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# Late Ordovician Conodonts from the Olistostromal Wisemans Arm Formation (New England Region, Australia)

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2 Text-Figures, 2 Tables and 4 Plates

*Australia*
*Ordovician*
*Conodonts*
*Olistoliths*
*Biochronology*

## Contents



## Oberordovizische Conodonten aus der olistostromen Wisemans Arm Formation (New England, Australien)

### Zusammenfassung

Allochthone Kalke von sieben Lokalitäten der olistostromen Wisemans Arm Formation der New-England-Faltenkette haben eine Fauna von einigen 700 Conodonten erbracht, die 24 Arten zugeteilt werden. Die Vergesellschaftung gleicht anderen, die kürzlich vom Lachlan Fold Belt im zentralen New South Wales dokumentiert wurden, insofern als sie eine Mischung von Arten enthält, die für mehrere spätordovizische Faunenprovinzen charakteristisch ist. Die Fauna wird dominiert durch *Panderodus gracilis* und *Belodina confluens* und enthält *Taoqupognathus tumidus*, *Yaoxianognathus ani* und *Panderodus nodus*, die ein spätes Eastonium-Alter (Ea3) angeben. Die Wisemans-Arm-Fauna ist vergleichbar mit derjenigen, die von den Trelawney-Schichten des Tamworth Belt bekannt sind, indem sie eine Verbindung zwischen den zwei wesentlichen tektonischen Einheiten des New-England-Faltenzuges vermitteln. Die Conodontenfaunen und Kalke weisen auf die Präsenz – während des späten Ordoviziums – von ozeanischen Vulkaninseln mit assoziierten Kalkriffen in diesem Gebiet hin.

### Abstract

Allochthonous limestone from seven localities in the olistostromal Wisemans Arm Formation of the New England Fold Belt has yielded a fauna of some 700 conodonts, assigned to 24 species. The assemblage is similar to others recently documented from the Lachlan Fold Belt in central New South Wales in comprising a mixture of species characteristic of several Late Ordovician faunal provinces. The fauna is dominated by *Panderodus gracilis* and *Belodina confluens* and includes *Taoqupognathus tumidus*, *Yaoxianognathus ani* and *Panderodus nodus*, indicating a Late Eastonian (Ea3) age. The Wisemans Arm fauna is comparable with that known from the Trelawney Beds of the Tamworth Belt, providing a link between the two major tectonic elements of the New England Fold Belt. The conodont fauna and limestone indicates the presence, during the Late Ordovician, of oceanic volcanic islands with associated limestone reefs in this region.

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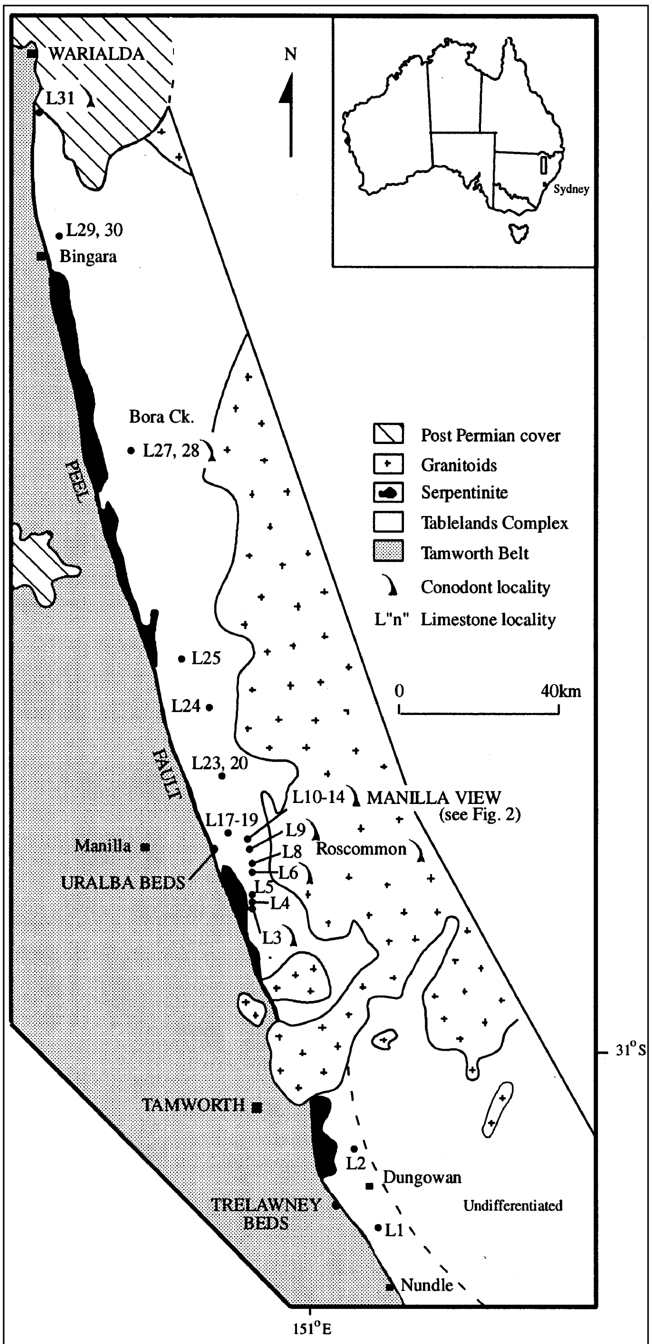
## 1. Introduction

Late Ordovician rocks crop out intermittently between Nundle and Warialda, east of the Peel Fault in the New England Fold Belt, northeastern New South Wales (Text-Fig. 1). Although a number of palaeontological reports concerning rocks in this area have documented ages ranging from Ordovician through Early Carboniferous (eg. CHAPPELL, 1961; PICKETT, 1973, 1982; HALL, 1975, 1978; LEITCH & CAWOOD, 1980; ISHIGA, 1988; ISHIGA et al., 1988; AITCHISON, J.C., 1993), none was based on investigation of more than isolated or a few localities. The need for a better data base prompted investigation of limestone outcrops along 250 km of strike with the principal aims of improving precision and understanding of the ages of the carbonates and evaluating their tectonic implications for the New England Fold Belt.




Text-Fig. 1.
Location of area investigated herein, major structural elements and representative limestone/conodont localities.

The presence of limestone outcrops in the tract just east of the Peel Fault has been reported sporadically for over a century (eg., DAVID, 1891; BENSON, 1913; CARNE & JONES, 1919; CHAPPELL, 1961; LISHMUND et al., 1986; LEITCH & CAWOOD, 1980). These, and a number of unpublished reports have led to the identification of more than 50 localities. Present work has involved the sampling of these (some, poorly specified localities, could not be located) and a number of additional outcrops have been found. Text-Fig. 2 indicates numerous carbonate occurrences east of Manilla, reflecting a number of detailed mapping efforts in that area (eg. CHAPPELL, 1961 and LEITCH & CAWOOD, 1980), and attests to the likelihood that small limestone bodies in the area of concern are relatively common.

Table 1 summarises locality details and outcrop data. The limestones examined herein are all considered to be allochthonous, often exposed as debris flows (Text-Fig. 2), and have a clast size ranging from sub-cm in conglomerates to olistoliths of several hundred meters. Limestones producing conodonts are characteristically recrystallised fine sands probably deposited in shallow settings, and contain rare small, rounded volcanic grains. The limestone blocks are hosted by a matrix of volcaniclastic sediments comprising a spectrum from conglomeratic to fine silt and mudstones. Results of investigation into sediment lithological and depositional characteristics will be published elsewhere.

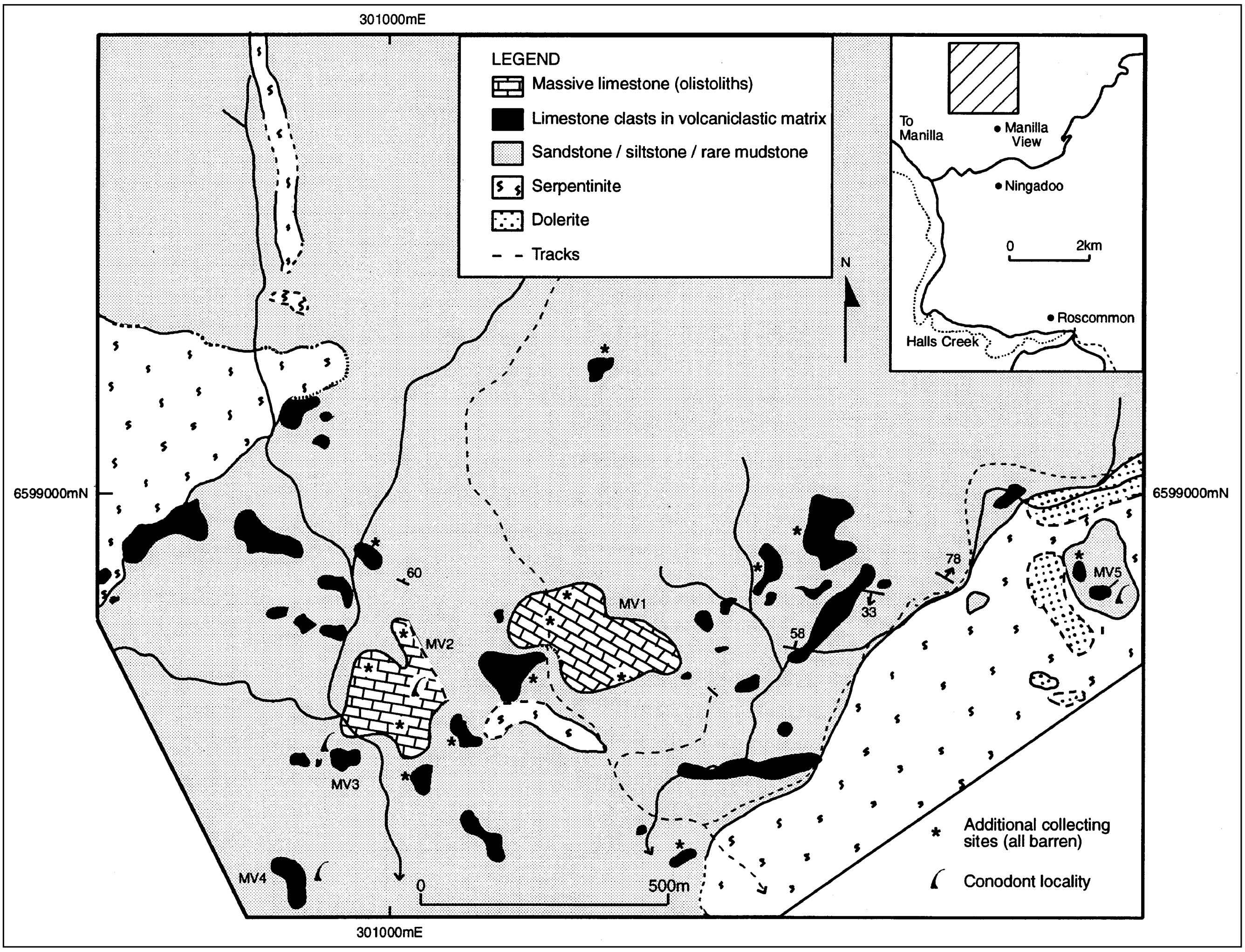
## 2. Geological Setting

The southern part of the New England Fold Belt is divided by the Peel Fault System into a western magmatic arc and forearc basin succession (Tamworth Belt), and an eastern subduction-accretion complex (Tablelands Complex) (LEITCH, 1974), that is the focus of this investigation.

