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## Potential role of macrofauna for the exchange processes between sediment and water column in an inner coastal water of southern Baltic Sea (Darß-Zingst Bodden Chain, Grabow)

### Abstract

The macrozoobenthos community at a shallow water station in the Darß Zingst Bodden Chain (DZBC) was analysed to estimate the influence of bioturbation on exchange processes at the sediment water interface under special view of phosphate. The polychaetes *Hediste diversicolor* and *Marenzelleria* spp., oligochaets as well as *Cerastoderma glaucum* and, because of their high abundance, also *Hydrobia* spp. where classified as important bioturbators, that have a pronounced effect on solute transport and particle mixing in the sediment. The community bioturbation potential ( $BP_c = 15534 \text{ m}^{-2}$ ) is high and indicates a strong influence on this shallow water sediments. This may lead to a fast nutrient turn over and low phosphate pore water concentration.

**Keywords:** macrozoobenthos, nutrients, bioturbation, bioirrigation

### 1 Introduction

Exchange processes at the sediment-water interface play an important role in the function of an aquatic ecosystem and are influenced by the bioturbation activity of macrobenthic infauna. Bioturbation is defined as “all transport processes carried out by animals that directly or indirectly affect sediment matrices. These processes include both particle reworking and burrow ventilation” (KRISTENSEN et al. 2012). These enhance the exchange processes between the sediment and water column thereby changing the oxygen supply in the sediment and stimulating the microbial degradation of organic matter and the release of nutrients as well as pollutants. The dimension of bioturbation effects is determined by species composition, abundance, depth and geometry of the burrows (ALLER 1980; KRISTENSEN et al. 2012; RENZ & FORSTER 2013). Recently the community bioturbation potential, ( $BP_c$ , QUEIRÓS et al. 2013; BRAECKMAN 2014) an index based on abundance, biomass and trait characteristics related to reworking of sediments, is used as a measure of overall bioturbation intensity.

The Darß-Zingst Bodden Chain (DZBC) is a shallow estuary at the southern Baltic Sea separated from the Baltic Sea by the peninsula Fischland-Darß-Zingst. It is differentiated into four connected basins and shows a distinct salinity decrease from the eastern to the western parts. Due to intense agriculture an increased nutrient influx took place since the 1960s that led to high eutrophication in this lagoon system. Despite a decrease in nutrient input since the 1990s, due to modernization and building of wastewater treatment plans, a decrease in nutrient concentrations and primary production could not be observed. It is assumed that the sediments act as internal nutrient reservoir and therefore as a lasting source for nutrient input to the water column (BLÜMEL et al. 2003). The high productivity of the system as well as the constantly mixed water column result in high abundances and biomasses of macrozoobenthic organisms due to food supply and constant oxygen availability at the sediment surface.

In the framework of the project BACOSA (Baltic Coastal System Analysis and Status Evaluation) the sediments in the most eastern part of the DZBC are analysed with special focus on the phosphorus dynamic in the sediment and between the sediment and the water column, which highly depends on oxygenation conditions in the sediment. Therefore a strong influence of benthic infauna could be expected. In the following, the potential bioturbation impact of the different benthic infauna species on the exchange processes between sediment and water should be discussed.

## **2 Material and Methods**

### **2.1 Sampling station**

The sampling station Dabitz is situated at the southwest shore of the Grabow, the most eastern basin of the Darß – Zingst Bodden chain, which is affected by differing exchange conditions with the adjacent Baltic Sea and therefore exposed to strong salinity variations. This nearshore environment is characterised by a broad reed belt and shallow water area from 0.5 to 1.0 m water depth covered with macrophytes in temporal and spatial variable densities.

Sampling took place within the context of a bachelor thesis in October 2012 (n=3) a master thesis in April 2013 (n=3) and in July 2013 (n=2) within the scope of the joint research project BACOSA.

### **2.2 Sediment parameters**

At the different sampling points, a sediment core with a diameter of 100 mm was taken respectively to analyse the water content and organic matter content. They were cut into 1 cm slices. Each slice was homogenised and three parallels were dried at 60 °C and reduced to ash at 500 °C respectively to determine the water content and the loss on ignition (LOI). Particle size of sediment was analysed by wet sieving of mixed sediment of the upper 0-2 cm (0-3 07/2013) of each core through 5 sieves with descending mesh (1000; 500; 250; 125; 63 µm).

