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RESEARCH PAPER

Rissooidea Species Distributed along the Turkish Levantine Coast

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Abstract

The present study was performed to determine the taxonomical and ecological features of Rissooidea species distributed along the Turkish Levantine coast. The investigated material was collected within the various research projects conducted in the area between the years 1997 and 2011. As a result of the faunistic analysis of the benthic samples taken from various biotopes at depths between 0 and 1302 m in 85 stations, revealed 44 Rissooidea species and 7066 specimens belonging to 7 families (Rissoidae, Barleeidae, Caecidae, Hydrobiidae, Iravadiidae, Tornidae, and Truncatellidae). Among the identified species, *Obtusella macilenta* (Monterosato, 1880) and *Alvania beanii* (Hanley in Thorpe, 1844) are new records for the Levantine coast of Turkey. Most of the Rissooidea species (38 species) were found at depths down to 100 m, however, *Alvania beanii*, *Alvania testae*, *Setia turriculata*, *Hyala vitrea*, *Obtusella macilenta* and *Benthonella tenella* were sampled at depths up to 200 m or more. Among the determined taxa, a small number of species (*Rissoa similis*, *Pusillina radiata* and *Ecrobia ventrosa*) were encountered at rocky and mussel biotopes, while the remaining ones were encountered in soft substrata.

In the present study, various statistical analyses on the ecological and distributional characteristics of the determined species were also provided.

Keywords: Rissooidea, Mollusca, Levantine Sea, Turkey, ecology, distribution.

Türkiye' nin Levantin Denizi Kıyılarında Dağılım Gösteren Rissooidea Türleri

Özet

Bu çalışma Türkiye'nin Levantin Denizi kıyılarında dağılım gösteren Rissooidea türlerinin taksonomik ve ekolojik özelliklerini belirlemek amacıyla gerçekleştirilmiştir. İncelenen materyal, 1997 ve 2011 yılları arasında bölgede yapılan farklı araştırma projelerinden elde edilmiştir. 0-1302 m derinlik aralığında çeşitli biyotoplara sahip 85 istasyondan alınan bentik örneklerin faunistik analizleri sonucunda, 7 familyaya ait (Rissoidae, Barleeidae, Caecidae, Hydrobiidae, Iravadiidae, Tornidae ve Truncatellidae) 44 tür ve 7066 birey tespit edilmiştir. Saptanan türlerden *Obtusella macilenta* (Monterosato, 1880) ve *Alvania beanii* (Hanley in Thorpe, 1844) Türkiye'nin Levantin Denizi kıyıları için yeni kayıttır. Rissooidea türlerinin çoğu (38 tür) 100 m'nin altındaki derinliklerde saptanmış olmasına karşın *Alvania beanii*, *Alvania testae*, *Setia turriculata*, *Hyala vitrea*, *Obtusella macilenta* ve *Benthonella tenella* 200 m ve üzeri derinliklerden örneklenmiştir. Az sayıda tür (*Rissoa similis*, *Pusillina radiata* and *Ecrobia ventrosa*) kayalık ve midye biyotoplarında rastlanırken diğer türler yumuşak substratumda saptanmışlardır.

Bu çalışmada saptanan türlerin, ayrıca ekolojik ve dağılım özellikleri çeşitli istatiksel yöntemlerle incelenmiştir.

Anahtar Kelimeler: Rissooidea, Mollusca, Levantin Denizi, Türkiye, ekoloji, dağılım.

Introduction

Rissooidea is an important taxon within the class Gastropoda represented by 10 families, 51 genera and 375 species along the European coasts, of which the family Rissoidae is the richest one including 28 genera and 318 species (CLEMAM). The rissooids are mainly marine living organisms, although they can also be encountered in brackish and freshwater biotopes, as well as in terrestrial (Assimineidae) environments (Fretter and Graham, 1978). They consist an important component of the food chain being nourishment to the other benthic invertebrates, birds and demersal fishes (Warén, 1996).

The rissooids are distributed in various depths and biotopes. Most of them inhabit littoral biotopes, although some of them, i. e., *Alvania cimicoides* (Forbes, 1844), *Benthonella tenella* (Jeffreys, 1869), are distributed down to bathyal and abyssal depths (Bouchet and Warén, 1993).

Numerous studies have been carried out on the taxonomy, ecology and distribution of the Rissooidea representatives, both in the Mediterranean Sea and eastern Atlantic Ocean (e. g., Aartsen, 1975, 1977; Aartsen and Verduin, 1978; Fretter and Graham, 1978; Verduin, 1982, 1984; Ponder, 1985; Gofas, 2007, 2010; Arconada *et al.*, 2007; Delongueville and Scaillet, 2014). Among the above mentioned works, the studies by Verduin (1976, 1982, 1984, 1985, 1986), Fretter and Graham (1978), Ponder (1985) and Arconada *et al.* (2007), including detailed information on the rissooid species, can be numbered among the fundamental studies on the subject. Despite numerous studies performed on Rissooidea species, the knowledge on the eastern Mediterranean rissooid taxa is insufficient as it was indicated by Aartsen *et al.* (1998), Tisselli and Giunchi (2013), Ovalis and Mifsud (2014), although in some general studies performed in the area (e.g., Forbes, 1844; Oberling 1960-1962; Kocataş, 1978; Bitlis *et al.*, 2010) were listed several species of different families. Among the last mentioned authors, Tisselli and Giunchi (2013) described two new species of the genus *Alvania* (*A. bozcaadaensis* and *A. campanii*) from the Bozcaada Island (Turkish Aegean coast), whereas Ovalis and Mifsud (2014) reported the alien rissooid *Caecum sepimentum* found at Taşucu (Levantine coast of Turkey). According to the studies performed along the Turkish Levantine coast to the present day, totally 62 rissooid species have been registered (Öztürk *et al.*, 2014).

The present study aims to improve the knowledge on the rissooid species distributed along the Turkish Levantine coast, with some additional notes on their ecology and distribution.

Materials and Methods

The Rissooidea specimens examined in the present study were collected during various cruises or research projects held along the Turkish Levantine coast between 1997 and 2011. The samples were taken from 85 stations at depths varying between 0 and 1302 m. The greater part of the material was sampled within the project 104 Y 065 supported by the Scientific and Technological Research Council of Turkey (TUBITAK) (Figure 1). Quantitative samples were collected by using a quadrat frame (20X20 cm) and a van Veen Grap (sampling an area of 0.1 m^2), and three replicates were taken at each station at depths between 0 and 200 m. Qualitative samples were collected by using a dredge, beam trawl, core, and snorkelling or by scuba diving at depths ranging between 0 and 1302 m. CTD bottle was used to take bottom-water samples at each grab and quadrat stations. The temperature and salinity of the water were measured with YSI 30 SCT and the dissolved oxygen concentration was determined by YSI 55 oxygen meter in the field. pH and nutrients (nitrite, nitrate, ammonia, phosphate phosphorus and silica) of the samples were determined with 420 A pH meter and spectronic 21 spectrophotometer in the laboratory (Parsons *et al.*, 1984).

