Effect of sea ice break-up on the foraging behaviour of Weddell seals

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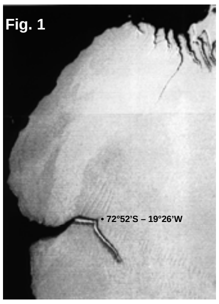
Objective

Weddell seals are excellent divers highly adapted to reside in the coastal fast ice zone, a dynamic ecosystem that is strongly influenced by the seasonal ice break-up. A joint seal – sea ice study was carried out at Drescher Inlet, eastern Weddell Sea coast, during the 1998 CS-EASIZ cruise of RV "Polarstern" in order to investigate the seals' diving behaviour inside the ice-covered inlet. One of our major objectives was the reconciliation of dive records with hydrographic events during periods of intensive sea ice break-up.



Study area and Field methods

Fig. 1. The Drescher Inlet (72°52'S – 19°26'W), a funnel shaped crack in the Riiser Larsen Ice Shelf, is characterized by a stable sea ice cover with an underlying platelet ice layer up to 30 m thick. Tidal cracks along the foot of the ice cliff and across the entire inlet provided breathing holes for at least 500 Weddell seals during the austral summer 1998. The inlet is 25 km long and flanked by floating ice cliffs of up to 30 m above and 80 m below the sea surface. The topography of the inlet is irregular with water depths ranging from 360 m to 430 m and the seabed extends for ca. 100 km under the ice shelf.

Twentyfive seals were fitted out with time-depth recorders (Pillboxdatalogger, Driesen & Kern, Germany) between 7 and 12 February 1998. We immobilized the animals for deployment and recapture of the loggers using a combination of ketamine, xylazine, and diazepam.

A SEACAT SBE 19 CTD profiler was launched through cracks in the ice or at the ice edge to record standard hydrographic data. Currents inside the inlet were measured by an "Aanderaa" RCM 8 current meter that was deployed under the fast ice at 130 m depth.

Results and Discussion

Fig. 2

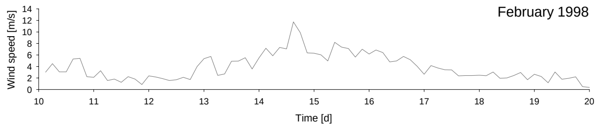


Fig. 2. Wind speed diagram. The automatic ARGOS weather station of the Alfred Wegener Institute at Drescher Inlet recorded large weather changes in mid February. Mean wind speeds of 3.4 m/s peaked between 13 and 16 February to a maximum of 11.8 m/s in westerly direction.

Fig. 3

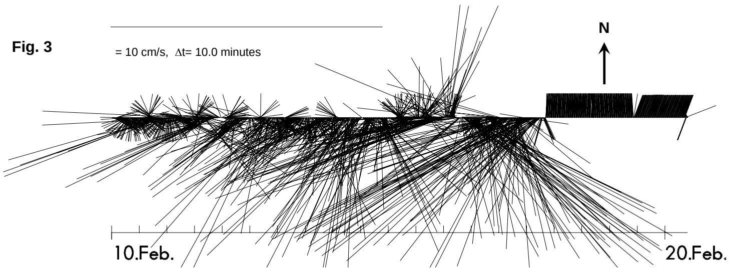


Fig. 3. Water current stick plot. Currents inside the inlet are mainly oriented to the south with mean speeds of about 2 cm/s. A northeastward directed current that was preceded by a wind speed maximum on 14 February (Fig. 3), peaked 2 days later with maximum velocities of 6 cm/s. Both the high wind and current speeds indicate a swell induced sea ice break-up that was most intensive on 17 February.

Fig. 4a

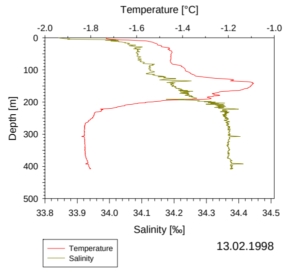


Fig. 4b

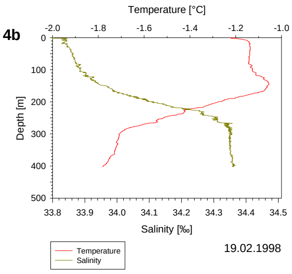


Fig. 4 a & b. CTD-profiles. The water temperature and salinity regime of the Drescher Inlet is characterized by a stable thermo- and pycnocline between 130 and 230 m water depth. Temperatures in the upper water column varied considerably depending on weather conditions and degree of ice cover. Before sea ice break-up, the surface layer down to about 30 m was cooled down and formed a weak thermocline between 30 and 50 m (Fig. 4 a). During the ice break up, Warm Deep Water was entrained due to surface water export caused by high wind speeds and the northeastward directed current on 16 February (Fig. 3). This resulted in a warming up of the upper water column and consequently melting of the fast ice and platelet layer, which is reflected in the marked reduction in salinity after the ice break-up (Fig. 4b).

Seal A

Fig. 5a

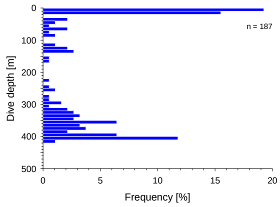


Fig. 5b

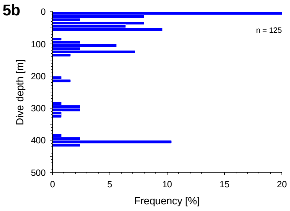


Fig. 5 a – d. Dive depths frequency distribution. Four seals provided data during the sea ice break-up. The data were grouped in periods of 60 hours each before and after the ice break-up on 17 February. In two of the four seals (seal A & B) we observed significant changes in the distribution of dive depths before (Fig. 5 a & c) and after the ice break-up (Fig. 5 b & d). Median dive depths shifted from 245 m to 50 m (seal A) and from 141 m to 47 m (seal B) respectively. Significance was tested using the Mann-Whitney Rank Sum Test with P values of 0.025 for seal A and < 0.001 for seal B. The latter showed a striking switch from a multimodal distribution of dive depths to an unimodal distribution after the ice break-up: 93 % of all dives were concentrated above the stable pycnocline of 130 m depth in contrast to 46 % before. The distribution of dive depths of seal A changed from 44 % before to 73 % after the ice break-up.

Seal B

Fig. 5c

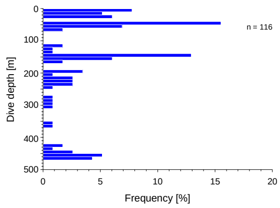
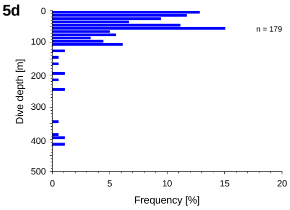


Fig. 5d



Conclusions

- We observed significant changes in the frequency distribution of dives during the sea ice break-up with a clear preference of shallower dives above 130 m after the ice had disintegrated.
- The sea ice break-up in the Drescher Inlet caused a local shift in the trophic interactions. Biomass which was formerly bound to the fast ice and platelet ice layer was released into the upper water column and constituted an attractive "feeding spot" for zooplankton, krill, pelagic fish, and, consequently, the fish feeding Weddell seal.

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