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The effect of water quality on the distribution of macro-benthic fauna in Western Lagoon and Timsah Lake, Egypt.I

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Abstract Macro-benthic fauna are considered the good bio-indicators for the environmental changes of any aquatic ecosystems. Samples of macro-benthos, sediments and surface water were collected from 13 stations representing different conditions in the Western Lagoon (10 stations) and Timsah Lake (3 stations) from autumn 2014 to summer 2015. Macro-benthic density and diversity in Timsah Lake were higher than those in the Western Lagoon; the density at Timsah Lake encompassed 167,649 individual/m^2 representing 42 species from the total of 46 species recorded in the investigated area. While species density in the Western Lagoon constituted 12,008 individual/m^2 presenting only 16 species. Winter recorded the highest density (74,854 individual/m^2); the highest dominance (CDI = 0.858) and the lowest Equitability (0.293) due to the dominance of the opportunistic species. Spring harvested both the highest diversity (28 species) and species richness (SR = 2.917). While autumn and summer procured both the lowest density and diversity (34,021 and 29,544 individual/m^2 and 23 and 25 species respectively). The equitability index (E') showed its highest values within the Western Lagoon (> 0.90) owing to the species poorness relative to Timsah Lake. The water quality data showed that the Western Lagoon and Timsah Lake had significant high oxygen influx in spring (11.00 and 9.35 mg/l, respectively) and oxygen depletion in summer (1.00 and 3.00 mg/l, respectively). Reactive phosphorus and ammonia in the Western Lagoon exceeded the world averages. Timsah Lake sediments were highly affected by the sediment drifts from the Western Lagoon. The highest influx of the fine sediment group (FSG) was estimated during spring with an average of 62.77% and 61.18% in Timsah Lake and Western Lagoon, respectively. Total organic matter (TOM) in Western Lagoon recorded the highest average of 17.05% in spring accompanied with the high biological productivities.

Introduction

Macro-benthic fauna have a vital role in the marine ecosystem. They provide the essential food source for most of the marine

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organisms throughout their different stages of life from juveniles to adults. Most macro-benthos process and oxygenate the underlying sediments as well as break down organic matter before bacterial demineralization. Many of them, particularly clams, are considered as human food source in addition to using them in ornamental and recreational purposes (Tagliapietra and Sigovini, 2010). The anthropogenic disturbances strongly affect the species richness of aquatic macro invertebrates (Rosenberg and Resh, 1993). The macro-benthic fauna are tending to remain in their original habitats with great acclimation capability. They can tolerate any changes in water quality and high loads of pollution. Under pollution conditions, the community structure may simplify in favor of tolerant species, but the abundance of a certain species may increase but the diversity and species richness decrease. By assessing the diversity and functional groups of the indicator species of the benthic macro-faunal community, it is possible to evaluate water quality. Consequently; they can be considered as good bio-indicators for the environmental changes of any aquatic ecosystem.

The wide range of activities surrounding Timsah Lake and the huge discharge effluents at the north and eastern parts of the lake led to high level of pollution in the lake water much more than the navigation activities in the nearby Suez Canal (Abd El Samie et al., 2008).

In Timsah Lake, most of the studies have been done on specific groups of macro-benthic fauna. Mohammad et al. (2009) investigated the clams *Cerastoderma gilaucum* as a bio monitor aspect of oil Pollution. Mohammad et al. (2014) studied the growth, age and reproduction of the clams *Venerupis aurea* and *Ruditapes decussatus*. Extensive studies on fouling groups were done by Ghobashy and El-Komi (1981a,b), Ghobashy et al. (1980), Emara and Belal (2004). In the same area Ghobashy et al. (1986) investigated the Serpulids polychaetes, while Belal and Ghobashy (2012) studied the distribution of newly recorded benthic polychaetes in the Lake. But the Western Lagoon has not received any attention, although it is considered the entrance to Timsah Lake from the western side and the main cause of pollution in the Lake.

Therefore, this is the first study that is concerned with the bottom fauna of the Western Lagoon.

The present study aims to identify the macro-benthic fauna of Timsah Lake and Western Lagoon and to determine the relationship between macro-benthos and some environmental variables in this polluted area.

Materials and methods

Study area

Timsah Lake is located at the midpoint of Suez Canal at 80 km south of Port Said with surface area of 15 km^2 with variable depth between 3 m and about 16 m and containing about 90×10^6 m^3 of water (Fig. 1). The Western Lagoon is located to the Western side of Timsah Lake and connected with the lake through one inlet of about 20 m width. The lagoon is small with average surface area of about 4 km^2 and shallow with an average depth of about 2.5 m. It is partially covered with dense mats of floating plants growing in patches such as water hyacinths and water weeds. It receives about 10^6 m^3/day of wastewater and sewage from agriculture, industrial and municipal drains. Timsah Lake receives freshwater from the Western Lagoon and Ismailia Channel meanwhile the saltwater was from Suez Canal.

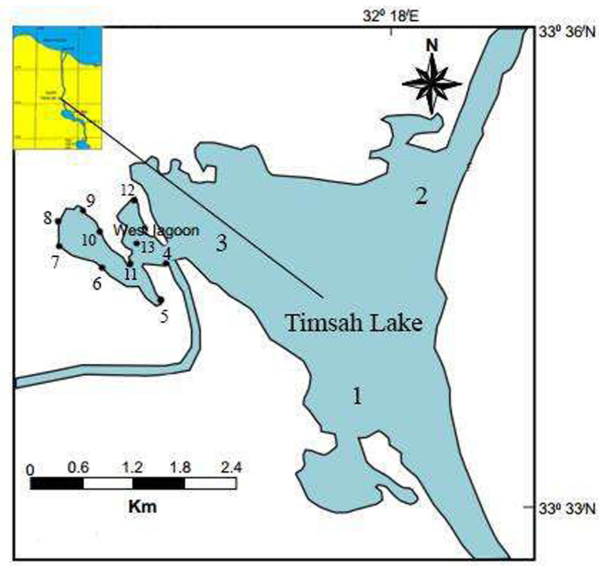

Figure 1 Map of sampling stations at the Western Lagoon and Timsah Lake.

Sampling and analysis

Surface water, sediment and macro-benthic fauna were collected from 13 stations; 3 stations were inside Timsah Lake (Stations; 1, 2 and 3) and the remaining 10 stations (St. 4–St. 13) were in the Western Lagoon (Fig. 1).

Physicochemical parameters

Physico-chemical parameters surface water temperature, pH, and dissolved oxygen (DO) were measured in situ using Hydrolab. Ver. 4. Nutrients salts; ammonia, nitrates, nitrites and dissolved phosphorus were measured seasonally in the lake water samples according to standard methods of APHA (2005) using JENWAY spectrophotometer.

Grain size analyses

The grain-size analyses of the collected sediment samples were performed using dry method depending upon Wentworth Scale (Folk, 1974) each one phi (Ø) interval. Seven fractions were obtained beginning from gravel ($Ø_{-1}$) to mud fraction ($Ø_5$). These fractions were categorized into three groups; coarse sediment group CSG ($Ø_{-1} + Ø_0$), medium sediment group MSG ($Ø_1 + Ø_2$) and fine sediment group FSG ($Ø_3 + Ø_4 + Ø_5$).

Total organic matter (TOM) determination

Determination of organic matter contents (TOM) was calculated as ignition loss at 550 °C (Dean, 1974) according the formula: