Journal of Great Lakes Research xxx (2014) xxx–xxx

Contents lists available at ScienceDirect

Journal of Great Lakes Research

journal homepage: www.elsevier.com/locate/jglr

Changes in the quantitative distribution of Caspian Sea polychaetes: Prolific fauna formed by non-indigenous species

Amir Faraz Ghasemi [a,b,*], Jeff C. Clements [c], Mehrshad Taheri [b], Ali Rostami [d]

[a] Department of Marine Biology, Faculty of Marine Science and Oceanography, Khorramshahr University of Marine Science and Technology, P.O. Box 64199-669, Khorramshahr, Khozestan, Iran
[b] Iranian National Institute for Oceanography and Atmospheric Science (INIOAS), 9, Etemadzadeh Avenue, West Fatemi Street, Tehran, Iran
[c] Department of Biology, University of New Brunswick, 100 Tucker Park Road, P.O. Box 5050, Saint John, NB E2L4L5, Canada
[d] Department of Environmental Sciences, Faculty of Technology and Engineering, Allame Mohaddes Noori University, P.O. Box 451-46415, Noor, Mazandaran, Iran

ARTICLE INFO

Article history:
Received 14 June 2013
Accepted 11 April 2014
Available online xxxx

Communicated by Lars Rudstam

Keywords:
Abundance
Biomass
Caspian Sea
Distribution
Polychaeta

ABSTRACT

Although considered major players in many ecosystems around the world, the ecology of Caspian Sea polychaetes is currently understudied. This study describes the species composition and quantitative distribution of polychaetes in the southern Caspian Sea and relates the distribution to seasonal changes in environmental parameters of water (temperature, salinity, and surface current speed) and sediments (organic matter and grain size composition) at four depths (2, 5, 9 and 14 m) on the Noshahr coast in the southern Caspian Sea in 2010. Four species were found: *Alitta succinea*, *Hediste diversicolor*, *Hypania invalida*, and *Streblospio gynobranchiata*. Among them, the non-indigenous *S. gynobranchiata* was the dominant species, accounting for 87% of the total abundance. Significant differences in abundance across the four species were observed among depths and seasons. Additionally, significant correlations between species abundances and the tested environmental factors were evident. This study highlights the potential consequences of established non-indigenous species in the southern Caspian Sea.

Introduction

The Caspian Sea is considered one of the most unique ecosystems in the world. It is the largest enclosed body of water on Earth, containing approximately 40% of the global continental water mass, which is primarily brackish in composition (Dumont, 1998). Although a substantial proportion of the Caspian Sea fauna is endemic (Dumont, 2000), non-native immigrants from the Arctic basin, Black-Azov Seas (Atlantic-Mediterranean fauna), and fresh water habitats are evident among the native species. As with many native aquatic species, the endemic fauna of the Caspian Sea is vulnerable to the negative effects of non-native species introductions and invasions. Inevitably, the enormous size and diversity of habitats make the Caspian Sea exceptionally suitable for the acclimation and establishment of invasive species and, consequently, the displacement of native species (Zenkevitch, 1963).

The Polychaeta are considered to be one of the most important taxa in aquatic systems. Due to their wide array of ecological adaptations, these worms inhabit many different habitats around the world. Additionally, they are often considered the dominant group in marine ecosystems (with respect to abundance and biomass) and are important contributors to the structure and functioning of benthic communities (Fauchald and Jumars, 1979; Surugiu et al., 2010). Within the Caspian Sea, polychaetes are the most abundant group of benthic animals, dominating the macrobenthic communities in which they reside (Parr et al., 2007; Roohi et al., 2010; Taheri and Yazdani, 2010; Taheri et al., 2012). As such, understanding the roles that polychaetes play in the benthic communities of the Caspian Sea is crucial for understanding ecosystem functioning and community structure in this area.