Stratigraphic nomenclature used by various authors in the intensely deformed Tablelands Complex immediately east of the Peel Fault (Text-Fig. 1) was summarised by CROOK (1961), he applied the name Woolomin Beds to the area. This has since been revised. CAWOOD (1980) and LEITCH & CAWOOD (1980) recognised two main units in the Attunga-Halls Creek area, the Woolomin and Wisemans Arm formations. The structurally lowest Woolomin Formation and its lateral correlatives extend for approximately 250 km from Warialda in the north to the Manning River headwaters, bounded by the Wisemans Arm Formation (WAF) and lateral correlatives to its west and the New England granitoids to the east, and is characterised by repeated slices of metabasalt, chert and siltstone with rare outcrops of sandstone and pebbly siltstones (CAWOOD, 1980). The WAF was defined by LEITCH & CAWOOD (1980) as a fault bounded unit cropping out between the Peel Fault in the west and the Mount Abundance Fault in the east. Lithological components include siltstone, tuff, sandstone and olistostromal conglomerates that contain olistoliths of chert and limestone in a volcaniclastic matrix of andesitic and basaltic provenance (CAWOOD, 1983). Present field work extends the WAF tract north to the Bungendore Spur area (FUREY-GREIG, in prep). CAWOOD (1980) mapped correlative rocks to the south between Nundle and Piallamore; AITCHISON et al. (1988) correlated the WAF with the Nangarah Formation in the Woodsreef-Bingara area to the north. Lithological similarities were considered by LEITCH & CAWOOD (1980) as evidence for provenance links between chert olistoliths in the WAF and

Table 1.
Summary of locality, outcrop and microfossil details.
cr = crinoid fragments; cnd = conodonts; crl = corals; oc = ostracoda; sc = scolecodonts; b = brachiopoda.

| LOCALITY | GRID & 1:25,000 Sheet | FORMATION | DESCRIPTION | OUTCROP AREA | FOSSILS | AGE | COMMENTS |
|---|---|---|---|---|---|---|---|
| 1 Wallaby Mtn. | 2050.3500 Woolomin | Wisemans Arm | deformed clasts | c. 50x50m | barren | no data | scattered clasts on W side of ' Mtn. |
| 2 Piallamore | 1580.5115 Dungowan | Wisemans Arm | altered clasts | 20x5m | barren | no data | loose boulders W of fence |
| **3 Springwater** | 0110.8560 Klori | Wisemans Arm | olistoliths & clasts | 35x10m | cnd. | indet. | c. 350m upslope from creek |
| 4 Serpentinite Hill | 0065.8660 Klori | Wisemans Arm | sheared clasts | 40x20m | barren | no data | c. 300 upslope from bend in road |
| 5 Parish Boundary | 0085.8735 Klori | Wisemans Arm | olistolith & clasts. | 20x20m | cr | no data | adj. to boundary fence |
| **6 Lone Boulder** | 0190.9140 Klori | Wisemans Arm | single megaclast | 1x1m | cnd. | Eastonian | probably = Cawood'80&Pickett'73 |
| 7 Wisemans Arm Rd. | 0180.9160 Klori | Wisemans Arm | clasts in congl. | 5x5m | barren | no data | next to fence |
| **8 Roscommon 1** | 0230.9280 Klori | Wisemans Arm | clasts, 1cm-2m | 500x100m | cnd,sc,crl | Eastonian | extends N from new road cutting |
| **9 Ningadoo South** | 0250.9585 Klori | Wisemans Arm | coarse sand & clasts | 200x75m | cnd | Eastonian | on SW side of creek |
| 10 Manilla View 1 | 1340.9880 Mundowey | Wisemans Arm | olistolith & clasts | 300x100m | barren | no data | straddles intersection of 4wd tracks |
| 11 Manilla View 2 | 1330.9870 Mundowey | Wisemans Arm | olistolith & clasts | 250x100m | cd,cr,oc | indet | extends S from new dam |
| **12 Manilla View 3** | 1200.8960 Mundowey | Wisemans Arm | clasts+ ?olistolith | 25x10m | cd | Eastonian | ? SW extension of MV2 |
| **13 Manilla View 4** | 0120.9860 Mundowey | Wisemans Arm | scattered clasts | 75x30m | cnd | Eastonian | S & adjacent to fence |
| **14 Manilla View 5** | 0150.9870 Mundowey | Wisemans Arm | clasts in skarn | 20x20m | cnd | Eastonian? | blocks adjacent to dolerite |
| 15 WG 116 | 1500.9900 Mundowey | Wisemans Arm | clasts in congl. | 200x50m | barren | no data | c. 200m upslope from creek |
| 16 Glen Bell 1 | 0230.9930 Mundowey | Wisemans Arm | clasts in congl. | 5x5m | barren | barren | next to track, 25m E of gate |
| 17 Ukolan 1 | 9830.9940 Mundowey | Wisemans Arm | megaclasts & clasts | 10x25m | barren | no data | on lower part of slope, N of creek |
| 18 Ukolan 2 | 9790.9950 Mundowey | Wisemans Arm | megaclasts & clasts | 50x80m | barren | no data | adjacent & on E side of gully |
| 19 Killarney | 9710.9990 Mundowey | Wisemans Arm | megaclasts & clasts | 60x10m | barren | no data | E of windmill; |
| 20 Windfall Valley | 9540.1230 Welsh | Wisemans Arm | olistolith & clasts | c.200x75m | barren | no data | W of watertank |
| 21 Dunmore S-1 | 9430.0450 Mundowey | Wisemans Arm | clasts | 10x5m | barren | no data | on W side of Glenbara Road |
| 22 Dunmore S-2 | 9380.0650 Mundowey | Wisemans Arm | deformed clasts | 15x50m | barren | no data | up steep slope, SW side of track |
| 23 Dunmore N-1 | 9585.1195 Welsh | Wisemans Arm | megaclasts (c. 2m) | 20x2m | barren | no data | 2 small O/C's, adj. to fence on hill |
| **24 Pera South** | 9325.2285 Welsh | ?Wisemans Arm | olistolith & clasts | 500x80m | cnd. | indet. | extends from S boundary of "PERA" |
| 25 Rocky Creek | 8565.3720 Linton | ?Wisemans Arm | clasts in red matrix | 10x3m | barren | no data | in W bank of Rocky Ck. |
| 26 Gulf Cr. smelter | 7680.5730Cobbadah | ?Woolomin | stockpile, local l\s | N/A | barren | no data | quarry inaccessible |
| 27 Bora 1 | 7070.8360 Dinoga | Nangarah | thermally altered | 2x5m | barren | no data | S of & next to fence, 500m E of creek |
| **28 Bora 2** | 7070.8350 Dinoga | Nangarah | thermally altered | 2x5m | cnd | indet | c. 250m SSW from Bora 1 |
| 29 Lochiel 2 | 6760.9600 Bingara | Nangarah | blasted blocks | 5x5m | barren | unknown | small quarry close to fence |
| 30 Lochiel 1 | 6750.9650 Bingara | Nangarah | blasted blocks | 5x5 | barren | unknown | small quarry on 4wd track |
| **31 Balfour** | 6370.1680 Mt. Rodd | ?Nangarah | megaclasts & clasts | 250x75m | cnd | Late Ord. | c. 1000m N from road |
| **32 Kellys Gully** | 6365.2455 Warialda | Undifferentiated | altered clasts | 300x50m | cnd | indet. | extends S from railway |




Text-Fig. 2.
Geological map of the Manilla View area (Localities 10–14), showing debris flow of limestone olistoliths and conglomerate in the Wisemans Arm Formation.

the Woolomin Formation, and between intermediate volcanic detritus and the Tamworth Belt arc volcanics.

Age determinations of limestones from the WAF vary from Ordovician to Early Devonian for limestones (Chappell, 1961; Hall, 1975, 1978; Pickett, 1982; Leitch & Cawood, 1980); an Early Carboniferous date was advanced for allochthonous chert, based on radiolaria (Ishiga et al., 1988). At least ono of the two reported Early Devonian limestones (Leitch & Cawood, 1980), Locality #6 herein, is in fact Eastonian. Samples from another locality proved barren, and the third was not located. The Early Devonian age reported should be regarded as unreliable as the diagnostic fossils quoted (never illustrated and now lost) have superficially identical forms in the late Ordovician (see Discussion). As recent research in the Tamworth Belt on Early Devonian conodonts (Furey-Craig, 1995; Mawson et al., 1995) has demonstrated the unreliability of biostratigraphic correlation using radiolaria to date New England sediments, Early Carboniferous dates in the WAF need to be substantiated by conodont data. Siliceous matrix sediments hosting the olistoliths are currently being processed for conodonts using the method described by Orchard (1987) and Fowler & Iwata (1995).

Mapping by Leitch & Cawood (1980) and present field work indicate that sub-units within the WAF that include either chert or limestone olistoliths appear to be mutually exclusive. Silurian age assignments based on conodonts, from Woolomin Formation chert (Ishiga et al., 1988) and from one limestone questionably within the WAF (Pickett, 1982), with Silurian (Late Llandoverian) corals reported from the same locality (Hall, 1978) [Locality 4 herein], might restrict the age of the WAF to no older than Early Silurian, but structural complexity in the area investigated raises the possibility that thin slices of early Palaeozoic strata are preserved within the WAF.

The current examination of siliceous rocks and associated detailed mapping should assist in further resolving the age of the WAF. Correlation between the WAF conodont fauna and conodonts from the Uralba Beds east of Manilla (Furey-Greig, in prep), and a fauna reported from the Trelawney Beds (Philip, 1966), south-east of Tamworth (see Discussion) has elucidated the palaeogeography of New England during the Late Ordovician.

## 3. Biostratigraphy

It is evident from data presented in this report that the Wisemans Arm conodont fauna is strikingly similar to material recently documented from Lachlan Fold Belt localities, namely the Malongulli Formation (Trotter & Webby, 1994) and the Downderry Member of the Ballingoole Limestone, Bowan Park Group (Zhen et al., 1998).

Trotter & Webby (1994) used graphical methods to correlate the Malongulli fauna with the *Oulodus velicuspis* zone of the North America Mid-continent system, with that determination underpinned by co-occurring graptolites of Late Eastonian (Ea3) age. The WAF fauna includes several species present in the Malongulli Formation, eg, *Belodina confluens* SWEET (12 % of the WAF material) and *Periodon grandis* (ETHINGTON) (2 %). More importantly, *Taoqupognathus tumidus* TROTTER & WEBBY has only previously been described from the abovementioned Lachlan Fold Belt occurrences and from the Carriers Well Formation (SIMPSON, 1997) and Fork Lagoons Beds (PALMIERI, 1978) in Queensland. *Panderodus nodus* ZHEN et al. and *Yaoxianognathus ani* ZHEN et al. are reported from the same units, as well as from Late Ordovician Chinese faunas (ZHEN et al., 1998). All are here described from the WAF fauna, indicating a Late Eastonian (Ea3) age for these limestones.

