Cah. Biol. Mar. (2010) 51 : 45-53

Distribution of alien bivalve species in the soft bottom of Iskenderun Bay (Turkey, NE Levantine Sea)

Serhat ALBAYRAK
Istanbul University, Faculty of Science, Department of Biology, 34134 Vezneciler - Istanbul, Turkey
Fax: + 90 212 528 05 27. E-mail: serhatal@istanbul.edu.tr

Abstract: Distribution of alien bivalves in the soft bottom of Iskenderun Bay according to physico-chemical parameters of sea water and sediment was investigated in this study, which was carried out in November 2005. A total of 2404 individuals belonging to 63 bivalve species were identified, of which 184 individuals belonged to 9 alien species. Alien species accounted for 14.3% of total number of bivalve species and 7.7% of total number of bivalve individuals. The most abundant species in the study area was the native species *Anodontia fragilis* (354 individuals). As for aliens, *Afrocardium richardi* was represented by a high number of individuals (155 individuals).

Résumé : *Distribution des espèces introduites de mollusques bivalves des sédiments meubles de la Baie d'Iskenderun (Turquie, nord-est de la Mer du Levant).* La répartition des bivalves introduits dans les sédiments meubles de la Baie d'Iskenderum selon les paramètres physico-chimiques de l'eau de mer et du sédiment a été examinée dans cette étude qui s'est déroulée en novembre 2005. Un total de 2404 individus appartenant à 63 espèces de bivalves a été identifié, dont 184 individus appartenant à 9 espèces introduites. Ces espèces introduites ont représenté 14,3% du nombre total d'espèces de bivalves et 7,7% du nombre total d'individus bivalves. L'espèce la plus abondante dans cette étude était l'espèce native *Anodontia fragilis* (354 individus). Quant aux espèces introduites, *Afrocardium richardi* est représenté par un grand nombre d'individus (155 individus).

Keywords: Alien species • Bivalvia • Iskenderun Bay • Levantine Sea • Turkey

Introduction

Alien species cause important problems in their new environments due to predation, competition, mixing of genes, habitat modification and the introduction of pathogens. Invasion of aliens is one of the four greatest threats to marine ecosystem while other three are marine pollution, overexploitation of marine resources and physical alteration/destruction of marine habitat (Streftaris et al., 2005). Negative impacts of alien species were documented by many studies (e.g. Galil & Zenetos, 2002; Occhipinti-Ambrogi & Savini, 2003; Çınar et al., 2005; Zenetos et al., 2005; Streftaris & Zenetos, 2006; Galil, 2007).

Reçu le 21 octobre 2009 ; accepté après révision le 4 janvier 2010.
Received 21 October 2009; accepted in revised form 4 January 2010.

A total of 903 alien species has been known from the Mediterranean by the year 2008. Most of them belonged to zoobenthos and Mollusca formed the most important part with 216 species, of which 60 belonged to Bivalvia (Zenetos et al., 2008). Of the 277 alien species reported from Turkish coasts, Mollusca was at the first place with 87 species and 29 of them belonged to Bivalvia (Çınar et al., 2005). After then, Albayrak & Çağlar (2006), Çeviker & Albayrak (2006) and Mifsud & Ovalis (2007) contributed some bivalve species to the alien biota of Turkey.

Alien species can reach to the Mediterranean by different ways, but Lessepsian migration via Suez Canal plays the most important role (Gofas & Zenetos, 2003). The proximity of Turkey to the Suez Canal induces intensive migration and settlement of Indo-Pacific species to the Levantine coasts. Dense maritime shipping also makes this region prone to biological invasion. Number of alien species in the seas surrounding Turkey dramatically increases from the Black Sea towards the Levantine Sea. Çınar et al. (2005) reported 20 alien species from the Black Sea, 48 from the Sea of Marmara, 98 from the Aegean Sea and 216 from the Levantine Sea.

Iskenderun Bay, located at NE of Levantine Sea, is extremely vulnerable to introduction of aliens. So far, many studies were performed on alien bivalves of this region and these species were documented by Öztürk & Çevik (2000) and Çınar et al. (2005). However, these studies were focused only at the taxonomy of the species. This study deals with qualitative and quantitative situations of alien bivalve species in the soft bottom of Iskenderun Bay.

