The Expedition ANTARKTIS XXI/2 (BENDEX) of RV "Polarstern" in 2003/2004

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2.3.6 Foraging ecology of Weddell seals

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Objectives

The Weddell seal, a fish predator, is adapted to exploit coastal shelf waters which are largely covered by fast ice for most of the year. Previous summer studies at Drescher Inlet showed that during a period of intensive ice break-up Weddell seals exhibited a diel pattern in foraging depths with day-time dives to the seafloor (400 m) and night-time dives well above the pycnocline (about 150 m). Complementary fishery data confirmed that *Pleuragramma antarcticum* were by far the most abundant fish, both in the upper water layer and close to the seabed. The spring campaign (4 Dec. 2003 – 3 Jan. 2004) extended our investigations on predator-prey relationships into a season characterized by unbroken ice and permanent daylight. For this study we conceived a new system of multiple micro-sensors and visual recording devices to obtain a more comprehensive picture of the spatial and temporal variations in the seals' diving behaviour and foraging success. Our study is complementary to studies of diel changes in distribution patterns of fish and of zooplankton included in this cruise report.

Work at Drescher Inlet

Non-lactating female Weddell seals of an estimated weight of 300 - 400 kg were immobilized for the attachment and retrieval of data logging devices. Two Telinject-blowpipe syringes, being placed cranio-dorsolateral of the seal's pelvic region, contained the initial dose of 'Hellabrunner Mischung' (HM). One syringe of HM contains 500 mg xylazine + 400 mg ketamine + 50 I.U. hyaluronidase in a volume of 4.5 ml. About 20 min after HM-injection, the seal was approached to test its reaction by acoustic stimuli. If the narcosis was not deep enough, small doses of xylazine, ketamine, and/or diazepam were administered by hand. The narcosis was reversed by the antidote yohimbine, given as 1% solution in a dose of 5 ml/100 kg body weight. To prevent seals from hyperthermia, the hind flippers were covered with snow. When seals were aroused after the first shot or when the syringe was placed inappropriately, the attempt of immobilization was terminated. In one seal we observed apnea which could not be reversed by antidote intervention. Of the total of 18 seals chosen for deployments, 7 animals were drugged once, and 3, 2 and 6 animals were drugged four, three and two times, respectively. Re-drugging was done in intervals of between 4 and 8 days.

Seals were deployed with the following types of devices: Inter Mandibular Angle Sensor (IMASEN), Multi Channel Logger (MCL), Digital Still picture Logger (DSL), Acceleration Logger (ACL). The IMASEN is a jaw-activity sensor based upon the Hall-effect, recording feeding events measured by mouth-opening angle at frequencies of up to 30 Hz. The MCL measures swimming speed, dive depth, temperature and ambient light levels as well as compass-heading and tilt-angles. The DSL is a camera which records still colour images at 30-s intervals and dive depth at 1-s intervals. The ACL measures swimming speed, dive depth and temperature at 1-s intervals, and 2-D accelerations at 1/16-s intervals.

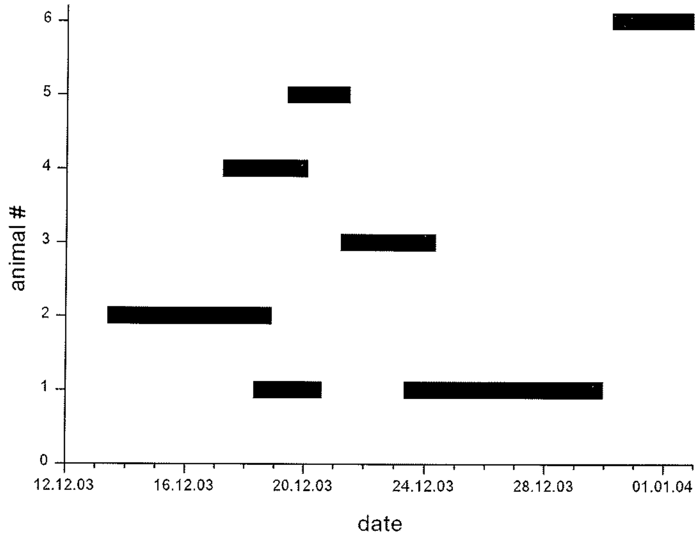

Fig. 38 Distribution of IMASEN and MCL data sets recorded for 6 Weddell seals over study period.