The WAF fauna, including species previously considered as representative of several "Faunal Provinces" as recognised by BERGSTRÖM (1990), adds to a growing list of similar eastern Australian faunas. NOWLAN et al. (1997) assessed such faunas and established a new "Australasian Province", within the Midcontinent Faunal Region (their Fig. 2).

## 3.1. Correlation with Other Eastern Australian Occurrences

PHILIP (1966) documented conodonts from coralline limestone of the "Trelawney Beds" southeast of Tamworth, including *B. confluens*, *Phragmodus undatus* and *Panderodus gracilis*, a fauna similar to that from the WAF. The Trelawney Beds, represented by loose blocks scattered in a field were interpreted by PHILIP as derived from a fault bounded remnant of a Late Ordovician unit adjacent to the Peel Fault System. CAWOOD (1980) remapped the area and considered that the limestones were Ordovician olistoliths within the Drik Drik Formation of the Tamworth Belt, known to be of Early Devonian (Emsian) age (FUREY-GREIG, 1994, 1995). The presence of such clasts elsewhere in the Drik Drik Formation has been demonstrated by CAWOOD (1980).

HALL (1975) reported a Late Ordovician coral fauna from the Uralba Beds, east of Manilla, an apparently fault bounded unit within the Peel Fault System. Recent collecting from the same locality has produced a conodont fauna that is correlatable with the WAF material (FUREY-GREIG, in prep.).

PALMIERI (1978) described a large fauna from the Fork Lagoons Beds in east-central Queensland that included *B. confluens*, *P. undatus* and *T. ?tumidus*. The stratigraphic and structural context of that unit is poorly understood, but the limestone may be correlated with the WAF material.

SIMPSON (1997) reported a fauna including *T. tumidus* and *B. confluens* from the Carriers Well Formation of north Queensland.

## 3.2. Comments on Supposed Silurian and Devonian Reports from the Wisemans Arm Formation

### 3.2.1. Silurian

A reported Silurian limestone (Loc. 4, Serpentinite Hill herein) proved barren in this investigation. BRADLEY (in PICKETT, 1982) reported *Kockelella variabilis* WALLISER from the locality and HALL (1978) documented a coral fauna also from this outcrop including *Acanthohalysites pycnoblastoides* (ETHERIDGE) and halysitids. This outcrop lies within a large mass of serpentinite mapped within the WAF (LEITCH & CAWOOD, 1980) and considered by HALL (1978) to lie on a strand of the Peel Fault System, and thus cannot be demonstrated to be a component of the WAF.

### 3.2.2. Devonian

An Early Devonian age was advanced for some limestones in the WAF (CAWOOD, 1980; LEITCH & CAWOOD, 1980).

The material on which the age determinations were based has since been lost. "*Belodella resima*" was reported from an outcrop equivalent to Loc. 6 (Lone Boulder) herein, a single olistolith that yielded Eastonian conodonts. It seems likely that the element was misidentified, probably being a denticulate element of *Ansella*. Similarly, "*Icriodus* sp." and "*B. triangularis*" reported from CAWOOD's (1980) #UP 79138, Loc. 1, (Wallaby Mtn.) herein, may represent elements of *Icriodella* and *Ansella* respectively (this outcrop proved barren herein). Similarly, "*B. triangularis*" from #UP 79129, not located in the present investigation, cannot be verified.

### 3.2.3. Palaeoenvironment and Tectonic Setting

Conodont producing clasts from the WAF are generally recrystallised, but preserve evidence of relatively shallow conditions. They are fine grained detrital limestones with allochems including ostracods, echinoid fragments, brachiopod and trilobite remains and approximately 80 % fine, recrystallised grains with micritic envelopes, probably deposited at no greater than shelf depths. Clasts of well washed, favositid coralline limestone (barren when processed for conodonts) also occur at some localities (eg. Roscommon). The two lithologies represent a depth range that accords with presence in the fauna of species indicative of shallow environments, eg. *Belodina confluens* SWEET and others characteristic of deeper water, eg. *Periodon grandis* (ETHINGTON) and *Phragmodus undatus* BRANSON & MEHL (TROTTER & WEBBY, 1994).

Some limestone clasts from Loc. 8 (Roscommon) contain rounded felsic volcanic grains, evidence for input of volcanic detritus at time of limestone deposition. This, and the considerable lateral extent of Late Ordovician limestone outcrops (Fig. 1) [Late Ordovician conodonts were reported from the vicinity of Loc. 23, herein barren, (PICKETT, 1973, 1982) extending the extent of Late Ordovician outcrops east of Manilla], provide evidence for a chain of volcanic edifices with flanking reefal limestone platforms and associated carbonate fans, possibly located west of the area studied.

SCHEIBNER (1973) suggested that Ordovician limestone occurrences east of the Peel Fault System were offscraped guyot cappings. Preserved guyot elements are characterised by associations of metabasalt, limestone and spicular& radiolarian cherts (eg. SANO & KANMERA, 1980). Such associations have not, thus far, been observed in any WAF limestone outcrops examined.

Correlation between the WAF fauna and that from the Trelawney Beds (PHILIP, 1966), and the close affinity of both with the Lachlan Fold Belt occurrences discussed earlier provides evidence that the two major tectonic elements of the New England Fold Belt developed in relative juxtaposition. This supports arguments that Early Palaeozoic elements in the New England Fold Belt are unlikely to have an exotic origin (LEITCH & CAWOOD, unpub. manuscript).

Table 2.
Distribution of conodont elements.

| LOCALITY / SPECIES | SPRING WATER | LONE BOULDER | ROSCOMMON Clast No. 1 | 6 | 7 | 11 | 21 | NINGADOO SOUTH | MANILLA VIEW 2 | 3 | 4 | 5 | PERA SOUTH | BORA 2 | BALFOUR | KELLY'S GULLY |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *Ansella sp.* | | | | 7 | | 2 | 4 | | | 1 | | | | | 1 | |
| *Belodina confluens* | | 14 | 1 | 35 | 7 | 22 | 10 | 2 | | 4 | 9 | 2 | | | | |
| *Belodina* sp. A | | | | | | | | | | | | | | | 1 | |
| *Belodina* sp. B | | 1 | | | | | | | | | | | | | | |
| *Belodina* sp. C | | 4 | | | | | | | | | | | | | | |
| *Belodina* sp. D | | 1 | | | | 1 | | | | | 1 | | | | | |
| *Belodina? sp.* E | | | | | 1 | | | | | | | | | | | |
| *Drepanoistodus suberectus* | | | | 3 | | 6 | 7 | | | | | | | | | |
| *Panderodus gracilis* | 16 | 3 | | 36 | 2 | 47 | 55 | 9 | 7 | 5 | 6 | | | 9 | 3 | |
| *Panderodus panderi* | | | | 10 | | 7 | 7 | | | | 1 | | | | | |
| *Panderodus nodus* | | | | 9 | | 10 | 11 | | | 2 | | | | | | |
| *Panderodus* sp. 1 | | | | 2 | | 2 | 5 | | | | | | | | | |
| *Panderodus* sp. 2 | | | | 1 | | 4 | 4 | | | | | | | | | |
| *Peridon grandis* | | | | 5 | | 3 | 8 | | | | | | | | | |
| *Phragmodus undatus* | | | 1 | 6 | 16 | 1 | 7 | | | | | | | | | |
| *Pseudobelodina dispansa* | | | 1 | 5 | | 6 | 7 | | | 2 | | | | | | |
| *Pseudooneotodus beckmanni* | | | | | | | | 1 | | | | | | | | |
| *Pseudooneotodus mitratus* | | | | 1 | 1 | 1 | | 1 | | | | | | | | |
| *Strachanognathus parvus* | | | | 1 | | | | | | | | | | | | |
| *Taoqupognathus tumidus* | | | 2 | 10 | | 12 | 14 | | | 1 | | 2 | | | | |
| *Yaoxianognathus ani* | | | | 5 | | 3 | 6 | | | | | | | | | |
| *Yaoxianognathus? tunguskaensis* | | | | 7 | 1 | 6 | 7 | | | | | | | ?1 | | |
| Gen. et sp. indet. A | | | | | | | | 1 | | | | | | | | |
| Gen. et sp. indet. B | | | | 1 | 2 | | | | | | | | | | | |
| Unassigned elements/fragments | 8 | 7 | 5 | 41 | 6 | 32 | 30 | 33 | 9 | 5 | 7 | 5 | 1 | 25 | 6 | 4 |

## 4. Methods

From 33 localities collected, 128 samples of 8–10 kg were processed. Eleven produced conodonts with 7 yielding age diagnostic faunas numbering some 700 elements. Several samples were collected from each olistolith, a number of individual clasts from conglomeratic localities. Limestones were digested in acetic acid (10 %) at the Macquarie University Center for Ecostratigraphy and Palaeobiology acid leaching facility. Separation was by centrifuging with sodium polytungstate at 2.75 SG using the method described by ANDERSON et al. (1995).

Conodont illustration using a JEOL 35CF SEM at the University of Technology Sydney Microstructural Analysis Unit, was entirely digital. Images were collected from SEM via Moran Scientific Instruments Software and saved to disk, each image requiring 0.3 MB. Processing for clarity and background was done using Paint Shop Pro Ver. 3, plates were prepared in Corel Draw Ver. 6.0 and printed by a Fuji digital Pictography system.

## 5. Systematic Palaeontology

Phylum: Conodonta PANDER, 1856
Class: Conodonta PANDER, 1856
Genus: *Ansella* FÅHRAEUS & HUNTER, 1985

Type species: *Belodella jemtlandica* LÖFGREN, 1978.

### *Ansella* sp.

(Pl. 1, Figs. 1–3)

Material: Thirteen elements from Loc. 8, one from Loc. 31, one from Loc. 12.

Remarks: Elements assigned to *Ansella* sp. herein include a denticulate and a single denticulate form. Adenticulate elements are similar to those illustrated by TROTTER & WEBBY (1994, Pl. 2, Figs. 5, 6) and to non-striate elements assigned to *Serraculodus*? sp. from the Cliefden Caves Limestone (ZHEN & WEBBY, 1995; Pl. 5, Figs. 1, 2). The adenticulate elements have deep basal cavities and faint surface striations on the upper half of their postero-lateral faces and are very similar to elements of *Ansella jemtlandica* (LÖFGREN) (FÅHRAEUS & HUNTER, 1985, Pl. 1, Figs. 3a, 3b). The denticulate element (Pl. 1, Fig. 1), despite poor preservation, resembles the asymmetrical element of *Ansella nevadensis* (ETHINGTON & SCHUMACHER) (FÅHRAEUS & HUNTER, 1985, Fig. 2, c).

Genus: *Belodina* ETHINGTON, 1959

Type species: *Belodus compressus* BRANSON & MEHL, 1933.