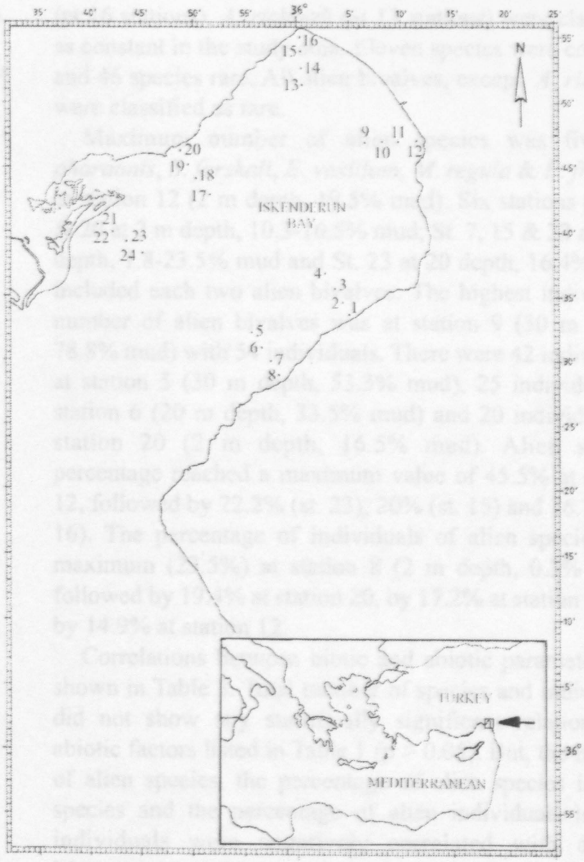

Figure 1. Location of sampling stations in the Iskenderun Bay
Figure 1. Localisation des stations d'échantillonnage dans la Baie d'Iskenderun.

Materials and Methods

This study was carried out in Iskenderun Bay in November 2005. Macrozoobenthic samples were obtained by means of a dredge from 24 stations belonging to six transects perpendicular to the coast line (Fig. 1). Each transect had four stations corresponding to 2, 10, 20 and 30 m depths.

Benthic samples were sieved through a 1 mm mesh and materials retained on the sieve were fixed with 4% formaldehyde. In the laboratory, bivalve specimens were identified to the species level and counted.

Surface sediment was taken by a van Veen grab and its mud percentage was determined (Folk, 1974).

To measure the temperature, salinity and dissolved oxygen of the sea water just above the bottom, a three liter Ruttner water sampler was used. The temperature was determined by a thermometer, salinity by the Mohr-Knudsen method (Ivanoff, 1972) and the dissolved oxygen concentration by the Winkler method (Winkler, 1888).

Frequencies of the species were determined according to the Soyer's (1970) Frequency Index (F). The species were classified as constant ($F \geq 50\%$), common ($25\% \leq F < 50\%$) or rare ($F < 25\%$).

Spearman's rank correlation coefficient (r_s) was used in order to detect correlation between biotic and abiotic parameters (Siegel, 1956).

Results

Environmental parameters of sampling stations were summarized in Table 1. Sea water temperature varied between 20.2°C (St. 16, 2 m) and 22°C (St. 4, 30 m). Salinity ranged between 38 (St. 10 & 23, 20 m) and 39.6 (St. 8, 2 m). Dissolved oxygen of the sea water was minimum (5.8 mg.L^{-1}) at St. 13 (30 m) and maximum (8.6 mg.L^{-1}) at St. 1 & 2 (2 and 10 m, respectively). Mud percentage of the sediment differed from 0.3% (St. 8 & 21, each 2 m) to 97.4% (St. 13, 30 m).

A total of 2404 individuals belonging to 63 bivalve species were identified during this study (Table 2). The

Table 1. Abiotic parameters measured at sampling stations. dO: Dissolved oxygen.

Tableau 1. Paramètres abiotiques mesurés aux stations d'échantillonnage. dO : oxygène dissous.

