	″	HY 268
27023	″ ″	″	HY 268

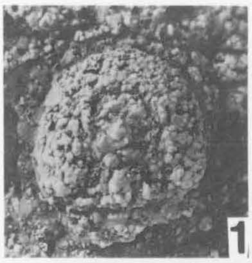
Number	*Classification*	*Illustration*	*Locality*
CPC 27024	″ ″	″	HY 268
27025	″ ″	″	HY 268
27026	″ ″	″	HY 268
27027	″ ″	″	HY 268
27028	Figured specimen	Pl. 9, fig. 3	ML 4
27029	″ ″	Pl. 9, fig. 7	ML 4
27030	Cited specimen	unfigured	ML 4
27031	″ ″	″	ML 4
27032	″ ″	″	ML 4
27033	″ ″	″	ML 4
27034	″ ″	″	ML 4
***Asaphellus*? sp. undet. 2**			
27035	Figured specimen	Pl. 9, fig. 21	NT 614
27036	″ ″	Pl. 9, fig. 22	NT 614
27037	Cited specimen	unfigured	NT 614
27038	″ ″	″	NT 614
27039	″ ″	″	ML 18
27040	″ ″	″	ML 18
27041	″ ″	″	ML 18
27042	Figured specimen	Pl. 9, fig. 24	ML 18
27043	″ ″	Pl. 9, figs. 19-20	ML 30E
27044	″ ″	Pl. 9, fig. 23	ML 30A
27045	Cited specimen	unfigured	ML 30A
27046	″ ″	″	ML 30A
27047	″ ″	″	ML 30A
27048	″ ″	″	ML 30A
27049	″ ″	″	ML 30A
27050	″ ″	″	ML 30A
***Kayseraspis*? *belli* sp. nov.**			
27051	Paratype	Pl. 7, fig. 17	AS 127
27052	″	unfigured	AS 127
27053	″	″	AS 127
27054	″	″	AS 127
27055	″	″	AS 127
27056	″	″	AS 127
27057	″	″	AS 127
27058	″	Pl. 7, fig. 14	NT 194
27059	″	Pl. 7, fig. 15	NT 194
27060	″	Pl. 7, fig. 18	NT 194
27061	″	Pl. 7, fig. 19	NT 194
27062	″	Pl. 7, fig. 19	NT 194
27063	″	Pl. 7, fig, 22	NT 194
27064	″	Pl. 7, figs, 20, 22	NT 194
27065	″	Pl. 7, fig. 21	NT 194
27066	Holotype	Pl. 7, fig. 13	NT 333
27067	Paratype	unfigured	NT 333
27068	″	″	NT 333
27069	″	″	NT 333
27070	″	″	NT 333
27071	″	″	AS 231A
27072	″	Pl. 7, fig. 16	ML 4
27073	″	unfigured	ML 4
***Pacootella collativa* gen. et sp. nov.**			
27074	Holotype	Pl. 7, fig. 2	AS 9
27075	Paratype	Pl. 7, fig. 1	AS 9
27076	″	Pl. 7, fig. 3	AS 9
27077	″	Pl. 7, fig. 5	AS 9
27078	″	unfigured	AS 9
27079	″	Pl. 7, fig. 8	AS 9
27080	″	Pl. 7, fig. 9	AS 9
27081	″	unfigured	AS 9
27082	″	″	AS 9
27083	″	Pl. 7, fig. 6	AS 9
27084	″	Pl. 7, fig. 7	AS 9
27085	″	unfigured	AS 9
27086	″	″	AS 9
27087	″	″	AS 9
27088	″	″	AS 9
27089	″	Pl. 7, fig. 10	AS 9
27090	″	Pl. 7, fig. 4	AS 306
27091	″	unfigured	AS 306
27092	″	″	AS 306
27093	″	″	AS 306
27094	″	″	AS 306
27095	″	″	AS 306

Number	*Classification*	*Illustration*	*Locality*
CPC 27096	Paratype	unfigured	AS 306
27097	″	″	AS 306
27098	Paratype	Pl. 7, fig. 11	AS 306
27099	″	Pl. 7, fig. 12	AS 306
27100	″	unfigured	AS 306
27101	″	″	AS 306
27102	″	″	AS 306
27103	″	″	AS 306
Psilocephalina **sp. cf.** ***P. lubrica*** **Hsu, 1948**			
27104	Figured specimen	Pl. 8, fig. 11	AS 265
27105	″ ″	Pl. 8, fig. 10	NT 195
27106	″ ″	Pl. 8, fig. 16	NT 335
27107	Cited specimen	unfigured	NT 335
27108	″ ″	″	NT 335
27109	″ ″	″	NT 335
27110	″ ″	″	NT 335
27111	″ ″	″	NT 335
27112	″ ″	″	NT 335
27113	″ ″	″	NT 237a
27114	″ ″	″	NT 237a
27115	″ ″	″	NT 237a
27116	″ ″	″	NT 237a
27117	Figured specimen	Pl. 8, fig. 9	NT 237a
27118	″ ″	Pl. 8, fig. 2	NT 237b
27119	″ ″	Pl. 8, fig. 4	NT 237b
27120	″ ″	Pl. 8, fig. 5	NT 237b
27121	Cited specimen	unfigured	NT 237b
27122	″ ″	″	NT 237b
27123	″ ″	″	NT 237b
27124	″ ″	″	NT 237b
27125	″ ″	″	NT 237b
27126	″ ″	″	NT 237b
27127	Figured specimen	Pl. 8, fig. 18	NT 237b
27128	″ ″	Pl. 8, fig. 19	NT 237b
27129	″ ″	Pl. 8, fig. 3	NT 237c
27130	″ ″	Pl. 8, fig. 7	NT 237c
27131	″ ″	Pl. 8, fig. 6	NT 237c
27132	Cited specimen	unfigured	NT 237c
27133	″ ″	″	NT 237c
27134	″ ″	″	NT 237c
27135	Figured specimen	Pl. 8, fig. 8	NT 237c
27136	″ ″	Pl. 8, fig. 17	NT 237c
27137	Cited specimen	unfigured	NT 237c
27138	″ ″	″	NT 237c
27139	″ ″	″	NT 237c
27140	″ ″	″	NT 237c
27141	″ ″	″	NT 237c
27142	″ ″	″	NT 237c
27143	″ ″	″	NT 237c
27144	″ ″	″	NT 237c
27145	Figured specimen	Pl. 8, figs 1,12,13	HY 269
27146	″ ″	Pl. 8, fig. 20	HY 269
27147	″ ″	Pl. 8, fig. 15	HY 269
27148	Cited specimen	unfigured	HY 269
27149	″ ″	″	NT 252
27150	″ ″	″	85/3058
27151	″ ″	″	HY 233
27152	″ ″	″	HY 233
27153	″ ″	″	HY 233
27154	″ ″	″	HY 233
27155	Cited specimen	unfigured	A1/26
27156	Figured specimen	Pl. 8, fig. 14	A1/26
27157	″ ″	Pl. 8, fig. 14	A1/26
Shumardia **sp. undet.**			
27158	Figured specimen	Pl. 1, figs. 25, 26	AS 9

PLATES

Plate 1

Figs	1–4	**Micragnostus (Micragnostus)** species indeterminate.
	1.	CPC26606, cephalon, x12, locality AS355.
	2.	CPC26607, cephalon, x12, locality AS355.
	3.	CPC26608, pygidium, x12, locality AS355.
	4.	CPC26609, pygidium, x12, locality AS355.
Figs	5	Pseudagnostinid genus et species undetermined.
	5.	CPC26612, pygidium, x8, locality AS355.
Figs	6–11	**Jegorovaia arena** sp. nov.
	6.	CPC26905, incomplete cranidium, x8, locality AS197.
	7.	CPC26906, incomplete cranidium, x8, locality AS197.
	8.	CPC26907, incomplete cranidium, x8, locality AS197.
	9.	CPC26908, cranidium, x12, locality AS197.
	10.	CPC26904, holotype cranidium, x8, locality AS197.
	11.	CPC26913, incomplete cranidium, x16, locality AS198.
Figs	12–17	**Shergoldia** species undetermined.
	12.	CPC26866A, effaced cranidium, x2, locality AS315.
	13.	CPC26866B, latex replica from external mould, x2, locality AS315.
	14.	CPC26871, cranidium with long (sag.) preglabellar area, x4, locality AS193.
	15.	CPC26868, latex replica of librigenal mould, x4, locality AS315.
	16.	CPC26872, pygidium, x4, locality AS193.
	17.	CPC26870, pygidium, x4, locality AS197.
Figs	18–22	**Plethometopus?** species undetermined
	18.	CPC26892A, effaced cranidium showing only anterolateral pits and trace of occipital furrow, x2, locality AS147.
	19.	CPC26896A, cranidium, x6, locality AS350.
	20.	CPC26893, librigena with characteristic lateral contour, x4, locality AS147.
	21.	CPC26899, pygidium, x4, locality AS350.
	22.	CPC26895, latex replica of pygidial external mould, x4, locality AS147.
Figs	23–24	**Wanwanaspis** species undetermined.
	23.	CPC26900, convex, effaced, cranidium, x4, locality AS355.
	24.	CPC26900, as above, lateral aspect, x4.
Figs	25–26	**Shumardia** species undetermined.
	25.	CPC27158B, latex replica of cranidial external mould, x12, locality AS9.
	26.	CPC27158A, internal mould of above, x12.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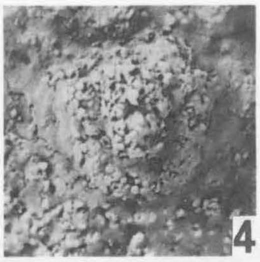
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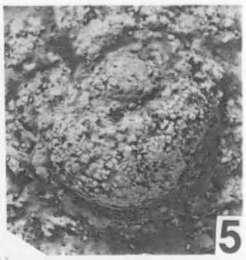
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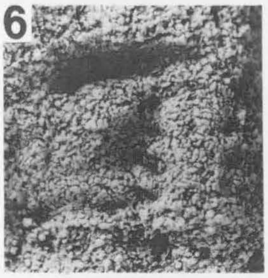
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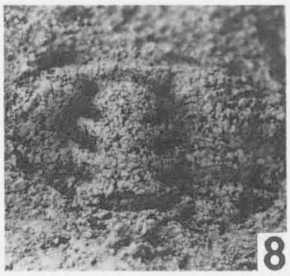
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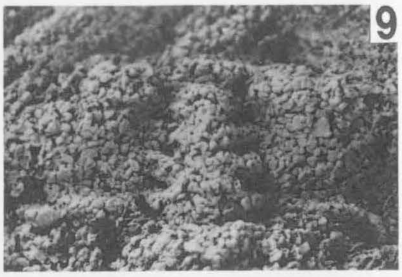
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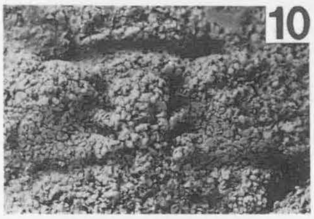
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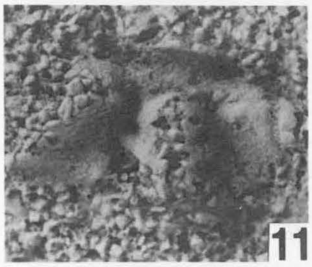
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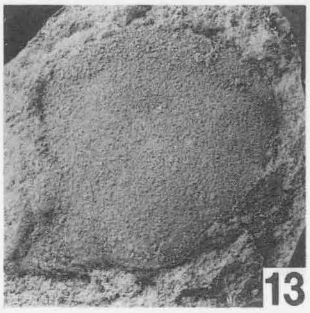
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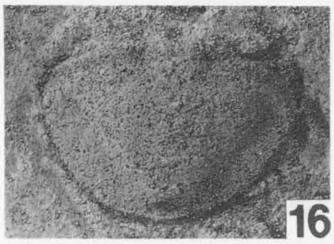
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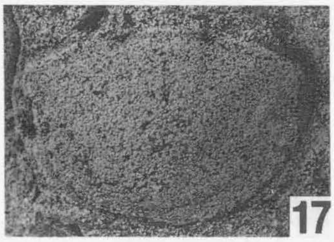
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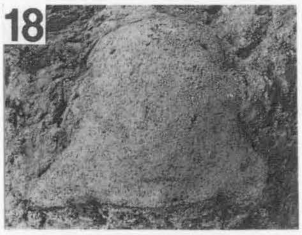
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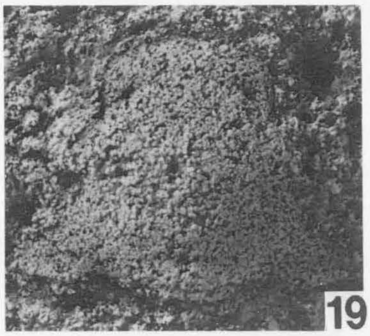
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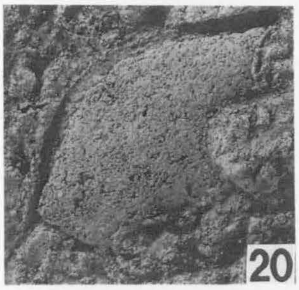
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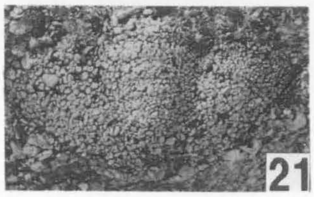
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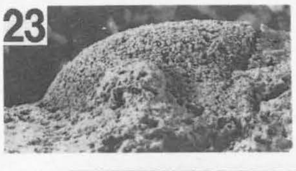
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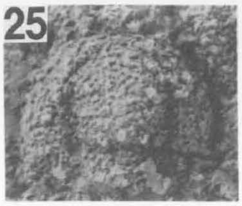
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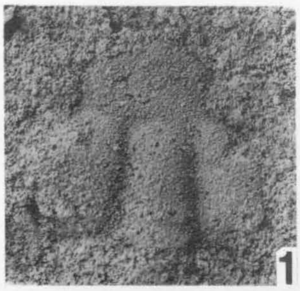
Plate 2