Benthic materials were sifted through a 0.5 mm mesh size and fixed with 4% formalin in the field. Afterwards, the samples were sorted according to major taxonomic groups under a stereomicroscope and preserved in 70% ethanol in the laboratory, and the Rissooidea specimens were separated from the other taxa, identified at species level and counted. Check List of European Marine Mollusca (CLEMAM) was taken into account for the classification of Rissooidea species encountered in the present study.

Some shell characteristics of the Rissooids, such as total height (H) with ± standard errors, mean diameter (D) with ± standard errors, mean height (h) of the last whorl with ± standard errors and maximum values of each species were calculated. The dimensions for each species are given in the following order: HxD-h mm [… mm].

Some ecological characteristics, such as the number of stations in which the species were found, the number of individual of each species, depth range, biotope, and some shell features of the identified species are also given (Table 1).

The Bellan-Santini's dominance index (Bellan-Santini, 1969) and Soyer's frequency index (Soyer, 1970) of the rissooids were calculated in the sampled biotopes. According to the biotopes, the relation between the environmental parameters and the species encountered in the study area were analysed by using the PRIMER package software (Clarke and Warwick, 2001).

The examined specimens of each species, with individual catalogue numbers, have been deposited in the museum collections of the Faculty of Fisheries (ESFM), Ege University (İzmir-Turkey).

Results

Faunistic Data

Faunistic analysis of the material collected along the Turkish Levantine coast between 1997 and 2011 revealed 44 Rissooidea species belonging to 16 genera and 7 families (Rissoidae, Barleeidae, Caecidae, Hydrobiidae, Iravadiidae, Tornidae and Truncatellidae) (Table 1, Figure 2, 3). Among the identified species, *Obtusella macilenta* (Figure 4) and *Alvania beanii* (Figure 5), are here being reported for the first time from the Turkish Levantine coast.

The majority of the identified 44 species belong to the family Rissoidae (35 species), following by the

