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Distribution of Eunicidae (Annelida: Polychaeta) along the Levantine coast of Turkey, with special emphasis on alien species

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Abstract Distributional features of Eunicidae (Annelida, Polychaeta) along the Levantine coast of Turkey were assessed based on data derived from qualitative and quantitative samples collected in various substrata, habitat and depths (0–100 m). The examined material contained 12 species and 4644 individuals belonging to five genera (*Eunice*, *Leodice*, *Lysidice*, *Marphysa* and *Palola*). *Marphysa* was represented by the highest number of species and *Lysidice* by the highest number of individuals in the area. The dominant species were *Lysidice ninetta*, *L. margaritacea* and *Leodice antennata*; the most frequent species were *Leodice antennata*, *Lysidice ninetta* and *L. unicornis* among the stations. The Lessepsian migrants, *Leodice antennata* and *Palola valida*, seem to have been well established and formed dense populations (max. 725 and 100 ind.m^{-2}, respectively) in the area. The distribution of *L. antennata* seems to be related to the total inorganic nitrogen and silica concentrations in the water column. The ratio between alien and native species' abundances increased from the western to the eastern parts of the region.

Keywords Eunicidae · Polychaeta · Ecology · Habitat · Lessepsian migrants · Mediterranean

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Introduction

Eunicid polychaetes occur at various types of biotopes from the mediolittoral zone to abyssal depths of the oceans. However, they prefer living in tropical warm waters, coral reefs and mangroves (Fauchald 1992). Although they are generally actively creeping on bottoms, some species live in parchment-like tubes or bore into limestone or coral reefs, playing a significant role as bio-eroders (Zanol et al. 2007; Veeramuthu et al. 2012). They also live within rhizomes of *Posidonia oceanica* (Linnaeus) Delile, 1813 or on various organisms as commensals or parasites (Martín and Britayev 1998; Rouse and Pleijel 2001; Gambi et al. 2005; Çinar 2013). Some species of Eunicidae are commercially important, because they are used as bait in leisure fishing and as food in aquaculture (Olive 1994; Gambi et al. 1994). Additionally, some species such as *Palola viridis* Gray *in* Stair, 1847 are also consumed as human food, especially in the Samoa and Fiji Islands in the South Pacific Ocean (Schulze 2006).

Eunicidae, the largest family of the order Eunicida, are represented by almost 409 species belonging to nine genera distributed worldwide (WoRMS Editorial Board 2015) and 24 species belonging to six genera in the Mediterranean (authors' database) and 19 species belonging to six genera (*Eunice* Cuvier, 1817; *Euniphysa* Wesenberg-Lund, 1949; *Leodice* Lamarck, 1818; *Lysidice* Lamarck, 1818; *Marphysa* Quatrefages, 1866; and *Palola* Gray *in* Stair, 1847) along the coasts of Turkey (Çinar et al. 2014). The studies on Eunicidae species along the coasts of the Levantine Sea are limited. The most detailed study was performed by Kurt Sahin and Çinar (2009), who reported eunicid species in and around Iskenderun Bay and re-described *Lysidice collaris* Grube, 1870 based on type material. On the coast of Egypt, Fauvel (1937) encountered six eunicid species [*Leodice torquata* (Quatrefages, 1866), *Eunice roussaei* Quatrefages, 1866 (cited

as *E. purpurea* Grube, 1866), *E. vittata* (Delle Chiaje, 1828), *Palola siciliensis* (Grube, 1840), *Marphysa fallax* Marion and Bobretzky, 1875 and *Lysidice ninetta* Audouin and Milne Edwards, 1833]. Fauvel (1955) and Tebble (1959) reported *P. siciliensis* and *Leodice torquata* from the Mediterranean coast of Israel. Three eunicid species [*Leodice harassi* (Audouin and Milne Edwards, 1833), *L. torquata* and *Lysidice ninetta*] were reported from the Lebanese coast by Laubier (1966). Ben-Eliahu (1972, 1976) found six eunicid species along the coasts of Cyprus and Israel. In addition, some eunicid species were also given in species lists of studies performed along the Levantine coasts by Ben-Eliahu (1995), Ergen and Çinar (1997), Ergen et al. (1998), Çinar (2005) and Dorgham et al. (2012). However, the distributional features of eunicid species and the importance of alien eunicid species in benthic communities have not been a subject of study in the area to date.

The area has a quite important status by means of species migration. The Suez Canal has played an important role for the species migration between the Mediterranean and the Red Sea. Almost 48 % of the alien polychaetes in the Mediterranean Sea are Lessepsian migrants (Zenetos et al. 2010). Because of the hydrographic features of the Levantine Sea, the southeastern coast of Turkey is more accessible to alien species that have entered the Mediterranean through the Suez Canal (Çinar et al. 2006a).

The main purpose of the present study is to determine the distribution features of native and alien eunicid species along the northern coast of the Levantine Sea.