Figs	1–10	**Mansuyia** sp. cf. **M. orientalis** Sun, 1924.
	1.	CPC26874B, latex replica from cranidial external mould, x4, locality AS193.
	2.	CPC26875, cranidium, x3, locality AS193.
	3.	CPC26876, latex replica of cranidium, x3, locality AS193.
	4.	CPC26874A, internal mould of cranidium, x4, locality AS193.
	5.	CPC26871, incomplete pygidium, x4, locality AS199.
	6.	CPC26882, incomplete pygidium, x2, locality AS193.
	7.	CPC26883A, incomplete pygidium, x4, locality AS193.
	8.	CPC26884, latex replica of pygidial external mould, x4, locality AS193.
	9.	CPC26880, associated librigena, latex replica, x2, locality AS193.
	10.	CPC26889, assigned hypostome, x6, locality AS196.
Figs	11–16	**Quadraticephalus** sp. cf. **Q. coreanicus** Kobayashi, 1960
	11.	CPC26849, cranidium, x2, locality AS354.
	12.	CPC26850, latex replica of cranidial external mould, x2, locality AS354.
	13.	CPC26851, latex replica of cranidium, x2, locality AS354.
	14.	CPC26853, latex replica of librigenal external mould, x1.5, locality AS354.
	15.	CPC26854, latex replica of librigena, x2, locality AS354.
	16.	CPC26861B, latex replica of pygidial external mould, x2, locality AS354.
Figs	17–23	**Changia correcta** sp. nov.
	17.	CPC26829, cranidium, x8, locality AS196.
	18.	CPC26830, late holaspid cranidium, x3, locality AS196.
	19.	CPC26831, cranidium, x4, locality AS196.
	20.	CPC26832, cranidium, x6, locality AS196.
	21.	CPC26833B, latex replica of cranidial external mould, x4, locality AS196.
	22.	CPC26839, latex replica of pygidial external mould, x8, locality AS196.
	23.	CPC26844A, internal mould of pygidium, x6, locality AS355.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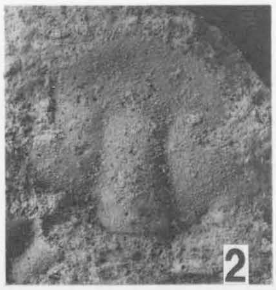
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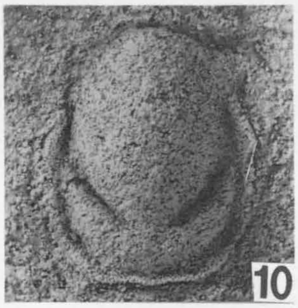
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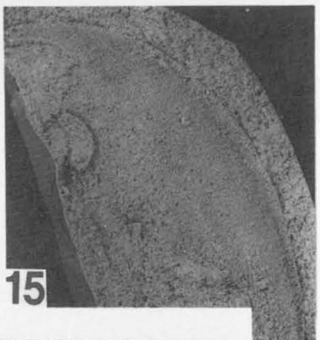
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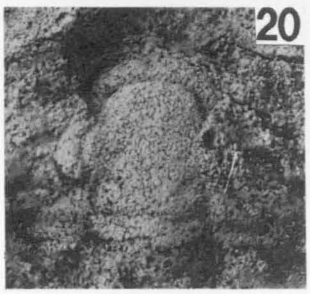
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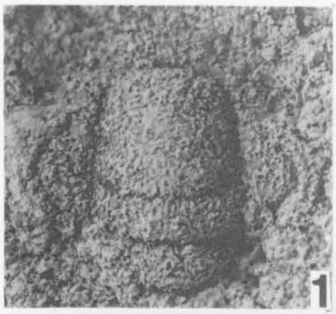
Plate 3

Figs 1–22 **Platysaukia jokliki** sp. nov.

1. CPC26711, latex replica of early holaspid cranidium. x12, locality AS199.
2. CPC26721, latex replica of early holaspid cranidium, x8, locality AS350.
3. CPC26678, early holaspid cranidium, x8, locality AS197.
4. CPC26679, cranidium, x6, locality AS197.
5. CPC26677, late holaspid cranidium, x2, locality AS197.
6. CPC26716, late holaspid cranidium, x3, locality AS199.
7. CPC26680, late holaspid cranidium, x2, locality AS197.
8. CPC26681, late holaspid cranidium, x3, locality AS197.
9. CPC26726, early holaspid cranidium, x8, locality AS13.
10. CPC26725, late holaspid cranidium showing differentiation of the preglabellar area, x2, locality AS13.
11. CPC26693, hypostome, x4, locality AS197.
12. CPC26720, latex replica of late holaspid pygidium, x1, locality AS300.
13. CPC26697A, internal mould of late holaspid pygidium, x1, locality AS197.
14. CPC26697B, latex replica of above, x1.
15. CPC26697B, as above, oblique lateral view, x1.
16. CPC26697B, as above, lateral view, x1.
17. CPC26735, internal mould of pygidium, x3, locality AS13.
18. CPC26736, pygidium, x3, locality AS13.
19. CPC26737, incomplete pygidium, x1, locality AS13.
20. CPC26709, pygidium, x8, locality AS196.
21. CPC26730, latex replica of librigenal external mould, with characteristic prosopon, x2, locality AS13.
22. CPC26729, internal mould of librigena, x3, locality AS13.

Figs 23–24 **Koldinioidia** sp. aff. **K. sulcata** Robison & Pantoja-Alor, 1968.

23. CPC26916, cephalon, x8, locality AS193.
24. CPC26917, cephalon, x8, locality AS193.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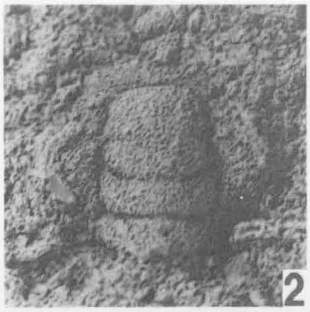
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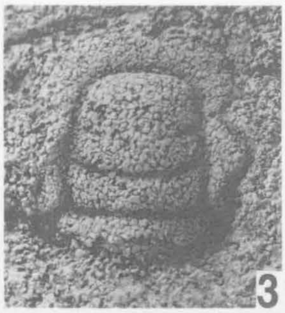
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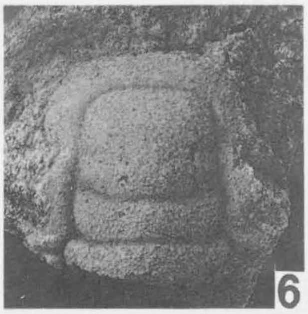
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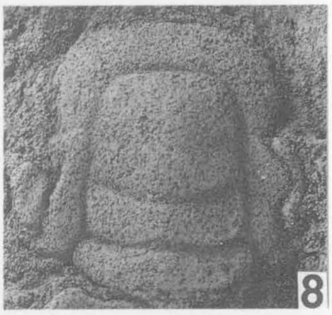
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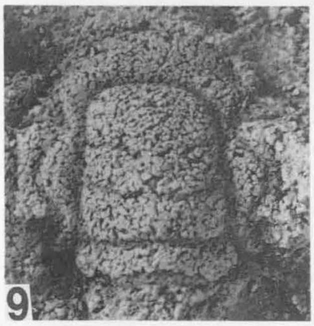
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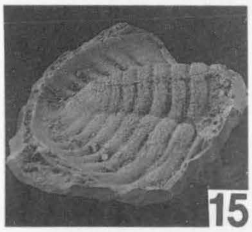
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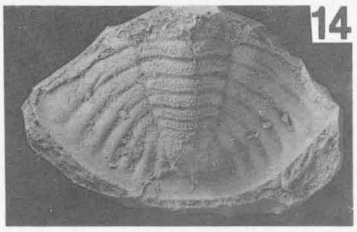
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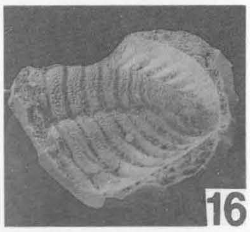
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Plate 4

Figs	1–7	**Lichengia simplex** sp. nov.
	1.	CPC26771, holotype, cranidium, internal mould, x2, locality AS147.
	2.	CPC26776, cranidium, x1.5, locality AS193.
	3.	CPC26772, latex replica from fragment of external mould showing prosopon of anterior cranidial border, x2, locality AS147.
	4.	CPC26779, latex replica from external mould of yolked librigenae, x2, locality AS193.
	5.	CPC26775, latex replica from external mould of pygidium, x2, locality AS147.
	6.	CPC26788, latex replica, x3, locality AS197.
	7.	CPC26773, internal mould of hypostome, x4, locality AS147.
Figs	8–14	**Platysaukia tomichi** sp. nov.
	8.	CPC26750B, latex replica from external mould of pygidium, x2, locality NT183.
	9.	CPC26757B, latex replica as above, x4, locality Hy265.
	10.	CPC26743B, latex replica from external mould of cranidium, x2, locality NT183.
	11.	CPC26743B, as above, lateral view, x2.
	12.	CPC26754B, latex replica, as above, x3, locality Hy266.
	13.	CPC26763B, latex replica from external mould of librigena, x3, locality Hy277.
	14.	CPC26746, hypostome tentatively assigned to this species, x3, locality NT183.
Figs	16–23	**Thailandium** species undetermined.
	16.	CPC26805A, internal mould of cranidial fragment, x6, locality AS355.
	17.	CPC26806, as above, x3, locality AS355.
	18.	CPC26807, as above, x2, loality AS355.
	19.	CPC26823B, latex replica from external mould of pygidium, x6, locality AS351.
	20.	CPC26814, associated hypostome, x3, locality AS355.
	21.	CPC26825, internal mould of large cranidium, x1.5 locality AS8.
	22.	CPC26825, as above, lateral view, x1.5.
	23.	CPC26828, latex replica from external mould of librigena attributed to this species, x1, locality NT183.
Fig.	24	**Platysaukia tomichi** sp. nov.
	24.	CPC26803, latex replica from external mould of pygidium, x4, locality Hy277.


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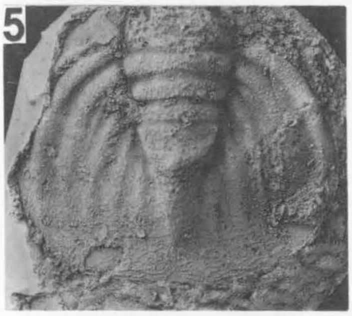
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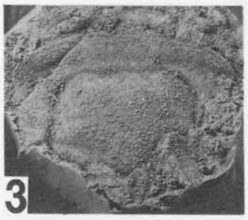
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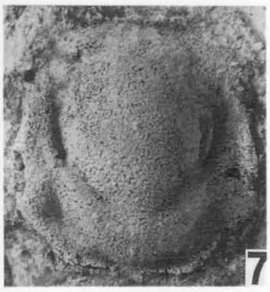
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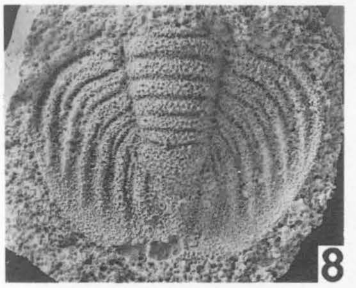
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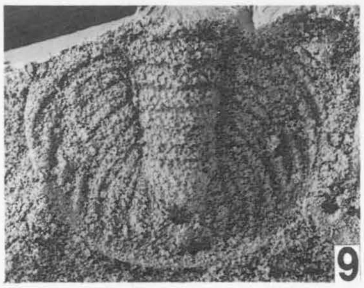
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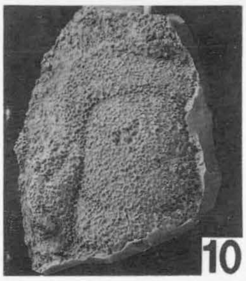
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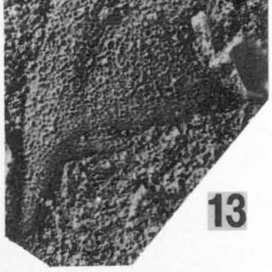
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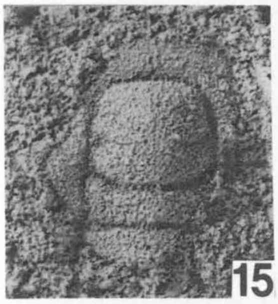
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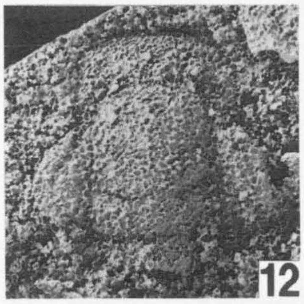
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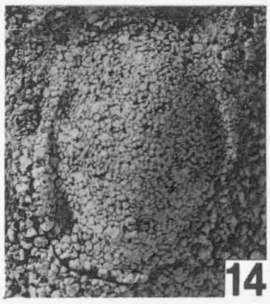
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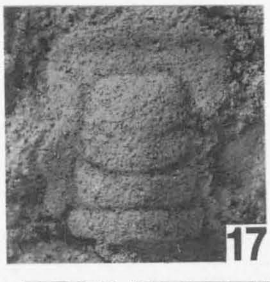
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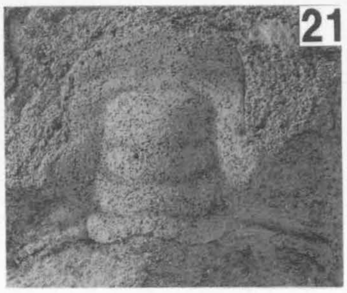
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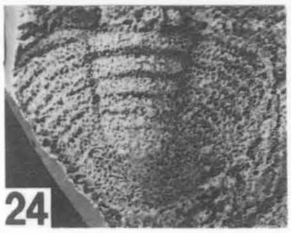
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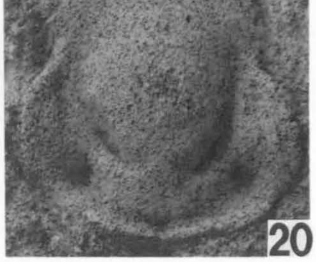
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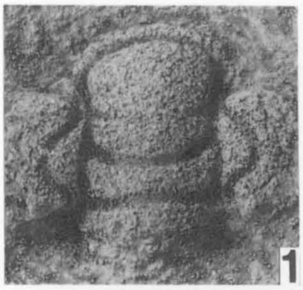
Plate 5