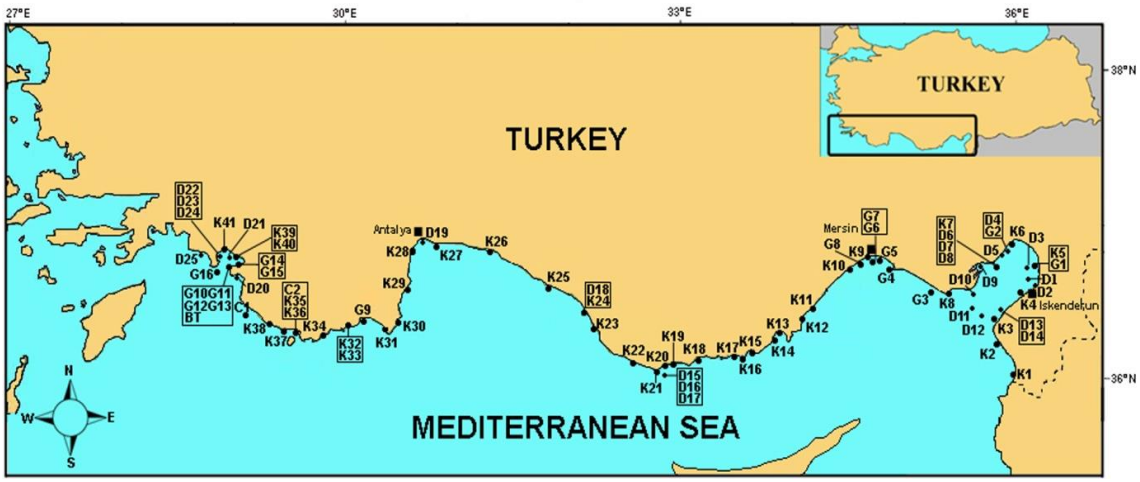

Figure 1. Map of the sampling stations: G1: 36º43'19"N-36º09'30"E; G2: 36º51'08"N-35º55'42"E; G3: 36°33'59"N-35°07'59"E; G4: 36°43'33"N-34°52'11"E; G5: 36º48'22"N-34º41'38"E; G6: 36º46'40"N-34º39'39"E; G7: 36°46'24"N-34°40'13"E; G8: 36°44'30"N-34°34'59"E; G9: 36º17'46"N-30º09'18"E; G10: 36º38'56"N-29º03'38"E; G11: 36º37'56"N-29º04'31"E; G12: 36º37'47"N-29º04'39"E; G13: 36º37'44"N-29º04'39"E; G14: 36º37'46"N-29º06'32"E; G15: 36º37'48"N-29º06'30"E; G16: 36º38'28"N-29º02'37"E; K1: 36º00'36"N-35º58'34"E; K2: 36º08'30"N-35º54'30"E; K3: 36º19'30"N-35º47'00"E; K4: 36º31'36"N-36º02'03"E; K5: 36º45'40"N-36º11'58"E; K6: 36º54'22"N-35º58'05"E; K7: 36º45'59"N-35º47'18"E; K8: 36º33'20"N-35º22'44"E; K9:36º46'55"N-34º36'45"E; K10: 36º42'15"N-34º28'00"E; K11: 36º28'42"N-34º10'21"E; K12: 36º26'22"N-34º07'02"E; K13: 36º18'51"N-33º51'47"E; K14: 36º17'24"N-33º50'10"E; K15: 36º11'31"N-33º38'28"E; K16: 36º08'17"N-33º32'53"E; K17: 36º09'35"N-33º27'33"E; K18: 36º08'22"N-33º09'43"E; K19: 36º05'05"N-32º54'03"E; K20: 36º01'17"N-32º48'14"E; K21: 36º04'13"N-32º52'00"E; K22: 36º06'03"N-32º33'37"E; K23: 36º19'16"N-32º14'07"E; K24: 36º25'59"N-32º08'52"E; K25: 36º35'48"N-31º49'34"E; K26: 36º48'50"N-31º18'47"E; K27: 36º50'25"N-30º48'30"E; K28: 36º47'35"N-30º34'31"E; K29: 36º31'37"N-30º33'08"E; K30: 36º17'53"N-30º28'20"E; K31: 36º16'32"N-30º24'15"E; K32: 36º16'15"N-30º03'03"E; K33: 36º15'43"N-30º04'07"E; K34: 36º11'26"N-29º50'51"E; K35: 36º12'06"N-29º37'30"E; K36: 36º12'03"N-29º37'30"E; K37: 36º12'44"N-29º30'49"E; K38: 36º15'47"N-29º24'45"E; K39: 36º38'40"N-29º05'30"E; K40: 36º38'38"N-29º04'36"E; K41: 36º44'20"N-28º55'43"E; D1: 36º37'34"N-36º08'44"E; D2: 36º36'37"N-36º10'51"E; D3: 36º43'31"N-36º10'02"E; D4a:36º51'35"N-35º54'45"E; D4b: 36º52'10"N-35º55'07"E; D4c: 36º52'23"N-35º55'25"E; D4d: 36º51'52"N-35º55'28"E; D4e: 36º51'24"N-35º56'00"E; D4f: 36º51'22"N-35º54'57"E; D4g: 36º50'27"N-35º54'32"E; D5a: 36º49'49"N-35º52'57"E; D5b: 36º50'14"N-35º53'31"E; D5c: 36º49'37"N-35º53'09"E; D5d: 36º50'03"N-35º53'44"E; D5e: 36º49'29"N-35º53'21"E; D5f: 36º49'34"N-35º53'32"E; D5g: 36º49'42"N-35º53'46"E; D5h: 36º49'51"N-35º53'57"E; D6: 36º45'58"N-35º48'18"E; D7: 36º45'39"N-35º48'28"E; D8: 36º46'00"N-35º47'45"E; D9: 36º43'36"N-35º42'44"E; D10: 36º30'12"N-35º36'23"E; D11: 36º27'24"N-35º35'14"E; D12: 36º23'37"N-35º39'25"E; D13: 36º20'07"N-35º46'56"E; D14: 36º20'57"N-35º48'43"E; D15: 36º02'02"N-32º53'59"E; D16: 36º02'31"N-32º54'54"E; D17: 36º02'55"N-32º53'43"E; D18: 36º25'36"N-32º08'36"E; D19: 36º52'58"N-30º41'30"E; D20: 36º32'23"N-29º03'13"E; D21a-b: 36º39'40"N-29º03'03"E; D22: 36º39'50"N-28º55'37"E; D23: 38º38'07"N-28º52'20"E; D24: 36º41'28"N-28º52'26"E; D25: 36º41'02"N-28º46'30"E; BT: 36º37'44"N-29º04'39"E; C1: 36º16'45"N-29º14'25"E; C2: 36º11'12"N-29º37'20"E.

family Tornidae (3 species), Caecidae (2 species), Barleeidae (1 species), Hydrobiidae (1 species), Iravadiidae (1 species) and Truncatellidae (1 species) respectively. Of the determined genera, the genus *Alvania* is represented by the highest number of species (14 species), pursued by the genus *Rissoa* (8 species), *Pusillina* (5 species), *Setia*, *Rissoina*, *Caecum* and *Tornus* (2 species), and the other 9 genera (*Benthonella*, *Crisilla*, *Manzonia*, *Obtusella*, *Barleeia*, *Ecrobia*, *Hyala*, *Circulus* and *Truncatella*) by a single species only.

***Obtusella macilenta* (Monterosato, 1880)** (Figure 4.)

Setia macilenta Monterosato, 1880.

Cingula macilenta; Aartsen and Verduin, 1982: 128, figure 1; Verduin, 1984: 57, fig. 22, 71; Aartsen *et al.*, 1989: 65.

Obtusella macilenta; Amati, 1986: 59-60, figure 3-5; Bouchet and Warén, 1993: 694, figure 1628-1630, 1634; Gianuzzi-Savelli *et al.*, 1997: 86, figure 298-301; Peñas *et al.*, 2006: 39.

Material: G1: 1, G16: 3 specimens.

Shell ellipsoid, conical, with 4 convex spiral whorls and a blunt apex. Teleoconch whorls flat and different from the whorls of the other congeneric species. There is an evident and narrow umbilical chink. Aperture rounded, labrum smooth. Shell shiny and whitish or brownish in colour.

The mean dimensions of three recorded specimens are 0.64 (±0.18) x 0.45 (±0.13) – 0.50 (±0.14) mm [1.00 x 0.65 – 0.70 mm].

Distribution: Eastern Atlantic Ocean and Mediterranean Sea (Aartsen and Verduin, 1982; Bouchet and Warén, 1993; Peñas *et al.*, 2006). *Turkish coasts*: Aegean Sea (Demir, 2003) as a questionable species and Levantine Sea (the present study).

***Alvania beanii* (Hanley in Thorpe, 1844)** (Figure 5.)

Cingula beanii Hanley in Thorpe, 1844.

Turbo reticulatus Montagu, 1803; Bogi *et al.*, 1984: 10, figure 3.

Alvania beanii; Hudenbick and Warén, 1969:

Table 1. List of Rissooidea species collected during the study, depth range, biotopes (S:sand, M: mud, Ms: muddy sand, Sm: sandy mud, A: Algae, Po: *Posidonia oceanica*, Hs: *Halophila stipulacea*, Zm: *Zostera marina*, Ce: *Cystoseira elegans*, Cc: *C. crinita*, Cs: *C. spinosa*, Pp: *Padina pavonica*, Hsc: *Halopteris scoparia*, Sh: *Sargassum hornsuchii*, Ss: *Stypopodium schimperi*, Jr: *Jania rubens*, Hi: *Halopyhtis incurvus*, Cm: *Corallina mediterranea*, Cel: *C. elongata*, Ar: *Amphiroa rigida*, Cn: *Cymodocea nodosa*, Bp: *Brachidontes pharaonis*, Mm: *Mytilaster marioni*, Cor: Coralligen, Cp: *Caulerpa prolifera*, D: detritus, R: rock), stations, number of individuals and shell measurements

