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Zooplankton in the Schelde estuary, Belgium and the Netherlands: long-term trends in spring populations

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Key words: Schelde estuary, zooplankton, long-term

Abstract

A compilation of available data in between 1967 and 2002 on spring zooplankton abundance was made for the brackish and the freshwater zone of the Schelde estuary. The general picture is a significant increase of 1–2 orders of magnitude in abundance for Rotifera, Copepoda and Branchiopoda (mainly Cladocera) in the freshwater zone, while zooplankton abundance in the brackishwater zone remained more constant. Possible natural and management related causes for this increase in zooplankton abundance are briefly discussed.

The *Schelde* estuary is one of the few remaining estuaries with an extensive salt-, brackish-and freshwater tidal reach in Europe (Fig. 1). Located in an area with high population density, the Schelde was considered as one of the most eutrophic systems in the world during the second half of the 20th century (Heip, 1988). A gradual improvement is however observed since the mid-seventies as a result of substantial emission reduction efforts throughout the watershed (Van Damme et al., 1995). By their pelagic life-style and their requirement for oxygen, zooplankton organisms are strongly affected by the water quality.

In this paper, we look at the long-term changes in the mesozooplankton populations in the Schelde estuary. We have combined abundance data on mesozooplankton in the Schelde obtained during 1967–1969 (De Pauw, 1973,1975; Bakker & De Pauw, 1975), 1989–1991 (Soetaert & Van Rijswijk, 1993) and 1996–2000 (Tackx et al., 2003 and unpublished results of the ongoing 'Onderzoek Milieu – effecten Sigmaplan (OMES) project). Two zones were considered : the brackish water zone (at 57.5–71.5 km from the mouth) and the freshwater zone (78.5–155 km) (Fig. 1; Van Damme et al. 2005). For each spring month (February–May), the average abundance of each taxon was calculated from all available data within the zone. The number of stations per zone varied between 1 and 12 (minimum 3 in most cases). During 1989–1991,

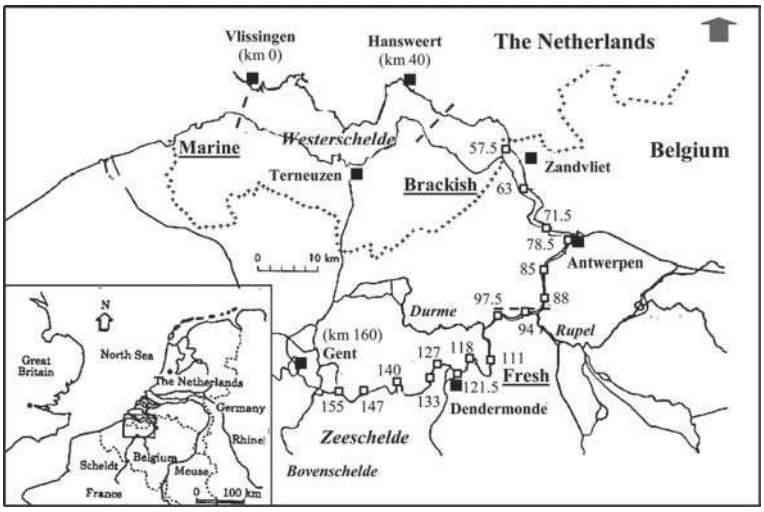

Figure 1. Positioning (inset) and map of the Schelde estuary showing the brackish and the fresh water zone. Numbers are distance in km from mouth at Vlissingen of stations used for monitoring in the OMES project.

200 ls of water was pumped at 2.5 m below surface, at 2.5 m above bottom and at mid-depth and filtered through a 50 μm sieve and the three samples were pooled. In all other cases, 50 ls taken from the surface was filtered through a 50 μm net. Samples were stored in 4% formaline and abundance analysed under binocular microscope. Taxa were grouped as Rotifera, Copepoda (copepodites and adults) and Branchiopoda. Significance of trends in abundance with time were tested by Spearmann rank at $p < 0.5$, and differences in abundance between time periods by Mann–Whitney at $p < 0.05$. Oxygen concentrations for the same zones and months were obtained from essentially the same sources as the zooplankton data, but not always sampled at the same location and at the same time as zooplankton.

During the study period, rotifer abundance (Fig. 2a) in the brackish water zone increased between 1967–1969 and 1989–1991 to remain rather stable afterwards. In the freshwater zone, it increased steadily over two orders of magnitude during the study period (Fig. 2b). Copepod abundance in the brackish zone (Fig. 2c) increased between 1967–1969 and 1989–1991, to decrease slightly afterwards. In the freshwater zone (Fig. 2d), copepod abundance increased over two orders of magnitude during the study period. This different tendency between the two zones can be explained by the fact that the dominant spring species *Eurytemora affinis* has shifted its bulk population from the brackish to the freshwater zone since the mid-nineties (Appeltans et al., 2003). In the brackish water zone, Branchiopoda (Fig 2e) (essentially Cladocera) were scarce and occurred in fluctuating abundance throughout the study period. The same was true for the freshwater zone (Fig. 2f) until 1991, but from 1996 onwards, the population reached a higher and steadier abundance. The quasi total absence of Copepoda and Branchiopoda from the freshwater zone during 1989–1991 was probably due to the fact that the only freshwater station sampled during this period was Antwerpen (78.5 km). This station was characterised by poor water quality conditions at that time, which caused a paucity of planktonic organisms (Soetaert & van Rijswijk, 1993).

