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Temporal variation of the soft-bottom molluscan fauna in north-western İskenderun Bay (Levantine Sea)

by

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Abstract

The present study was performed to follow temporal variation of the soft-bottom molluscan fauna in north-western İskenderun Bay. The benthic material was collected at a depth ranging from 3 to 37 m at 12 sampling locations by the van Veen grab sampler in the summer season of 2012, 2013 and 2014. A total of 133 species were identified in the study area through the examination of the collected material. Among the identified species, *Corbula gibba* (Olivi, 1792), *Bittium reticulatum* (da Costa, 1778), *Nassarius pygmaeus* (Lamarck, 1822), *Cerithidium diplax* (Watson, 1886) and *Finella pupoides* Adams, A., 1860 have the highest values of the frequency index. According to the Bray-Curtis similarity index, these species also have an important effect on the similarity between the stations. Furthermore, *C. diplax* and *F. pupoides* are alien species to the Mediterranean.

Key words: Mollusca, İskenderun Bay, Levantine Sea, Temporal variation

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Introduction

İskenderun Bay, with big international harbors and jetties for crude oil and coal transportation, is located in the eastern part of the Turkish Levantine coast. This location facilitates the transfer of alien species into the region by ship traffic. In addition, due to its proximity to the Suez Canal, İskenderun Bay is one of the important areas preferred by the Lessepsian species for their colonization. The impact of alien species on their new environment includes restructuring of established food webs, importing new diseases and competition with native organisms for food and space (Çınar et al. 2005).

Previous studies performed in the region have focused mainly on alien molluscan species (Çevik & Öztürk 2001; Çeviker 2001; Delongueville & Scaillet 2006a,b; Albayrak & Çağlar 2006; Albayrak 2010). Bitlis Bakır et al. (2012) listed 424 molluscan species from Iskenderun Bay, including 77 alien species (18%). Some new alien mollusks [*Pseudorhaphitoma iodolabiata* (Hornung & Mermod, 1928), *Plocamopherus tilesii* Bergh, 1877, *Nudiscintilla* cf. *glabra* Lützen & Nielsen, 2005, *Eunaticina papilla* Gmelin, 1791, *Martesia striata* (Linnaeus, 1758), *Lodderia novemcarinata* (Melvill, 1906), *Eratoena sulcifera* (Gray in Sowerby G.B.I, 1832), *Zafra obesula* (Hervier, 1899) and *Zafra pumila* (Dunker, 1858)] have also been added to the inventory of the molluscan fauna in the area (Öztürk 2012; Yokeş et al. 2012; Mifsud & Ovalis 2012; Öztürk & Bitlis-Bakır 2013; Çevik et al. 2015; Öztürk et al. 2015). On the other hand, some studies relate to ecological and faunistic features of mollusks in İskenderun Bay (Houart 2000; Çevik & Sarıhan 2004; Çevik & Ergüden 2004; 2008; Öztürk et al. 2008) have also been carried.

In the present study, the temporal variation of mollusks recorded on the soft bottoms in the north-western part of İskenderun Bay was analyzed.

Materials and methods

Benthic samples were collected from the soft substrates (mud, sandy mud and silt) at 12 stations by means of the van Veen grab sampler at a depth ranging from 3 to 37 m in July 2012, August 2013 and July 2014 (Table 1, Figure 1). The sampled material was sieved through a mesh (0.5 mm) and fixed in a 4% formalin solution in the field. The molluscan specimens were separated from the other taxa using also a stereomicroscope and preserved in 70% ethanol in the laboratory. Next, the specimens were identified and counted. The total wet weight of each sample was estimated by using a 0.0001 g sensitive balance.

To analyze the community structure, Soyer's frequency index (F), Shannon-Weaver's diversity index ($\log_2$ base) (H') and Pielou's evenness index (J') were calculated for each station in 2012, 2013 and 2014. According to Soyer's frequency index, the species with the frequency value (F) greater than or equal to 50% were considered as "Constant", those with the F value between 25% and 49% as "Common" and species with the F value below 25% were considered as "Rare". The dominance of mollusks in the samples was also calculated. The abundance data from the stations in each sampling period were analyzed using cluster and multidimensional scaling (MDS) techniques, based on Bray-Curtis similarity using the PRIMER package (Clarke & Warwick, 2001) in order to determine the temporal variation. Prior to the cluster and multidimensional scaling analyses, the raw data (the number of individuals) were transformed using the transformation yji=log(xji+1). SIMPER analysis was applied to indicate the percentage contribution of each species to all similarities or dissimilarities in each of the groups identified through the cluster analysis. Density values of some important mollusk species were processed on the map using the SURFER programme.