## 2.3 Macrofauna

At each sampling point 2 to 3 sediment cores of 100 up to 194 mm in diameter were taken. The sediment was sieved through 500 µm mesh and the fauna was fixed in habitat water with 4% formalin.

To estimate the benthic oxygen budget, three sediment cores with a respective sample area of 283 cm<sup>2</sup> were taken in July 2013 at Dabitz. Total oxygen uptake (TOU) and diffusive oxygen uptake (DOU) were assessed several times using planar optodes and oxygen microelectrodes. Fauna mediated oxygen uptake was quantified as the difference between TOU and DOU. The oxygen consumption mediated by *H. diversicolor* was determined by adding polychaetes to macrofauna-free sediment in abundances comparable to those found at Dabitz and controlling the increase of TOU before and after the addition.

## 2.4 Statistical analysis

The abundance data were processed in a multivariate community analysis with the software package PRIMER v6 (CLARKE & GORLEY 2006). Singletons were excluded from analysis and data were double root transformed. Based on the BRAY-CURTIS-coefficient, which indicates the percentage similarity between two samples/stations a triangular similarity-matrix was generated. Subsequently a hierarchical clustering was performed including the test routine "Simprof".

In order to explore in general if the BP<sub>c</sub> - index would indicate high or low influence of bioturbation, we calculated the community bioturbation potential according to trait scores describing increasing intensity of sediment reworking (values R<sub>i</sub> from 1 - 5) and mobility of the organisms (M<sub>i</sub> from 1 - 4) according to QUEIRÓS et al. (2013).

$$BPc = \sum_{i=1}^n \sqrt{B_i/A_i} * A_i * M_i * R_i$$

Following BRAEKMANN et al. (2014) we used biomass (B<sub>i</sub>; FW m<sup>-2</sup>) and abundance (A<sub>i</sub>) of those species considered most important for bioturbation effects in the sediment at our location. Values used in this calculation represent a sample taken in July 2013 in an area covered with macrophytes. Since QUEIRÓS et al. (2013) do not list *Marenzelleria* spp. and *R. harris* we assigned R<sub>i</sub> and M<sub>i</sub> ourselves.

