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The distribution and abundance of *Mysis* populations in the Baltic Sea

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This paper summarizes present knowledge on the distribution and abundance of nectobenthic mysids in the Baltic Sea. *Mysis relicta* is the dominating species in the Bothnian Bay and the northern parts of the Bothnian Sea. The northern distribution limit of *Mysis mixta* lies in the Quark area, the species being more abundant in the Finnish coastal waters compared to the Swedish waters. In the southern Baltic Mysis relicta was not found abundantly southwards from 56°N, nor westwards from 18°30′E. The abundance of *M. relicta* in the Baltic Proper is negligible compared to the northern and eastern parts of the sea. *Mysis* generally avoided waters less than 50 m deep in the Gulf of Finland and Bothnian Sea. In the southern Baltic Proper they were, by contrast, also found in relatively shallow waters. In deep areas of the Baltic Sea mysid populations are weak or even entirely absent, as is the case with the Bay of Gdansk and the Bornhorm Basin. Our results support the hypothesis that oxygen deficiency in the water layer near the bottom prevents the formation of nectobenthic mysid populations. Mysid shrimps were found in the southern part of the study area generally in more shallow water. The dominating species in the southern area is *M. mixta*, which is of Atlantic origin. A salinity high enough to support the species is also found in shallow waters in the southern part of the study area, while in the Baltic Proper such salinity levels are not found in the surface water layer. On the contrary, *M. relicta*, the dominating species in the northern part of the area studied, seems to prefer deep waters in the Gulf of Finland and the Bothnian Sea. Both species would thus favour deep water in the Baltic Proper, but as this zone is inaccessible due to oxygen deficiency the abundance of mysids in the central Baltic Proper is low. Alternative and/or supplementary explanations may be found in the ecological differences between the northern and southern Baltic Sea, e.g. productivity of the benthos.

1. Introduction

Although the earliest information on the abundance and distribution of *Mysis mixta* and *M. relicta* in the Baltic Sea date back to the beginning of this century (Apstein 1906, Ekman 1914), studies on mysid ecology were generally neglected until recent years. This is due to the nectobenthic characteristics of *Mysis* species with their nocturnal vertical migrations and shoaling. Consequently, quantitative data on *Mysis* populations have been mere side products of zooplankton studies (Hessle and Vallin 1934, Lindquist 1959).

This paper summarizes our present knowledge of the distribution and abundance of nectobenthic mysids in the Baltic Sea in the light of the results of the *Mysis*-project at the Finnish Institute of Marine Research in 1984–88 (Salemaa et al. 1986), investigations in the Gulf of Riga (Kotta 1979, 1980, 1984, Kotta & Simm 1979) and Askö archipelago (Rudstam et al. 1986).

2. Material and methods

Our data on the distribution of mysid populations are mostly based on nocturnal plankton sampling on board the r/v Aranda during the years 1984–1988 (Fig. 1). For sampling, two macroplankton nets were used with a diameter of 80 or 100 cm and mesh size 500 µm. These nets, originally used in lake conditions (Hakala 1978), collect mysids effectively when the density of the animals exceeds 50 ind./m^2 (Salemaa et al. 1986). Three or more replicate hauls were usually made in each sampling area. The sampling was performed by lowering the net to the bottom and then hauling it to the surface at a speed of 0.5–0.8 m/s. The net was then externally rinsed and the mysids were stored in 4% formaldehyde. Population estimates in the Gulf of Riga are based on the trawling of *Mysis* shoals in the daytime (e.g. Kotta & Simm 1979) and at Askö on nocturnal hauls with a Bongo net (Rudstam et al. 1986).

3. Results

Our sampling areas and the distribution limits of *Mysis relicta* and *M. mixta* are illustrated in Fig. 1 and their population densities in relation to depth in Fig. 2. *M. relicta* is the dominating species in the Bothnian Bay and the northern parts of the Bothnian Sea. The northern distribution limit of *M. mixta* lies in the Quark area, the species being more abundant in the Finnish coastal waters than it is in the Swedish waters. The eastern distribution of *M. mixta* extends to the innermost Gulf of Finland (Järvekülg 1979). In the southern Baltic *M. relicta* was not found abundantly southwards from 56°N nor westwards from 18°30′E. The abundance of *M. relicta* in the Baltic Proper is negligible (about one percent of all mysids) compared to the northern and eastern parts of the sea. Although shoals of *Mysis* occasionally occur near the coasts they generally avoided waters less than 50 m deep in the Gulf of Finland and Bothnian Sea. In the southern Baltic Proper they were, by contrast, also found in relatively shallow waters. In the deep areas of the Baltic Proper and the Gulf of Finland, mysid populations are weak, or even completely absent, as in the Bay of Gdansk and the Bornhorm Basin. The richest *Mysis* populations, exceeding 300 ind./m^2, were observed in the Bothnian Sea. Here the two species co-occur in varying proportions. *M. mixta* forms on average 54.5 % (SD = 25.6, n = 15) of all mysids in the Bothnian Sea. Forgetting the spatial variation in their occurence our estimate on the average density of mysids in the open waters of the Baltic Sea is one ind./m^3 of water. However, as nectobenthic consumers and as the food of fish mysids occur in heterogenous clusters, the shoal density occasionally increasing to several hundreds of ind./m^3 (Kotta 1984).

