

Short note

Aligned growth positions in Pliocene *Laternula elliptica* (King & Broderip) (Bivalvia: Anomalodesmata: Laternulidae)

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The circum-Antarctic clam *Laternula elliptica* (King & Broderip 1831) is the largest infaunal bivalve of the Southern Ocean. It mostly lives in water depths of less than 100 m (highest densities from 20–30 m; e.g. Ahn 1994), in soft or semi-consolidated substrates from sandy mud to gravelly sand (Soot-Ryen 1951, Nicol 1966). Animals are deep-burrowing (to >0.5 m; Zamorano *et al.* 1986) and consequently have large siphons. These are fused, highly muscular and covered by thick, rugose periostracum, and are capable of partial retraction only (Burne 1920). The ecology of *L. elliptica* was likened by Ralph & Maxwell (1977) to that of *Mya arenaria* L. in northern temperate and Arctic waters.

Late Pliocene fossils of *L. elliptica* are common in the Cockburn Island Formation on Cockburn Island (64°12'S, 56°50'W), James Ross Island group, northern Antarctic Peninsula (Soot-Ryen 1952, Jonkers 1998), which has an age of about 3 Ma (Jonkers & Kelley 1998). Most specimens consist of isolated internal moulds without any remaining original shell material. However, specimens of *L. elliptica* with preserved shell were observed in one prominent loose slab of pebbly sandstone. Within a surface area of c. 0.15 m² 19 individuals were identified (Fig. 1) and, by extrapolation, specimen density may thus have exceeded 100 ind. m⁻². This figure is comparable to maximum densities observed in studies of modern *L. elliptica*: 75 m⁻² near Anvers Island (Stout & Shabica 1970), 140 m⁻² in Îles Kerguelen (Beurois 1989), and 136 m⁻² at King George Island (Ahn 1994).

Seventeen specimens in the slab were fossilised in life position. Surprisingly, these were all found to have their sagittal planes in a non-randomly orientated position: planes of about one third are within 10°, and the total range of variation in orientation is only 66°. There is also a distinct polarity in sagittal plane orientation, with the ventral side of 16 individuals all pointing in the same direction (Fig. 1).

Preferential orientation of deep-burrowing, sedentary bivalves was reported for *Mya arenaria*, living on a tidal flat in the St Lawrence estuary, Canada (Vincent *et al.* 1988). The mean orientation of the animal's sagittal plane appeared to be perpendicular to the principal component of current direction. Such a position is thought to optimise filtration and feeding in a bidirectional flood and ebb current system by minimising recirculation of sea water and siphon flow interaction. This is suggested also by flume experiments (Monismith *et al.* 1990,

for a review see Wildish & Kristmanson 1997).

Polarity in sagittal plane orientation may also occur in burrowing bivalves living under a unidirectional flow regime, and has been observed in the unionacean *Margaritifera margaritifera* (L.), a partly buried species with about half of its valves exposed above the sediment–water interface (Thoms & Berg 1985). In this species, inhalant apertures were found in an upstream position, which would also prevent mixing of exhalant and inhalant flows, as well as minimising drag. It would thus seem most likely that the orientation of *Laternula* shells results from rheotaxis in response to hydrodynamics.

Laternula elliptica has adopted a number of feeding and metabolic strategies for survival in Antarctic coastal environments, which are characterized by a pronounced seasonality. Summer metabolism is low compared to that of temperate bivalve species, and seen as a means to conserve energy in a generally low-temperature environment (Ahn & Shim 1998). However, during the short summer period fecal production may occasionally be as high as in *Mytilus edulis* L. under similar trophic conditions (Ahn 1993), thus indicating increased feeding activity at times when food is in abundant supply. Resulting growth rates in this species are much higher than in most other Antarctic bivalves (Everson 1977), but overall still lower than in *Mya arenaria* (Ralph & Maxwell 1977). Positive rheotaxis, as seen in Pliocene *L. elliptica*, may yet be another way of maximising energy gain in environments where primary production is extremely seasonal.

On the basis of the fossil record it is here suggested that non-random orientation can also be expected in populations of modern *L. elliptica*, but that, given the widely different environmental settings of the species' habitats, rheotaxis may not necessarily occur in every population. In habitats with a rather strong tidal current regime and a marked unidirectional trend in net water movement, e.g. in eastern McMurdo Sound, Ross Sea, (Dayton & Oliver 1977), preferential orientation, as observed in the fossils from Cockburn Island, could benefit the animals. By contrast, in sheltered bay environments, where obvious directional cues are much less in evidence (e.g. in Marian Cove, King George Island, South Shetland Islands; Ahn 1993), specimens may assume random orientation. Field observations on the orientation of *L. elliptica* would be very welcome to further our knowledge of the adaptive strategies of this unique Antarctic bivalve.

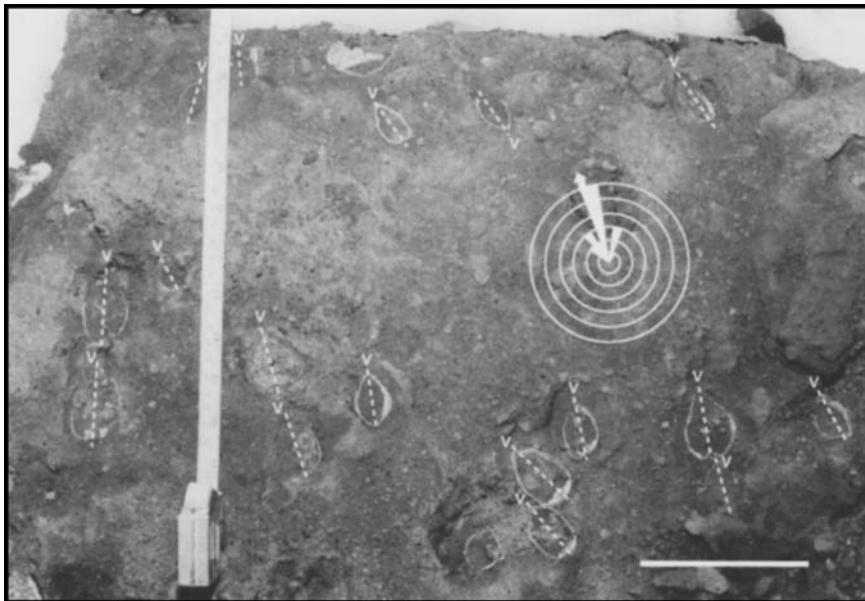


Fig. 1. Plan view of bedding plane of Pliocene sandstone on Cockburn Island, Antarctica, with preferentially orientated specimens of *Laternula elliptica* ($n = 17$; scale bar: 100 mm), and circular histogram of specimen orientation relative to an arbitrarily chosen direction (top of photograph) (class interval: 10° ; each circle represents one observation). Dashed lines indicate sagittal planes of individuals (V: ventral direction of sagittal plane). Suggested palaeocurrent direction is from top of frame to bottom.

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