Table 1

Coordinates, sampling methods, depth range and biotopes of the stations

Stations	Coordinates Latitude-Longitude	Sampling methods	Depth range (m)	Biotope
1	36°51'35.0"N-35°54'45.1"E	Grab	3.4	Sandy mud
2	36°52'10.1"N-35°55'07.3"E	Grab	4.4	Sandy mud
3	36°52'23.0"N-35°55'25.1"E	Grab	4	Sandy mud
4	36°51'52.2"N-35°55'28.3"E	Grab	8.6	Sandy mud
5	36°50'57.4"N-35°55'47.2"E	Grab	30	Sandy mud
6	36°52'04.0"N-35°55'47.0"E	Grab	11.7	Silt
7	36°51'24.1"N-35°56'00.2"E	Grab	25.5	Silt
8	36°51'37.2"N-35°56'16.8"E	Grab	25.4	Silt
9	36°50'59.7"N-35°55'33.1"E	Grab	24	Silt
10	36°51'22.1"N-35°54'57.6"E	Grab	7.3	Sand
11	36°50'27.0"N-35°54'32.0"E	Grab	12.2	Silt
12	36°49'45.2"N-35°55'43.4"E	Grab	37	Silt

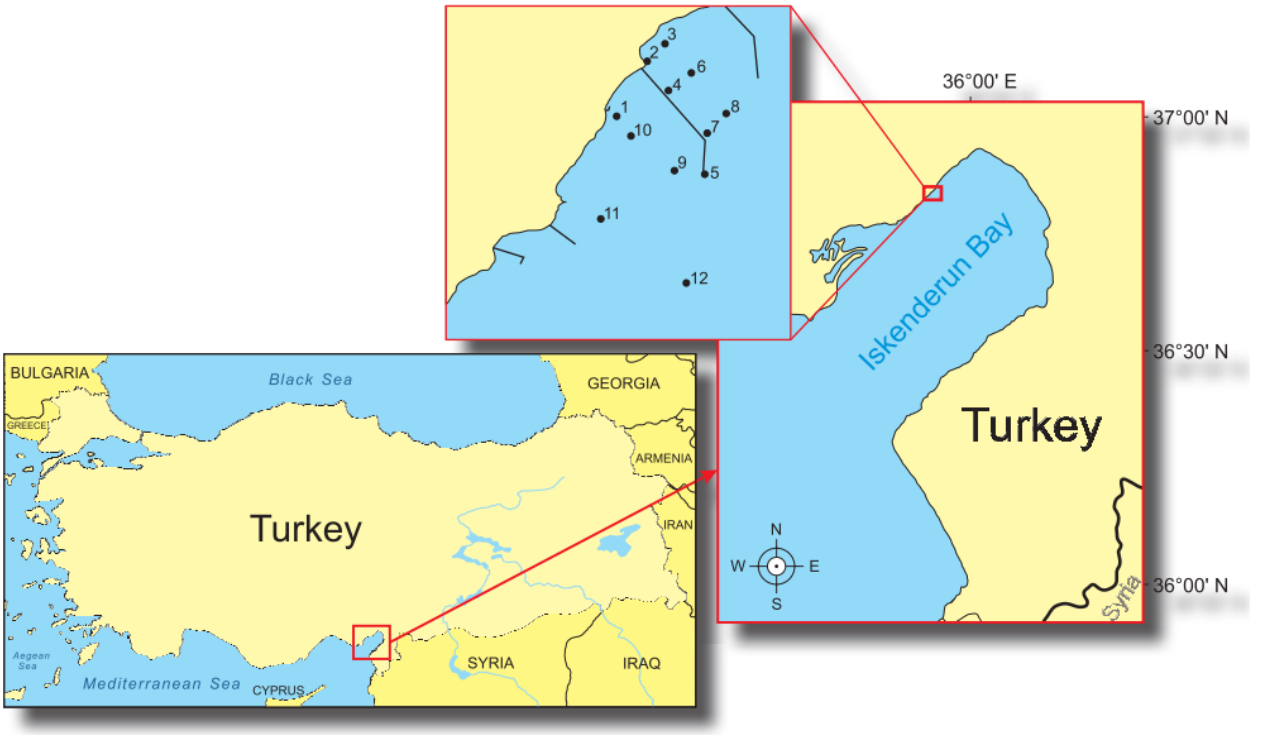

Figure 1

Map of the study region with the location of sampling sites (continuous lines represent the jetties)