# 3 Results

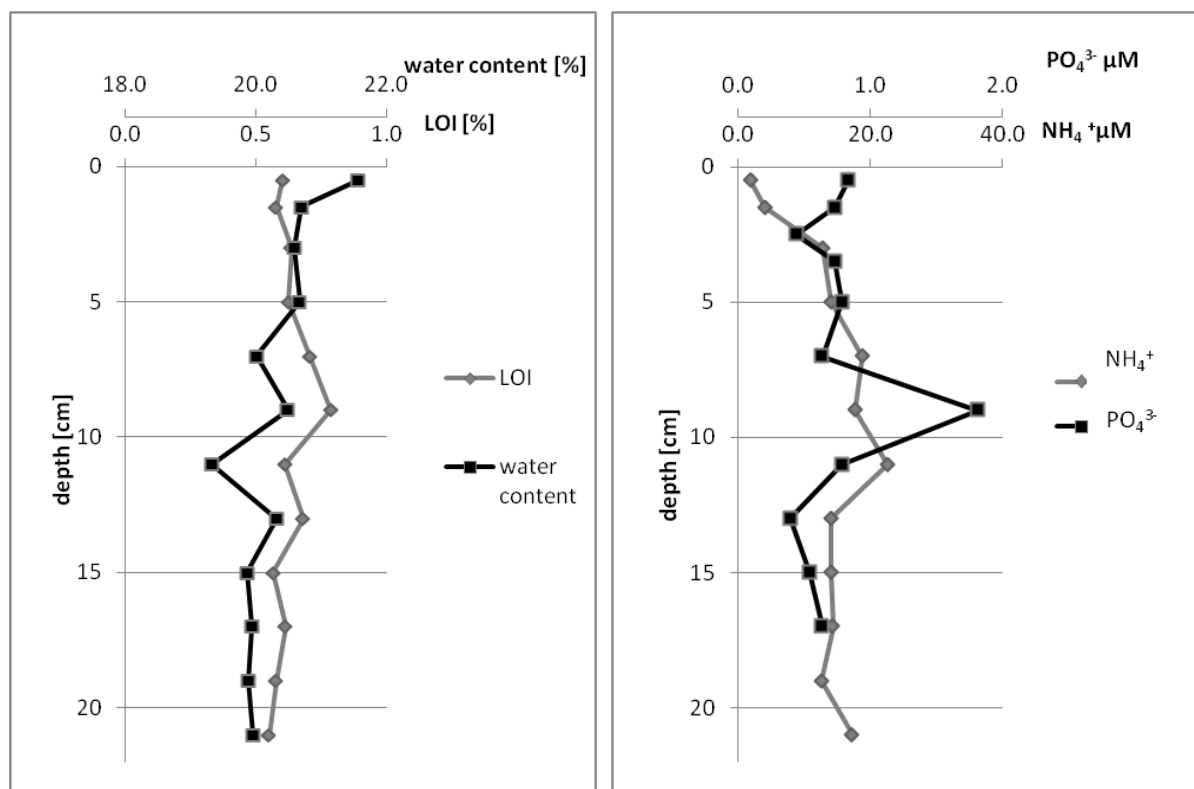
## 3.1 Sediment parameters

The sediment of the shallow area of the Grabow can be characterised as fine sand with an average grain size of 187±3 µm, the water content is on average 26.8±3.7 % and the LOI is 1.0±0.22 %. The sediment parameters show no seasonal variability (Tab. 1)

The water content slightly decreases with increasing sediment depth and LOI remains constant through the depth profile (Fig. 1). The phosphate and ammonium concentration in porewater was measured at four different points of time during 2014. The typical profile is shown in Fig. 1, respectively. The phosphate concentration in the pore water is constantly low, while the ammonium concentration shows an increase in deeper sediment layers.

**Tab.1:** Sediment parameters of the upper sediment layer (0-2 cm) and abiotic conditions at the sampling station Dabitz, n.a. data not available

Date	Temperature [°C]	Salinity [PSU]	Median grain size [µm]	Water content [weight-%]	LOI [weight-%]
10/2012	7,1	8,3	177	26,1	n.a.
04/2013	11,2	4,7	185	25,4	0,9
07/2013	21,2	7,0	190	28,8	1,1



**Fig. 1:** Depth profile in sediments from Dabitz 2014. left: water content and loss on ignition (LOI); right: concentration of ammonium (NH<sub>4</sub><sup>+</sup>) and phosphate (PO<sub>4</sub><sup>3-</sup>)

## 3.2 Macrofauna

17 taxa could be determined (Tab. 2). Except for the oligochaeta and the chironomidae larvae, it was possible to identify all organisms down to genus or species level. After elimination of stray finds (mostly organisms of mobile epifauna), 12 taxa were considered in multivariate analysis.

The polychaetes *Hediste diversicolor* and *Marenzelleria* spp., the oligochaetes as well as *Cerastoderma glaucum* and because of their high abundance also *Hydrobia* spp. were classified as important for exchange processes and were therefore taken in closer consideration in the further discussion. The multivariate analysis shows that parallel samples of the different sampling dates are grouped together in significantly different clusters (SIMPROF-test) (Fig 2). Hence it can be concluded, that seasonal variations in the local macrofauna community occur. Namely for the taxa Oligochaeta (e.g. Tubificidae), Nemertini, *Marenzelleria* spp. and chironomid larvae. For example *Marenzelleria* spp. is missing in October 2012, instead, oligochaetes and chironomidae larvae occur in this sample. Oligochaeta also occur in high abundances in July 2013, but are missing in April of the same year.

