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# Reassessment of agnostids and trilobites from the lower Wagonga Group (Furongian), the oldest fossils in the eastern Lachlan Orogen, N.S.W., and their significance

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## ABSTRACT

Reassessment of the agnostid and trilobite assemblages originally figured by Bischoff and Prendergast (1987) from the lowest Wagonga Group (herein informally named the “lower formation”), allows for a more precise interpretation of the unit’s age which was previously assigned a very approximate range of “Middle” to “Late” Cambrian. The presence of *Micragnostus* (=*Innitagnostus*) cf. *medius* (Shergold, 1980), *Onchonotellus* cf. *kuruktagensis* (Zhang, 1981), *Wuhuia* aff. *silex* Shergold, 1980 and an indeterminate species of *Pseudorhaptagnostus* Lermontova, 1951, correlate with early Iverian assemblages in the Georgina Basin, Queensland, and early Jiangshanian taxa in South China (between the *Wentsuia iota-Rhaptagnostus apsis* to *Peichiashania secunda-Prochuangia glabella* trilobite assemblage zones of Australia). The paraconodonts *Westergaardodina bohlini* Müller, 1959 and *Westergaardodina kleva* Müller, 1959 further support a Jiangshanian age.

The consistent faunal composition across all limestone olistoliths and beds suggests a penecontemporaneous origin, contradicting previous interpretations that the limestones resulted from prolonged erosion of an older carbonate platform. Instead, we propose a dynamic depositional environment on the flanks of a volcanic seamount, with limestone blocks transported via debris flows during volcanic events, analogous to modern deep-sea sedimentation processes. Faunal similarities with the Australian craton suggest proximity of this seamount to the eastern Gondwana margin during the Cambrian.

## INTRODUCTION

Cambrian fossils within the Lachlan Orogen represent rare discoveries that provide critical insights into the early development of eastern Australia. These fossils occur in two distinct depositional settings: the shallow marine sediments along the Heathcote and Governor Fault zones of Victoria (Brock and Talent 1999; Paterson and Laurie 2004; Jell 2014), and the deep water cherts of the Albury–Bega and Narooma accretionary complexes spanning New South Wales and Victoria (Stewart and Fergusson 1988;

Stewart and Glen 1991; Glen *et al*. 2004; Kakuwa and Webb 2010; Percival *et al*. 2011; Zhen and Rutledge 2021).

The oldest known Cambrian fossils in the eastern Lachlan Orogen are confined to a single locality at Burrewarra Point, south of Batemans Bay. These fossils occur within isolated limestone olistoliths and potentially parautochthonous limestone beds associated with the Wagonga Group, a complex suite of highly deformed sedimentary and volcanic rocks exposed along the New South Wales southern coastline between Batemans Bay and Narooma (Fig. 1). Previous biostratigraphic assessments by Bischoff and Prendergast (1987) broadly constrained these rocks to the "Middle" or "Late" Cambrian based primarily on paraconodonts and organophosphatic brachiopods. Despite their importance for age determination, the cooccurring agnostid arthropod and trilobite fauna were inadequately documented, with only 12 specimens figured, nine of which were assigned to a single indeterminate catillicephalid species. The recent rediscovery of both published and unpublished material from Bischoff and Prendergast's (1987) collection at Macquarie University (now housed in the Australian Museum) has enabled a comprehensive reexamination and taxonomic reassessment of these specimens. Given that agnostid arthropods and trilobites constitute the primary biostratigraphic indices for "Middle" to "Late" Cambrian successions across Australia (Shergold 1995), this reassessment provides critical new constraints on the depositional age of the limestone components within the Wagonga Group and enhances our understanding of the early tectonic evolution of the eastern Lachlan Orogen.

**Nomenclatural history of the fossil bearing succession**

The Wagonga Group, as originally defined near Narooma and Batemans Bay, comprises three lithologically distinct units arranged in stratigraphic succession: the Kianga Basalt (basal), Narooma Chert (middle), and Bogolo Formation (top) (Lewis *et al*. 1994). The Kianga Basalt was named by Glen (in Lewis *et al*. 1994) to describe a mafic, volcanic-rich unit considered to underlie the Narooma Chert, with a type locality designated along the road from Kianga to the Princes

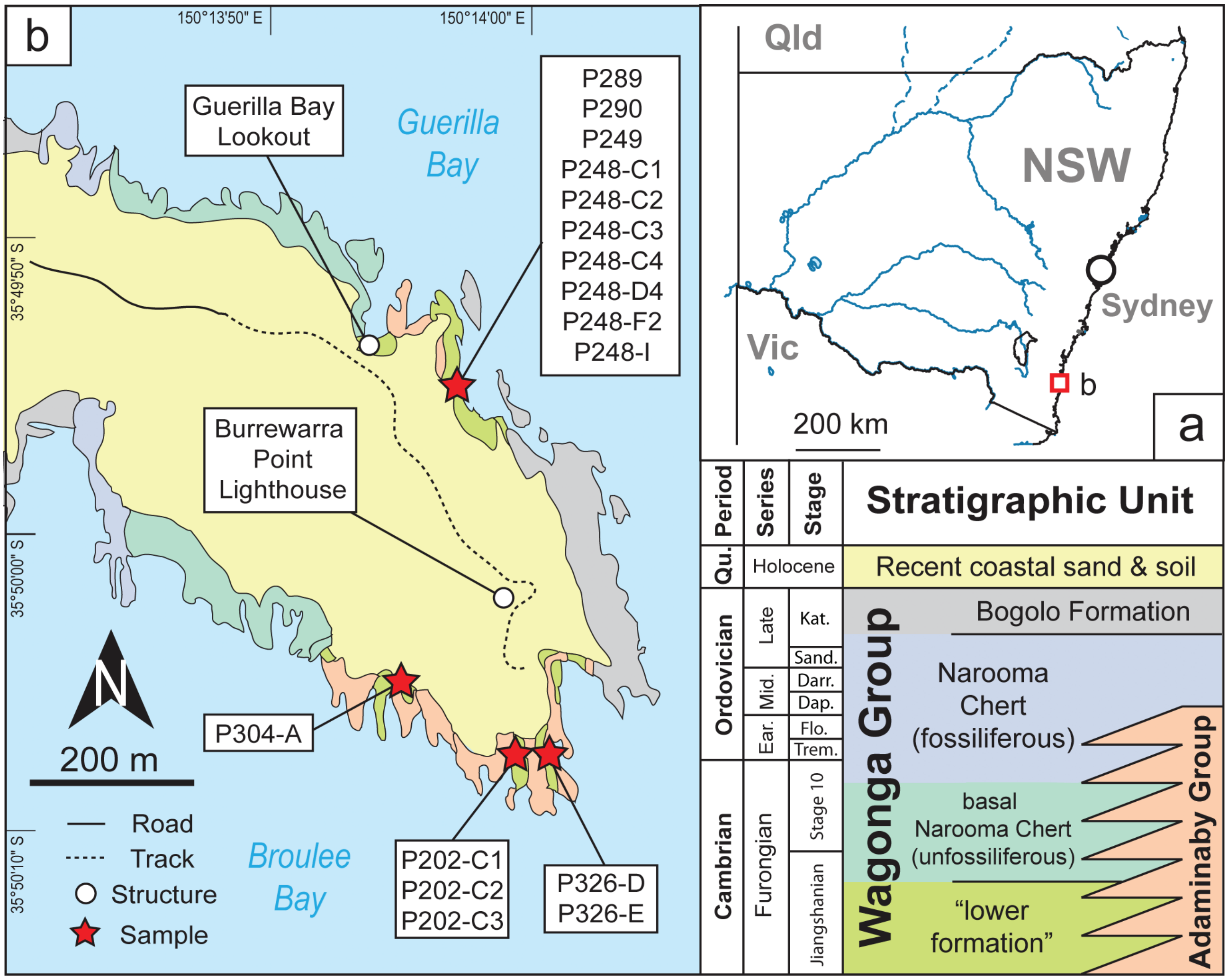



**Figure 1. Geography, geology, and regional stratigraphy of the lower formation of the Wagonga Group at Burrewarra Point, south of Batemans Bay. a, map of New South Wales showing the location of Burrewarra Point, (red square highlighting area shown in b). b, on the left, a simplified geological map of Burrewarra Point (modified from Fergusson 2025) with Bischoff and Prendergast's (1987) fossiliferous sample localities indicated by red stars; on the right, simplified stratigraphy at Burrewarra Point with periods, series and global stages shown on the left-hand side of the column. Abbreviations used: Ear. = Early, Mid. = Middle, Trem. = Tremadocian, Flo. = Floian, Dap. = Dapingian, Darr. = Darriwilian, Sand. = Sandbian, Kat. =Katian.**

Highway (36°11'58.0"S 150°07'30.8"E to 36°12'04.9"S 150°07'15.1"E). However, the definition of the Kianga Basalt suffered from shortcomings that undermined its stratigraphic validity. Glen's lithological descriptions were based on exposures at Surf Beach (Narooma) rather than the type locality, where lithology and contact relationships were not adequately documented. Moreover, the proposed "Middle" to "Late" Cambrian age was not established from within the unit itself, but inferred from fossils in adjacent or distant exposures; such as "Late" Cambrian fossils at the base of the Narooma Chert (Stewart and Glen 1991) and presumed "Middle" to "Late" Cambrian fossils in limestone clasts within basaltic breccias at Burrewarra Point, 45 km to the north (Bischoff and Prendergast 1987, and herein). Subsequent field mapping and further investigations of their contact relationships in the type area southwest of Kianga convinced Glen *et al.* (2004) to treat the Kianga Basalt as part of the Bogolo Formation rather than as a separate unit. This revision was subsequently accepted by the Australian Stratigraphy Commission (2025) and is reflected in the Seamless Geological Maps of the Geological Survey of New South Wales (Colquhoun *et al*. 2024).

