Early Devonian Conodonts from the Southern Thomson Orogen and Northern Lachlan Orogen in North-western New South Wales

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Early Devonian (Lochkovian) conodonts, recovered from carbonate intervals within the Amphitheatre Group of the northern Cobar Basin (Lachlan Orogen) and from unnamed correlative strata encountered in drillcore from Louth in the southern Thomson Orogen in north-western New South Wales, include the biostratigraphically important taxon *Caudicriodus woschmidti*. Associated species include *Belodella resima*, *Caudicriodus* spp. indet., *Oulodus astriatus*?, *Oulodus spicula, Oulodus* sp., *"Ozarkodina" planilingua*, *Panderodus unicostatus, Wurmiella excavata*, and *Zieglerodina remscheidensis*. These conodont faunas provide the first biostratigraphically constrained correlations between rocks of the Cobar Basin (Cobar Supergroup) in the northern Lachlan Orogen and subsurface strata in the adjacent southern Thomson Orogen.

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KEYWORDS: Cobar Basin, Conodonts, Early Devonian, Lachlan Orogen, Thomson Orogen.

INTRODUCTION

Considerable conjecture characterises interpretations of the relationship between the southern Thomson Orogen and the Lachlan Orogen in northwestern New South Wales (e.g. Burton 2010; Cayley 2012; Glen et al. 2013). Exposure of rocks attributed to either orogen in the region north of Cobar is very limited, and outcrops of Thomson Orogen strata are rare due to thick cover comprising Cenozoic regolith units and Mesozoic sedimentary rocks of the Eromanga Basin. Information on basement geology relies heavily on geophysical surveys that penetrate the cover, with drillcores providing the only means of sampling most basement rocks. The southern Thomson Orogen is the focus of current investigations by the Geological Survey of New South Wales in collaboration with Geoscience Australia, the Geological Survey of Queensland and several universities – these studies aim to uncover the mineral systems potential of this remote and under-explored region. One of the key objectives of these projects is to investigate and improve the age constraints for the Thomson Orogen rocks and to test correlations with better-known stratigraphic successions to the south, including that of the Cobar Basin in central NSW.

In the Louth area (Fig. 1), volcanic and metasedimentary rocks of uncertain age and association occur in sparse outcrops and mineral exploration drillholes. This area is located within the east–west zone where the southern Thomson Orogen melds with the Lachlan Orogen. In 2010, conodonts of latest Silurian to Early Devonian aspect were identified by Percival in residues from core obtained from drillhole L2 from south of Louth, leading to this detailed study. Although Early Devonian conodonts were first retrieved more than three decades ago (Pickett 1984) from limestone intersected by drillholes in the Cobar Basin adjacent to the southern

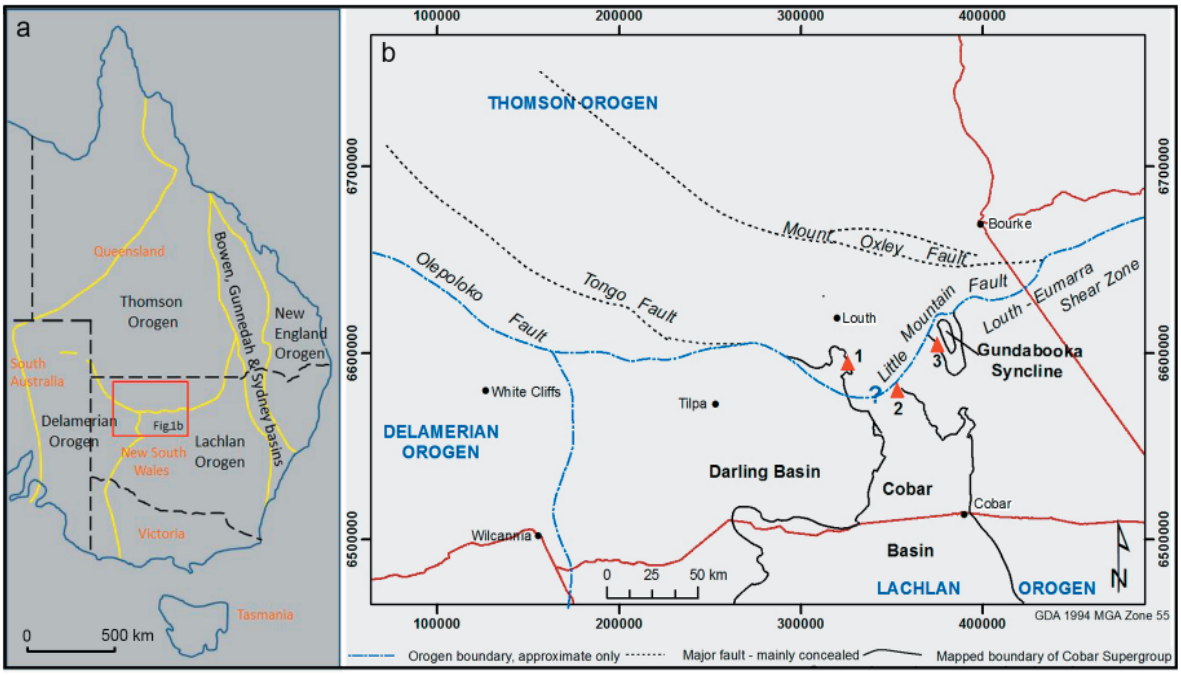

Fig. 1. Map showing the four sites (three subsurface and one surface) from where Early Devonian conodonts were collected for this study in the southern Thomson Orogen and northern Lachlan Orogen of northwestern New South Wales (background: NSW Surface Geology Map, third edition); 1, (Louth L2 drillhole); 2, (Kiri DDH K1 and DDH K6 drillholes); 3, (limestone outcrop near Stoney Tank, in the Mount Gunderbooka area).

margin of the Thomson Orogen, these have not been described or illustrated. Additional sampling has provided more diverse faunas which are documented herein, supporting greater precision in regional correlations for subsurface strata in the Louth area. When integrated with geophysical and geochemical data being gathered in the Southern Thomson Project, these age constraints will be crucial for better understanding the geological and tectonic history of the southern Thomson Orogen, and its relationship with the Lachlan Orogen during the Early Devonian.