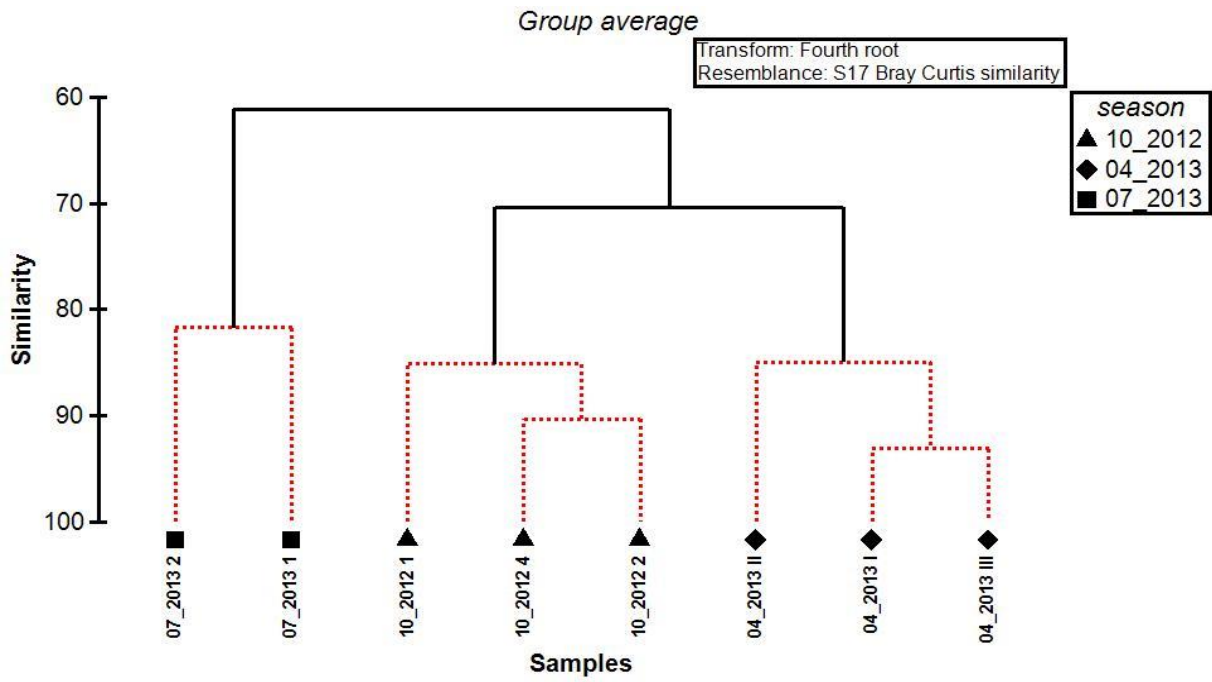
TOUs ( $68.30 \pm 3.09 \text{ mmol}\cdot\text{m}^{-2}\cdot\text{d}^{-1}$ ;  $n = 6$ ) clearly exceeded DOUs ( $4.05 \pm 1.04 \text{ mmol}\cdot\text{m}^{-2}\cdot\text{d}^{-1}$ ;  $n = 9$ ), indicating that macrozoobenthos mediates 85 – 90 % of the TOU at Dabitz in summer. The addition of *H. diversicolor* to defaunated sediment increased TOU by  $26.0 \pm 2.5 \text{ mmol}\cdot\text{m}^{-2}\cdot\text{d}^{-1}$  ( $n = 3$ ). Respiration was estimated by using allometry (BANTA & HOLMER 1999) and only accounted for 29.6 % of the oxygen flux induced by *H. diversicolor*, suggesting that oxygen consumption effects stimulated by irrigation of the polychaetes may reach considerable amounts (Fig. 2).

Community bioturbation potential,  $BP_c$ , describes the effects of benthic fauna in a general way by assigning higher calculated values to increasingly stronger potential effect exerted on those sediments by the fauna. With this in mind, we calculated the  $BP_c$  for one sample (07-2013-M) for which we also obtained biomass data along with abundance. To conservatively estimate  $BP_c$  for comparison with literature data (BRAECKMAN et al. 2014) we reduced the species list in Tab. 2 and calculated the bioturbation potential (Tab 3). We excluded those species not considered important in the context of bioturbation (Nemertini, epifauna) and excluded the rare single finding of *Rithropanopeus harrisi*. Additionally we excluded the oligochaeta for which the present taxonomic information is not detailed enough to argue for strong bioturbation effects and because these organisms occurred massively in this one sample only.

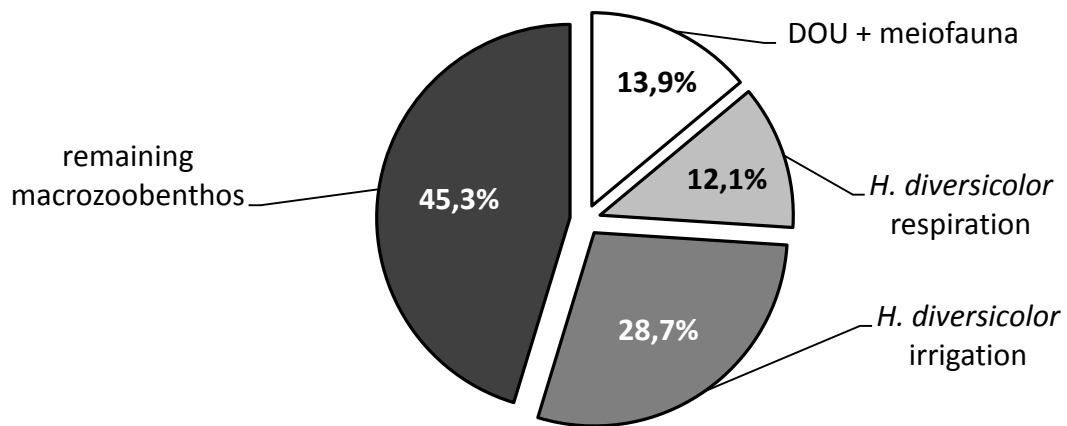
This snapshot may be somewhat biased since abundances of *Hydrobia* spp. and *H. diversicolor* in particular vary considerably between samples. However, the abundance of *H. diversicolor* is close to the average found throughout all samples, Hydrobiidae exceed the number used in this calculation often times and some potentially important additional bioturbators (*R. harrisi* and tubificid oligochaetes) have been excluded. Therefore, we consider the overall value of  $BP_c$  calculated,  $15534 \text{ m}^{-2}$ , a reliable value.