Fergusson (2025) recently attempted to revive the Kianga Basalt as a separate unit, by re-interpreting the geology and structure of the type area on the northwestern side of Wagonga Inlet and redefined it as consisting of "altered massive and pillowed basalt in addition to basaltic breccias". This reinterpretation is partly supported by geochemical affinities of the basalt components (Packham and Hubble 2016) and apparent stratigraphic continuity with the overlying basal Narooma Chert (Glen *et al*. 2004; Stokes *et al*. 2015; Fergusson 2025). This relationship suggests that the volcanic and volcaniclastic facies were deposited contemporaneously and are genetically linked to the earliest phases of the Wagonga Group, similar to the original concept proposed for the Kianga Basalt (Glen in Lewis *et al*. 1994). This volcanic and volcaniclastic unit shows substantial lithological variability that likely reflects lateral changes in depositional environment and volcanic facies over the unit's lateral extent. For instance, at Melville Point the succession is dominated by greenstone informally termed the "Tomakin basalt" (Packham and Hubble 2016), whereas at Burrewarra Point the sequence is more heterogeneous, including interbedded basaltic

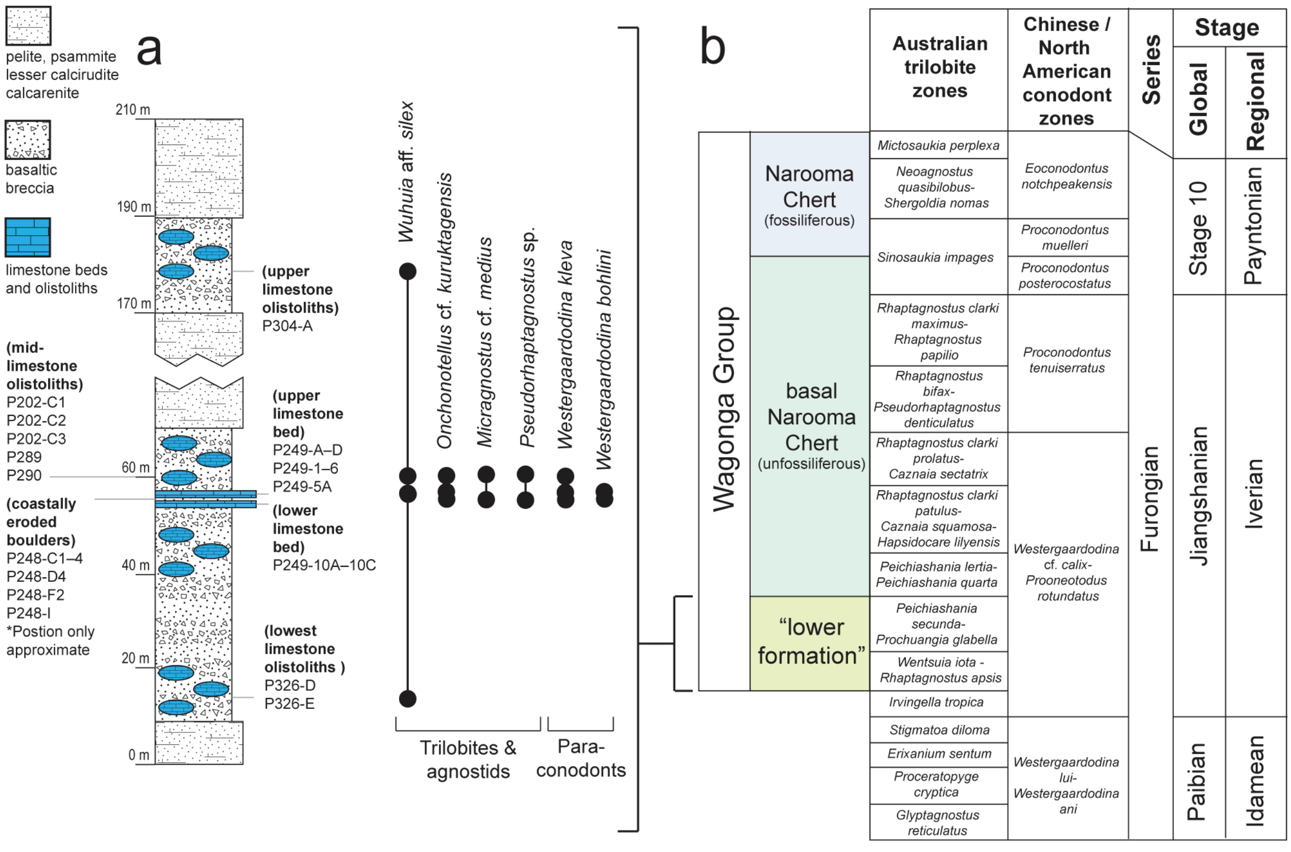



**Figure 2. a, generalised lithostratigraphy for the limestone olistoliths and limestone beds in lower formation of the Wagonga Group at Burrewarra Point figured against the agnostid, trilobite and paraconodont ranges. Meterage based on measurements taken along the coastal platform exposed on the northern headland, and those of Bischoff and Prendergast (1987). Measurements on the left side of the section are in metres (apparent thickness) from the base of unit. Solid circles represent the occurrences of taxa within the olistoliths and limestone beds presented in this study. Solid lines represent the assumed stratigraphic ranges given the data presented here. Ranges of all taxa from spot localities (particularly those of the coastally eroded boulders) are only approximate, and have been inferred using lithological, faunal and geographical information. b. Regional Furongian ("Late" Cambrian) stratigraphy of the Wagonga Group showing biostratigraphic position of the lower formation (as figured in a) and overlying Narooma Chert plotted against their respective Australian trilobite and Chinese/North American conodont biozones. Global and local stages shown on the right-hand side of the column (zone correlation based on Peng *et al*. 2012, 2020).**

breccia, fossiliferous limestone, calcarenite, calcirudite, and olistoliths—variously referred to as the “Burrewarra Point Formation” (Frikken 1997) or “Batemans Bay basalts” (Packham and Hubble 2016).

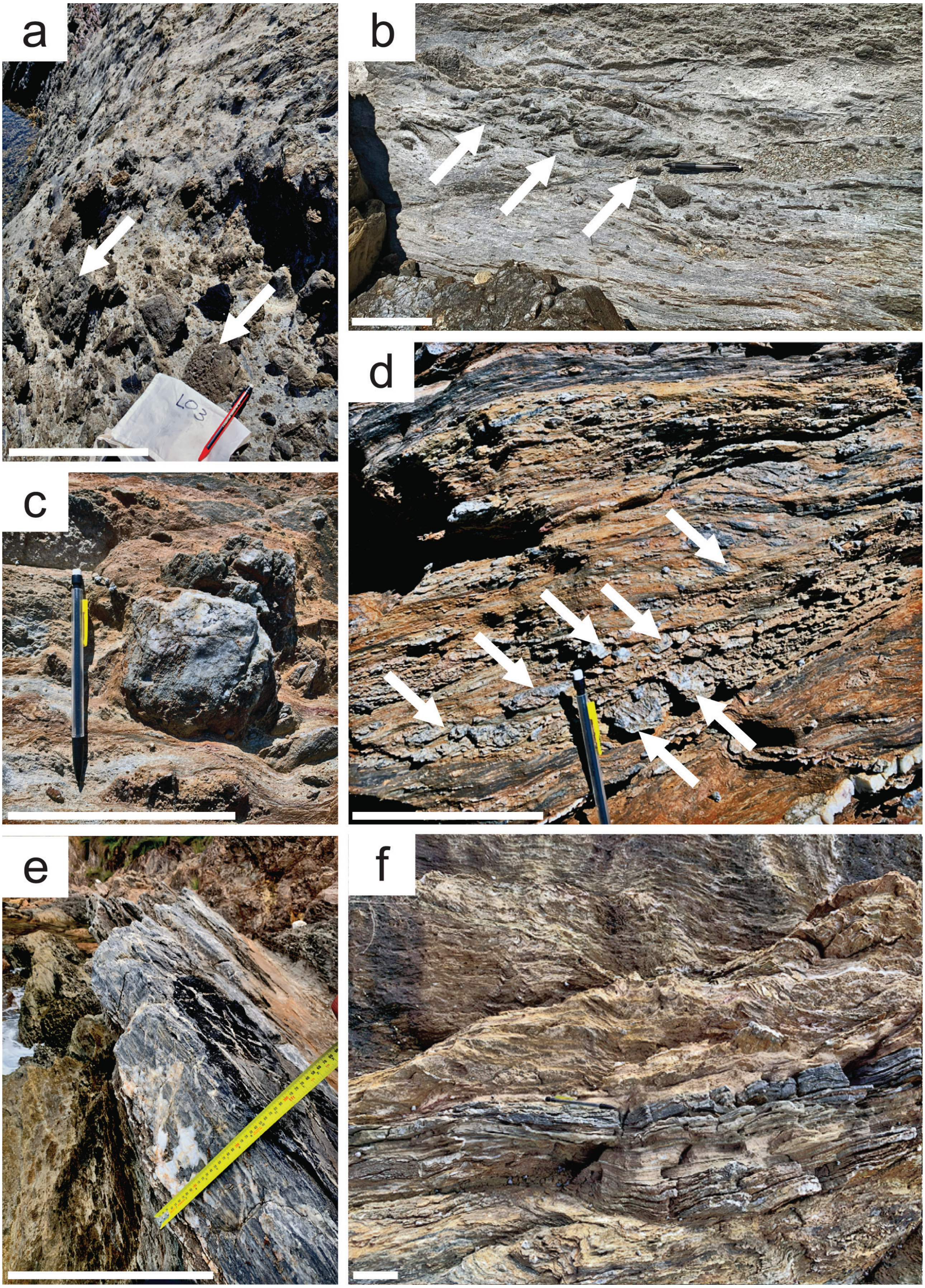
Despite these efforts to correlate lithologies across the region, the Kianga Basalt *sensu stricto* remains poorly constrained at its type locality, where diagnostic features and unambiguous contact relationships are lacking. Given these uncertainties, attempts to correlate the type Kianga Basalt with the fossiliferous interval examined herein at Burrewarra Point may inadvertently exacerbate stratigraphic confusion rather than clarify it. Hence, we consider the reinstatement of the Kianga Basalt as a named stratigraphic unit premature. Instead, we assign the lowermost volcanic succession within the Wagonga Group to an informal “lower formation”, which is justified on both lithostratigraphic and genetic grounds. This approach recognizes the reality of an extensive volcanic and volcanoclastic sequences at the base of the group while avoiding the inconsistencies and ambiguities associated with the legacy of the Kianga Basalt. This “lower formation” represents deposition associated with a major volcanic episode in the region before the deposition of the turbiditic succession that is accommodated into the Narooma Chert. Within this informal “lower formation”, there are several types of dominant lithologies representing different facies spread spatially away from eruption centre (or centres), which may represent discrete members of the unit which will be defined in later studies.

