Tidal flat macrobenthos resistance to medium-term emersion: The case of the Tricolor oil pollution prevention in the Zwin nature reserve (Belgium)

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1. Introduction

On the 14th of December 2002, the car carrier Tricolor collided with the containership Kariba in the English Channel and sank in French waters nearby the Belgian border. Five weeks later, on the 22nd of January 2003, approximately 170 tons of fuel leaked from the wreck of the Tricolor during salvage operations. Due to the meteorological conditions, with strong onshore winds, the oil washed ashore on Belgian, French and Dutch beaches and threatened some coastal nature reserves, among which the saltmarshes of the Zwin nature reserve. To keep out the oil from the Zwin nature reserve both entrance channels were blocked by use of a sandbarrier.

(1) Oil spill of the Tricolor wreck on the 22nd of January 2003 (picture:BMM)
(2) Due to meteorological conditions, with strong onshore winds, the oil washed ashore on Belgian, French and Dutch beaches and threatened some coastal nature reserves, among which the saltmarshes of the Zwin nature reserve.
(3) Different methods of protection were used. Finally, both entrance channels were blocked by use of a sandbarrier.

2. Objectives

Catching up a dam prevents the tidal regime within the area. It is generally accepted that biotic and abiotic aspects of saltmarsh ecosystems are strongly determined by the frequency and duration of emersion by the tidal waters. Closure of intertidal areas with the ambient sea may therefore result in minor to irreversible effects on organisms and ecosystems. This method of protection therefore led to a lot of discussion: **the choice between keeping out chronic pollution versus acute mortality due to emersion**. The damming up was taken as the ideal opportunity to study the effects of a medium-term emersion on macrobenthic species of a norhwestern European intertidal habitat in winter, with a view of making better estimations in the future whenever this measure of protection could be needed.

3. Materials & Methods

• Sampling of a small side-creek of the Dutch entrance creek and the flanking intertidal mud –and sandflats, which were blocked during 27 days. A total of 12 sampling stations were localized in mud –and sandflats in order to encompass a maximal diversity of benthic habitats and species.

• Samples were collected starting just before, two times during (after 12 and 21 days of emersion) and frequently (one to two monthly) after the damming up during one year after the construction of the sandbarrier.

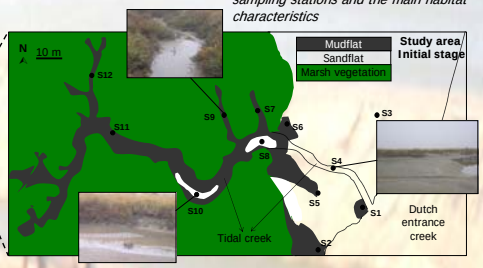
• Macrobenthic samples were taken to a depth of 15 cm and sieved alive over a 500 µm mesh sized sieve.

• To characterize the sampling stations and to correlate possible effects (Spearman rank test; Sokal & Rohlf,1981), sediment characteristics (mud content and median particle size), relative intertidal elevation and submersion time were measured.