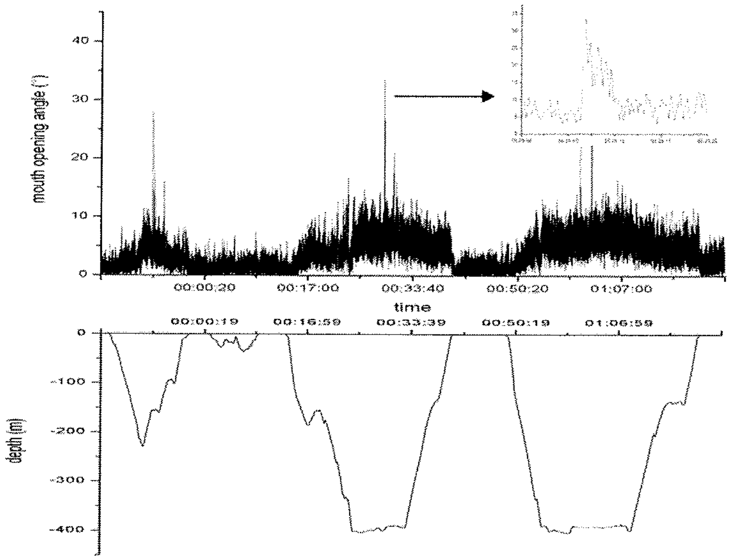

Fig. 39 Sequence of dive pattern and concomitant mouth-openings of a Weddell seal; arrow indicates details of a feeding event.

Preliminary results

IMASEN & MCL: From the 18 logging units recovered, 7 data sets of 6 seals were selected (Fig. 38) and analyzed for feeding events in relation to dive depth (Figs. 39 & 40) and time of day (Fig. 41). Clear changes in mouth-opening-angle over time (at least 10°), occurring under water, were counted as feeding events (Fig. 39). Foraging was most common in the upper parts of the water column. Of the total of 611 feeding events recorded in 219 dives, highest frequencies occurred at around 100 m water depth (Fig. 40). A moderate increase of feeding events appeared close to the seafloor in excess of 400 m. The seals were most active between 22:00 and 06:00 hrs, showing a maximum of feeding events around midnight (Fig. 41). Additional peaks of feeding events occurring in the afternoon hours were mainly caused by one seal which concentrated its diving activity over a depth range of 50 - 100 m during the day. Because of the limited amount of data obtained from this animal, its apparently high prey catch success does not constitute a representative sample of foraging characteristics observed in the other seals studied.

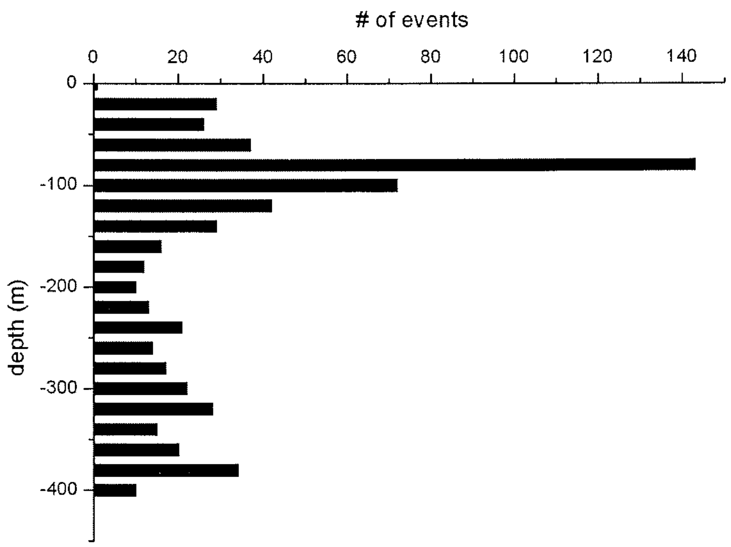

Fig. 40 Distribution of feeding events (n = 611; given in 20-m ranges) against depth of dives (n = 219) recorded for 6 Weddell seals.

DSL & ACL: 4 sets of visual (image) data and 5 sets of acceleration data have been obtained; the recording time ranged from 9 to 36 h and 75 to 167 h, respectively. The seals primarily foraged in two depth layers. These extended from the sea surface to 160 m where the DSL images showed abundant euphausiids and organic particles, and near the seafloor at about 400 m depth. A number of images documented that the seals moved adjacent to underwater ice cliffs and foraged underneath the shelf-ice at ca. 150 m depth, sometimes stretching their necks towards the ice presumably to catch cryopelagic fish. The images often showed aggregations of amphipods, isopods and possibly hydroids at the shelf-ice base (Fig. 42). During the dives underneath the shelf-ice, the seals' swim speed, swaying acceleration and surging acceleration changed simultaneously (Fig. 43). These changes might correspond to prey capture events.