Fig.	1	**Sinosaukia** sp. aff. **S. impages** Shergold, 1975.
	1.	CPC26676, internal mould of cranidium, x4, locality AS354.
Figs	2–9	**Mictosaukia** species undetermined.
	2.	CPC26662, internal mould of cranidium, x4, locality AS199.
	3.	CPC26663, as above, x6, locality AS199.
	4.	CPC26664, as above, x8, locality AS199.
	5.	CPC26667, latex replica from external mould of librigena showing typical prosopon, x4, locality AS199.
	6.	CPC26668, internal mould of exfoliated librigena, x3, locality AS199.
	7.	CPC26669, latex replica from external mould of pygidium, x2, locality AS199.
	8.	CPC26673, latex replica of cranidial external mould tentatively assigned to this species showing slightly different border morphology, x3, locality AS302.
	9.	CPC26674, similarly preserved associated cranidium, x2, locality AS302.
Figs	10–19	**Eosaukia** sp. cf. **E. walcotti** (Mansuy, 1915).
	10.	CPC26613, latex replica from external mould of cranidium, x3, locality AS354.
	11.	CPC26613, as above, lateral view, x3.
	12.	CPC26613, as above, anterior view, x3.
	13.	CPC26614, latex replica as above, x4, locality AS354.
	14.	CPC26615, internal mould of cranidium, x4, locality AS351.
	15.	CPC26616, as above, x6, locality AS13.
	16.	CPC26651, internal mould of librigena, x4, locality AS354.
	17.	CPC26654, latex replica from pygidial external mould, x8, locality AS193.
	18.	CPC26656, internal mould of pygidium, x4, locality AS354.
	19.	CPC26655, as above, x8, locality AS13.
Figs	20–22	**Eosaukia latilimbata** Lu, 1954.
	20.	NI7227, latex replica from external mould of fully articulated specimen, holotype, x4.
	21.	NI7227, as above, x4.
	22.	NI7227, as above, enlargement of cephalon, x6.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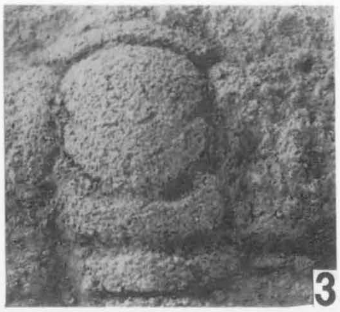
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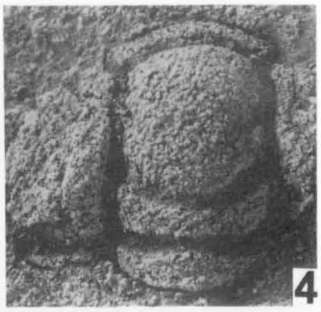
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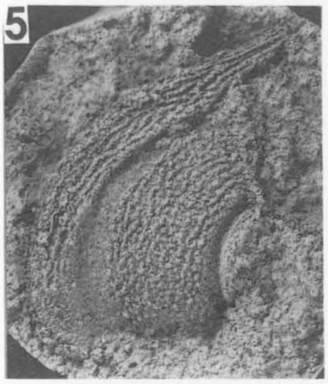
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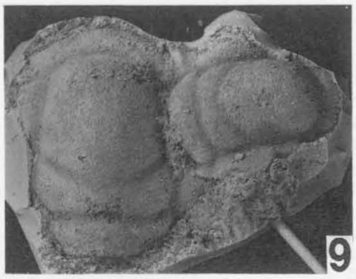
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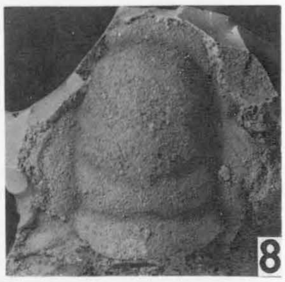
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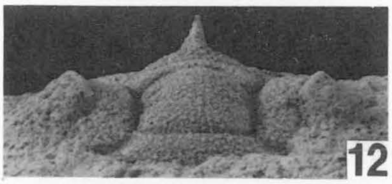
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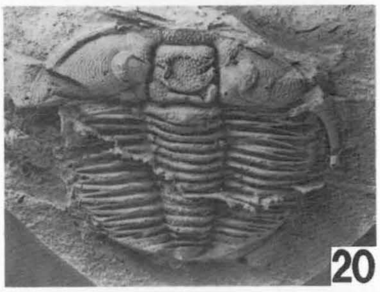
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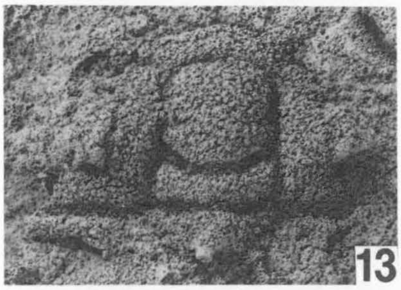
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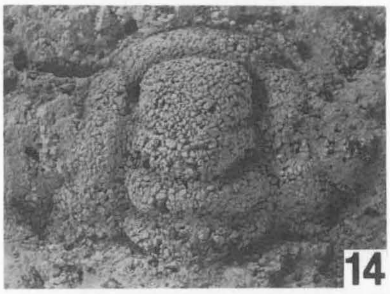
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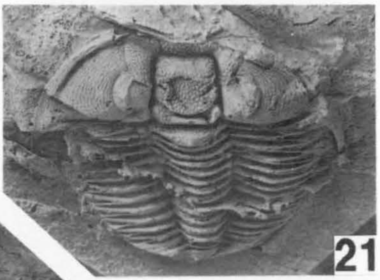
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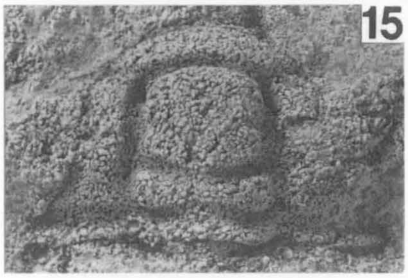
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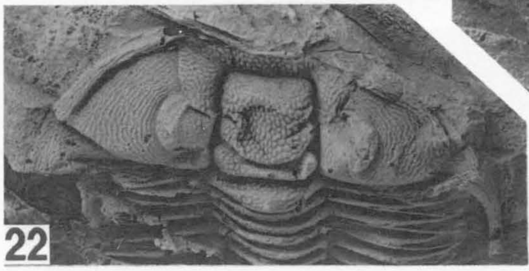
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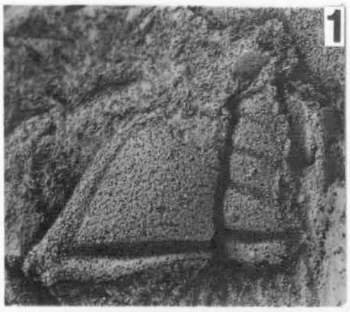
Plate 6

Figs	1–9	**Koraipsis** sp. cf. **K. taiziheensis** Kuo & Duan, 1982.
	1.	CPC26952, cranidial fragment, internal mould, showing proximal end of anterior spine, x4, locality A1/26.
	2.	CPC26953A, as above, x6, locality A1/26.
	3.	CPC26953B, latex replica of above, x4.
	4.	CPC26967B, latex replica from external mould of cranidial fragment, x3, locality 85/3101.
	5.	CPC26976, latex replica, as above, showing extent of genal spine, x2, locality LA36.
	6.	CPC26961, latex replica, as above, x3, locality 85/3058.
	7.	CPC26965, pygidium with extraordinary macropleural spines on second segment, x4, locality 85/3058.
	8.	CPC26973, latex replica from pygidial external mould, x6, locality NT252.
	9.	CPC26972, internal mould of pygidial fragment, x3, locality NT252.
Figs	10–18	**Hystricurus** sp. cf. **H. eurycephalus** Kobayashi, 1934.
	10.	CPC26931, internal mould of cranidium, x4, locality A1/26.
	11.	CPC26924, silicified internal mould of cranidium, x4, locality 85/3101.
	12.	CPC26925, as above, x6, locality 85/3101.
	13.	CPC26925, as above, lateral view, x6.
	14.	CPC26926, as above, dorsal view, x4, locality 85/3101.
	15.	CPC26926, as above, lateral view, x4.
	16.	CPC26929, silicified internal mould of librigena, x6, locality 85/3101.
	17.	CPC26930, latex replica from external mould of librigena, x4, locality 85/3101.
	18.	CPC26932, latex replica from fragment of external mould of pygidium, x4, locality Hy77.
Figs	19–21	**Apatokephalus** sp. cf. **A. hyotan** Kobayashi, 1953.
	19.	CPC26920, internal mould of cranidial fragment, x8, locality NT252.
	20.	CPC26921, cranidium, as above, x8, locality A1/26.
	21.	CPC26919, cranidial fragment, x8, locality NT252.
Fig.	22.	**Hystricurus eurycephalus** Kobayashi, 1934.
	22.	PA827, silicone replica of holotype cranidium illustrated for comparison, x6.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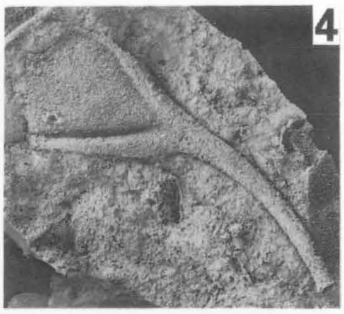
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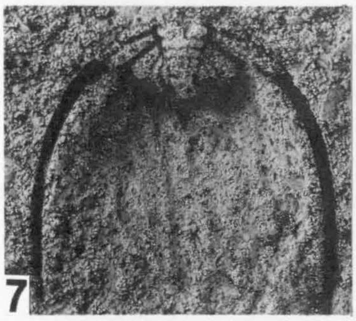
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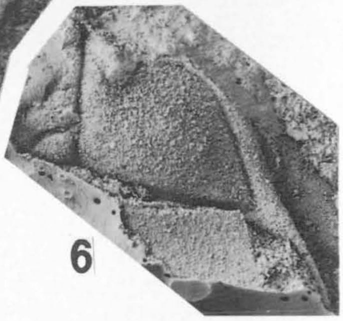
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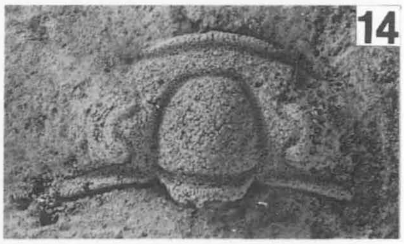
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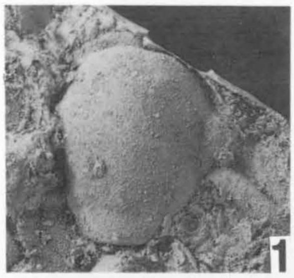
Plate 7

Figs 1–12 **Pacootella collativa** gen. et sp. nov.

1. CPC27075, latex replica cranidial external mould, showing very narrow (sag.) border, posteriorly sited axial node, and traces of an occipital ring, x3, locality AS9.
2. CPC27074, holotype, latex replica, as above, x2, locality AS9.
3. CPC27076, cranidial fragment, internal mould, x3, locality AS9.
4. CPC27090, latex replica from cranidial external mould, x2, locality AS306.
5. CPC27077, cranidium, internal mould, x2, locality AS9.
6. CPC27082, hypostome, internal mould, x6, locality AS9.
7. CPC27083, hypostome, as above, x4, locality AS9.
8. CPC27079, latex replica showing ventral surface of librigena, x2, locality AS9.
9. CPC27080, latex replica from librigenal external mould, x3, locality AS9.
10. CPC27089, latex replica from external mould of pygidium, x3, locality AS9.
11. CPC27098, latex replica, as above, x1.5, locality AS306.
12. CPC27099, latex replica, as above, x2, locality AS306.

Figs 13–22 **Kayseraspis? belli** sp. nov.

13. CPC27066B, holotype, latex replica from external mould of cranidium, x6, locality NT333.
14. CPC27058, cranidium, internal mould, x4, locality NT194.
15. CPC27059, latex replica from cranidial external mould, x6, locality NT194.
16. CPC27072, latex replica, as above, x2, locality ML4.
17. CPC27051, cranidium, internal mould, x2, locality AS127.
18. CPC27060, cranidium, as above, x1.5, locality NT194.
19. CPC27062, latex replica from external mould of pygidium, and CPC27061, associated cranidial fragment, x2, locality NT194.
20. CPC27064, latex replica from external mould of pygidium, x3, and associated librigenal fragments, locality NT194.
21. CPC27065, latex replica of pygidium, as above, x3, locality NT194.
22. CPC27064, latex replica of pygidium, as above, and CPC27063, associated librigena plus other unnumbered fragments, x0.5, locality NT194.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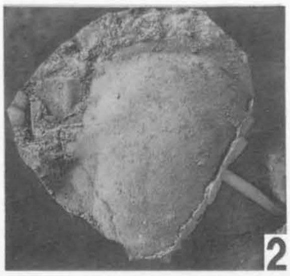
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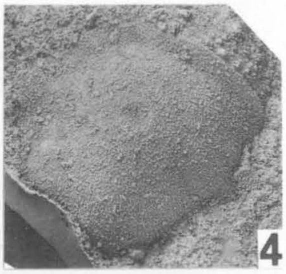
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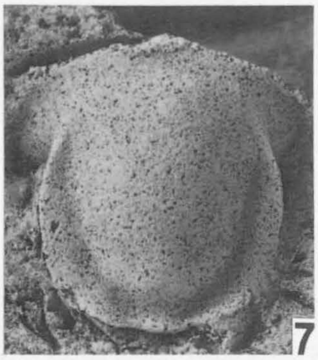
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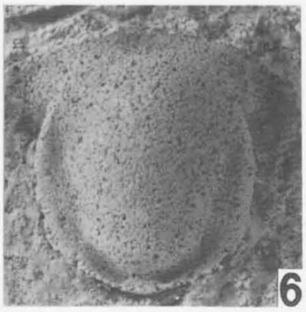
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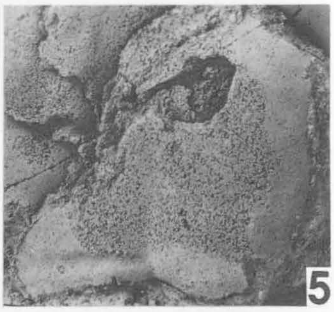
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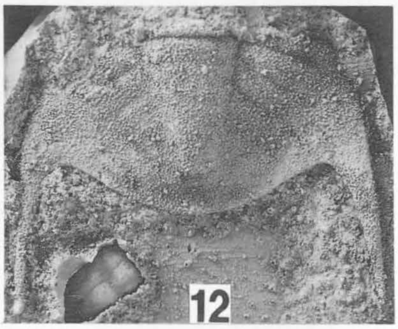
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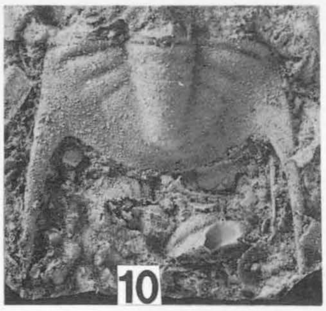
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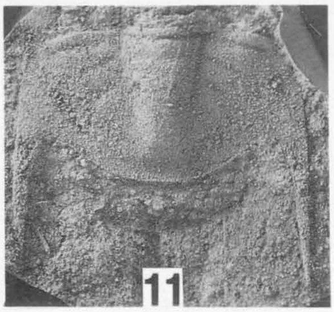
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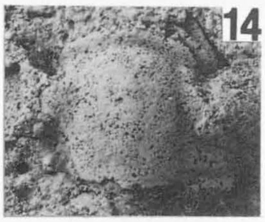
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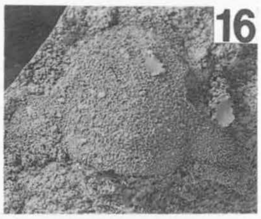
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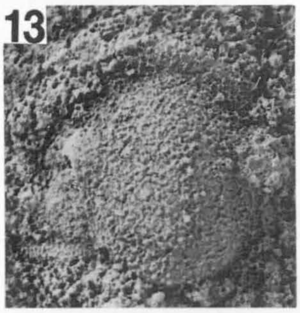
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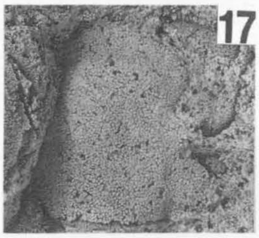
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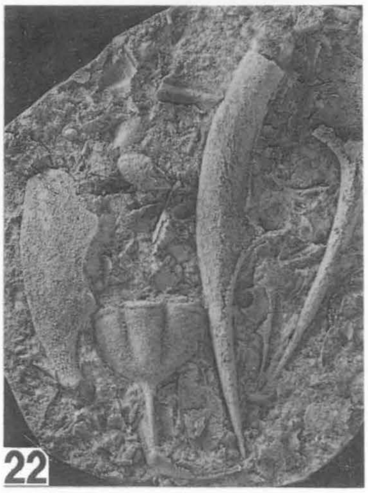
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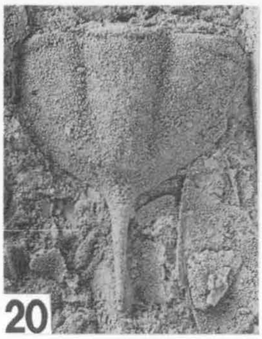
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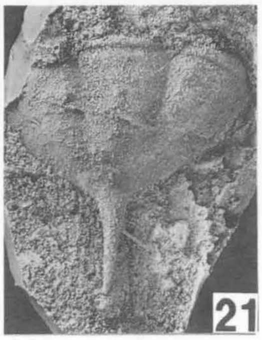
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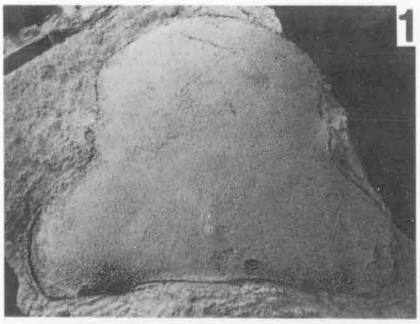
Plate 8

