Weekly report no. 5 GLOBEC II (ANT XXI/4) RV „Polarstern“ 2nd May 2004

The krill expedition into the Lazarev Sea in autumn is ending soon. A stable atmospheric high-pressure system with southerly wind force 5 bft. allowed us to finish the programme in time and to extend the sampling grid further to the north. In total 184 net hauls were done on 93 stations. Although many more samples have to be processed in home institutes, we also collected lots of data already and gained several new insights:

In April 2004 the krill spawning period was over for at least several weeks. Organisms had already started to reduce their metabolism, and were in a transition phase from high summer to low winter conditions. The relatively high oxygen consumption of larvae and juveniles – a measure of their metabolic activity - indicated that the specimens still found sufficient food in the water and between ice. Adult krill, however, had already reduced the summer values in daily carbon consumption (30% of the body carbon) down to only a few percent typical for food intake in winter. Ingested food comprised in 2/3 of phytoplankton and the remaining 1/3 in microzooplankton. The trigger that induces the reduction in body metabolism and the reduction in feeding is still unknown but we will perform enzymatic measurements in the home laboratory on frozen samples to gain some insight into the underlying mechanisms. Growth experiments with different larval stages of krill show that they were very fit with a daily mortality of less than 2%. We assume that krill larvae did feed on ice algae to fulfil their energy demand, but it is still unclear to which degree krill larvae also feed on microzooplankton. In first experiments performed during our cruise it became evident that the amount of microzooplankton as food items increases with the age of the krill larvae. But krill larvae are still mysterious in many respects. They do not carry sufficient lipid reserves, as do the adults, to account for hunger periods during winter. And they do not show any mechanisms like the reduction in metabolic activity to save body energy. Thus, it still remains unclear how krill larvae survive during the strong long winter and we have to perform more experiments to construct a proper energy budget for the different growing seasons. The deep frozen krill will be analysed for biochemical and pharmaceutical substances back in home laboratories.

The krill in the Lazarev Sea were concentrated in two areas: the northeast corner between 61°S and 64°S and the marginal ice edge zone (MIZ) between 67°S and 69°S. In the MIZ the largest krill with body length up to 54 mm and an age of more than 3 years was found. Krill in the north were considerably smaller, younger and did not spawn in the previous season. Ice krill were found only in the very proximity of the continental ice shelf. Krill distribution was monitored down to 600m water depth by means of the echo sounder. The krill swarms were rather small and did migrate vertically on a diurnal cycle. Juveniles of the age class 1 (year) – the recruits – were virtually absent, with one exception on a single northern station, which indicates that the breeding success of krill in the previous year was rather low. Very young larvae, i.e. larvae from the current year, were rather abundant. These larvae have to feed continuously to survive and this might become a problem in the coming winter months. Spawning must have taken place rather late this year and we assume that the survival rate of these late spawners are rather low despite the fact that most young larvae were in excellent physiological condition. Krill larvae in the age between 30 and 60 days were very abundant in the central area (65-67°S), a fact that contradicts published findings that in turn show maximum larvae abundance on the continental shelf in the south of the Lazarev Sea. We have to closely examine the oceanographic current regime to solve this mystery. We also have to analyse the frozen samples at home to determine whether the krill here are genetically similar to the krill of the other Antarctic areas e.g. from the Antarctic Peninsula region.

The surface under ice trawl (SUIT) net caught krill larvae in the close vicinity of sea ice floes, an indication that the organisms were feeding on the ice biota and were hiding between floes against their predators. The biomass obtained from the SUIT net hauls of the upper metres in the ocean ranged between 10 and 1000 grams with one exceptional catch of 30 kg. This also indicates, that krill occurred - if at all - in locally concentrated swarms, and that krill was only present at sea surface and under the ice during night time and that its distribution was rather patchy. On the contrary, the guts of sea birds, attracted by the ships light and landing on deck, did contain many krill, fish larvae and squid - the latter not being caught in considerable numbers by the nets. Besides krill, the salps (tunicates) were surprisingly abundant in the ice covered areas. Whether this exceptional occurrence of the so-called "warm water species” in the Coastal Current indicate an intrusion of advecting water masses from the north, or is an indicator for climate shifts, has still to be determined.