Species	Stations	Number of individuals	Depth range (m)	Biotope	Shell measurements
Rissoidae					
Rissoa auriscalpium (Linnaeus, 1758)	K22	1	2	Po	4.70 x 1.50 – 2.50
Rissoa lia (Monterosato, 1884)	K23	1	5	S	2.30 x 1.10 – 1.40
Rissoa membranacea (Adams J., 1800)	K35, G14, D8	9	5-10	Po, Ms	5.52 (±0.23) x 2.06 (±0.08) – 3.24 (±0.10) [6.40 x 2.20 – 3.70]
Rissoa monodonta Philippi, 1836	G7, G9	2	5-15	Sm	3.10 x 1.70 – 2.20 -6.70 x 3.50 – 4.70
Rissoa rodhensis Verduin, 1985	D18	2	21	S	4.10 x 1.00 – 2.00 5.30 x 1.20 – 2.50
Rissoa scurra (Monterosato, 1917)	K29, K31, K36, K37	204	0.1-0.3	Jr, Ce	1.78 (±0.05) x 0.97 (±0.02) – 1.17 (±0.03) [2.50 x 1.20 – 1.60]
Rissoa similis Scacchi, 1836	K2, K4, K6-K8, K10-12, K14-17, K19-K24, K26-31, K37-38 D4a,c, D5a, d-f, D6, D8, D14, D22	1662	Medio-25	S, Sm, Ms, Cor., Bp, Jr, Hi, Cm, Cel, Hsc, Ce, Cc, *Cystoseira* sp., Pp, Sh, Po, R, Ss	2.48 (±0.02) x 1.18 (0.01) – 1.51 (±0.03) [3.90 x 1.60 – 2.00]
Rissoa ventricosa Desmarest, 1814	K35, G12, G13	45	9-25	Po, Ms	5.66 (±0.16) x 2.45 (±0.05) – 3.41 (±0.08) [8.70 x 3.10 – 4.70]
Alvania amatii Oliverio, 1986	K15, K34, K36, D14	21	0.1-10	Cm, S	1.99 (±0.09) x 1.14 (±0.03) – 1.37 (±0.06) [2.50 x 1.30 – 1.70]
Alvania aspera (Philippi, 1844)	K41	2	3	Zm	3.10 x 1.90 – 2.10 3.50 x 2.10 – 2.30
Alvania beanii (Hanley in Thorpe, 1844)	D21b, C2	3	60-1302	M,	2.90 (±0.26) x 1.63 (±0.05) – 1.96 (±0.05) [3.10 x 1.70 – 2.00].
Alvania bozcaadensis Tisselli & Giunchi, 2013)	D19	1	17	A	2.40 x 1.45 – 1.65
Alvania cancellata (Da Costa, 1778)	K35	1	9	Po	3.60 x 2.00 – 2.50
Alvania cimex (Linnaeus, 1758)	K35, D7	16	9-50	Po, Ms	3.65 (± 0.29) x 2.06 (± 0.12) – 2.69 (± 0.19) [5.50 x 2.90 – 3.80]
Alvania colossophilus Oberling, 1970	K13, K15, G1, D3, D14, D17, D20, D23	30	4-50	S, Sm, Ms, Cp, *Cystoseira* spp., Hs	3.79 (±0.15) x 2.23 (±0.07) – 2.66 (±0.10) [5.00 x 2.40 – 3.00-]
Alvania datchaensis Amati & Oliverio, 1987	K13, K15, K29, K30, K34-K36, K40, K41, D4c, D5d, D14, D19,	185	0.1-17	Sm, Ms, R,Jr, Cm, Ar, Ce, Hs, Cn, Po, Zm	2.28 (±0.03) x 1.25 (±0.01) – 1.53 (±0.02) [3.20 x 1.50 – 2.00]
Alvania discors (Allan, 1818)	K7, K8, D4a, c, D14,	110	0.1-10	S, Sm, R, Jr, Hi, Ss	2.44 (±0.06) x 1.42 (±0.03) – 1.70 (±0.04) [5.00 x 2.70– 3.20]
Alvania geryonia (Nardo, 1847)	K35, K40, K41, G11-G13	51	3-50	Sm, Ms, Po, Zm	3.61 (±0.12) x 1.78 (±0.05) – 2.40 (±0.07) [4.30 x 2.00 – 2.90]
Alvania lactea (Michaud, 1830)	K6	1	Medio	S	5.00 x 3.00 – 4.00
Alvania mamillata Risso, 1826	K3, K7, K8, K11, K14-K16, K18-20, K22, K25, K29, K34-K37, K40, G1, G13, D3, D4a, c, D5a, D13, D14, D22, D25	155	0.1-50	S, Sm, Ms, Jr, Hi, Cm, Ar, Ce, Cc, Po, Zm, Cn, Ss	3.47 (±0.05) x 1.93 (±0.02) – 2.58 (±0.04) [4.50 x 2.30 – 3.20]
Alvania scabra (Philippi, 1844)	K19, K22, K37, K38, D19	9	0.1-17	S, Jr, Cm	1.53 (±0.08) x 0.90 (±0.04) – 1.08 (±0.05) [1.80 x 1.00 – 1.30]
Alvania testae (Aradas and Maggiore, 1844)	G16, D11, D15	3	100-200	S	2.80 (±0.06) x 1.30 (±0.00)–1.67 (±0.03) [2.90 x 1.30 – 1.70]

Table 1. Continued.