### *Belodina confluens* SWEET, 1979

(Pl. 1, Figs. 4–9)

1966 *Belodina grandis* (STAUFFER); PHILIP, Fig. 2.
1966 *Belodina wykoffensis* (STAUFFER); PHILIP, Fig. 3.
1966 *Eobelodina fornicala* (STAUFFER); PHILIP, Figs. 4, 8.
1978 *Belodina compressa* (BRANSON & MEHL); PALMIERI, Pl. 3, Figs. 12–15, 20, 21, 23–25; Pl. 4, Figs. 1–17.
1979 *Belodina confluens* SWEET, Fig. 5, 10, 17; Fig. 6, 9.
1981 *Belodina confluens* SWEET, in ZIEGLER, Pl. 2, Figs. 8–14.
1988 *Belodina confluens* SWEET; NOWLAN & MCCRACKEN, in NOWLAN et al., Pl. 1, Figs. 16–21.
1990 *Belodina confluens* SWEET; BERGSTRÖM, Pl. 3, Figs. 8–12.
1990 *Belodina confluens* SWEET; PICKETT & INGPEN, cover illustration, K.
1990 *Belodina confluens* SWEET; UYENYO, Pl. 1, Fig. 9, ?Fig. 8.
1990 *Belodina confluens* SWEET; SAVAGE, Fig. 9, 1–6.
1994 *Belodina confluens* SWEET; TROTTER & WEBBY, Pl. 2, Figs. 7, 18–20, 24, 25, 27–30.
1995 *Belodina confluens* SWEET; ZHEN & WEBBY, Pl. 1, Figs. 16–18.
1998 *Belodina confluens* SWEET; ZHEN et al., Pl. 1, Figs. 7–9.

Material: 118 elements; 95 from Loc. 8, 11 from Loc. 6, 2 from Loc. 12, 8 from Loc. 13 and 2 from Loc. 14.

Remarks: Compressiform elements display the diagnostic smoothly arcuate anterior margin described by SWEET (1979). These specimens show some variation in degree of compression and number of posterior denticles. A small number of specimens (Pl. 1, Figs. 10–11) have a lobe-like cusp (in lateral view), resembling *B. confluens*? illustrated by ZHEN & WEBBY (1995, Pl. 1, Fig. 20) and are tentatively assigned to this species. *B. confluens* constitutes 12 % of the WAF fauna, is common in central New South Wales faunas (ZHEN & WEBBY, 1995; PERCIVAL, 1997) and appears to be relatively abundant in New England occurrences, having also been reported from the Trelawney Beds (PHILIP, 1966), and recovered in material from the Uralba Beds (FUREY-GREIG, in prep.).

### *Belodina* sp. A

(Pl. 1, Fig. 12)

Material: One compressiform element from Locality 31, Balfour.

Remarks: A robust compressiform element distinguished by a short, rapidly tapering heel and prolate adjacent denticles.

### *Belodina* sp. B

(Pl. 1, Fig. 13)

Material: One grandiform element from Locality 6, Lone Boulder.

Remarks: The specimen is broken and displays an unusual, blunt heel with numerous, alate denticles that commence on its upper surface and extend along the cusp's posterior margin.

### *Belodina* sp. C

(Pl. 1, Figs. 14–15)

Material: Three compressiform and one eobelodiniform element from Locality 6, Lone Boulder.

Remarks: The elements display a distinct, wide, short heel, while compressiform elements have blade like, horizontal denticles. They are similar to *Belodina* spp. E & F from the Malongulli Formation (TROTTER & WEBBY, 1994).

### *Belodina* sp. D TROTTER & WEBBY, 1994

(Pl. 1, Figs. 16–17)

1994 *Belodina* sp. D TROTTER & WEBBY, Pl. 2, Figs. 16, 17, 22, 23.

Material: One compressiform element from each of locs 6, 8, 13.

Remarks: This species is distinguished by its markedly extended anterior margin, and resembles *Belodina* sp. D of TROTTER & WEBBY (1994).

### *Belodina* ? sp. E

(Pl. 1, Fig. 18)

Material: One compressiform element from Locality 8, Roscommon.

Remarks: The single element is poorly preserved, but is distinct in having an anterior margin similar to *B.* sp. D herein but with strongly prolate denticles.

## Genus: *Drepanoistodus* LINDSTRÖM, 1971

Type species: *Oistodus forceps* LINDSTRÖM, 1955.

### *Drepanoistodus suberectus* (BRANSON & MEHL, 1933)

(Pl. 2, Figs. 1–3)

1933 *Oistodus suberectus* BRANSON & MEHL, Pl. 35, Figs. 22–27.
1978 *Drepanoistodus suberectus* (BRANSON & MEHL); PALMIERI, Pl. 5, Figs. 14–31.
1988 *Drepanoistodus suberectus* (BRANSON & MEHL); NOWLAN & MCCRACKEN in NOWLAN et al., Pl. 16, Figs. 19–22 (cum syn).
1989 *Drepanoistodus suberectus* (BRANSON & MEHL); MCCRACKEN & NOWLAN, Pl. 2, Fig. 9.
1990 *Drepanoistodus suberectus* (BRANSON & MEHL); BERGSTRÖM, Pl. 2, Figs. 4–6; Pl. 3, Fig. 15.
1990 *Drepanoistodus suberectus* (BRANSON & MEHL); UYENO, Pl. 1, Figs. 13, 16–18.
1994 *Drepanoistodus suberectus* (BRANSON & MEHL); TROTTER & WEBBY, Pl. 5, Figs. 27–31.
1995 *Drepanoistodus suberectus* (BRANSON & MEHL); ZHEN & WEBBY, p. 282, Pl. 3, Figs. 8–10.
1995 *Drepanoistodus* sp.; FOWLER & IWATA, Fig. 2, 13.

Material: Twelve specimens from Locality 8, Roscommon.

Remarks: Elements from this fauna are either drepanodiform or suberectiform. There are insufficient specimens for comparison with the transition between suberectiform and drepanodiform described by ZHEN & WEBBY (1995, p. 282).

## Genus: *Panderodus* ETHINGTON, 1959

Type species: *Paltodus unicostatus* BRANSON & MEHL, 1933.

### *Panderodus gracilis* (BRANSON & MEHL, 1933)

(Pl. 2, Figs. 4–11)

1933 *Paltodus gracilis* BRANSON & MEHL, p. 108, Pl. 8, Figs. 20, 21.
1988 *Panderodus gracilis* (BRANSON & MEHL), NOWLAN & MCCRACKEN, In NOWLAN et al., p. 21, Pl. 7, Figs. 1–10, 12, 13, 19 (cum syn).
1990 *Panderodus gracilis* (BRANSON & MEHL), UYENO, p. 69–70, Pl. 1, Figs. 14, 19, 20.
1990 *Panderodus gracilis* (BRANSON & MEHL), SAVAGE, p. 827, Fig. 7–10.
1994 *Panderodus gracilis* (BRANSON & MEHL), TROTTER & WEBBY, p. 483, Pl. 5, Figs. 1–4, 9, 10, 12–15.
1995 *Panderodus gracilis* (BRANSON & MEHL), ZHEN & WEBBY, p. 283, Pl. 3, Figs. 18–22.
1998 *Panderodus gracilis* (BRANSON & MEHL); ZHEN et al., Pl. 3, Figs. 8–12.

Material: One hundred and ninety specimens, sixteen from Loc. 3; three from Loc. 6; one hundred and forty from Loc. 8; nine from Loc. 9; seven from Loc. 12; five from Loc. 13, six from Loc. 14, nine from Loc. 28 and three from Loc. 31.

Remarks: This species is the most common in the WAF fauna constituting 23 % of the total. Using the nomenclature proposed by ORCHARD (1980), elements herein include M, Sc-Sb and Sa types. There is some variation in position and number of lateral costae and in degree of curvature of the cusp, a feature reported of this species from Cliefden Caves (ZHEN & WEBBY, 1995).

### *Panderodus nodus* ZHEN, WEBBY & BARNES, 1998

**(Pl. 2, Figs. 12–14)**

**1978** *Panderodus* sp. aff. *P. panderi*, PALMIERI, p. 23, Pl. 1, Fig. 13, possibly also Fig. 14, only.
1985 *Panderodus recurvatus* (RHODES), AN et al., Pl. 2, Figs. 17, 21.
1994 *Panderodus* sp. D, TROTTER & WEBBY, p. 484, Pl. 5, Figs. 24–25, doubtfully 26.
1995 *Panderodus* sp., ZHEN & WEBBY, p. 284, Pl. 4, Figs. 1–2.
1998 *Panderodus nodus* ZHEN et al., Pl. 3, Figs. 13–20.

Material: Thirty specimens from Loc. 8, Roscommon and two from Loc. 12, Manilla View 3.

Remarks: The WAF elements of this species are all more or less identical to the "long based" elements described by ZHEN et al., though there is a variation in degree of recurvature. It is noteworthy that "short based" elements are not represented in the WAF fauna. This new species, documented from the Bowan Park Group (ZHEN et al., 1998), is also known from the Fork Lagoon Beds in Queensland (PALMIERI, 1978), the Cliefden Caves Limestone (ZHEN & WEBBY, 1995) and the Malongulli Formation (TROTTER & WEBBY, 1994), and occurs in material recently recovered from the Uralba Beds in New England (FUREY-GREIG, in prep).

### *Panderodus panderi* (STAUFFER, 1940)

(Pl. 2, Figs. 15–17)

1940 *Paltodus panderi* STAUFFER, Pl. 60, Figs. 8–9.
1988 *Panderodus*? *panderi* (STAUFFER); NOWLAN & MCCRACKEN in NOWLAN et al., Pl. 7, Figs. 20, 23–25 (cum syn).
1990 *Panderodus panderi* (STAUFFER); UYENO, Pl. 1, Figs. 23, 29.
1995 *Panderodus panderi* (STAUFFER); ZHEN & WEBBY, p. 283–284, Pl. 3, Figs. 23–25.

Material: Twenty-four specimens from Locality 8 (Roscommon) and one from Loc. 13 (Manilla View 4).

Remarks: Two types of element are recognised, one is identical to similiform elements illustrated from the Canadian Eastern Arctic Archipelago (UYENO, 1990, Pl. 1, Figs. 23, 29), the other elements resemble "long based" elements from Cliefden Caves (ZHEN & WEBBY, 1995, Pl. 3, Figs. 23, 24). A noteworthy feature of the latter elements is a fine lateral carina preserved on some specimens.

### *Panderodus* sp. 1

(Pl. 2, Fig. 18)

Material: Nine specimens from Locality 8, Roscommon.

Remarks: Falciform specimens closely resemble those illustrated from Cliefden Caves (ZHEN & WEBBY, 1995) and those assigned, as M elements, to *P. gracilis* from the Malongulli Formation (TROTTER & WEBBY, 1994, Pl. 5, Figs. 13, 14), having keel-like anterior and posterior margins, a feature not characteristic of *P. gracilis*.

### *Panderodus* sp. 2

(Pl. 2, Fig. 20)

Material: Nine specimens from Loc. 8, Roscommon.

Remarks: The elements are short cones that have almost cylindrical cross-sections and a lateral furrow that extends to the apex.

## Genus: *Periodon* HADDING, 1913

Type species: *Periodon aculeatus* HADDING, 1913.

### *Periodon grandis* (ETHINGTON, 1959)

(Pl. 2, Figs. 21, 22; Pl. 3, Figs. 1, 2)

1959 *Loxognathus grandis* ETHINGTON, p. 281, Pl. 40, Fig. 6.
1981 *Periodon grandis* (ETHINGTON); LINDSTRÖM, in ZIEGLER, p. 243–244, Pl. 1, Figs. 13–18.
1989 *Periodon grandis* (ETHINGTON); MCCRACKEN & NOWLAN, p. 1889, Pl. 3, Figs. 7–9.