The general increase in zooplankton abundance since the 60s in the freshwater zone is likely to be a reflection of changed environmental conditions. Despite global warming, water temperature in the freshwater zone does not show a trend during the period considered (OMES database). Restoration efforts are more likely to be at the origin of this zooplankton development. A complete overview of management strategies and their consequences regarding the Schelde estuary is given by Van Damme et al. (1995; 2005). The general decrease in pollution levels and especially the increase in oxygen concentration occurring mainly in the

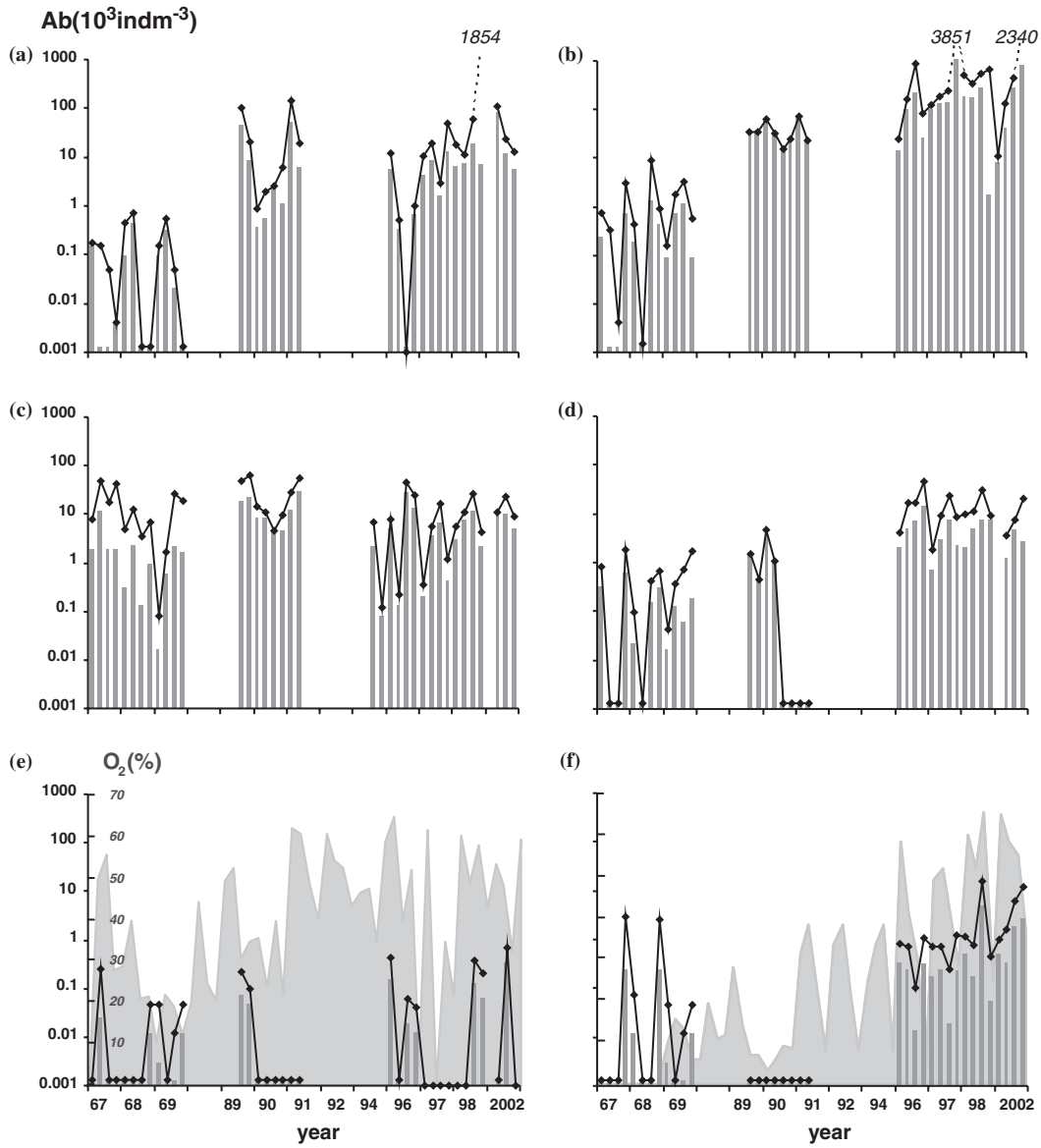

Figure 2. Spring (February–May) mean abundance (bars) and maximum abundance (line with diamonds) of Rotifera (a), Copepoda (c) and Branchiopoda (e) observed in the brackish zone and of Rotifera (b), Copepoda (d) and Branchiopoda (f) observed in the freshwater zone of the Schelde estuary from 1967 till 2002. Note the logarithmic scale. Shaded area in Fig. 2e, f Percentage oxygen saturation. See text for further explanation.

freshwater zone from the 90ties onwards (Fig. 2e, f) can be considered an important factor in relation to this zooplankton development. Multivariate analysis using the more the consistent dataset between zooplankton and environmental variables since the OMES monitoring campaigns (1986) could further elucidate this hypothesis (Azémar et al., in preparation).

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