Materials and methods

Sampling

A total of 260 samples were collected from different biotopes [macroalgal beds: *Halopteris scoparia* (Linnaeus) Sauvageau, 1904; *Jania rubens* (Linnaeus) J. V. Lamouroux, 1816; *Corallina mediterranea* Areschoug *in* J Agardh, 1852; *Cystoseira crinita* Duby, 1830; and *C. elegans* Sauvageau, 1912; phanerogams: *Posidonia oceanica*, *Cymodocea nodosa* (Ucria) Ascherson, 1870; sponges: *Aplysina aerophoba* (Nardo, 1833), *Sarcotragus foetidus* Schmidt, 1862; mollusc bed: *Brachidontes pharaonis* (Fischer, 1870); rock, mixture of mud and sand] and depths (0–100 m) at 51 stations along the Levantine coast of Turkey in September–October 2005 (Table 1; Fig. 1). Qualitative samples were taken by using dredge, beam and bottom trawls on soft bottoms, and hammer and shovel on rocky substratum without algal cover. Quantitative samples were taken using a quadrate of 20 × 20 cm in dimension on hard bottoms (algal beds, the mussel *Brachidontes pharaonis*) and a van Veen grab (sampling 0.1 m^{-2} surface area) on soft bottoms (muddy and sandy bottoms). Specimens of sponges were randomly sampled and dissected to extract eunicid specimens from the pores and bases of sponges. Samples were first sieved with a 0.5 mm mesh and the retained fauna was put in jars containing 4 % seawater–formalin solution. In the laboratory, the material was sorted according

Table 1 List of the sampling stations and biotopes

	Sampling type	Biotopes	Depth (m)	Number of samples	Stations
Hard substratum	Quantitative	*Brachidontes pharaonis*	0.1–0.3	10	K5, K18, K19, K27, K28, K37
		Jania rubens	0.1–3	41	K1, K5, K10, K11, K17, K20, K23, K24, K26, K27, K30, K33, K35–K38, K40, K44, K46–K48, K50, K51
		Corallina mediterranea	0.1–0.5	36	K18, K19, K23, K24, K26, K27, K29, K31, K33, K40, K44–K46, K48
		Cystoseira crinita and *C. elegans*	0.1–1	23	K6–K8, K36, K38, K44, K46, K50, K53
		Halopteris scoparia	0.1–0.2	9	K27, K30, K48
		Aplysina aerophoba and *Sarcotragus foetidus*	2–3	11	K6, K17, K29, K37, K45, K53
	Qualitative	Rock	0–5	42	K1, K4, K5, K6–K11, K15, K17, K19–K27, K29–K38, K40, K44–K48, K50–K52
Soft substratum	Quantitative	*Posidonia oceanica*	2–9	19	K25, K29, K30, K33, K45, K50, K51
		Cymodocea nodosa	3	13	K25, K31, K37, K44, K53
		Soft substratum (grab)	5–100	27	G1, G14, G15, G18, G23, G24, G27, G29, G34–G38
	Qualitative	Soft substratum (dredge, bottom trawl, beam trawl)	9–100	29	D4, D5, D8–D13, D18, D19, D21, D22, D27–D33, D35–D37, DT3, DT4, BT2, BT7, BT8, BT10, BT11

