Weddell seals and shelf ice-associated cryobenthos

Horst Bornemann[1], Dominik Nachtsheim[1,2,3], Nils Owsianowski[1], Richard Steinmetz[1], Claudio Richter[1], and Christoph Held[1]
[1]*Alfred-Wegener-Institut Helmholtz-Zentrum für Polar- und Meeresforschung, Am Handelshafen 12, 27570 Bremerhaven, Germany*
[2]*Institute for Terrestrial and Aquatic Wildlife Research, University of Veterinary Medicine Hannover, Werftstrasse 6, 25761 Büsum, Germany*
[3]*BreMarE - Bremen Marine Ecology, Marine Zoology, University of Bremen, P.O. Box 330440, 28334 Bremen, Germany*

Incidences of cryo-benthic communities beneath ice shelves are rare and recent discoveries. Images taken by seal-borne cameras at Drescher Inlet (Riiser-Larsen Ice Shelf, eastern Weddell Sea) in 2004 led to the discovery of a hitherto unknown cryo-benthic community of crustaceans being attached head-down to the underside of the floating ice shelf at depths between 130-150m (Watanabe et al. 2006). Resolution and exposure of these images did not allow distinct identification on species level, being considered as likely isopods or cnidarians, and no information could be gained on the composition, size, dimension and density of the faunal aggregation at that time. Recently, however, a re-assessment and augmentation of the earlier findings (Bornemann et al. 2016) has become feasible due to the use of combined seal- and ROV-borne imagery and novel sampling technologies.

The Drescher Inlet is a 25km long and between 2 and 4km wide crack in the Riiser-Larsen Ice Shelf and characterized by perennial fast ice that disintegrates at irregular intervals. The fast ice of the inlet provides habitat for Weddell seals, hauling-out along tidal cracks in numbers of 200 – 300 individuals. In December 2016 German logistics and the research platforms *Neumayer Station III* and RV *Polarstern* coordinated a field camp on the ice shelf close to the inlet that had been maintained for four weeks.

Weddell seals were instrumented with infrared still picture camera loggers (IR-DSL; Little Leonardo, JP) or CTD-combined satellite relay data loggers (CTD-SRDL; Sea Mammal Research Unit, UK). A Remotely Operated Vehicle (ROV; Ocean Modules, SE) was launched through a hole dug in the fast ice near the shelf ice cliffs.

Seal-borne IR-DSLs took close-ups of aggregations of isopods underneath the floating ice shelf at 100m water depth. ROV-borne high resolution video footage showed dense aggregations of a single morphospecies of filter-feeding isopods. Significant size differences and clustering of the isopod aggregations imply a specific association of adults and juvenile life stages along the scallop structure of the shelf ice underside. A custom-made ROV-mounted dredge collected several specimens at depths between 60 and 80m. Molecular barcodes from a dozen specimens from all size classes and both sexes revealed all individuals as members of a single species. Furthermore, an exact molecular match of these newly sampled cryobenthic isopods with *Antarcturus cf. spinacoronatus* from nearby benthic communities (Baltzer et al. 2000) confirms that this species inhabits the seabed, too, albeit at significantly lower abundances.

The aggregations of isopods are likely to represent an attractive food horizon, where seals could benefit from a local hotspot of highly biological productivity. The factors contributing to this hotspot and its relation to physical processes are not yet understood. We therefore compiled available local physical and biological data and will discuss their relevance in the wider regional context for this faunal hotspot. These include data on shelf, sea and platelet ice, seafloor topography, and hydrography, as well as associated pelagic and benthic marine life.

Diving profile data from over thirty adult Weddell seals that had been instrumented with time-depth recorders during the course of six field campaigns between 1990 and 2016 were retrospectively analyzed using an automated broken stick algorithm (Heerah et al. 2014), to identify within-dive hunting phases and to correlate those to the local physical environment of the Drescher Inlet. A tri-modal frequency distribution of mean hunting depths suggests that Weddell seals concentrated their foraging in three depth strata corresponding with pelagic (20-50m), shelf ice associated (110-160m), and demersal (below 370m) foraging depths. Midwater and demersal foraging depths are concordant with data from air-borne and bathymetric measurements of the shelf ice contour and seafloor topography.

Our results indicate that earlier reports of increased mid-water foraging of Weddell Seals (Plötz et al. 2001; Liebsch et al. 2007) and the identification of filter-feeding isopods on seal-borne still images from the underside of the shelf ice (Watanabe et al. 2006) are causally linked.

References

Baltzer, C., C. Held, and J.W. Wägele, *Furcarcturus polarsterni* gen. nov., sp nov., a large deep-sea arcturid isopod from the Drake Passage, with a preliminary molecular characterization. Polar Biology, 23, 833-839, 2000.

Bornemann, H., C. Held, D. Nachtsheim, N. Owsianowski, C. Richter, and R. Steinmetz, Seal research at the Drescher Inlet (SEADI), pp 116 - 129 in Schröder M (ed) The Expedition PS96 of the Research Vessel POLARSTERN to the southern Weddell Sea in 2015/2016, Berichte zur Polar- und Meeresforschung = Reports on polar and marine research, Bremerhaven, Alfred Wegener Institute for Polar and Marine Research, 700, 142 p, 2016.

Heerah, K., M. Hindell, C. Guinet, and J.-B. Charrassin, A new method to quantify within dive foraging behaviour in marine predators. PLoS ONE, 9, e99329, 2014.

Liebsch, N., R.P. Wilson, H. Bornemann, D. Adelung, and J. Plötz, Mouthing off about fish capture: jaw movements in pinnipeds reveal the real secrets of ingestion. Deep Sea Research II, 54, 256-269, 2007

Plötz, J., H. Bornemann, R. Knust, A. Schröder, M.N. Bester, Foraging behaviour of Weddell seals, and its ecological implications. Polar Biology, 24, 901-909, 2001.

Watanabe, Y., H. Bornemann, N. Liebsch, J. Plötz, K. Sato, Y. Naito, and N. Miyazaki, Seal-mounted cameras detect invertebrate fauna on the underside of an Antarctic ice shelf. Marine Ecology, Progress Series, 309, 297-300, 2006.