GEOLOGICAL SETTING

The Thomson Orogen (Fig. 1), one of the major geological provinces of the Tasmanides in eastern Australia, extends from north-western NSW into southwestern, central and north-eastern Queensland, with minor extensions into the northeastern corner of South Australia and the far southwest of the Northern Territory. In NSW its southern boundary against the Delamerian Orogen in the southwest and the Lachlan Orogen in the south is defined by the curved W-NW trending Olepoloko Fault in the west and the broad E-NE trending Louth-Eumarra Shear Zone in the east (Glen et al. 2013; Dunstan et al. 2016). Due to deep weathering and covering of the Palaeozoic (and possibly older) rocks comprising the Thomson Orogen by a thick succession of Mesozoic Eromanga Basin and Cenozoic sediments, there are few surface data to constrain the exact geometry and kinematics of these major structures. Based on seismic interpretation and gravity modelling (Glen et al. 2013; Folkes 2017), the Olepoloko Fault is interpreted as a north-dipping, crustal-scale fault system. The Louth-Eumarra Shear Zone, including the Mount Oxley and Little Mountain Faults, is steep to south-dipping based on potential field gradients and modelling (Van der Wielen and Korsch 2007).

Basement rock types identified by drilling and outcrop in the Louth area include black shale, turbiditic sandstone/siltstone sequences, low-grade slate and minor limestone, with basaltic andesite and tuff, volcaniclastic rocks and gabbro/dolerite. Ages of these rocks are not well understood and are reliant on very few data as follows:

1. Poorly preserved graptolites in core from drillhole L5, sited 9 km south of Louth, were identified by Pickett (1965) as *Climacograptus* sp. and *Dicellograptus* sp. of probable Late Ordovician age.
2. Bryozoa and *Tentaculites* sp. found in limestone from drillhole L2, located 32 km south-southeast of Louth, suggested a late Silurian age (Pickett pers.

comm., cited in Brunker 1968 and Glen et al. 2010).
3. Calcareous fossil fragments within quartz-rich sandstone from drillhole L1 (collar location same as L2, but drilled towards the east) were identified as a heliolitid tabulate coral of uncertain Early Palaeozoic age in a petrographic study of Louth core by Vickery (2008).
4. Two maximum depositional ages based on U/Pb zircon provenance studies reported by Glen et al. (2010) indicate that turbidites in the L5 drillhole cannot be older than 470 Ma and volcanogenic sandstone from drillhole L2 at a depth of 139 m was most probably 422 Ma (i.e. Pridoli, latest Silurian or younger.
5. A few non-diagnostic specimens of conodonts *Ozarkodina* sp. and *Walliserodus* sp. were extracted from Burracurry Hill, 25 km northeast of Louth, by Iwata et al. (1995) as part of a study of cherts from outcrops of the Ballast Formation. They suggested an uncertain Late Ordovician age for these samples. Radiolarians were also visible but have not yet been successfully extracted using HF.

At Mount Gunderbooka, located in the Gundabooka Syncline 58 km east of Louth, (Fig. 1), Devonian sequences of the Cobar Basin (Lachlan Orogen) unconformably overlie the Early to Middle Ordovician Girilambone Group. Mount Gunderbooka is a prominent outlier of gently-dipping sandstones overlying fossiliferous siltstones and limestone (exposed at Stony Tank along the western side of the outlier). Mapping and sedimentological studies by Sharp (1992) identified a coarsening-upwards sequence from Early to Late Devonian age deposited in a prograding shelf environment.

Glen et al. (2013) suggested that the Thomson and Lachlan orogens were amalgamated or interacted around the Middle/Late Ordovician boundary interval (about 460 Ma). Current geological mapping in the region indicates that Cobar Basin stratigraphy has been confidently extrapolated approximately 80 km north of Cobar to the Kerrigundi mine area, but does not extend further north towards Louth. Improved age control for the complex rocks around Louth would help determine whether deposition was continuous from the Cobar Basin into the southern part of the Thomson Orogen during the late Silurian to Early Devonian.

MATERIAL AND SAMPLE LOCALITIES

The conodont faunas documented herein comprise 813 specimens assignable to 16 species (including some indeterminate forms), of which 389 specimens were recovered from unnamed limestones in core from Louth L2 in the southern Thomson Orogen near Louth, and a further 190 from limestone intervals of the Amphitheatre Group encountered in drillholes Kiri DDH K6 and DDH K1 (Fig. 2). The remaining 234 specimens were obtained from a small limestone outcrop near Stoney Tank (on Belah Station) in the northern Cobar Basin (Fig. 1; Table 1). The CAI of the conodonts from these localities is consistently similar, about 4 to 4.5.

Louth L2, located about 32 km south of Louth township (grid ref. 30.802657ºS, 145.194924ºE; Fig. 1), was drilled by the Electrolytic Zinc Company of Australasia Ltd. in 1965, and reached a depth of 570.9 m (Fig. 2). The drillcore is stored at the Londonderry Core Library of the Geological Survey of New South Wales in outer western Sydney. A total of 11 conodont samples (half core samples, about 1 kg each) were collected from calcareous intervals over the past decade and of these ten were productive, yielding a total of 389 conodont specimens (Table 1).

Getty Oil drilled Kiri DDH K6 (grid ref. 30.901510ºS, 145.450495ºE) and DDH K1 (grid ref. 30.903339ºS, 145.452558ºE) in 1984, 50 km south-east of Louth (Figs. 1, 2). Conodont samples C0986, C0987 (both DDH K6) and C0816, C0817 (both from DDH K1) collected from limestones intersected in these drillholes were initially reported by Pickett (1984, 1988), and are included in this study (Table 1). Glen et al. (2013:fig. 3) depict the location of Kiri in the northern extremity of the Cobar Basin, south of the boundary fault separating the Thomson and Lachlan orogens.

A spot sample (C0964) from a limestone lens exposed about 400 m east of Stoney Tank (Belah Station) in the Mount Gunderbooka district (grid ref. 30.641012ºS, 145.655903ºE) of the northern Cobar Basin yielded abundant conodonts. These were initially reported by Pickett (1987) and are also incorporated in this contribution. Mathieson (2006) and Mathieson et al. (2016) described other Early Devonian (Pragian) conodonts from the vicinity of this locality.

Conodonts attributed to *Caudicriodus woschmidti* (Ziegler, 1960) from the Derriwong Group in the Trundle area (samples C0227, C0228, and C0230) and *Caudicriodus* sp. from the Yarrabandai Formation of the Bogan Gate area (sample C0001), both units of the Lachlan Orogen in central western NSW (Pickett 1975, 1992), were examined and illustrated for comparative purposes.

