New Cretaceous brachiopods from the South Island, New Zealand

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Two new brachiopod taxa of Late Cretaceous age are described from contrasting depositional settings in North Canterbury, South Island, New Zealand. *Gowanella capralis* gen. et sp. nov. lived in a shallow water oyster reef. The second taxon, which cannot be properly diagnosed, is a deep water form from an outer shelf to upper slope environment. Both species are terebratulids; *Gowanella* is placed in the new family Ostreathyridae but the other form cannot be readily placed in an appropriate family.

Keywords: Brachiopods, terebratulids, Late Cretaceous, New Zealand

Introduction

Cretaceous brachiopods are rare and poorly known components of marine faunas in New Zealand; fewer than 30 species can be recognised and of these only a handful have been fully described and formally named (MacFarlan et al. 2009). Lee and Motchurova-Dekova (2008) described a new rhynchonellide from the Kahuitara Tuff on Pitt Island, Chatham Islands, and Hiller (2011) described a new notosariid rhynchonellide and a bizarre new terebratulidine of uncertain affinities from the *Ostrea* Bed, Broken River Formation of North Canterbury. In addition, he mentioned two indeterminate terebratulides from the same stratigraphic unit.

In this paper, additional species from Upper Cretaceous rocks of North Canterbury are described. Further sampling of the Ostrea Bed at the top of the Broken River Formation has produced another species of terebratulidine brachiopod. These shallow water forms are contrasted with similarly aged deep water forms from the Mead Hill Formation on the Kaikoura Peninsula.

The specimens are housed in the collections of Canterbury Museum, Christchurch, New Zealand (CM) and the University of Otago Geology Museum (OU).

South Island Cretaceous stratigraphic horizons with brachiopods

The earliest mention of Cretaceous brachiopods in South Island rocks appears to have been that made by Haast (1879, p.295) who included the three brachiopod genera *Terebratella* d'Orbigny, 1847, *Waldheimia* King, 1850, and *Rhynchonella* Fischer, 1809 in his list of fossils from the oyster beds associated with his 'brown coal formation'. However, it is uncertain whether these genera were actually derived from Cretaceous rather than Cenozoic strata. Unfortunately, the whereabouts of the specimens is unknown.

Warren & Speden (1978, p. 50) listed four brachiopod genera from two Upper Cretaceous stratigraphic units at Haumuri Bluff in South Marlborough. These include a discinid (originally identified as *Patella? amuritica* by Wilckens (1922)), *Rhynchonella* (s.l.) sp. and *Terebratula* (s.l.) sp. from the Okarahia Sandstone, and a linguloid from the slightly younger Conway Formation. These specimens require further investigation.

Numerous specimens of a linguloid brachiopod were obtained during preparation of a plesiosaur skeleton discovered in a calcareous concretion from the Conway Formation at the Waipara River, North Canterbury (Hiller & Mannering 2005; Hiller et al. 2005). Whether these belong to the same taxon as the linguloid from Haumuri Bluff requires further research. The Conway Formation at the Waipara River has been shown to be somewhat younger than it is at Haumuri Bluff (Roncaglia et al. 1999).

Thomson (1920) mentioned the presence of a rhynchonellide in the *Ostrea* Bed at Weka Creek, North Canterbury. More recently, the discovery of Cretaceous brachiopods from the *Ostrea* Bed among Cenozoic forms in the Robin S Allan collection at Canterbury Museum led Hiller (2011) to investigate that stratigraphic unit, at the top of the Broken River Formation, in Weka Creek and surrounding area (Fig. 1B). This confirmed Thomson's observation and produced the new taxa mentioned above. The specimens that are the subject of this study were recovered from a bulk sample taken at a locality where weathering had made the *Ostrea* Bed quite friable so that fossils were easily separated from the medium-grained sandy matrix.

In 2005, a number of participants in a mid-conference field trip, held during the 50th annual conference of the Geological Society of New Zealand, made the first discovery of invertebrate macrofossils in the Mead Hill Formation, a glauconitic, fine-grained siliceous limestone exposed along the foreshore at Kaikoura, North Canterbury (Fig. 1C). Among the specimens collected at that time and subsequently were sponges, echinoid spines, a possible belemnite and, significantly, articulated brachiopods.

