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Baseline

Seasonal variations of epipelic algal community in relation to environmental factors in the Istanbul Strait (the Bosphorus), Turkey

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ABSTRACT

This study was implemented to investigate the species composition, abundance, seasonal variations and diversity of epipelic algae, to determine environmental variables affecting them and to reveal the accumulation of total organic carbon in the sediment in the coastal zone of the Istanbul Strait, Turkey. Epipelic algal community consisted of 44 taxa with a low diversity. The sediment structure which is highly unstable due to the high hydrodynamism of the zone played a dominant role as the main factor in the epipelic algal flora along the coasts of Istanbul Strait. Low TOC and high carbonate values also support this result. The dominance of cyanobacteria in some periods and, as a result of this, the record of the lowest diversity index values indicated the effect of nutrient enrichment and the risk of coastal eutrophication. High dominance of cyanobacteria may also be explicated by climate changes considering its effect in the other areas.

The coastal zone is the most productive and highly dynamic marine environment (Charpy-Roubaud and Sournia, 1990; Decho, 2000) and has been regarded as an important filter and transition zone of organic material and nutrients discharged from land (Kautsky and Kautsky, 1995). Microorganisms have important and established roles which may effect large scale changes in these systems (Decho, 2000). Primary producers have an important role for the functioning of shallow coastal ecosystems and their productivity by far exceeds that of the open oceans (Charpy-Roubaud and Sournia, 1990; Aberle-Malzahn, 2004). The major primary producers are macro- and microalgae (benthic, epiphytic and pelagic) colonizing all sorts of substrates and covering vast areas within the euphotic zones of aquatic systems (Aberle-Malzahn, 2004; Nielsen et al., 2004).

Epipelic algae, defined as Cyanobacteria and eukaryotic algae that live on or in association with fine–grained and illuminated substrata (MacIntyre et al., 1996; Pouličková et al., 2008; Špačková et al., 2009), play a key role in biodiversity and primary production in aquatic ecosystems. It may contribute up to 50% of the total primary production (Perissinotto et al., 2002; Montani et al., 2003), influence the flux of inorganic nutrients between sediment and water (Welker et al., 2002; Sundbäck et al., 2004), stabilize sediments (Yallop et al., 2000) and play an important role in the benthic and pelagic trophic web (Montagna et al., 1995; Peletier, 1996). Of the epipelic algae the species composition of which varies significantly among various habitats, especially diatoms are the most dominant group in terms of species and individual number (Round, 1981; Scipione and Mazzella, 1992; Underwood and Paterson, 1993; Snoeijs, 1994; De Stefano et al., 2000). Diatoms, important primary producers in these systems (Decho, 2000), have been the primary focus of monitoring studies due to their rapid assemblage response to stress, existing knowledge of the narrow tolerance ranges for a large number of species (Potapova et al., 2004; Bellinger et al., 2006). Many factors such as light, temperature and nutrients as well as waves and currents, sediment type and particle size, consumption by aquatic animals have effects on this flora (Round, 1981; Jesus et al., 2009).

Benthic microalgal studies are more difficult than studies on phytoplankton. Sampling as well as separation of microphytobenthos from sediment, and cleaning procedures is hampered by several methodological difficulties (Ribeiro et al., 2003). Benthic diatoms are traditionally grouped according to the substratum they colonize (Round, 1981), the free-living forms that move through muddy sediments are known as epipelic while sessile forms attached to the particles of sandy sediments are referred to as epipsammic (MacIntyre et al., 1996). In this study, traditional epipelon sampling methodology was pioneered within freshwater habitats by Round (1953) was used. However, according to some researchers, this method does not provide adequate quantitative accuracy of true epipelic biomass and leads to contamination of epipelic community by other autotrophic groups (Pouličková et al., 2008). Due to their ecological importance, studies on microbenthic algal structure have increased in number (Peletier, 1996;

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Haubois et al., 2005; Parikh et al., 2006; Cibic et al., 2007; Facca and Sfriso, 2007). On the other hand, the number of studies carried out along the coasts of Turkey is very low (Aktan and Aykulu, 2003; Aktan and Aykulu, 2005) compared to the freshwater and planktonic studies in the same zone. The studies on algae of the Istanbul Strait are limited. While the phytoplankton community structure, which is an indicator of the changes in water quality, and its seasonal changes have been studied by Uysal (1987, 1996), Uysal and Ünsal (1996), Tüfekci and Okus (1998), Aktan et al. (1999), there is no detailed study on the epipelic algae in the coastal zone of the Istanbul Strait.

The aim of this study is to investigate the species composition, abundance and seasonal variations of epipelic algae that play an important role on the biological diversity and primer productivity, to determine environmental variables affecting them and to reveal accumulation of total organic carbon in the sediment samples in the coastal zone of the Istanbul Strait.