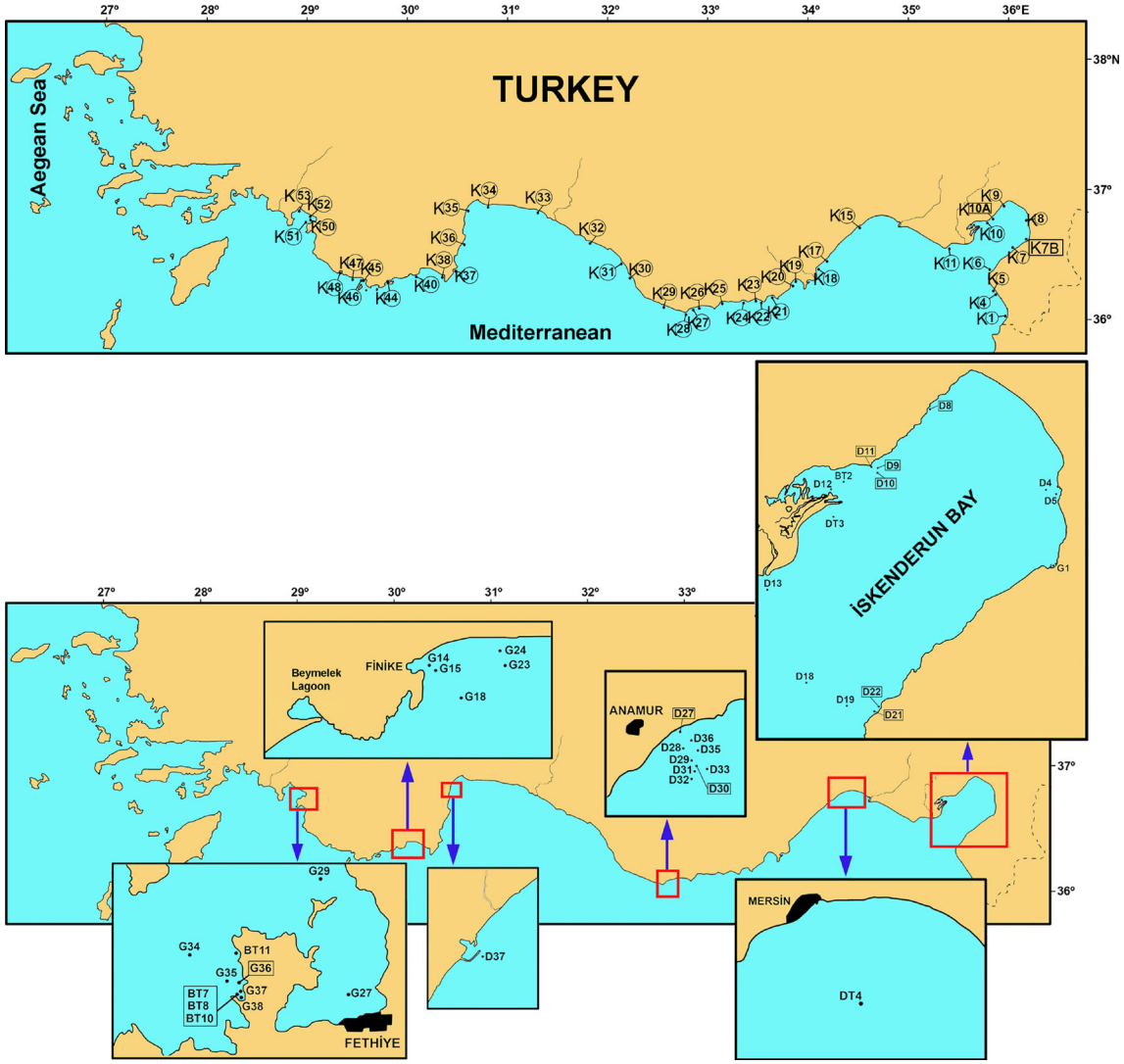

Fig. 1 Map of the sampling stations (*K*: coastal stations, *G*: grab, *D*: dredge, *BT*: beam trawl, *DT*: bottom trawl)

to the major taxonomic groups under a stereomicroscope and preserved in 70 % ethanol. The specimens were identified and counted. Population densities of eunicid species were calculated for quantitative samples only. The population densities (individuals per square metre) of the most common species were calculated at stations and in biotopes along the studied area.

To determine the relationship between environmental variables and species distribution, a bottom water sample was taken by using a Nansen bottle at each station during the sampling period. Temperature and the dissolved oxygen concentration were determined in the field. Water samples for analysing salinity, pH, nitrite, nitrate, ammonium, phosphate phosphorus and silicate were poured into the bottles after prefiltration, frozen and then transferred to the laboratory immediately. Salinity, pH and nutrients were analysed by using the Mohr–Knudsen method, a pH meter and a spectrophotometer, respectively (Parsons et al. 1984).

Data analysis

The Soyer's frequency index (F) was used to determine the frequencies of species in the samples and the results were evaluated as constant (F ≥ 50 %), common (50 % > F ≥ 25 %) and rare (F < 25 %) (Soyer 1970). The dominance index was used to find the dominant species in the study area (Bellan-Santini 1969).

For the multivariate analysis, data obtained from the most common habitats, such as algae and mussel beds, were used to characterise species assemblages and the abiotic factors affecting them. Principal coordinate analysis (PCO) based on the Bray–Curtis similarity was performed to determine the environmental variables principally responsible for structuring eunicid assemblages in benthic habitats. In this analysis, the study area was divided into three parts, the eastern part (including stations K1–K28), the middle part (stations K29–K37) and the western part (stations K38–K53), according to

hydrographical conditions and the importance of alien species in benthic communities (see Çinar and Dagli 2013). All analyses were performed by using the PRIMER v6 package. The materials were deposited in the Museum of the Faculty of Fisheries of Ege University (ESFM), Izmir (Turkey).

Results

Examination of a total of 260 benthic samples yielded 12 species and 4644 individuals belonging to five genera: *Eunice*, *Leodice*, *Lysidice*, *Marphysa* and *Palola* (Tables 2 and 3). Among these, two species, *Leodice antennata* Savigny *in* Lamarck, 1818 and *Palola valida* (Gravier, 1900), are alien species. *Marphysa* was represented by four species (33 % of the total species) and 232 individuals (5 % of the total individuals), *Lysidice* by three species (25 %) and 2696 individuals (58 %) and *Leodice* by two species (17 %) and 1004 individuals (22 %). *Lysidice ninetta* comprised 33 % of the total individuals, followed by *Leodice antennata* (21 %) and *Lysidice margaritacea* Claparède, 1868 (18 %). Among the species, *L. ninetta* formed relatively dense populations on rocks, *Corallina mediterranea* and *Cystoseira* spp. The Lessepsian species *Leodice antennata* was found in all substrata in the area, with high abundances on rocks, *Posidonia* beds and photophilic algae (Tables 2 and 3). Eunicidae species were found at the 0–100 m depth range. The bathymetrical distribution of species is shown in Tables 2 and 3. *Eunice vittata*, *Marphysa bellii* (Audouin and Milne Edwards, 1833) and *Lysidice unicornis* (Grube, 1840) were found at all depths up to 75 m; *Leodice torquata*, *Marphysa fallax*, *Palola siciliensis* and *P. valida* between 0 and 10 m; *Leodice antennata*, *Lysidice margaritacea*, *L. ninetta* and *Marphysa sanguinea* (Montagu, 1813) between 0 and 50 m; *Marphysa cinari* Kurt-Sahin, 2014 only at 100 m depth.