### Geological context and locality

Four well-exposed sections (Fig. 1) were examined on the north and south sides of Burrewarra Point (35°49’51.7”S 150°13’55.7”E to 35°50’09.4”S 150°13’60.0”E; 3.5 km southeast of Tomakin). The northern exposure of basaltic breccia is the largest of these, being up to 80 m thick and also intercalated with calcarenite, calcirudite and fossil bearing limestone beds. The 210 m lithostratigraphic section in Fig. 2a is a generalised composite of the four sections, and was discussed in detail by Bischoff and Prendergast (1987), hence only an updated summary is provided here. At the northern and southern sides of the headland, the unit is interbedded with sandstones of the Adaminaby Group. The latter were originally lumped into the Wagonga Group by Bischoff and Prendergast (1987). However, mapping by Fergusson and Frikken (2003, fig. 5a), demonstrated yellow-brown coloured, quartzose sandstone (more typical of the Adaminaby Group) occurred together with darker orange, grey and black pelites and psammites of the lowest Wagonga Group in distinct bands. Intercalation of the two groups occur at several locations south of Batemans Bay, such as around Melville Point (Fergusson and Frikken 2003; Fergusson 2025). The Bogolo Formation is faulted against the lower formation of the Wagonga Group towards the east at Burrewarra Point as part of an east-west trending thrust repeated sequence, which dips west-south-west at approximately 44° to 67° (Fergusson and Frikken 2003; Fergusson 2025). Slumping of the original sediment in the lower formation of the Wagonga Group and mild tectonic forcing has caused low-grade metamorphism which shows distinct foliation along a north-south trend.

The basal beds of the lower formation of the Wagonga Group consist psammite, calcarenite, calcirudite, and pelite followed by a thicker sequence of a polymict (primarily basalt and limestone), epiclastic breccia in a orange-brown-black psammite and pelite matrix with a few moderate (up to 2 m thick) interbeds of calcarenite and calcirudite (Figs 2a, 3a, b). Samples P326-D and P326-E were collected from olistoliths in these horizons on the southern side of the headland. Basalt fragments at this level are highly altered and often contain vesicles with circular trails, suggestive of a pillow-basalt origin and shallow-water eruptions (Bischoff and Prendergast 1987; Fergusson 2025). This is also supported by their geochemical affinities which suggest these fragments derived from ocean island basalts (Prendergast and Offler 2012). These beds are presumed continuous between the northern and southern sides of the headland and are approximately 60 m thick when measured on the wave platforms (the actual stratigraphic thickness is difficult to precisely gauge due to the intense folding). Stratigraphically overlying are two distinct lensoidal beds of limestone (extending to 0.5 metres in thickness, and approximately 1 m apart stratigraphically) (Fig. 2a, 3e). Fourteen samples through these beds, P249-A–D, P249-1–6, P249-5A and P249-10A–10C were collected from the northern side of the headland. Either side of these beds are calcirudites, calacarenites, psammites and pelites densely packed with smaller limestone olistoliths (Fig. 2a, 3d). The individual limestone olistoliths range between 1

**Figure 3. Photos showing field exposures of the lower formation of the Wagonga Group on the northern side of Burrewarra Point; a, polymict, lithic fragmental breccia, epiclastic with dominant angular clasts of basalt (vesicular examples with white arrows), minor limestone, psammites and pelites. Majority of clasts in foreground between 1 – 10cm long. These beds are towards the basal portion of the stratigraphic sequence of Fig. 3 (35°49'56.3"S 150°14'0.2"E). b, cross section of volcanoclastic, polymict breccia showing alignment of clasts along bedding planes (white arrows), and slight imbrication (35°49'52.2"S 150°13'56.3"E). c, limestone clast (11 cm long x 2 cm thick) grey, partially recrystallised, flattened parallel to bedding. Host rock comprises pelites, psammites and calcarenites. Clast from the middle olistolith-bearing unit of Fig. 3 (35°49'52.1"S 150° 13'56.2"E). d, abundant light grey limestone clasts and discontinuous, parallel limestone beds (<10 mm thick, indicated by white arrows). These are predominantly in orange to brown sediments that range from pelites, psammites, calcarenites and calcirudites. Some dark grey, finely laminated pelite also obvious. White, secondary, fracture fill quartz veins present in lower right corner (35°49'52.2"S 150°13'56.3"E). e, upper limestone bed viewed from the southeast, up to 30 cm thick, interbedded with pelites, psammites, calcarenites and calcirudites. Traced for ~19 m along strike. Immediately overlain by reddish-brown-orange calcarenite (35°49'54.4"S 150°13'57.1"E). f, limestone lenses and discontinuous beds viewed from the west, up to 6 cm thick, folded, interbedded with calcarenites, psammites and pelites, upper part of limestone-bearing unit (35°49'55.1"S 150°13'57.2"E). All scale bars 20 cm.**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to 30 cm in diameter and are sub-angular to sub-rounded (Fig. 2a, 3c). Samples P202-C1, P202-C2, P202-C3 were collected from these olistoliths on the southern side, as well as P289 and P290 from the northern side. Isolated coastally eroded boulders on the wave platform (containing olistoliths) which originated from near this horizons were also collected on the northern side in samples P248-C1–4, P248-D4, P248-F2, P248-I. Overlying these are the uppermost beds which consist of 20–30 m of psammites, pelites, and calcarenite (Fig. 2a, 3f) with minor polymict breccia similar to the lower beds. Limestone olistoliths from these upper beds are only common in the highest stratigraphic horizons and were collected in sample P304-A from the southern side of Burrewarra Point. Above are a series of calcarenites, calcirudites, psammites and pelites which lack olistoliths but contain basalt breccia, followed by well-bedded siltstones representing a transition away from the volcanically derived lower formation into the unfossiliferous siltstones of the basal Narooma Chert.

**Revised age**

Bischoff and Prendergast (1987) assigned several different ages, ranging from "Middle" to "Late" Cambrian to the various olistoliths and limestone beds collected from Burrewarra Point. The oldest of these was thought to be P202-Cl (Fig. 2a), which they identified as being "Middle" to "late Middle" Cambrian based on the occurrence of the mollusc-like *Costipelagiella* sp. (similar to *Costipelagiella* sp. cf. *C. zazvorkai* Horný, 1964 of Mackinnon 1985) and the acrotretoid brachiopod *Aphelotreta minuta* Rowell, 1980. Slightly younger was apparently P290 (Fig. 2a), which was assigned a "Middle" or possibly "early Late" Cambrian age based on the presence of the acrotretoid brachiopod *Treptotreta jucunda* Henderson and MacKinnon, 1981. The youngest identifiable fossil bearing olistoliths (P202-C3, P248-C1, P248-C2, P248-C3, and P248-C4) and beds (P249-A–D, P249-1–6, P249-5A and P249-10A–10C) (Fig. 2a) were all broadly assigned a "Late" Cambrian age based on the paraconodonts *Westergaardodina kleva*, *Westergaardodina tricuspidate*, the acrotretoid brachiopod *Anabolotreta tegula* and a "catillicephalid" trilobite (herein *Onchonotellus* cf. *kuruktagensis* [Zhang, 1981]).

The majority of Bischoff and Prendergast's (1987) identifications, however, are now outdated casting doubt on their age interpretations. For example, *Costipelagiella* has recently been regarded as a junior synonym of *Pelagiella* (Kouchinsky *et al.* 2011, 2013; Thomas *et al.* 2020; Ebbestad *et al.* 2024). The latter genus has a slightly longer range from Cambrian Series 2 into the Furongian (Lochman 1940; Yochelson and Weber 2006; Thomas *et al.* 2020). Likewise, Bischoff and Prendergast's (1987) specimens of "*Aphelotreta minuta*", "*Treptotreta jucunda*", and "*Anabolotreta tegula*" all lacked images of the ventral valve exterior, essential for generic level identification. Thus, these taxa are only assignable to indeterminate acrotretids based on a modern appraisal, making their biostratigraphic utility limited (e.g. see Holmer and Popov 2000).

Reassessment of the agnostids and trilobites herein identifies at least four tentative species: *Micragnostus* cf. *medius* (Shergold, 1980), *Onchonotellus* cf. *kuruktagensis* (Zhang, 1981), *Pseudorhaptagnostus* sp., and *Wuhuia* aff. *silex* Shergold, 1980. Whilst the material is relatively poorly preserved, tentative correlations can be made, particularly to the Chatsworth Limestone of the Georgina Basin, Queensland. *Micragnostus medius* occurs in the early Iverian (*Wentsuia iota*-*Rhaptagnostus apsis* Assemblage Zone) at the Horse Creek section; and slightly stratigraphically higher *Wuhuia silex* occurs in the overlying early Iverian (*Peichiashania secunda*-*Prochuangia glabella* Assemblage Zone) to mid-Iverian (*Peichiashania lertia*-*Peichiashania quarta* Assemblage Zone) at the Lily Creek section (Shergold 1980) (Fig. 2b). The overlap of these ranges would suggest an age for the Burrewarra Point specimens somewhere within the early Iverian on the Australian Stage scheme (Fig. 2b). This age is supported by the occurrence of *O*. cf. *kuruktagensis*, which occurs in the early Jiangshanian (*Rhaptagnostus ciliensis*-*Onchonotellus* cf. *kuruktagensis* Assemblage Zone) of Hunan, South China (Peng 1992, 2020; Duan *et al.* 1999; Peng 2009). The latter is broadly correlated with the *Wentsuia iota*-*Rhaptagnostus apsis* to *Peichiashania secunda*-*Prochuangia glabella* assemblage zones of the early Iverian in Australia (Peng *et al*. 2012, 2020).

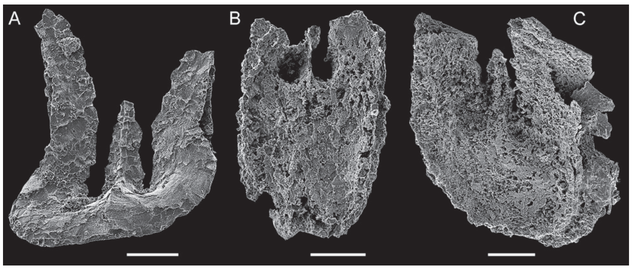


**Figure 4. Stratigraphically important paraconodonts from the early Iverian lower formation of the Wagonga Group at Burrewarra Point. a. *Westergaardodina bohlini* Müller, 1959, AM F.165833 (previously MU41979), P202-C3, posterior view of partial element. b-c *Westergaardodina kleva* Müller, 1959. b. AM F.165834 (previously MU41981), P248-C4. posterior view of partial element. c. AM F.165835 (previously MU42041), P202-C3. Scale bars 200 µm.**

Further confirmation of this age comes from the previously identified paraconodonts of Bischoff and Prendergast (1987) which overlap (albeit more widely) with the overall trilobite biostratigraphic range. *Westergaardodina bohlini* Müller, 1959, and *Westergaardodina kleva* Müller, 1959 (Fig. 4) are restricted to between the *Parabolina spinulosa* to *Peltura scarabaeoides* trilobite zones in Sweden (Müller 1959, 1971; Müller and Hinz 1991; Bagnoli and Stouge 2014), these are approximately equivalent to early Jiangshanian to mid-Stage 10 (below the *Cordylodus proavus* Zone) on the global scale (Ahlberg 2003; Zhao *et al.* 2022; Yan *et al.* 2024; Fig. 2b). A slightly younger fauna of conodont (and conodont-like) elements are known from the overlying strata of the Narooma Chert at Melville Point, as well as west of Narooma and southwest of Dalmeny (Stewart and Glen 1991; Glen *et al.* 2004; Zhen and Rutledge 2021). The oldest of these are unpublished specimens of *Proconodontus muelleri* Miller, 1969 from Melville Point collected by G.C.O. Bischoff (Macquarie University geology specimen MQ42044, PMS pers. obsv.). This would place the lowest Narooma Chert within the *Proconodontus muelleri* to *Eoconodontus* zones of China and the western USA (Miller 1988; Miller *et al.* 2003; Dong *et al.* 2004; Dong and Zhang 2017; Miller *et al.* 2018; Miller 2020; Fig. 2b). This suggests a maximum deposition age of early Stage 10 depending on where the boundary is placed for the lowest Narooma Chert. The temporal gap between the early Iverian (early Jiangshanian) lower formation of the Wagonga Group at Burrewarra Point and the stratigraphically higher early Stage 10 fossiliferous portion of the Narooma Chert appears to be less than 2–3 million years (with the intervening time potentially represented in the thick unfossiliferous basal siltstone of the Narooma Chert). Such stratigraphic continuity has important palaeogeographic implications, suggesting that the eastern margin of Gondwana maintained relatively stable depositional environments during this interval despite the complex tectonic setting of the developing Macquarie Arc to the west (Glen and Cooper 2021).

