

VERTICAL MIGRATIONS OF MYSIDS IN THE GULF OF RIGA

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Abstract. Vertical migrations of *Mysis mixta*, *M. relicta*, and *Neomysis integer* were studied in the north-eastern part of the Gulf of Riga during May–September 1999. All three mysid species performed diel vertical migrations. These migrations were more intense in late summer and autumn than in spring and early summer. The proportion of juveniles and small-sized adults (<11 mm) in the vertical migrations was higher than that of adults. Usually *N. integer* appeared in the water column first in the evening, followed later by *Mysis* spp. Both *Mysis* spp., often referred to as cold stenotherms, were found in high abundance in the surface waters in spite of very strong temperature gradients.

Key words: Baltic Sea, distribution, Mysidacea, *Mysis*, *Neomysis*.

INTRODUCTION

The literature on the vertical migration of mysids is not very extensive and mainly from fresh waters (e.g. Beeton & Bowers, 1982; Lassenby et al., 1986). In the Baltic Sea the majority of studies have been focused on the mysid species inhabiting the open sea areas (Salemaa et al., 1986; Rudstam et al., 1989; Rudstam & Hansson, 1990).

Shallow and eutrophicated bays are often characterized by much higher densities of mysids than similar open sea areas (Kotta & Kotta, 1999). Hence, in these water bodies mysids are particularly important in the food webs (Kinne, 1955; Ojaveer, 1997). Owing to differences in depth, light regime, and temperature and salinity conditions it is likely that the diel changes in the vertical distribution of mysids in shallower seas differ considerably from those in deeper areas.

This paper discusses the diel vertical migrations of mysids in the north-eastern part of the Gulf of Riga during May to September 1999. The distribution of the three most prevalent mysid species – *Neomysis integer* (Leach), *Mysis mixta* Lilljeborg, and *M. relicta* Lovén – is described. The first is confined to warmer waters while the two *Mysis* species are mainly found in colder waters. We also analyse whether temperature is limiting the vertical distribution of cold-water mysid species and whether there are differences in the structure of mysids length frequency between migrating and nonmigrating parts of the populations.

MATERIAL AND METHODS

Sampling was performed at a 25 m deep station in the north-eastern part of the Gulf of Riga (58°00.0' N, 23°53.6' E) from May to September 1999 (15–16 May, 10–11 June, 17–18 Aug, 24–25 Sep). The Gulf of Riga is a relatively isolated water body. Its average salinity varies from 0.5–2 PSU in surface layers in its southern areas to 7 PSU at the Irbe Strait. The northern part of the gulf is characterized by a wide coastal zone with a diverse bottom topography and extensive reaches of boulders. The gulf is on average twice as eutrophicated as the Baltic Proper (Mägi & Lips, 1998).

The abundance of mysids in the near-bottom layer was estimated by a modified Rass dredge during daytime (Rass, 1933; Kotta & Kotta, 1999). The abundance of mysids in the water column was obtained by vertical Hensen net (opening diameter 0.8 m) tows, from 1 m off the bottom to surface. The mesh size of both nets was 0.4 mm. The sampling was performed every hour (May, August) or every second hour (June, September) covering the period from sunset to sunrise (reported time is local summer time). In each sampling occasion three hauls were taken: from 5 m to surface, from thermocline to 5 m, and from 1 m above bottom to thermocline. Earlier pilot studies (Kotta, 1980; Kotta, 1984) demonstrated that the within month variation in the vertical migration of mysids is moderate, hence, a period of one night is considered representative for the whole month. Temperature profiles were recorded during sampling.

All samples were stored in 4% buffered formaldehyde–seawater solution. Species composition, abundance, and biomass were determined in the laboratory. The total length (from rostrum to telson) of mysids was determined with a vernier caliper.

RESULTS

All three mysid species performed diel vertical migrations. The response to light was an important factor in the migrations. The migration began at sunset, usually reached a peak at 2:00 a.m. in May, June, and August and at midnight in September. A few individuals remained near the surface until dawn (Fig. 1).

