

# Weddell seals and shelf ice-associated cryo-benthos at the Ekström and Riiser-Larsen ice shelves

## Outline

Incidences of cryo-benthic communities beneath ice shelves are rare and recent discoveries. Combined seal- and ROV-borne imagery and sampling tools allowed for an assessment and augmentation of earlier data on cryo-benthic communities being attached head-down beneath the floating shelf ice at the Ekström (Atka Bay) and the neighbouring Riiser-Larsen ice shelves (Drescher Inlet); eastern Weddell Sea. These *hanging gardens* represent a *food horizon* where Weddell seals could benefit from locally enhanced biological activity, and are hence probably indicative for increased abundances of Weddell seals at the interface between shelf and sea ice. This ecosystem is endemic and unique to the Antarctic and under severe threat due to climate warming.

## Rationale

The question whether the occurrence of cryo-benthos is representative for the far-ranging high Antarctic ice shelves or unique is open, and factors contributing to its existence and its stability over time are unexplored. In view of the vast but almost entirely unsampled habitat of >1.5 million square km in the entire Southern Ocean, knowledge on the magnitude of the carbon stored in cryo-benthos is a significant gap in our knowledge of the Southern Ocean food web. We carried out synoptic field studies at two oceanographically and biologically differing sites 500 km apart, where the seals' dives show bimodal distributions of bottom times at depths corresponding to the underside of floating ice shelves, supporting the hypothesis of ice shelf associated foraging.

## Synopsis

- **Molecular barcoding** of Antarcturids from DI identifies the same species occurring in nearby benthic communities; abundances in the seabed are at 5 orders of magnitude lower
- **Abundance** of isopods seen on footage differs strongly between locations, with only few specimen at AB compared to dense *hanging gardens* at DI
- **Presence of life-stages** including ovigerous females at DI indicates local reproduction away from the seabed; not seen at AB
- **Cryo-benthic fish fauna** identical; abundance higher at AB
- **Diversity** of cryo-benthic species higher at AB, where platelet ice layers of several meters aggregate on shelf ice, perhaps allowing a broader spectrum of species to shelter
- **Weddell seal** dive distributions indicate ice shelf associated foraging at both locations