METHODS AND REPOSITORY

Limestone samples were dissolved in 10% acetic acid, and insoluble residues were separated by using sodium polytungstate solution to reduce the residue volume for picking. Specimens illustrated were gold coated and photographed by using a mix of secondary and backscattered electrons. All photographic illustrations shown in Figures 3-7 are SEM photomicrographs of conodonts captured

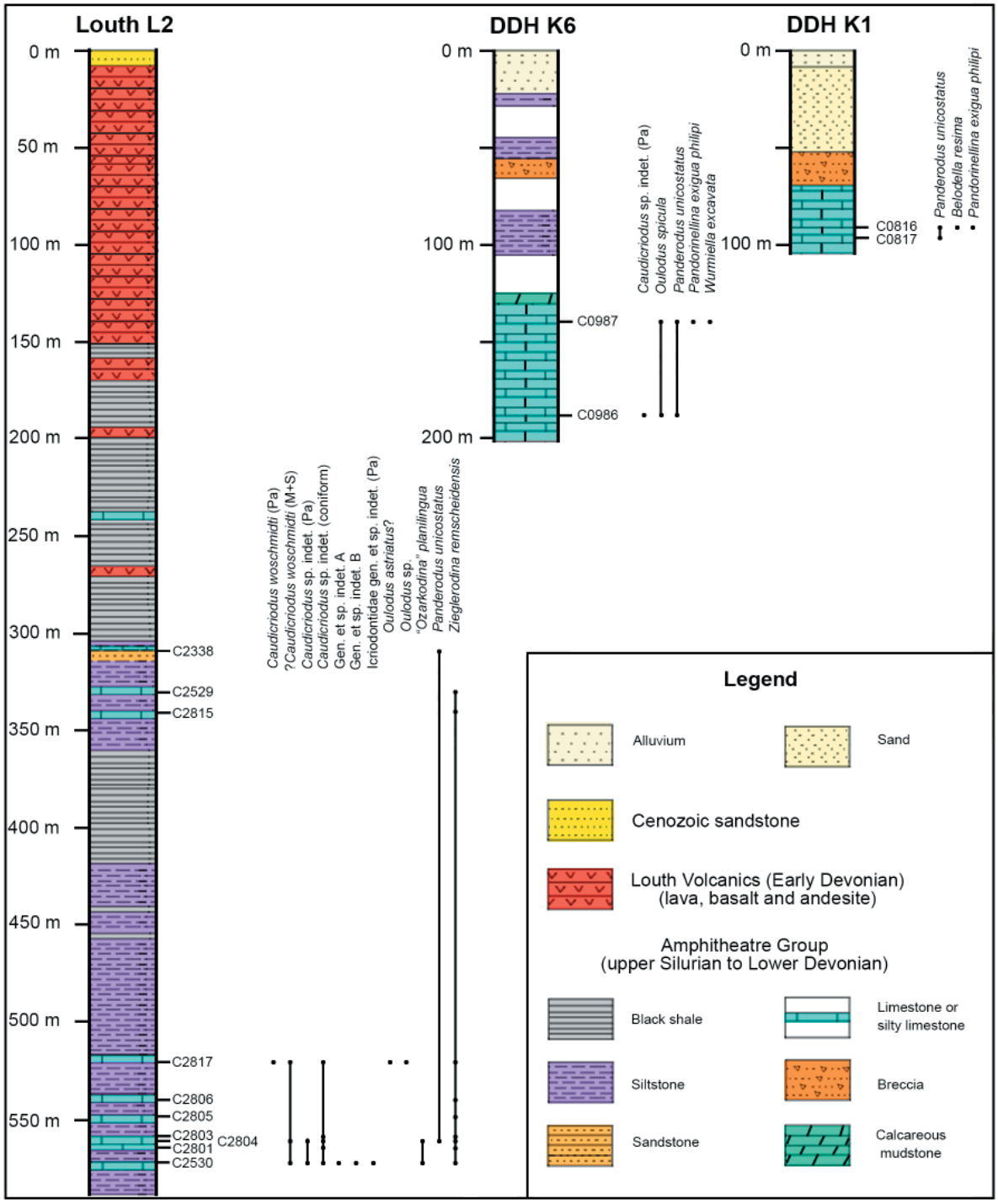

Fig. 2. Stratigraphic logs of the Lower Devonian and sampled horizons yielding conodonts in the Louth L2 drillcore, about 32 km south of Louth township in northwestern New South Wales, and the Kiri DDH K1 and DDH K6 drillholes, 50 km south-east of Louth (based on data from Lewington 1984).

Localities	Louth L2										DDH K6		DDH K1		Belah St.	
Sample numbers	C2530	C2801	C2804	C2803	C2805	C2806	C2817	C2815	C2529	C2338	C0986	C0987	C0817	C0816	C0964	**Total**
Sampling depth (m) in wells	569.75-570.9	564.69-565.79	562.46-563.58	558.24-559.18	548.72-549.76	541.53-542.54	520.14-521.06	343.81-344.88	330.71-331.62	309.37-310.3	182.5-189.3	138.8-139.6	97	91.7	surface exposure	
Belodella resima (Philip, 1965)														1		1
Caudicriodus woschmidti (Ziegler, 1960) (Pa element)							1								3	4
?*Caudicriodus woschmidti* (M and S elements)	1		3				1									5
Caudicriodus spp. indet. (Pa element)	3		3								1					7
Caudicriodus sp. indet. (coniform elements)	15	2	15	3			19									54
Gen. et sp. indet. A (coniform)	1															1
Gen. et sp. indet. B (coniform)	1															1
Icriodontidae Gen. et sp. indet. (Pa element)	1															1
Oulodus astriatus Mathieson et al., 2016 ?							1									1
Oulodus spicula Mawson, 1986											1	1				2
Oulodus sp.							3									3
"Ozarkodina" planilingua Murphy and Valenzuela-Rios, 1999	1		2													3
Pandorinellina exigua philipi (Klapper, 1969)												4		1		5
Panderodus unicostatus (Branson and Mehl, 1934)			1							1	3	127	1	21	209	363
Wurmiella excavata (Branson and Mehl, 1933)												29				29
Zieglerodina remscheidensis (Ziegler, 1960)	74	10	79	37	6	2	94	8	1						22	333
Total	97	12	103	40	6	2	119	8	1	1	5	161	1	23	234	813

Table 1. Distribution of conodont species in the samples from the Amphitheatre Group and correlative units encountered in subsurface drillholes (Louth L2, Kiri DDH K6 and DDH K1), and a small surface limestone exposure exposed near Stoney Tank (Belah Station) adjacent to the southern margin of the Thomson Orogen in north-western New South Wales.

digitally (numbers with the prefix IY are the file names of the digital images). Figured specimens (69 in total) bearing the prefix MMMC (5173 to 5241) are deposited in the microfossil collection of the Geological Survey of New South Wales, housed at the WB Clarke Geoscience Centre at Londonderry in outer western Sydney.