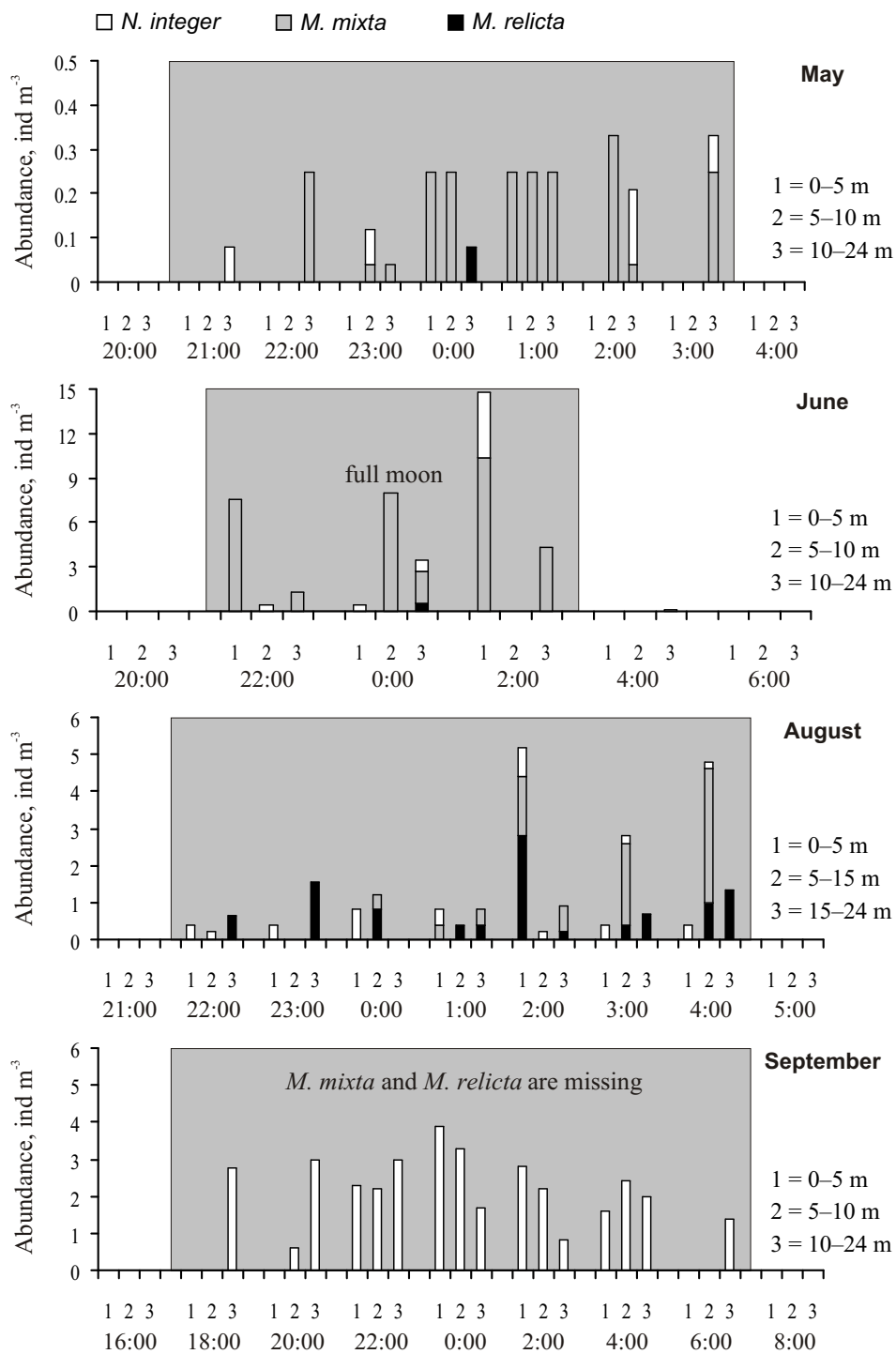


Fig. 1. Diurnal variation in the abundance of mysid species in the study area from May to September 1999. Periods between sunset and sunrise are indicated by grey.

N. integer was relatively rare in the water column during May, June, and August. Higher abundances were recorded only during June at 2:00 a.m. On the other hand it was the only mysid species found in the study area during September and its abundances were many times higher than recorded earlier in the year.

M. mixta was observed at low abundances in the water column in May and was missing in September. The species dominated in the samples during June and its abundance was slightly lower in August. *M. relicta* was found in higher numbers during August. Occasionally, the share of *M. relicta* exceeded even that of *M. mixta* and *N. integer*. In May, June, and September the share of *M. relicta* was negligible.

Regardless of species the proportion of juveniles and small-sized adults (<11 mm) was higher in the vertical migrations than that of adults (Fig. 2). Just after sunset the small-sized mysids started to migrate towards surface layers. Usually *N. integer* was the first to appear to the water column, followed later by *Mysis* spp. The migration of adults was delayed about 3–4 hours. Hence, the importance of adults in the water column increased with the duration of dark period at night. In June strong moonlight had an effect on the pattern of the vertical distribution of mysids. By shortening the dark period it induced a very clear peak in the vertical migration of mysids. When clouds overshadowed the moon the maximum abundance values of mysids were recorded (15 ind m⁻³).