Stations	Depth (m)	Temperature (°C)	Salinity	dO ($mg.L^{-1}$)	Mud (%)
1	2	20.5	39.2	8.6	0.9
2	10	21.8	39.1	8.6	16.7
3	20	21.9	38.7	8.1	48.9
4	30	22	39.2	6.5	92.1
5	30	21.4	39	6.2	53.3
6	20	21.2	39.3	7.2	33.5
7	10	21.8	39.3	6.4	4.9
8	2	21.5	39.6	7.2	0.3
9	30	21.8	39.3	6.1	78.8
10	20	21.9	38	6.4	21.3
11	10	21	38.9	5.9	5.1
12	2	20.8	38.7	8.3	19.5
13	30	21.2	39.2	5.8	97.4
14	20	21	39.2	6.6	86.1
15	10	20.3	39.2	6.6	23.5
16	2	20.2	38.6	8.4	10.3
17	30	21.1	38.8	6.2	95.4
18	20	20.4	39.1	6.1	25.9
19	10	21	39.1	6.6	3.7
20	2	20.5	39.3	7.3	16.5
21	2	21.2	39.3	7.9	0.3
22	10	21.5	38.2	7.5	1.8
23	20	21.1	38	7.3	16.4
24	30	21.3	38.7	7.6	78.9

majority (2220 individuals) of individuals belonged to the native bivalve species (54 species), whereas only 184 individuals belonged to 9 alien species (*Brachidontes pharaonis* (St. 12), *Septifer bilocularis* (St. 10), *Septifer forskali* (St. 8, 12, 16, 20 & 23), *Electroma vexillum* (St. 12 & 16), *Malvufundus regulus* (St. 12), *Cardites akabana* (St. 11), *Afrocardium richardi* (St. 2, 3, 4, 5, 6, 7, 9, 15, 18, 19, 20, 22 & 23), *Fulvia fragilis* (St. 7, 12, 15 & 22) and *Gafrarium pectinatum* (St. 1)). Alien bivalve species accounted for 14.3% of the total number of species and 7.7% of the total number of individuals.

The most abundant species in the study area was *Anodontia fragilis* (354 individuals), followed by *Tellina pulchella* (334 ind.), *Nucula nitidosa* (296 ind.), *Abra alba* (181 ind.), *Gouldia minima* (160 ind.) and *Corbula gibba* (159 ind.). As for aliens, *Afrocardium richardi* had the highest number of individuals (155 individuals), followed by *Septifer forskali* (14 individuals) and *Fulvia fragilis* (7 individuals). *Electroma vexillum* and *Cardites akabana* were represented by two individuals and others by one specimen.

Only five species *A. fragilis* (occurred at 20 stations), *C. gibba* (at 17 stations), *N. nitidosa* (at 16 stations), *A. alba* (at 16 stations), *A. richardi* (at 13 stations) were classified as constant in the study area. Eleven species were common and 46 species rare. All alien bivalves, except *A. richardi*, were classified as rare.

Maximum number of alien species was five (*B. pharaonis*, *S. forskali*, *E. vexillum*, *M. regula* & *F. fragilis*) at station 12 (2 m depth, 19.5% mud). Six stations (St. 16 & 20 at 2 m depth, 10.3-16.5% mud; St. 7, 15 & 22 at 10 m depth, 1.8-23.5% mud and St. 23 at 20 depth, 16.4% mud) included each two alien bivalves. The highest individuals number of alien bivalves was at station 9 (30 m depth, 78.8% mud) with 54 individuals. There were 42 individuals at station 5 (30 m depth, 53.3% mud), 25 individuals at station 6 (20 m depth, 33.5% mud) and 20 individuals at station 20 (2 m depth, 16.5% mud). Alien species percentage reached a maximum value of 45.5% at station 12, followed by 22.2% (st. 23), 20% (st. 15) and 16.7% (st. 16). The percentage of individuals of alien species was maximum (23.5%) at station 8 (2 m depth, 0.3% mud), followed by 19.4% at station 20, by 17.2% at station 15 and by 14.9% at station 12.

Correlations between biotic and abiotic parameters are shown in Table 3. Total number of species and individuals did not show any statistically significant relation with abiotic factors listed in Table 1 ($p > 0.05$). But, the number of alien species, the percentage of alien species in total species and the percentage of alien individuals in total individuals were negatively correlated with depths. Moreover, the above mentioned aliens' parameters were also negatively related with the mud percentage of the sediment ($p < 0.05$).

Discussion

To date, a total of 27 alien bivalve species were reported from the Turkish Levantine coasts (Table 4). Of these, only 9 alien bivalves were encountered in this study. This is mostly attributed to the facts that I studied in a restricted area (only Iskenderun Bay) and also took samples only from soft sediment (no samples from hard bottoms). In a previous study performed in Iskenderun Bay, only 7 alien species were reported (Çevik & Sarıhan, 2004).