The investigated material was deposited at the Museum of the Faculty of Fisheries, Ege University (ESFM), İzmir, Turkey.

Results

The analysis of grab samples revealed a total of 133 molluscan species, including 64 species identified in the material sampled in 2012, 64 species – in the material of 2013 and 86 mollusk species – in the material of 2014 (Table 2). Although the number of species increased in the subsequent years, the number of individuals and the total biomass values decreased to reach 2927 ind. and 887.53 g m^{-2} in 2012, 2539 ind. and 413.08 g m^{-2} in 2013, and 2318 ind. and 137.24 g m^{-2} in 2014 (Table 2). Of the species identified in the present study, the most abundant species were *Bittium reticulatum* (da Costa, 1778) (39%) in 2012, *Cerithidium diplax* (Watson, 1886) (43%) in 2013 and *Finella pupoides* Adams, A., 1860 (41%) in 2014. As for the frequency index values, the most frequent species were *Corbula gibba* (Olivi, 1792) (83%), *C. diplax* (75%) and *Nassarius pygmaeus* (Lamarck, 1822) (75%) in 2012, *F. pupoides* (100%), *C. diplax* (100%) and *B. reticulatum* (75%) in 2013, followed by *F. pupoides* (92%), *B. reticulatum* (83%) and *N. pygmaeus* (83%) in 2014 (Table 2).

Temporal variation in terms of the community parameters (the number of species, the number of individuals, the biomass value, the diversity index value and the evenness index value) at all the stations is presented in Table 3. In 2012 and 2013, the largest number of species and individuals was encountered at station 4 (44 species and 11910 ind. m^{-2}), and at station 10 (28 species, 7490 ind. m^{-2}). In 2014, the largest number of species was encountered at stations 1 and 10 (33 species), whereas the largest number of individuals was found at station 4 (4330 ind. m^{-2}).

Table 2

The number of species (S), the number of individuals (N), biomass (g m^{-2}) (B), frequent and dominant species in 2012, 2013 and 2014

Years	S	N	B	Frequent species (%)	Dominant species (%)
2012	64	2927	887.53	*C. gibba* (83%) *C. diplax* (75%) *N. pygmaeus* (75%)	*B. reticulatum* (39%)
2013	64	2539	413.08	*F. pupoides* (100%) *C. diplax* (100%) *B. reticulatum* (75%)	*C. diplax* (43%)
2014	86	2318	137.24	*F. pupoides* (92%) *B. reticulatum* (83%) *N. pygmaeus* (83%)	*F. pupoides* (41%)

Table 3

Temporal variation in the community parameters at the stations in 2012, 2013, 2014

Station	Number of species			Number of individuals (ind m^{-2})			Total Biomass (g m^{-2})			Diversity index			Evenness index		
	2012	2013	2014	2012	2013	2014	2012	2013	2014	2012	2013	2014	2012	2013	2014
1	37	17	**33**	4090	950	2050	222.30	0.43	2.25	**3.74**	**2.94**	2.95	0.72	0.72	0.58
2	17	23	29	2140	6050	2900	41.63	1.84	0.96	1.96	1.94	2.81	0.48	0.42	0.58
3	21	10	22	1550	2470	3540	55.80	9.36	1.14	3.32	2.14	2.32	0.76	0.58	0.52
4	**44**	11	22	**11910**	980	**4330**	**325.32**	6.28	**61.42**	2.15	1.97	1.98	0.39	0.57	0.44
5	4	23	20	120	4530	1360	0.50	7.94	31.99	1.61	2.46	3.04	0.81	0.53	0.70
6	15	8	14	970	420	1000	2.27	2.35	0.03	3.13	1.42	2.86	0.80	0.47	0.75
7	1	11	14	10	520	1130	0.15	0.61	0.38	0.00	2.63	3.02	0.00	0.71	**0.79**
8	1	7	10	10	190	470	0.02	0.12	0.05	0.00	2.27	2.53	0.00	0.81	0.76
9	3	5	20	40	140	3170	0.07	0.11	0.33	1.50	1.43	1.83	**0.95**	0.62	0.42
10	28	**28**	**33**	7390	**7490**	2190	229.15	3.59	36.52	2.78	2.71	**3.94**	0.58	0.56	0.78
11	16	12	21	860	1500	1030	9.89	**380.40**	2.16	3.21	2.33	2.78	0.80	0.65	0.63
12	4	5	1	180	150	10	0.44	0.06	0.02	1.23	1.96	0.00	0.62	**0.85**	0.00