Species	Stations	Number of individuals	Depth range (m)	Biotope	Shell measurements
Pusillina inconspicua (Alder, 1844)	G1, G11, G13, D7, D24	18	10-50	Sm, Ms, Po, Cn	2.27 (±0.11) x 1.28 (±0.05) – 1.58 (±0.07) [2.90 x 1.60 – 2.00]
Pusillina lineolata (Michaud, 1830)	K7, K34, G1, G4-G8, D4a-c, e, f, D5a-f, D6, D7	77	0.1-50	S, M, Sm, Ms, Cm	1.78 (±0.08) x 0.98 (±0.03) – 1.19 (±0.04) [4.00 x 1.80 – 1.80]
Pusillina marginata (Michaud, 1830)	K6, K7, K35, K40, K41, G1, G2, G13, D2, D3, D5b, e, f, h, D7, D21a	50	3-50	S, M, Sm, Ms, Cs, Po, Zm	2.34 (±0.10) x 1.31 (±0.05) – 1.56 (±0.07) [4.00 x 2.10 – 2.60]
Pusillina philippi (Aradas and Maggiore, 1844)	K35, K41, D5f, D14	5	0.2-10.2	S, Ms, Ar, Zm	2.20 (± 0.10) x 1.16 (± 0.04) – 1.34 (± 0.05) [2.60 x 1.30 – 1.50]
Pusillina radiata (Philippi, 1836)	K6, K7, K13-K15, K35, K39-K41, G1, G3, G4, G7, G8, G12-G14, D1, D2, D4a-d, f, g, D5a, b, d-h, D6, D7, D9, D22, D24, BT	344	0.2-50	S, M, Sm, Ms, R, Cc, Cm, Hs, Zm, Po, Cn	2.72 (±0.05) x 1.42 (±0.04) – 1.79 (±0.05) [5.00 x 2.20 – 3.10]
Setia turriculata Monterosato, 1884	K7, K8, K15, K19, K20, K22, K29, K35, G4, D4a, c, D5a, b, D16	134	0.1-200	S, M, Sm, Jr, Cm, Cel, Pp, Hsc	1.21 (±0.06) x 0.75 (±0.03) – 0.90 (±0.04) [2.30 x 1.40 – 1.60]
Setia fusca (Philippi, 1841)	K5, BT	2	5-30	S, Po	1.20 x 0.75 – 1.00
Benthonella tenella (Jeffreys, 1869)	C1	8	852	M	2.50 x 2.00 – 2.00
Crisilla semistriata (Montagu, 1808)	K35	7	0.1-3	Cm, R	1.63 (± 0.06) x 0.97 (± 0.03) – 1.26 (± 0.05) [2.10 x 1.10 – 1.40]
Manzonia crassa (Kanmacher, 1798)	K7, K13, K15, K35	6	1-9.2	S, Hs, Po	2.32 (±0.19) x 1.08 (±0.05) – 1.47 (±0.10) [2.90 x 1.30 – 1.80]
Obtusella macilenta (Monterosato, 1880)	G1, G16	4	50-200	M, Sm	0.64 (±0.18) x 0.45 (±0.13) – 0.50 (±0.14) [1.00 x 0.65 – 0.70]
Rissoina bertholleti Issel, 1869	K7, K12, K14, K15, D14	13	0,1-10	S, Cor.	6,02 (±0,29) x 2,32 (±0,07) – 3,27 (±0,14) [7,10 x 2,60 – 4,00]
Rissoina brugiueri (Payraudeau, 1826)	K6, K12, K14, K15, K35, K40, K41, G13, D3, D4a, D5d, D14, D22	35	Medio-25	S, Sm, Ms, Cc, Zm, Po	4.38 (±0.13) x 1.73 (±0.04) – 2.58 (±0.07) [5.90 x 2.70 – 3.50]
Barleeidae					
Barleeia unifasciata (Montagu, 1803)	K3	1	0.2-3	R	3.50 x 1.70 – 2.30
Caecidae					
Caecum clarkii Carpenter, 1859	K6	1	0.2	Pp	1.10 x 0.25
Caecum trachea (Montagu, 1803)	G1, D5f, D6	4	10.2-50	Sm, Ms	1.54 (±0.17) x 0.29 (±0.02) [2.40 x 0.50]
Hydrobiidae					
Ecrobia ventrosa (Montagu, 1803)	K1, K9, K30, K32-34, G10, D4c, D4f, D5b,e, f, D6, D9	3823	0.1-75	S, M, Sm, Ms, Jr, Mm, Bp	1.65 (±0.07) x 0.93 (±0.03) – 1.20 (±0.04) [4.30 x 2.00 – 2.70]
Iravadiidae					
Hyala vitrea (Montagu, 1803)	G2, G14, G15, D10, D12	11	5-100	M, Ms	1.92 (±0.16) x 0.86 (±0.03) – 1.41 (±0.10) [2.60 x 1.10 – 1.90]
Tornidae					
Tornus subcarinatus (Montagu, 1803)	K6-8	4	Medio	S, Jr	1.28 (±0.08) x 1.78 (±0.09) – 1.18 (±0.08) [1.40 x 1.90 – 1.30]
Tornus mienisi van Aartsen, Carrozza & Menkhorst, 1998	D8	1	10	Ms	0.60 x 1.30 – 0.55
Circulus striatus (Philippi, 1836)	K5	1	5	S	0.85 x 1.35 – 0.65
Truncatellidae					
Truncatella subcylindrica (Linnaeus, 1767)	G12	1	25	Ms	4.30 x 1.30 – 2.10

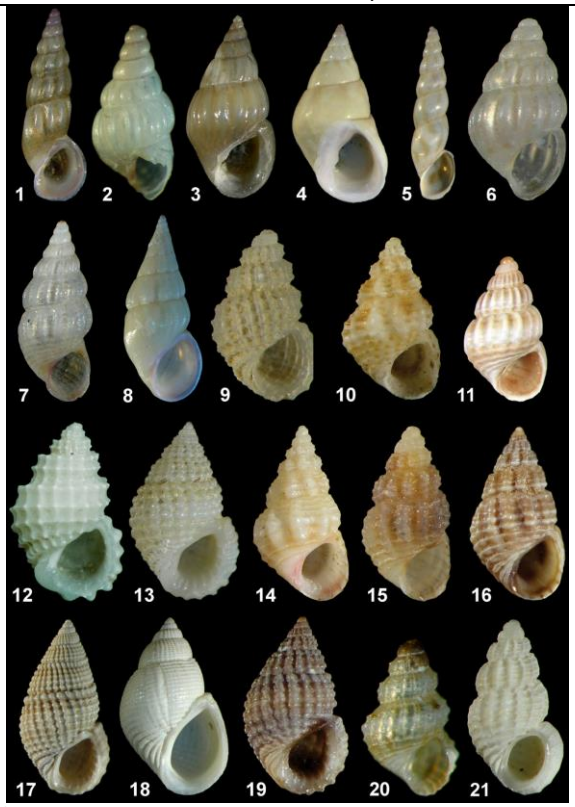

Figure 2. Frontal view of the identified species in the present study:
1. *R. auriscalpium* (h=4.7 mm), 2. *R. lia* (h=2.3 mm), 3. *R. membranacea* (h=5.6 mm), 4. *R. monodonta* (h=6.7 mm), 5. *R. rodhensis* (h=4.1 mm), 6. *R. scurra* (h=2.0 mm), 7. *R. similis* (h=2.9 mm), 8. *R. ventricosa* (h=8.5 mm), 9. *A. amatii* (h=2.3 mm), 10. *A. aspera* (h=3.1 mm), 11. *A. bozcaadensis* (h=2.4 mm), 12. *A. cancellata* (h=3.6 mm), 13. *A. cimex* (h=5.1 mm), 14. *A. colossophilus* (h=5.0 mm), 15. *A. datchaensis* (h=2.8 mm), 16. *A. discors* (h=5.0 mm), 17. *A. geryonia* (h=4.0 mm), 18. *A. lactea* (h=5.0 mm), 19. *A. mamillata* (h=4.4 mm), 20. *A. scabra* (h=1.6 mm), 21. *A. testae* (h=2.3 mm).