**Tab. 2:** Species list with numbers of individuals per m<sup>2</sup>, important species for material exchange underlaid in gray, \* - Endofauna. Column heads indicate month, year and either parallel sample index.

	10_2012 4	10_2012 2	10_2012 1	04_2013 I	04_2013 II	04_2013 III	07_2013 1	07_2013 2
<i>Arenomya arenaria</i> *	0	0	0	35	35	106	0	0
<i>Cerastoderma glaucum</i> *	0	127	255	212	212	282	127	382
<i>Hydrobia</i> spp.	25223	20000	41656	34917	13191	32448	3949	12866
<i>Potamopyrgus jenkinsi</i>	382	1019	1401	141	141	353	764	3312
<i>Theodoxus fluviatilis</i>	0	0	0	0	0	0	764	127
<i>Hediste diversicolor</i> *	7006	3822	2548	952	2328	2328	3949	1529
<i>Manayunkia estuarina</i> *	0	0	0	35	0	35	0	0
<i>Marenzelleria</i> spp.*	0	0	0	353	141	71	382	0
<i>Corophium volutator</i> *	0	0	0	0	71	0	0	0
<i>Gammarus</i> spp.	127	127	255	0	0	0	0	127
<i>Idotea chelipes</i>	0	255	127	0	0	0	127	0
<i>Jaera albifrons</i>	0	0	0	0	0	0	127	127
<i>Neomysis integer</i>	0	0	0	0	35	0	0	0
<i>Rithropanopeus harrisii</i>	0	0	0	0	0	0	127	0
<i>Oligochaeta</i> *	127	127	0	0	0	0	16051	4204
Chironomid larvae*	127	127	127	0	0	0	0	0
Nemertini*	0	0	0	0	0	0	764	637



**Fig 2:** Dendrogram showing similarities between macrofauna communities of different sampling points at Dabitz.



**Fig. 3:** Estimated percentages of diffusive oxygen uptake (DOU) including additional meiofauna-mediated enhanced diffusion, respiration and irrigation of *H. diversicolor* as well as activity of the remaining macrozoobenthos abundant at Dabitz in the measured TOU of 68.3 mmol m<sup>-2</sup> d<sup>-1</sup>.

**Tab. 3:** Community bioturbation potential,  $BP_c$ , calculations based on biomass ( $B_i$ ) and abundance ( $A_i$ ) for those species (I) considered important and found in samples from July 2013 in areas covered with macrophytes. Trait scores  $M_i$  (mobility) and  $R_i$  (reworking) for *Marenzelleria* spp. are not included in QUEIRÓS et al. 2013 and were assigned according to our own expertise.

I	$B_i$ g FW $m^{-2}$	$A_i$ Ind $m^{-2}$	$M_i$ (1 – 4)	$R_i$ (1 – 5)	$BP_i$ $m^{-2}$
<i>Cerastoderma glaucum</i>	5.27	127	2	2	104
<i>Hydrobia</i> spp.	3.2	3949	2	3	676
<i>Hediste diversicolor</i>	207.6	3949	4	4	14488
<i>Marenzelleria</i> spp.	11.7	382	2	2	268

## 4 Discussion

The presented dataset cannot give a complete image of the macrofauna community in the Darß-Zingst Bodden Chain. It is limited to a restricted area in the very shallow coastal zone of the Grabow, the most eastern basin of the DZBC. It is known that the macrobenthic community does change along the salinity gradient from east to west and even in the deeper parts of this lagoon system where the Chironomidae larvae become more dominant (ARNDT 1994).