1990 *Periodon grandis* (ETHINGTON); BERGSTRÖM, p. 11, Pl. 3, Fig. 7.
1994 *Periodon grandis* (ETHINGTON); TROTTER & WEBBY, p. 484, Pl. 4, Figs. 13–14, 27, 28.
1995 *Periodon grandis* (ETHINGTON); FOWLER & IWATA, Fig. 2, 1, 4–5 (only).
1995 *Periodon grandis* (ETHINGTON); ZHEN & WEBBY, p. 284, Pl. 4, Figs. 3. 4.
1998 *Periodon grandis* (ETHINGTON); ZHEN et al., Pl. 4, Figs. 19–21.

Material: Ten ramiform and 6 oistodontiform elements from Locality 8, Roscommon.

Remarks: Oistodontiform elements in this collection are similar to material reported from the Craighead Limestone (BERGSTRÖM, 1990), the Malongulli Formation (TROTTER & WEBBY, 1994) and the Cliefden Caves Limestone (ZHEN & WEBBY, 1995). Ramiform elements are of two types, some (Pl. 3, Fig. 1) resemble that illustrated from the Cliefden Caves Limestone (ZHEN & WEBBY, 1995, pl, 4, Fig. 4), others are identical to "prioniodiniform" elements from the Malongulli Formation (TROTTER & WEBBY, 1994, Pl. 4, Fig. 14) and from Akpatok Island (MCCRACKEN & NOWLAN, 1989, Pl. 3, Fig. 9). This species has been also reported from the Triangle Group of central NSW (FOWLER & IWATA, 1995).

## Genus: *Phragmodus* BRANSON & MEHL, 1933

Type species: *Phragmodus primus* BRANSON & MEHL, 1933.

### *Phragmodus undatus* BRANSON & MEHL, 1933

(Pl. 3, Figs. 3–9)

1933 *Phragmodus undatus* BRANSON & MEHL, p. 115–116, Pl. 8, Figs. 22–26.
1966 *Phragmodus undatus* BRANSON & MEHL, PHILIP, p. 112, Fig. 1, 5, 6, ?7, 9.
1988 *Phragmodus undatus* BRANSON & MEHL, NOWLAN & MCCRACKEN in NOWLAN et al., p. 26–27, Pl. 10, Figs. 1–3, 6–7 (cum syn).
1989 *Phragmodus undatus* BRANSON & MEHL, MCCRACKEN & NOWLAN, Pl. 3, Figs. 10–12.
1994 *Phragmodus undatus* BRANSON & MEHL, TROTTER & WEBBY, p. 485, Pl. 6, Figs. 2–11.
1998 *Phragmodus undatus* BRANSON & MEHL; ZHEN et al., Pl. 5, Figs. 1–4.

Material: Thirty-one specimens from Loc. 8, Roscommon.

Remarks: The material, dominantly Sc and M elements, is representative of the species, closely resembling material reported from the Trelawney Beds (PHILIP, 1966), the Fork Lagoons Beds (PALMIERI, 1978) and the Malongulli Formation (TROTTER & WEBBY, 1994). Elements typically lack preservation of the more delicate parts, a characteristic of the type material (BRANSON & MEHL, 1933). The specimens illustrated from the Trelawney and Fork Lagoons beds appear to be better preserved, possibly recording evidence for lower energy environments.

## Genus: *Pseudobelodina* SWEET, 1979

Type species: *Belodina kirki* STONE & FURNISH, 1959.

### *Pseudobelodina dispansa* (GLENISTER, 1957)

(Pl. 3, Figs. 10–13)

1957 *Belodus dispansus* GLENISTER, p. 729–730, Pl. 88. Figs. 14,15.
1978 *Belodina* sp. D, PALMIERI, Pl. 3, Figs. 18, 19, 22.
1988 *Pseudobelodina*? *dispansa* (GLENISTER), NOWLAN & MCCRACKEN, in NOWLAN et al., p. 30–31. Pl. 12, Figs. 8–26.
1989 *Pseudobelodina*? *dispansa* (GLENISTER), MCCRACKEN & NOWLAN, Pl. 4, Figs. 2–4.
1990 *Pseudobelodina dispansa* (GLENISTER), UYENO, Pl. 1, Figs. 24, 30.
1994 *Pseudobelodina dispansa* (GLENISTER), TROTTER & WEBBY, Pl. 1, Figs. 21–29, 31–33 (only).

Material: Nineteen specimens from Loc. 8, 2 from Loc. 12.

Remarks: These elements display a similar variation in degree of recurvature and cusp length as the material from the Malongulli Formation (TROTTER & WEBBY, 1994).

## Genus: *Pseudooneotodus* DRYGANT, 1974

Type species: *Oneotodus*? *beckmanni* BISCHOFF & SANNERMANN, 1958.

### *Pseudooneotodus beckmanni* (BISCHOFF & SANNERMANN, 1958)

(Pl. 3, Fig. 14)

1958 *Oneotodus*? *beckmanni* BISCHOFF & SANNEMANN, p. 98, Pl. 15, Figs. 22–25.
1981 *Pseudooneotodus beckmanni* (BISCHOFF & SANNEMANN); NOWLAN & BARNES, p. 23, Pl. 2, Figs. 20, 21 (cum syn.).
1990 *Pseudooneotodus beckmanni* (BISCHOFF & SANNEMANN); UYENO, p. 99–100, Pl. 1, Figs. 36, 37.
1994 *Pseudooneotodus beckmanni* (BISCHOFF & SANNEMANN); TROTTER & WEBBY, p. 486, Pl. 4, Figs. 29, 30.
1995 *Pseudooneotodus beckmanni* (BISCHOFF & SANNEMANN); FUREY-GREIG, Pl. 1, Fig. 3.

Material: One specimen from locality 9 (Ningadoo South).

Remarks: The specimen from locality 9, though being less strongly recurved, closely resembles the material from the Vaureal Formation (NOWLAN & BARNES, 1981) and from the Malongulli Formation (TROTTER & WEBBY, 1994).

### *Pseudooneotodus mitratus* (MOSKALENKO, 1973)

(Pl. 3, Fig. 15)

1973 *Ambalodus mitratus mitratus* MOSKALENKO, p. 86, Pl. 17, Figs. 9–11.
1988 *Pseudooneotodus mitratus* (MOSKALENKO, 1973); NOWLAN & MCCRACKEN, p. 34, Pl. 16, Figs. 2–6.
1990 *Pseudooneotodus mitratus* (MOSKALENKO, 1973); POHLER & ORCHARD, Pl. 6, Fig. 12.
1994 *Pseudooneotodus mitratus* (MOSKALENKO, 1973); TROTTER & WEBBY, Pl. 4, Figs. 21, 22.
1995 *Pseudooneotodus mitratus* (MOSKALENKO, 1973); ZHEN & WEBBY, Pl. 4, Figs. 16, 17.
1998 *Pseudooneotodus mitratus* (MOSKALENKO, 1973); ZHEN et al., Pl. 5, Figs. 14, 15.

Material: Three elements from Loc. 8, one from Loc. 9.

Remarks: Previously illustrated specimens of this species display a degree of morphological elasticity, most notable in the forms illustrated by TROTTER & WEBBY (1994). Specimens herein most closely resemble those from the Cliefden Caves Limestone illustrated by ZHEN & WEBBY (1995) in having no nodes and appear to be more symmetrical than the type specimens from Siberia (MOSKALENKO, 1973).

## Genus: *Strachanognathus* RHODES, 1955

Type species: *Strachanognathus parvus* RHODES, 1955.

### *Strachanognathus parvus* RHODES, 1955

(Pl. 3, Fig. 16)

1955 *Strachanognathus parvus* RHODES, p. 132, Pl. 7, Fig. 16, Pl. 8, Figs. 1–4.
1978 *Strachanognathus parvus* RHODES; LÖFGREN, p. 112, Pl. 1, Fig. 29.

1978 *Strachanognathus parvus* RHODES; PALMIERI, p. 27, Pl. 6, Figs. 27, 28.
1980 *Strachanognathus parvus* RHODES; ORCHARD, Pl. 14, Figs. 34, 35.
1990 *Strachanognathus parvus* RHODES; BERGSTRÖM, Pl. 1, Fig. 10.
1994 *Strachanognathus parvus* RHODES; TROTTER & WEBBY, Pl. 4, Figs. 24–25.

Material: One damaged specimen from Locality 8 (Roscommon).

Remarks: This damaged element preserves sufficient detail for assignment to *S. parvus* but has some noteworthy features. The lateral costa on the cusp appears slightly twisted, a faint costa flanks the anterior denticle and small protrusion on the anterior face of the cusp (broken) may record development of a small extra denticle. SERPAGLI (1967, p. 99–100) regarded such variations as pathological.

## Genus: *Taoqupognathus* AN, 1985

Type species: *Taoqupognathus blandus* AN, 1985.

### *Taoqupognathus tumidus* TROTTER & WEBBY, 1994

(Pl. 4, Figs. 1–9)

1978 *Drepanodus* ? *altipes* (?) PALMIERI, Pl. 2, Figs. 24–25.
1994 *Taoqupognathus tumidus* TROTTER & WEBBY, p. 487–486, Pl. 7, Figs. 10–24.
1998 *Taoqupognathus tumidus* TROTTER & WEBBY; ZHEN et al., Pl. 7, Figs. 1–9.

Material: Thirty-eight elements from Locality 8, two from Loc. 12 and two from Loc. 14.

Remarks: *T. tumidus* was first described from the Malongulli Formation by TROTTER & WEBBY (1994), being the youngest species in a lineage of three (*T. philipi* SAVAGE – *T. blandus* AN – *T. tumidus* TROTTER & WEBBY) known from the Late Ordovician of New South Wales (ZHEN & WEBBY, 1995). Elements in this collection essentially match the apparatus described by TROTTER & WEBBY, but display the following noteworthy features. Using the nomenclature of ZHEN & WEBBY (1995), the *T. tumidus* apparatus from New England includes an Sc6 element (Pl. 4, Fig. 3) with a bilobed posterior process (3 specimens) previously recognised only in *T. blandus*, and recently also reported from *T. tumidus* of the Bowan Park Group faunas (ZHEN et al., 1998). A few P elements (Pl. 4, Fig. 7) from Locality 8 display a prominent knob like protrusion of the anterior margin at the point of its posteriorally directed inflexion, while others from the same clasts (Pl. 4, Fig. 5) are identical to the type material. Two tall, relatively straight elements with a moderately bulged posterior margin (Pl. 4, Fig. 2) appear unique to the present collection and may represent a rare and unrecognised Sc element as they show similarity to the Sc5 element of *T. philipi*; one other tall element (Pl. 4, Fig. 9) with a strongly posteriorally directed cusp appears to be an aberrant form, possibly a P element. The Wisemans Arm collection is dominated by Sb elements (33 %). *T. tumidus* has also been reported from the Sofala Volcanics of the Capertee Rise in the Lachlan Fold Belt (PERCIVAL, 1997).

## Genus: *Yaoxianognathus* AN, 1985

Type species: *Yaoxianognathus yaoxianensis* AN, 1985.

