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# Size structure of the primary producers, food webs and fluxes in the Southern Ocean

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## A rapid change in the community structure in the Weddell/Scotia Sea as an example of a no-diatom community in the Southern Ocean

During the EPOS cruise in the Weddell/Scotia Confluence area, a rapid change was observed in the chlorophyll concentration and in the community structure. During the last days of November, a chlorophyll-rich area reaching 4 mg $m^{-3}$ and spreading over more than 90 km was observed. In the heart of this bloom, more than 80% of the biomass was provided by a diatom community >10 $\mu$m.

Three weeks later, the total biomass was decreasing to values close to 1 mg Chl *a*. $m^{-3}$, owing to a strong decrease of the diatom stock very due to grazing by krill. The biomass of the autotrophic nanoplankton community increased during the same time, the cryptophyceans being the main contributors. After this event, the relative mean biomass of the size fraction >10 $\mu$m remained at a level below 20% for the rest of the cruise, and very often below 10% of the total phytoplankton biomass in the area.

The evolution occurring in the Weddell/Scotia system during early summer point out a change from a new production-based ecosystem with a large fraction of the organic matter produced by large diatoms (exported into the deep water through their rapid sinking or by way of fecal pellets) towards a regenerated system which is a weak exporter of organic matter (Fig.1). Do these results modify the classical concept of the predominating position of large diatoms at the basis of Antarctic marine food chains in he Seasonal Ice Zone (SIZ) and the Permanently Open Oceanic Zone (Pooz) ?

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## Size structure of the food weds and fluxes in the SIZ and the Pooz

Some features clearly identify the Seasonal Ice Zone:

• the zone beside the ice is a site of enhanced primary production and concentration of living resources : the average production should be of 1 gC $m^{-2}$ $d^{-1}$ in the Ross Sea and 0.6 gC $m^{-2}$ $d^{-1}$ in the Weddell Sea.

• the Marginal Ice Zone (MIZ) extends for a distance of 150 to 250 km from the edge of the ice with a bloom persisting for 1 - 2 months, which is no longer lasting and surface limited when compared to other regions of high production in the world. In spite of this, the role of this phenomenon in total production could represent approximately 70% of the annual production, or respectively : 100 gT C in the Ross Sea and 85 gT C in the Weddell Sea.

• the onset of the bloom is linked to the speed of pack ice retreat and is almost srecific to the spring period. These blooms are dominated by diatoms generally with a size > 10 $\mu$m among which *Nitzschia curta*, which is equally an epontic species, is predominant. But as the summer season progress, the food web frequently toppled towards a microbial loop based regenerated system (see before).

• the *f* ratio of new production/total production is high: above 0.4, even, at times, above 0.6. Accordingly, a large fraction of the primary biomass is exported towards higher trophic levels and, especially, directly to the sediment. Due to the diatom dominance during the spring bloom, this aspect is even

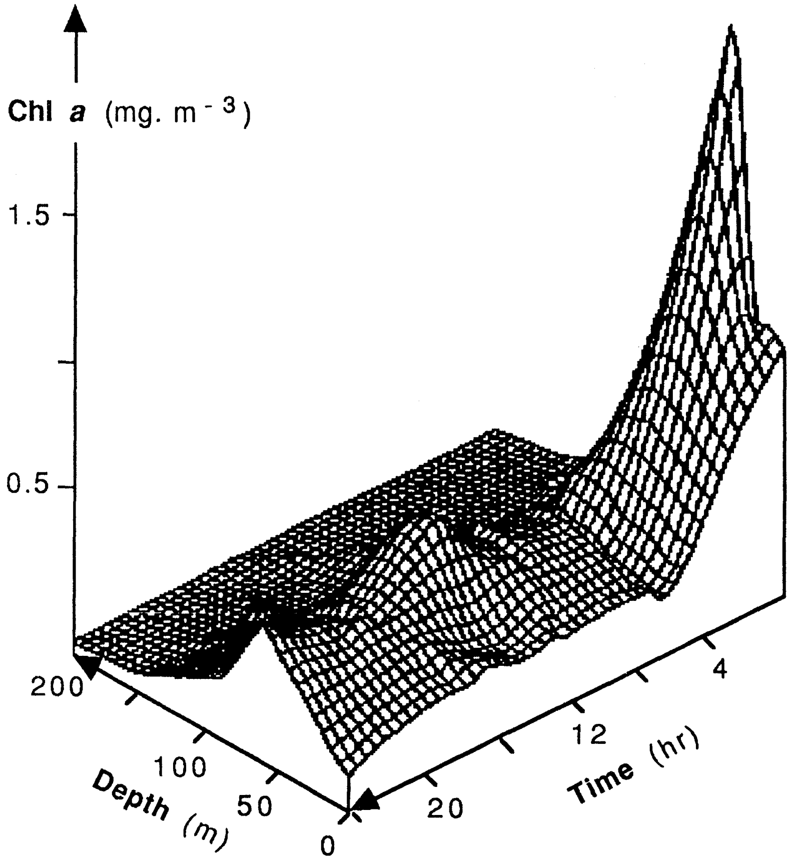


Fig. 1. Evolution of a diatom bloom at the Station 157 in the Weddell Sea. The diatom bloom vanished in less than 20 h and the phytoplankton community toppled towards a flagellate-dominated system.

more evident for silica: from 25% to 50% of the silica produced ends up at the water-sediment interface.

The Permanently Open Oceanic Zone is a typical well-mixed system of the Antarctic Ocean, first identified as an almost "oligotrophic" area although nutrient rich. Even if some data showed that nanoplankton largely contributed to the total phytoplankton stocks, most of the recent results reinforce the classical concept giving diatoms a predominating position in the POOZ; then, the regional variation of total phytoplankton chlorophyll biomass approximately reflects the change of >20 $\mu$m diatoms. Sometimes, the dominant diatom assemblage is <10 $\mu$m in size, which may explain some discrepencies in the size fraction data:

•dominant "nanoplanktonic-weakly silicified" diatoms are : *Nitzschia nana*" (*N. cylindrus, N. pseudonana*), *Chaetoceros dichaeta, C. atlanticum* v. *gracilis, C. simplex, D. tenuijunctus, N. prolongatoides, N. subcurvata.*

• dominant microplanktonic-heavy silicified diatoms are: *N. kerguelensis, N. turgiduloides, Dactylisolen antarcticus, Asteromphalus hookeri, A.parvulus, A.hyalinus, Chaetoceros criophilum, Thalassiosira antarctica.* At times, *F. kerguelensis* is by far the most abundant species.

What is the importance of the POOZ compared to the other subsystems in terms of vertical fluxes ? The unproductive open ocean generates only a small vertical carbon flux towards the sea bottom. However, it is becoming more and more obvious that diatom accumulation in the sediment does not necessarily imply a high level of production. The best present estimates indicate that the Southern Ocean accounts for ≤ 5% of global organic matter production in the upper ocean (annual primary production ≠ 15 $gC\,m^{-2}$? ) and subsequent accumulation of organic matter in the sediment, but it is the site of about 75% of the global-scale transfer of biogenic silica to the seabed. This particularity can be explained by two characteristice: biogenic silica may be pro-duced in higher proportion to organic carbon in the surface waters and/or unusu-ally high fractions of that silica may be delivered to the seabed rather than dissoled in the water column.

The POOZ appears to be therefore a system where the large amount of intact frustules in the sediment indicate a predominance of large diatoms in the pelagic system and their subsequent rapid sedimentation. It is now evident that the so-called "microbial loop" is not as important in the POOZ as in the others systems.