Figure 2 shows the habitat preferences of the eunicid species. Most species were found on rocky bottoms (59.63 % of total individuals). *Lysidice ninetta*, *L. margaritacea* and *Leodice antennata* were the main components of rocky shores, representing 35.27 %, 25.85 % and 22.71 % of the total number of individuals, respectively (Fig. 2). Soft substrata composed of a mixture of mud and sand were also characterised by higher numbers of species and individuals. *Eunice vittata* and *Marphysa bellii* were typical species of soft bottoms. *Eunice vittata* inhabited a variety of soft substratum, such as *Cymodocea nodosa* (max. 25 ind.m^{-2}), *Posidonia oceanica* (max. 275 ind.m^{-2}) and mixture of sand and mud

Table 2 List of eunicid species from the Levantine coast of Turkey with their abundance (%), frequency and dominancy values in biotopes

	Depth (m)	Hard substratum												Soft substratum					D%
		R	F%	Cs	Hs	Jr	Cm	F%	Bp	F%	Aa	Sf	F%	Cn	Po	F%	Ms	F%	
Eunice vittata (Delle-Chiaje, 1828)	0–75	0.5	14.29	–	1.7	–	–	0.91	–	–	54.5	11.1	18.18	10.3	13.8	37.50	39.6	67.86	9.32
Leodice antennata Savigny *in* Lamarck, 1818	0–10	22.7	92.86	17.0	78	51.4	20.3	75.45	29.1	30.00	36.4	22.2	45.45	5.1	42.9	46.88	1.4	10.71	21.55
Leodice torquata (Quatrefages, 1866)	0–3	0.1	4.76	–	–	–	–	–	–	–	–	–	–	–	0.4	3.13	–	–	0.06
Lysidice margaritacea Claparède, 1868	0–50	25.8	57.14	1.6	6.8	6.7	12.2	24.55	65.5	40.00	–	–	–	–	2.0	9.38	1.4	1.79	17.70
Lysidice ninetta Audouin and Milne Edwards, 1833	0–10	35.3	40.48	81.4	10.2	32.4	52.5	43.64	–	–	–	22.2	18.18	–	13.4	31.25	3.6	10.71	32.70
Lysidice unicornis (Grube, 1840)	0–75	5.1	59.52	–	3.4	8.6	11.4	13.64	3.6	20.00	9.1	–	9.09	79.5	19.4	75.00	11.5	32.14	7.64
Marphysa bellii Audouin and Milne Edwards, 1833	0–75	–	–	–	–	–	–	–	–	–	–	–	–	2.6	0.4	6.25	36.0	41.07	3.08
Marphysa cinari Kurt-Sahin, 2014	100	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	0.7	1.79	0.02
Marphysa fallax Marion and Bobretzky, 1875	0–10	0.8	4.76	–	–	–	1.0	1.82	–	–	–	11.1	9.09	–	7.7	18.75	5.8	17.86	1.70
Marphysa sanguinea (Montagu, 1815)	0–3	0.3	2.38	–	–	–	–	–	–	–	–	–	–	2.6	–	3.13	1	1.79	0.19
Palola siciliensis (Grube, 1840)	0–7	0.9	26.19	–	–	1.0	–	0.91	–	–	–	22.2	18.18	–	–	–	–	–	0.58
Palola valida (Gravier, 1900)	0–7	8.7	66.67	–	–	–	2.6	6.36	1.8	10.00	–	11.1	9.09	–	–	–	–	–	5.45

R: rock; Cs: *Cystoseira* spp.; Hs: *Halopteris scoparia*; Jr: *Jania rubens*; Cm: *Corallina mediterranea*; Bp: *Brachidontes pharaonis*; Aa: *Aplysina aerophoba*; Sf: *Sarcotragus foetidus*; Cn: *Cymodocea nodosa*; Po: *Posidonia oceanica*; Ms: mixture of mud and sand; F: frequency; D: total dominance

Table 3 List of eunicid species from the Levantine coast of Turkey with their maximum number of individuals (m^{-2}), frequency and dominancy values in biotopes based on quantitative samples

	Depth (m)	Hard substratum												Soft substratum			D%
		Cs	Hs	Jr	Cm	F%	Bp	F%	Aa	Sf	F%	Cn	Po	F%	Ms	F%	
Eunice vittata (Delle-Chiaje, 1828)	0–75	–	25	–	–	0.91	–	–	150	25	18.18	25	275	37.50	200	67.86	7.42
Leodice antennata Savigny *in* Lamarck, 1818	0–10	125	475	125	450	75.45	350	30.00	50	25	45.45	25	725	46.88	25	10.71	26.65
Leodice torquata (Quatrefages, 1866)	0–3	–	–	–	–	–	–	–	–	–	–	–	25	3.13	–	–	0.07
Lysidice margaritacea Claparède, 1868	0–50	50	75	50	200	24.55	325	40.00	–	–	–	–	50	9.38	50	1.79	7.78
Lysidice ninetta Audouin and Milne Edwards, 1833	0–10	1350	75	200	1150	43.64	–	–	–	25	18.18	–	150	31.25	50	10.71	39.35
Lysidice unicornis (Grube, 1840)	0–75	–	25	125	325	13.64	25	20.00	25	–	9.09	200	300	75.00	75	32.14	11.23
Marphysa bellii Audouin and Milne Edwards, 1833	0–75	–	–	–	–	–	–	–	–	–	–	25	25	6.25	450	41.07	3.89
Marphysa cinari Kurt-Sahin, 2014	100	–	–	–	–	–	–	–	–	–	–	–	–	–	25	1.79	0.07
Marphysa fallax Marion and Bobretzky, 1875	0–10	–	–	–	75	1.82	–	–	–	25	9.09	–	250	18.75	150	17.86	2.35
Marphysa sanguinea (Montagu, 1815)	0–3	–	–	–	–	–	–	–	–	–	–	25	–	3.13	–	–	0.07
Palola siciliensis (Grube, 1840)	0–7	–	–	25	–	0.91	–	–	–	25	18.18	–	–	–	–	–	0.22
Palola valida (Gravier, 1900)	0–7	–	–	–	100	6.36	25	10.00	–	25	9.09	–	–	–	–	–	0.88