### Cryo-benthos at Drescher Inlet (DI)

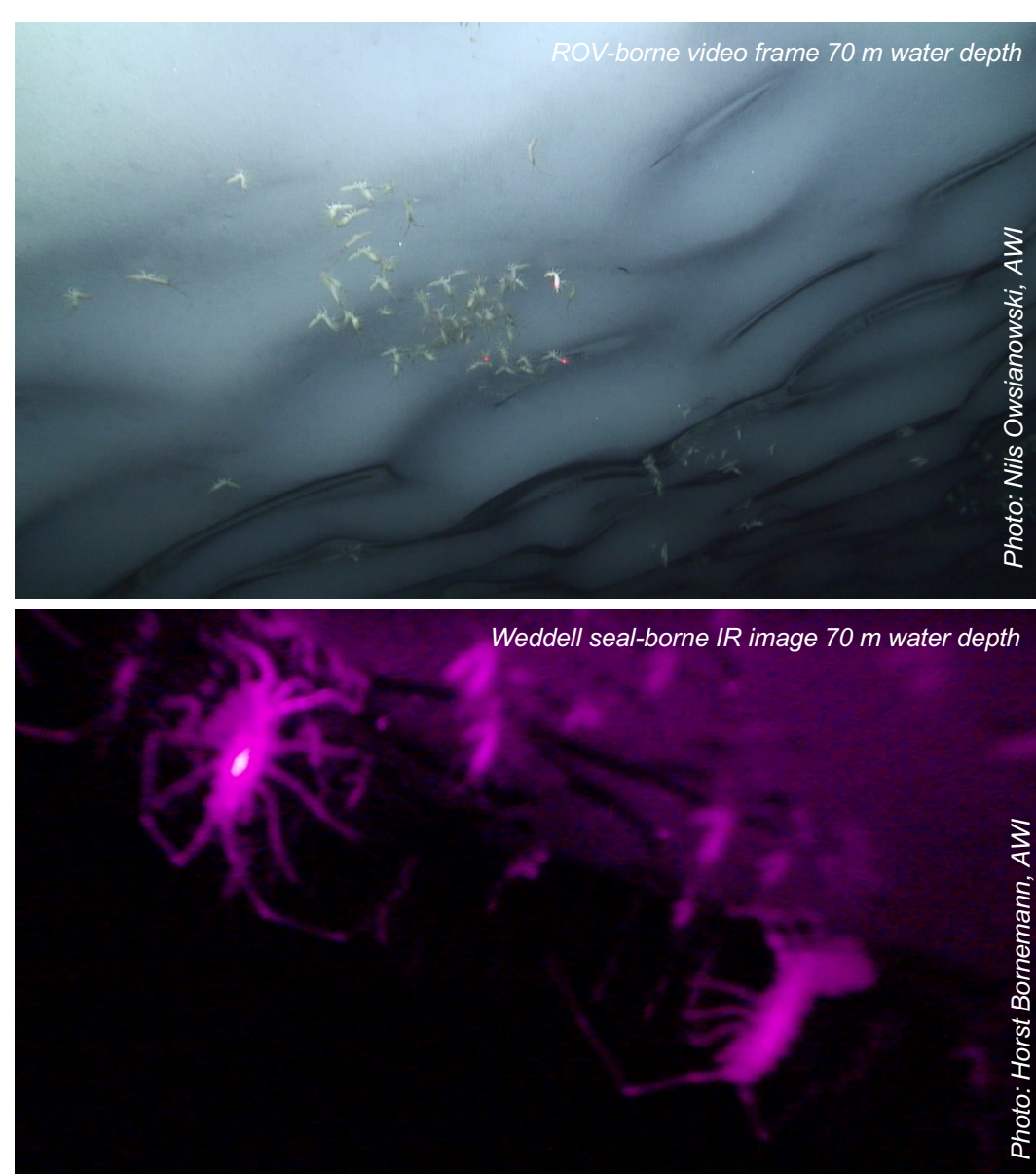


Fig. 1: *Antarcturus* cf. *spinacoronatus*. Dense aggregations of adults along ridges, and juveniles in the dents of the scallop surface of the shelf ice. Images taken at 70 m.

