BIODEPOSITION IN A JUVENILE MUSSEL BED
OF THE EAST FRISIAN WADDEN SEA
(SOUTHERN NORTH SEA)

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ABSTRACT

Seasonal trends of biodeposition and animal coverage in backbarrier beds of the mussel *Mytilus edulis* in the East Frisian Wadden Sea were documented and quantified to assess the effects of physical disturbance by storms and to develop a conceptual model for the interpretation of biodeposits in the stratigraphic record. Accretion and erosion of biogenic muds (faeces and pseudofaeces) were quantified by repeated precision levelling of a 12 m² test area. Animal coverage was documented by vertical photography prior to each levelling survey. Levelling and photography were conducted from a bridge and rail system to avoid physical disturbance by trampling. Four surveys, covering a period of different weather conditions, showed variable mean accretion/erosion rates of biodeposits ranging from +0.56 mm d⁻¹ (accretion) to −1.34 mm d⁻¹ (erosion) and areal coverage of mussels ranging from 39.1% to 0%. A pronounced seasonal trend in the biodepositional pattern was observed. Mean accretion rates were high (>0.5 mm d⁻¹) during the summer season, whereas in the winter season net deposition decreased to zero or showed erosional trends. Long-term sediment budgets are thus composed of highly variable mean annual rates which, in turn, comprise highly variable seasonal and even monthly rates, depending on the local weather pattern. This forms the basis for a conceptual model, in terms of which the stratigraphic record of fossil biodeposits can be meaningfully interpreted.

INTRODUCTION

Backbarrier beds of the mussel *Mytilus edulis* L. form a prominent component of the Wadden Sea ecosystem, occupying as much as 10% of the total area of individual tidal catchments (e.g. behind Spiekeroog Island; HERTWEEK, 1993), where they can account for up to 25% of total macrobenthic production (BEUKEMA, 1983). As such, they have received considerable attention in long-term stock evaluation surveys (e.g. REISE and SCHUBERT, 1987; JENSEN, 1992), a prerequisite in assessing the importance of *M. edulis* in structuring tidal flat communities (see REISE, 1985 and SMAAL, 1991 for references).

Marked interannual variations in the standing stock of this commercially important species have primarily been explained in terms of erratic larval spatfalls (see MCGORTY et al., 1990), predation, human exploitation and eutrophication (OBERT and MICHAELIS, 1991; CADEE and HEGEMAN, 1993). In addition, abiotic factors such as storms and severe ice winters have long been known to dramatically influence animal distribution patterns (e.g. BEUKEMA, 1979; DÖRLE, 1980). In such cases, however, it is mainly the immediate, sometimes catastrophic effects of episodic weather events which have been documented (e.g. LANDAHL, 1988). Indeed, there is a surprising paucity of studies accounting for the potential impact of long-term changes in weather patterns.
Recently, NEHLS and THIEL (1993) reported differential survival rates of *M. edulis* beds dependent on the degree of exposure to physical disturbance in the northern part of the Wadden Sea. In spite of such local effects, the regional distribution of mussel beds has remained fairly constant there for at least the past 50 years. Similar observations were made in the Ameland region (Dutch Wadden Sea) by DANKERS and KOELEMAIJ (1989), although these mussel beds have in the meantime disappeared.

In contrast, it is to be expected that structural features of mussel beds, including the accumulation of biodeposits, are more susceptible to both short- and long-term climatic variability. Through its filtering activity, *M. edulis* concentrates and deposits mud in form of faeces and pseudofaeces in places where wave energy is normally too high for physically controlled sedimentation (FLEMMING, 1991; FLEMMING and NYANOWI, 1994; FLEMMING and ZIEGLER, 1995). Biodeposited muds are therefore particularly prone to resuspension by storms, a process directly linked to water turbidity and the cycling of organic matter. Both aspects have far-reaching implications for the stability of the ecosystem as a whole. Surprisingly few direct measurements, however, have been made of seasonal or annual variations in biodeposition by mussel beds in tidal flats (e.g. VERWEY, 1952; KAMPS, 1962; LANDAHL, 1988). In the North Sea region, most assessments have been based on laboratory work using single animals (e.g. NIELSEN, 1985; OITTMANN, 1987; TEN BRINKE and DRONKERS, 1993).

The present study had three major objectives: first, to directly quantify seasonal biodeposit turnover relative to the areal coverage of *M. edulis*; second, to assess the effects of physical disturbance by storms; third, to develop a conceptual model in terms of which the stratigraphic record of biodeposited muds could be interpreted.

**Study area**

The study area was located in the backbarrier tidal flats of Spiekeroog Island in the German Wadden Sea (Fig. 1A). The work was carried out in Test Area 1, situated just below mean tide level on the Neuharlingersieler Nacken (Fig. 1B).