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Biodiversity and spatial distribution of copepods community in the south coast of Sfax city (Tunisia)

Zohra Ben Salem *, Habib Ayadi

Biodiversity and Aquatic Ecosystems UR/11ES72 Research Unit, Department of Life Sciences Research, Sfax Faculty of Sciences, University of Sfax, Street of Soukra Km 3.5. BP 1171 - PO Box 3000 Sfax, Tunisia

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ABSTRACT

The present study, conducted in winter 2008 at 20 stations in the south coast of Sfax, covered the spatial distribution of the physic-chemical parameters (temperature, salinity, pH, orthophosphate, ammonium, nitrate and nitrite) and planktonic copepods. The orthophosphate and ammonium were higher than those reported for the near-shore of the Gulf of Gabès. Copepods were the most abundant zooplankton present during the entire study period, comprising 66% of the total zooplankton community. Four copepod orders were identified, with a high percentage of cyclopoida (64% of copepods) with the prevalence of *Oithona nana* followed by Harpacticoïda (24%) dominated by *Euterpina acutifrons*. The Shannon–Weaver diversity index values show that the study site is under the influence of pollution stress or eutrophication, human pressure and industrial activities. Thus, a combination of physicochemical and biological analysis is a good way to screen overall environmental circumstances.

1. Introduction

During the last few decades, the expansion of industrial and commercial activities in the coast of Sfax has become an issue of increasing environmental concern. Many works have reported its high level of atmospheric (Azri et al., 2010) and aquatic pollution such as hydrocarbon (Zaghden et al., 2014), phosphogypsum (Tayibi et al., 2009) and heavy metals content (Gargouri et al., 2011; Serbaji et al., 2012). This anthropogenic pollution, associated with the demographic expansion and the rapid urban development, has seriously affected the biota (Banni et al., 2005; Barhoumi et al., 2009; Hamza-Chaffai et al., 1997; Smaoui-Damak et al., 2003) and the spawning and refuge area for fish larvae, especially the endemic seagrass *Posidonia oceanica* (Hamza-Chaffai et al., 2003; Ben Brahim et al., 2010). The zooplankton is the optimal prey of nekton (Mazumder et al., 2006) among which copepods make a major contribution to optimal growth and survival in fish (Hop et al., 1997). As elsewhere in the Mediterranean Sea, copepods are the most abundant components of coastal and oceanic zooplankton assemblages (Calbet et al., 2001; Duggan et al., 2008; Ragosta et al., 1995; Porri et al., 2007). Indeed, the variability in their abundance in time and space is important to the dynamics of marine food webs. The importance of small copepods and their ubiquity have made them the focus of many studies that attempt to link pelagic primary production with higher trophic levels and in budgets of pelagic carbon and nutrient flux (Turner, 2004). So, the investigation of the biodiversity and spatial distribution of copepods community and their relationship between the environmental circumstances highlights the budgets of pelagic carbon and nutrient flux. This work is meant to study the spatial distribution and the biodiversity of planktonic copepods in relation to physicochemical properties of the water, in the south coast of Sfax, subject for high pollution pressure.

2. Materials and methods

2.1. Study site

The study investigates the spatial distribution of physicochemical and zooplankton in the Southern coast of Sfax (Central Eastern coast of Tunisia, between 34.63°N–34.71°N and 10.71°E–10.78°E). In fact, Sfax is characterized by a dry climate (average precipitation: 210 mm) and by winds, waves and currents (0.2–0.3 s^{-1}) having a predominant north–south direction (Serbaji, 1991). It has a population of 733.687 inhabitants, of which 53% live in the urban parts of the City (Louati et al., 2001). The Southern coast of Sfax extends along 15 km from the fish port to Gargour (zone characterized by urban and industrial activity). It has received industrial wastewater drained from the phosphate treatment plant

* Corresponding author. Tel.: +216 26 55 72 36; fax: +216 74 27 44 37.
E-mail address: bensalemzohra@gmail.com (Z. Ben Salem).

