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On the input of nutrients into the Baltic through the Belts and the Sound

by

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Abstract: The relatively high nutrient concentrations in the Western Baltic and in the Arkona Basin immediately after the influx of high saline water show that this event causes additional eutrophication in the Baltic. Ammonia concentrations exceeding 2 µg at./l under oxic conditions are signs that nitrification in this water is incomplete, and indicate a previous organic load, which has not yet been completely overcome. The input of nutrients and organic matter through the Belts and the Sound can thus be regarded as one of the causes for the increasingly frequent occurrence of anoxic conditions in the deep water of the Baltic.

The Baltic ecosystem is endangered not only by pollutants with a direct toxic effect such as certain metal ions, pesticides or mineral oil, but also by compounds which lead to increased oxygen demand. Apart from biochemically degradable organic compounds, this group also includes nutrients, as inorganic phosphorus and nitrogen compounds, causing an increasing production of organic matter.

The water of the Kattegat which penetrates into the Baltic through the Belts and the Sound as a salt-rich deep current or, in the event of large salt water intrusions, distributed over the whole water column would also appear to be a source for the transport of nutrients and organic matter into the Baltic. Although no direct measurements are available for the organic load of this water, chemical investigations have shown indirectly that particularly the western subregions of the Baltic have been considerably affected in this way.

In the event of a high saline water intrusion, the water flowing into the Baltic from the Kattegat carries noticeable quantities of nutrients which cause additional eutrophication particularly in the western subregions. For example, in the winter of 1976 nutrient concentrations which substantially exceeded the values for other years were measured in the western Baltic and the Arkona Basin immediately after such a salt water penetration (table 1). Relatively high values were also determined during the winter of 1977. These are probably related to the lengthy inflow of salt-rich water during the autumn of 1976, which led to a substantial improvement in the oxygen conditions in the deep water throughout the Baltic (NEHRING and FRANCKE, 1978).

Ammonia assumes a special position when the quality of water is being assessed. Generally, the concentration of this compound in Baltic water is low. Its concentration in the surface layer only temporarily achieves values of around 1 µg-at./l during the late autumn when the ammonia formed by the ammonification of organic substances is no longer consumed by the phytoplankton. Later, the concentration decreases again since this nitrogen compound is oxidised to form nitrate during the process of nitrification.

No nitrification can take place under the anoxic conditions prevailing from time to time in the deep water of the Baltic because the necessary oxygen is not available. Ammonia is accumulated under these conditions. Concentrations of 10 µg-at./l and above being reached under certain conditions.

If, however, ammonia concentrations exceed 2 µg-at./l under oxic conditions, this is a sign that nitrification is incomplete and indicates that a previous organic load has not yet been completely overcome. Under this point of view, the high ammonia concentrations occasionally observed in the western Baltic assume special importance. Previous investigations (NEHRING, 1971) have already shown that the deep current (gradient current) penetrating into the Baltic can contain relatively high ammonia concentrations without an acute oxygen deficiency being present. These conditions can be seen particularly well in examples involving the Arkona Basin. The stations shown in figure 1 both lie in the valley followed by the deep water flowing into the Baltic.

The proportions between the nitrogen compounds, particularly the high ammonia content, below the halocline indicate incomplete nitrification and are signs of an organic load which has not yet been overcome.

The relatively high ammonia concentrations which occurred in the winter of 1976 (table 1) and 1977 immediately after intensive inflow situations not only in the deep water but also in the surface layer of the Baltic should also be considered with respect to the water quality. These concentrations also indicate that the inflowed water from the Kattegat was organically loaded and had not yet completely overcome this load. The episodic inflow of large quantities of salt-rich water leads to the renewal of the deep water and the improvement of the oxygen conditions in the Baltic. But the organic matter carried with this water requires oxygen for its degradation and through that deteriorate the oxygen conditions.

Furthermore, the increased nutrient potential of the Baltic caused by the relatively high phosphorus and nitrogen content of the inflowing water creates the conditions necessary for a higher level of bioproductivity. The resultant biomass, after it has died and sunk down to the deep water and bottom, also requires oxygen for its biochemical degradation. Therefore the oxygen deficit in the layer below the halocline, where the vertical exchange of water is severely hindered, continues to become more severe. The input of nutrients and organic matter through the Belts and Sound can thus be regarded as one of the causes for the increasingly frequent occurrence of anoxic conditions in the deep water of the Baltic.

Literature

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Table 1 The distribution of selected nutrients in the surface water of the western Baltic and the central Arkona Basin

	western Baltic			Arkona Basin		
	PO_4-P	NO_3-N	NH_4-N	PO_4-P	NO_3-N	NH_4-N
	µg-at./l			µg-at./l		
January 1976	0.4-0.5	2 - 4	2 - 4	0.3-0.4	3 - 4	2 - 3
February 1976	0.6-0.7	7 - 9	0.5	0.7-0.9	3 - 5	0.5
March 1976	0.0-0.1	0.1-0.2	0.5	0.2-0.7	1 -2.5	0.5
February, average conditions	0.4-0.6	3 - 5	0.5- 1	0.3-0.6	3 - 5	0.5- 1

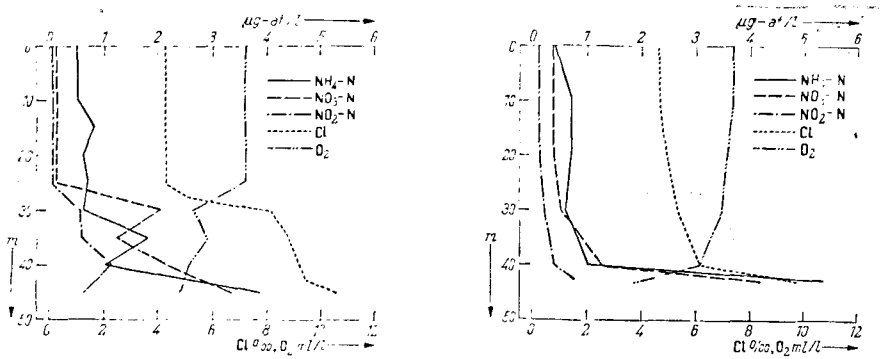

Figure 1 Distribution of selected oceanological parameters at 2 stations in the Arkona Basin

a) station 113 (54° 55,5' N, 13° 30,0'E), October 24th, 1969

b) station 114 (54° 51,6' N, 13° 16,6' E), October 28th, 1969