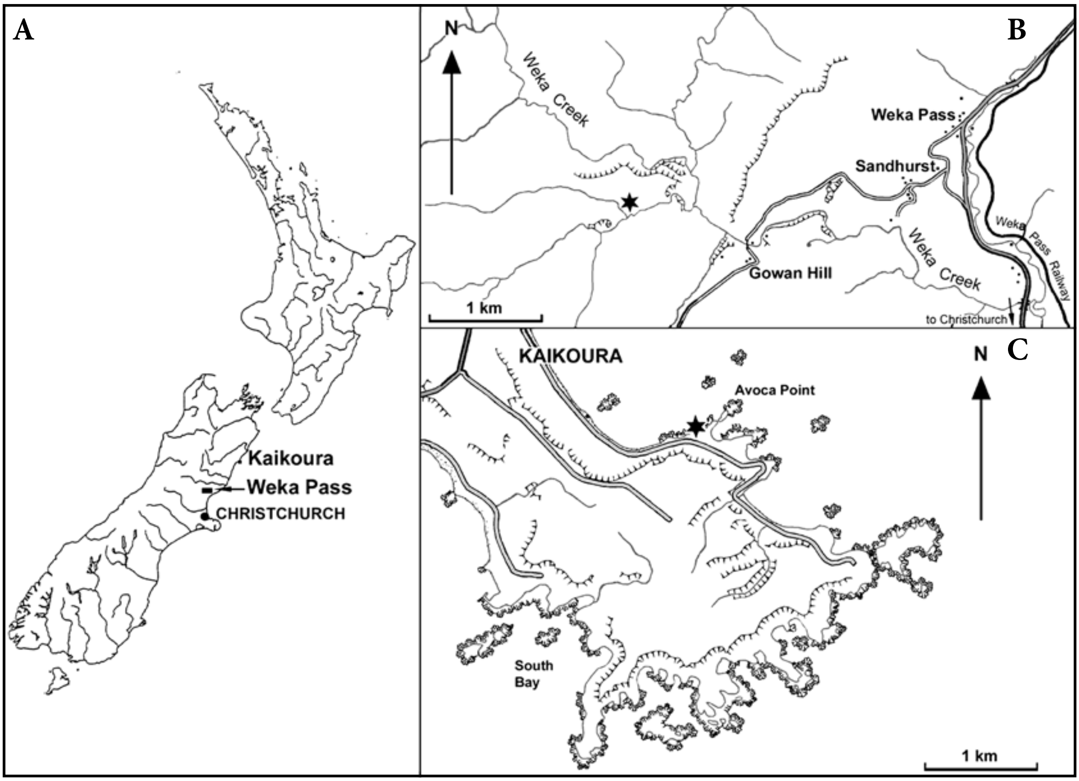

Figure 1. Locality maps. **A**, Positions of the collection sites within the South Island of New Zealand. **B**, Collection site on the farm Gowan Hill in the Weka Pass area. **C**, Kaikoura collection site on the rocky shore near Avoca Point. Collecting sites are indicated by stars.

Systematic Palaeontology

Order Terebratulida Waagen, 1883
Suborder Terebratulidina Waagen, 1883
Superfamily uncertain
Family Ostreathyridae fam. nov.

Diagnosis: Thick-shelled, short-looped brachiopods with ventribiconvex shells of variable outline; anterior commissure plicate; hinge line almost straight; greatest width at or close to hinge line; beak markedly attrite; large foramen permesothyrid.

Age: Late Cretaceous (Maastrichtian).

Included genera: Ostreathyris Hiller, 2011; *Gowanella* gen. nov.

Remarks: The included genera developed their shells without the involvement of any median support structure for the loop. For this reason they are placed within the Suborder Terebratulidina. If this systematic placement is correct, then they differ from most other members of the suborder. Generally, terebratulidines are smooth, elongately ovoid with maximum width well anterior of the hinge line, quite unlike the members of the new family. Although the new family cannot be readily placed within any known superfamily, its erection is warranted by the highly distinctive, somewhat aberrant nature of the genera included in it, even though knowledge of the entire loop is lacking at this stage.

Genus *Gowanella* gen. nov.

Etymology: Named after the farm Gowan Hill on which the specimens were found.

