Weekly report no. 4 GLOBEC II (ANT XXI/4) RV „Polarstern“ 22 April 2004

Some research activities in Antarctica are still high-risk enterprises, even in times of satellite communication and other electronic systems. We experience this also during our cruise especially when we try to catch krill, zooplankton and fish that live close to the sea ice. The last weekly report mentions that krill hides under sea ice against predators and also finds there a suitable feeding ground. Video sequences and photographs taken in the eighties by remotely operated underwater vehicles document high concentrations of krill between piled ice floes. And last year a British autonomous mini submarine equipped with upward looking echo sounders gathered the information that dense krill aggregations were associated to the marginal sea ice zone opposed to the rarely populated open water or fully ice covered areas. Up to now no net system was available, however, to catch the under ice biota quantitatively.

The Dutch group on board has constructed such a net that can be trawled under the sea ice with a speed high enough to get the fast swimming krill. The net really has to be robust. The 2.5 square metre wide and 4 m long frame is made of 9 cm wide steel tubes. On the upper front bar, 4 car wheel tires help the net to slide and roll under the ice. A sprout is attached to one side of the frame that also serves as otter doors. Thus, once pulled with 2 knots ship speed, the net slides aside under the undisturbed sea ice as it leaves the wake produced by Polarstern steaming through the ice. The top lid opens to allow big pieces of ice to leave the frame again, as they are bushed upward by steel bars at a width of a man’s arm. The fine mesh sized 14 m long net itself is attached to the lower end of the frame and is protected on the outside by a course strong additional fishing net. After several trials, crew and scientists working as a team managed to lower this prototype sampling gear under the ice in a distance of 100m aside from the ship. To do so, we had to attach an additional lead weight of 800kg to the 18mm pulling wire to suppress the cable deep enough to slide freely under the up to 2m thick ice floes.

The catch of each of the 19 hauls (including 7 under the ice) accounted for 10 to 1000 gram fresh weight in 25-minute trawls. Most biomass was caught between 10pm and 4am comprising mainly of krill, siphonophores, salps and fish larvae that were abundant during night time in the 2 m uppermost layers of the ocean. Only that layer can be harvested by storm petrels that obviously can find the prey in the total darkness of a cloudy Antarctic night. Some net hauls, however, got a very different catch: ice. In the super cold water of the Antarctic Coastal Current penetrating the shelf ice edge and reaching water temperatures at or slightly below its –1.86°C freezing temperature, platelet ice can form. Platelet ice forms even in several hundred meters water depth, when super cool water rise from below and experience adiabatic cooling. The very thin ice plates can reaching 1cm in diameter and gently rise to the sea surface where they were caught by the fishing net. In the coldest night so far at –20°C we emptied about 10 tonnes of platelet ice on the aft deck of the ship after one hour of hard

work and by means of three winches at the time. The temperature difference between water and cold air created sea smoke, a vision of steaming water between ice floes. On the early morning horizon a thin moon slowly emerged from the dark sea into the starry night and created a profound panorama for the 8 people working hard and hand in hand to operate the net that's nickname has become "chariot".

Polarstern is equipped with acoustic measuring systems to detect zooplankton and krill several hundreds of meters under the steaming ship. Vertically directed, narrow acoustic beams of four frequencies ping in regular intervals of about 1 second and the reflecting echo from particles is passively recorded by the appropriate receivers build into the ship's hull. Each zooplankton group, species or even developmental stage, of e.g. krill, performs rather distinct vertical migrations on daily basis but also in an annual pattern that are regulated by ocean physics (e.g. light, temperature, currents) and ocean biology (e.g. presents of prey and predators, reproduction cycle). By means of the under water acoustics we attempt to not only study the vertical migration pattern but also we can estimate the biomass of single groups of zooplankton, krill and fish all of that being prey for whales, seals, penguins and flying birds. Many of these species feed on the ocean surface during nighttime when the prey appears in the uppermost water layers. Unfortunately, German environmental regulations for Antarctica are interpreted in a way that does not allow us to perform the proposed acoustic measurements relevant to accumulate basic scientific knowledge as a background for marine mammal protection. We are only allowed to operate our acoustic equipment during the short day hours, in the absence of marine vertebrates in the water and outside the fully ice-covered areas, or in other words only in the ocean deserts where this research is least relevant. Given these harsh boundary conditions, we were able to operate the German acoustics programme for only about 15% of the time available south of 60°S, the northern boundary of the Antarctic treaty area. Under these circumstances the obtained data set is not sufficient to result in a profound scientific publication.

With our various nets we caught numerous fish, fish larvae and salps. Krill larvae and their predators, the lantern fish (Myctophids), co-occur and both migrate to the ocean surface during nighttime. This pattern was observed nearly on all stations in the Lazarev Sea. On the contrary, the larvae of the Antarctic silverfish Pleurogramma were mostly found in the very cold –1.86°C waters of the Antarctic Coastal Current that flows in a 100km broad band westwards along the Antarctic ice shelf. To our very surprise also salps appeared in this current but not in the northern locations under the influence of the Weddell Gyre. There is a hypothesis that salps increased in numbers in recent years in more southern parts of Antarctica, but they never were found in the coldest, most southern Antarctic waters. These tunicates, often refereed to as "oceanic vacuum cleaners", make a substantial part of so-called gelatinous zooplankton, as their body contains about 95% water. There are two species of tunicates or salps in the region of investigation. These 2-5cm long salps are successful

in feeding by pumping water through the body that is shaped like a barrel open at both ends which also allows them to extract oxygen with their gills located inside the body. With a fine filtering net they can retrieve particles down to 0.005 mm in size. The cold temperatures near the continental shelf did not suppress salp development and they were feeding well. We are still processing the data and have to closely examine the ocean hydrography of that region to solve the new paradox emerging from our cruise.

Unfortunately, a mechanic part of the winch hosting the 18mm conductor cable to operate electronic equipment from the stern of the ship, broke. That was the end of the operation of the multiple-RMT; the standard RMT is now operated without the electronic depths sensor.

On the last sunny day in the pack ice zone we were surrounded by picturesque icebergs. As we had to deploy a satellite buoy on a large ice flow, that drift will be monitored for the next year from the home institute in Bremerhaven, we used the nice environment to take the group photograph from our cruise. Scientists covered in heavy polar gear were standing on the upper deck with a bluish glittering iceberg giving the appropriate background. Many more electronic pictures of ice in different forms were available the following night on Polarstern intranet server that together with the countless, normal slides which will serve as a splendid memory of Antarctica.

We are still kept in the cold by frequent snow showers, but our minds are directed north towards home, as will be the ships course in due time.
We are back not before long.

Uli Bathmann