Numbers in **bold** indicate the largest values.

The highest biomass values were determined at stations 4 and 11 due to the presence of *Gonomurex persicus* (Swainson, 1821) (max 204.371 g m^{-2} at station 4) and (max 378.08 g m^{-2} at station 11) in 2012 and 2013, respectively. The highest diversity index values were calculated at stations 10 (3.94) in 2014 and at station 1 (3.74) in 2012 and 2013. The highest evenness values were determined at station 9 (0.95), at station 12 (0.85) and at station 7 (0.79) in 2012, 2013 and 2014, respectively (Table 3).

A total of 26 alien species were identified in the study area. The majority of the alien species (22 species) have entered the Mediterranean via the Suez Canal, the others (*C. diplax*, *C. perparvulum*, *G. persicus* and *Ergalatax junionae* Houart, 2008) are known to be introduced by shipping traffic (Çınar et al. 2011). Although the number of alien species found in 2012 and 2013 were 14 and 13 respectively, it increased to 24 species in 2014.

Based on Bray-Curtis similarity values higher than 40%, seven groups of stations (A-G) can be distinguished in MDS (Figure 2). Five species affect the similarity (dissimilarity) between the years and the stations. *Cerithidium diplax* was the species with the strongest effect on the similarity (dissimilarity) among the samples collected in different years (Table 4).

In 2012, 2013 and 2014, the density of *C. diplax* and *F. pupoides* was examined at different stations in the region (Figure 3). The density values of *C. diplax* varied between 20 ind. m^{-2} (station 9) and 2660 ind. m^{-2} (station 10) in 2012, 50 ind. m^{-2} (station 8) and 3870 ind. m^{-2} (station 2) in 2013 and 10 ind. m^{-2} (station 8) and 1170 ind. m^{-2} (station 2) in 2014. The density of *F. pupoides* at station 10 in 2012 (1290 ind. m^{-2}) and

Table 4

Mollusk species contributing to a similarity between the years of 2012, 2013 and 2014 and their average similarity

	2012	2013	2014	2012-2013	2012-2014	2013-2014
average similarity/dissimilarity (%)	**23**	**39**	**30**	**77**	**79**	**70**
Corbula gibba	22	-	-	-	-	-
Cerithidium diplax	**16**	**39**	**14**	**11**	**6**	**7**
Nassarius pygmaeus	11	-	7	-	-	-
Finella pupoides	11	24	22	8	7	7
Bittium reticulatum	6	11	13	7	6	6

Numbers in **bold** indicate the largest values.