Type species: Gowanella capralis sp. nov.

Horizon: Ostrea Bed Member at the top of the Broken Hill Formation, North Canterbury, South Island, New Zealand.

Age: The Broken River Formation has been dated, on the basis of dinoflagellate cysts, as late Haumurian (late Campanian–early Maastrichtian) by Roncaglia et al. (1999), making the Ostrea Bed probably early Maastrichtian.

Diagnosis: Small to medium sized, ventribiconvex shells with subcircular to roundly hexagonal outline; anterior commissure plicate; shell surface smooth apart from strong growth lines; hinge line almost straight; beak markedly attrite with large permesothyrid foramen. Shell punctate. Dorsal median septum lacking.

Gowanella capralis gen. et sp. nov.
(Figs 2a–r)

Etymology: From the Latin *caprale*, a marsh or swamp fit only for goats, referring to the small marshy gully that is the type locality for the species.

Material: Six complete shells, two dorsal valves and two broken ventral valves from Site 4, Gowan Hill West, of Hiller (2011) (Fig 1B); New Zealand Fossil Record File Number M34/f0928. Holotype: CM 2014.1.1; Paratypes: CM 2014.1.2 and CM 2014.1.3 in Canterbury Museum, Christchurch.

Diagnosis: As for genus.

Description: Ventribiconvex shells with subcircular to roundly hexagonal outline; maximum width about mid-valve. Dorsal valve very gently to gently convex in lateral profile; anterior profile varying from almost flat to gently convex; rounded median fold subdued in early growth stages but becoming higher as shell gets larger and separating flat to concave lateral areas. Ventral valve gently to strongly convex in lateral profile; anterior profile strongly convex apart from narrow flat to concave median portion that coincides with sulcus, which becomes deeper in later growth stages. Beak short, markedly attrite with large permesothyrid foramen. Relatively short, wide deltidial plates disjunct in early growth stages but becoming conjunct or fused in mature shells. Shell surface smooth apart from strongly developed stepped growth lines, becoming crowded near anterior margin. Shell substance thick; punctate.

Ventral valve interior with broad, short, robust teeth; dental plates absent. Rounded median ridge corresponds to sulcus. Dorsal