4. Discussion

Salemaa et al. (1986) hypothesized that low numbers of mysids in the deep areas are due to oxygen deficiency. Our data largely support this since hauls totally devoid of mysids were made only in areas suffering from oxygen deficiency (Fig. 2). Furthermore, at station PV 5 (54°58.5′N, 14°13.5′E) in the Arkona Basin we found an average of 127 mysids/m^2 (12 hauls) in August 1987, when the oxygen content in the water layer near the bottom was 3.25 ml/l (11.4°C, salinity 14.8‰), while a year later at the same station

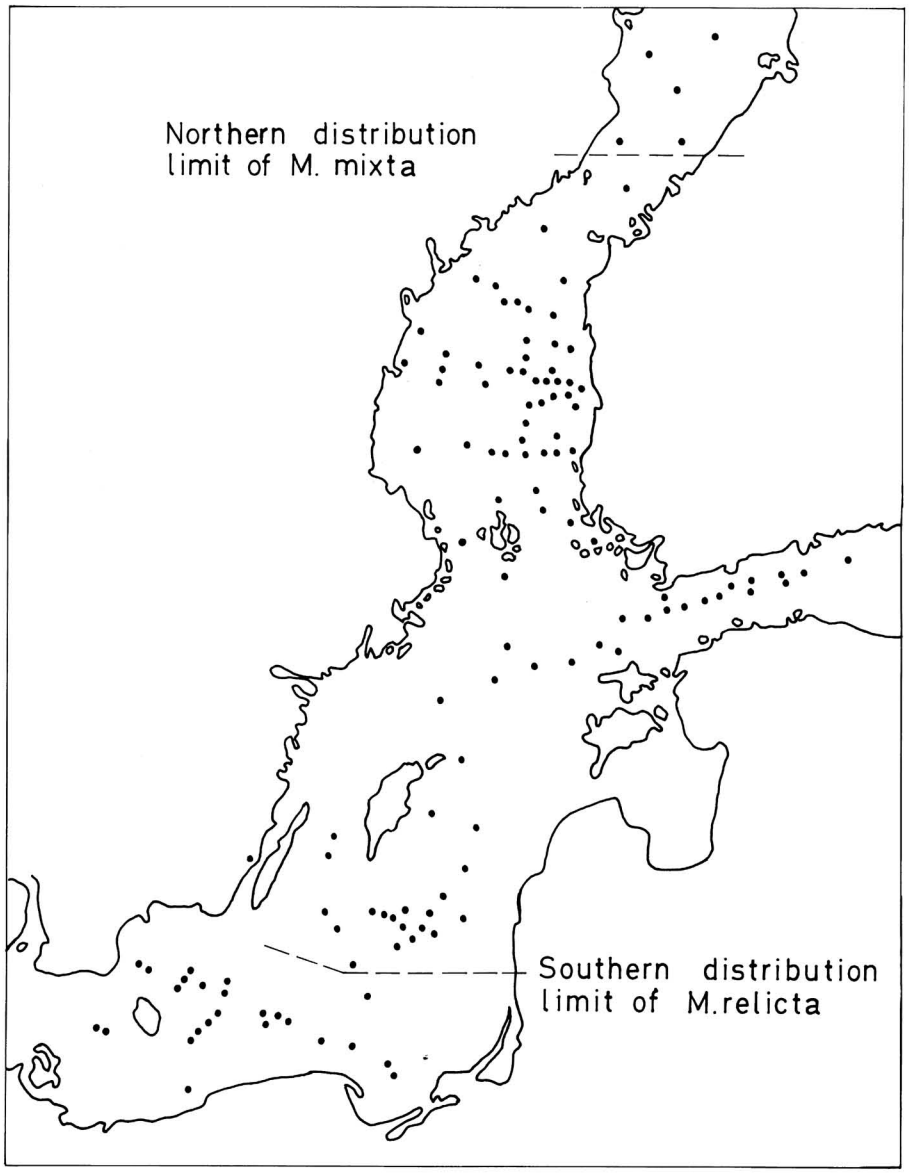

Fig. 1. Sampling sites and distribution of *Mysis mixta* and *M. relicta* in the Baltic Sea in the years 1984–1988.

when the oxygen content was 1.31 ml/l no mysids were found in 6 hauls (13.0°C, salinity 17.8‰). The same phenomenon, i.e. low numbers of mysids in deep areas (e.g. the Gotland deep), was also observed by Hessle & Wallin (1934). This may likewise have resulted from oxygen deficiency, which occurred in the area in 1931 and 1932 (Andersin et al. 1978).