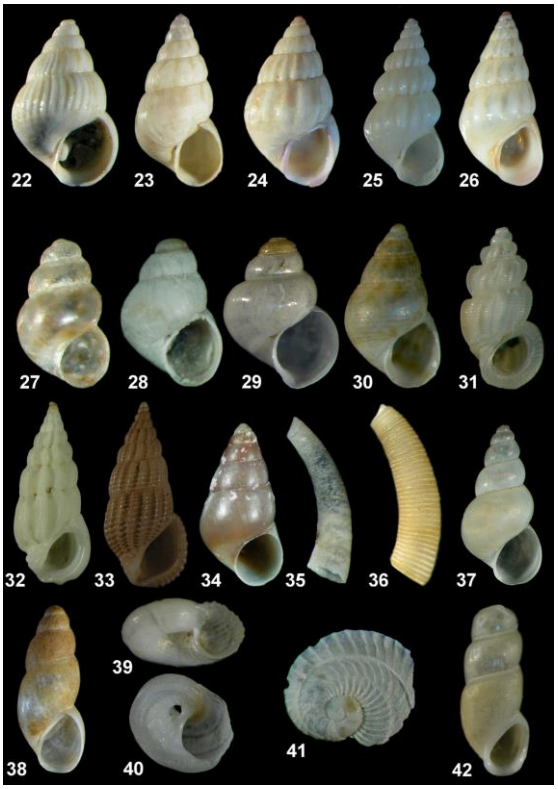

Figure 3. Frontal view of the identified species in the present study (*continued*):
22. *P. inconspicua* (h=2.6 mm), 23. *P. lineolata* (h=3.6 mm), 24. *P. marginata* (h=3.5 mm), 25. *P. philippi* (h=2.6 mm), 26. *P. radiata* (h=4.8 mm), 27. *S. turriculata* (h=1.2 mm), 28. *S. fusca* (h=1.2 mm), 29. *B. tenella* (h= 2.5 mm), 30. *C. semistriata* (h=2.1 mm), 31. *M. crassa* (h=2.3 mm), 32. *R. bertholleti* (h=6.3 mm), 33. *R. bruguieri* (h=5.9 mm), 34. *B. unifasciata* (h=3.5 mm), 35. *C. clarkii* (h=1.1 mm), 36. *C. trachea* (h=2.4 mm), 37. *E. ventrosa* (h=4.3 mm), 38. *H. vitrea* (h=2.6 mm), 39. *C. striatus* (d=1.3 mm), 40. *T. subcarinatus* (d=1.4 mm), 41. *T. mienisi* (d=1.3 mm), 42. *T. subcylindrica* (h=4.3 mm).

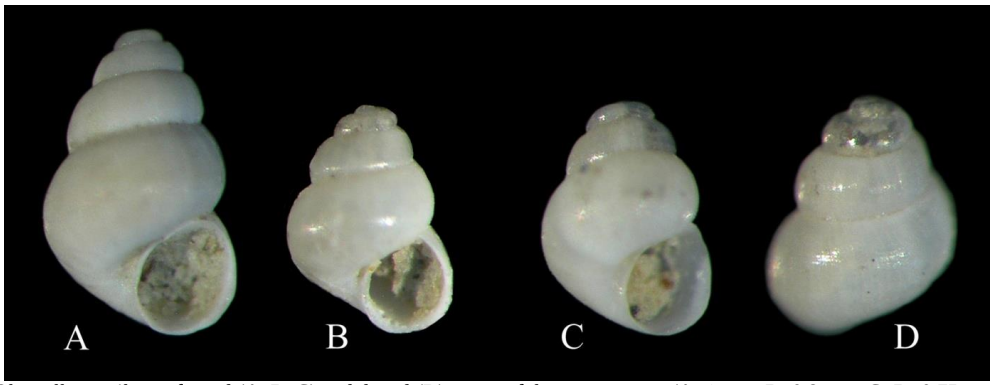

Figure 4. *Obtusella macilenta*: frontal (A, B, C) and dorsal (D) views of three specimens (A=1 mm, B=0,8 mm, C=D=0,75 mm).

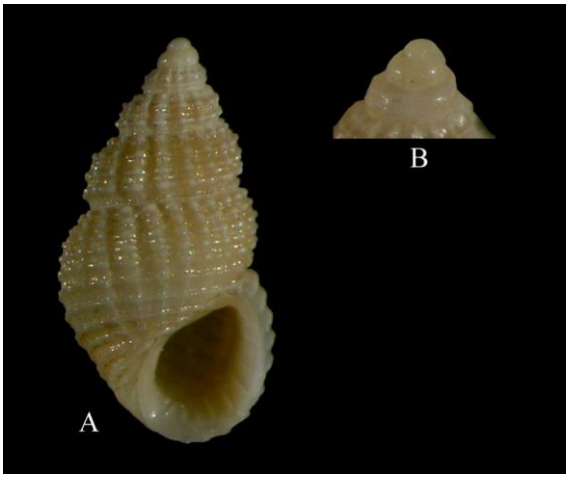

Figure 5. *Alvania beanii*: frontal view of a specimen and its protoconch (B) (A=3,1 mm).

57, figure 5-6; Aartsen, 1982: 20, figure 5-6; Gianuzzi-Savelli *et al.*, 1997: 104, figs. 409-412; Scaperrotta *et al.*, 2011: 55.

Material: D21b: 2, C2: 1 specimens.

Shell conical, moderately slim, with 4 convex teleoconch whorls. Protoconch planctotrophic. On the body whorl there is a sculpture of 6-7 spiral cords and 24-26 axial ribs. Aperture rounded and labrum thickened. Shell dirty white or dark brown in colour.

The mean dimensions of three recorded specimens are 2.90 (±0.26) x 1.63 (±0.05) – 1.96 (±0.05) mm [3.10 x 1.70 – 2.00 mm].

Distribution: Eastern Atlantic Ocean and Mediterranean Sea (Hudenbick and Warén, 1969; Bogi *et al.*, 1984; Avila, 2000). *Turkish coasts*: Sea of Marmara (Ostroumoff, 1894; Marion, 1898), Aegean Sea (Demir, 2003) and Levantine Sea (the present study).

Ecological Data

Considering all the samples taken from the area, *E. ventrosa* attracted attention as the most abundant species with 3823 specimens (54% of the total number), following by *R. similis* (1662 specimens and 24%) and *P. radiata* (344 specimens and 5%) respectively.

The most common species in the area was *R. similis* (found in 40% of the samples), pursuing by *A. mamillata* (30%) and *P. radiata* (28%). The other taxa was found to have a rare distribution along the Turkish Levantine coast.

