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Short Note
Ice krill under the Amery Ice Shelf, East Antarctica

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The 550 km long Amery Ice Shelf in East Antarctica, comprising 58 000 km^2 of floating ice, is fed by a series of glacier streams from the interior Lambert Glacier Basin. Ice thicknesses vary from 2800 m near the grounding zone at 73.3ºS to 200–250 m at the more than 200 km wide calving front in Prydz Bay near latitude 68.6ºS. A modular hot water drill (HWD) system, deployed at site AM01b (69º25.9'S, 71º26.8'E) in December 2003, 100 km from the open ocean (Fig. 1), was used to melt a 300–350 mm diameter borehole through 480 m of ice, the lower 200–210 m of which consists of accreted marine ice (Morgan 1972, Craven *et al.* 2004). The sea floor was detected at 840 m below the ice shelf surface (65 m a.s.l.) by oceanographic cavity profiling, and sediment core sampling.

A JPL–CalTech ice borehole probe (Carsey *et al.* 2002) provided real time *in situ* data stored to digital video tape via a 4-core fibre optic cable. Video footage at the sea floor showed a benthic assemblage dominated by filter feeders but also including deposit feeders, grazers and at least one species of predator/necrophage (Craven *et al.* unpublished), indicating that water in the sub-shelf cavity was sufficiently nutrient-rich to sustain a viable and quite complex ecosystem, as has previously been reported under other Antarctic ice shelves (Littlepage & Pearse 1962, Arnaud 1975, Heywood & Light 1975, Oliver *et al.* 1976, Lipps *et al.* 1979).

Surprisingly, a pelagic crustacean was observed at a depth of 775 m below sea level at the sea floor beneath the shelf, 100 km from the calving front (Fig. 2). A mysid shrimp and possibly a Euphausiid have been reported before at 550–590 m depth under the Ross Ice Shelf, at 430 km from the seaward front (Lipps *et al.* 1979). The crustacean in our photographs is undoubtedly a species of Euphausiid, or krill. Specific identification is not possible but the evidence would suggest that it is *E. crystallorophias* as this is the only krill species where adults have been recorded from deep within Prydz Bay (Hosie 1994). Five species of Euphausiids occur in Antarctic waters: *Euphausia superba*, *E. crystallorophias*, *E. triacantha*, *Thysanoessa macrura* and *E. frigida* (Baker 1965). The most southerly of these species is *E. crystallorophias*, known as "ice krill" because

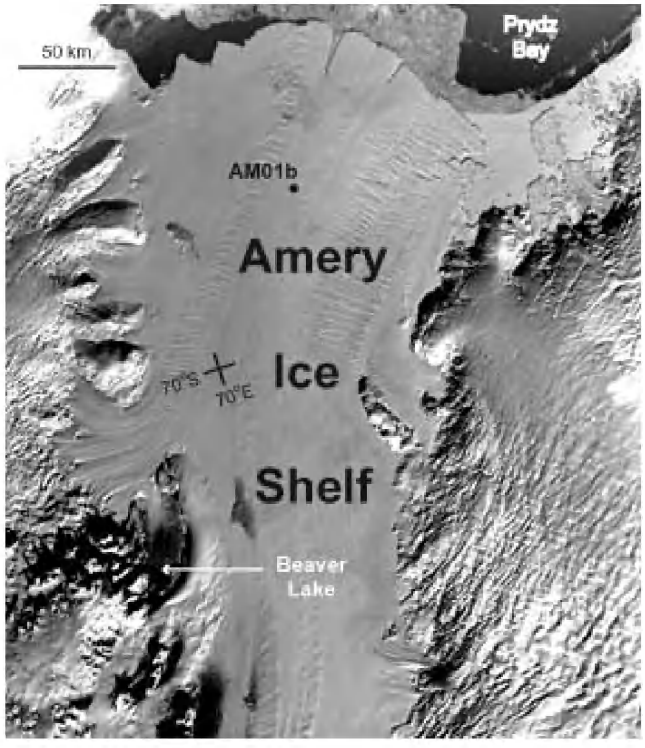

Fig. 1. Map of northern half of the Amery Ice Shelf and AM01b borehole location.

Fig. 2. Krill captured on a video frame at a depth of 775 m below sea level under the Amery Ice Shelf, 100 km from the iceberg calving front. Note also the benthic community on the seafloor. The depth indicated in the top right hand corner is from the ice shelf surface (65 m a.s.l.), and does not take account of non-vertical extension of the tether cable (image centre) under the influence of sub-shelf currents.

of its association with sea ice. This species is also the most coastal of Antarctic krill species but has been encountered in a variety of diverse habitats: in ice covered coastal fjords (Kirkwood 1996), from deep within the Ross Sea (75°S) (Sala *et al.* 2002), from Deception Island (Brierley 1999), in current jets far to the north of the sea ice zone (54°S) (Brierley & Brandon 1999) and from within polynyas (Nicol *et al.* 2004). Their overall distribution pattern has often been linked to the presence of polynyas (Pakhomov & Perisonotto 1994). As *E. crystallorophias* is mainly a coastal and shelf species it is thought to occur in depths of less than 500 m and it is thought to undergo diurnal vertical migrations within the surface layer (Pakhomov & Perisonotto 1994).

The circulation pattern of the waters off the Amery Ice Shelf is such that species like *E. crystallorophias* could be entrained in the under-ice circulation. Low salinity shelf water is advected under the eastern end of the ice shelf throughout the year, while there is a strong outflow of very cold ice shelf water from under the centre and west of the shelf. Closer to the bottom of the cavity, at 740 m depth, the water has a higher salinity signal, similar to that in western Prydz Bay in late spring, suggesting that water from the Prydz Bay polynya drains under the shelf at least as far as AM01b (Leffanue & Craven 2004). Entrainment in currents has been observed for this species in other areas (Brierley & Brandon 1999) and the cold water tolerance of this species suggests that it could survive the conditions beneath the shelf. *Euphausia crystallorophias* has not been reported at depths of 750–775 m before but this may just be an artefact of sampling regimes and because the shelf waters around Antarctica where this species is found rarely reach this depth. As this species was found so far (100 km) from the open water and thus from its normal food sources it implies that either it is tolerant of starvation, as many krill species are, (Nicol *et al.* 2004) or it can survive on suspended material in the waters circulating beneath the ice shelf. *Euphausia crystallorophias* is thought to be omnivorous (Pakhomov & Perisonotto 1994) and the presence of benthic detritus in the photographs may indicate a possible food source. The flow field under the ice shelf suggests that if these krill had been merely drifting in the current (0.10–0.15 ms^{-1}) (Leffanue & Craven 2004) they would have spent at least 8–12 days under the ice.

The environment under ice shelves is, on first inspection, not particularly favourable for biological production yet the camera system recorded both pelagic and benthic organisms. Further studies should thus investigate the communities that occur there and should examine ways in which they can be documented and sampled.

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