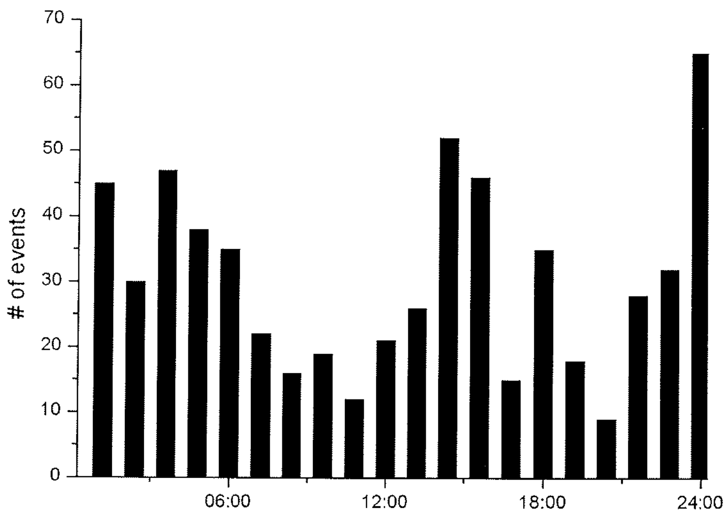

Fig. 41 Distribution of feeding events (n = 611) of 6 Weddell seals against time of day.

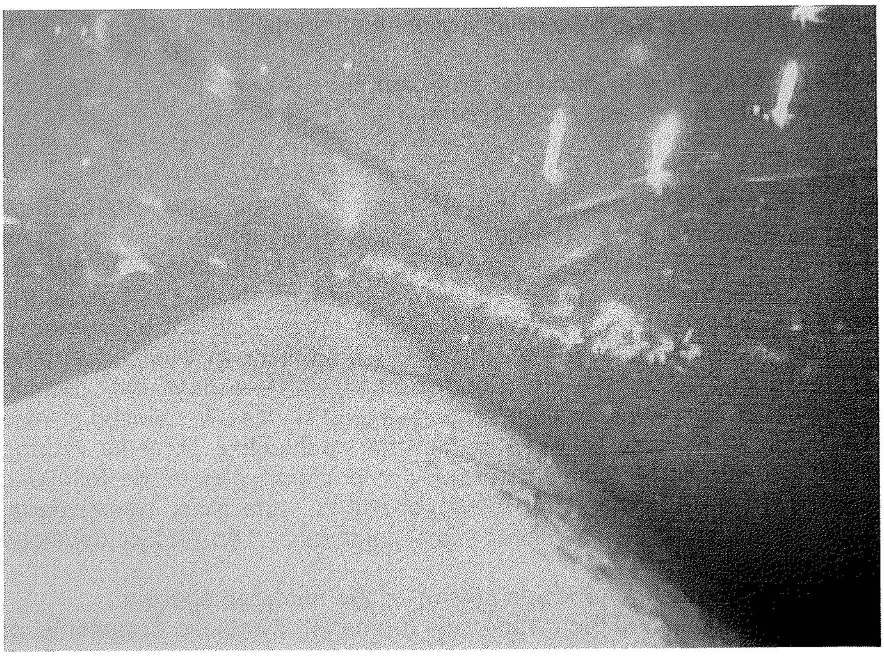

Fig. 42 A Weddell seal stretching its neck towards the underside of the ice shelf (see also text). The image was taken at 150 m depth, by a camera logger attached to the seal's back.

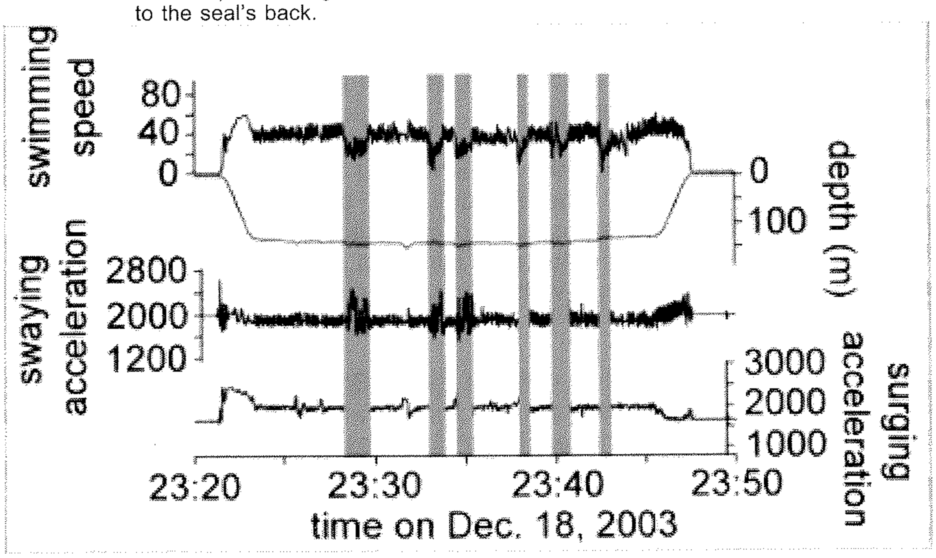

Fig. 43 Swimming speed, dive depth, swaying and surging accelerations recorded from a Weddell seal diving underneath the ice shelf. All parameters except for dive depth are relative values. The shaded areas highlight simultaneous changes of speed and acceleration.