### Cryo-benthos at Atka Bay (AB)

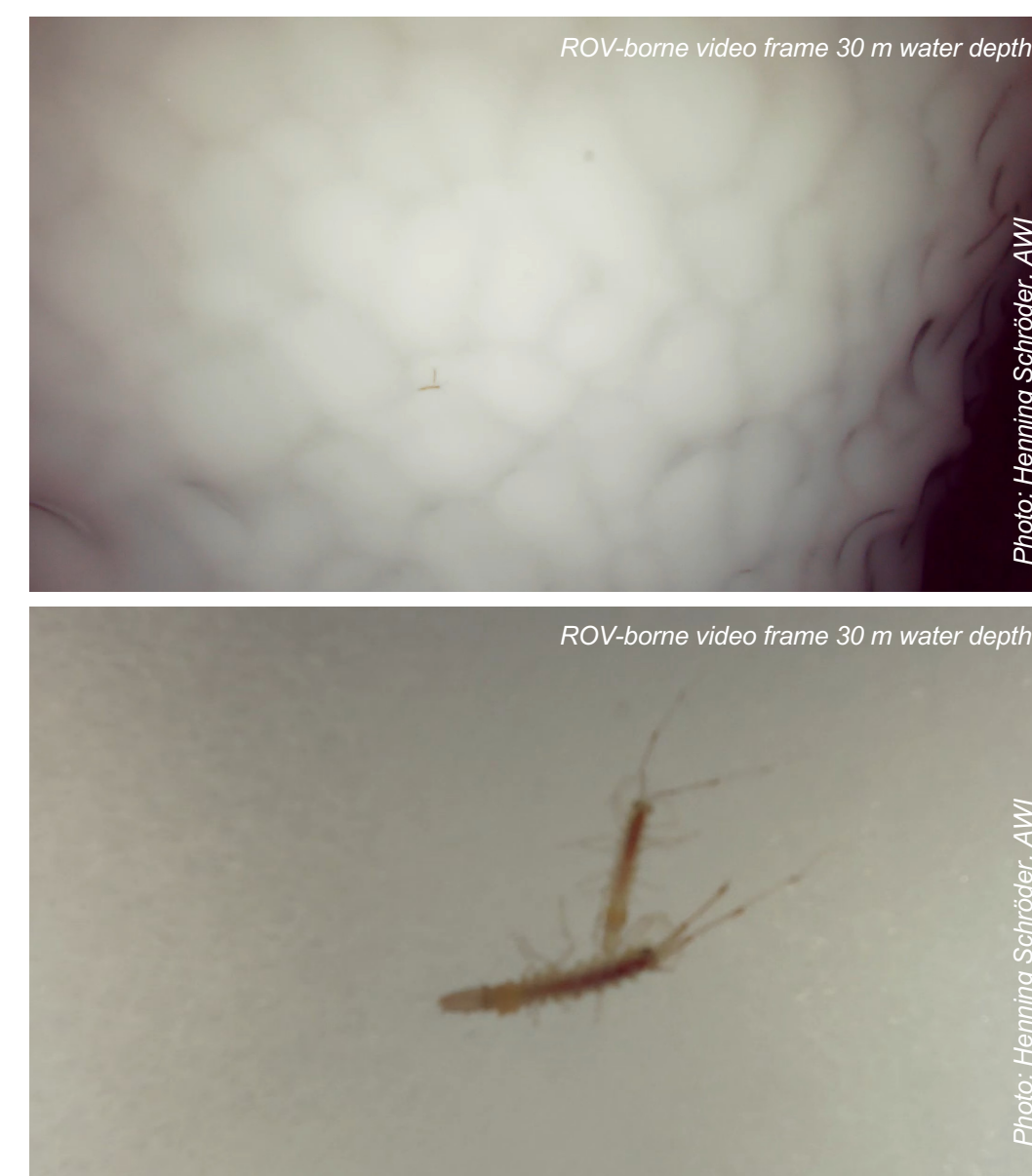


Fig. 2: *Antarcturus* cf. *spinacoronatus*. Few adults (single or pairwise) on ridges of the shelf ice scalloped surface or associated with aggregations of platelet ice attached to shelf ice. Images taken at at 30 m.

### Species diversity



Fig. 3: *Antarcturus* cf. *spinacoronatus* (top left to bottom right), *Amphipoda*, *Pagothenia borchgrevinkii*, *Pteropoda*, *Polychaeta*, and *Aega antarctica* as well as nemertid worms (not shown) as representatives of ice-associated taxa collected with the ROV in Atka Bay. Samples taken on shelf ice (grounded or floating) at several locations inside Atka Bay between 30 and 150 m.

Cryo-benthic filter-feeding *Antarcturus* cf. *spinacoronatus* (Fig. 1) populate in dense aggregations (average: 25 adults/m<sup>2</sup>) the underside of the floating shelf ice at Drescher Inlet (DI) 72°50'S – 19°09'W, (Riiser-Larsen Ice Shelf, eastern Weddell Sea). Here, Weddell seals feed in corresponding depths (70 – 150 m), possibly on isopods or related fish fauna, and on demersal and bottom fish (and squid) at the seafloor in around 400 m.

Cryo-benthic filter feeding *Antarcturus* cf. *spinacoronatus* (Fig. 2) occur as singletons or pairs, as well as other evertebrates and fishes (Fig. 3) at the shelf ice either grounded or floating at Atka Bay (AB) 70°40'S – 07°45'W, (Ekström Ice Shelf, eastern Weddell Sea). Here, Weddell seals feed in corresponding depths (around 50 m) and at the seafloor ranging from 70 – 200 m likely as a result of concentration of prey in these depths.



Fig. 4: Adult Weddell seal (*Leptonychotes weddellii*) equipped with underwater Infrared Videocamera-logger (Little Leonardo). Feeding events were documented on nothotenid fish but not on cryo-benthos. The proximity of the exposure (~30 cm) of images taken at DI and dive depth distributions in line with the immersion depth of the floating ice shelves at DI and AB indicate shelf ice associated foraging.

### Oceanography & megabenthos at DI

DI is a 25 km long, 2 – 3 km wide inlet with depths ranging from 400 to 520 m. DI is under immediate influence of the open ocean, as isobaths indicate a steep gradient within a short distance off the inlet mouth. The floating shelf ice allows the coastal current flowing beneath the ice shelf, transporting eastern shelf water and nutrients in reach of the high abundant *hanging garden* community. The seabed in 400 m contrasts with a mixed community of rather low sea-bed cover.

### Oceanography & megabenthos at AB

AB is a 25 x 20 km embayment with depths ranging from 50 to 200 m. AB is under less oceanic influence, sheltered by an extended shelf area off the bay and in lee of the coastal current. Mayor sections of the bay contour are grounded, impeding advective currents. Aggregated platelet ice along shelf ice provides shelter for a variety of cryo-benthic organisms albeit at low abundance. By contrast, the local benthos represents one of the richest communities in the Southern Ocean.

### Weddell seals (*Leptonychotes weddellii*)

Weddell seals (Fig. 4) are common with at least 120 adult seals considered resident at both locations. Increased stratification of temperature layers within the water column is associated with increased foraging efforts by the seals. The seals' dive depth distributions follow a typical bimodal pattern at both locations and seals target both, pelagic and benthic depths as a result of concentrations of the seals' prey species in these particular layers (i.e. fish, squid and crustaceans).

<sup>1</sup> Alfred-Wegener-Institut, Helmholtz-Zentrum für Polar- und Meeresforschung, Am Handelshafen 12, D-27570 Bremerhaven, Germany. E-mail: horst.bornemann@awi.de

All data are available via the Data Publisher for Earth & Environmental Science PANGAEA ([www.pangaea.de](http://www.pangaea.de))