Cs: *Cystoseira* spp.; Hs: *Halopteris scoparia*; Jr: *Jania rubens*; Cm: *Corallina mediterranea*; Bp: *Brachidontes pharaonis*; Aa: *Aplysina aerophoba*; Sf: *Sarcotragus foetidus*; Cn: *Cymodocea nodosa*; Po: *Posidonia oceanica*; Ms: mixture of mud and sand; F: frequency; D: total dominance

(max. 80 ind.m^{-2}) (Fig. 2). *Marphysa bellii* was found only in soft substrata (max. 180 ind.m^{-2}). No species of *Palola* occurred in soft substrata and *M. cinari* was only found in mud (Fig. 2). Photophilic algae had a diversified eunicid fauna. Among algae, *Corallina mediterranea* had the highest number of species (six species), followed by *Jania rubens* and *Halopteris scoparia* (five species). *Cystoseira elegans* had the maximum density of eunicids (1425 ind.m^{-2}), followed by *C. mediterranea* (1300 ind.m^{-2}) and *P. oceanica* (925 ind.m^{-2}). The most dominant species on *C. mediterranea* and *Cystoseira elegans* was *Lysidice ninetta* (1150 ind.m^{-2} and 1425 ind.m^{-2}, respectively). *Leodice antennata* was dominant on *P. oceanica* (725 ind.m^{-2}) and *H. scoparia* (475 ind.m^{-2}). The mussel *Brachidontes pharaonis* hosted four eunicid species (*Leodice antennata*, *Lysidice margaritacea*, *L. unicornis* and *Palola valida*) and had a maximum eunicid density of 350 ind.m^{-2}. The sponges *Aplysina aerophoba* and *Sarcotragus foetidus* were occupied by seven eunicid species. On rhizomes and leaves of phanerogams, nine eunicid species were identified. Among the phanerogams, *P. oceanica* had the highest species richness (eight species) and population density (925 ind.m^{-2}).

The Lessepsian migrant *Leodice antennata* was the most common species along the Turkish coast of the Levantine Sea (Fig. 3). This species occurred in both hard and soft substrata. The maximum density of *L. antennata* (725 ind.m^{-2}) was calculated on *Posidonia oceanica* at station K25. The other common species was *Lysidice unicornis*, which was found in all biotopes sampled. This species formed dense populations at stations K29 (325 ind.m^{-2}) and K33 (300 ind.m^{-2}). The highest population density of *L. margaritacea* (325 ind.m^{-2}) was found on the Lessepsian mytilid species *Brachidontes pharaonis* at station K19. *Lysidice ninetta* dominated the facies of *Cystoseira* spp. (1350 ind.m^{-2}) collected at station K44 (Fig. 3). *Eunice vittata* is a typical soft bottom species of the area and had a maximum density of 80 ind.m^{-2} in Fethiye Bay.

A clear pattern between the environmental variables and the eunicid assemblages was evident (Fig. 4a, b). The algae and mussel samples were grouped across the ordination planes according to spatial scales of the study area. It seems that different community structures occurred in the eastern, middle and western parts of the study area, and the sea-surface temperature of stations, the biomass of the habitats and the nutrient concentrations were the main factors influencing the species assemblages. The mean sea-surface temperature was around 28.2 °C in the eastern part (including stations K1–K28), 26.4 °C in the middle part (stations K29–K37) and 25.2 °C in the western part (stations K38–K53). The first axis of the PCO for samples explained 36 % of the total variation, while the second axis explained 23.9 %. A clear distinction was evident in the ordination graph between the eunicid assemblages of *Jania rubens* in the western and eastern parts of the study area. This pattern was also obvious in the species assemblages of *Cystoseira* spp. The species responsible for