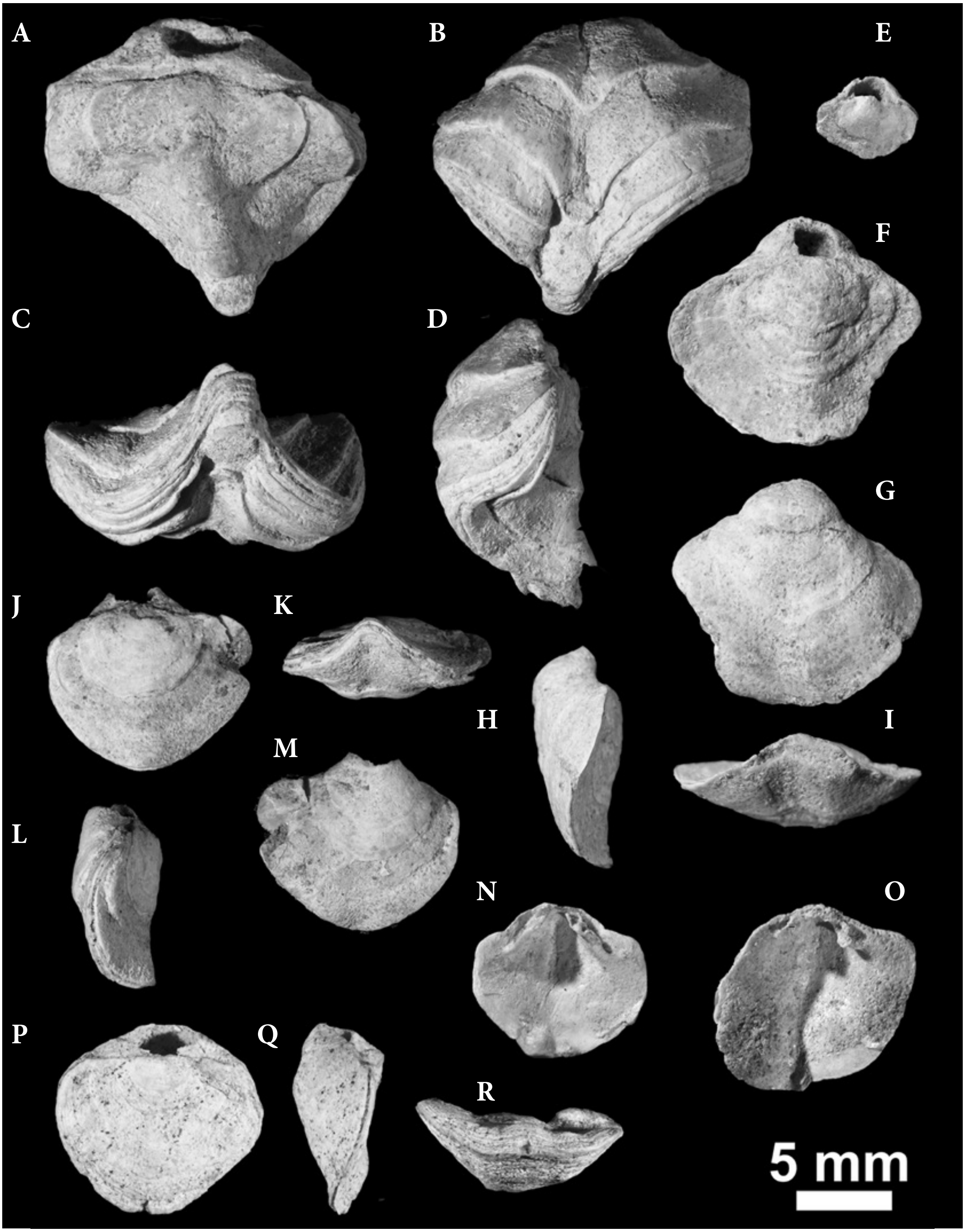

Figure 2. *Gowanella capralis* gen. et sp. nov. **A–D**, Holotype CM 2014.1.1, complete shell in dorsal **A,** ventral **B,** anterior **C,** and lateral **D,** views. **E**, CM 2014.1.6, juvenile complete shell in dorsal view. **F–I**, CM 2010.41.50, complete shell in dorsal **F,** ventral **G,** lateral **H,** and anterior **I,** views. **J–M,** Paratype CM 2014.1.2, complete shell in dorsal **J,** anterior **K,** lateral **L,** and ventral **M,** views. **N,** Paratype CM 2014.1.5, dorsal valve in interior view. **O,** Paratype CM 2014.1.4, dorsal valve in interior view. **P–R,** Paratype CM 2014.1.3, complete shell in dorsal **P,** lateral **Q,** and anterior **R,** views.

interior with broad ovate cardinal process that extends across posterior ends of socket ridges. Broad shallow sockets separated from narrow triangular hinge plates by sharp socket ridges. Crural bases poorly defined; nature of crura and loop unknown.

Discussion: The lack of a dorsal median septum indicates that the loop of *Gowanella capralis* gen. et sp. nov. developed without the involvement of a septal pillar or any other median support for a loop during ontogeny. This precludes placing the genus within the long-looped brachiopods and so it is classified as a short-looped terebratulidine.

In the overall form of the shell, the new genus resembles *Ostreathyris* Hiller, 2011 with which it occurs. The latter differs from *Gowanella* in being very coarsely ribbed but it also possesses an attrite beak and a large foramen. Internally, the dorsal valve of *Ostreathyris* is characterized by the presence of broad, triangular hinge plates; these are not seen in *Gowanella.*

Suborder Terebratellidina Muir-Wood, 1955

Superfamily uncertain
Family uncertain
Genus and species indeterminate

Horizon: Mead Hill Formation, Kaikoura, South Island, New Zealand.

Age: Haumurian; Late Cretaceous (Maastrichtian), Browne et al. (2005).

Material: Ten pairs of conjoined valves, all deformed by crushing and tectonic distortion, from exposures along the rocky foreshore near the wharf at Kaikoura (Fig. 1C); New Zealand Fossil Record File Number O31/f0617. Holotype: CM 2014.1.38; Paratypes: CM 2014.1.39 in Canterbury Museum, Christchurch and OU 45287 in the Department of Geology, Otago University, Dunedin.