**Implications for depositional environment**

Detailed biostratigraphic analysis reveals a near-identical trilobite and agnostid fauna across all limestone olistoliths (P202-C1–C3, P304-A, P326-D, P326-E, P248-C1–C4, P248-I) and beds (P249-A–D[1–6]) of the lower formation of the Wagonga Group at Burrewarra Point. This strong faunal correlation (Bischoff and Prendergast 1987, table 2) indicates they were penecontemporaneous deposits, rather than representing various ages as previously suggested by Bischoff and Prendergast (1987) who interpreted the limestones as derived from weathering of an emergent carbonate platform. In our view, the depositional setting of these limestone olistoliths is best explained by a dynamic seamount flank environment. The olistoliths occur in association with island arc basaltic breccia both in the lower and upper portions of the unit (Prendergast and Offler 2012), indicating a consistent depositional regime throughout formation. We propose a model where original carbonate deposition occurred within the photic zone on a restricted carbonate platform on the upper flanks surrounding the summit of a volcanic seamount. Periodic distal slope failure of the outer platform margin transported semi-lithified to lithified carbonate material downslope as gravity debris flows likely due to instabilities caused by regular tectonic activity associated with frequent volcanic eruptions. These limestone blocks became incorporated within the volcanogenic sediments derived from erosion of the mafic edifice. This model accounts for both the regular input of carbonate material and the interbedded basaltic breccia. The proposed depositional setting closely parallels modern seamount environments. Submarine mass wasting processes documented around Hawaiian volcanoes (Hampton *et al*. 1997) demonstrate carbonate deposits are repeatedly transported and redeposited on volcanic flanks.

The faunal assemblage within these limestones also provides important paleogeographic constraints. The presence of trilobite and agnostid taxa closely resembling those found in the intracratonic Georgina Basin of mainland Australia suggests this volcanic seamount existed in relatively close proximity to the seaward continental margin of Eastern Gondwana during the Furongian (“Late” Cambrian). This position aligns with tectonic reconstructions proposed by Glen and Cooper (2021), placing these deposits within the peripheral zone of the eastern Gondwanan convergent margin system.

## SYSTEMATIC PALAEONTOLOGY

Morphological terminology follows Shergold and Laurie (1997) for the agnostids and Whittington and Kelly (1997) for the trilobites. Photographed specimens were imaged under a JEOL JCM-7000 NeoScopeTM Benchtop SEM, operated at 15 kV, with a working distance of about 12–15 mm. Specimens were coated with gold using Emitech K550 sputter coater before imaging, and are stored in the Palaeontology Collection, Australian Museum, Sydney, with the prefix AM F.

Phylum ARTHROPODA von Siebold, 1848
Class AGNOSTOMORPHA Geyer, 2024
Order AGNOSTIDA Salter, 1864
Family AGNOSTIDAE M’Coy, 1849
Subfamily AGNOSTINAE M’Coy, 1849
*Micragnostus* Howell, 1935a

**Type species**

*Agnostus calvus* Lake, 1906, p. 23, pl. 2, fig. 18.

**Remarks**

*Micragnostus* Howell, 1935a has previously been considered synonymous with *Agnostus* Brongniart, 1822 and *Innitagnostus* Öpik, 1967, (e.g., Robison 1994; Peng and Robison 2000; Høyberget and Bruton 2008), although, some authors have retained them as separate genera (e.g. Shergold and Laurie 1997; Laurie in Paterson and Laurie 2004; Westrop and Eoff 2012; Naimark 2014; Zhu *et al.* 2022). *Micragnostus calvus* (Lake, 1906), the type for the genus, differs from *Agnostus* in possessing a slightly longer (sag.) preglabellar field; narrower (tr.) cephalon; indistinct to entirely effaced preglabellar furrow; shorter (sag.) pygidial axis (which is less than 75% total pygidial length); a slight constriction of the pygidial axis at M2; and a more well-defined pygidial F2. Similarly, it differs from *Innitagnostus*, in possessing complete effacement of the glabellar F1 and F2; maximum cephalon width (tr.) approximately inline with the anterior glabellar lobe; a narrower (tr.) pygidium; and a shorter (sag.) pygidial axis. Given consistent points of difference we follow the latter authors and retain *Micragnostus* as a separate genus. However, it is important to note that all the listed traits are extremely subtle and potentially may only warrant separation at species level. A more detailed review of *Micragnostus* and other closely allied genera (e.g. *Agnostus*, *Connagnostus* Öpik, 1967, *Erudagnostus* Lermontova, 1951, *Innitagnostus*, *Homagnostus* Howell, 1935b, *Kymagnostus* Hohensee and Stitt, 1989, *Oncagnostus* Whitehouse, 1936, *Rudagnostus* Lermontova, 1951, *Strictagnostus* Shergold, 1975, and *Trilobagnostus* Harrington, 1938) may prove these features are only of interspecific significance (see discussion on this topic under the generic diagnosis of *Homagnostus* in Westrop and Eoff 2012, p. 214). Such a comprehensive work, however, is beyond the scope of this study.

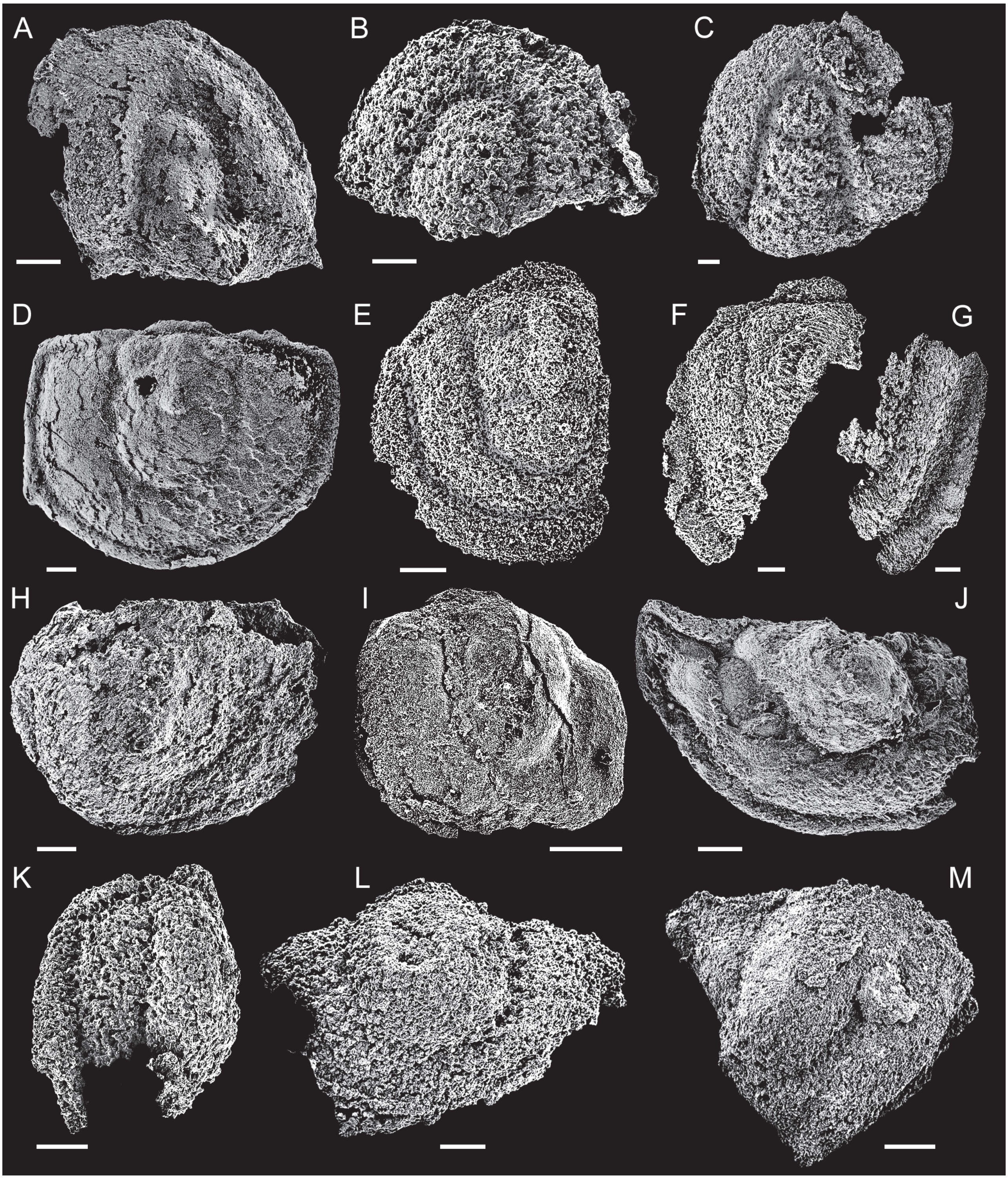


**Figure 5. *Micragnostus* cf. *medius* (Shergold, 1980) from the early Iverian lower formation of the Wagonga Group at Burrewarra Point. a. AM F.165695 (previously MU41998), P248-C4, dorsal view of partial cephalon. b, AM F.165696, P248-C4, dorsal view of partial cephalon. c, AM F.165697, P248-C4, dorsal view of partial cephalon. d, AM F.165698 (previously MU41999), P248-C4, dorsal view of near complete pygidium. e, AM F.165699, P248-C4, dorsal view of partial pygidium. f, AM F.1656700, P248-C4, dorsal view of partial pygidium. g, AM F.165701, P248-C4, dorsal view of partial pygidium. h, AM F.165702, P248-C4, dorsal view of partial pygidium. i, AM F.165703, P248-C2, dorsal view of partial pygidium. j, AM F.165704, P202-C1, dorsal view of partial pygidium. k, AM F.165705, P248-C4, dorsal view of partial pygidium. l, AM F.165706, P248-C4, dorsal view of partial pygidium. m, AM F.165707, P248-C4, dorsal view of partial pygidium. Scale bars 200 µm.**

***Micragnostus* cf. *medius*** (Shergold, 1980)

Figure 5

cf. 1980 *Innitagnostus medius*; Shergold, p. 22, pl. 11, figs 7–11, text-fig. 9

1987 Agnostinae (aff. *lnnitagnostus* Öpik, 1967); Bischoff and Prendergast, fig. 5k

1987 Agnostina, gen. et sp. indet.; Bischoff and Prendergast, fig. 5j, non fig. 5i

**Diagnosis**

For a diagnosis of *Micragnostus medius* see Shergold (1980, p. 22).