### *Yaoxianognathus ani* ZHEN, WEBBY & BARNES

(Plate 4, Figs. 10–14)

1994 *Ozarkodina sesquipedalis* NOWLAN & BARNES; TROTTER & WEBBY, p. 483, Pl. 6, Figs. 13–25.
1998 *Yaoxianognathus ani* ZHEN, WEBBY & BARNES, Pl. 8, Figs. 1–16.

Material: Fourteen elements from locality 8 (Roscommon).

Remarks: The small collection of elements assigned to *Y. ani* include most elements documented by ZHEN et al. (1998), and closely resemble elements assigned to *O. sesquipedalis* by TROTTER & WEBBY (1994). This species occurs in the *T. tumidus* fauna of the Bowan Park Group, (ZHEN et al., 1998).

### *Yaoxianognathus*? *tunguskaensis* (MOSKALENKO, 1973)

(Pl. 4, Figs. 15–17)

1973 *Phragmodus*? *tunguskaensis* MOSKALENKO, 1973, p. 74, Pl. XII, Figs. 1–3.
1983 *Phragmodus*? *(Spinodus*?) *tunguskaensis* MOSKALENKO; MOSKALENKO. Fig. 4.Z.
1985 *Oulodus*? *tunguskaensis* (MOSKALENKO); AN, p. 108. Pl. 2, Fig. 9.
1988 *Spinodus*? sp. A NOWLAN & MCCRACKEN, p. 38, Pl. 17, Figs. 17–22.
1990 *Phragmodus*? *tunguskaensis* MOSKALENKO; SAVAGE, Fig. 10.7, 10.8.
1994 *Yaoxianognathus*? *tunguskaensis* (MOSKALENKO); TROTTER & WEBBY, Pl. 4, Figs. 18–20.
1995 *Yaoxianognathus*? *tunguskaensis* (MOSKALENKO, 1973); ZHEN & WEBBY, p. 289–290, Pl. 6, Fig. 22.
1998 *Yaoxianognathus*? *tunguskaensis* (MOSKALENKO); ZHEN et al., Pl. 6, Fig. 14, Pl. 7, Fig. 24, Pl. 8, Figs. 17–22.

Material: Twenty-one elements from Locality 8, Roscommon, one from Loc. 28 (doubtfully).

Remarks: The small number of elements in this collection are all more or less broken, but they display sufficient features for assignment to this little understood species. Eight specimens herein are identical to those from the Malongulli Formation (TROTTER & WEBBY, 1994), lacking small denticles between cusp and adjacent denticles and displaying a reduced anterior denticle. A single element (Pl. 4, Fig. 16) is similar to that illustrated from Cliefden Caves (ZHEN & WEBBY, 1995, Pl. 6, Fig. 22).

One broken element from Locality 8 is very similar to the Sd elements illustrated by ZHEN et al. (1998, Pl. 6, Fig. 14; Pl. 8, Fig. 18) in their recent multi element revision of this species.

### Gen. et sp. indet. A

(Pl. 4, Fig. 18)

Material: One partial specimen from Locality 9, Ningadoo South.

Remarks: This, the only platform conodont in the present fauna, is unfortunately broken. The preserved part is inadequate for assignment, but the arrangement of the short blade and nodes/ridges on the platform is similar to Pa elements of the Silurian genus *Aspidognathus*.

### Gen. et sp. indet. B

(Pl. 4, Fig. 19)

Material: Three specimens from Locality 8.

Remarks: The three elements from Roscommon cannot be accomodated in any known Late Ordovician genus. They feature three bar-like processes, two of which (posterior and anterior?) are relatively long with a reduced lateral? process. The long processes support four or five stout denticles with an elliptical cross-section. The short process is adenticulate. One element has slightly curved bars, two have straight ones.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## References


AITCHISON, J.C., 1993: Albaillellaria from the New England Orogen, eastern NSW, Australia. – Marine Micropalaeontology, **21**, 353–367, London.

AITCHISON, J.C., BLAKE, M.C, Jnr., FLOOD, P.G. & MURCHEY, B.L., 1988: New and revised lithostratigraphic units from the southwestern New England Fold Belt. – New South Wales Geological Survey Quarterly Notes, **72**, 10–16, Sydney.

ANDERSON, M.A., DARGAN, G., BROCK, G.A., TALENT, J.A. & MAWSON, R., 1995: Maximising efficiency of conodont separations using sodium polytungstate. – Courier Forschungsinstitut Senckenberg, **182**, 515–522, Frankfurt.

AN, TAIXIANG, ZHANG, ANTAI & XU, JIANMIN, 1985: Ordovician conodonts from Yaoxian and Fuping, Shaanxi Province, and their stratigraphic significance. – Acta Geol. Sinica, **59**, 97–108, Beijing.

BERGSTRÖM, S.M., 1990: Biostratigraphic and biogeographic significance of Middle and Upper Ordovician conodonts in the Girvan Succession, South West Scotland. – Courier Forschungsinstitut Senckenberg **118**, 1–44, Frankfurt.

BISCHOFF, G.C. & SANNEMANN, D., 1958: Unterdevonische Conodonten aus dem Frankenwald. – Notizblatt hessisches Landesamt für Bodenforschung, **86**, 87–110, Darmstadt.

BRANSON, E.B. & MEHL, M.G., 1933: Conodont studies. – University of Missouri Studies, **8** (1–4), 343 p., Columbia.

CARNE, J.E. & JONES, L.J., 1919: The Limestone Deposits of New South Wales. – Geological Survey of New South Wales, Mineral Resources **25**, 411 p., Sydney.

CAWOOD, P.A., 1980: The geological development of the New England Fold Belt in the Woolomin-Nemingha and Wiseman's Arm Regions: the evolution of a Palaeozoic forearc terrain. – Unpublished PhD thesis, 429 p.; Sydney (University of Sydney).

CAWOOD, P.A., 1983: Modal composition and detrital clinopyroxene geochemistry of lithic sandstones from the New England Fold Belt, eastern Australia. – Geol. Society America Bulletin., **94**, 1199–1214, Boulder.

CHAPPELL, B.W., 1961: The stratigraphy and structural geology of the Manilla-Moore Creek district, N.S.W. – Journal and Proceedings of the Royal Society of New South Wales, **95**, 63–75, Sydney.

DAVID, T.W.E., 1891: Report on the discovery of Cinnabar at Bingara. – Annual Report, New South Wales Department of Mines, 234–239, Sydney.

DRYGANT, D.M., 1974: Prostye Konodonty Silura i nizhov Devona Volnyo-Podolya (Simple conodonts from the Silurian and lowermost Devonian). – Palaeontologicheskiy Sbornik, **10**, 64–69, Prague.

ETHINGTON, R.L., 1959: Conodonts of the Ordovician Galena Formation. – Journal of Paleontology, **33**, 257–292, Tulsa.

ETHINGTON, R.L. & SCHUMACHER, D., 1969: Conodonts of the Copenhagen Formation (Middle Ordovician) in central Nevada. – Journal of Paleontology, **43**, 440–484, Tulsa.

FÅHRAEUS, L.E. & HUNTER, D.R., 1985: Simple-cone conodont taxa from the Cobbs Arm Limestone (Middle Ordovician), New World Island, Newfoundland. – Canadian Journal of Earth Sciences, **22**, 1171–1182, Calgary.

FOWLER, T.J. & IWATA, K., 1995: Darriwilian–Gisbornian conodonts from the Triangle Group, Triangle Creek area, New South Wales. – Australian Journal of Earth Sciences, **42**, 119–122, Sydney.

FUREY-GREIG, T.M., 1994: Age, depositional environments and silicified faunas of the Nemingha and Loomberah limestones, and associated carbonate occurrences in the Tamworth Belt, east and south-east of Tamworth, N.S.W. – Unpub. BSc. Hons. thesis, Macquarie University, 118 p., Sydney.

FUREY-GREIG, T.M., 1995: The "Nemingha" and "Loomberah" limestones (Early Devonian; Emsian) of the Nemingha-Nundle area, northern New South Wales: conodont data and inferred environments. – Courier Forschungsinstitut Senckenberg, **182**, 217–234, Frankfurt.

FUREY-GREIG, T.M.: Late Ordovician microfossils from the "Uralba Beds", east of Manilla, northern New South Wales. – In Prep.

GLENISTER, A.T., 1957: The conodonts of the Ordovician Maquoketa Formation in Iowa. – Journal of Paleontology, **31**, 715–736, Tulsa.

HADDING, A., 1913: Undre dicellograptusskiffern i skåane jämte nåagra därmed ekvivalenta bildigningar. – Lunds Universitets Årsskrift. Adv., **2**, 9, 1–90, Lund.

HALL, R., 1975: Upper Ordovician coral faunas from north-eastern New South Wales. – Journal of the Royal Society of New South Wales, **108** (1–2), 75–93, Sydney.

HALL, R., 1978: A Silurian (Upper Llandovery) coral fauna from the Woolomin Beds near Attunga, New South Wales. – Proceedings of the Linnean Society of New South Wales, **102**/3, 85–108, Sydney.

ISHIGA, H., 1988: Palaeontological study of radiolarians from the New England Fold Belt. – In: IWASAKI, M.: Preliminary Report on the Geology of the New England Fold Belt, Australia (1), 77–94, Co-operative Research Group of Japan and Australia, Tokushima.

ISHIGA, H., LEITCH, E.C., WATANABE, T., NAKA, T. & IWASAKI, M., 1988: Radiolarian and conodont biostratigraphy of siliceous rocks from the New England Fold Belt. – Australian Journal of Earth Sciences **35**, 73–80, Sydney.

LEITCH, E.C., 1974: The geological development of the southern part of the New England Fold Belt. – Journal of the Geological Society of Australia, **21**, 133–156, Sydney.

LEITCH, E.C. & CAWOOD, P., 1980: Olistoliths and debris flows at ancient consuming plate margins: an eastern Australian example. – Sedimentary Geology, **25**, 5–22, Amsterdam.

LEITCH, E.C. & CAWOOD, P.: Early Palaeozoic history of the east Gondwana margin of the Proto-Pacific: the inception of the Pacific ring of fire. – Unpublished manuscripts.

LISHMUND, S.R., DAWOOD, A.D. & LANGLEY, W.V., 1986: The Limestone Deposits of New South Wales, 2nd Edition. – N.S.W. Mineral Resources **25**, 373 p., Sydney.

LÖFGREN, A., 1978: Arenigian and Llanvirian conodonts from Jämt-
land, northern Sweden. – Fossils and Strata, **13**, 1–129, Lund.

MCCRACKEN, A.D. & NOWLAN, G.S., 1989: Conodont paleontology and biostratigraphy of Ordovician carbonates and petroliferous carbonates of Southampton, Baffin and Akpatok islands in the eastern Canadian Arctic. – Canadian Journal of Earth Sciences, **26**, 1880–1903, Ottawa.

MAWSON, R., TALENT, J.A. & FUREY-GREIG, T.M., 1995: Coincident conodont faunas (late Emsian) from the Yarrol and Tamworth belts of northern New South Wales and central Queensland. – Courier Forschungsinstitut Senckenberg, **182**, 421–446, Frankfurt.

MOSKALENKO T.A., 1973: Conodonts of the Middle and Upper Ordovician on the Siberian Platform. – Academy of Sciences of the USSR, Siberian Branch, **137**, 1–143, in Russian, Novosibirsk.