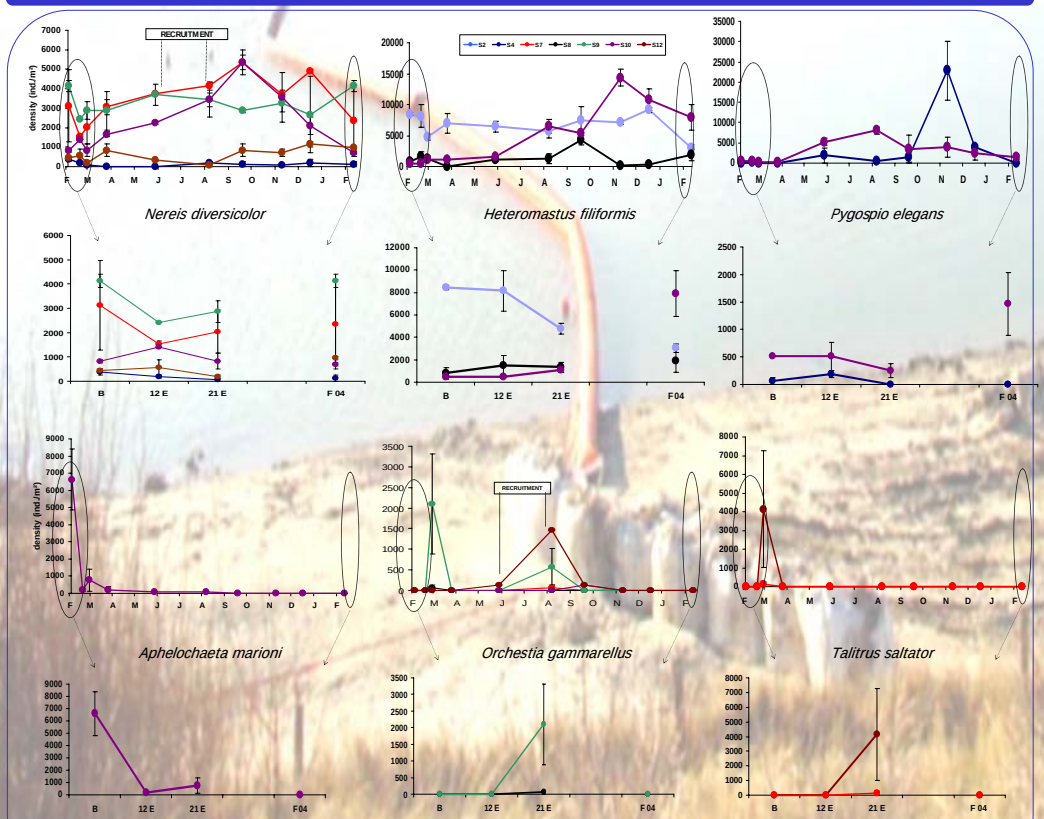
• Kruskal-Wallis rank sum test (Kruskal & Wallis, 1952) was used to examine the variance between the densities of species after 12 and 21 days of emersion per sampling station and to examine seasonal variation in species densities in order to detect possible recovery. When significant differences were observed, multiple comparisons were made between groups, following Connover (1971).

Sandbarriers in the Belgian (red) and Dutch (yellow) entrance creek. Both are connected to protect the marsh vegetation (blue)

Study area, with indication of the sampling stations and the main habitat characteristics



4. Results



Temporal variation (upper graphs) and the effect of the medium-term emersion on some dominant intertidal macrobenthic species (detail graphs). Macrobenthic densitie values (B) before, after 12 days (12 E) and 21 days (21 E) of emersion, as these one year after the construction of the sandbarrier (F 04, February 2004) are given. Station labels are given on top of the graphs.

5. Discussion and Conclusions

• This study shows a high resistance of all macrobenthic species to a medium-term emersion during winter.

• Two ecological patterns could be distinquised during the emersion: **(1) Immigration** into the intertidal zone of *Talitrus saltator* and *Orchestia gammarellus* and **(2) Decreasing densities** of polychaete species which were very abundant before the construction of the sandbarrier. However, only for *N. diversicolor* and only in one station (S11) the latter pattern was statiscally significant ($p<0.05$). *Pygospio elegans* and *Aphelochaeta marioni* declining in all sampling stations were these species were present. Both species are known to be very sensitive for periods of emersion, even during winter (Fortuyn et *al.*, 1989). Even more, *A. marioni* declined to 0. However additional samples taken nearby the study area after the damming up show the presence of *A. marioni* in the Zwin nature reserve.

•The high resistance of the tidal flat macrobenthos to the emersion is presumptively associated with **the season of emersion: the winter**. During winter, intertidal macrobenthic organisms need only a few food and oxygen (Zwarts & Wanink, 1991).

•The high abundance of *T. saltator* and *O. gammarellus* during the emersion and their low abundance afterwards can be explained by the natural distribution of this species. Both species are found most frequently nearby the high-water mark at the supralittoral, semi-terrestrial habitats (Jones & Wigham, 1993). An immigration into the intertidal zone of both species from these habitats during emersion seems likely.

•There was no significant correlation between the physical variables and the density effect during the damming up (Spearman rank test, $p>0,05$).

• In general this study shows a high resistance of all macrobenthic species in the Zwin nature reserve to a medium-term emersion during winter. In view of the high survival and the fact that an oil pollution in the nature reserve was inhibited, the choice to protect the reserve from the empending oil pollution by use of a sandbarrier may be **positively evaluated**.

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