In comparison to the Black Sea (140 species) and Azov Sea (38 species), the Caspian Sea has a relatively low diversity of polychaetes. Only eight species have historically inhabited the Caspian Sea: *Parhypania brevispinis*, *Hypania invalida*, *Hypaniolla kowalewskii*, *Manayunkia caspia*, *Fabricia sabella*, *Alitta succinea*, *Hediste diversicolor*, and *Streblospio gynobranchiata*. Of these species, only *P. brevispinis* is endemic, while *F. sabella*, *H. invalida*, *H. kowalewskii*, and *M. caspia* are autochthonous Ponto-Caspians, and *A. succinea*, *H. diversicolor* and *S. gynobranchiata* are introduced from the Mediterranean-Atlantic (Birshtein et al., 1968; Ghasemi et al., 2013; Karpinsky, 2005; Kasymov, 1994; Khlebovich, 2009; Taheri et al., 2009; Zenkevitch, 1963). Although Khlebovich (2009) mentions the invasion of *Hypania antique* in the North Caspian Sea, there is no evidence to support a prolonged establishment of *H. antique* in the Caspian Sea. Interestingly, *Ficopomatus enigmaticus*, a serpulid worm that has invaded brackish waters around the world, was also introduced to the Krasnovodsky Gulf of the Caspian Sea in 1958–1961

* Corresponding author at: Department of Marine Biology, Faculty of Marine Science and Oceanography, Khorramshahr University of Marine Science and Technology, P.O. Box 64199-669, Khorramshahr, Khozestan, Iran. Tel.: +98 9123083875.
E-mail addresses: faraz_ghasemi@yahoo.com (A.F. Ghasemi), j.clements@unb.ca (J.C. Clements), mehrshadtaheri@yahoo.com (M. Taheri), ali.rostami_93@yahoo.com (A. Rostami).

http://dx.doi.org/10.1016/j.jglr.2014.05.004
0380-1330/

(Grigorovich et al., 2003). Upon its introduction, *F. enigmaticus* reproduced rapidly in Turkmenbashi Bay and its biomass (including the shell) reached 30 kg/m^2 (Bogoroditskii, 1963). However, soon after its establishment, *F. enigmaticus* declined and may now be extirpated from the Caspian Sea (Karpinsky et al., 2005).

Although they are important components of benthic systems worldwide, polychaetes and their associated habitats in the Caspian Sea are, at present, poorly understood. Furthermore, information from the southern Iranian coasts of the Caspian Sea is extremely limited. Because polychaete species in the southern Caspian Sea are generally non-indigenous, quantifying their biomass and abundance is necessary to understand the impacts of biological invasions, prioritize research, and guide national management strategies (Thomsen et al., 2009). As such, this study attempted to understand the species composition and quantitative distribution (abundance and biomass) of polychaetes in the Mazandaran Province of the southern Caspian Sea in relation to seasonal changes in environmental parameters of water (temperature, salinity, and surface current speed) and sediments (organic matter and grain size composition). Ultimately, the comprehensive assessment of the biotic and abiotic factors affecting the population dynamics of southern Caspian Sea polychaetes in this study facilitates a better understanding of the factors influencing the community structure in this area.

Materials and methods

The Caspian Sea is comprised primarily of brackish waters. It extends in a north-south direction and is approximately 1204 km long, with a maximum width of approximately 566 km. The Caspian Sea encompasses a total area of 436, 000 km^2 and has an approximate volume of 77,000 km^3, reaching an average depth of 180 m (Zenkevitch, 1963). The Mazandaran province (sampling area) is located along the Iranian coast in the middle of the southern beach of the Caspian Sea (Fig. 1). Tides in this area are essentially absent and the gradient and structure of the seabed are highly uniform. Salinity and temperature are relatively static above 20 m depth (Hadjizadeh-Zaker et al., 2007). Although no major rivers empty into the study area, strong rip currents are evident and primarily drive the hydrodynamics of the area (Shafiei Sabet and Barani, 2011).

Samples were collected in March (winter), June (spring), September (summer) and November (autumn) of 2010 on the Noshahr coast at four depths (2 ± 1 m, 5 ± 1 m, 9 ± 1 m, and 14 ± 1 m) at 16 sites between 51 31′ 12″ and 51 49′ 54″ E, and 36 39′ 28″ and 36 35′ 11″ N in 2010 (Fig. 1). At each site, three replicate samples of 300 cm^2 were collected using a Van Veen grab. In the field, the contents of each grab were stored in plastic containers and brought back to the laboratory, where each sample was gently sieved over 0.5 mm mesh. Retained material was fixed in 4% buffered formalin and stained with Rose Bengal. Macrofauna were then separated and all polychaetes were identified, counted, weighed (wet-weight to nearest 0.0001 g), and photographed.