Even if this limited dataset does not record the temporal and spatial patchiness of macrofauna at all, it shows that the variations in macrofauna community seemed to be influenced by season (Fig. 2). Because sediment properties at all sampling dates are very similar (Tab. 1), seasonal variations in salinity and temperature could be the controlling factor for the macrofauna changes. Especially the eastern parts of the DZBC show high salinity fluctuations depending on the different in- and outflow situations between the Bodden waters and the adjacent Baltic Sea (SCHLUNGBAUM et al. 1994). Also long-term investigations of macrozoobenthos between 1969 and 1990 show pronounced seasonal and interannual variations in abundances and biomass of macrofauna species that could be partly explained by changing salinity and temperature, especially for species living at their distribution boundary in this estuarine system (ARNDT 1994).

Despite the highly dynamic macrozoobenthic community, the shallow water sediment is densely populated by different bioturbating species at any time, like the tube dwelling worms *Hediste diversicolor*, *Marenzelleria* spp. and *Oligochaeta*, that could influence the sediment down to 25 cm. The surface of the sediment is strongly influenced by the grabbing and grazing activity of the bivalve *Cerastoderma glaucum* and the snail *Hydrobia* spp. Additionally the crab *Rhithropanopeus harrisi*, a neozoic species in the Bodden Chain that shows intensive grabbing activity, will probably become more important in the future (NEHRING 2000).

Different processes summarized as bioturbation influence the sediment characteristics and therefore chemical processes therein. Here solute exchange through burrows has the most pronounced effect on pore water chemistry of dissolved substances. The solute exchange increases with the increasing inner surface of the burrows, which is influenced by the number of tubes per area, their diameter and the depth of the tubes (ALLER 1980). To a lesser extent non tube-dwelling organisms also influence the pore-water exchange by crawling and grubbing in the sediment. These activities as well as the building of burrows additionally conduct particle movement.

Due to the structural modifications at the sediment, surface erosion can be in- or decreased.

In the following the potential influence of the taxa classified as important bioturbators (*H. diversicolor*; *Marenzelleria* spp.; Oligochaeta-Tubificidae; *C. glaucum*; *Hydrobia* spp.) shall be discussed under special view on the phosphorus cycle in the sediment. The phosphorus dynamics in the sediment depends strongly on the redox situation in the different sediment layers, which in turn is influenced by bioturbation activity. About 85-90 % of oxygen uptake of the sediment at this location is induced by macrofauna, both directly by faunal respiration itself and indirectly by stimulation of microbial metabolism. The polychaete *Hediste diversicolor* builds branched tubes in the upper 10 cm of the sediment (max. depth: 30 cm) (ZETTLER et al. 1994), which can account for a three-fold increase of the sediment surface (DAVEY & WATSON 1995). As shown in figure 3 28.7 % of benthic oxygen consumption on this station is mediated by ventilation activity of the worms. This leads to an increased oxygen supply to deeper sediment layers, supporting the microbial remineralisation of nutrients and also an enhanced exchange of solutes with the overlying water (DAVEY & WATSON 1995). HEDMAN (2011) reported a solute exchange with the overlying water of  $12 \text{ l m}^{-2} \text{ d}^{-1}$  ( $0.6 \text{ g ww ind}^{-1}$ ,  $800 \text{ lnd m}^{-2}$ ).

Since the 1990s the invasive species of the genus *Marenzelleria* becomes more important also in the DZBC (ARNDT 1994; BLANK et al. 2007). *Marenzelleria* spp. build unbranched L- or J-shaped tubes, which penetrate the sediment down to 25 cm (max. depth: 35 cm) (Zettler 1994). The intensity of solute exchange with  $0.28 \text{ ml ind}^{-1} \text{ h}^{-1}$  (RENZ & FORSTER 2013) is comparable to that of *H. diversicolor* (HEDMAN et al. 2011). RENZ & FORSTER (2014) show that the release of ammonium and phosphate, as well as the total oxygen uptake of the sediment (TOU), was stimulated by the presence of *Marenzelleria*, and especially *M. viridis* and *M. neglecta* showed markedly enhanced fluxes of nutrients and oxygen.

