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Structure and functional characteristics of the meiofauna community in highly unstable intertidal mudbanks in Suriname and French Guiana (North Atlantic coast of South America)

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ABSTRACT

The North Atlantic coast of South America is influenced by the Amazon River. This coast is considered the muddiest in the world due to the enormous suspended sediment input from the Amazon River. The mobility of the sediment imposes a geomorphological dynamic with a rapid change of shoreline and fast alternation of facies types of the sediment. This study first describes the spatial and functional structure of meiofauna communities of highly unstable intertidal flats along coasts of French Guiana and Suriname in relation to environmental variables. Six sampling sites, composed mainly of muddy sediment, were located 700 km (Kourou) to 1200 km (Nickerie) from the mouth of the Amazon River. The granulometry, chlorophyll *a* biomass, prokaryote abundance, percentage of organic matter, meiofauna abundance and feeding guilds of nematodes in sediment stations were independent of the distance of the Amazon River mouth and likely were more influenced by the local dynamism of migration of mudbanks. Meiofauna was not more abundant when the sediment was dominated by the finest sediment particles and also when chlorophyll *a* and prokaryotes, potential prey of meiofauna, were greater. However, as a percentage, small nematodes (biomass of 0.07 ± 0.001 μg ind^{-1}), which are mainly epigrowth-feeders, were more abundant in very fluid mud. Local granulometry and organic matter content appeared to be driving factors of the size structure and functional characteristics of nematodes. Despite the high instability of mudflats, chlorophyll *a* biomass and meiofauna abundance always tended to be higher toward other world areas. No foraminifera among the six stations of the study were found. Very fluid mud with physical instability of sediment caused a large perturbation to the settlement of meiofauna; the least amounts of chlorophyll *a* biomass and prokaryotic and meiofauna abundances were found there. Thus, the probable mobility of sediment may select for smaller meiobenthic organisms, mainly epigrowth-feeders nematodes, and disturb the larger organisms in the sediment, and, therefore, they would not permit the settlement of the foraminifera. In addition, no non-permanent meiofauna largely was found in the sediment.

1. Introduction

The coast between the Amazon and Orinoco Rivers (1500 km) in South America is considered the muddiest in the world due to the enormous suspended sediment input from the Amazon River (754 Mt y^{-1} ± 9%) (Martinez et al., 2009). Thus, a large amount of fluid mud is transported from the Amazon River mouth in a north-western direction along the coasts of the Guianas, including French Guiana and Suriname, by a complex interaction of waves, tidal forces, and coastal currents. These complex interactions result in the formation of a series of large mudbanks that are distributed in at least 15 units 10–60 km long and 20–30 km wide and migrate 1 km y^{-1} (Allison et al., 2000). They impose a geomorphological dynamic leading to rapid changes of shoreline and fast alternation of facies type (Anthony et al., 2010). The intertidal area, bordered by mangroves, represents approximately 5% of the entire mudbank. Although these emerged mudflats are unique in the world considering their high dynamic processes and particular instability, the diversity and structure of communities as well as food web functionality associated with these mudbanks are mostly unknown.

Intertidal soft sediment habitats rank among the most productive ecosystems on Earth, largely owing to the primary

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production of highly diverse assemblages of benthic diatoms (Underwood and Kromkamp, 1999). Indeed, at every low tide, the intertidal flats are rapidly covered by mats of microalgae (microphytobenthos [MPB]) (Underwood and Kromkamp, 1999). Diatoms have the ability to migrate through fine sediments according to the tidal and daily irradiation cycles in order to find optimal light conditions for their growth. The MPB constitutes a complex biofilm in association with prokaryotic communities, mainly composed of bacteria in the sediment surface (van Duyl et al., 1999). These prokaryotes play a fundamental role through the degradation and remineralisation of nutrients. The components of biofilm (MPB and prokaryotes) are considered key ecosystem engineers in food webs. In addition, diatoms are known to be important trophic sources for many benthic organisms (meiofauna and macrofauna), and the prokaryotes can represent a complementary food source for meio- and macrofauna (Moens and Vincx, 1997; Pascal et al., 2008a, b; Pascal et al., 2009).

Meiobenthos occurs in all types of sediments and is thus able to reside in a wide variety of habitats (subtidal and intertidal areas). Nevertheless, the texture of the sediment is an important variable for structure and composition of meiobenthic assemblages (Schwinghamer, 1981; Semprucci et al., 2010, 2011). Abundance of benthic organisms is generally higher toward fine grains due to a concomitant increase of food availability (Balsamo et al., 2010; Heip et al., 1992). Meiofauna is generally considered to constitute recurrent taxa, such as nematodes, copepods, and foraminifera, and non-permanent taxa, such as small gastropods, small bivalves, and small annelids. In mudflats, nematodes are consistently considered the most abundant meiobenthic taxa (Boucher and Lambshead, 1995). Some authors have suggested that the ecological significance of nematodes is crucial in terms of food web relationships (reviewed in Balsamo et al., 2012; Heip et al., 1985; Platt and Warwick, 1980), production of detritical organic matter, and recycling of nutrients, thereby enriching the coastal waters to support marine benthic production. Nematodes are functionally diverse, as they can be herbivores, bacterivores, deposit feeders, epigrowth feeders, or predators (Pascal et al., 2008b; Rzeznik-Orignac et al., 2003).

The spatial structure of meiofauna assemblages has been well studied in temperate mudflats (Pascal et al., 2008b; Rzeznik-Orignac et al., 2003) and tropical mangrove areas (Alongi, 1987; Chinnadurai and Fernando, 2007; Debenay et al., 2002; Xuan et al., 2007). Nevertheless, studies of bare tropical mudflat meiofauna are scarce and completely absent for the Guiana coast areas submitted to high dynamic processes, leading to a strong instability rarely met among coastal ecosystems.

The present study first describes the spatial and trophic functional structure of meiofauna communities of intertidal flats along the French Guiana and Suriname coasts in relation to environmental variables such as granulometry, chlorophyll *a* biomass, prokaryote abundance, and percentage of organic matter in sediment. The sampling stations are influenced by the Amazon flume, considered the largest and muddiest river in the world, and the choice of the stations presented a gradient of influence of the river from east to west (from French Guiana to Suriname). Second, three types of mud facies (fluid mud, moderately compacted mud, and compacted mud) were sampled on the intertidal mudflats of Awala (French Guiana), and their meiofauna communities were compared. We hypothesised that in highly unstable intertidal mudbanks:

1. Compositions and abundances of meiofauna were different according to the grain size and particularly the fraction of fine sediment particles.
2. Meiofauna was more abundant when MPB biofilm containing diatoms and prokaryotes, which are potential prey for meiofauna, was more abundant.

2. Materials and methods

2.1. Study sites

The intertidal mudflats studied are located along the French Guianese coast in front of the city of Kourou and village of Awala-Yalimapo and on the Surinamese coast near the River of Warappa and city of Nickerie (Fig. 1). All stations were sampled in April 2012 (wet season) at low tide in the upper area of the intertidal mudflats. The tides of the considered coast sections are semidiurnal with a tidal range of 0.8 m (neap tides) to 2.9 m (spring tides).

The median sediment grain size was characterised using a Malvern Mastersizer 2000 (Malvern Instruments, Ltd., UK) (size

Fig. 1. Map showing the study area and location of samples collected in French Guiana and Suriname.