Distribution of Labile and Residual Particulate Carbon in the Baltic Sea

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Abstract

During the September 1971 cruise of F. K. "Alkor" in the central Baltic Sea, the surface or summer water layer down to a depth of about 30 m was found to contain 187.4 μg/l of particulate organic carbon, with a C:N (atoms) ratio of 8.97. This carbon was 44 % (89.9 μg/l) labile to bacterial decomposition, as determined by burning an aliquot of each sample in a CHN-analyser before and after maintenance in nutrient-enriched sea water at 20° C for 3 months. The particulate material from the intermediate or winter water layer, with a depth ranging from 30 to 70 m, contained only 48 % (43.8 μg/l) of the labile carbon found in the summer surface layer, and had a significantly higher C:N ratio (11.25). These two facts indicate that a considerable breakdown of the organic material had taken place. The material, removed from the particulate state during this process, was 48 % (89.7 μg/l) of the original total particulate carbon, and was relatively nitrogen-rich, with a C:N ratio of 6.49. In this material, 52 % (46.8 μg/l) of the organic carbon was labile. The particulate material in the rest of the water column showed no significant changes until it reached the sediment. The slurry immediately above the sediment had a C:N ratio of 9.15, indicating the introduction of nitrogen from either dissolved or colloidal material. Labile carbon (44 % of the total) was also present in sufficient quantities to support life and to make this an important diagenetic site.

Introduction

It is generally assumed that one of the prime sources of organic material on the surface of marine sediments is the particulate material which has sunk down from the upper water layers. Of special interest is the question to what degree this organic material is labile and, therefore, capable of being further processed by organisms that live at the sediment-water interface. Menzel and Goering (1966) undertook such a study in the Atlantic Ocean. They measured the labile particulate carbon at 1,200 and 1,000 m, and found labile particulate carbon only in the surface samples. It was felt to be of interest to carry out a similar study within a shallower body of water such as the Baltic Sea, where a large degree of the particulate organic material deposited upon the sediment would be expected to be of labile nature, since the amount of time that it had spent in the water column was relatively brief.

Another reason for choosing the Baltic Sea for this study is that it comprises several interesting hydrographic features, including water bodies with various degrees of oxygen saturation. Adams and Richards (1968), for example, found certain quantitative and qualitative differences in the dissolved organic material from anoxic and aerated waters. Perhaps similar trends exist for the particulate organic material of the Baltic Sea.

Material and Methods

Samples were taken during the September, 1971 cruise of the F. K. "Alkor" at stations along a segment of the Baltic Sea ranging from the Arkona Basin to the Färö Deep (Fig. 1). Two litres of water were removed from a 5 l water sampler, and divided into two aliquots, each of which was then filtered through a pre-combusted glass fibre Whatman GF/C filter. The filters were stored below -20° C until further processing in the laboratory. The water samples were taken at 1, 10, 20, 40, 60, 100, 150, 200 and 10 m above the sediment surface. Each station, a sediment sample was also taken with a small Plexiglas corer. Only the uppermost slurry was decanted off and frozen. Samples were also taken 1 and 3 m above and below the main halocline in the Bornholm Basin (Station 5 A) and the Gotland Deep (Station 15 A). Oxygen content, salinity, temperature, and inorganic nutrients were determined throughout the cruise by a research group under Dr. K. Graßhoff of this institute.

In the laboratory, one filter was dried at 80° C and then burned in a commercial CHN-analyser in order to determine the total particulate carbon and nitrogen content. The other filters of each pair were simply placed upon a plastic plate, where holes exactly large enough to accommodate them had been cut out. The plate was submerged in a tray containing an amount of sea water sufficient to cover the filters. This amount was kept small in order to minimize the introduction of additional particulate material. The sea water was previously enriched by the addition of 100 mg at NO₃-N/l and 10 mg at PO₄-P/l. The tray was sealed to prevent loss of water due to evaporation, and was stored in a dark incubator at 20° C for 3 months. This method is almost exactly the same