The vertical distribution of mysids was not affected by the temperature conditions. Both *M. mixta* and *M. relicta* were found in the surface layer despite the occurrence of strong temperature gradients. Only in September the cold-loving *M. mixta* and *M. relicta* were not observed in the study area when the temperatures of the near-bottom layer were too high for the species. Figure 3 illustrates the temperature profiles in the study area in different seasons.

DISCUSSION

The results of this study are in accordance with previous works demonstrating that the vertical migration of mysids is related to light levels. During upward migrations induced by low light mysids prey on phytoplankton and zooplankton while in daytime they feed mainly on detritus (Sanina, 1961; Chekhova, 1961; Rudstam et al., 1989). Vertical migrations of mysids in stratified waters allow them to save the energy for reproduction (food is less sparse in warmer waters, the consumption of energy is lower at lower temperatures) and better escape from predators (see e.g., MacLaren, 1974; Beeton & Bowers, 1982).

The monthly differences in the diel vertical migration of mysids are partly explained by their seasonal pattern of reproduction. During May the population of *N. integer* consists mainly of a few overwintering individuals (Järvekülg, 1965), which do not perform such pronounced migrations as juveniles do (Sanina, 1961).

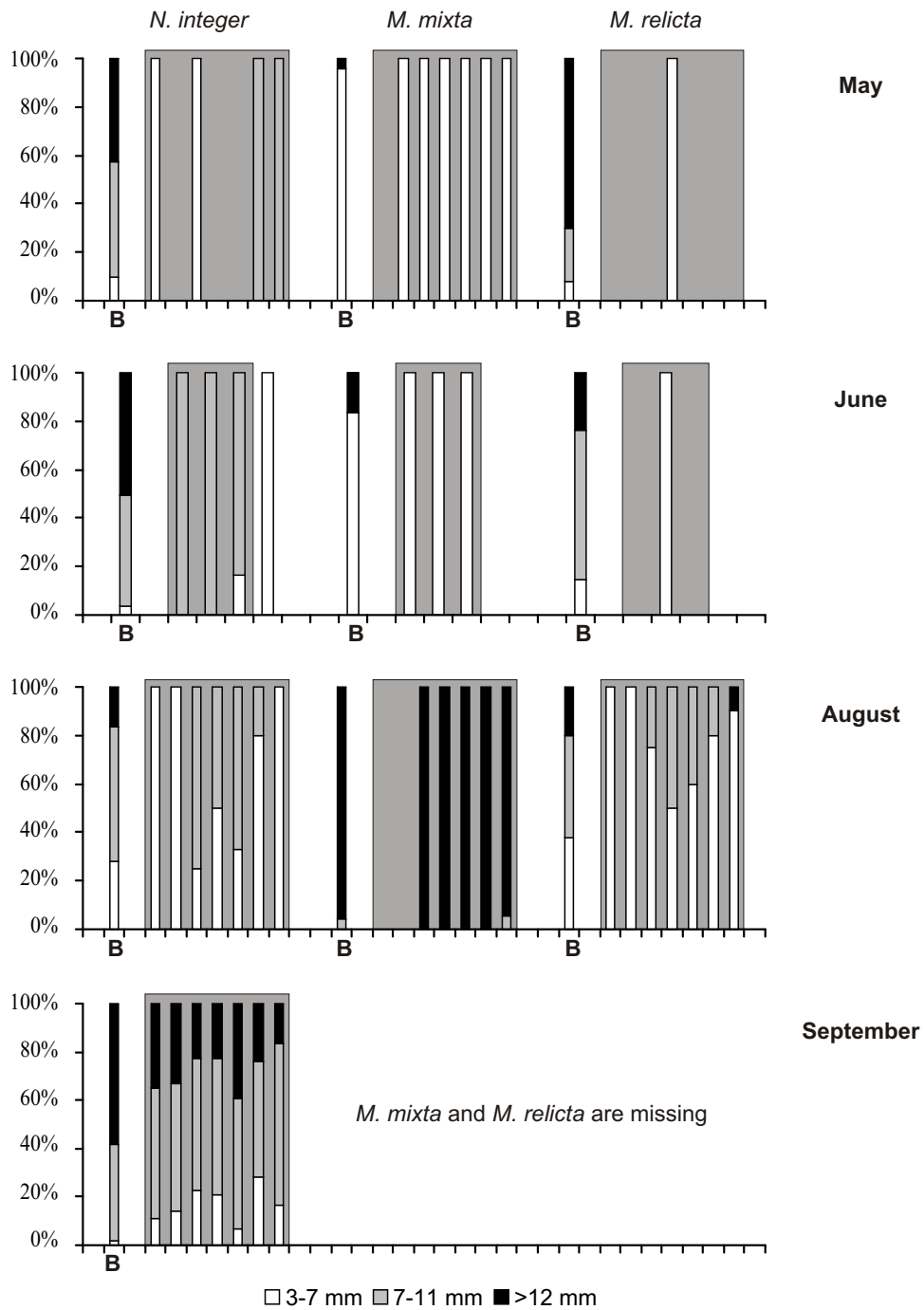


Fig. 2. Diurnal variation in the length structure of migrating populations of mysids in the study area from May to September 1999. Periods between sunset and sunrise are indicated by grey; **B** shows the population length structure of mysids at bottom during daytime.