Figs 1–20 **Psilocephalina** sp. cf. **P. lubrica** Hsu, 1948.

1. CPC27145, cranidium, internal mould, x1.5, locality Hy269.
2. CPC27118, cranidium, as above, x2, locality NT237b.
3. CPC27129, cranidium, as above, x2, locality NT237c.
4. CPC27119, cranidium, as above, x4, locality NT237b.
5. CPC27120, cranidium, as above, x4, locality NT237b.
6. CPC27131, cranidium, as above, x2, locality NT237c.
7. CPC27130, cranidium, as above, x2, locality NT237c.
8. CPC27135, hypostome, internal mould, x4, locality NT237c.
9. CPC27117, hypostome, as above, x8, locality NT237c.
10. CPC27105, librigena, internal mould, x2, locality NT195.
11. CPC27104, librigena, as above, x1.5, locality AS265.
12. CPC27145, cranidium, lateral view, x1.5, locality Hy269.
13. CPC27145, cranidium, anterior view, x1.5, locality Hy269.
14. CPC27157, pygidium, internal mould, and associated cranidial fragment, CPC27156, x2, locality A1/26.
15. CPC27147, pygidium, internal mould, x2, locality Hy269.
16. CPC27106, pygidium, as above, x2, locality NT335.
17. CPC27136, pygidium, as above, x4, locality NT237c.
18. CPC27127, pygidium, as above, x1.3, locality NT237b.
19. CPC27128, pygidium, as above, x2, locality NT237b.
20. CPC27146, pygidium, as above, x2, locality Hy269.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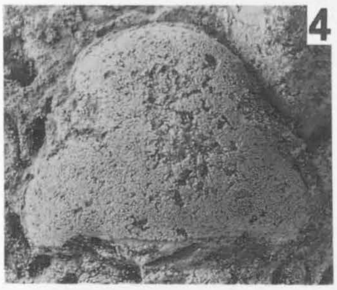
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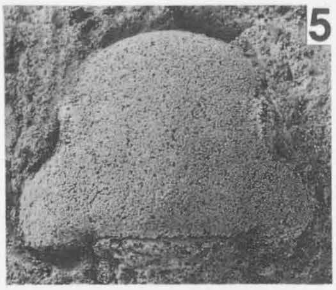
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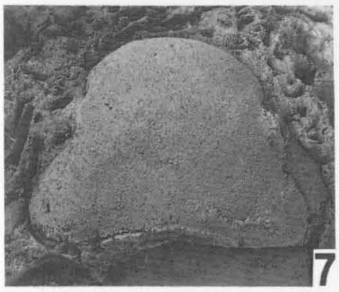
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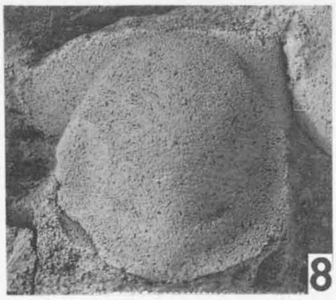
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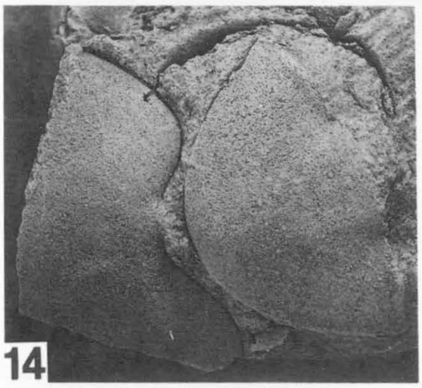
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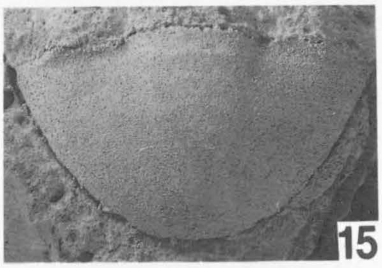
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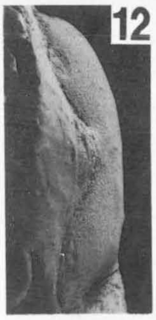
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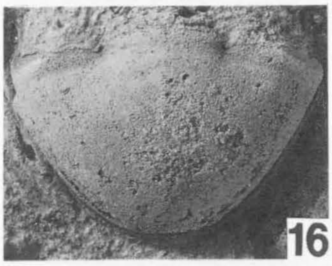
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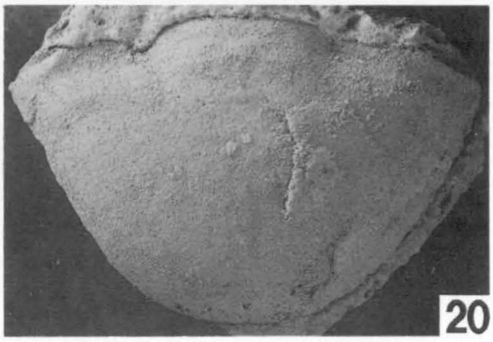
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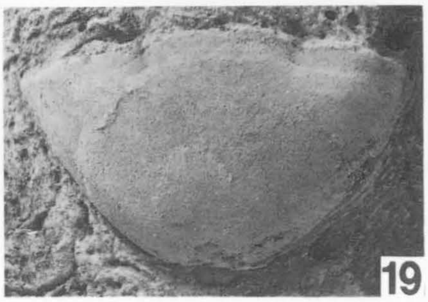
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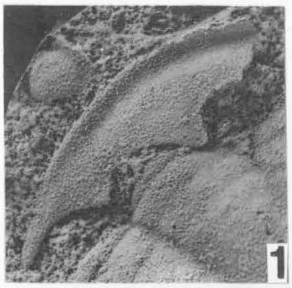
Plate 9

Figs 1–8 **Asaphellus?** species undetermined 1.
1. CPC26999, latex replica from external mould of librigena, associated with a pygidium, CPC26996B, and cranidial fragment, CPC27000, x4, locality AS265.
2. CPC27012, cranidium associated, internal mould, x4, locality Hy268.
3. CPC27028, latex replica of cranidial fragment, x2, locality ML4.
4. CPC26996B, latex replica of pygidial external mould, x4, locality AS265.
5. CPC27018, latex replica, as above, x4, locality Hy268.
6. CPC27007, latex replica, as above, x6, locality NT331.
7. CPC27029, pygidium, internal mould, x2, locality ML4.
8. CPC27001, latex replica from external mould of pygidium, x4, locality NT195.

Figs 9–18 **Asaphellus** sp. cf. **A. trinodosus** Chang, 1949.
9. CPC26977B, latex replica from cranidial external mould, x2, locality 85/3058.
10. CPC26977A, cranidium, internal mould, x2, locality 85/3058.
11. CPC26978B, latex replica from cranidial external mould, x3, locality 85/3058.
12. CPC26979, cranidium, internal mould, x3, locality 85/3058.
13. CPC26993B, latex replica from cranidial external mould, x2, locality 85/3055.
14. CPC26993A, as above, internal mould, x2, locality 85/3055.
15. CPC26981, latex replica from external mould of librigena, x1.5, locality 85/3058.
16. CPC26988B, latex replica from external mould of pygidium, x4, locality 85/3058.
17. CPC26989B, latex replica, as above, x2, locality 85/3058.
18. CPC26995, latex replica, as above, x2, locality 85/3055.

Figs 19–24 **Asaphellus?** species undetermined 2.
19. CPC27043B, latex replica from external mould of cranidium, x1, locality ML30E.
20. CPC27043A, counterpart internal mould, x1, locality ML30E.
21. CPC27035, latex replica from external mould of pygidium, x2, locality NT614.
22. CPC27036, pygidium, internal mould, x4, locality NT614.
23. CPC27044, latex replica from external mould of pygidium, x6, locality ML30A.
24. CPC27042, pygidium, internal mould, x3, locality ML18.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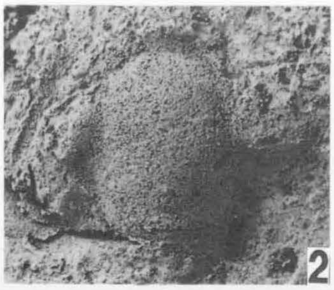
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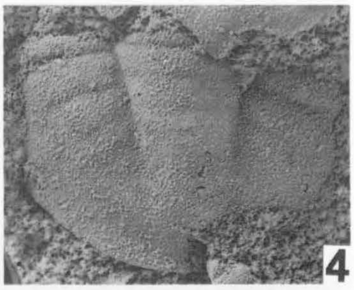
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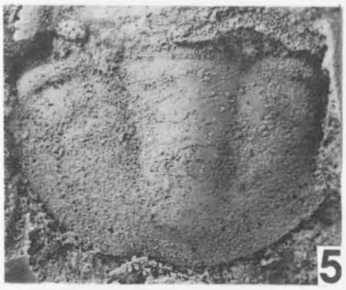
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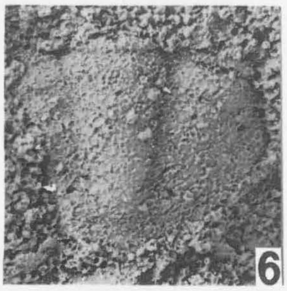
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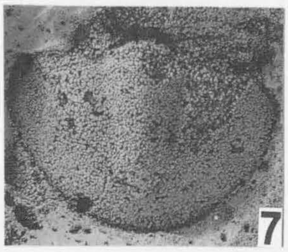
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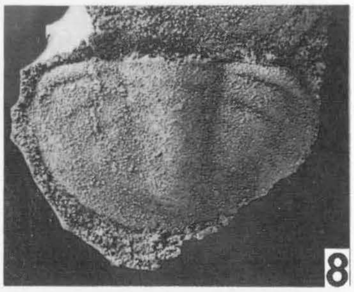
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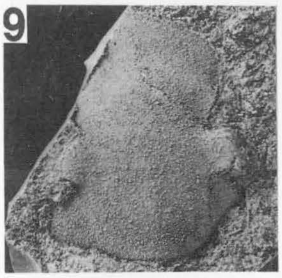
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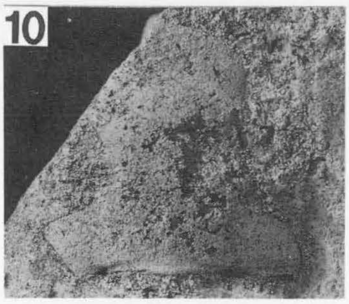
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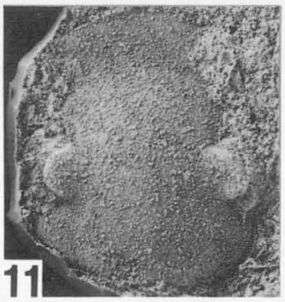
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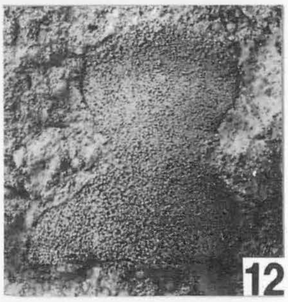
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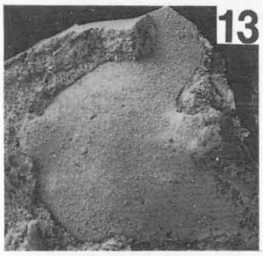
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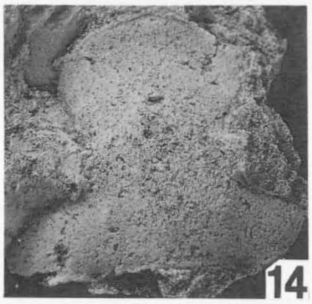
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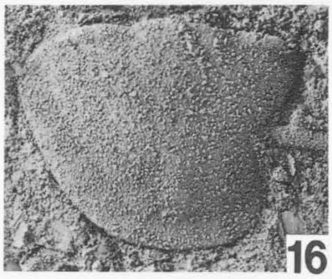
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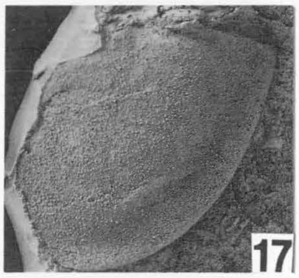
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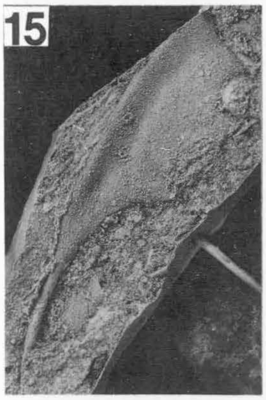
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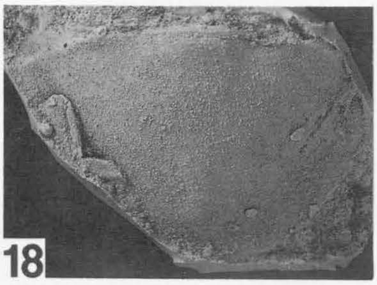
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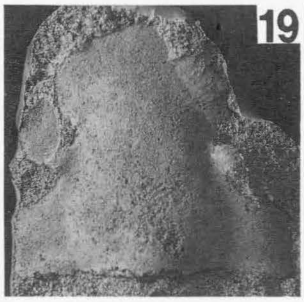
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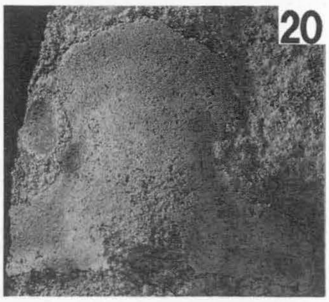
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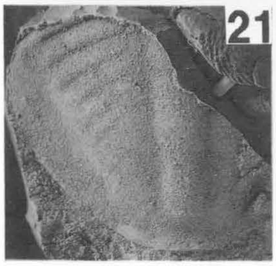
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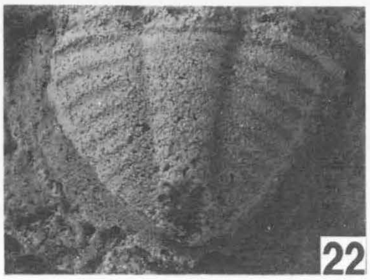
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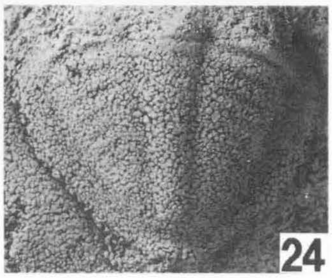
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Pacoota Sandstone macrofossil locality index