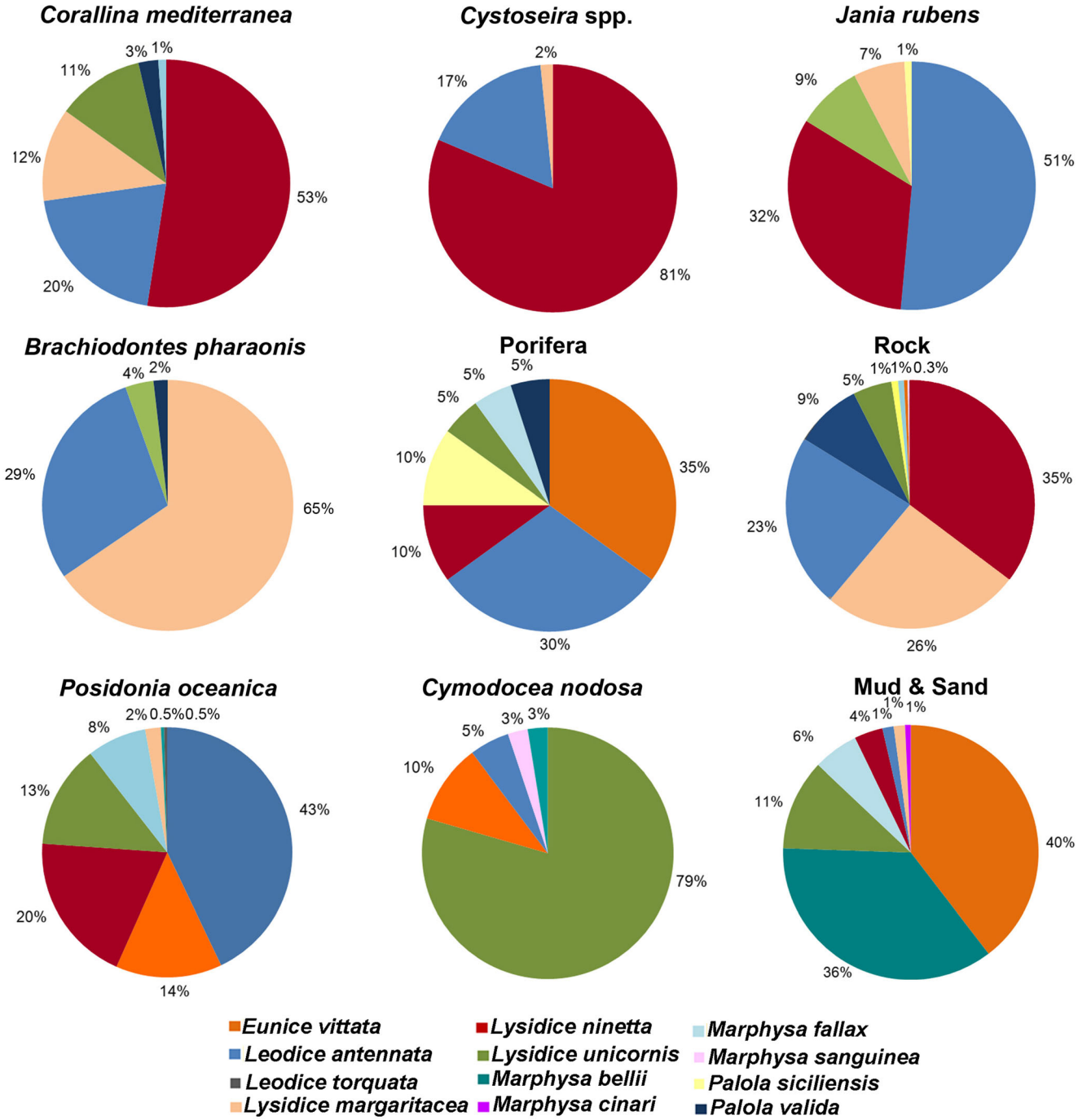

Fig. 2 The habitat preferences of the eunicid species

the grouping of samples are indicated in Fig. 4b. The Lessepsian migrant *Leodice antennata* particularly dominated algal facies in the eastern part of the study area, but *Lysidice ninetta* preferred algal facies collected from the western part of the study area. *Palola siciliensis*, *P. valida* and *Lysidice unicornis* were exclusively found on the alga *Corallina mediterranea* in the middle part of the study area. The distribution of *Leodice antennata* showed a correlation with the total inorganic nitrogen and silicate.

Leodice antennata and *Palola valida* are the Lessepsian migrants that seem to have been well established on the Levantine coast of Turkey. They form dense populations on rocky shores, especially in Iskenderun Bay, where these two species comprised almost 100 % of the total eunicid individuals (Fig. 5). The importance of alien eunicid species on benthic communities was found to increase from the western to the eastern parts of the area. *Leodice antennata* was also found in all biotopes and its population was largely dominated by