**Material**

Figured: Three partial cephala, AM F.165695–F.165697 (Fig. 5a–c); nine partial pygidia, AM F.165698–F.165707 (Fig. 5d–m). All specimens are from P248-C4, except AM F.165703, which is from P248-C2, and AM F.165704 which is from P202-C1. Unfigured: 2 fragments from P202-C1, 4 fragments from 248-C2, and 10 fragments from 248-C4.

**Occurrence**

Recovered from samples P202-C1, P248-C2, and P248-C4.

**Description**

Cephalon broadly subcircular, widest (tr.) at approximately in line with the middle of the anterior lobe. Margin evenly convex laterally and anteriorly. Anterior border narrower (sag.), flat, sloping slightly towards acrolobe; border furrow non-deliquiate. Acrolobe widest at or near its posterolateral corners, moderately convex. Shoulder furrows of moderate depth, narrow (tr.), separating acrolobe from small spines. Preglabellar furrow very indistinct, only developed in posterior half, wide (tr.). Axial furrow deep and moderately broad (tr.). Basal furrows poorly preserved. Glabella narrow (tr.), tapering very slightly forward; maximum width (tr.) across the posterior lobe; F1 and F2 effaced; F3 indistinctly defined, transverse to bowed very slightly backwards. Anterior lobe subcircular in outline. Glabellar node not preserved.

Pygidium broadly semicircular, widest just before anterior margin, lateral and posterior margins evenly convex. Small posterolateral spines positioned level with axial termination. Simplimarginate, border convex, of moderate length (sag.) in smaller individuals and narrow (sag.) in larger individuals, sloping away from acrolobe; border furrow non-deliquiate. Acrolobe widest at or near its anterolateral corners. Shoulder furrows very narrow, deep, separating acrolobe from broadly triangular shoulders. Axial furrows well developed. Axis narrow (tr.), bullet-shaped, maximum width across M1; short (sag.), length less than 70% that of pygidium. Articulating half-ring convex, arched moderately forward, widest medially, narrowing laterally. Articulating furrow deep, narrowing slightly laterally. F1 only impressed laterally, curving forward to isolate narrow, subtriangular lateral lobes. F2 straight to very slightly bowed forward, interrupted medially by prominent axial spine placed on the posterior of M2. Posteroaxis approximately the same to a little shorter (sag.) than anterior two segments, axial termination rounded, stops well short of the posterior border furrow.

**Remarks**

Bischoff and Prendergast (1987, fig. 5i, k) illustrated a cephalon of this taxon which they assigned to “Agnostina, gen. et sp. indet.”, as well as a pygidium which they assigned separately to “Agnostinae (aff. *lnnitagnostus* Öpik, 1967)”. The Burrewarra Point specimens resemble material described as *Innitagnostus medius* Shergold, 1980 from the early Iverian portion of the Chatsworth Limestone at the Horse Creek section, Georgina Basin, Queensland (Shergold 1980). In particular, they share a narrow (sag.) anterior and posterior border in larger individuals; indistinct preglabellar furrow (only visible posteriorly); transverse (to very slightly bowed) glabellar F3; a circular anterior glabellar lobe; pygidial axis which is less than 70% of the total pygidial length (sag.); narrow (tr.) and subtriangular anterolateral lobes; and very small posterolateral spines positioned inline with the termination of the pygidial axis. However, the Burrewarra Point specimens differ slightly in having a marginally shorter (sag.) glabella, and an anteriorly wider (tr.) pygidium. These differences are potentially the result of the tectonic distortion of the specimens, hence we only tentatively compare this material.

An ontogenetic trend is evident in the pygidial morphology of the Burrewarra Point material, particularly in the length (sag.) of the posterior border. Smaller individuals consistently have a slightly longer (sag.) posterior border (Fig. 5E, F, G), whereas larger specimens exhibit a markedly shorter (sag.) one (Fig. 5D). This pattern is similarly observed in the two figured paratype pygidia of *I. medius*, where the smaller (CPC15111; overall length [sag.] 50 mm; Shergold 1980, pl. 11, fig. 9) shows a notably longer (sag.) posterior border compared to a larger specimen (CPC15112; overall length [sag.] 90 mm; Shergold 1980, pl. 11, fig. 10). Hence, this variation likely reflects a growth-related change rather than a taxonomic distinction.

Generic placement of *I. medius* in *Innitagnostus* as originally suggested by Shergold (1980) seems unlikely, since this taxon possesses its maximum cephalic width (tr.) approximately inline with the anterior glabellar lobe, effacement of both F1 and F2 on the glabella, and a short (sag.) pygidial axis. These features are more characteristic of *Micragnostus*.

Material assigned to *I. medius* has been reported from the Paibian–Taoyuanian (i.e. “Late” Cambrian) of northern Tianshan, China on the Tarim Craton (Xiang and Zhang, 1985, p. 65, pl. 5). However, it differs noticeably in possessing a notch-like F2 and F3 on the glabella; subdeliquiate border furrows; a moderate forward bow in the pygidial F2; and the posterolateral spines positioned slightly further back on the pygidium. Naimark (2014) suggested these were either closely comparable with, or synonymous to, *Eurudagnostus kazakhstanicus* Ergaliev and Ergaliev, 2008 (Naimark 2014, p. 169, 173). Placement in *Eurudagnostus* seems reasonable for these latter specimens given the notch-like F2 and F3 and subdeliquiate border furrows, both of which are not characteristic of *Micragnostus*.

Family DIPLAGNOSTIDAE Whitehouse, 1936
Subfamily PSEUDAGNOSTINAE Whitehouse, 1936

*Pseudorhaptagnostus* Lermontova, 1951

**Type species**

*Pseudorhaptagnostus simplex* Lermontova, 1951 [=*P. punctatus* (Lermontova, 1940)].

**Remarks**

As part of Shergold's (1977) reclassification of *Pseudagnostus* Jaekel, 1909 he erected two primary divisions. This included the papilionate forms (with the glabellar node between the anterolateral lobes) and the spectaculate forms (with the glabellar node behind the anterolateral lobes). He assigned the former to *Rhaptagnostus* Whitehouse, 1936, and the latter to either *Pseudagnostus* or *Neoagnostus* Kobayashi, 1955. The "*araneavelatus* species group" was one of those assigned to *Neoagnostus* and comprised "Late" Cambrian taxa from Australia, South Korea and the eastern United States. These share a subcircular to semiovate cephalon, non-deliquiate to subdeliquiate border, effaced glabellar F2 and F3 externally, subcircular pygidium, which is non-plethoid, a narrow (tr.) pygidial axis, and a well-defined pygidial F2. Nielsen (1996) later reasoned that *Neoagnostus* (including the "*araneavelatus* species group") should be a junior synonym of *Pseudorhaptagnostus* Lermontova, 1951. However, Naimark (2016) argued that all the Australian members of the "*araneavelatus* species group" (along with several other Chinese species) should be assigned to *Pseudagnostus*, chiefly citing a shorter (sag.) anterior border, narrower (tr.) pygidial axis and the lack of a lanceolate field on the posteroaxis of the pygidium. However, some members of the group such as "*Neoagnostus*" *greeni* Shergold, 1980, do possess a indistinct lanceolate field (Shergold 1980, pl. 9, fig. 8–12). The remaining apparent differences are not convincing, as they are only of intraspecific importance amongst members in the closely allied *Pseudagnostus*, e.g. compare *Pseudagnostus ampullatus* Öpik, 1967 with *Pseudagnostus communis* (Hall and Whitfield, 1877) (see Shergold 1977, pl.15, figs 3, 4 to figs 5, 6, respectively). Species in the "*araneavelatus* species group" share fewer features with *Pseudagnostus* (particularly the type, *Pseudagnostus cyclopyge* [Tullberg, 1880]), and more in common with *Pseudorhaptagnostus*. This includes a cephalon which is widest (tr.) at approximately midlength (sag.); a relatively smaller anterior glabellar lobe; a pygidial pleural field which is widest (tr.) at midlength (sag.) (rather than tapering posteriorly); and moderately sized posterolateral spines. Hence, we assign the Australian members of the "*araneavelatus* species group" to *Pseudorhaptagnostus*. As recently recommended by Laurie *et al.* (2025), a more comprehensive revision of pseudagnostid genera is required to assess their validity at present.

To Naimark's (2016, p. 58) species list we add: *Pseudorhaptagnostus coronatus* (Shergold, 1975), *Pseudagnostus clarki patulus*-*Caznaia squamosa*–*Pseudagnostus clarki prolatus*-*C. sectatrix* zones, Queensland, Australia; *Pseudorhaptagnostus cyclopygeformis* (Sun, 1924) (*sensu* Kobayashi 1960) *Kaolishania* Zone, Tanggok, South Korea; *Pseudorhaptagnostus cyclostigma* (Raymond, 1924) *Missisquoia* Zone, Vermont, USA; *Pseudorhaptagnostus denticulatus* (Shergold, 1975), *Pseudagnostus bifax*-*Pseudorhaptagnostus denticulatus* Zone, Queensland, Australia; *Pseudorhaptagnostus greeni* (Shergold, 1980), *Wentsuia iota*-*Rhaptagnostus apsis* Zone, Queensland, Australia; *Pseudorhaptagnostus sabulosus* (Peng, 1992), *Lotagnostus punctatus*–*Hedinaspis regalis* Zone, China; *Pseudorhaptagnostus* sp. C (Shergold 1975), *Pseudagnostus clarki prolatus*-*Caznaia sectatrix* Zone, Queensland, Australia.