Regarding the biotopes, *P. radiata*, and *R. similis* were encountered almost in all kind of biotopes, except for *Jania rubens* and *Caulerpa prolifera* respectively, although, some species prefer only a single biotope type. For example, *A. lactea* was encountered in sandy materials only, whereas *R. auriscalpium*, *A. aspera* and *A. cancellata* inhabit phanerogam meadows (Table 1).

The rissooid species investigated in the present study was examined in terms of distribution according to depth. 38 species (86%) were found at depths ranging between 0 and 50 m, and the remained 6 species (14%) were encountered at stations deeper than 50 m (50-1302 m). Only *Benthonella tenella* and *Alvania beanii* attracted attention as species with distribution over the littoral depths found at 852 and 1302 m.

Rissooidea species in samples taken by using a quadrat frame and van Veen Grap was compared according to the biotopes given in Table 2. The sandy

biotopes were found to have the highest number of species (18 species), following by substrates being mixture of mud and sand and different phanerogams such as *Halophila stipulacea*, *Zostera marina* and *Posidonia oceanica* (17 species) and red algae (*Halophytis incurvus*, *Corallina mediterranea*, *Corallina elongata*, *Amphiroa rigida*) (11 species). The highest number of individuals was found at rocky bottoms inhabiting by *Brachidontes pharaonis* and *Mytilaster marioni* (3812 ind.), pursuing by *Jania rubens* (1389 ind.) and brown algae (*Cystoseira elegans*, *Cystoseira crinita*, *Padina pavonica*, *Halopteris scoparia* and *Sargassum hornsuchii*) (629 ind.) (Table 2).

The dominancy and frequency of the species depend on the biotopes. The sandy bottoms were dominated by *R. similis* (21%) and *A. mamillata* (19%), while *P. radiata* and *P. lineolata* were important in terms of dominance and frequency values in muddy and sandy bottoms. *Pusillina radiata* also attracted attention with its highest dominancy and frequency values in phanerogams. The most dominant and abundant species in hard substrata was *Ecrobia ventrosa* (in rocky bottoms and mussel's populations), *Rissoa similis* in brown algae and at bottoms inhabiting by *J. rubens*. At bottoms covered by red algae (except for *J. rubens*), *Alvania mamillata* was the most abundant species (57%) (Table 2).

According to BIOENV analysis, the most important environmental parameters causing grouping among the stations according to biotopes, were: 1) sand biotopes: temperature and salinity (pr=0,45); 2) biotopes consisting of mud and sand: oxygen, temperature, silica and phosphate (pr=0,58); 3) phanerogams: pH and total inorganic nitrogen (pr=0,19); 4) bottoms covered by *J. rubens*: silica and total inorganic nitrogen (pr=0,15); 5) other red algae (except for *J. rubens*): salinity and pH (pr=0,84); 6) brown algae: salinity (pr=0,58) and 7) rocky and mussel's biotopes: temperature and phosphate (pr=0,37) (Figure 6 and 7).

Discussion

A total of 44 species and 7066 individuals belonging to the superfamily Rissooidea were encountered in the present study performed along the Turkish Levantine coast. Among the identified species, *Obtusella macilenta* and *Alvania beanii* are new records to the Turkish Levantine coast. *O. macilenta* was previously reported by Demir (2003) as a suspicious record from the Turkish Aegean coast.

On the other hand, *E. ventrosa* was the mostly distributed in lagoons and brackish waters (Giusti and Pezzoli, 1982). As it was mostly encountered at the stations in Beymelek Lagoon (St. K32 and St. K33), where the salinity was the lowest one (‰14,4) in the present study.

Along the Turkish coasts, *Rissoa similis*, which was the species with the most common distribution in the sampling area, was the first recorded by Ostroumoff (1894) in the Sea of Marmara and later the species was reported from different localities and biotopes at depths up to 49 m (Barash and Danin, 1992; Öztürk *et al.*, 2008; Bitlis-Bakır *et al.*, 2012).

The highest number of species was established at sandy bottoms (18 species). A similar result concerning the biotope preference of the Rissooidea species was also indicated in the studies by Fretter and Graham (1978), Çınar *et al.* (2012) and Bitlis Bakır *et al.* (2012).

The bathymetric features were concordant with the information given by Avila *et al.* (2012) for the Rissoidae species originated from the Atlantic Ocean and Mediterranean Sea. According to the last study, out of 542 studied species, 329 species (61%) were found at depths between 0 and 50 m, and 146 species (27%) were found at depths over than 50 m.

Benthonella tenella, although in the Mediterranean Sea is known to be distributed at depths between 108-4000 m (Warén, 1974 and Danovaro *et al.*, 2010), the species is one of the few deep-sea gastropods having distribution down to 5500

Table 2. The number of samples taken in the area (R), number of species (S), individuals (N), and dominant and frequent species found in the sampled biotopes

Biotopes	R	S	N	Dominant species(%)	Frequent species (%)
Soft substratum					
Sand	19	18	132	*R. similis* (21%) *A. mamillata* (19%)	*A. mamillata* (50%)
Mud and Sand	16	17	120	*P. radiata* (34%) *P. lineolata* (27%)	*P. radiata* (47%) *P. lineolata* (40%)
Phanerogams	12	17	300	*P. radiata* (38%) *A. geryonia* (16%)	*P. radiata* (58%) *A. mamillata* (50%)
Hard substratum					
Rock and mussels	6	3	3812	*E. ventrosa* (99.9%)	*E. ventrosa* (67%)
Brown algae	9	5	629	*R. similis* (89%)	*R. similis* (89%)
Jania rubens	23	9	1389	*R. similis* (69%)	*R. similis* (87%)
Red algae (except for *J. rubens*)	7	11	176	*A. discors* (30%) A. *datchaensis* (25%)	*A. mamillata* (57%) *R. similis* (57%)