CONODONTS FROM THE SOUTHERN THOMSON OROGEN

Conodonts from the unnamed carbonate intervals within the Amphitheatre Group encountered in Louth L2 drillhole (Table 1; Figs 3-6) include a Pa element (Fig. 3b-d) and doubtfully assigned M and S (Fig. 3j-o) elements of *Caudicriodus woschmidti, Caudicriodus* sp. indet. (Pa element; Fig. 3e-f), *Caudicriodus* sp. indet. (coniform elements; Fig. 4a-p), Gen. et sp. indet. A (Fig. 3p), Gen. et sp. indet. B (Fig. 4q), Icriodontidae gen. et sp. indet. (Pa element; Fig. 3a), *Oulodus* sp. (Fig. 5n-q), *Oulodus astriatus*? Mathieson, Mawson, Simpson and Talent, 2016 (Fig. 6a), *"Ozarkodina" planilingua* Murphy and Valenzuela-Rios, 1999 (Fig. 5a-b), *Panderodus unicostatus* (Branson and Mehl, 1933), and *Zieglerodina remscheidensis* (Ziegler, 1960) (see Fig. 5c-m). A well preserved specimen (Fig. 3b-d) assignable to the Pa element of *C. woschmidti* was recovered from sample C2817 from 520.14-521.06 m depth in the L2 drillhole, and supports the correlation of this fauna with the typical basal Lochkovian *Caudicriodus woschmidti* Biozone recognized worldwide. Several broken specimens (Fig. 3e-f) recovered from samples C2530 and C2804 were assigned to *Caudicriodus* sp. indet. These likely represent the Pa element of *C. woschmidti*, but lack the diagnostic posterior part. Ramiform and coniform elements tentatively assigned to the species apparatus of *C. woschmidti* were also recovered from three samples in the Louth L2 drillhole (Table 1), and are identical with those documented by Serpagli (1983:pl. 7, A-D, H, I) from Europe. The Sc element (Fig. 3k-l, n-o) has a single denticle on the posterior edge, and the Sb element (Fig. 3j) typically has two denticles and a sharp blade-like protoprocess on the outer-lateral side. The M element is scandodiform, with the cusp proclined and also curved posteriorly (Fig. 3m). The other biostratigraphically important species recovered from the L2 drillcore samples is *"Ozarkodina" planilingua*, which is characterized by having larger basal platform lobes with a small terrace compared with the associated *Z. remscheidensis*. *"Ozarkodina" planilingua* has a stratigraphic range from the uppermost Přidoli to middle Lochkovian in North America and the Spanish Pyrenees (Murphy and Valenzuela-Rios 1999:text-fig. 1). In central New South Wales, *"O." planilingua* has a very similar range, extending through the uppermost Přidoli (uppermost *eosteinhornensis* Biozone) to lower Lochkovian (*woschmidti* Biozone) in the Camelford Limestone at the Gap, about 10 km NE of Cumnock (Farrell 2004).

EARLY DEVONIAN CONODONTS FROM THE LACHLAN OROGEN

In the Lachlan Orogen of central NSW, conodont faunas of Early Devonian age characterized by the occurrence of *C. woschmidti* were reported from the Amphitheatre Group of the northern Cobar Basin (Pickett 1987, 1988), the White Tank Limestone

Fig. 3 (next page). a, *Icriodontidae* gen. et sp. indet., Pa element, MMMC5173, from sample C2530 (Louth L2), upper view (IY310-020), b-d, *Caudicriodus woschmidti* (Ziegler, 1960). Pa element, MMMC5174, from sample C2817 (Louth L2), b, outer-lateral view (IY308-012), c, upper view (IY310-022), d, close up of upper view (IY310-023). e-g, *Caudicriodus* sp. indet., Pa element, e, MMMC5175, from sample C2804 (Louth L2), upper view (IY309-009); f, MMMC5176, from sample C2530 (Louth L2), upper view (IY279-022). g, MMMC5177, from sample C0986 (DDH K6), upper view (IY310-010). h, *Caudicriodus woschmidti* (Ziegler, 1960). Pa element, MMMC5178, from sample C964 (Belah Station), upper view (IY303-001). i, *Caudicriodus woschmidti*? (Ziegler, 1960). Pa element, MMMC5179, from sample C964 (Belah Station), upper view (IY303-002). j-o, ?*Caudicriodus woschmidti* (Ziegler, 1960). j, Sb element, MMMC5180, from sample C2804 (Louth L2), outer-lateral view (IY309-001); k-l, Sc element, MMMC5181, from sample C2817 (Louth L2), k, inner-lateral view (IY308-015), l, close up showing surface striation (IY308-016); m, M element, MMMC5182, from sample C2817 (Louth L2), outer-lateral view (IY308-023); n-o, Sc element, n, MMMC5183, from sample C2530 (Louth L2), anterior view (IY279-024); o, MMMC5184, from sample C2804 (Louth L2), outer-lateral view (IY309-002). p, Gen. et sp. indet. A, coniform (asymmetrical, short-based) element, MMMC5185, from sample C2530 (Louth L2), outer-lateral view (IY308-023). Scale bar 100 µm unless otherwise indicated.


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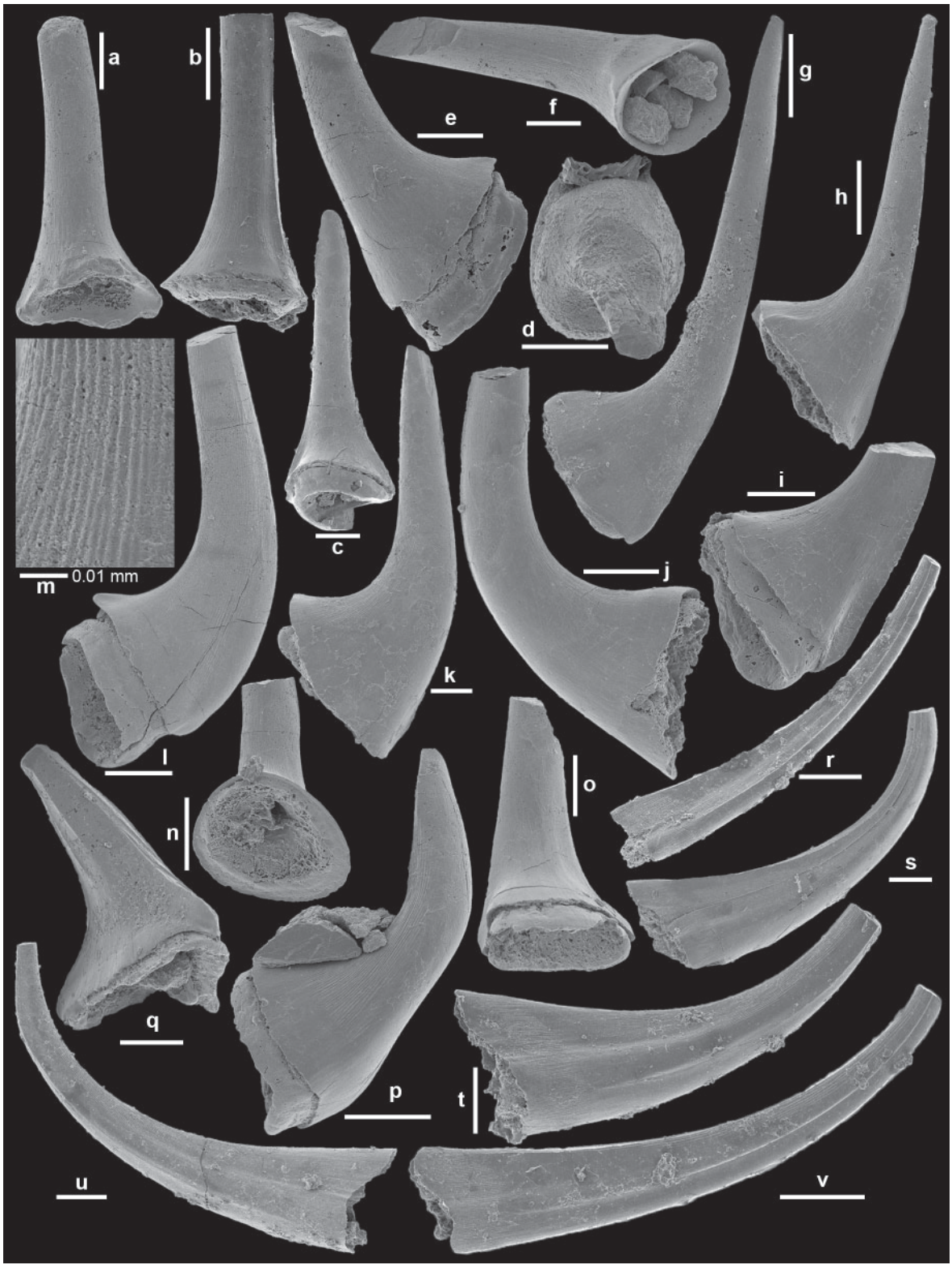