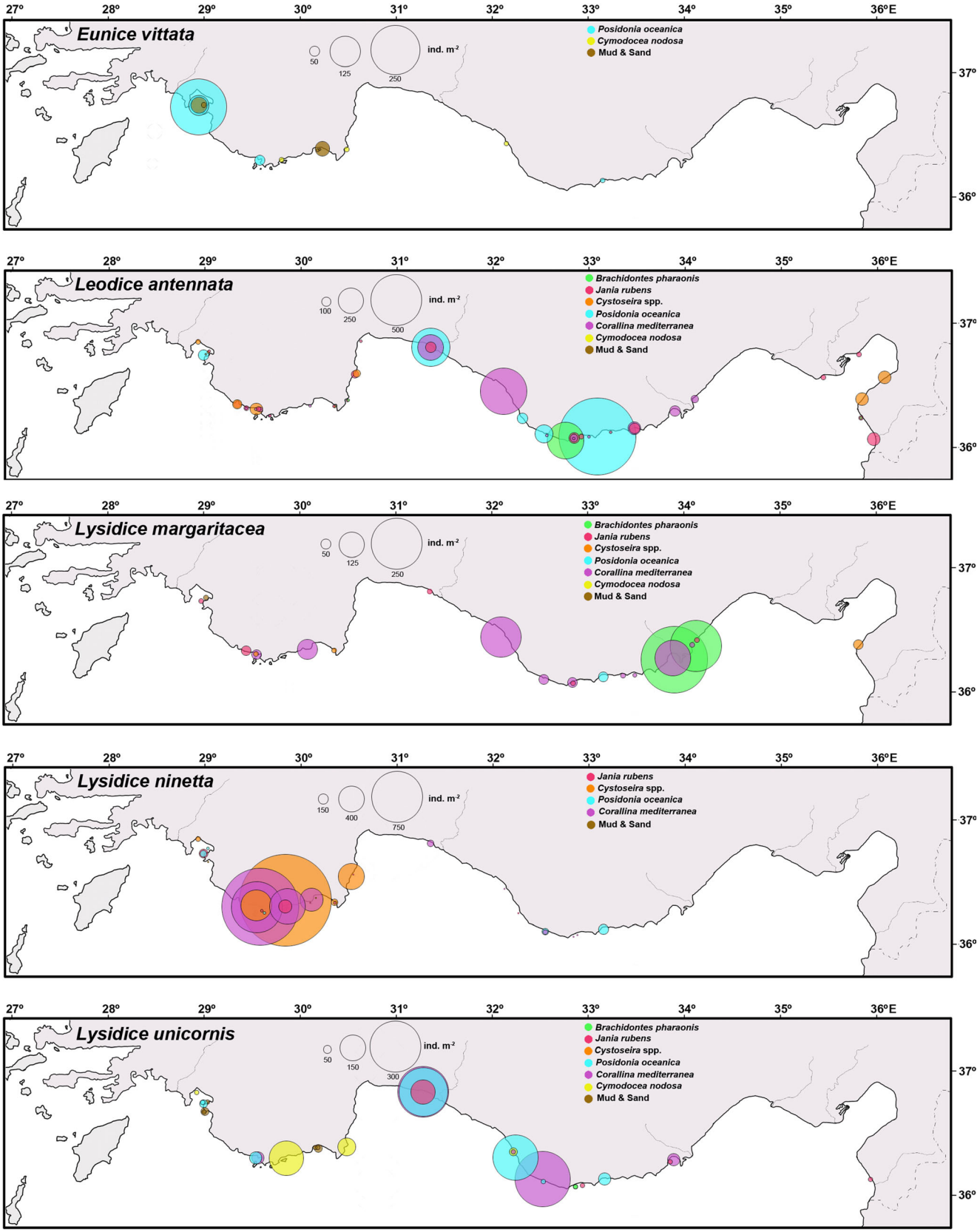

Fig. 3 The maximum population densities of the most common species at stations and in biotopes along the studied area

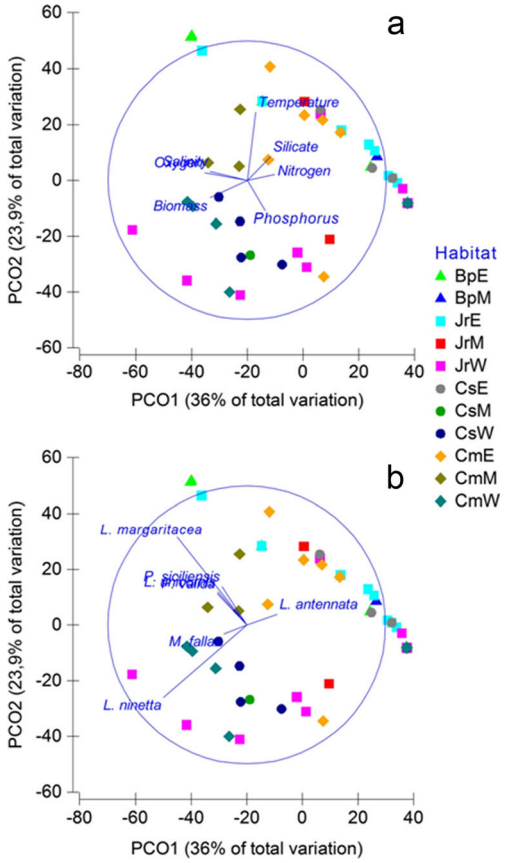

Fig. 4 Principal coordinate analysis (PCO) ordination plots for: **a** environmental variables and **b** faunal assemblages for the quantitative hard substratum samples (*Bp*: *Brachidontes pharaonis*; *Jr*: *Jania rubens*; *Cs*: *Cystoseira* spp.; *Cm*: *Corallina mediterranea*) (*E*: eastern, *M*: middle; *W*: western parts of the study area)

juvenile individuals, suggesting that its reproduction month took place in the beginning of September or just before September. The other Lessepsian species, *P. valida*, was only found on hard substrata.

Discussion

A total of 12 species belonging to six genera were found on various soft and hard substrata on the Levantine coast of Turkey. Among them, the Lessepsian migrant species *Leodice antennata* formed dense populations at some stations and comprised 70 % of the total number of individuals of *Leodice* and 28 % of the total eunicid populations in the area. This species was previously found in Iskenderun Bay by Kurt Sahin and Çinar (2009). The species was first reported from the Italian coast within the Mediterranean Sea (Cantone et al. 1991). *Eunice vittata*, which is a native species, is a typical soft bottom component of the area and formed dense populations only in the western part of the area, which might indicate its possible competition with the invasive species *L. antennata*, which was abundant in the eastern part of the area. The other Lessepsian species, *Palola valida*, which was originally described from the Red Sea (Gravier 1900), was more frequent and dominant than the native congener, *P. siciliensis*. *Palola valida* comprised 90 % of the total number of individuals of *Palola* in the area.

Eunicids generally prefer the shallow water benthic environments in the Turkish coast of Levantine Sea. The maximum number of species (11 species) was encountered at 0–10 m depths. Fauchald (1992) and Rouse and Pleijel (2001) noticed that hard substrata such as rocks and coral reefs in shallow waters are known to be the preferred habitats for the settlement of eunicids. Among eunicids, *Eunice vittata* and *Marphysa bellii* were typical soft bottom components in the area and our findings parallel with the species were reported from soft substratum from different regions (Pettibone 1963; Campoy 1982; George and Hartmann-Schröder 1985; Simboura et al. 1995; Çinar 2005). *Palola siciliensis* and *P. valida* were found only on hard substratum in the present study and in numerous studies carried out to date (Miura 1977; Alòs et al. 1981; Campoy 1982; Somaschini et al. 1994; Giangrande et al. 2003; Çinar 2005). However, only one individual of *P. siciliensis* was reported on soft substratum from the coast of Cyprus by Çinar (2005). This record may be considered to be random because of sampling a kind of hard substratum (shell fragment, stone etc.) embedded in the soft substratum. Various studies were focused on eunicid polychaetes associated with *Posidonia* meadows and five eunicid species (*Lysidice collaris*, *L. ninetta*, *L. unicornis*, *L. margaritacea* and *Marphysa fallax*) were known to live in