compiled by

M. Owen, S. Warsina, & J.H. Shergold

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INTRODUCTION

The following appendix lists the localities from which the trilobites described in the previous paper by Shergold have been obtained. Fossils found at each locality are given, and localities grouped, according to the macrofossil assemblage they have yielded.

Abbreviated prefixes refer to the names of 1:250 000 scale geological map sheets:

- As Alice Springs, Hy-Henbury, Rd-Rodinga, LA-Lake Amadeus, ML-Mount Liebig.
- Material from these localities was collected by Officers of the 1960–1964 1:250 000 mapping of the Amadeus Basin.
- Prefixes A1, A4, etc., refer to collections made by geologists of Frome Broken Hill Pty Ltd in 1959.
- NT refers to collections made across the Northern Territory by individual geologists, mostly between 1952–1966.
- Numerical prefixes refer to subsequent collections made by year.

Pacoota Sandstone macrofossil localities

ASSEMBLAGE 1

Locality - 85/3105
Loc. description - Approximately 1 km southeast of Williams Bore
Map sheet - Alice Springs
Photo reference - AS R11/5060
Latitude - 23° 51' 30"
Longitude - 134° 17' 08
Macrofossils - Saukiidae indeterminate
Assemblage - Assemblage 1

Locality - 87/001
Loc. description - Fergusson Syncline, approx. 5 km northeast of Shannon Bore
Map sheet - Alice Springs
Photo reference - AS R11/5065
Latitude - 23° 51' 30"
Longitude - 134° 32' 52"
Macrofossils - *Platysaukia* sp. indet.
Assemblage - Assemblage 1

Locality - 87/002
Loc. description - south flank Waterhouse Range, section HyR5, approx. 455m above base of Goyder Formation
Map sheet - Henbury
Photo reference - HEN R1/5188
Latitude - 24° 01' 04"
Longitude - 133° 18' 41"
Macrofossils - *Platysaukia* sp. indet.
Assemblage - Assemblage 1

Locality - 87/003
Loc. description - south flank of Waterhouse Range, section HyR5, approx. 457m above base of Goyder Formation
Map sheet - Henbury
Photo reference - HEN R1/5188
Latitude - 24° 01' 04"
Longitude - 133° 18' 41"
Macrofossils - *Platysaukia* sp. indet.
Assemblage - Assemblage 1

Locality - 87/004
Loc. description - south flank of Waterhouse Range, section HyR5 approx. 490m above base of Goyder Formation
Map sheet - Henbury
Photo reference - HEN R1/5188
Latitude - 24° 01' 04"
Longitude - 133° 18' 41"
Macrofossils - *Platysaukia* sp. indet.
Assemblage - Assemblage 1

Locality - 87/005
Loc. description - Ellery Creek section, approx. 40 km northeast of Hermannsburg Mission at base of lower Pacoota channel deposits
Map sheet - Hermannsburg
Photo reference - HG R13/5028
Latitude - 23° 49' 15"
Longitude - 133° 04' 30"
Macrofossils - *Platysaukia* sp. indet.
Assemblage - Assemblage 1

Locality - 87/006
Loc. description - Ellery Creek section, approx. 40 km northeast Hermannsburg Mission at top of lower Pacoota channel deposits
Map sheet - Hermannsburg
Photo reference - HG R13/5028
Latitude - 23° 49' 15"
Longitude - 133° 04' 30"
Macrofossils - Saukiidae indeterminate
Assemblage - Assemblage 1

Locality - As 003
Loc. description - northeast end of Waterhouse Range
Map sheet - Alice Springs
Photo reference - HEN R1/5181/507
Latitude - 23° 58' 52"
Longitude - 133° 38' 14"
Macrofossils - *Thailandium* sp. indet.
Assemblage - Assemblage 1

Locality - As 008
Loc. description - Ross River, west bank, 3.2 km south of homestead
Map sheet - Alice Springs
Photo reference - AS R10/5094/518
Latitude - 23° 37' 30"
Longitude - 134° 29' 20"
Macrofossils - *Lichengia simplex* sp. nov., *Platysaukia jokliki* sp. nov., *Eosaukia* cf. *walcotti* (Mansuy), *Thailandium* sp. indet.
Assemblage - Assemblage 1

Locality - As 012
Loc. description - 8 km south of Ross River Homestead
Map sheet - Alice Springs
Photo reference - AS R10/5094/525
Latitude - 23° 39' 33"
Longitude - 134° 28' 34"
Macrofossils - *Platysaukia jokliki* sp. nov.
Assemblage - Assemblage 1

Locality - As 013
Loc. description - 8 km south of Ross River Homestead, east bank of Ross R.
Map sheet - Alice Springs
Photo reference - AS R10/5094/528
Latitude - 23° 40' 09"
Longitude - 134° 29' 21"
Macrofossils - *Platysaukia jokliki* sp. nov., *Eosaukia* cf. *walcotti* (Mansuy), *Pinnocaris*? sp., *Hyseloconus*? sp.
Assemblage - Assemblage 1

Locality - As 051
Loc. description - Todd River Anticline, west flank
Map sheet - Alice Springs
Photo reference - AS R13/5155
Latitude - 23° 51' 12"
Longitude - 134° 19' 00"
Macrofossils - *Platysaukia jokliki* sp. nov., articulate brachiopod indet.
Assemblage - Assemblage 1

Locality - As 052
Loc. description - Todd River Anticline, west flank
Map sheet - Alice Springs
Photo reference - AS R13/5155
Latitude - 23° 51' 12"
Longitude - 134° 19' 00"
Macrofossils - Saukiidae? indeterminate
Assemblage - Assemblage 1

Locality - As 083
Loc. description - Fergusson Syncline, east of Loves Creek
Map sheet - Alice Springs
Photo reference - AS R10/5091
Latitude - 23° 38' 59"
Longitude - 134° 34' 59"
Macrofossils - Saukiidae indeterminate, *Cymatopegma semiplicatum* Pojeta et al.
Assemblage - Assemblage 1

Locality - As 085
Loc. description - Fergusson Syncline
Map sheet - Alice Springs
Photo reference - AS R10/5091
Latitude - 23° 38' 46"
Longitude - 134° 34' 04"
Macrofossils - *Platysaukia jokliki* sp. nov., *Cymatopegma semiplicatum* Pojeta et al., *Cruziana* sp. indet.
Assemblage - Assemblage 1

Locality - As 123
Loc. description - 4.5 km southeast of Jay Creek Aboriginal Settlement
Map sheet - Alice Springs
Photo reference - HG R14/5080/2017
Latitude - 23° 50' 03"
Longitude - 133° 32' 07"
Macrofossils - Saukiidae indetermined, *Pinnocaris*? sp., *Leptembolon*? sp.
Assemblage - Assemblage 1

Locality - As 125
Loc. description - 16.1 km east-southeast of Jay Creek Aboriginal Settlement
Map sheet - Alice Springs
Photo reference - AS R14/5226/2023
Latitude - 23° 49' 16"
Longitude - 133° 38' 36"
Macrofossils - *Platysaukia jokliki* sp. nov., *Cruziana* sp.
Assemblage - Assemblage 1

Locality - As 147
Loc. description - 38.6 km east of Alice Springs
Map sheet - Alice Springs
Photo reference - AS R12/5022/2124
Latitude - 23° 44' 05"
Longitude - 134° 14' 32"
Macrofossils - *Plethometopus*? sp. indet., *Lichengia simplex* sp. nov., *Eosaukia* cf. *walcotti* (Mansuy)
Assemblage - Assemblage 1

Locality - As 175
Loc. description - 4.8 km northeast of No. 6 Bore
Map sheet - Alice Springs
Photo reference - AS R11/5062/2250
Latitude - 23° 41' 26"
Longitude - 134° 22' 49"
Macrofossils - Saukiidae sp. indeterminate, *Cymatopegma semiplicatum* Pojeta et al., *Hypseloconus* sp.
Assemblage - Assemblage 1

Locality - As 177
Loc. description - 6.4 km northeast of No. 6 Bore
Map sheet - Alice Springs
Photo reference - AS R11/5062/2254
Latitude - 23° 41' 01"
Longitude - 134° 23' 37"
Macrofossils - Saukiidae indeterminate, *Cymatopegma semiplicatum* Pojeta et al.
Assemblage - Assemblage 1

Locality - As 193
Loc. description - Ross River, west bank
Map sheet - Alice Springs

Photo reference - AS R10/5093/2324
Latitude - 23° 40' 04"
Longitude - 134° 29' 12"
Macrofossils - *Shergoldia* sp. indet., *Changia correcta* sp. nov., *Koldinioidia* sp. indet. aff. *K. sulcata* Robison & Pantoja-Alor, *Mansuyia* cf. *orientalis* Sun, *Lichengia simplex* sp. nov., *Eosaukia* cf. *walcotti* (Mansuy), *Pelagiella*? sp. indet., *Billingsella*? sp. indet.
Assemblage - Assemblage 1

Locality - As 194
Loc. description - Ross River, west bank
Map sheet - Alice Springs
Photo reference - AS R10/5093/2324
Latitude - 23° 40' 04"
Longitude - 134° 28' 41"
Macrofossils - Saukiid indeterminate
Assemblage - Assemblage 1

Locality - As 195
Loc. description - Ross River, east bank, 7.5 km south of Ross River Chalet
Map sheet - Alice Springs
Photo reference - AS R10/5093/2325
Latitude - 23° 39' 53"
Longitude - 134° 29' 12"
Macrofossils - Saukiidae indeterminate, *Pinnocaris*? sp.
Assemblage - Assemblage 1

Locality - As 196
Loc. description - Ross River East bank, 7.5 km south of Ross River Chalet
Map sheet - Alice Springs
Photo reference - AS R10/5093/2325
Latitude - 23° 39' 53"
Longitude - 134° 29' 12"
Macrofossils - *Changia correcta* sp. nov., *Koldinioidia* sp. indet. aff., *K.* sp. aff. *K. sulcata* Robison & Pantoja-Alor, *Platysaukia jokliki* sp. nov., *Cymatopegma semiplicatum* Pojeta et al., Pelmatozoan debris
Assemblage - Assemblage 1

Locality - As 197
Loc. description - Ross River, East bank, 7.5 km south of Ross River Chalet
Map sheet - Alice Springs
Photo reference - 5093
Latitude - 23° 39' 53"
Longitude - 134° 29' 12"
Macrofossils - *Shergoldia* sp. indet., *Jegorovaia*? *arena* sp. nov., *Platysaukia jokliki* sp. nov., *Lichengia simplex* sp. nov., *Eosaukia* cf. *walcotti* (Mansuy), *Mictosaukia* sp. indet., *Cymatopegma semiplicatum* Pojeta et al., articulate brachiopod indet.
Assemblage - Assemblage 1

Locality - As 198
Loc. description - Ross River, east bank, 7.5 km south of Ross River Chalet
Map sheet - Alice Springs
Photo reference - AS R10/5093/2325
Latitude - 23° 39' 53"
Longitude - 134° 29' 12"
Macrofossils - *Micragnostus* sp. indet, *Jegorovaia*? *arena* sp. nov., *Platysaukia jokliki* sp. nov., *Eosaukia* cf. *walcotti* (Mansuy), *Cymatopegma semiplicatum* Pojeta et al., *Kimopegma pinnatum* Pojeta et al., *Pinnocaris robusta* Pojeta et al., *Pinnocaris wellsi* Pojeta et al., *Ribeiria jonesi* Pojeta et al.
Assemblage - Assemblage 1

Locality - As 199
Loc. description - Ross River, east bank, 7.5 km south of Ross River Chalet
Map sheet - Alice Springs
Photo reference - AS R10/5093/2325
Latitude - 23° 39' 53"
Longitude - 134° 29' 12"
Macrofossils - *Quadraticephalus* cf. *coreanicus* Kobayashi, *Mansuyia* cf. *orientalis* Sun, *Platysaukia jokliki* sp. nov., *Eosaukia* cf. *walcotti* (Mansuy), *Mictosaukia* sp. indet., *Pinnocaris* sp.
Assemblage - Assemblage 1

Locality - As 230
Loc. description - 4.8 km northeast of Williams Bore
Map sheet - Alice Springs
Photo reference - AS R11/5060/3760
Latitude - 23° 40' 19"
Longitude - 134° 18' 49"
Macrofossils - Gastropoda indet., monoplacophoran? indet.
Assemblage - Assemblage 1

Locality - As 247
Loc. description - west limb of Todd River Anticline
Map sheet - Alice Springs
Photo reference - AS R14/5210
Latitude - 24° 40' 30"
Longitude - 134° 18' 00"
Macrofossils - *Platysaukia jokliki* sp. nov.
Assemblage - Assemblage 1