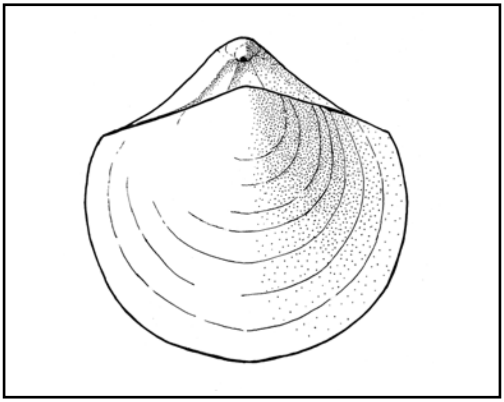

Figure 3. A reconstruction of the indeterminate Mead Hill Formation taxon in dorsal view, based mostly on specimen CM2014.1.39.

Description: Shells with subcircular outlines (Fig. 3); maximum width about midvalve. Anterior commissure rectimarginate to very gently sulcate. Beak narrow, erect to slightly incurved; foramen very small, circular, mesothyrid; beak ridges well developed. Delthyrium closed by fairly high concave symphytium that has developed from conjunct deltidial plates. Ventral valve gently convex in lateral profile; anterior profile more strongly convex medianly. Dorsal valve gently and evenly convex in both profiles. Shell substance thin anteriorly but thickened in posterior regions.

Table 1. Dimensions (in mm)

specimen number	length	width	thickness
CM 2014.1.1 holotype complete shell	16.7	17.5	8.3
CM 2014.1.2 paratype complete shell	10.1	11.0	4.5
CM 2014.1.3 paratype complete shell	10.2	11.0	4.6
CM 2014.1.4 paratype dorsal valve	11.6	11.7	
CM 2014.1.5 paratype dorsal valve	8.8	9.3	
CM 2014.1.6 juvenile complete shell	4.7	5.8	2.6
CM 2014.1.7 juvenile complete shell	3	3	
CM2010.41.50 complete shell	11.6	12.9	4.9