NOWLAN, G.S. & BARNES, C.R., 1981: Late Ordovician conodonts from the Vauréal Formation, Anticosti Island, Québec. – Geological Survey of Canada, Bulletin **329**, 1–50, Ottawa.

NOWLAN, G.S., MCCRACKEN, A.D. & CHATTERTON, B.D.E., 1988: Conodonts from Ordovician-Silurian boundary strata, Whittaker Formation, Mackenzie Mountains, Northwest Territories. – Geological Survey of Canada Bulletin, **373**, 99 p., Ottawa.

NOWLAN, G.S., MCCRACKEN, A.D. & MCLEOD, M.J., 1997: Tectonic and paleogeographic significance of Late Ordovician conodonts in the Canadian Appalachians. – Canadian Journal of Earth sciences, **34**, 1521–1537, Ottawa.

ORCHARD, M.J., 1980: Upper Ordovician conodonts from England and Wales. – Geologica et Palaeontologica **14**, 9–30, Marburg.

ORCHARD, M.J., 1987: Conodonts from western Canadian chert: their nature, distribution and stratigraphic application. – In: AUSTIN, R.L. (Ed.): Conodonts: Investigative techniques and applications, 419 p., ChicHester.

PALMIERI, V., 1978: Late Ordovician conodonts from the Fork Lagoons Beds, Emerald area, central Queensland. – Geol. Survey of Queensland, Publication **369**, Palaeontological Paper 43, 55 p., Brisbane.

PERCIVAL, I.G., 1997. Late Ordovician biostratigraphy of the Capertee Volcanic Rise. – N.S.W. Department of Mineral Resources Unpublished Palaeontological Report 97/02 (GS1997/393), 8 p., Sydney.

PHILIP, G.M., 1966: The occurrence and palaeogeographic significance of Ordovician strata in northern New South Wales. – Australian Journal of Science **29** (4), 112–113, Sydney.

PICKETT, J.W., 1973: Conodont samples from limestones within the Woolomin Beds. – Geological Survey of New South Wales Unpublished Palaeontological Report **73**/2 (GS1973/047), 3 p., Sydney.

PICKETT, J.W., 1982: The Silurian System in New South Wales. – Geological Survey of New South Wales Bulletin **29**, 264 pp, Sydney.

PICKETT, J.W., 1992: Conodont samples from structurally complex areas northeast of Manilla. – Geological Survey of New South Wales Unpublished Palaeontological Report **91**/05 (GS1992/132), 5 p., Sydney.

PICKETT, J.W. & INGPEN, I.A., 1990: Ordovician and Silurian strata south of Trundle, New South Wales. – Geological Survey of New South Wales Quarterly Notes, **78**, 14 p., Sydney.

POHLER, S.M.L. & ORCHARD, M.J., 1990: Ordovician conodont biostratigraphy, western Canadian Cordillera. – Geological Survey of Canada Paper, **90**/15, 1–37, Ottawa.

RHODES, F.H.T., 1955: The conodont fauna of the Keisley Limestone. – Quarterly Journal of the GeoloGical Society of London, **11**, 117–142, London.

SANO, H. & KANMERA, K., 1988: Palaeogeographic reconstruction of accreted oceanic rocks, Akiyoshi, southwest Japan. – Geology, **16**, 600–603, London.

SAVAGE, N.M., 1990: Conodonts of Caradocian (Late Ordovician) age from the Cliefden Caves Limestone, southeastern Australia. – Journal of Paleontology, **64**/5, 821–831, Tulsa.

SCHEIBNER, E.. 1973: A plate tectonic model of the Palaeozoic tectonic history of New South Wales. – Journal of the Geological Society of Australia, **20**, 405–426, Sydney.

SERPAGLI, E., 1967: I conodonti dell'Ordoviciano Superiore (Ashgilliano) delle Alpi Carniche. – Bolletino della societa Palaeontologica Italiana, **6**, 30–111, Modena.

SIMPSON, A., 1997: Late Ordovician conodonts from Gray Creek and the headwaters of Stockyard Creek, north Queensland. – Palaeobiogeography of Australasian Faunas and Floras, Geological Society of Australia, Abstracts **48**, p. 111, Wollongong.

STAUFFER, C.R., 1940: Conodonts from the Devonian and associated clays of Minnesota. – Journal of Paleontology, **14**, 417–435, Tulsa.

SWEET, W.C., 1979: Late Ordovician conodonts and biostratigraphy of the western Midcontinent Province. – Brigham University Geology Studies, **26**, 45–86, Provo.

SWEET, W.C. & BERGSTRÖM, S.M., 1974: Provincialism exhibited by Ordovician conodont faunas. – In: ROSS, C.A. (ed.), Paleogeographic provinces and provinciality. Society of Economic Paleontologists and Mineralogists Special Publication, **21**, 189–202, Tulsa.

SWEET, W.C. & BERGSTRÖM, S.M., 1984: Conodont provinces and biofacies of the Late Ordovician. – Geological Society of America, Special Paper, **196**, 69–87, Boulder.

TROTTER, J.A. & WEBBY, B.D., 1994: Upper Ordovician conodonts from the Malongulli Formation, Cliefden Caves area, central New South Wales. – AGSO Journal of Australian Geology & Geophysics, **15** (4), 475–499, Canberra.

UYENO, T.T., 1990: Biostratigraphy and conodont faunas of Upper Ordovician through Middle Devonian rocks, eastern Arctic Archipelago. – Geological Survey of Canada Bulletin 401, 194 p., Ottawa.

ZHEN, Y.Y. & WEBBY, B.D., 1995: Upper Ordovician conodonts from the Cliefden Caves Limestone Group, central New South Wales, Australia. – Courier Forschungsinstitut Senckenberg **182**, 265–305, Frankfurt.

ZHEN, Y.Y., WEBBY, B.D. & BARNES, C.R., 1998: Upper Ordovician conodonts from the Bowan Park Succession, central New South Wales, Australia. – Geobios, In press, Lyon.

ZIEGLER, W. (ed.), 1981: Catalogue of conodonts, **4**, 445 p. – Schweizerbart'sche Verlagsbuchhandlung, Stuttgart.

ZIEGLER, W. (ed.), 1991: Catalogue of conodonts, **5**, 212 p. – Schweizerbart'sche Verlagsbuchhandlung, Stuttgart.

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## Plate 1

Figs. 1–3: ***Ansella* sp.**
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Fig. 7: Grandiform element, AMF 104003, Loc. 8.
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Compressiform element, AMF104008, Loc. 31.

Fig. 13: ***Belodina* sp. B.**
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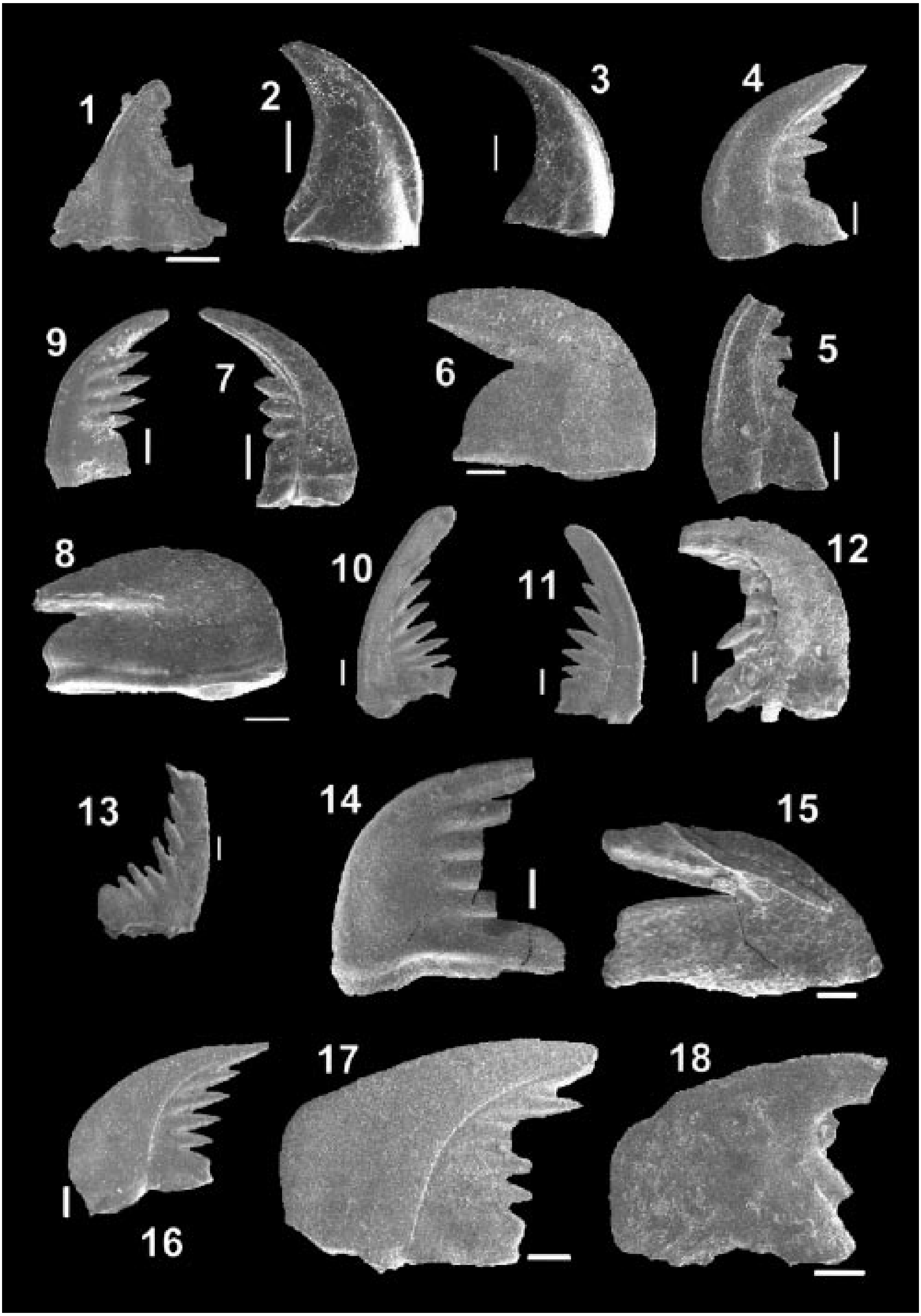
Fig. 16: Compressiform element, AMF 104012, Loc. 13.
Fig. 17: Compressiform element, AMF 104013, Loc. 8.

Fig. 18: ***Belodina* sp. E.**
Compressiform element, AMF 104014, Loc. 8.