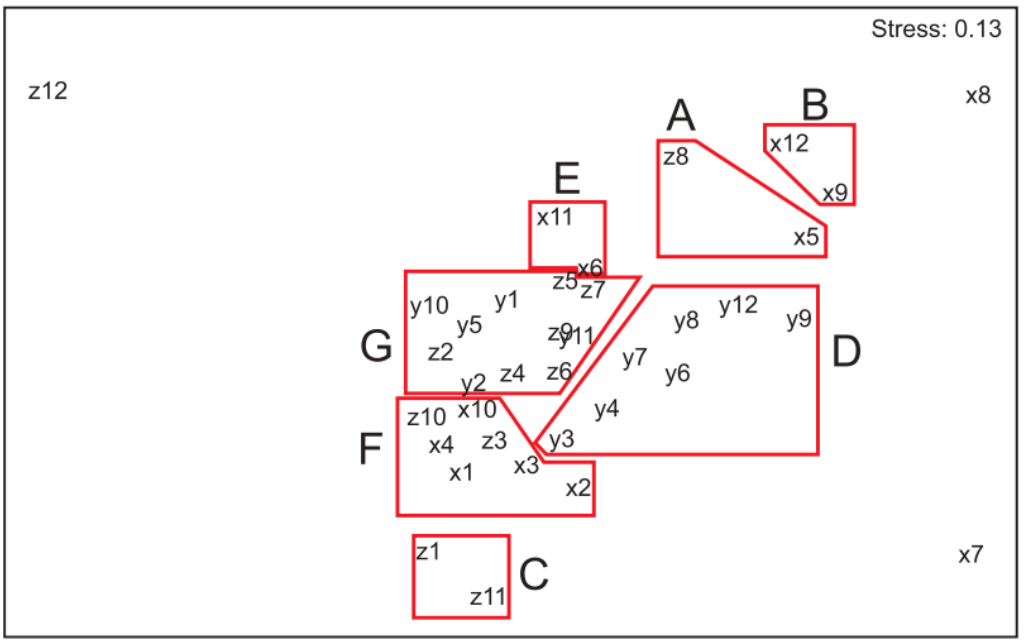

Figure 2

Multidimensional scaling plot of similarity between temporal samples (each association ≥40%); x = 2012, y = 2013, z = 2014

2013 (2110 ind. m^{-2}) was much higher than at the other stations. However, two stations (4 and 9) were represented by the highest density of *F. pupoides*, 2940 ind. m^{-2} and 2130 ind. m^{-2} respectively in 2014 (Figure 3).

Discussion

A total of 133 molluscan species belonging to 58 families were identified in the present study carried out in İskenderun Bay. Gastropoda was the richest class, with 36 families and 94 species, followed by Bivalvia (21 families, 37 species) and Scaphopoda (1 family, 2 species). Among them, *C. gibba, N. pygmaeus* and *T. communis* are known as pollution indicators (Diaz & Rosenberg 1995; Çınar et al. 2006; Moreira et al. 2010). *C. gibba* and *N. pygmaeus* also had a wide distribution in the study area. It is a known fact that *C. gibba* is one of the indicators of anoxic conditions and environment rich in organic matter (Diaz & Rosenberg 1995). Çınar et al. (2006) reported that the species forms large populations (15860 ind. m^{-2}) in the inner part of İzmir Bay (Aegean coast of Turkey), which is the most polluted area of the bay. In the same study, *Nassarius pygmaeus* was also reported as a species forming a dense population in the polluted areas of İzmir Bay. *Turritella communis*, which was encountered only in the samples collected in 2013, is known as a species distributed in semi-polluted waters (Moreira et al. 2010).

The temporal variation of the soft bottom molluscan fauna in İskenderun Bay was found to be somewhat similar to that reported by Cinar et al. (2012) from Mersin Bay (Levantine coast of Turkey), where *B. reticulatum*, *C. diplax*, *C. gibba*, *N. pygmaeus* and *T. communis* were the most abundant species. The authors also reported that in the more polluted stations in Mersin Bay, *C. diplax* and *F. pupoides* were found to form larger populations compared to those of native species such as *C. gibba*, *N. pymaeus* and *T. communis*.

According to Çınar et al. (2012), alien species can affect the composition of the local molluscan fauna in the polluted areas as it was observed in İskenderun Bay where *C. diplax* and *F. pupoides* were the dominant components of the molluscan fauna, and *C. gibba, N. pygmaeus* and *T. communis* did not form dense populations in the region.

Furthermore, *C. gibba, N. pygmaeus, F. pupoides, C. diplax* and *B. reticulatum* which were widely distributed in the sampling area, contributed extensively to the similarity or dissimilarity of the stations in different years.