Locality - As 269
Loc. description - N'Dhala Gorge, west of Ross River, east slope of gorge
Map sheet - Alice Springs
Photo reference - AS R10/5094
Latitude - 23° 38' 25"
Longitude - 134° 28' 51"
Macrofossils - Indeterminate trilobite fragments, *Cymatopegma semiplicatum* Pojeta et al., inarticulate brachiopod indet.
Assemblage - Assemblage 1

Locality - As 270
Loc. description - N'Dhala Gorge, west of Ross River
Map sheet - Alice Springs
Photo reference - AS R10/5094
Latitude - 23° 39' 18"
Longitude - 134° 28' 51"
Macrofossils - *Eosaukia* cf. *walcotti* (Mansuy), *Lichengia simplex* sp. nov.
Assemblage - Assemblage 1

Locality - As 300
Loc. description - Ross River, east bank, 7.5 km south of Ross River Chalet
Map sheet - Alice Springs
Photo reference - AS R10/5093/2325
Latitude - 23° 39' 51"
Longitude - 134° 29' 13"
Macrofossils - *Platysaukia jokliki* sp. nov., *Cymatopegma semiplicatum* Pojeta et al.
Assemblage - Assemblage 1

Locality - As 301
Loc. description - Ross River, east bank, 7.5 km south of Ross River Chalet
Map sheet - Alice Springs
Photo reference - AS R10/5093/2325
Latitude - 23° 39' 51"
Longitude - 134° 29' 13"
Macrofossils - *Platysaukia jokliki* sp. nov.
Assemblage - Assemblage 1

Locality - As 302
Loc. description - Ross River, east bank, 7.5 km south of Ross River Chalet
Map sheet - Alice Springs
Photo reference - AS R10/5093/2325
Latitude - 23° 39' 51"
Longitude - 134° 29' 13"
Macrofossils - *Platysaukia jokliki* sp. nov., *Mictosaukia* sp. indet.
Assemblage - Assemblage 1

Locality - As 314
Loc. description - 1 km southeast of Williams Bore
Map sheet - Alice Springs
Photo reference - AS R11/5059/2335
Latitude - 23° 41' 22"
Longitude - 134° 17' 11"
Macrofossils - *Platysaukia jokliki* sp. nov.
Assemblage - Assemblage 1

Locality - As 315
Loc. description - 4.5 km north of Shannon Bore
Map sheet - Alice Springs
Photo reference - AS R11/5064/2336
Latitude - 23° 40' 15"
Longitude - 134° 29' 36"
Macrofossils - *Shergoldia* sp. indet., *Mansuyia* cf. *orientalis* Sun, Saukiidae indet.
Assemblage - Assemblage 1

Locality - As 350
Loc. description - Ross River Syncline, south limb, 8.5 km northeast of No.6 Bore
Map sheet - Alice Springs
Photo reference - AS R11/5063
Latitude - 23° 41' 11"
Longitude - 134° 24' 57"
Macrofossils - *Plethometopus*? sp. indet., *Platysaukia jokliki* sp. nov., *Eosaukia* cf. *walcotti* (Mansuy), *Hypseloconus* sp., *Cymatopegma semiplicatum* Pojeta et al., *Pinnocaris robusta* Pojeta et al.
Assemblage - Assemblage 1

Locality - As 351
Loc. description - Ross River Syncline, south limb, 10.5 km northeast of No.6 Bore
Map sheet - Alice Springs
Photo reference - AS R11/5063
Latitude - 23° 41' 21"
Longitude - 134° 32' 52"
Macrofossils - *Thailandium* sp. indet., *Eosaukia* cf. *walcotti* (Mansuy), *Platysaukia jokliki* sp. nov., *Cymatopegma semiplicatum* Pojeta et al., *Hypseloconus* sp.
Assemblage - Assemblage 1

Locality - As 352
Loc. description - Fergusson Syncline, 5 km northeast of Shannon Bore
Map sheet - Alice Springs
Photo reference - AS R11/5065
Latitude - 23° 51' 30"
Longitude - 134° 32' 52"
Macrofossils - *Eosaukia* cf. *walcotti* (Mansuy), *Cymatopegma semiplicatum* Pojeta et al., *Ribeiria huckitta* Pojeta et al.
Assemblage - Assemblage 1

Locality - As 354
Loc. description - Fergusson Syncline, 5.5 km northeast of Shannon Bore
Map sheet - Alice Springs
Photo reference - AS R11/5065
Latitude - 23° 40’ 29"
Longitude - 134° 32’ 52"
Macrofossils - *Shergoldia* sp. indet., *Quadraticephalus* cf. *coreanicus* Kobayashi, *Plethometopus*? sp. indet., *Lichengia simplex* sp. nov., *Eosaukia* cf. *walcotti* (Mansuy), *Sinosaukia*? sp. indet., *Wanwanaspis* sp. indet., monoplacophoran indet., rostroconch indet.
Assemblage - Assemblage 1

Locality - As 355
Loc. description - Ross River Syncline, east bank of Ross River
Map sheet - Alice Springs
Photo reference - AS R10/5093
Latitude - 23° 39’ 53"
Longitude - 134° 29’ 12"
Macrofossils - *Micragnostus* sp. indet, Pseudagnostinoid gen. et sp. indet., *Shergoldia* sp. indet., *Changia correcta* sp. nov., *Plethometopus*? sp. indet., *Thailandium* sp. indet., *Wanwanaspis* sp. indet.
Assemblage - Assemblage 1

Locality - As 356
Loc. description - Ross River Syncline, east bank of Ross River
Map sheet - Alice Springs
Photo reference - AS R10/5093
Latitude - 23° 39’ 53"
Longitude - 134° 29’ 12"
Macrofossils - *Shergoldia* sp. indet., Saukiidae indeterminate
Assemblage - Assemblage 1

Locality - Hy 265
Loc. description - south flank Waterhouse Range, section HyR5, 339m above base of Goyder Formation
Map sheet - Henbury
Photo reference - HEN R1/5188
Latitude - 24° 01’ 04"
Longitude - 133° 18’ 41"
Macrofossils - *Thailandium* sp. indet., *Platysaukia tomichi* sp. nov., *Lichengia simplex* sp. nov.?
Assemblage - Assemblage 1

Locality - Hy 266
Loc. description - south flank Waterhouse Range, section HyR5, base of mapped Pacoota Sandstone
Map sheet - Henbury
Photo reference - HEN R1/5188
Latitude - 24° 01’ 04"
Longitude - 133° 18’ 41"
Macrofossils - *Platysaukia* sp. nov., *Thailandium* sp. indet., *Quadraticephalus*? sp. indet.
Assemblage - Assemblage 1

Locality - Hy 267
Loc. description - south flank Waterhouse Range, section HyR5, 58.5m above base mapped Pacoota
Map sheet - Henbury
Photo reference - HEN R1/5188
Latitude - 24° 01’ 04"
Longitude - 133° 18’ 41"
Macrofossils - Saukiidae indet., *Pinnocaris* sp.
Assemblage - Assemblage 1

Locality - Hy 276
Loc. description - Waterhouse Range, Hugh River valley, west side
Map sheet - Henbury
Photo reference - ?
Latitude - 23° 58’ 40"
Longitude - 133° 26’ 50"
Macrofossils - *Platysaukia jokliki* sp. nov., *Eosaukia* cf. *walcotti* (Mansuy), *Pinnocaris* sp.
Assemblage - Assemblage 1

Locality - Hy 277
Loc. description - Waterhouse Range, Hugh River valley, west side
Map sheet - Henbury
Photo reference - ?
Latitude - 23° 58’ 40"
Longitude - 133° 26’ 50"
Macrofossils - *Platysaukia tomichi* sp. nov., *Thailandium* sp. indet., gastropoda indet., rostroconch indet.
Assemblage - Assemblage 1

Locality - NT 183
Loc. description - west wall of Hugh River Gap, north side Waterhouse Range
Map sheet - Henbury
Photo reference - HEN R1/5787
Latitude - 23° 58’ 10"
Longitude - 133° 26’ 50"
Macrofossils - *Plethometopus*? sp. indet., *Lichengia simplex* sp. nov. , *Thailandium* sp. indet., *Platysaukia tomichi* sp. nov.
Assemblage - Assemblage 1

Locality - NT 191
Loc. description - west of sawmill, Ross River Gorge
Map sheet - Alice Springs
Photo reference - AS R10/5093/B2693
Latitude - 23° 36' 20"
Longitude - 133° 26' 50"
Macrofossils - Saukiidae indeterminate, *Cymatopegma semiplicatum* Pojeta et al.
Assemblage - Assemblage 1

Locality - NT 229
Loc. description - 14 km SW of Alice Springs, 1.6 km from Temple Bar Creek
Map sheet - Alice Springs
Photo reference - AS R10/5170
Latitude - 23° 48' 35"
Longitude - 133° 47' 03"
Macrofossils - Saukiidae indeterminate, *Pinnocaris robusta* Pojeta et al., *Hypseloconus*? sp.
Assemblage - Assemblage 1

Locality - NT 251
Loc. description - Ellery Creek, ca.40 km northeast Hermannsburg Mission, 360m above base Pacoota Sandstone
Map sheet - Hermannsburg
Photo reference - HG R13/5028
Latitude - 23° 49' 15"
Longitude - 133° 04' 30"
Macrofossils - *Cymatopegma semiplicatum* Pojeta et al., *Ribeiria jonesi* Pojeta et al.
Assemblage - Assemblage 1

Locality - NT 320
Loc. description - Native Pine Gap section, 1.8m above base
Map sheet - Alice Springs
Photo reference - AS R13/5171
Latitude - 23° 48' 30"
Longitude - 133° 46' 20"
Macrofossils - *Jegorovaia*? *arena* sp. nov., rostroconch indet., *Hypseloconus* sp.
Assemblage - Assemblage 1

Locality - NT 321
Loc. description - Native Pine Gap section, 16m above base
Map sheet - Alice Springs
Photo reference - AS R13/5171
Latitude - 23° 48' 30"
Longitude - 133° 46' 20"
Macrofossils - Indeterminate trilobite fragments, *Pinnocaris* sp.
Assemblage - Assemblage 1

Locality - NT 322
Loc. description - Native Pine Gap section, 23m above base
Map sheet - Alice Springs
Photo reference - AS R13/5171
Latitude - 23° 48' 30"
Longitude - 133° 46' 20"
Macrofossils - Indeterminate dikelocephalacean trilobite fragments.
Assemblage - Assemblage 1

Locality - NT 323
Loc. description - Native Pine Gap section, 23m above base
Map sheet - Alice Springs
Photo reference - AS R13/5171
Latitude - 23° 48' 30"
Longitude - 133° 46' 20"
Macrofossils - Saukiidae indeterminate, *Pinnocaris robusta* Pojeta et al.
Assemblage - Assemblage 1

Locality - NT 325
Loc. description - Native Pine Gap section, 35m above base
Map sheet - Alice Springs
Photo reference - AS R13/5171
Latitude - 23° 48' 30"
Longitude - 133° 46' 20"
Macrofossils - *Quadraticephalus*? sp. indet., inarticulate brachiopod debris
Assemblage - Assemblage 1

Locality - NT 326
Loc. description - Native Pine Gap section, 40m above base
Map sheet - Alice Springs
Photo reference - AS R13/5171
Latitude - 23° 48' 30"
Longitude - 133° 46' 20"
Macrofossils - *Jegorovaia*? *arena* sp. nov., *Quadraticephalus*? sp. indet., Saukiidae indet., *Cymatopegma semiplicatum* Pojeta et al., *Pinnocaris* sp. indet.
Assemblage - Assemblage 1

Locality - NT 327
Loc. description - Native Pine Gap section, 43.5m above base
Map sheet - Alice Springs
Photo reference - AS R13/5171
Latitude - 23° 48' 30"
Longitude - 133° 46' 20"
Macrofossils - *Quadraticephalus*? sp. indet., Saukiidae indet., *Cymatopegma semiplicatum* Pojeta et al., *Ribeiria jonesi* Pojeta et al.
Assemblage - Assemblage 1

Locality - NT 606
Loc. description - 8 km east of east bank localities in Ross River area
Map sheet - Alice Springs
Photo reference - ASR10/5093
Latitude - 23° 39' 53"
Longitude - 134° 28' 42"
Macrofossils - *Shergoldia* sp. indet., *Eosaukia* cf. *walcotti* (Mansuy).
Assemblage - Assemblage 1

Locality - Rd 184
Loc. description - 1.6 km northwest of Nomera Bore, Mt. Peachy Range, section RdC-7
Map sheet - Rodinga
Photo reference - RD R7/5156
Latitude - 24° 21' 30"
Longitude - 133° 36' 30"
Macrofossils - Saukiidae? indeterminate, *Pinnocaris* sp.
Assemblage - Assemblage 1

Locality - Rd 198
Loc. description - north of Mt. Peachy, section RdC-8
Map sheet - Rodinga
Photo reference - RD R7/5149
Latitude - 24° 23' 20"
Longitude - 133° 51' 03"
Macrofossils - Indeterminate trilobite fragments, *Leptembolon* sp. indet., *Pinnocaris* sp. indet.
Assemblage - Assemblage 1

Locality - Rd 203
Loc. description - north of Mt. Peachy, section RdC-8
Map sheet - Rodinga
Photo reference - RD R7/5149
Latitude - 24° 23' 20"
Longitude - 133° 51' 03"
Macrofossils - Indeterminate trilobite fragments
Assemblage - Assemblage 1

Locality - Rd 204
Loc. description - north of Mt. Peachy, section RdC-8
Map sheet - Rodinga
Photo reference - RD R7/5149
Latitude - 24° 23' 20"
Longitude - 133° 51' 03"
Macrofossils - *Quadraticephalus* sp. indet., *Platysaukia jokliki* sp. nov.
Assemblage - Assemblage 1

ASSEMBLAGE 2

Locality - 85/3055
Loc. description - west Gardiner Range
Map sheet - Mt. Liebig
Photo reference - ML R15\5230
Latitude - 23° 55' 16"
Longitude - 131° 54' 59"
Macrofossils - *Asaphellus* sp. cf. *A. trinodosus* Chang, *Koraipsis* sp. cf. *K. taiziheensis* Kuo & Duan
Assemblage - Assemblage 2

Locality - 85/3058
Loc. description - Close to HY 77 Gardiner Range 8 km south of Areyonga and 8 km east of track to Tempe Downs
Map sheet - Henbury
Photo reference - HEN R3/5089
Latitude - 24° 08' 41"
Longitude - 132° 20' 58"
Macrofossils - *Asaphellus* sp. cf. *A. trinodosus* Chang, *Koraipsis* sp. cf. *K. taiziheensis* Kuo & Duan, *Psilocephalina* sp. cf. *P. lubrica* Hsu, *Apatokephalus* sp. cf. *A. hyotan* Kobayashi, *Colpantyx woolleyi* Pojeta & Tomlinson, *Xestoconcha kraciukae* Pojeta & Tomlinson, Ostracoda indet., nautiloid and gastropod molluscs indet., inarticulate brachiopod debris, orthoid brachiopod indet.
Assemblage - Assemblage 2