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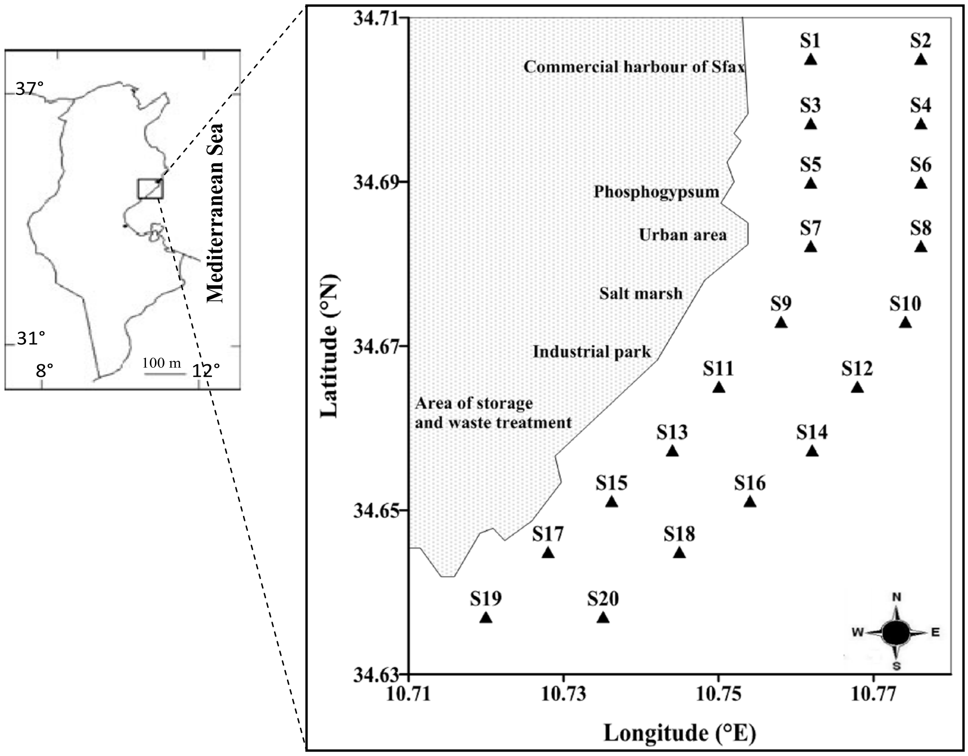

Fig. 1. Geographical map focusing on the sampling stations in the southern coast of Sfax.

SIAPE since 1952 and treated domestic wastewater drained from the wastewater treatment plant of Sfax city which has been operational since 1983 (Baati et al., 2011). Samples for nutrients were collected in winter 2008 at 20 stations (from 0.5 to 4.2 m in depth) in the coast south of Sfax, along 8 km from the fishing port and with 20 m between transect (Fig. 1). The depth at 9 stations (stations 3, 5, 7, 9, 11, 13, 15, 17 and 19) varied from 0.5 to 2 m and it varied from 2 to 4.2 at 11 stations (numbers 1, 2, 4, 6, 8, 10, 12, 14, 16, 18 and 20).

2.2. Physicochemical analyses

Temperature, salinity and pH were measured immediately in the field using a multi-parameter kit (Multi 340 i/SET). Water transparency was measured with a Secchi disc. Samples for nutrient analyses were preserved immediately upon collection (−20 °C, in the dark). Nutrients (nitrite: NO_2^-, nitrate: NO_3^-, ammonium: NH_4^+ and orthophosphate: PO_4^{3-}), were analysed by a BRAN and LUEBBE type 3 analyser and concentrations were determined colorimetrically according to Grasshof (1983). The suspended matter concentrations were determined by measuring the dry weight of the residue after filtration onto Whatman GF/C membrane filters.

2.3. Zooplankton collection

Zooplankton was collected at the previously mentioned stations using a cylindro-conical net (30 cm aperture, 100 cm height, 100 μm mesh size), equipped with a Hydro-Bios flowmeter. The net was towed obliquely from a depth near the bottom to the surface at each station at a mean speed of 1 m s^{-1} for 10 min. Zooplankton samples were rapidly preserved in 2% buffered formaldehyde solution after collection and stored in the dark at 4 °C. For a zooplankton enumeration, sub-samples were counted under a vertically mounted deep-focus dissecting microscope (Olympus TL 2) after being coloured with rose Bengal, to identify internal tissues of the different zooplankton species and also to facilitate the dissection of copepods. Zooplankton especially planktonic copepods, were identified to genus or species level according to Rose (1933), Boltovskoy (1999) and Boxshall and Halsey (2004).

3. Data analysis

The level of community structure was assessed with the Shannon and Weaver's (1949) H' diversity index. $H' = -\sum_{ni}^{i=1} \frac{ni}{N} \log_2 \frac{ni}{N}$; ni/N: is the frequency of species in the sample; N: number of species in the community.

A non-metric multidimensional scaling (MDS) based on Bray–Curtis similarity coefficient was used to obtain an ordination of station. Bray–Curtis similarities were calculated on root-transformed data. The SIMilarity PERcentages (SIMPER) test was performed to determine which species contributed to within-group similarity. These techniques were used with PRIMER (Plymouth Routines in Multivariate Ecological Research) software.

4. Results and discussion

4.1. Physicochemical parameters

The range (min–max) and mean values of physicochemical variables recorded at the 20 sampled points are summarized in Table 1.

Water temperature ranged from 14 to 16.2 °C (mean ± s.d. = 15.33 ± 0.64 °C) (Fig. 2(a)). Temperature slightly varies among sampling sites. Salinity, which ranges from 39 to 40.1 p.s.u (mean± s.d. = 39.78 ± 0.38), tending to stability over the spatial scale (Fig. 2(b)). The temperature and salinity slightly differ from one station to another, so the recorded values were typical of arid to semi-arid zones (Kchaou et al., 2009; Khemakhem et al., 2010). The pH ranges from 6.79 (station 17) to 8.24 (station 10) (mean ± s.d. = 7.76 ± 0.44) (Fig. 2(c)). The lowest value of pH is recorded in stations front of the outlet of the industrial park, the