***Pseudorhaptagnostus*** **sp.**

Figure 6

1987 Agnostina, gen. et sp. indet.; Bischoff and Prendergast, fig. 5i, non fig. 5j.

**Material**

Figured: Four partial cephala, AM F.165708–F.165711 (Fig. 6a–d); eight partial pygidia, AM F.165712–F.165719 (Fig. 6e–l). All specimens are from P248-C4, except AM F.165709, which is from P202-C1, and AM F.165710 and AM F.165713, which are from P248-C2. Unfigured: 4 fragments from P202-C1, 1 fragment from 248-C2, and 20 fragments from 248-C4.

**Occurrence**

Recovered from samples P202-C1, P248-C2, and P248-C4.

**Description**

Cephalon broadly semiovate, widest (tr.) at approximately midlength (sag.), margin evenly convex laterally and anteriorly. Border flat, slightly sloped toward border furrow; moderately wide (sag.). Border furrow non-deliquiate, narrow (tr.), very shallow. Acrolobe widest at or near its posterolateral corners, moderately convex. Shoulder furrows very deep, narrow, separating acrolobe from small, blunt spines. Preglabellar furrow absent. Axial furrow deep and narrow (tr.). Basal furrows deep and broad (tr.). Basal lobes wide (tr.), subtriangular. Glabella is narrow (tr.), tapering forward, constricted slightly behind slightly inflated anterolateral lobes (seen in undistorted specimens); maximum width (tr.) across the posterior lobe; F1 and F2 effaced; F3 indistinctly defined, V-shaped. Anterior lobe subquadrate in undistorted specimens. Posterior lobe elevated, angular and well-inflated at posterior. Glabellar node of moderate size, positioned in the anterior portion of the posterior lobe.

Pygidium outline incompletely known, widest near midlength, margin evenly convex laterally and posteriorly. Moderately sized, broad (tr.) based, pygidial posterolateral spines positioned inline with the rear of acrolobe. Border wide (sag.); slightly convex.

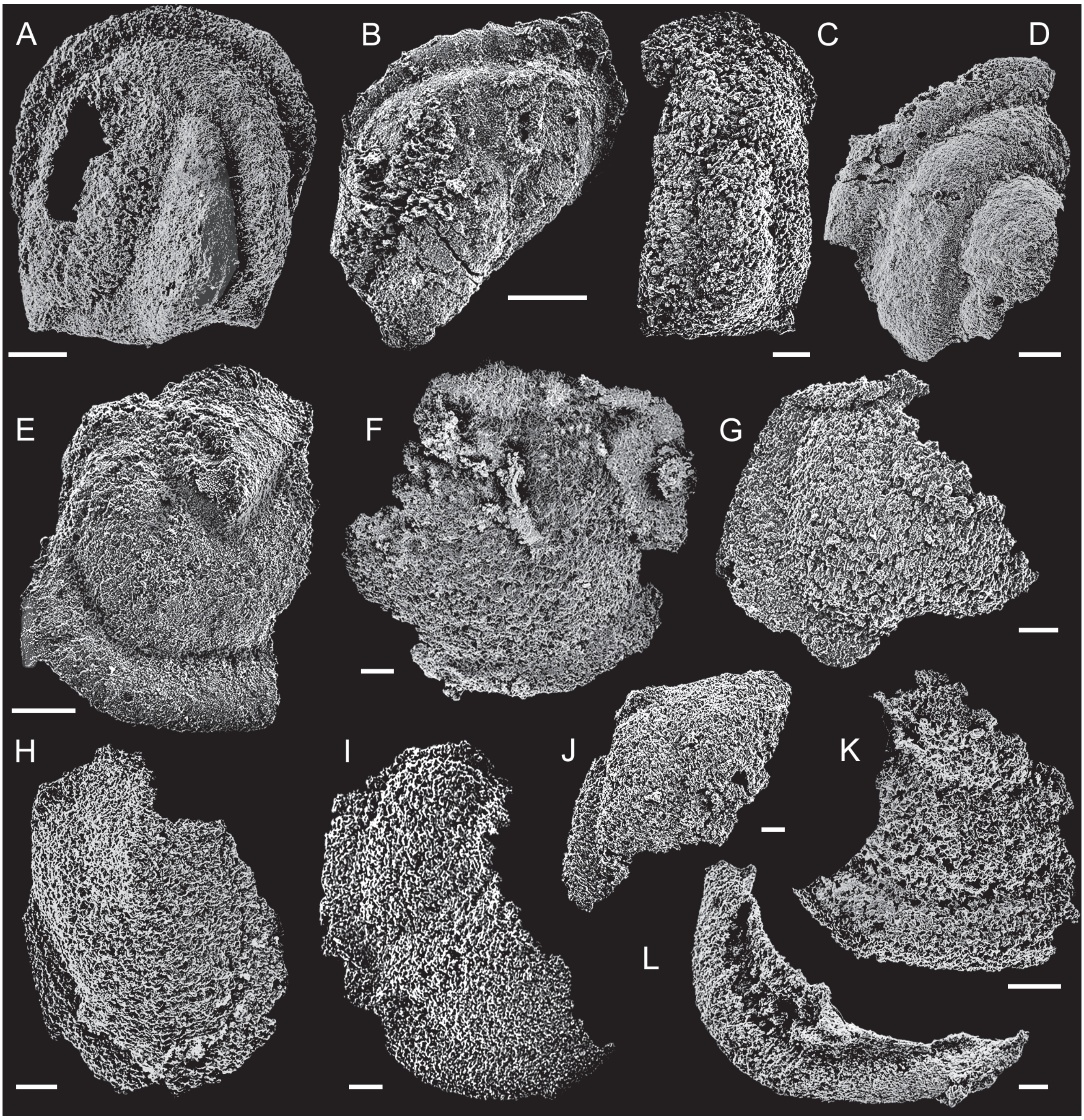


**Figure 6. *Pseudorhaptagnostus* sp. from the early Iverian lower formation of the Wagonga Group at Burrewarra Point. a, AM F.165708 (previously MU41997), P248-C4, dorsal view of partial cephalon. b, AM F.165709, P202-C1, dorsal view of partial cephalon. c, AM F.165710, P248-C2, dorsal view of partial cephalon. d, AM F.165711, P248-C4, dorsal view of partial cephalon. e, AM F.165712, P248-C4, dorsal view of partial pygidium. f, AM F.165713, P248-C2, dorsal view of partial pygidium. g, AM F.165714, P248-C4, dorsal view of partial pygidium. h, AM F.165715, P248-C4, dorsal view of partial pygidium. i, AM F.165716, P248-C4, dorsal view of partial pygidium. j, AM F.165717, P248-C4, dorsal view of partial pygidium. k, AM F.165718, P248-C4, dorsal view of partial pygidium. l, AM F.165719, P248-C4, dorsal view of partial pygidium. Scale bars 200 µm.**

Border furrow subdeliquiate, of moderate width (sag.) and shallow. Acrolobe widest at posterolateral corners in undistorted material. Shoulder furrows very narrow, deep, separating acrolobe from obtusely triangular shoulders. Axial furrow non-plethoid, well-developed adjacent M1 and M2, completely effaced adjacent posteroaxis. Axis narrowing (tr.) at M2. Articulating half-ring convex, bowed moderately forward, widest (sag.) medially, narrowing (exsag.) laterally. Articulating furrow poorly preserved. F1 furrow effaced, F2 furrow well-defined, V-shaped, narrow (sag.), shallow, interrupted medially by prominent axial spine placed on the posterior of M2.

**Remarks**

Bischoff and Prendergast (1987, fig. 5i) assigned a single cephalon of this taxon to “Agnostina, gen. et sp. indet.” and did not figure any pygidial material. The collection from Burrewarra Point is very similar to other Australian species assigned to the "*araneavelatus* species group" by Shergold (1977, p. 79). In particular, it is closest to *Pseudorhaptagnostus denticulatus* (Shergold, 1975) from the late-Iverian portion of the Chatsworth Limestone at the Black Mountain section in the Georgina Basin, Queensland. Both possess an indistinctly defined, V-shaped glabellar F3; indistinct glabellar node placed in the anterior portion of the posterior lobe; and pygidial axial furrows completely effaced adjacent the posteroaxis. However, the material described here differs in having a slightly smaller anterior glabella lobe, narrower (tr.) pygidial axis adjacent M2, moderately wider (sag,) posterior pygidial border, and larger posterolateral spines. It seems possible this taxon represents a new species, but the lack of undistorted material makes it difficult to be certain of any truly diagnostic features, hence the taxon is left under open nomenclature.

Class TRILOBITA Walch, 1771
Order PTYCHOPARIIDA Swinnerton, 1915
Suborder PTYCHOPARIINA Richter, 1933
Superfamily DIKELOCEPHALOIDEA Miller, 1889
Family DOKIMOCEPHALIDAE Kobayashi, 1935
Subfamily WUHUIINAE Shergold, 1980

*Wuhuia* Kobayashi, 1933

**Type species**

*Solenopleura belus* Walcott, 1905, p. 90 nom. nud. = *Conocephalina belus* (Walcott, 1905), Walcott, 1913, p. 138, pl. 13, figs 12, 12a. Original designation by Kobayashi, 1933.

**Remarks**

See Zhang and Jell (1987, p. 239) for a revised diagnosis for the genus, and Smith (2024, p. 55) for a comparison with the morphologically similar *Lorrettina* Shergold, 1972. For a comprehensive species list see Shergold (1975,1980), Zhang and Jell (1987), Peng (1992), Wright *et al.* (1994), Qian (1994), Shergold *et al.* (2007), Choi *et al.* (2008), Wernette and Hughes in Wernette *et al.* (2023), and Laurie *et al.* (2025).

***Wuhuia* aff. *silex* Shergold, 1980**
Figure 7

aff. 1980 *Wuhuia silex*; Shergold, p. 47, pl. 16, figs 1–10; text fig. 22.

1987 Catillicephalidae (aff. *Onchonotellus* Lermontova [in Ivshin], 1956); Bischoff and Prendergast, fig. 5n, 6b, c, non fig. 5l, m, o, p–q.