Chironomid larvae that are mostly known from limnic ecosystems are also abundant in the DZBC. They become more dominant in the deeper and eastern parts with lower salinity (ARNDT 1994) where they could take over the function of other tube-dwelling organisms. They build U-shaped burrows down to 15 cm depth, which are periodically ventilated (LEWANDOWSKI et al. 2007). These authors found decreased pore water concentrations of nutrients around the burrow walls in comparison to the surrounding sediment. This effect could be explained by the oxygenation of the burrow walls that leads to increased sorption capacities of dissolved P on Fe (III) oxyhydroxids, as well as by the convective transport of dissolved ions through the burrow lumen to the overlying water by pumping activity. The activity of chironomid larvae as well as the activity of oligochaets in the sediment decrease the  $\text{PO}_4^{3-}$  release across the sediment-water interface due to the import of oxidising agents into the sediment but increase the horizontal heterogeneity in the sediment (LEWANDOWSKI & HUPFER 2005; LEWANDOWSKI et al. 2007). It can be assumed, that these processes also take place on the burrow walls of other tube dwelling organism.

Besides the direct bioturbation effects by the movement of the worms, indirect hydrodynamic effects also may take place at the burrow opening that can irrigate the tubes without a living worm inside (ZIEBIS et al. 1996).

Even if the solute transport has the most pronounced effects on sediment chemistry and exchange of nutrients it cannot be separated from particle transport. If solutes are moved through sediments, they take particles with them and vice versa.

The Hydrobiidae, which occur in Dabitz at high abundances, plough through the upper sediment layer and move particles and pore water in the uppermost millimetres of the sediment and the overlying fluff-layer (RYSGAARD & CHRISTENSEN 1995; BLANCHARD et al. 1997; ORVAIN et al. 2006). Our own analysis in the laboratory shows that every individual replace  $0.183 \text{ cm}^3$  of sediment per hour by crawling with a mean velocity of  $6 \text{ mm h}^{-1}$  (KRÖNER unpubl. 2006). According to an average of  $23\,000 \text{ ind. m}^{-2}$  at this sampling station the sediment turnover amounts to around  $4200 \text{ cm}^3 \text{ h}^{-1} \text{ m}^{-2}$  and thus basically mixes the uppermost 5 millimetres of the sediment once per hour.

*Hediste diversicolor* also increases the mixing of particles in the upper centimetres of the sediment. The polychaete is classified as 'gallery-diffuser', whose particle reworking is characterised as similar to diffusion in the dense gallery parts of burrows and non-local transport to the tube bottoms (GERINO & STORA 2003; FRANCOIS et al. 2006). Depending on worm abundance, the burrowing and surface feeding activity of *H. diversicolor* increase sediment erodability. WIDDOWS et al. (2009) showed that at high abundances ( $>1000 \text{ ind. m}^{-2}$ ) and under low current speeds ( $5 \text{ cm s}^{-1}$ ) active sediment resuspension took place.

The *Marenzelleria* species are less effective in sediment transport than *H. diversicolor* (RENZ & FORSTER 2013). Both species show an increased biodiffusion in the biodiffusive layer (1-2 cm), but in contrast to *M. neglecta* non-local particle transport could be detected only for *H. diversicolor* (HEDMAN et al. 2011).

Tubificidae (Olygochaeta) usual burrow in the upper 16 cm of the sediment, but are able to burrow down to 25 cm. They are classified as "conveyor belt species" (RHOADS 1974), ingest sediment at a certain depth and expel this material at the sediment surface with a sediment reworking rate of  $59.7 \pm 10.1 \times 10^{-5} \text{ cm}^3 \text{ ind}^{-1} \text{ h}^{-1}$  (FISHER et al. 1980).

The bivalve *Cerastoderma glaucum* burrows in the sediment up to 2 cm sediment depth. Due to the burrowing behaviour of the cockle (TRUEMAN et al. 1966) particles were moved from the surface downwards into the sediment as well as relocated laterally. Depending on the cockle density in the sediment, they increase the sediment erodability and enhance bioresuspension (CIUTAT et al. 2007).

*H. diversicolor* and *C. glaucum* are important filter feeders and are able to control the phytoplankton biomass in shallow waters (RIISGAARD et al. 2004). A part of the ingested organic material is deposited as faecal pellets in deeper sediment layers. This biodeposition supports the flux of organic carbon from the primary production in the water column to the sediments and therefore enhance microbial activity and remineralisation in the sediment (GRAF & ROSENBERG 1997).