Among the alien species reported from the area, eight (*A. inflata*, *S. bilocularis*, *S. forskali*, *E. vexillum*, *C. akabana*, *P. praerupta*, *A. lamellaris* and *P. hemprichi*) are "casual", which has been recorded only once in the scientific literature, and one (*S. multisetosus*) is "questionable", whose species with insufficient information and taxonomic status unresolved (Zenetos et al., 2005). From casual species, *Septifer bilocularis* was firstly recorded from the Israel coasts by Mienis (2004) and later from the Iskenderun Bay by Albayrak & Çağlar (2006). *Septifer forskali*, first reported by Albayrak & Çeviker (2001) from

Table 2. List of bivalve species and their abundance at sampling staions. TN: total number of individuals of each species, F: Frequency values of each species, * denotes alien bivalve species.

Tableau 2. Liste des espèces de bivalves et nombre d'individus récoltés aux stations d'échantillonnage. TN : nombre total d'individus récolté, F : abondance relative, * désigne les espèces introduites.

TAXA STATIONS	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	TN	F
Nuculidae																										
Nucula nitidosa Winckworth, 1930		2	22	9	28	61	11		71	7			6	7			10	46	8	3		1		4	296	66.6
Nuculanidae																										
Nuculana pella (Linnaeus, 1767)			3		13	14			4				1			1		2							38	29.1
Arcidae																										
Arca noae Linnaeus, 1758						4				8										2					14	12.5
Noetiidae																										
Striarca lactea (Linnaeus, 1758)																				2					2	4.1
Glycymeridae																										
Glycymeris glycymeris (Linnaeus, 1758)							12	2			3								6	2	4				29	25
Mytilidae																										
**Brachidontes pharaonis* (Fischer P., 1870)												1													1	4,1
Modiolarca subpicta (Cantraine, 1835)																		1							1	4.1
Modiolus adriaticus (Lamarck, 1819)							1					2													3	8.3
**Septifer bilocularis* (Linnaeus, 1758)										1															1	4.1
**Septifer forskali* Dunker, 1855								4				3				1				5			1		14	20.8
Pteriidae																										
**Electroma vexillum* (Reeve, 1857)												1				1									2	8.3
Malleidae																										
**Malvufundus regulus* (Forsskal, 1775)												1													1	4.1
Pectinidae																										
Flexopecten glaber (Linnaeus, 1758)									4					1											5	8.3
Mimachlamys varia (Linnaeus, 1758)									3				1							2			1		7	16.6
Pecten jacobeus (Linnaeus, 1758)																		1							1	4.1
Talochlamys multistriatus (Poli, 1795)																		1							1	4.1
Anomiidae																										
Anomia ephippium Linnaeus, 1758	1															2				1					4	12.5
Lucinidae																										
Anodontia fragilis (Philippi, 1836)	1	27	18	2	68	93	4	1	46		4	1	3	5	2		3	39	7	28	1	1			354	83.3
Ctena decussata (Costa O.G., 1829)						6	1	2										1							10	16.6
Loripes lacteus (Linnaeus, 1758)							4																		4	4.1
Lucinella divaricata (Linnaeus, 1758)							1				6							2	5			1			15	20.8
Kelliidae																										
Kellia suborbicularis (Montagu, 1803)			1								3														4	8.3
Montacutidae																										
Tellimya ferruginosa (Montagu, 1808)											1														1	4.1
Carditidae																										
**Cardites akabana* (Sturany, 1899)											2														2	4.1
Glans trapezia (Linnaeus, 1767)	1					42			31	12	5									2					93	25
Cardiidae																										
Acanthocardia echinata (Linnaeus, 1758)									14		2														16	8.3
A. paucicostata (Sowerby G.B.II, 1841)					38	8	3											13	3						65	20.8
**Afrocardium richardi* (Audouin, 1826)		3	1	1	42	25	1		54						1			3	4	15		1	4		155	54.1