1987 Gen. et. sp. indet.; Bischoff and Prendergast, fig. 6d.

**Material**

Figured: Three partial cranidia, AM F.165720–F.165722 (Fig. 7a–c); one partial hypostome, AM F.165723 (Fig. 7d); one partial left librigena, AM F.165724 (Fig. 7e); one partial right librigena, AM F.165727 (Fig. 7h); two partial left thoracic pleurae, AM F.165725–F.165726 (Fig. 7f–g); one right thoracic pleural spine, AM F.165728 (Fig. 7i); eight partial pygidia, AM F.165729–F.165737 (Fig. 7j–r). All specimens are from P248-C4, except AM F.165722 and AM F.165723 which are from P248-C2, and AM F.165728 and AM F.165737 which are from P202-C1. Unfigured: >20 fragments (mostly thoracic segments) from P202-C1, 15 fragments (mostly thoracic segments) from P202-C3, >20 fragments (mostly thoracic segments) from P326-E, 1 fragment (thoracic segment) from P304-A , >20 fragments (mostly thoracic segments) from P248-C2, >20 fragments (mostly thoracic segments) from P248-C3, >20 fragments (mostly thoracic segments) from 248-C4. 15 fragments (mostly thoracic segments) from P248-I, and >20 fragments (mostly thoracic segments) from P249-A–D[1–6].

**Occurrence**

Recovered from samples P202-C1, P202-C3, P326-E, P304-A, P248-C2, P248-C3, P248-C4, P248-I, and P249-A–D[1–6].

For a diagnosis of *Wuhuia silex* see Shergold (1980, p. 47).

**Description**

Largest cranidium 2 mm long (sag.); moderately convex (sag., tr.). Anterior margin very gently rounded. Anterior branches unknown. Glabella anteriorly truncate; moderately tapering forward; moderately convex. Axial furrow shallow and narrow (sag. and tr.). Lateral glabellar furrows effaced. Occipital ring and SO not preserved. Anterior cranidial border moderately wide (sag., exsag.), medially widening (sag), strongly convex. Anterior border furrow shallow and moderately wide (sag.). Preglabellar field of moderate length (sag., exsag.), slightly convex. Preocular field moderately convex, downsloping toward the anterior border furrow and becoming steeper abaxially. Palpebral lobes incompletely preserved. Palpebral furrow narrow (tr.) and shallow, long (exsag.), probably crescentic in outline, anterior tip unknown, posterior tip situated slightly anterior to posterior border furrow. Eye ridge

**Figure 7. *Wuhuia* aff. *silex* Shergold, 1980, from the early Iverian lower formation of the Wagonga Group at Burrewarra Point. a, AM F.165720, P248-C4, dorsal view of partial cranidium. b, AM F.165721, P248-C4, dorsal view of partial cranidium. c, AM F.165722, P248-C2, dorsal view of partial cranidium. d, AM F.165723, P248-C2, ventral view of partial hypostome. e, AM F.165724, P248-C4, dorsal view of partial left librigena. f, AM F.165725, P248-C4, ventral view of partial left thoracic pleura. g, AM F.165726, P248-C4, ventral view of partial left thoracic pleura. h, AM F.165727, P248-C4, lateral view of partial right librigena. i, AM F.165728, P202-C1, dorsal view of right thoracic pleural spine. j, AM F.165729, P248-C4, dorsal view of partial pygidium. k, AM F.165730, P248-C4, dorsal view of partial pygidium. l, AM F.165731, P248-C4, dorsal view of partial pygidium. m, AM F.165732, P248-C4, dorsal view of partial pygidium. n, AM F.165733 (previously MU42007), P248-C4, dorsal view of partial pygidium. o, AM F.165734, P248-C4, dorsal view of partial pygidium. p, AM F.165735, P248-C4, dorsal view of partial pygidium. q, AM F.165736 (previously MU42006), P248-C4, dorsal view of partial pygidium. r, AM F.165737 (previously MU42008), P202-C1, dorsal view of partial pygidium. Scale bars 200 µm.**


A
B
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D
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effaced. Palpebral area of fixigena narrow (tr.); downsloping towards axial furrows. Posterolateral projections of fixigena not preserved. Posterior border furrow narrow (exasg.), deep. Posterior border incompletely preserved.

Largest hypostome 2 mm in length (sag.), subquadrate in outline. Anterior border weakly defined, evenly rounded, anterior wings incompletely preserved. Anterior lobe of middle body moderately inflated, elongate (sag.), ovate to rounded rectangular in outline; posterior lobe crescent-shaped. Maculae indistinct, level approximately with hypostome mid-length; directed posteromedially and bowed slightly backwards. Lateral borders defined by a narrow (tr.), shallow furrow; marginally narrower (tr.) in posterior half. Posterior border narrowing (sag.). Posterior margin bowed strongly backwards.

Librigena up to 2 mm in length excluding spine. Lateral margin evenly curved. Lateral border well-defined, gradually widening (tr.) towards genal angle, moderately convex. Lateral and posterior border furrows shallow, narrow (tr.), merging with posterior border at genal angle. Posterior border incompletely preserved. Genal field subtrapeziform, slightly convex. Genal spine flattened ovoid in cross section, blade-like, length unknown.

Thorax only known from pleural tip, which is recurved into a short (tr.) thorn-like thoracic spine.

Pygidium up to 2 mm long (sag.), broadly subtriangular in outline in undistorted material to almost transversely elliptical in distorted specimens, moderately convex. Axis occupying approximately 75% of pygidial length (sag.), moderately convex. Articulating half-ring narrow (sag., exsag.), narrowing abaxially; separated from anterior axial ring by shallow, narrow, articulating furrow. Three indistinct to entirely effaced axial rings; indistinct rings defined by narrow, shallow interring furrows. First two interring furrows approximately transverse, third interring furrow bowed slightly backwards. Terminal piece extremely short (sag.), lenticular, bowed slightly posteriorly. One pleural furrow indistinctly developed, with a second barely visible furrow developed in one specimen. Anterior-most pleural furrow extending from near anterior extremity of axial furrow and gently curving posteriorly, following the curvature of the anterior margin. Second pleural furrow arising near midlength of axis and running posterolaterally. Interpleural furrows absent. Pygidial border slightly convex, wide (exsag.) at anterolateral corners and slightly narrowing medially; bound by a wide (sag. and tr.), shallow, border furrow.

Prosopon smooth over entire exoskeleton.

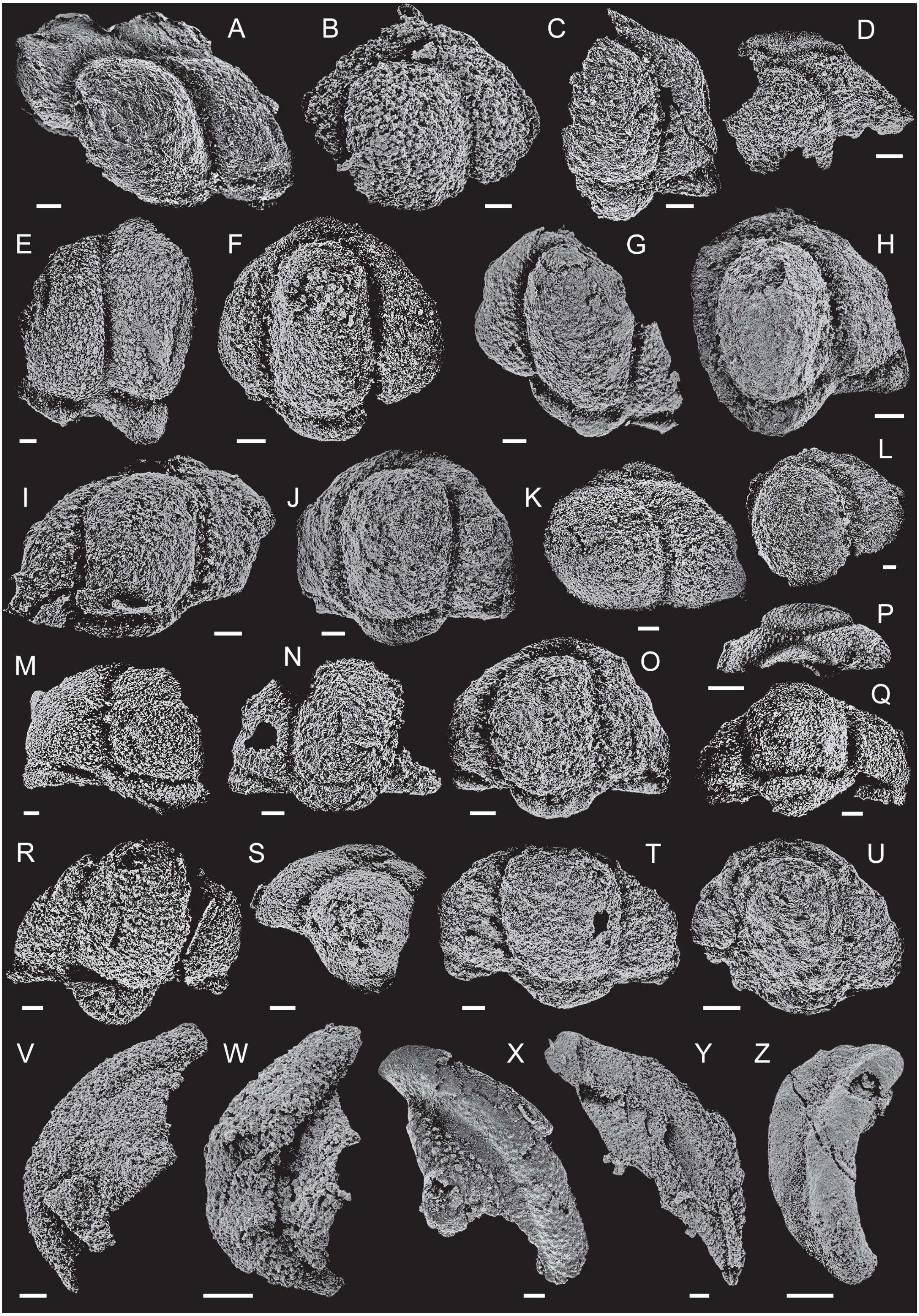
Rostral plate unknown.

**Remarks**

The Burrewarra Point material shares the distinctive smooth prosopon, complete effacement of the lateral glabellar, and broad (tr.) lateral border on the librigena, which are characteristic of *Wuhuia silex* Shergold, 1980. This species was originally described from the mid-Iverian portion of the Chatsworth Limestone at the Lily Creek section in the Georgina Basin, Queensland. The Burrewarra Point material differs slightly from the type material in possessing a somewhat shorter (sag.) preglabellar field, and straight (rather than slightly outwardly bowed) glabella axial furrows. Unfortunately, the relatively poorly preserved cranidia make definitive assignment difficult, hence we have only tentatively identified these specimens.