Gonomurex persicus is one of the alien species reported in the present study, which attracts attention due to its high biomass value. Similarly, in the study

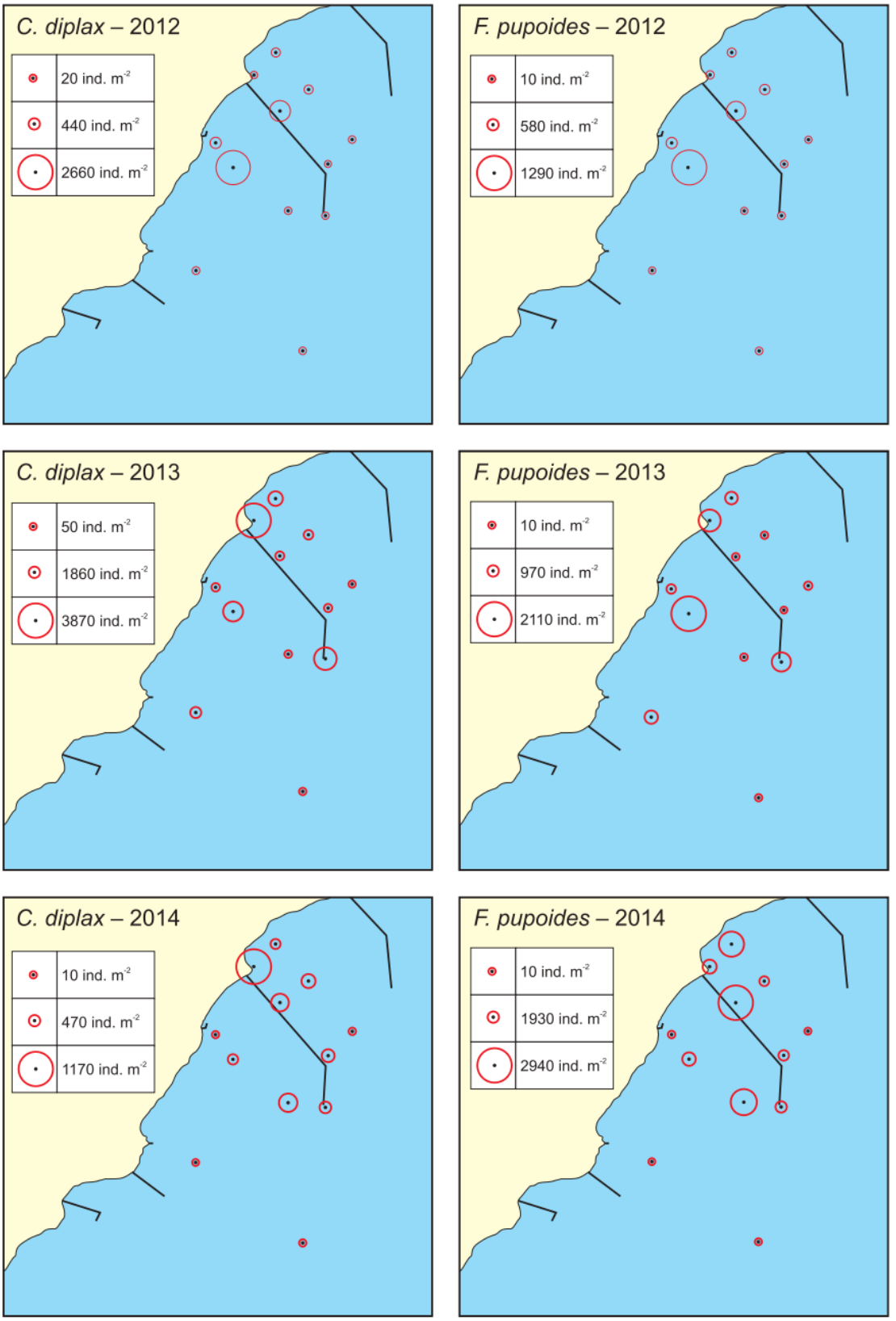

Figure 3

The number of individuals (ind. m^{-2}) of *C. diplax* and *F. pupoides* at the stations in 2012, 2013 and 2014

conducted by Mutlu & Ergev (2008), this large gastropod was the most dominant species of the soft-bottom at a depth from 1 and 10 m, accounting for 97% of the total biomass in Mersin Bay.

The number of species encountered in 2014 was higher compared to 2012 and 2013 in the present study. Ten of the species that caused the increase in the number of species in 2014 were alien species previously known from the area. Although the increase in the total species number in any area could be accepted as an indicator of the biodiversity, the increase in the number of alien species might be considered as a threat to the populations of native species.

This study is the first attempt to explain the temporal variation of the soft-bottom molluscan fauna in the north-western part of İskenderun Bay. Further studies should be carried out, including also deeper stations to better understand the components of the biodiversity and the effect of alien species in the region.

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