Cerastoderma glaucum (Poiret, 1789)																				2			2				4	8.3
**Fulvia fragilis* (Forsskal, 1775)							1				1			4									1				7	16.6
Papillicardium papillosum (Poli, 1791)					10	8			9						1						8						36	20.8
Parvicardium exiguum (Gmelin, 1791)									10																		10	4.1
Mactridae																															
Mactra stultorum (Linnaeus, 1758)											1				2							1	1				5	16.6
Pharidae																															
Pharus legumen (Linnaeus, 1758)															1												1	4.1
Tellinidae																															
Gastrana fragilis (Linnaeus, 1758)																					6						6	4.1
Tellina distorta Poli, 1791								1										7	7								15	12.5
Tellina donacina Linnaeus, 1758				6									7	1									1	4			19	20.8
Tellina fabula Gmelin, 1791	1	7									19	4			4											3	38	25
Tellina nitida Poli, 1791					7		4			8						2	5	4					2				32	29.1
Tellina planata Linnaeus, 1758																							2				2	4.1
Tellina pulchella Lamarck, 1818			37		55	131	6	1	67								32		5								334	33.3
Tellina tenuis da Costa, 1778															5							3					8	8.3
Donacidae																															
Donax semistriatus Poli,1795	4						3	1		1	11		1	2	21			2				4					50	41.6
Donax trunculus Linnaeus, 1758															2							5					7	8.3
Donax venustus Poli, 1795	1										6												3				10	12.5
Scrobiculariidae																															
Scrobicularia cottardi (Payraudeau, 1826)																							1				1	4,1
Semelidae																															
Abra alba (Wood W., 1802)		10	7	3	34	19	5		49		4		1		6	4		29				1	1	7	1	181	66.6
Abra longicallus (Scacchi, 1835)																	1										1	4.1
Abra prismatica (Montagu, 1808)																		3									3	4.1
Solecurtidae																															
Azorinus chamasolen (da Costa, 1778)					11													1									12	8.3
Veneridae																															
Chamelea gallina (Linnaeus, 1758)	2				6	10	14	4		7										10		2					55	33.3
Dosinia exoleta (Linnaeus, 1758)			2				6							1										1			10	16.6
Dosinia lupinus (Linnaeus, 1758)		1			8		1							1				2		1		6					20	29.1
**Gafrarium pectinatum* (Linnaeus, 1758)	1																										1	4.1
Gouldia minima (Montagu, 1803)			6	6	41	47			44	2	8		1					3				1		1			160	45.8
Pitar rudis (Poli, 1795)						4			9	6						3	1										23	20.8
Tapes rhomboides (Pennant, 1777)						4	1	1	3												8		1				18	25
Timoclea ovata (Pennant, 1777)			1																								1	4.1
Venus verrucosa Linnaeus, 1758									1												5						6	8.3
Petricolidae																															
Petricola lithophaga (Philippson, 1788)										12											8						20	8.3
Corbulidae																															
Corbula gibba (Olivi, 1792)		4	11	2		17	4		8	6	5		9	5	4		2	55				1	2	22	2	159	70.8
Thraciidae																															
Thracia papyracea (Poli, 1791)							1							7										1			9	12.5
Pandoridae																															
Pandora inaequivalvis (Linnaeus, 1758)	1																										1	4.1

Table 3. Spearman's rank-correlation coefficient between biotic and abiotic parameters. TNS: Total number of species, TNI: Total number of individuals, NAS: Number of alien species, NAI: Number of alien individuals, PAS: Percentage of alien species, PAI: Percentage of alien individuals, dO: Dissolved oxygen. Statistically significant correlations are in bold. N = 24.

Tableau 3. Coefficient de corrélation de rang de Spearman entre les paramètres biotiques et abiotiques. TNS : nombre total d'espèces, TNI : nombre total d'individus, NAS : nombre d'espèces introduites, NAI : nombre d'individus d'espèces introduites, PAS : pourcentage d'espèces introduites, PAI : pourcentage d'individus d'espèces introduites, dO : oxygène dissous. Les corrélations significatives sont indiquées en gras. N = 24.

		TNS	TNI	NAS	NAI	PAS	PAI
Depth	r_s	-0.268	0.148	**-0.493**	-0.160	**-0.479**	**-0.433**
	p-level	0.103	0.245	**0.007**	0.227	**0.009**	**0.017**
Temperature	r_s	-0.158	0.132	-0.210	-0.136	-0.078	-0.179
	p-level	0.230	0.269	0.162	0.263	0.359	0.201
Salinity	r_s	0.188	0.054	-0.187	0.173	-0.272	0.164
	p-level	0.190	0.401	0.191	0.209	0.099	0.222
dO	r_s	-0.169	-0.263	0.279	-0.035	**0.462**	0.201
	p-level	0.215	0.107	0.093	0.436	**0.011**	0.173
Mud %	r_s	-0.333	0.121	**-0.426**	-0.175	**-0.388**	**-0.411**
	p-level	0.056	0.287	**0.019**	0.206	**0.031**	**0.023**