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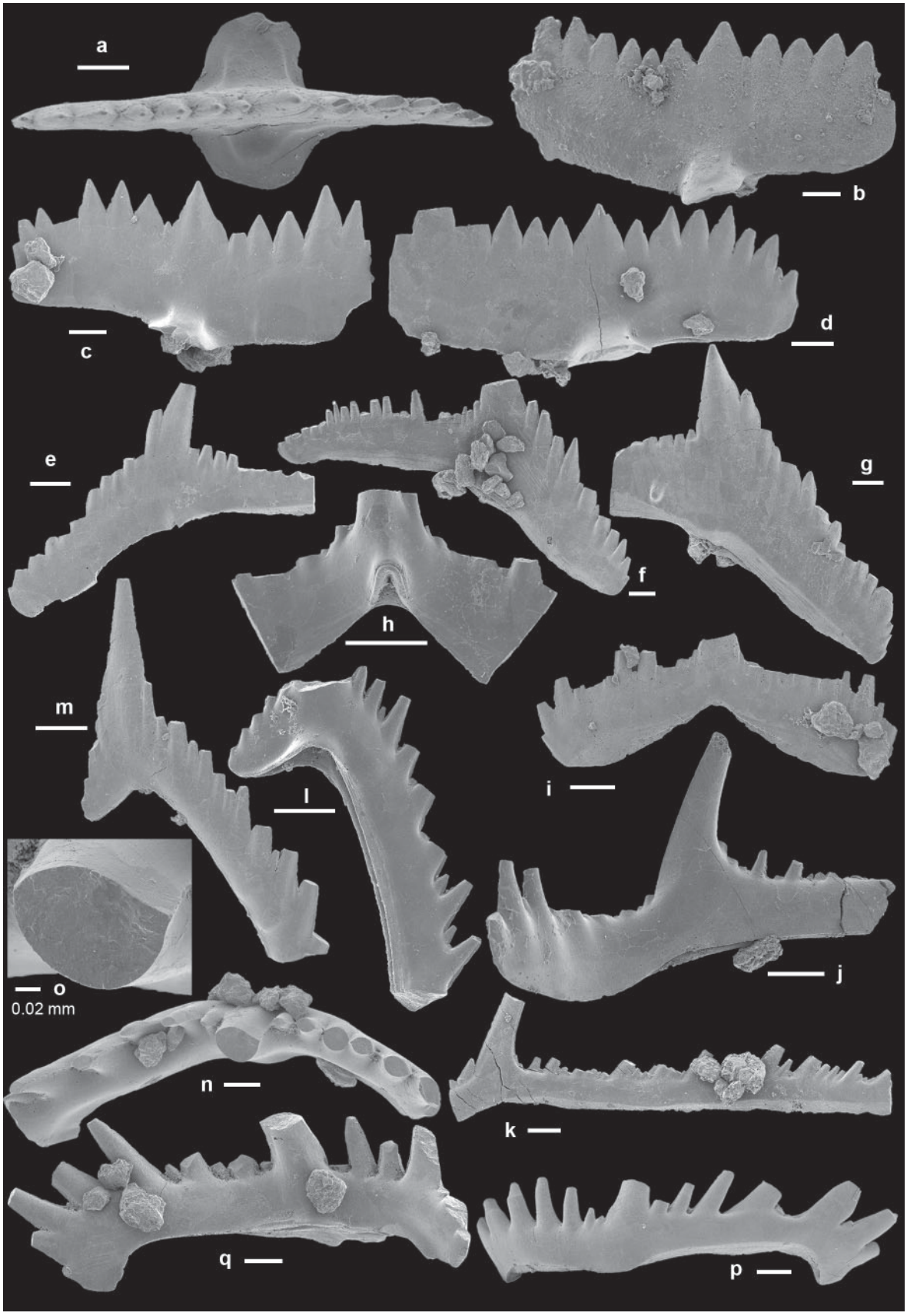
Fig. 4 (preceding page). a-p, *Caudicriodus* sp. indet. (coniform elements); a-d, Sa element; a, MMMC5194, from sample C2804 (Louth L2), posterior view (IY309-003); b, MMMC5195, from sample C2530 (Louth L2), posterior view (IY279-029); c, MMMC5196, from sample C2530 (Louth L2), posterior view (IY279-026); d, MMMC5197, from sample C2530 (Louth L2), upper view (IY280-002);e-i, Sb element; e, MMMC5198, from sample C2530 (Louth L2), outer-lateral view (IY280-003); f, MMMC5199, from sample C2817 (Louth L2), posterior view (IY308-021); g, MMMC5200, from sample C2804 (Louth L2), outer-lateral view (IY309-005); h, MMMC5201, from sample C2804 (Louth L2), inner-lateral view (IY309-004); i, MMMC5202, from sample C2804 (Louth L2), inner-lateral view (IY309-007); j-m, Sc element; j, MMMC5203, from sample C2804 (Louth L2), outer-lateral view (IY309-006); k, MMMC5204, from sample C2817 (Louth L2), upper view (IY308-020); l-m, MMMC5205, from sample C2530 (Louth L2), l, inner-lateral view (IY279-031), m, close up showing surface striation (IY279-032); n-o, Sd element; n, MMMC5206, from sample C2817 (Louth L2), basal-posterior view (IY308-017); o, MMMC5207, from sample C2817 (Louth L2), posterior view (IY308-018); p, Sc element, element, MMMC5208, from sample C2817 (Louth L2), outer-lateral view (IY308-022). q, Gen. et sp. indet. B, S? element, MMMC5209, from sample C2530 (Louth L2), inner-lateral view (IY279-028). r-v, *Panderodus unicostatus* (Branson and Mehl, 1933), all from sample C964 (Belah Station). r, qg element, MMMC5210, outer-lateral view (IY303-017); s, qa element, MMMC5211, outer-lateral view (IY303-010); t, qa element, MMMC5212, outer-lateral view (IY303-008); u, qg element, MMMC5213, outer-lateral view (IY303-011); v, qg element, MMMC5214, outer-lateral view (IY303-016). Scale bar 100 µm unless otherwise indicated.