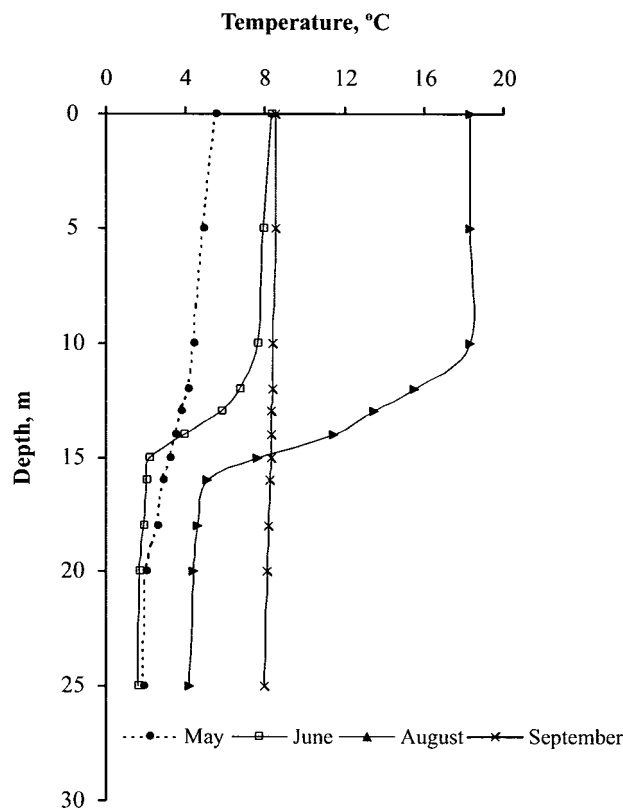


Fig. 3. Temperature profiles in the study area during different months.

Hence, the proportion of *N. integer* was small in the plankton samples during May. The species breed during summer (Kotta, 1976) and consequently the abundances of migrating *N. integer* gradually increased from May till September.

On the other hand *Mysis* spp. breed mainly during April–May (Simm & Kotta, 1992). In June, when the share of juveniles was at its maximum, we observed high abundances of *Mysis* spp. in the water column. In August the peak of *Mysis* spp. migration was delayed about 3–4 hours as compared to June. It is likely that the difference is due to the higher share of large-sized *Mysis* specimens in the population that start their migration later in the evening.

Strong vertical mixing in September increased the deep water temperature so much that the cold-loving *M. mixta* and *M. relicta* retreated towards depths greater than 30 m (Kotta & Kotta, 1999). Together with their occurrence in warm surface water in summer, this autumn migration indicates that the *Mysis* spp. need to retreat to cold water for at least some period of the day. This explains why only individuals of *N. integer* were found in the samples during September.

Except the above-mentioned example, temperature did not affect significantly the vertical migration of mysids. According to Beeton (1960) *M. relicta* does not migrate through a pronounced thermocline with temperature gradients of around 2°C m^{-1} . This was not the case in our study as we observed adult *M. relicta* in the surface water during August, although temperature gradients of 4°C m^{-1} were observed in the area. According to Chekhova (1961) high abundances of *Mysis* spp. are found close to the thermocline in the Gulf of Riga during night. However, our data demonstrated that both *Mysis* species, when they perform migrations, are often found in the surface layer. Our data also show that the vertical migrations of *Mysis* spp. are not restricted by temperatures higher than 12°C as postulated by Chekhova (1961).

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MÜSIIDIDE VERTIKAALSED RÄNDED LIIVI LAHES

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Mysis mixta, *M. relicta* ja *Neomysis integer*'i vertikaalseid rändeid uuriti Liivi lahe kirdeosas 1999. aasta maist septembrini. Kõigile kolmele müsiidiliigile olid omased ööpäevased ränded. Võrreldes kevade ja varasuvega olid ränded intensiivsemad hilissuvel ja sügisel. Noorte ja väikeste täiskasvanud isendite osakaal oli rännetes suur. Tavaliselt ilmus *N. integer* õhtuti esimesena veesambasse ning temale järgnesid *Mysis*'e liigid. Mõlemaid külmalembeseid *Mysis*'e liike leidis arvukalt pindmises veekihis vaatamata väga tugevate temperatuurigradientide esinemisele.