Iskenderun Bay, and *Psammotreta praerupta*, first reported by Engl & Çeviker (1999) from Karataş-Adana, were later reported from Cypriot coasts by Katsanevakis et al. (2009). *Electroma vexillum*, first reported by Çevik et al. (2005) from the Iskenderun Bay, is confirmed by the present study. Thus, these species can be considered as "established", whose species with at least two records spread over time and space. Çevik et al. (2001) reported *Saccostrea commercialis* (Iredale & Roughley, 1933) from Taşucu-Mersin. However, it was accepted as a misidentification of *S. cucullata* by Zenetos et al. (2003) and Çınar et al. (2005). However, the photograph of this species in the paper by Çevik et al. (2001) resembles to *D. frons* rather than a *Saccostrea* species. Therefore, the presence of this species in the Turkish Levantine coasts is suspicious.

Studies about alien bivalves on the Turkish Levantine coast are generally focused just on these species. There were a few studies referring to native species together with aliens. Aartsen & Kinzelbach (1990) mentioned only one alien bivalve species (*B. variabilis*) within a total of 77 species from Dalyan, westernmost part of the Levantine Sea, and argued that unsuitable local environment such as brackish water negatively affected the establishment of alien species in the area. However, Çınar et al. (2009) reported that 26.6% of polychaete fauna in the brackish waters of the Golden Horn Estuary belonged to alien species. Buzzurro & Greppi (1996) identified 72 native and 5 alien bivalves from Taşucu. Öztürk & Çevik (2000) mentioned only 10 alien bivalves (8%) within a total of 127 species from Levantine coasts of Turkey in their check-list, but, Çınar et al. (2005) gave 26 alien species in the area. At the present time, a total of 197 bivalve species are known from the region and 27 (13.7%) of them are aliens (Enzenrohs & Enzenrohs, 1987; Aartsen & Kinzelbach, 1990; Tringalli & Villa, 1990; Buzzurro & Greppi, 1996; Öztürk & Çevik, 2000; Çevik et al., 2001; Demir, 2003; Çınar et al., 2005; Albayrak & Çağlar, 2006; Mifsud & Ovalis, 2007). The percentage of alien bivalve species living in Iskenderun Bay is slightly higher than that of whole Levantine coasts. Çevik & Sarıhan (2004) reported 7 aliens (14%) within a total of 50 species. The present study included 63 species, 9 of which were alien species (14.3%). The percentage of individuals number of alien species was almost half (7.7%) of the species number percentage. Unfortunately, there is no detailed study on individual numbers of alien bivalves within total fauna in Iskenderun Bay. Only, Niederhöfer et al. (1991) determined 5 aliens and mentioned all of them were rare except *A. natalensis* at western part of Iskenderun Bay and Buzzurro & Greppi (1996) reported 5 different alien bivalves and indicated *B. pharaonis* and *P. radiata* were very common, with more than 100 individuals, *M. regula* common, with 21-100 individuals, *F. fragilis* and *G. pectinatum* very rare, with 1-3 individuals. Since they did not give any data about specimen number of native bivalves in their study area, it is impossible to compare the results of this study with prior studies in regard to specimen number percentage.

Alien bivalves preferred shallower stations rather than

Table 4. Alien bivalve species reported from Turkish Levantine Sea. FRM: First record in the Mediterranean, FRTL: First record in the Turkish Levantine Sea, O: Origin (IO: Indian Ocean, IP: Indo-Pacific, PO: Pacific Ocean, RS: Red Sea), MI: Mode of introduction (Aq: Aquaculture, L: Lessepsian, S: Shipping). From Zenetos et al., 2003; Çınar et al., 2005; Albayrak & Çağlar, 2006; Çeviker & Albayrak, 2006; Mifsud & Ovalis, 2007; Katsanevakis et al., 2009.

Tableau 4. Espèces de bivalves introduits signalées sur les côtes turques de la Mer du Levant. FRM : premier signalement en Méditerranée, FRTL : premier signalement sur les côtes turques de la Mer du Levant, O : origine géographique (IO : Océan Indien, IP : Indo-Pacifique, PO : Océan Pacifique, RS : Mer Rouge), MI : type d'introduction (Aq : aquaculture, L : lesseptienne, S : transport maritime). De Zenetos et al., 2003; Çınar et al., 2005; Albayrak & Çağlar, 2006; Çeviker & Albayrak, 2006; Mifsud & Ovalis, 2007; Katsanevakis et al., 2009.