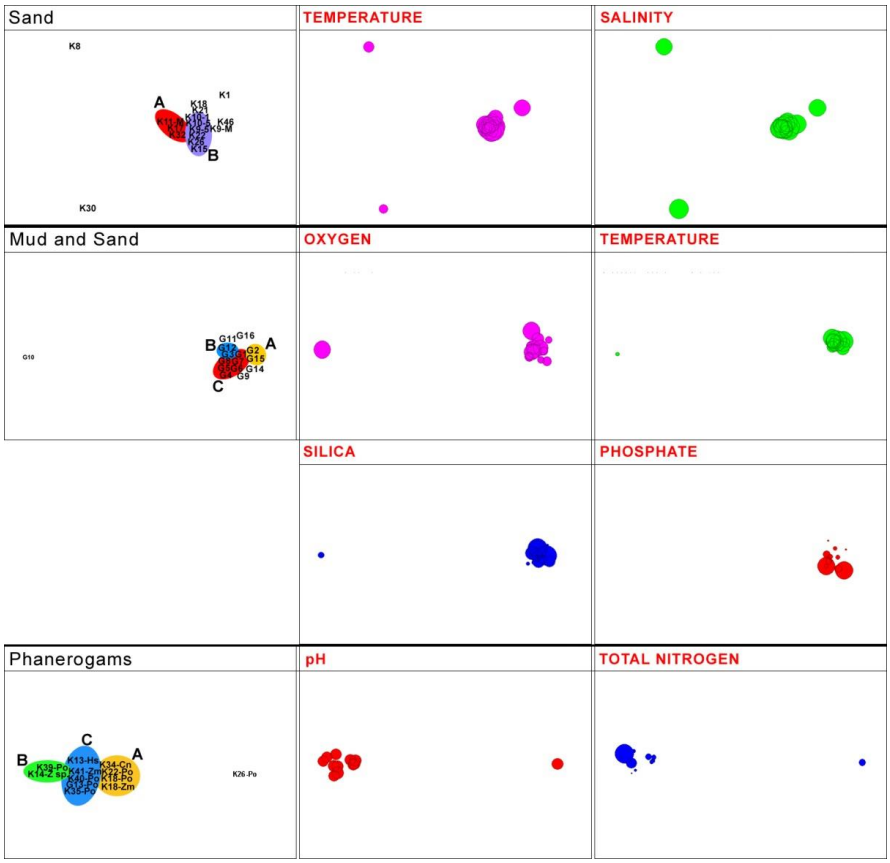

Figure 6. The relation between the environmental parameters and the species associations in the various biotopes (sand, mixture of sand and mud, phanerogams).

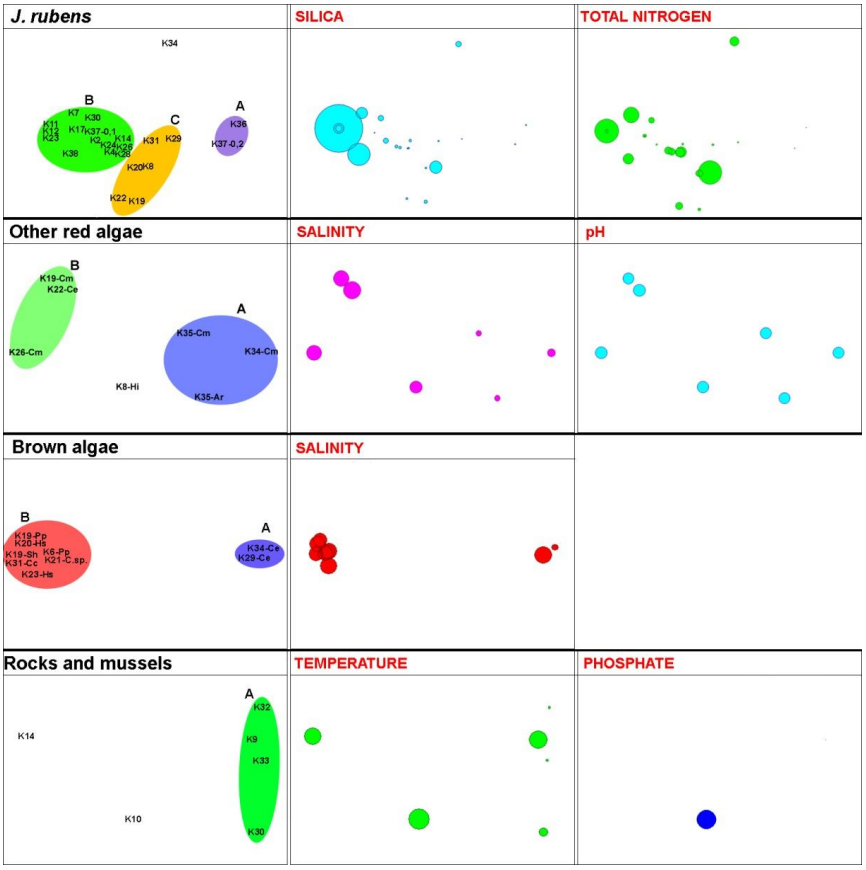

Figure 7. The relation between the environmental parameters and the species associations in the other biotopes (i. e., *J. rubens*, other red algae, brown algae, rocks and mussels).

m depth (Bouchet and Warén, 1993).

Some of the Rissooidea species (*Rissoa auriformis, R. guerinii, R. splendida, R. variabilis, Alvania dorbignyi, A. fractospira, Alvania lanciae, A. corona, A. lineata, A. carinata,, A. cimicoides, A. schwartziana, Botryphallus epidauricus, Rissoina ambigua, Caecum armoricum, C. auriculatum, C. sepimentum, Paludinella littorina, Parastrophia asturiana* and *Hydrobia acuta*) reported in the previous studies from the Turkish Levantine coasts (Öztürk *et al.*, 2014), were not encountered in the present study, probably due to their rare distribution in the eastern Mediterranean. For example, *Alvania lanciae* and *A. carinata*, showing the widespread distribution in the Western Mediterranean (Borja and Muxika, 2001; Amati, 2012) have been rarely recorded along the Turkish coasts.

The majority of the considered species in the present study are with Atlanto-Mediterranean origin or Mediterranean endemics, except for *Rissoina bertholleti*, which originated outside the Mediterranean Sea. The last species introduced probably via the Suez Canal was the first recorded along the Israeli coasts in 1965 (Barash and Danin, 1973). Then the species expanded its distribution range to the Cyprus and Turkish coasts (Bogi *et al.*, 1989; Enzenross *et al*., 1990). Another alien species belonging to the same genus is *Rissoina ambigua*, which was not encountered in the present study. The species is normally distributed in the Indo-Pacific Ocean and Red Sea (Draper, 1987; Janssen *et al.*, 2011), and was the first recorded along the Turkish coasts by Mienis (2004). Although it was not included in the list of the Mediterranean mollusc species published by Coll *et al.* (2010), maybe due to inadequate information, a shell of the species was recently found near Kale (Hatay), Turkey (Öztürk *et al.*, 2015).

The present study was performed with the aim to contribute to the knowledge of rissooids distributed along the Turkish Levantine coast. At the present, 64 species are known to be distributed along the mentioned coast (Öztürk *et al.*, 2014 and the present study). But, probably in the near future, their number would be increased due to the studies that would be carried along the mentioned coast or incoming of alien species to the area by different ways. Thus, the biodiversity is a dynamic process, being constantly changing.

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