Zooplankton in the Lazarev Sea comprised of copepods, tunicates, arrow worms, polychaetes, amphipods, pteropods and jellyfish and was concentrated in the upper hundreds metres of the water column. Copepods dominated in abundance and very often also in biomass. Whereas the smaller 2 mm copepods were concentrated in the surface layers, the 4mm Calanoides acutus already had started to migrate down for hibernation in 500 to 1000m. The other large Calanus propinquus remained in surface layers as it contains special storage and anti freeze lipids that help the organisms to be active in winter. Both groups of copepods were preyed upon by chaetognaths whose slime transparent body helps them to grab the prey with the setae equipped with hooks and attached on either side of the head. In the upper 100m of the –1.86°C super cool waters of the coastal current, the zooplankton was somewhat reduced and was dominated by appendicularia and salps. Most of the zooplankton in the coastal current was found in the slightly warmer waters that intruded onto the shelf between 400 and 150m. These layers were inhibited by polychaetes, hunting copepods well known from the Weddell Gyre.

The two whale observers from the International Whaling Commission scanned the horizon and the vast expanse of Southern Ocean for that ever-elusive whale blow. The initiative of collaboration with other Antarctic research programs aims to examine variability in baleen whale distribution and movements in southern waters in relation to their prey, Antarctic krill and sea ice concentrations. At this time of the year they would expect to see a number of whale species migrating between the continental waters and warmer breeding waters, especially humpback whales. They would also expect to see some species in the sea ice areas, including minke whales and orcas. On transit between Cape Town and the cruise survey area, only one whale sighting was made, probably due to weather and low sightability conditions. The survey area proved to be different with 16 sightings of 22 whales including humpback and minke whales, a single sperm whale and some unidentified species. Four sightings of 12 individual humpback whales were made on the 25th April in the extended survey leg north of the 4th transect. These whales were all travelling north, an indication of the ice cover extending and the whales starting on their northward migration. One exceptional sighting occurred on the 27th April with 5 humpback whales choosing to spend over four hours with the vessel. There were also approximately 150 chinstrap penguins swimming around the vessel and as the whales approached closer to the vessel, they started chasing each other, possibly for play or seeking the same food source. At one point, the group of five whales split and two individuals swam around the bow to the starboard side while the other three remained on the port side. During this time, one of the whales from the port side disappeared out towards the horizon where another group of humpback whales was present. The remaining four then continued to surface around the vessel for the next hours, blowing, snorting, pectoral fin slapping, spyhopping and even breaching, giving everyone on board a spectacular show, although it is possible that the whales were just as interested in us as we were in them. Although the overall total of sightings during the voyage is not high at 26 observations of 50 individuals, it is reasonable for this area at this time of year and the patchiness expected in whale distribution. In summary, the low numbers of top predators in the area indicate that the central Lazarev Sea seems to be a low production area for krill.

Additional highlights of the expedition were the 9 stations where sediment surface layers were sampled and analysed by the geochemical group on board ship. These stations included those at the Polar front where the previous iron experiment EIFEX had been performed. First results indicate that the phytoplankton growing at sea surface did sink through the water column and had reached the sea floor in about 4000m water depth within a few weeks. This input of rather fresh organic material induced biological degradation at and in the surface sediments. On one core retrieved from the sediments of the Polar front, a 10cm thick, fluffy layer of fresh organic matter showed remarkable biological degradation that caused oxygen reduction in about 5cm sediment depth followed by oxygen rich layers underneath. This exciting finding just illustrates how tightly the biological processes at ocean surface are coupled with biogeochemical reactions in the sediments. If we can fully understand these mechanisms we are in a better position to use the sediment record as history books to reconstruct upper ocean processes which in turn are related to global processes in general. After weeks of day-night shifts and miserably cold, icy work on deck we enjoyed the barbeque of delicious meat, fish and vegetables celebrated on 1 May that was followed by a night of dancing, gently effected by the rolling Polarstern. In the meantime severe low-pressure systems have passed our investigation areas in the Lazarev Sea and at the Polar Front. One low with 936 hPa, a value that seldom occurs in the northern hemisphere, induced strong storms of Beaufort 12 and wave heights of 20m and more. We are lucky of having completed our research and that we are on our way back to Cape Town were we dock on 6 May.

Finally I thank, also in the name of all scientists on board, the captain, the officers and all crewmembers for their most skilful, and foreseeing constant help that also was offered in a warm human atmosphere. Some of our work would not be possible without their effort. Many thanks also to those at home that have interestingly watched our expedition into ice and wind and also have accompanied us retrieving data and presenting our first results.

We are desperately looking forward to the ongoing green spring (or nice autumn days in Australia) and all the other pleasures awaiting us at home.

Perhaps until next time
Yours Uli Bathmann