Fig. 5 (next page). a-b, "*Ozarkodina*" *planilingua* Murphy and Valenzuela-Rios, 1999; Pa element; a, MMMC5215, from sample C2804 (Louth L2), upper view (IY309-018); b, MMMC5216, from sample C2530 (Louth L2), outer-lateral view (IY279-010). c-m, *Zieglerodina remscheidensis* (Ziegler, 1960). c-d, Pa element; c, MMMC5217, from sample C2817 (Louth L2), inner-lateral view (IY308-003); d, MMMC5218, from sample C2817 (Louth L2), outer-lateral view (IY308-008); e-g, Pb element; e, MMMC5219, from sample C2817 (Louth L2), inner-lateral view (IY308-002); f, MMMC5220, from sample C2817 (Louth L2), inner-lateral view (IY308-009); g, MMMC5221, from sample C2817 (Louth L2), outer-lateral view (IY308-001); h-i, Sa element; h, MMMC5222, from sample C2817 (Louth L2), posterior view (IY308-013); i, MMMC5223, from sample C2801 (Louth L2), posterior view (IY309-010); j-k, Sc element; j, MMMC5224, from sample C2817 (Louth L2), inner-lateral view (IY308-011); k, MMMC5225, from sample C2817 (Louth L2), outer-lateral view (IY309-011); l-m, M element; l, MMMC5226, from sample C2817 (Louth L2), posterior view (IY308-006); m, MMMC5227, from sample C2804 (Louth L2), anterior view (IY309-013). n-q, *Oulodus* sp.; Sb element, n-o, MMMC5228, from sample C2817 (Louth L2), n, upper view (IY309-014), o, close up showing cross section of cusp (IY309-015); p, MMMC5229, from sample C2817 (Louth L2), anterior view (IY308-010); q, MMMC5230, from sample C2817 (Louth L2), posterior view (IY308-004); Scale bar 100 µm.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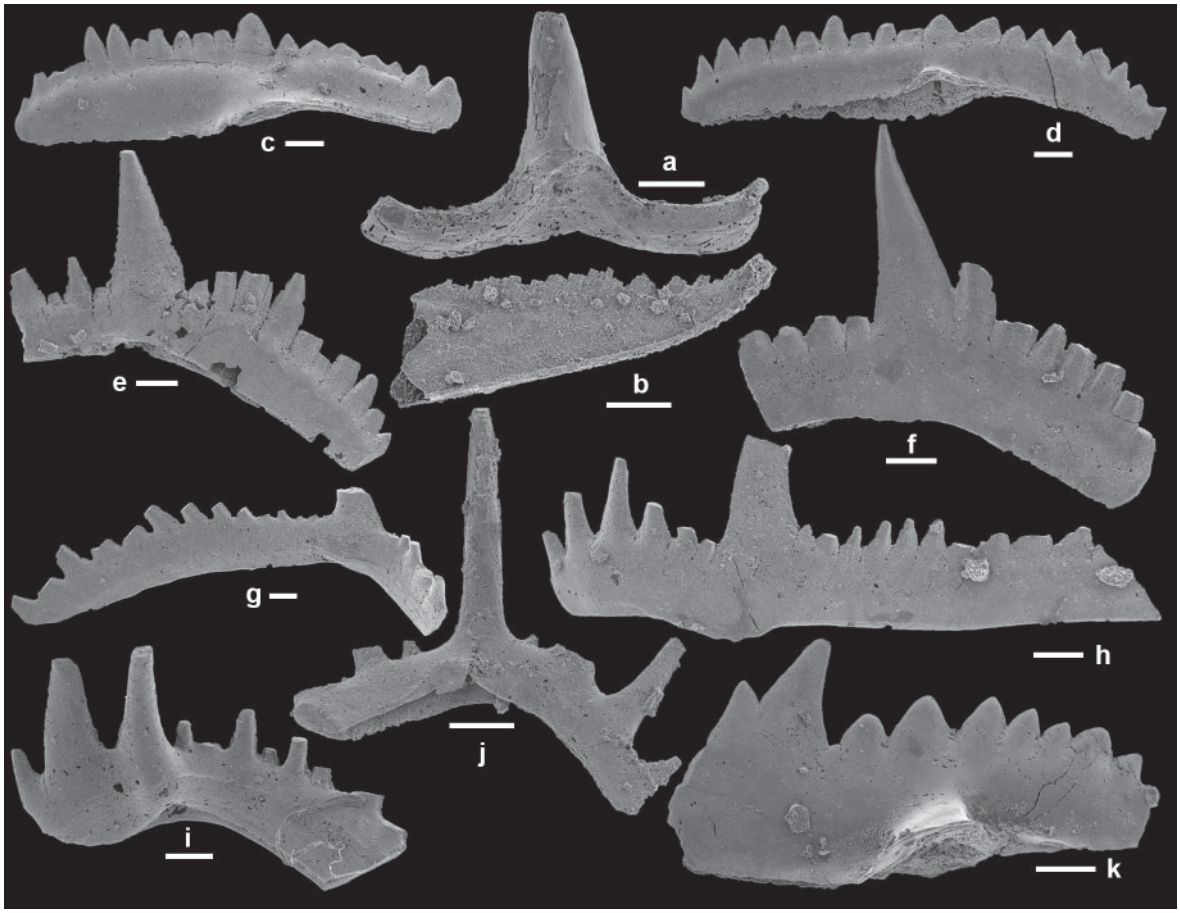