Locality - 85/3061
Loc. description - Ellery Creek, locality NT 252, about 480m above base of Pacoota Sandstone
Map sheet - Hermannsburg
Photo reference - HG R13/5028
Latitude - 24° 32' 15"
Longitude - 133° 05' 10"
Macrofossils - *Psilocephalina* sp. cf. *P. lubrica* Hsu, *Koraipsis* sp. cf. *K. taiziheensis* Kuo & Duan, *Apatokephalus* sp. cf. *A. hyotan* Kobayashi, *Colpantyx woolleyi* Pojeta & Tomlinson
Assemblage - Assemblage 2

Locality - 85/3062
Loc. description - Ellery Creek, locality NT 252 about 480m above base of Pacoota Sandstone
Map sheet - Hermannsburg
Photo reference - HG R13/5028
Latitude - 24° 32' 15"

Longitude - 133° 05' 10"
Macrofossils - *Kayseraspis*? *belli* sp. nov.
Assemblage - Assemblage 2

Locality - 85/3101
Loc. description - southwest Waterhouse Range sections HyR5-6, main creek section
Map sheet - Henbury
Photo reference - HEN R1/5181
Latitude - 24° 01' 04"
Longitude - 133° 21' 41"
Macrofossils - *Psilocephalina* sp. cf. *P. lubrica* Hsu, *Koraipsis* sp. cf. *K. taiziheensis* Kuo & Duan, *Hystricurus* sp. cf. *H. eurycephalus* Kobayashi, *Colpantyx woolleyi* Pojeta & Tomlinson, *Xestoconcha kraciukae* Pojeta & Tomlinson, nautiloid and gastropod molluscs indet., monoplacophoran indet.
Assemblage - Assemblage 2

Locality - 85/3102
Loc. description - southwest Waterhouse Range sections HyR5-6
Map sheet - Henbury
Photo reference - HEN R1/5181
Latitude - 24° 01' 41"
Longitude - 133° 21' 41"
Macrofossils - *Psilocephalina* sp. cf. *P. lubrica* Hsu, *Colpantyx woolleyi* Pojeta & Tomlinson, gastropod indet.
Assemblage - Assemblage 2

Locality - A1/26 (=Hy 250)
Loc. description - south flank Gardiner Range Anticline, approximately 19 km southeast of Areyonga
Map sheet - Henbury
Photo reference - HEN R3/5086
Latitude - 24° 09' 04"
Longitude - 132° 25' 25"
Macrofossils - *Hystricurus* sp. cf. *H. eurocephalus* Kobayashi, *Koraipsis* sp. cf. *K. taiziheensis* Kuo & Duan, *Psilocephalina* sp. cf. *lubrica* Hsu, nautiloid and pelecypod molluscs.
Assemblage - Assemblage 2

Locality - A4 (NT237)
Loc. description - 12 km southwest of Alice Springs on old Owen Springs Road at Pine Gap
Map sheet - Alice Springs
Photo reference - AS R13/5171
Latitude - 23° 48' 42"
Longitude - 133° 47' 00"
Macrofossils - see NT237A-C for faunal list.
Assemblage - Assemblage 2

Locality - As 009
Loc. description - 4.8 km south-southwest of Ross River Homestead
Map sheet - Alice Springs
Photo reference - AS R10/5094/521
Latitude - 23° 38' 02"
Longitude - 134° 28' 23"
Macrofossils - *Apatokephalus* sp. cf. *A.hyotan* Kobayashi, *Pacootella collativa* gen. et sp. nov., *Shumardia* sp. indet., ostracoda gen et sp. indet.
Assemblage - Assemblage 2

Locality - As 126
Loc. description - 16.1 km east-southeast of Jay Creek Aboriginal Settlement
Map sheet - Alice Springs
Photo reference - AS R14/5226/2023
Latitude - 23° 49' 30"
Longitude - 133° 38' 36"
Macrofossils - *Kayseraspis*? *belli* sp. nov.
Assemblage - Assemblage 2

Locality - As 127
Loc. description - 20.1 km east of Jay Creek Aboriginal Settlement
Map sheet - Alice Springs
Photo reference - AS R14/5225/2024
Latitude - 23° 49' 08"
Longitude - 133° 41' 45"
Macrofossils - *Kayseraspis*? *belli* sp. nov., *Asaphellus*? sp. indet. 1., bivalved molluscs indet.
Assemblage - Assemblage 2

Locality - As 128
Loc. description - 29 km southwest of Alice Springs
Map sheet - Alice Springs
Photo reference - AS R13/5170/2025
Latitude - 23° 48' 43"
Longitude - 133° 45' 32"
Macrofossils - *Asaphellus*? sp. indet. 1., *Technophorus nicolli* Pojeta et al.
Assemblage - Assemblage 2

Locality - As 231A-B
Loc. description - 4.8 km northeast of Williams Bore
Map sheet - Alice Springs
Photo reference - AS R11/5060/3760
Latitude - 23° 40' 15"
Longitude - 134° 18' 38"
Macrofossils - *Kayseraspis*? cf. *belli* sp. nov., *Asaphellus*? sp. indet. 1., bivalved molluscs indet.
Assemblage - Assemblage 2

Locality - As 257
Loc. description - N'Dhala Gorge, west of Ross River, east bank of creek
Map sheet - Alice Springs
Photo reference - AS R10/5094/3888
Latitude - 23° 38' 38"
Longitude - 134° 27' 47"
Macrofossils - *Hystricurus* sp. cf. *H. eurycephalus* Kobayashi , *Xestoconcha kraciukae* Pojeta & Tomlinson, gastropod mollusc indet., nautiloid mollusc indet., Ostracoda gen. et sp. indet., inarticulate brachiopod debris, *Cruziana* sp.
Assemblage - Assemblage 2

Locality - As 260
Loc. description - N'Dhala Gorge, west of Ross River, west slope of gorge
Map sheet - Alice Springs
Photo reference - AS R10/5094/3889
Latitude - 23° 52' 07"
Longitude - 134° 51' 40"
Macrofossils - *Kayseraspis? belli* sp. nov., *Apatokephalus* sp. cf. *A.hyotan* Kobayashi, *Hypseloconus* sp. indet., gastropoda spp. indet., *Technophorus nicolli* Pojeta et al.
Assemblage - Assemblage 2

Locality - As 262
Loc. description - N'Dhala Gorge, west of Ross River, west slope of gorge
Map sheet - Alice Springs
Photo reference - AS R10/5094
Latitude - 23° 38' 22"
Longitude - 134° 27' 58"
Macrofossils - *Kayseraspis? belli* sp. nov., Ichnofossil indet.
Assemblage - Assemblage 2

Locality - As 263
Loc. description - N'Dhala Gorge, west of Ross River, west slope of gorge
Map sheet - Alice Springs
Photo reference - AS R10/5094
Latitude - 23° 38' 22"
Longitude - 134° 27' 58"
Macrofossils - *Deceptryx?* sp. A., *Xestoconcha?* sp. indet., trilobite fragments indet.

Locality - As 264
Loc. description - N'Dhala Gorge, west of Ross River, west slope of gorge
Map sheet - Alice Springs
Photo reference - AS R10/5094
Latitude - 23° 38' 22"
Longitude - 134° 27' 58"
Macrofossils - *Kayseraspis? belli* sp. nov., bivalved mollusc indet., inarticulate brachiopod debris
Assemblage - Assemblage 2

Locality - As 265
Loc. description - N'Dhala Gorge, west of Ross River, west slope of gorge
Map sheet - Alice Springs
Photo reference - AS R10/5094
Latitude - 23° 38' 22"
Longitude - 134° 27' 58"
Macrofossils - *Asaphellus?* sp. indet. 1., *Kayseraspis? belli* sp. nov., *Colpantyx woolleyi* Pojeta & Tomlinson, *Xestoconcha kraciukae* Pojeta & Tomlinson
Assemblage - Assemblage 2

Locality - As 266
Loc. description - N'Dhala Gorge, west of Ross River, west slope of gorge
Map sheet - Alice Springs
Photo reference - AS R10/5094
Latitude - 23° 38' 22"
Longitude - 134° 27' 58"
Macrofossils - Rostroconch molluscs indet., trilobite fragments indet.
Assemblage - Assemblage 2

Locality - As 267
Loc. description - N'Dhala Gorge, west of Ross River, west slope of gorge
Map sheet - Alice Springs
Photo reference - AS R10/5094
Latitude - 23° 38' 22"
Longitude - 134° 27' 58"
Macrofossils - *Asaphellus?* sp. indet. 1.
Assemblage - Assemblage 2

Locality - As 304
Loc. description - Ross River, east bank, 7.5 km south of Ross River Chalet
Map sheet - Alice Springs
Photo reference - AS R10/5093/2325
Latitude - 23° 39' 51"
Longitude - 134° 29' 13"
Macrofossils - *Apatokephalus* sp. cf. *A. hyotan* Kobayashi
Assemblage - Assemblage 2

Locality - As 306
Loc. description - 1.6 km east of Williams Bore
Map sheet - Alice Springs
Photo reference - AS R11/5060/2327
Latitude - 23° 41' 15"
Longitude - 134° 17' 46"
Macrofossils - *Pacootella collativa* gen. et sp. nov., asaphid fragments indet.
Assemblage - Assemblage 2

Locality - AS 307
Loc. description - 1.6 km east of Williams Bore
Map sheet - Alice Springs
Photo reference - AS R11/5060/2328
Latitude - 23° 41' 15"
Longitude - 134° 17' 46"
Macrofossils - Asaphid fragments indet., *Xestoconcha*? sp. indet.
Assemblage - Assemblage 2

Locality - Hy 077
Loc. description - Gardiner Range, 8 km southeast of Areyonga
Map sheet - Henbury
Photo reference - HEN R3/5089
Latitude - 24° 08' 41"
Longitude - 132° 20' 58"
Macrofossils - *Hystricurus* sp. cf. *H. eurycephalus* Kobayashi, *Koraipsis* sp. cf. *K. taiziheensis* Kuo & Duan, gastropod molluscs indet.
Assemblage - Assemblage 2

Locality - Hy 079
Loc. description - Gardiner Range, 8 km south of Areyonga, section HyR4, 347m from base
Map sheet - Henbury
Photo reference - HEN R3/5090
Latitude - 24° 04' 30"
Longitude - 132° 15' 00"
Macrofossils - *Psilocephalina*? sp. indet.
Assemblage - Assemblage 2

Locality - Hy 080
Loc. description - Gardiner Range, 8 km south of Areyonga, section HyR4, 347m from base
Map sheet - Henbury
Photo reference - HEN R3/5090
Latitude - 24° 05' 30"
Longitude - 132° 15' 00"
Macrofossils - *Apatokephalus* sp. cf. *A. hyotan* Kobayashi, *Colpantyx woolleyi* Pojeta & Tomlinson, nautiloid mollusc indet., *Skolithos* sp.
Assemblage - Assemblage 2

Locality - Hy 081
Loc. description - Gardiner Range, 8 km south of Areyonga, section HyR4, 116m from top
Map sheet - Henbury
Photo reference - HEN R3/5090
Latitude - 24° 05' 30"
Longitude - 132° 15' 00"
Macrofossils - Asaphid trilobite fragments indet., nautiloid, bivalve, and gastropod molluscs spp. indet.
Assemblage - Assemblage 2

Locality - Hy 204
Loc. description - James Range 'A' Anticline, south flank, 6km east of Finke River, section HyC1
Map sheet - Henbury
Photo reference - HEN R4/5024/577
Latitude - 24° 10' 49"
Longitude - 132° 56' 43"
Macrofossils - Asaphid trilobite fragment indet., bivalved mollusc indet.
Assemblage - Assemblage 2

Locality - Hy 209
Loc. description - James Range 'A' Anticline, south flank, section HyC1
Map sheet - Henbury
Photo reference - HEN R4/5026
Latitude - 24° 11' 29"
Longitude - 132° 58' 34"
Macrofossils - *Psilocephalina* sp. cf. *P. lubrica* Hsu
Assemblage - Assemblage 2

Locality - Hy 210
Loc. description - James Range 'A' Anticline, south flank, section HyC1
Map sheet - Henbury
Photo reference - HEN R4/5026
Latitude - 24° 11' 29"
Longitude - 132° 58' 34"
Macrofossils - Asaphid trilobite fragements indet., pelecypod indet., inarticulate brachiopod.
Assemblage - Assemblage 2

Locality - Hy 211
Loc. description - James Range 'A' Anticline, south flank, section HyC1
Map sheet - Henbury
Photo reference - HEN R4/5026
Latitude - 24° 11' 29"
Longitude - 132° 58' 34"
Macrofossils - *Kayseraspis*? *belli* sp. nov., inarticulate brachiopod indet.
Assemblage - Assemblage 2

Locality - Hy 212
Loc. description - James Range 'A' Anticline, south flank, section HyC1
Map sheet - Henbury
Photo reference - HEN R4/5026
Latitude - 24° 11' 29"
Longitude - 132° 58' 34"
Macrofossils - Trilobite fragments indeterminate, *Leptembolon*? sp. indet.
Assemblage - Assemblage 2

Locality - Hy 233
Loc. description - Walker Pass, on track to old Tempe Downs Homestead, south limb of anticline
Map sheet - Henbury
Photo reference -
Latitude - 24° 20' 21"
Longitude - 132° 15' 03"
Macrofossils - *Psilocephalina* sp. cf. *P. lubrica* Hsu, *Hystricurus* sp. cf. *H. eurycephalus* Kobayashi, *Koraipsis* sp. cf. *K. taiziheensis* Kuo & Duan, rostroconch mollusc indet.
Assemblage - Assemblage 2

Locality - Hy 246
Loc. description - 3.2 km south of west end of Liddle Hills
Map sheet - Henbury
Photo reference - HEN R14a/5155
Latitude - 24° 52' 08"
Longitude - 132° 03' 40"
Macrofossils - Indeterminate trilobite debris.
Assemblage - Assemblage 2

Locality - Hy 260
Loc. description - James Range 'A' Anticline, east end of Merrick Gully
Map sheet - Henbury
Photo reference - HEN R3/5072
Latitude - 24° 08' 58"
Longitude - 132° 58' 00"
Macrofossils - *Psilocephalina* sp. cf. *P. lubrica* Hsu, *Technophorus walteri* Pojeta et al., nautiloid, bivalve and gastropod molluscs spp. indet.
Assemblage - Assemblage 2

Locality - Hy 268
Loc. description - south flank of Waterhouse Range, section HyR5, 315m above base of mapped Pacoota Sandstone
Map sheet - Henbury
Photo reference - HEN R1/5188
Latitude - 24° 01' 04"
Longitude - 133° 21' 41"
Macrofossils - *Asaphellus*? sp. indet. 1., *Xestoconcha kraciukae* Pojeta & Tomlinson
Assemblage - Assemblage 2