Shergold (1980) did not assign any pygidial material to *W. silex*. However, the pygidia figured here share similarities with isolated material assigned to *Wuhuia longa* Peng, 1992 from the late-Jiangshanian (late-Iverian equivalent) of Hunan, South China (Peng 1992, fig. 22n). Both possess an axis which tapers strongly posteriorly, extending to the posterior border furrow; three indistinct axial rings; two indistinct pleural furrows (the anterior-most being slightly more well-defined); and a indistinct posterior border furrow. However, the Burrewarra Point material differs in having a slightly narrower (tr.) axis; transverse to forwardly bowed interring furrows; and longer (sag. and exsag.) posterior border, particularly at the posterolateral corners. The Burrewarra Point material exhibit considerable morphological variability, mostly in overall outline. While some specimens (e.g. Fig. 7M–R) display a broadly subtriangular shape consistent with the expected morphology for the genus, others are markedly distorted, showing compression along the sagittal axes (e.g. Fig.7L). The similarity in overall size, proportion of the axis, as well as the depth and number of axial rings and pleural furrows, suggests this variation likely results from tectonic forcing of the silicified material rather than taxonomic differences.

**Figure 8. *Onchonotellus* cf. *kuruktagensis* (Zhang, 1981), from the early Iverian lower formation of the Wagonga Group at Burrewarra Point. a, AM F.165738, P248-C4, dorsal view of partial cranidium. b, AM F.165739, P248-C4, dorsal view of partial cranidium. c, AM F.165740, P248-C4, dorsal view of partial cranidium. d, AM F.165741, P248-C4, dorsal view of partial cranidium. e, AM F.165742, P248-C4, dorsal view of partial cranidium. f, AM F.165743 (previously MU42001), P248-C4, dorsal view of partial cranidium. g, AM F.165744, P248-C4, dorsal view of partial cranidium. h, AM F.165745, P248-C4, dorsal view of partial cranidium. i, AM F.165746, P248-C4, dorsal view of partial cranidium. j, AM F.165747 (previously MU42000), P248-C4, dorsal view of partial cranidium. k, AM F.165748, P248-C4, dorsal view of partial cranidium. l, AM F.165749, P248-C4, dorsal view of partial cranidium. m, AM F.165750, P248-C4, dorsal view of partial cranidium. n, AM F.165751, P248-C4, dorsal view of partial cranidium. o, AM F.165752 (previously MU42003), P248-C4, dorsal view of partial cranidium. p, AM F.165753, P248-C4, anterior view of partial cranidium. q, AM F.165754, P248-C2, dorsal view of partial cranidium. r, AM F.165755, P248-C4, dorsal view of partial cranidium. s, AM F.165756, P248-C4, dorsal view of partial cranidium. t, AM F.165757, P248-C4, dorsal view of partial cranidium. u, AM F.165758, P248-C4, dorsal view of partial cranidium. v, AM F.165759 (previously MU42002), P248-C4, dorsal view of partial left librigena. w, AM F.165760 MU42005), P248-C4, dorsal view of partial left librigena. x, AM F.165761, P248-C4, dorsal view of partial right librigena. y, AM F.165762, P248-C2, dorsal view of partial right librigena. z, AM F.165763, P202-C1, dorsal view of partial thoracic pleura. Scale bars 200 µm.**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Superfamily PTYCHOPARIOIDEA Matthew, 1887
Family SOLENOPLEURIDAE Angelin, 1854
Subfamily ONCHONOTININAE Lu in Lu *et al.*, 1965

*Onchonotellus* Lermontova in Ivshin, 1956

**Type species**

*Solenopleura subcincta* Lermontova, 1951 (see Öpik, 1967, p. 206, 207 for discussion of validity).

**Remarks**

See Öpik (1967), Shergold (1980), Peng *et al.* (2004), Westrop and Dengler (2014), Smith *et al.* (2025) for a comprehensive discussion of the genus and species assignment. We concur with Westrop and Dengler (2014, p. 92) and Smith *et al.* (2025, p. 92, 93) in placing Onchonotininae Lu in Lu *et al.*, 1965 within the Solenopleuridae Angelin, 1854, rather than Catillicephalidae Raymond, 1938.

***Onchonotellus* cf. *kuruktagensis*** (Zhang, 1981)

Figure 8

1987 Catillicephalidae (aff. *Onchonotellus* Lermontova [in Ivshin], 1956); Bischoff and Prendergast, fig. 5l, m, o, p–q, non fig. 5n, fig. 6a, non fig. 6b, c.

cf. 1992 *Onchonotellus* cf. *kuruktagensis* Zhang; Peng, p. 65, figs 37, 39D–I.

cf. 1999 *Onchonotellus* cf. *kuruktagensis* Zhang; Duan *et al.* p. 159, 161, figs 6H; 9H, I; 12C–E; 13E.

cf. 2020 *Onchonotellus* cf. *kuruktagensis* Zhang; Peng, pl. 172, fig. 9–11.

**Material**

Figured: Twenty partial cranidia, AM F.165738–F.165758 (Fig. 8a–u); two partial left librigenae, AM F.165759–F.165760 (Fig. 8v–w); two partial right librigenae, AM F.165761–F.165762 (Fig. 8x–y); one partial thoracic pleura, AM F.165763 (Fig. 8z). All specimens are from P248-C4, except AM F.165754 and AM F.165762, which are from P248-C2, and AM F.165763, which is from P202-C1. Unfigured: >20 fragments (mostly cranidia and thoracic segments) from P202-C1, >20 fragments (mostly cranidia and thoracic segments) from P248-C2, >20 fragments (mostly cranidia and thoracic segments) from P248-C3, >20 fragments (mostly cranidia and thoracic segments) from 248-C4. 15 fragments (mostly thoracic segments) from P248-I, and >20 fragments (mostly cranidia and thoracic segments) from P249-A–D [1–6].

**Occurrence**

Recovered from samples P202-C1, P248-C2, P248-C3, P248-C4, P248-I, and P249-A–D[1–6].

For a diagnosis of *Onchonotellus kuruktagensis* see Zhang (1981, p. 169).

**Description**

Cranidium, subquadrate in outline; small, with largest specimen 2 mm long (sag.) and 3 mm wide (tr.); maximum width (tr.) across posterior limbs of fixigenae; very strongly convex (sag., tr.); anterior margin bowed strongly anteriorly. Anterior branches of the facial sutures (α–γ) strongly deflecting inward anteriorly. Posterior branches directed backwards over most of their length in a broad arc. Glabella subquadrate in outline; anterior broadly rounded to truncate; slightly tapered forwards with lateral margins moderately convex to almost parallel, extending to just before the anterior border furrow; occupying just under 90% of cranidial length (sag.); strongly convex (sag., tr.) with maximum convexity at midwidth. Axial furrows deep and narrow (tr.). Lateral glabella furrow effaced. SO deep and narrow (sag.), bowed strongly backwards. Occipital ring (LO) short (sag.), narrowing abaxially, bowed strongly backwards. Anterior border moderately wide (tr.), short (sag.) and becoming shorter abaxially; moderately convex (sag., exsag.). Anterior border furrow transverse for the most part, bowed slightly backwards medially near preglabellar furrow, deep and narrow (sag., exsag.). Preglabellar field very short (sag.), slightly depressed medially into a shallow, narrow (tr.) preglabellar furrow. Preocular field of moderate length (exsag.), slopes steeply down to anterior border furrow. Palpebral lobe short (exsag.), narrow (tr.), bounded by a deep, narrow (tr.) palpebral furrow; positioned slightly forward of mid-cranidial length (exsag.). Eye ridges entirely effaced. Palpebral area of moderate width (tr.); slightly convex (tr.), downsloping towards posterolateral projections. Postocular area very wide (exsag.), gently downsloping towards posterior border furrow. Posterolateral projection of fixigena short (tr.) and wide (exsag.), sloping steeply downward laterally. Posterior border narrow (exsag.), becoming slightly wider (exsag.) abaxially; bounded by a deep, narrow (exsag.) posterior border furrow.

Largest librigena 2 mm in length (exsag.). Lateral margin evenly curved. Genal field slightly convex. Lateral border wide (tr.), well-defined by deep, narrow (tr.), border furrow; furrow merges with posterior border furrow at genal angle. Posterior border not preserved. Genal spine not preserved.

Prosopon with prominent granules covering most of the dorsal surface except furrows.

Rostral plate, hypostome, thorax, pygidium unknown.

**Remarks**

The Burrewarra Point material is comparable to specimens referred to *Onchonotellus* cf. *kuruktagensis* (Zhang, 1981) described from the Jiangshanian (Iverian equivalent) of Hunan South China (Peng 1992, 2020; Duan *et al.* 1999). Both possess a moderately wide (tr.), short (sag.) anterior border; short (sag.), narrow (tr.) preglabellar furrow; palpebral lobes positioned slightly anterior of mid-cranidial length (exsag.); subquadrate glabella with a rounded to slightly truncate glabella anterior; and prominent granules on the prosopon. However, the Burrewarra Point material differs in lacking eye ridges and lateral glabella furrows. Yet, this is likely the result of ontogenetic differences between the collections. The smallest specimens figured by Peng (1992) and Duan *et al.* (1999) are almost twice the size of the material figured here. Small specimens they figured also appear to lack eye ridges and discernible glabella furrows (e.g. Peng 1992, fig. 39F, I). Given the paucity of non-tectonically deformed cranidia in our collection, we have only tentatively compared this material, as we can not be certain they are conspecific.

The Burrewarra Point material is also somewhat similar to *Onchonotellus longiceps* (Liu in Zhou *et al.*, 1977) (and its junior synonym *Onchonotina*? *taoyuanensis* Zhou in Zhou *et al.*, 1977) from the Paibian (Idamean equivalent) of Hunan, South China (Duan *et al.* 1999; Peng *et al.* 2004; Zhou and Zhen 2008), as well as *Onchonotellus abnormis* Ivshin, 1956 from the Jiangshanian (Iverian equivalent) of Hunan, South China and Selety River, central Kazakhstan (Ivshin 1956, 1962; Peng 1992, 2020). The material figured here, however, differs subtly from both these taxa in possessing a more subquadrate glabella, and slightly more forwardly placed palpebral lobes. Two other species, *Onchonotellus vigilans* (Lu in Lu and Qian, 1964) described from the Taoyuanian (early Payntonian equivalent) of Xiyangshan, Zhejiang, South China (refigured by Lu *et al.*, 1974, pl.2, fig. 4, and later Peng *et al.* 2020 pl. 172, fig. 9) as well as *Onchonotellus globosa* (Zhou in Zhou *et al.*, 1977) from the Jiangshanian (Iverian equivalent) of Hunan South China are also similar. They share a short (sag.) anterior border, a distinct preglabellar furrow intersecting the anterior border furrow, the palpebral lobes positioned anteriorly on the fixigena, and prominent pustules on the prosopon. However, they differ in their anterior border being considerably narrower (tr.), glabella being relatively shorter (sag.) as well as more egg-shaped, and the eye ridges being more prominent on the external surface of the exoskeleton.

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