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Functional trait responses to sediment deposition reduce macrofauna-mediated ecosystem functioning in an estuarine mudflat

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Abstract. Human activities, among which dredging and land use change in river basins, are altering estuarine ecosystems. These activities may result in changes in sedimentary processes, affecting biodiversity of sediment macrofauna. As macrofauna controls sediment chemistry and fluxes of energy and matter between water column and sediment, changes in the structure of macrobenthic communities could affect the functioning of an entire ecosystem. We assessed the impact of sediment deposition on intertidal macrobenthic communities and on rates of an important ecosystem function, i.e. sediment community oxygen consumption (SCOC). An experiment was performed with undisturbed sediment samples from the Scheldt river estuary (SW Netherlands). The samples were subjected to four sedimentation regimes: one control and three with a deposited sediment layer of 1, 2 or 5 cm. Oxygen consumption was measured during incubation at ambient temperature. Luminophores applied at the surface, and a seawater–bromide mixture, served as tracers for bioturbation and bio-irrigation, respectively. After incubation, the macrofauna was extracted, identified, and counted and then classified into functional groups based on motility and sediment reworking capacity. Total macrofaunal densities dropped already under the thinnest deposits. The most affected fauna were surficial and low-motility animals, occurring at high densities in the control. Their mortality resulted in a drop in SCOC, which decreased steadily with increasing deposit thickness, while bio-irrigation and bioturbation activity showed increases in the lower sediment deposition regimes but decreases in the more extreme treatments. The initial increased activity likely counteracted the effects of the drop in low-motility, surficial fauna densities, resulting in a steady rather than sudden fall in oxygen consumption. We conclude that the functional identity in terms of motility and sediment reworking can be crucial in our understanding of the regulation of ecosystem functioning and the impact of habitat alterations such as sediment deposition.

1 Introduction

It is widely accepted that biodiversity plays an important role in ecosystem functioning. A higher biodiversity can convey a higher resilience and a more efficient functioning of ecosystems in terms of, for example, nutrient cycling and primary productivity (Cardinale et al., 2012; Hooper et al., 2005). Since biodiversity-mediated ecosystem functioning depends on the functional identities of the species present in the community and their densities (Braeckman et al., 2010; Van Colen et al., 2013), functional community descriptors often predict functioning better than taxonomic diversity (Wong and Dowd, 2015). Functional traits, e.g. in terms of motility or sediment reworking rate, can be an indication for a species' behaviour. By being able to rework more or less sediment, species can differentially influence biogeochemical cycling (Wrede et al., 2017). Furthermore, variations in population densities of individual species can