Fig. 6. a, *Oulodus astriatus*? Mathieson, Mawson, Simpson and Talent, 2016. Sa element, MMMC5231, from sample C2817 (Louth L2), posterior view (IY310-001). b, *Belodella resima* (Philip, 1965). Sc element, MMMC5232, from sample C0816 (DDH K1), inner-lateral view (IY308-006). c-h, *Wurmiella excavata* (Branson and Mehl, 1933). c-d, Pa element; c, MMMC5233, from sample C0987 (DDH K6), inner-lateral view (IY310-004); d, MMMC5234, from sample C0987 (DDH K6), outer-lateral view (IY310-005); e-f, Pb element; e, MMMC5235, from sample C0987 (DDH K6), inner-lateral view (IY310-002); f, MMMC5236, from sample C0987 (DDH K6), outer-lateral view (IY310-003); g-h, Sc element; g, MMMC5237, from sample C0987 (DDH K6), inner-lateral view (IY310-006); h, MMMC5238, from sample C0987 (DDH K6), posterior view (IY310-007). i-j, *Oulodus spicula* Mawson, 1986. i, Sb element, MMMC5239, from sample C0987 (DDH K6), posterior view (IY310-008); j, Sa element, MMMC5240, from sample C0986 (DDH K6), posterior view (IY310-011). k, *Pandorinellina exigua philipi* (Klapper, 1969). Pa element, MMMC5241, from sample C0987 (DDH K6), outer-lateral view (IY310-009). Scale bar 100 µm.

Member of the Meryula Formation (Kopyje Group) exposed immediately S-SE of Cobar (Pickett 1980), and from the Derriwong Group exposed NW of Bogan Gate (Pickett 1975) and in the Mineral Hill – Trundle area (Pickett, 1975, 1992).

Conodonts from two samples (C0986, C0987) collected from limestone intervals intersected in the borehole Getty Oil Kiri DDH K6 and initially reported by Pickett (1988) are re-evaluated herein. The following species were recognised (Table 1): *Caudicriodus* sp. indet. (Fig. 3g), *Oulodus spicula* Mawson, 1986 (Fig. 6i-j), *Pandorinellina exigua philipi* (Klapper, 1969) (Fig. 6k), *Panderodus unicostatus*, and *Wurmiella excavata* (Fig. 6c-h), with *P. unicostatus* being dominant. The only icriodiform specimen is incomplete with its posterior part broken, and is assigned to *C.* sp. indet. A prominent cusp exhibited by this specimen (Fig. 3g) indicates that it may be more comparable with *Caudicriodus postwoschmidti* (Mashkova, 1968). *Oulodus spicula*

was originally reported by Mawson (1986) from the Windellama Limestone (now Windellama Limestone Member of the Tangerang Formation – see Percival and Zhen 2017:39) of central NSW, and its association with *Caudicriodus postwoschmidti* at the type locality suggested a middle Lochkovian age (*eurekaensis* to *delta* biozones). However, later studies indicated that this species ranges into the lower Pragian (*sulcatus* Biozone; Wilson 1989; Farrell 2004). *Pandorinellina exigua philipi* is widely distributed with a stratigraphic range extending from the upper Lochkovian (*pesavis* Biozone) to upper Emsian (*patulus* Biozone). Therefore, co-occurrence of these species in the sampled interval of the DDH K6 drillcore supports a middle–late Lochkovian age for that level.

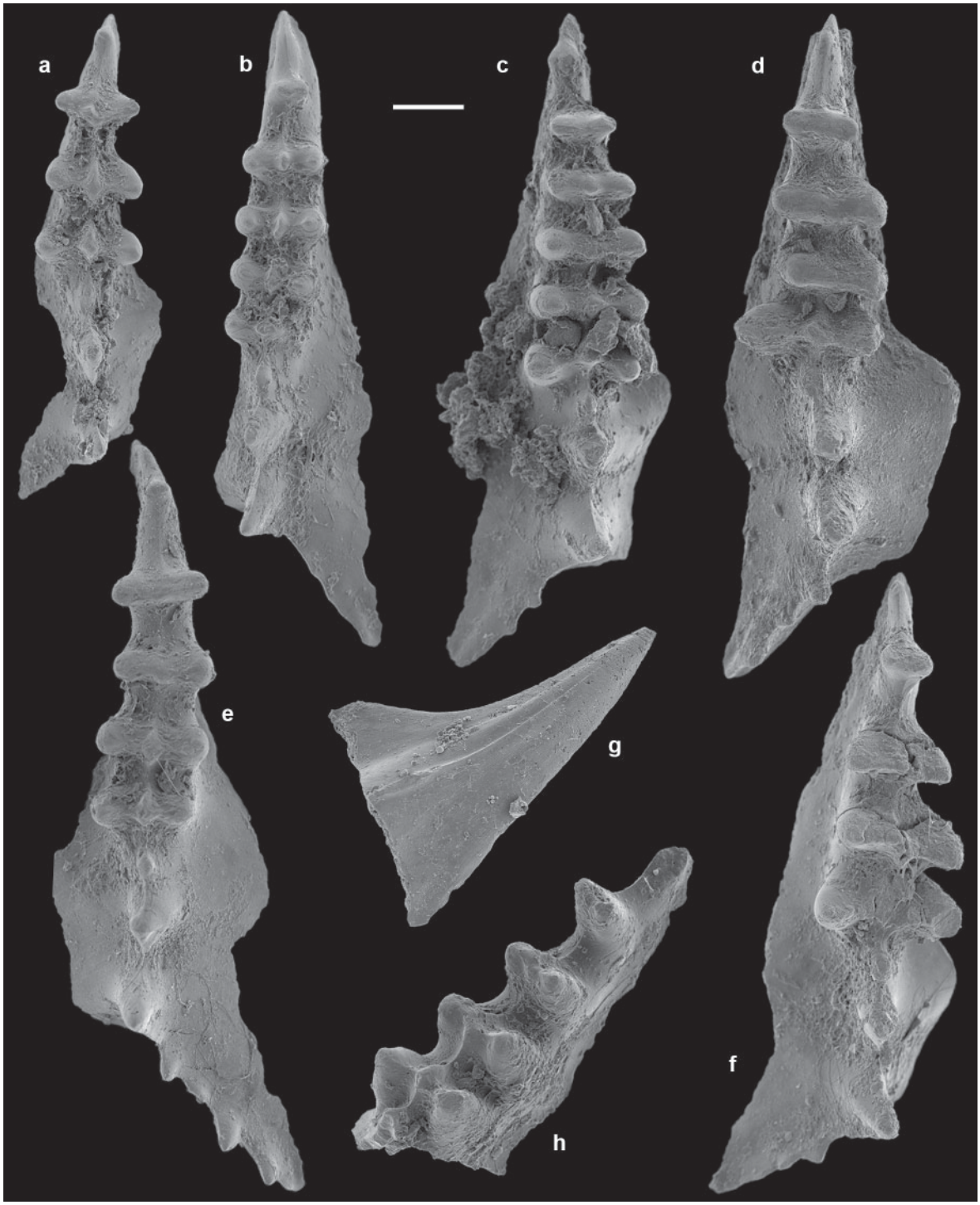
Conodonts recovered from samples C0816 and C0817, taken from a carbonate interval encountered in the nearby Getty Oil Kiri DDH K1 drillhole (Pickett, 1984), are not diagnostic of a precise age, comprising only *Belodella resima* (Philip, 1965) (Fig. 6b), *Panderodus unicostatus* and *Pandorinellina exigua philipi*, with the latter species implying a generally Early Devonian age. However, *Amydrotaxis johnsoni* was subsequently found at a comparable depth of 93.22-93.96 m in DDH K1, indicating a Lochkovian (*delta* or *pesavis* zones) age (Mawson 2006).