All scale bars = 100 microns.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## Plate 2

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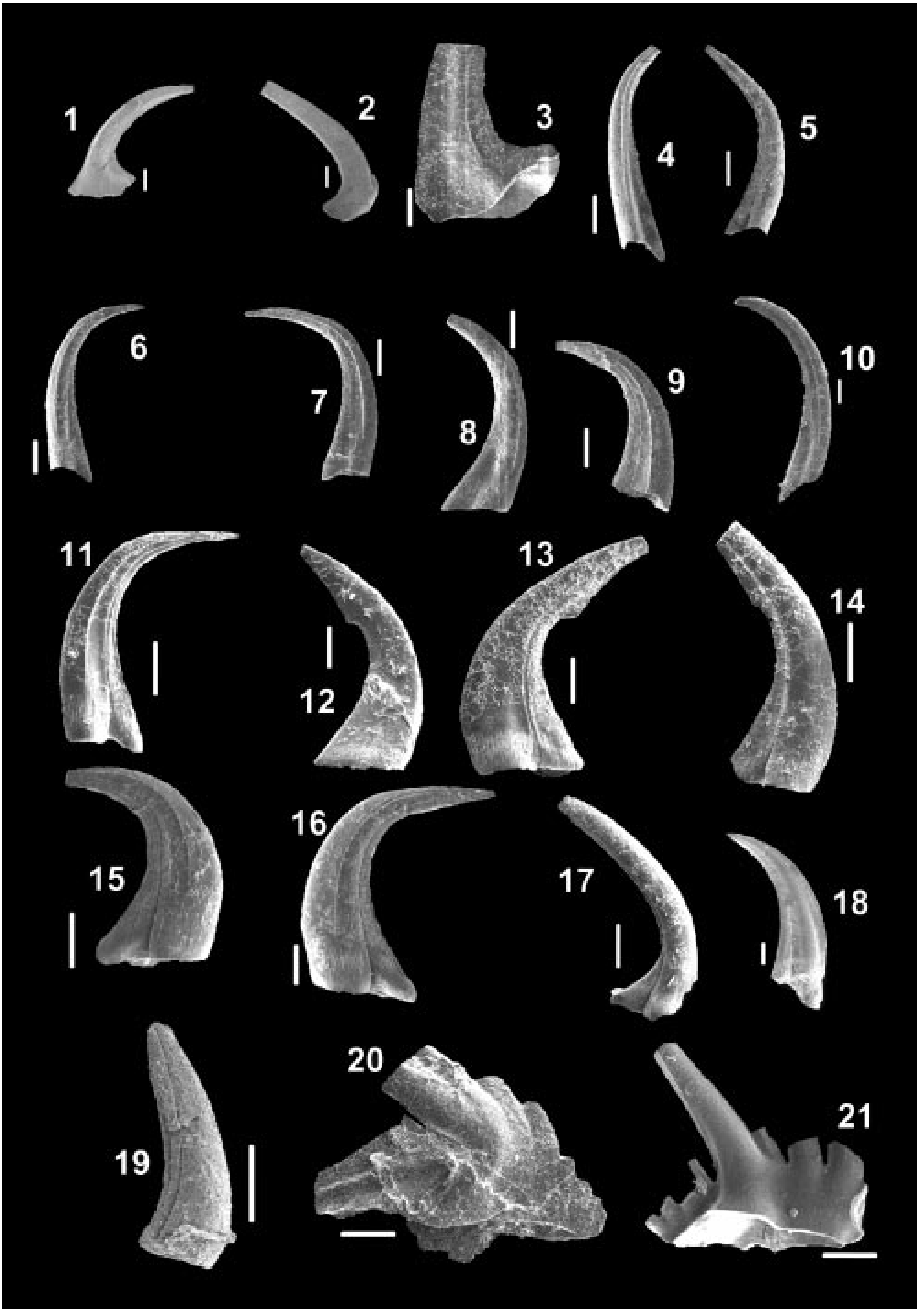
All scale bars = 100 microns.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# Plate 3

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Fig. 16: ***Strachanognathus parvus* Rhodes, 1955.**
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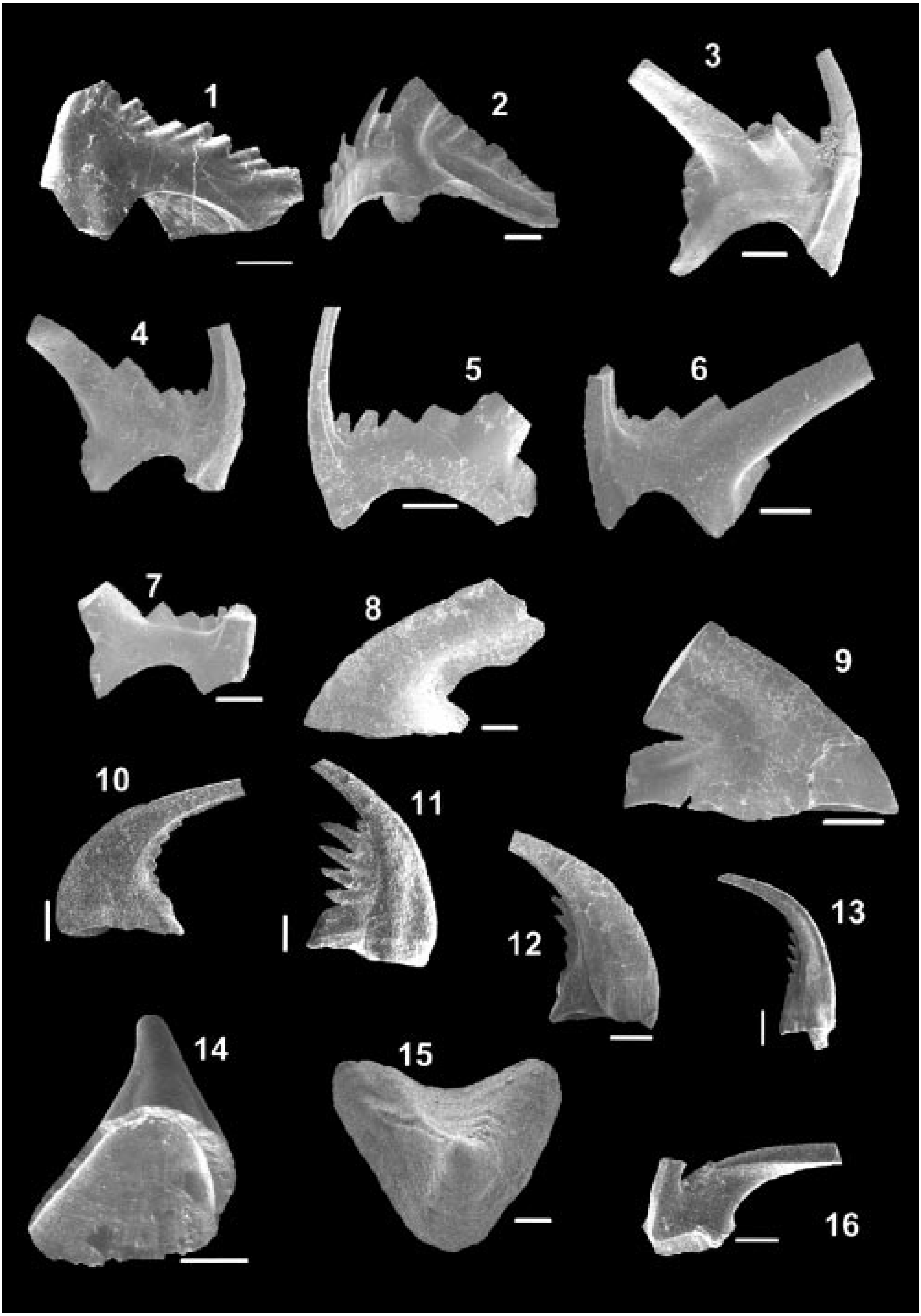
All scale bars = 100 microns.
Note: 4,5 same scale.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## Plate 4

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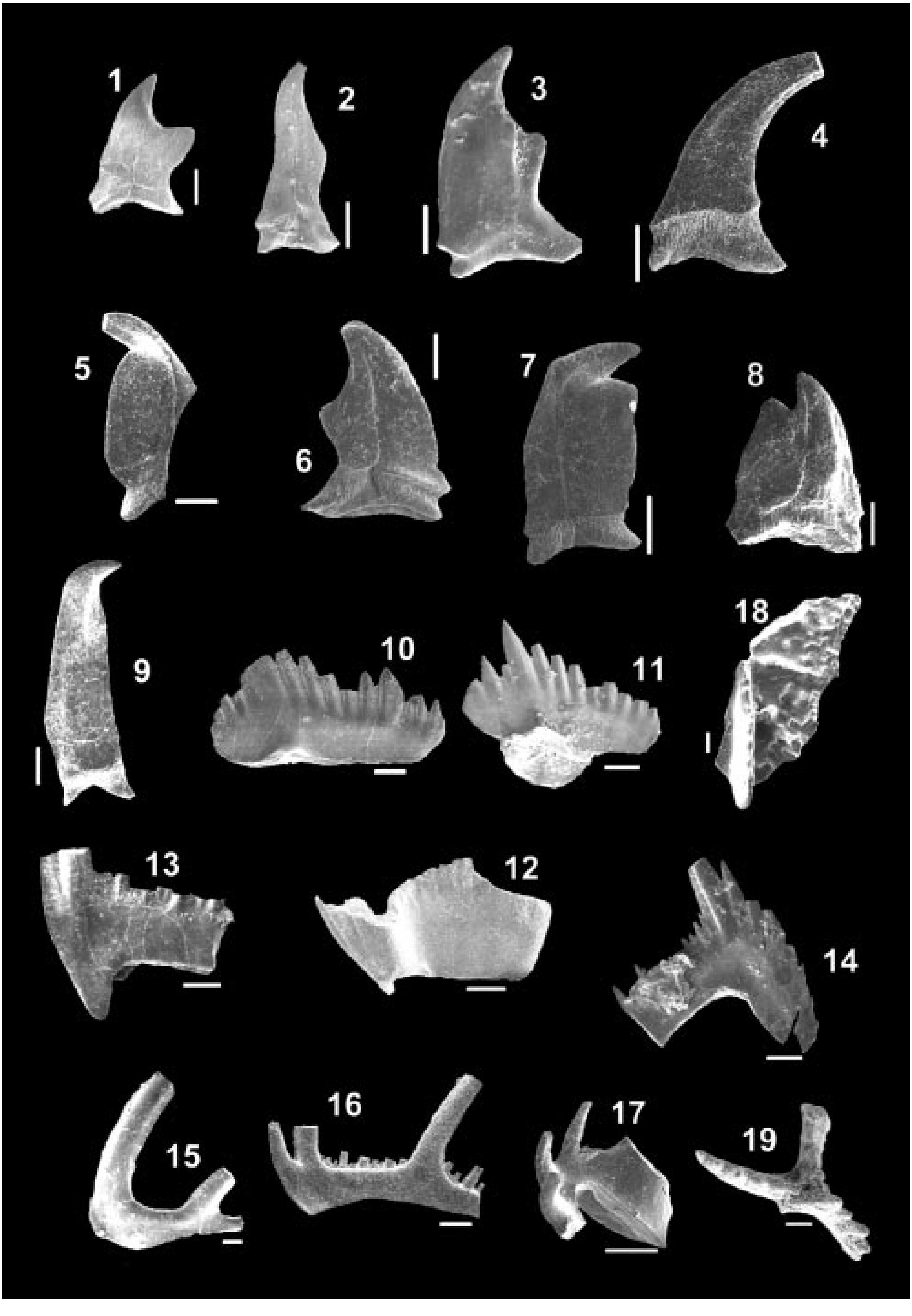
Fig. 19: **Gen. et sp. indet. B.**
AMF 104070, Loc. 8.

All scale bars = 100 microns.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