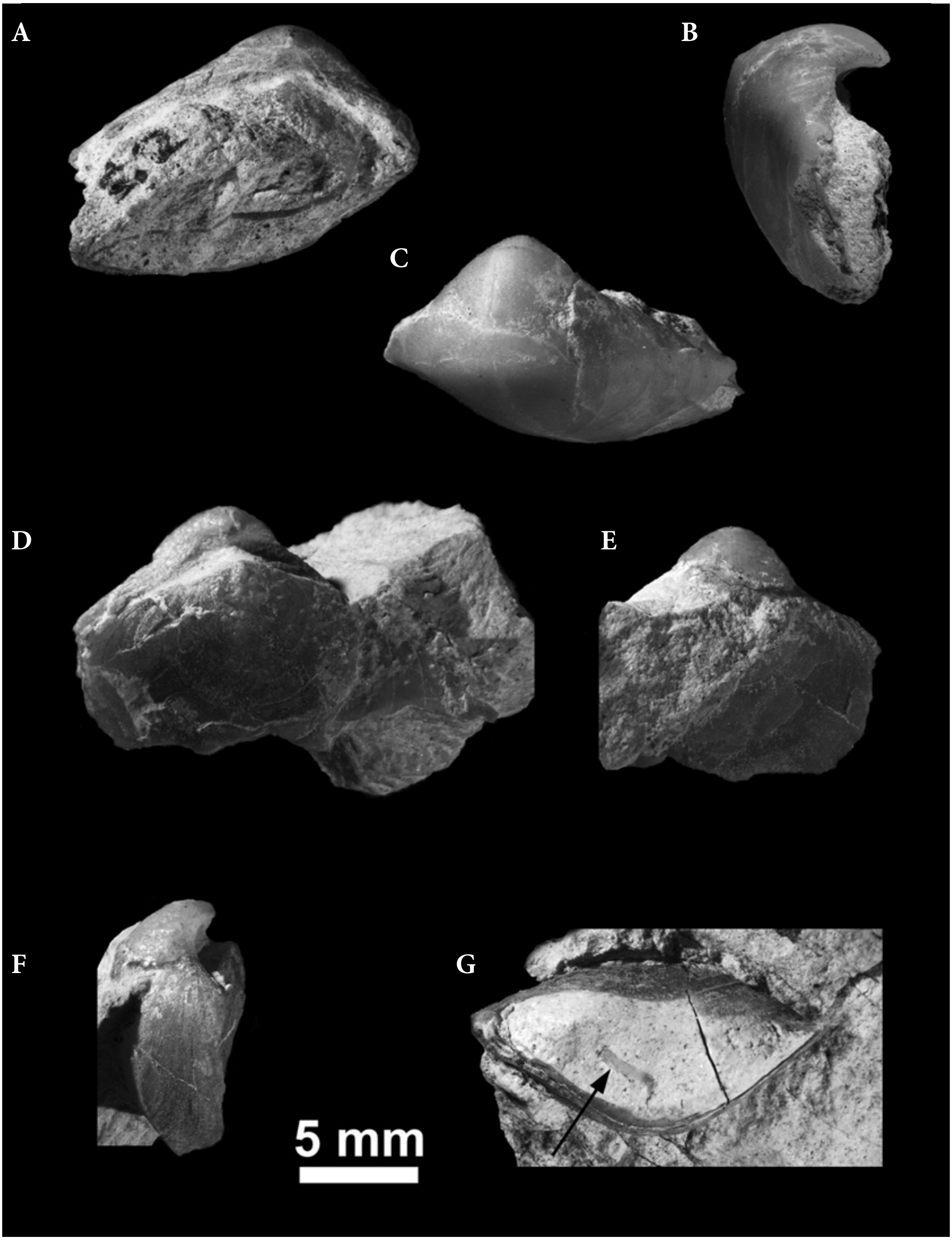

Figure 4. Genus and species indeterminate. **A–C,** CM 2014.1.38, complete shell in dorsal **A,** lateral **B,** and ventral **C,** views. The exaggerated curvature of the ventral valve is due to tectonic distortion. **D–F,** CM 2014.1.39, complete shell in dorsal **D,** ventral **E,** and lateral **F,** views. The thin shell at the growth margins of both these specimens has been broken off. **G,** OU 45287, complete shell in anterior view showing broken anterior end with portion of the loop visible (arrowed).

Details of the interior of the shell are unknown except that one specimen, OU 45287 (Fig. 4g), shows a portion of a long loop, although this appears to have been displaced slightly from its life position.

Discussion: The placement of this genus in the Terebratellidina is based on specimen OU 45287, which shows part of the loop preserved, but placement in a superfamily is not possible without more information about the cardinalia and brachidium. Externally, the species closely resembles *Aliquantula tapirina* (Hutton, 1873), a New Zealand terebratelloid of Oligocene age, but it would be wrong to assume it belongs in the same superfamily.

The hard, very fine sedimentary filling of the shells precludes excavation of the internal structures and tectonic distortion rendered the specimens unsuitable for serial sectioning.

Discussion

Hiller (2011) interpreted the *Ostrea* Bed at the top of the Broken River Formation to represent an oyster reef formed in very shallow water, probably only a few metres deep. In contrast, the Mead Hill Formation was deposited by pelagic sedimentation in an outer shelf to upper slope environment (Hollis et al. 2003a; Hollis et al. 2003b; Browne et al. 2005). The silica content of the Mead Hill Formation, derived from in situ diatoms and radiolarians, is consistent with deposition in a setting analogous to modern biogenic oozes (Hollis 2003; Hollis et al. 2003a; Hollis et al. 2003b). The external morphology of both new taxa reflects the environments in which they lived. The robust shell, attrite beak and large foramen of *Gowanella* attests to a species adapted for living in a high energy environment in which it used a short, thick pedicle to attach closely and firmly to a hard substrate, in this case the large oyster shells among which it lived. The somewhat variable outline of the specimens probably reflects the crowded and cramped conditions in which they grew.

In contrast, the indeterminate form from Kaikoura lived in a very low energy environment lacking current and wave activity. In such a setting, it is likely that each larval brachiopod would have attached, using a very slender pedicle, to a single sedimentary particle that it quickly outgrew to effectively live free on the sea floor. Thickening of the posterior part of the shell served to stabilize the shells in their life positions.

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