Locality - Hy 269
Loc. description - south flank of Waterhouse Range, section HyR5, 363m above base of mapped Pacoota Sandstone
Map sheet - Henbury
Photo reference - HEN R1/5188
Latitude - 24° 01' 04"
Longitude - 133° 21' 41"
Macrofossils - *Psilocephalina* sp. cf. *P. lubrica* Hsu, *Hystricurus* sp. cf. *H. eurycephalus* Kobayashi, *Technophorus walteri* Pojeta et al., *Colpantyx woolleyi* Pojeta & Tomlinson, *Xestoconcha kraciukae* Pojeta & Tomlinson, nautiloid and gastropod molluscs indet.
Assemblage - Assemblage 2

Locality - LA 036
Loc. description - Parana Hill Anticline, south limb.
Map sheet - Lake Amadeus
Photo reference - LA R7/5155
Latitude - 24° 24' 50"
Longitude - 131° 59' 50"
Macrofossils - *Koraipsis* sp. cf. *K. taiziheensis* Kuo & Duan, *Hystricurus* sp. cf. *H. eurycephalus* Kobayashi, inarticulate brachiopod indet.
Assemblage - Assemblage 2

Locality - ML 004
Loc. description - Southern scarp of Idirriki Range
Map sheet - Mt. Liebig
Photo reference - ML R11/5072/6
Latitude - 23° 38' 53"
Longitude - 131° 40' 35"
Macrofossils - *Asaphellus*? sp. indet. 1., *Kayseraspis*? *belli* sp. nov.
Assemblage - Assemblage 2

Locality - ML 151
Loc. description - Gardiner Range, section MLR7b
Map sheet - Mt. Liebig
Photo reference - ML R15/5232
Latitude - 23° 56' 20"
Longitude - 131° 57' 50"
Macrofossils - *Pharcidoconcha raupi* Pojeta & Tomlinson, asaphid trilobite fragments indet.
Assemblage - Assemblage 2

Locality - ML 152
Loc. description - Gardiner Range, section MLR7
Map sheet - Mt. Liebig
Photo reference - ML R15/5232
Latitude - 23° 56' 20"
Longitude - 131° 57' 50"
Macrofossils - Asaphid trilobite fragments indet., articulate brachiopod indet.
Assemblage - Assemblage 2

Locality - NT 194
Loc. description - Ross River area 8 km south-southwest of Old Loves Creek Homestead
Map sheet - Alice Springs
Photo reference - ASR10/5093
Latitude - 23° 39' 50"
Longitude - 134° 28' 30"
Macrofossils - *Kayseraspis? belli* sp. nov., *Xestoconcha kraciukae* Pojeta & Tomlinson, inarticulate brachiopod debris
Assemblage - Assemblage 2

Locality - NT 195
Loc. description - creek bed, Ross River area, 8 km south-southwest of Old Loves Creek Homestead.
Map sheet - Alice Springs
Photo reference - AS R10/5093
Latitude - 23° 39' 30"
Longitude - 134° 29' 20"
Macrofossils - *Psilocephalina* sp. cf. *P. lubrica* Hsu, *Asaphellus*? species indet. 1., *Xestoconcha krackiukae* Pojeta & Tomlinson, *Technophorus nicolli* Pojeta et al., ?*Ribeiria* sp. indet.
Assemblage - Assemblage 2

Locality - NT 237A
Loc. description - 12 km southwest of Alice Springs on old Owen Springs Road at Pine Gap
Map sheet - Alice Springs
Photo reference - AS R13/5171
Latitude - 23° 48' 42"
Longitude - 133° 47' 00"
Macrofossils - *Psilocephalina* sp. cf. *P. lubrica* Hsu, *Technophorus walteri* Pojeta et al., *Colpantyx woolleyi* Pojeta & Tomlinson, monoplacophoran mollusc indet., nautiloid mollusc indet.
Assemblage - Assemblage 2

Locality - NT 237B
Loc. description - 12 km southwest of Alice Springs on old Owen Springs Road at Pine Gap
Map sheet - Alice Springs
Photo reference - AS R13/5171
Latitude - 23° 48' 42"
Longitude - 133° 47' 00"
Macrofossils - *Psilocephalina* sp. cf. *P. lubrica* Hsu, *Technophorus walteri* Pojeta et al., *Colpantyx woolleyi* Pojeta & Tomlinson, *Xestoconcha kraciukae* Pojeta & Tomlinson, inarticulate brachiopod indet., monoplacophoran mollusc indet., nautiloid mollusc indet.
Assemblage - Assemblage 2

Locality - NT 237C
Loc. description - 12 km southwest of Alice Springs on old Owen Springs Road at Pine Gap
Map sheet - Alice Springs
Photo reference - AS R13/5171
Latitude - 23° 48' 42"
Longitude - 133° 47' 00"
Macrofossils - *Psilocephalina* sp. cf. *P. lubrica* Hsu, *Apatokephalus* sp. cf. *A. hyotan Kobayashi, Koraipsis* sp. cf. *K. taiziheensis* Kuo & Duan, *Technophorus walteri* Pojeta et al., *Pinnocaris* sp. indet., *Colpantyx woolleyi* Pojeta & Tomlinson, *Xestoconcha kraciukae* Pojeta & Tomlinson, ?*Euconia* sp. indet.
Assemblage - Assemblage 2

Locality - NT 252
Loc. description - Ellery Creek, ca. 40 km northeast Hermannsburg Mission, 480m above base of Pacoota Sandstone
Map sheet - Hermannsburg
Photo reference - HG R13/5028
Latitude - 23° 49' 15"
Longitude - 133° 04' 30"
Macrofossils - *Psilocephalina* sp. cf. *P. lubrica* Hsu, *Koraipsis* sp. cf. *K. taiziheensis* Kuo & Duan, *Apatokephalus* sp. cf. *A. hyotan* Kobayashi, *Colpantyx woolleyi* Pojeta & Tomlinson, inarticulate brachiopods indet., *Xestoconcha kraciukae* Pojeta & Tomlinson
Assemblage - Assemblage 2

Locality - NT 255
Loc. description - Parkes Pass south of Running Water Yard
Map sheet - Henbury
Photo reference - HEN R6/5097
Latitude - 24° 21' 30"
Longitude - 132° 59' 30"
Macrofossils - *Colpantyx woolleyi* Pojeta & Tomlinson, *Xestoconcha kraciukae* Pojeta & Tomlinson, gastropod mollusc indet., trilobite fragments indet.
Assemblage - Assemblage 2

Locality - NT 331
Loc. description - Native Pine Gap section, 278.5m above base
Map sheet - Alice Springs
Photo reference - AS R13/5171
Latitude - 23° 48' 00"
Longitude - 133° 46' 20"
Macrofossils - *Asaphellus*? species indet. 1.
Assemblage - Assemblage 2

Locality - NT 332
Loc. description - Native Pine Gap section, 285m above base
Map sheet - Alice Springs
Photo reference - AS R13/5171
Latitude - 23° 48' 30"
Longitude - 133° 46' 20"
Macrofossils - *Asaphellus* sp. indet., *Xestoconcha* sp. indet.
Assemblage - Assemblage 2

Locality - NT 333
Loc. description - Native Pine Gap section, 291.5m above base
Map sheet - Alice Springs
Photo reference - AS R13/5171
Latitude - 23° 48' 30"
Longitude - 133° 46' 20"
Macrofossils - *Kayseraspis? belli* sp. nov., *Asaphellus* sp. indet., *Technophorus* sp. indet., bivalved mollusc indet.
Assemblage - Assemblage 2

Locality - NT 335
Loc. description - Native Pine Gap section, 381m above base
Map sheet - Alice Springs
Photo reference - AS R13/5171
Latitude - 23° 48' 30"
Longitude - 133° 46' 20"
Macrofossils - *Psilocephalina* sp. cf. *P. lubrica* Hsu, asaphid indet., *Technophorus walteri* Pojeta et al., *Colpantyx woolleyi* Pojeta & Tomlinson
Assemblage - Assemblage 2

Locality - NT 609
Loc. description - Native Pine Gap, east of main section line
Map sheet - Alice Springs
Photo reference - AS R13/5171
Latitude - 23° 48' 30"
Longitude - 133° 47' 20"
Macrofossils - *Psilocephalina* sp. cf. *P. lubrica* Hsu, *Colpantyx woolleyi* Pojeta & Tomlinson, *Xestoconcha kraciukae* Pojeta & Tomlinson, *Hyselonconus*? sp. indet.
Assemblage - Assemblage 2

Locality - NT 615
Loc. description - Ellery Creek, left bank, 605m above base Pacoota Sandstone
Map sheet - Hermannsburg
Photo reference - HG R13/5028
Latitude - 23° 49' 20"
Longitude - 133° 03' 30"
Macrofossils - *Pharcidoconcha raupi* Pojeta & Tomlinson, *Leptembolon* sp. indet., *Skolithos* sp., gastropod mollusc indet., *Diplocraterion* sp., *Crytodonta*? sp. indet.
Assemblage - Assemblage 2

Locality - NT 617
Loc. description - Ellery Creek, left bank, 75m above base Pacoota Sandstone
Map sheet - Hermannsburg
Photo reference - HG R13/5028
Latitude - 23° 49' 20"
Longitude - 133° 03' 30"
Macrofossils - *Colpantyx woolleyi* Pojeta & Tomlinson, *Psilocephalina* sp. cf. *P. lubrica* Hsu, asaphid trilobite fragments, nautiloid mollusc indet., gastropod mollusc indet.
Assemblage - Assemblage 2

Locality - NT 619
Loc. description - Ellery Creek area, right hand tributary valley
Map sheet - Hermannsburg
Photo reference - HG R13/5028
Latitude - 23° 49' 15"
Longitude - 133° 04' 30"
Macrofossils - *Psilocephalina* sp. cf. *P. lubrica* Hsu, *Kayseraspis? belli* sp. nov., bivalved molluscs indet.
Assemblage - Assemblage 2

Locality - NT 650
Loc. description - Waterhouse Range, north flank, Hugh River (west bank)
Map sheet - Hermannsburg
Photo reference -
Latitude - 23° 58' 40"
Longitude - 133° 26' 50"
Macrofossils - Gastropod mollusc indet., inarticulate brachiopod debris, indet. trilobite fragments.
Assemblage - Assemblage 2

Locality - Rd 189
Loc. description - 1.6 km northwest of Nomera Bore, Mt. Peachy Range, section RdC-7
Map sheet - Rodinga
Photo reference - RD R7/5156
Latitude - 24° 21' 30"
Longitude - 133° 36' 30"
Macrofossils - *Leptembolon* sp. indet., inarticulate brachiopod debris, *Pinnocaris* sp. indet., *Colpantyx woolleyi* Pojeta & Tomlinson, *Xestoconch kraciukae* Pojeta & Tomlinson, gastropod mollusc indet.
Assemblage - Assemblage 2

Locality - Rd 202
Loc. description - north of Mt. Peachy, section

RdC-8
Map sheet - Rodinga
Photo reference - RD R7/5149
Latitude - 24° 23' 20"
Longitude - 133° 51' 03"
Macrofossils - *Psilocephalina* sp. cf. *P. lubrica* Hsu, *Ctenodonta*? sp. indet., *Ribeiria*? sp. indet., Gastropoda spp. indet.
Assemblage - Assemblage 2

Locality - NT 231
Loc. description - Gardiner Range, same as Hy 079
Map sheet - Henbury
Photo reference - HEN R3/5091
Latitude - 24° 05' 30"
Longitude - 132° 15' 00"
Macrofossils - *Psilocephalina* sp. cf. *P. lubrica* Hsu, *Koraipsis* sp. cf. *K. taiziheensis* Kuo & Duan, *Leptembolon* sp. indet.
Assemblage - Assemblage 2

Locality - 87/007
Loc. description - Ellery Creek section, approx. 40 km northeast Hermannsburg Mission, float from interval 305-465m.
Map sheet - Hermannsburg
Photo reference - HG R13/5028
Latitude - 23° 49' 15"
Longitude - 133° 04' 30"
Macrofossils - Undeterminate trilobites
Assemblage - Assemblage 2?

Locality - A2/A3 (NT236)
Loc. description - Old Owen Springs Road at Pine Gap
Map sheet - Alice Springs
Photo reference - AS R13/5170
Latitude - 23° 48' 36"
Longitude - 133° 43' 30"
Macrofossils - *Leptembolon* sp. indet.
Assemblage - Assemblage 2?

Locality - Hy 286
Loc. description - Near The Sisters, 4 km SW of Horse Camp Waterhole
Map sheet - Henbury
Photo reference - HEN R11/5072
Latitude - 24° 42' 13"
Longitude - 133° 22' 33"
Macrofossils - *Skolithos* sp.
Assemblage - Assemblage 2?

Locality - Rd 187
Loc. description - 1.6 km northwest of Nomera Bore, Mt. Peachy Range, section RdC-7
Map sheet - Rodinga
Photo reference - RD R7/5156
Latitude - 24° 21' 30"
Longitude - 133° 36' 30"
Macrofossils - *Leptembolon* sp. indet., indeterminate trilobite debris
Assemblage - Assemblage 2?

ASSEMBLAGE 3

Locality - ML 018
Loc. description - Hills south of Deering Creek
Map sheet - Mt. Liebig
Photo reference - ML R12/5090/46
Latitude - 23° 43' 16"
Longitude - 131° 44' 30"
Macrofossils - *Asaphellus*? sp. indet. 2., *Kayseraspis*? *belli* sp. nov., *Leptembolon*? sp. indet., bivalved mollusc indet.
Assemblage - Assemblage 3

Locality - ML 030A
Loc. description - Hills south of Deering Creek, section MLW5
Map sheet - Mt. Liebig
Photo reference - ML R12/5090
Latitude - 23° 44' 15"
Longitude - 131° 44' 30"
Macrofossils - *Asaphellus*? sp. indet. 2., orthoid brachiopod indet., aff. *Palaearca watti* (Tate)
Assemblage - Assemblage 3

Locality - ML 030E
Loc. description - Hills south of Deering Creek, section MLW 5
Map sheet - Mt. Liebig
Photo reference - ML R12/5090
Latitude - 23° 44' 15"
Longitude - 131° 44' 30"
Macrofossils - *Asaphellus*? sp. indet. 2., bivalved mollusc indet.
Assemblage - Assemblage 3

Locality - NT 614
Loc. description - Ellery Creek, left bank, about 690m above base Pacoota Sandstone
Map sheet - Hermannsburg
Photo reference - HG R13/5028
Latitude - 23° 49' 20"
Longitude - 133° 03' 30"
Macrofossils - *Asaphellus*? sp. indet. 2, Strophomenoid brachiopod indet., gastropod mollusc indet., bivalved mollusc indet.
Assemblage - Assemblage 3