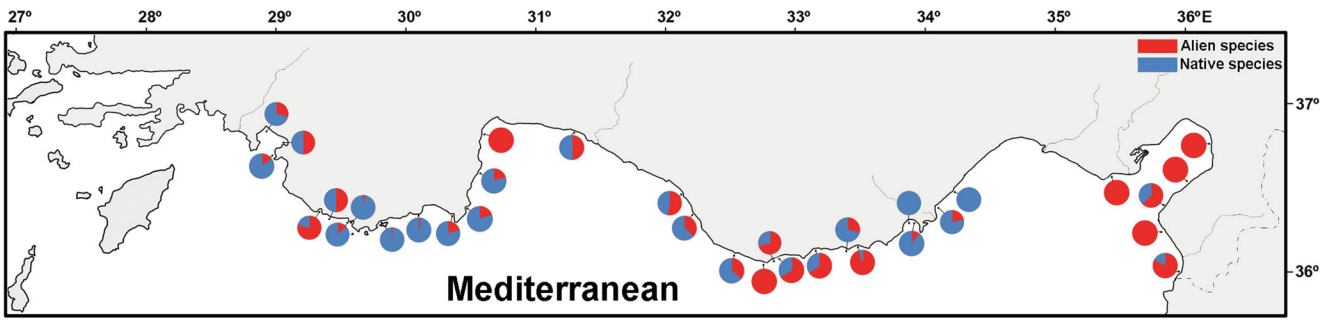

Fig. 5 The relative percentages of alien and native eunicid species populations at coastal stations

rhizomes of *Posidonia oceanica* as borers (Alòs 1984; Sardà 1991; Guidetti et al. 1997; Gambi and Cafiero 2001; Gambi et al. 2005; Çinar 2013). Guidetti et al. (1997) reported three species (*Lysidice collaris*, *L. ninetta* and *Nematonereis unicornis*) and Gambi et al. (2005) found four boring eunicids (*Lysidice collaris*, *L. ninetta*, *Marphysa fallax* and *Nematonereis unicornis*). Çinar (2013) mentioned that *L. collaris* was noted to be the most frequent borer species, while *M. fallax* was very rare according to Gambi et al. (2000). *Lysidice collaris* prefers shallow water (<15 m), whereas *L. ninetta* dominates deep waters (>20 m) (Gambi 2002). These species inhabit *Posidonia oceanica* meadows under different environmental situations, including depth range, bed typology, shoot density and potential human influence (Gambi et al. 2005). Iannotta et al. (2009) also indicated that *L. ninetta* was a complex of species which densely occurred on the hard substratum in the Mediterranean Sea. In the present study, eight eunicid species were found in *P. oceanica* samples. The dominant species were *Leodice antennata* and *Lysidice unicornis*. The species *Lysidice ninetta*, *L. unicornis*, *L. margaritacea* and *Marphysa fallax* were found as borers in rhizomes of *Posidonia oceanica*. The other eunicid species lived around rhizomes, leaves or sediment as vagile forms.

The Lessepsian eunicid species *Lysidice collaris*, which was widely distributed in the Aegean Sea and the western Mediterranean (Martín 1987; Sardà 1991; Çinar and Ergen 1998, 1999; Çinar et al. 1998), was not found in the present study. Because of its wide distribution pattern in the Mediterranean, *L. collaris* was considered as a questionable alien species in several papers (Ergen et al. 2001; Çinar et al. 2005; Zenetos et al. 2005). Çinar (2005) and Kurt Sahin and Çinar (2009) mentioned that this species closely resembles *L. margaritacea*, which is endemic to the Mediterranean, and the presence of *L. collaris* in the Mediterranean is questioned. Martín (1987) and Sardà (1991) also pointed out that diagnostic features of the specimens of *Lysidice* collected from the western Mediterranean coincided with the syntypes of *L. collaris*. The presence of *L. collaris* in the western Mediterranean was proven, but the reports in the eastern Mediterranean should be re-checked in order to clarify whether they belong to *L. collaris* or *L. margaritacea*.

The environmental factors affecting the distributional patterns of alien species (particularly Lessepsian invaders) were studied by Cinar et al. (2012) and Çinar and Bakir (2014) in the Mediterranean Sea. According to them, the main abiotic factors drastically affecting the abundance of the alien species in soft substrata were depth, clay percentage of sediment and organic carbon in sediment. In Izmir Bay (Aegean Sea), where the polluted part of the bay was densely colonised by ship-mediated species, the nutrient concentrations in the water column and pH were the factors significantly affecting alien species' distributional patterns in soft (Çinar et al. 2006b) and hard bottom (mussel bed) (Çinar et al. 2008) habitats. In the present study, the total inorganic nitrogen and silica concentrations in the water column had impacts on the distribution of *Leodice antennata*.

The present study highlights the distribution and habitat preferences of the eunicid species in the shallow water of the Levantine coast of Turkey, where no detailed ecological study on this family had been undertaken to date. In the present study, a density value of eunicids per their habitats is given for the first time from the Levantine coast of Turkey. The diversity and ecological aspects of the eunicid fauna in the area will be better achieved if benthic studies are extended to include coralligenous and deep sea habitats.

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