As outlined above, life history and specific feeding and locomotion traits identify certain mainly endobenthic species as particularly active in shaping sediment chemistry through bioturbation. In investigations at the Belgian North Sea coast  $BP_c$  was highest with values of  $\sim 10000 \text{ m}^{-2}$  in fine sandy as opposed to silt or coarser sand sediments (BRAECKMAN et al. 2014). The  $BP_c$  of roughly  $15500 \text{ m}^{-2}$  calculated for Dabitz underscores that the community is able to affect the sedimentary habitat massively. The highest effect here is clearly associated with *H. diversicolor* owed to both high numbers and biomass (compare table 3). Abundance of this species varies and may be lower at times. The same is true for abundance of *Hydrobia* spp. but with abundances which can exceed the values used in our calculation 10-fold. We conclude that the bioturbation potential, too, indicates that relatively strong bioturbation effects are to be expected here.

## 5 Conclusion

While wave action at this site is likely to often resuspend surficial sediments, the fauna community present has the potential to mix, stir and resuspend sediment as well. Considering the surface activities of 4000-4200 Hydrobiidae, 1000-7000 *H. diversicolor* and up to 400 *C. glaucum per m<sup>2</sup>*, one can assume a high impact of particle movement in the upper 2 cm of the sediment. Especially the uppermost 2-5 mm may underlie an intense mixing by crawling and graze activities of the organisms.

In the sediment layers deeper than 2 cm the intensity of particle movement decreases and solute exchange becomes more important. Due to high abundances of tube dwelling worms the sediment is influenced down to 25 cm depth. The low and constant phosphate pore water concentration (see Fig. 1) may be an evidence for the pronounced bioturbation influence on this shallow water habitat with two major effects. On the one hand, the burrows increase the oxygenated sediment surface and therefore may enhance the adsorption capacity of the sediment, since  $\text{PO}_4^{3-}$  is adsorbed by iron- and manganese-oxides under oxic conditions (SUNDBY 1992). On the other hand, the oxygenation around the burrows as well as the deposition of organic material to deeper sediment layers stimulate microbial remineralisation. The non-local transport of solutes through the burrows enhances the nutrient fluxes out of the sediment and may also decrease the pore water concentration. The intense bioturbation at this habitat probably leads to a fast turnover of nutrients and may be a partial explanation for the constantly low phosphate concentration even in the water body.

Community bioturbation potential,  $\text{BP}_c$ , has recently been used to estimate the particle reworking potential of faunal assemblages. Calculating this index from monitoring data may emerge as a tool for translating biomass and abundance data into a more functional aspect of the benthos assemblage. The  $\text{BP}_c$  combines wet biomass, abundance and reworking and mobility traits of burrowing macrofauna (QUEIRÓS et al. 2013) into an index indicating a high or low potential influence on sedimentary processes by this local fauna (BRAECKMAN 2014). Based on summer 2013 data in the presence of macrofauna (table 3) typical for location and combined with wet weight measurements not shown, the shallow water area at Dabitz is characterized by  $\text{BP}_c = 15534 \text{ m}^{-2}$  including *Marenzelleria* spp, *H. diversicolor*, *Hydrobia* spp and *C. glaucum*. This value exceeds that of the highest  $\text{BP}_c$  published for sediments at the Belgian North Sea coast (BRAECKMAN 2014; fine sand) and underscores the presence and strong bioturbation influence that benthic macrofauna has in this DZBC sediment.

### Zusammenfassung

In der vorliegenden Studie wurde die Makrozoobenthosgemeinschaft in Dabitz, einem Flachwasserstandort der Darß-Zingster-Boddenkette untersucht um die potentiellen Bioturbationseffekte auf die Austauschprozesse an der Sediment-Wasser-Grenzfläche abzuschätzen. Besonderes Augenmerk soll dabei auf die Phosphatdynamik gelegt werden. Die Polychaeten *Hediste diversicolor* und *Marenzelleria* spp., Olygochaeten sowie *Cerastoderma glaucum* und auf Grund ihrer hohen Abundanzen auch *Hydrobia* spp. wurden als bedeutende bioturbierende Arten eingestuft, welche einen ausgeprägten Effekt auf den Flüssigkeitsaustausch wie auch die Partikeldurchmischung haben. Das hohe gemeinschaftliche Bioturbationspotential ( $\text{BP}_c$ ) von  $15534 \text{ m}^{-2}$  lässt auf einen starken Bioturbationseinfluss auf diese

Flachwassersedimente schließen. Dies führt womöglich zu einem schnellen Nährstoffaustausch und niedrigen Phosphatkonzentrationen im Porenwasser.

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