Three replicate Van Veen grab samples were taken at each station to measure percent total organic matter (%TOM) and sediment grain size of surface sediment (approx. top 4 cm). Samples were dried (24 h at 90 °C) and weighed before being ignited (4 h at 550 °C) to determine %TOM (weight loss after ignition). Grain size analysis was performed using a particle size analyzer. Sediment fractions (gravel, sand, and silt–clay) were reported as percentages and defined according to the Wentworth scale. Physical data (temperature, salinity and surface current velocity) were also recorded at a 2 meter depth at a single location by the Noshahr Ports and Maritime Organization.

All data from the four stations at each depth (12 samples from each depth) were plotted and analyzed as four separate isobathal lines (Fig. 1). Principal component analysis (PCA) using the Euclidean distance was used to determine differences in environmental variability between sampling stations. All environmental data were natural log (X + 1) transformed and normalized, and then plotted in two-dimensional space. The scores of the stations on the first two axes were correlated with environmental parameters using Spearman rank correlation. Statistical significance was tested using $\alpha < 0.05$ (unless otherwise noted). The relationship between polychaete species abundance and sediment characteristics (%TOM and grain size composition) was estimated using Spearman's nonparametric correlation coefficient.

Given that the assumptions for parametric analyses were violated, two-way permutational ANOVA (PERMANOVA) was applied to test for differences in abundance and biomass against depth and season. A Euclidean distance and Bray–Curtis based resemblance matrix were used for univariate and multivariate data, respectively. Pair-wise comparisons among factor levels were performed whenever significant interaction terms were present between depth and season. Due to the restricted number of possible permutations in pairwise tests, *P*-values were obtained using Monte Carlo methods (Anderson and Robinson,

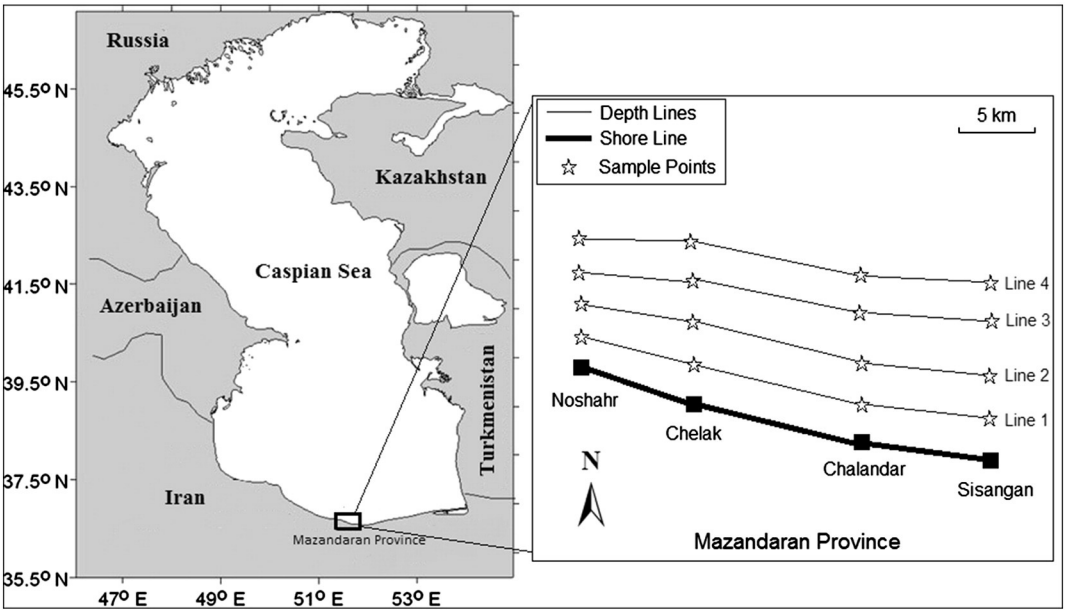

Fig. 1. Map of sampling area (left) and location of sampling stations in Mazandaran province with isobathal depth lines (line 1 = 2 ± 1 m, line 2 = 5 ± 1 m, line 3 = 9 ± 1 m, and line 4 = 14 ± 1 m depth) between 51 31′ 12″ and 51 49′ 54″ E, and 36 39′ 28″ and 36 35′ 11″ N.

Please cite this article as: Ghasemi, A.F., et al., Changes in the quantitative distribution of Caspian Sea polychaetes: Prolific fauna formed by non-indigenous species, J Great Lakes Res (2014), http://dx.doi.org/10.1016/j.jglr.2014.05.004