Species	FRM	FRTL	O	MI
Anadara inflata (Reeve, 1844)	2002	2002	IO	?S
Anadara natalensis (Krauss, 1848)	1937	1991	IO, RS	L
Brachidontes pharaonis (Fischer P., 1870)	1878	1985	IO, RS	L, S
Septifer bilocularis (Linnaeus, 1758)	2004	2006	PO	?S
Septifer forskali Dunker, 1855	2001	2001	RS	L, S
Crassostrea gigas (Thunberg, 1793)	1964	2001	PO	Aq
Saccostrea cucullata (Born, 1778)	2001	2001	IP, RS	?S
Dendostrea frons (Linnaeus, 1758)	2001	2001	IP, RS	S
Pinctada radiata (Leach, 1814)	1878	1985	IP, RS	L, Aq
Electroma vexillum (Reeve, 1857)	2005	2005	IP, RS	?S
Malvufundus regulus (Forsskal, 1775)	1931	1974	IP, RS	L
Spondylus cf. *multisetosus* Reeve, 1856	2001	2001	IP	?S
Spondylus spinosus Schreibers, 1793	1993	1999	IP, RS	L, S
Chama pacifica Broderip, 1834	1905	2001	IP, RS	L
Chama aspersa Reeve, 1846	2004	2007	IP	?L
Cardites akabana (Sturany, 1899)	2006	2006	RS	?L
Fulvia fragilis (Forsskal, 1775)	1973	1987	IO, RS	L, S
Afrocardium richardi (Audouin, 1826)	1999	2000	IO, RS	L
Tellina valtonis Hanley, 1844	1977	2001	IO, RS	L
Psammotreta praerupta (Salisbury, 1934)	1999	1999	IP, RS	?L
Gafrarium pectinatum (Linnaeus, 1758)	1905	1987	IP, RS	L
Clementia papyracea (Gray, 1825)	1948	1995	IP, RS	L
Paphia textile (Gmelin, 1791)	1948	1991	IP, RS	L
Antigona lamellaris Schumacher, 1817	1999	1999	IP, RS	?
Petricola hemprichi Issel, 1869	1905	2006	RS	?L
Gastrochaena cymbium Spengler, 1783	1973	1991	IP, RS	L
Laternula anatina (Linnaeus, 1758)	1905	1995	IP, RS	L

deeper ones. Seven alien species (*B. pharaonis*, *S. forskali*, *E. vexillum*, *M. regula*, *A. richardi*, *F. fragilis*, *G. pectinatum*) were encountered at stations at 2 m depth, three species (*C. akabana*, *A. richardi*, *F. fragilis*) at 10 m, three species (*S. bilocularis*, *S. forskali*, *A. richardi*) at 20 m and only one species (*A. richardi*) at 30 m depth. Çınar et al. (2005) also discussed this trend and denoted 41% of the total number of all aliens occurred solely at depths between 0-10 m. Thus, it is clear that shallower waters are more densely occupied by alien species.

Streftaris & Zenetos (2006) mentioned 12 bivalve species between the 100 worst invasive aliens. From the invasive bivalves, only *B. pharaonis* was represented by only one individual in this study. But, *B. pharaonis* was reported from Turkish Levantine coasts by many studies and Buzzurro & Greppi (1996) indicated it as a very common species at Taşucu-Mersin.

Introduction of new aliens to the Turkish coasts increased after 1980 and especially after 2000. One new alien species was introduced to the Turkish Levantine coasts every 52 weeks between 1961-1980, 6.4 weeks between 1981-2000 and just 4.7 weeks between 2001-2005 (Çınar et al., 2005). In the Mediterranean, rate of introduction has been estimated to be one species every 1.3 week (Zenetos et al., 2008). To date, aliens spread shallow waters successfully but not deeper waters. Immigration of Indo-Pacific species is mainly depth-restricted and these invaders are found in the Mediterranean littoral and infralittoral to a depth of 50 m and it is hard to find them in deeper waters. If the Suez Canal is deepen to allow the

passing of super tankers as planned by Egyptian government, many new aliens, of which upper depth range is not suitable until now, will enter to the Levantine (Galil & Zenetos, 2002). Either this is implemented or not, introduction of aliens to the Mediterranean is an on-going process. Thus, alien species should be monitored especially by giving importance to their individual dominance.

Acknowledgements

This work was supported by the Research Fund of the İstanbul University, project number: 410/13092005.

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