Finding low numbers of mysids in areas where the water layer near the bottom has an oxygen lack suggests that there may exist a truly pelagic, i.e. non-nectobenthic, population of mysids. Alterna-

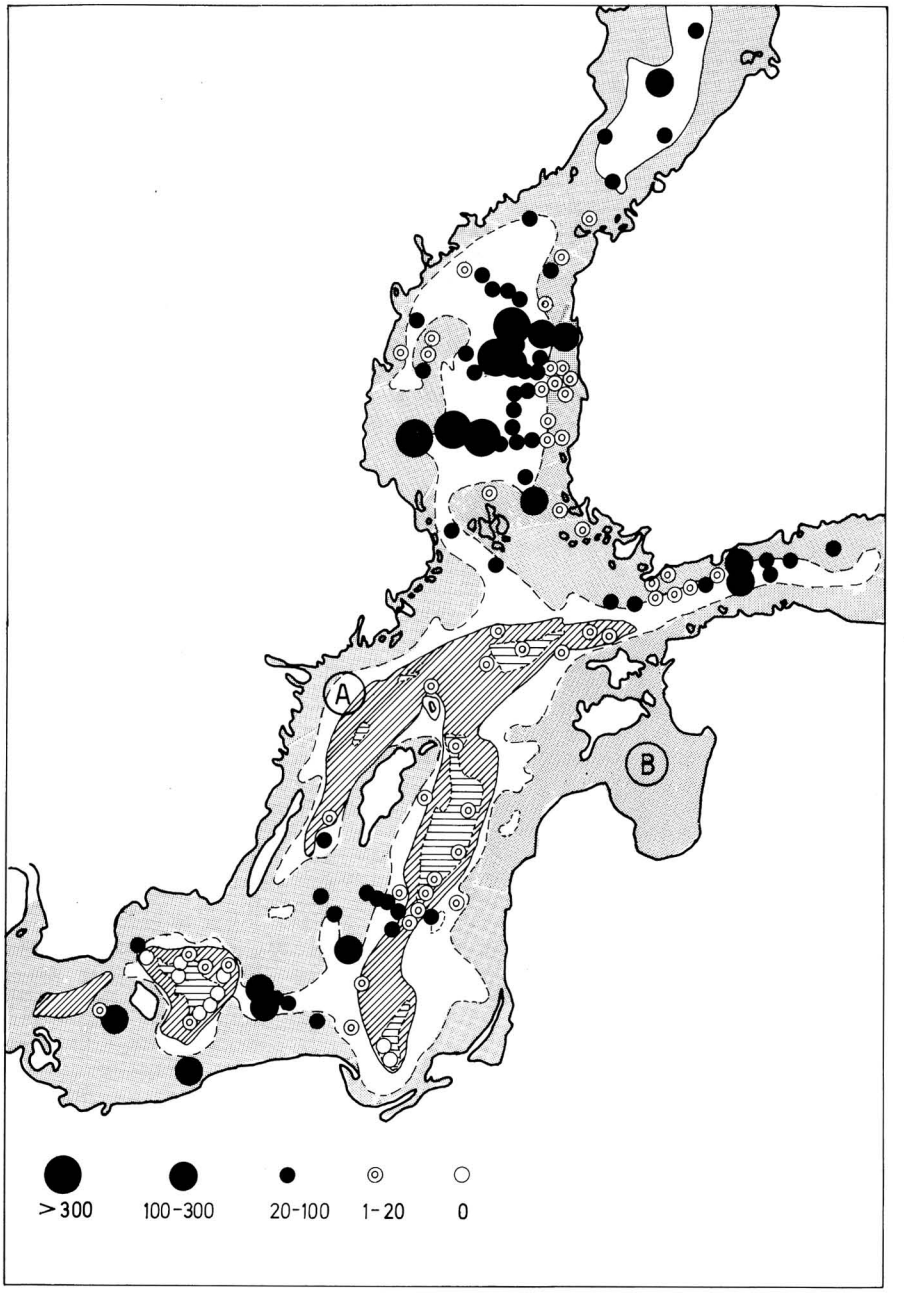

Fig. 2. Abundance (ind./m^2) of mysid shrimps in the Baltic Sea in 1984–1988. Shaded areas = depth <60 m. Vertically striped = occurrence of hydrogen sulphide (according to the Finnish Institute of Marine Research). Diagonally striped = oxygen <2 ml/l. A = 20–200 ind./m^2 (Rudstam et al. 1986), B = swarms of >300 ind./m^3 (Kotta 1984).

tively, the specimens found may be "washed off" from populations living and reproducing in more favourable areas. Single specimens found in the open Baltic Proper may thus be migrants, e.g. from the Gulf of Riga.

Mysid shrimps were found in the southern part of the study area generally in more shallow water. This may be due to the fact that the dominant species in the southern area is *M. mixta*, which is of Atlantic origin and consequently favours high salinity. High salinities are also found in shallow waters in the southern part of the study area, which is not the case in the northern Baltic. On the contrary, *Mysis relicta*, the dominating species in the northern part of the area studied, prefers deep waters in the Gulf of Finland and the Bothnian Sea. In the Baltic Proper deep waters are inaccessible due to oxygen deficiency, resulting in the distribution shown in Fig. 2. Alternative explanations may be found in the ecological differences between the northern and southern Baltic Sea, e.g. productivity of the benthos.

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