A closely comparable conodont assemblage to that found in L2 and Kiri DDH K6 was reported by Pickett (1987) from a unnamed limestone lens (sample C0964) of the Amphitheatre Group, exposed 400 m east of Stoney Tank (Belah Station) in the Gunderbooka district of the northern Cobar Basin. It includes *Caudicriodus woschmidti, Panderodus unicostatus*, and *Zieglerodina remscheidensis* with *P. unicostatus* as the dominant species (Table 1). Occurrence of *C. woschmidti* (Fig. 3h-i) in the fauna suggests an early Lochkovian age (the *Caudicriodus woschmidti* Biozone). However, samples from this area yielded a diverse conodont fauna of late Pragian age (Mathieson et al. 2016), suggesting that they were derived from a younger carbonate interval exposed in the area.

Pickett (1980:69) interpreted an early Lochkovian age (late *woschmidti* Biozone) for the White Tank Limestone Member of the Meryula Formation based on the occurrence of *Caudicriodus woschmidti*, and a late Lochkovian (*pesavis* Biozone) for the Rookery Limestone Member (also of the Meryula Formation) mainly on the occurrence of *Pedavis pesavis* and absence of *Caudicriodus woschmidti*. However, Mathieson et al. (2016) considered both units to be of Pragian age (late *sulcatus* Biozone). They reported the co-occurrence of *Caudicriodus ampliatus* Mathieson, Mawson, Simpson and Talent, 2016 with *Zieglerodina remscheidensis*, *O.* sp. cf. *O. eurekaensis* (Klapper and Murphy, 1975), *Oulodus* sp. cf. *O. walliseri* (Ziegler, 1960), *Panderodus* spp., and *Wurmiella wurmi* (Bischoff and Sannemann, 1958) in the White Tank Limestone Member, and argued that significant compositional differences in faunas recovered from the two limestone members within the Meryula Formation were attributable to facies differences – according to Felton (1981) the White Tank Limestone Member was deposited in the forereef setting, laterally grading into the Rookery Limestone Member of the backreef facies. Alternatively, the apparent faunal differences might suggest the periodical exposure and erosion of the shallow water, reefal carbonates, which resulted in the mixing of conodont assemblages of different ages (Thomas Suttner, pers. comm. 2017).

Samples C0227-C0230 from the Derriwong Group exposed about 7 km NNE of Trundle township reported by Pickett (1975) yielded *Caudicriodus woschmidti* (Fig. 7a-g), *Wurmiella excavata,* and *Panderodus unicostatus*. A specimen likely conspecific with *C. woschmidti* but lacking the diagnostic posterior part also occurs in a sample (C0001; Fig.

Fig. 7 (next page). a-g, *Caudicriodus woschmidti* (Ziegler, 1960) from the Derriwong Group of the Lachlan Orogen in central western New South Wales; a-f, Pa element, g, Pb element; a, MMMC5186, from sample C0230, juvenile specimen without denticles on the posterior process, upper view (IY310-021); b, MMMC5187, from sample C0230, juvenile specimen with tendency of rudimentary denticles on the posterior process, upper view (IY310-019); c, MMMC5188, from sample C0228, specimen with weakly-developed denticles on the posterior process, upper view (IY310-017); d, MMMC5189, from sample C0228, specimen with well-developed denticles on the posterior process, upper view (IY310-016); e, MMMC5190, from sample C0227, specimen with well-developed denticles on the posterior process, upper view (IY310-013); f, MMMC5191, from sample C0227, specimen with weakly-developed denticles on the posterior process, upper view (IY310-014); g, MMMC5192, from sample C0227, outer-lateral view (IY310-015). h, *Caudicriodus* sp., Pa element, MMMC5193, from sample C0001, Yarrabandai Formation of the Lachlan Orogen in central western New South Wales, upper view (IY310-018). Scale bar 100 µm (specimens are illustrated at the same magnification).



7h, Table 2) originally reported by Pickett (1975) from the Yarrabandai Formation exposed NW of Bogan Gate along with *Zieglerodina remscheidensis* and *Panderodus unicostatus*. However, a spot sample from a small limestone exposure about 10 km SSW of Trundle township produced a diverse assemblage of younger age (Mathieson et al. 2016:fig. 32A-O). It includes *Caudicriodus ampliatus, Eognathodus sulcatus lanei* Mathieson, Mawson, Simpson and Talent, 2016, *Ozarkodina paucidentata* Murphy and Matti, 1982, *Ozarkodina selfi* Lane and Ormiston, 1979*, Panderodus unicostatus, Wurmiella excavata,* and *Zieglerodina remscheidensis,* indicative of the early Pragian *sulcatus* Biozone.

CONCLUSIONS

Low diversity conodont faunas of Early Devonian age were recovered from four sites (three drill cores and one outcrop) in the vicinity of the boundary between the Thomson Orogen and the Lachlan Orogen in northwest NSW. The rare occurrence of *Caudicriodus woschmidti* in both the Louth L2 drill core and the exposure in the Gunderbooka district indicates the presence of the *Caudicriodus woschmidti* Biozone of Lochkovian age. Recognition of correlative units of Lochkovian age on either side of the Olepoloko Fault marking the boundary between the Thomson Orogen to the north from the Lachlan Orogen (northern Cobar Basin and Kopyje Shelf) to the south implies that the reactivation of this major fault took place no earlier than the late Early Devonian (Emsian). The study also has important ramifications for constraining the age of the Louth Volcanics, which in Louth L2 overlie the calcareous units containing Lochkovian conodont faunas. This supports the maximal U/Pb detrital zircon dating age of 422 Ma obtained by Glen et al. (2010) from volcanogenic sandstone within the volcanic succession at a depth of 139 m in drillhole L2, and indicates that the actual depositional age of this bed is slightly younger.

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