Located at the northern part of the Turkish Straits System, the Istanbul Strait (Turkey) is one of the narrowest straits of the world and has an average length of 31 km, a width ranging between 0.7 and 3.5 km, an average depth of 35.8 m, and its deepest point has an average depth of 110 m (Gunnerson and Özturgut, 1974). It has a two-layered current regime formed by the water exchange between the Black Sea and the Mediterranean and a special ecosystem characterized by this feature (Tuğrul and Salihoğlu, 2000). Since the Istanbul Strait is continuously fed by the surface waters flowing from the Black Sea and negatively affected by the domestic and industrial waste waters of the Istanbul city and dense sea traffic, the water quality is harmed. Observations on hydrography of the Istanbul Strait shown that the exchange flows respond dynamically to time-dependent meteorological in the area and also hydrological forcing in the adjacent basins (Özsoy et al., 2002). The current velocity of the Istanbul Strait decreases from the upper layer through the middle layer and reversibly increases from the middle layer to the surface again. The current velocity in upper layer varies between 5 and 90 cm/s but its speed can be up to 2.5 m/s under extreme weather conditions (Yüksel et al., 2003 and Yalçıner et al., 2007).

Monthly sampling was performed from June 2003 to May 2004 at five sampling stations on the coastal sediments of the Istanbul Strait which were chosen to represent the effects of different environmental conditions (Fig. 1).

Overlying water was sampled for determining some physical and chemical parameters. Temperature was measured with a thermometer, salinity by the Mohr–Knudsen method (Ivanoff, 1972) and the dissolved oxygen by the Winkler method (Winkler, 1888).

Water samples for determining nutrients were collected in 100-ml polyethylene bottles and kept in deep freeze (−20 °C) until their analysis in the laboratory. Nitrite + Nitrate-N ($NO_3 + NO_2$-N) concentrations were analyzed by the cadmium reduction method on autoanalyzer (APHA, 1999). Phosphate-P (PO_4-P), Silicate-Si (SiO_4-Si) and chlorophyll *a* (Chl *a*) analyses were carried out by the methods described by Parsons et al. (1984). Chlorophyll *a* was measured after filtering 1 liter of the sample through 0.45 μm membrane filters (Whatman GF/C). One milliliter of a 1% suspension of $MgCO_3$ was added to the sample prior to filtration. Samples were stored in a freezer, and pigments were extracted in a 90% acetone solution and measured with a spectrophotometer. Organic carbon contents of the samples were measured using a CARLO ERBA EA-1108 carbon analyzer following the removal of the inorganic carbon by acid treatment with 1 N HCl. The total carbonate contents were determined by the gasometric–volumetric method after treatment with 4 M HCl (Loring and Rantala, 1992).

Epipelic algal samples were obtained by drawing a glass tube (0.7 cm in diameter) over the sediment of one-meter deep, and depositing the sample into a petri dish (10 cm diameter) to a depth of 1 cm. Then, coverslips were placed on the mud in the Petri dishes and left for 24 h. During this time, the positively phototactic algae moved upwards through the sediments and came to rest on the undersurface of the coverslips. The latter were then removed, placed on a glass slide and transects were taken across them using a light microscope (40 × 10). The number of cells for each species was then calculated from three slides Round (1953). However, as stated above, this technique does not provide adequate to a quantitative study of epipelic community. For this reason, the abundance of epipelic diatoms and their data analyses was reported only as relative abundance. For diatom identification, an appropriate volume of each sample was boiled with H_2SO_4 and HNO_3 and washed in distilled water. The acid cleaned diatoms were mounted in Naphrax medium with a high refractive index. Hustedt (1930), (1959), (1961–1966), (1985) Cupp (1943), Hendey (1964), Patrick and Reimer (1966, 1975), Kramer and Lange-Bertalot (1986), Poulin et al. (1986), Tomas (1995), Hartley et al., (1996), Komarek and Anagnostidis (1999) were used for identifications of microalgae.

Shannon–Weaver (H′) diversity index was used to describe epipelic algal assemblage structure (Odum, 1971; Clarke and Warwick, 1994). Spatial patterns in community structure were

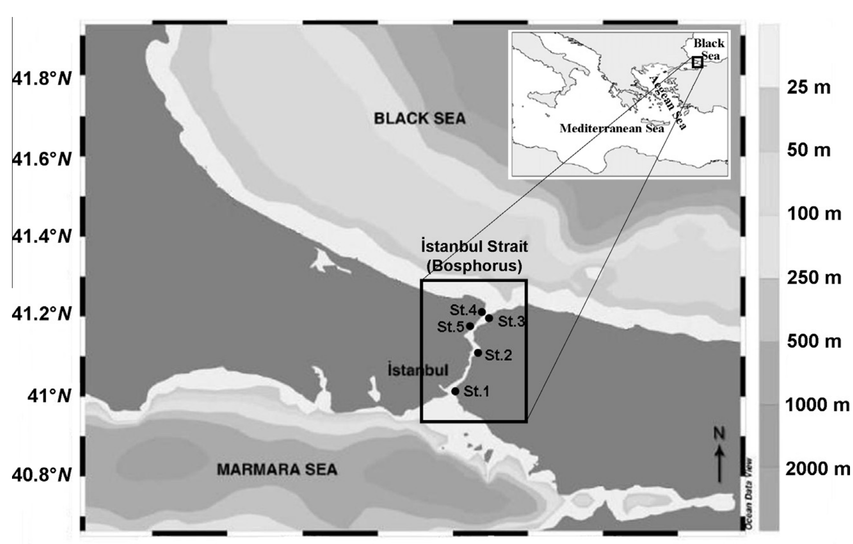

Fig. 1. Geographical map and sampling stations in the coastal zone of the Istanbul Strait.