

Bivalvia (Mollusca) fauna of the Sea of Marmara

Serhat ALBAYRAK, Hüsamettin BALKIS and Neslihan BALKIS

*Department of Biology, Faculty of Science, Istanbul University,
34118 Vezneciler - Istanbul, Turkey
E-mail: serhatal@istanbul.edu.tr*

The aim of this study was to determine which Bivalvia fauna exist in the Sea of Marmara and some of the ecological characteristics of their habitats. Eighty-six of 254 stations that were studied between 1990 and 1999 were sampled and 59 species belonging to 49 genera and 28 families were identified. These species are listed together with 205 previously recorded species. Also listed are the primary hydrographic conditions (salinity, temperature, dissolved oxygen) of the stations at the moment of sampling. The fact that fewer species were found than in earlier reports indicates the negative impact on species richness of habitats damaged by new ports and motorways on the edge of the sea plus domestic and industrial pollution.

Key words: Bivalvia, Mollusca, Sea of Marmara

INTRODUCTION

The Sea of Marmara is a small basin with an approximate size of 70 x 250 km, surface area of 11500 km², and maximum depth of 1390 m. It is located between Europe and Asia (BEŞİKTEPE *et al.*, 1995) and, together with the Bosphorus and the Dardanelles, forms the "Turkish Straits System". It connects to the Black Sea through the Bosphorus in the northeast and to the Aegean Sea via the Dardanelles in the southwest. There are two distinctly different water masses in the basin (ÜNLÜATA *et al.*, 1990; TUĞRUL & POLAT, 1995). The surface water is brackish, originating in the Black Sea (22-26 psu), and the bottom layer originates in Mediterranean subhalocline waters (38.5-38.6 psu). As a result of containing both brackish and sea water, the Sea of Marmara may have a rich variety of fauna. However, the

fauna has been negatively influenced by human and natural factors for many years.

Although, the biological diversity increases from the Black Sea towards the Mediterranean, the number of bivalve species in the Sea of Marmara is greater than on Turkish coasts of the Aegean and Mediterranean Seas (ÖZTÜRK ÇEVİK, 2000). Yet the biological diversity of this region is facing threats of decreasing because of the high levels of pollution and human activity. Many studies have collected data on bivalves in the Sea of Marmara (COLOMBO, 1885; OSTROUMOFF, 1896; MARION, 1898; PALLARY, 1917; NINNI, 1923; DEVEDJIAN, 1926; DEMİR, 1952; KANEVA-ABADJIEVA, 1959; TORTONESE, 1959; CASPERS, 1968; OBERLING, 1969-1971; PINAR, 1974; OKUŞ, 1989; YÜKSEK, 1989; BALKIS, 1992; ALBAYRAK & BALKIS, 1996; ERYILMAZ, 1997; UYSAL *et al.*, 1998; DEMİR, 2003) but there are few recent studies on the current situation. Further,

ecological characteristics of the habitats in which the species were found were not always adequately recorded in earlier studies.

The aim of this study is to report on the present situation of *Bivalvia* in the Sea of Marmara and some of the ecological characteristics of their habitats.

MATERIALS AND METHODS

Coastal fauna were collected with a scoop net. Deep sea fauna were collected by the R/V ARAR from various depths using trawl, beam-trawl and dredging. Data were collected during 1990-1999 at 86 of 254 studied stations (Fig. 1). Depth, temperature, salinity, dissolved oxygen

and the bottom structure of the stations are given in Table 1.

The samples were rinsed through a 0.5 mm mesh sieve. Bivalve specimens were removed from the samples and fixed and preserved in a 5% formaldehyde solution prepared in sea water. TEBBLE (1966), PARENZAN (1974, 1976), POUTIERS (1987), POPPE & GOTO (1993) were used to identify the bivalves, SABELLI *et al.* (1990) and CLEMAM (2003) database were followed in classification of species.

After identifying the species in our laboratory, all specimens were sent to the Museum National d'Histoire Naturelle, Paris, and the Istituto di Scienze Ambientali Marine, Genova, for confirmation of identification and comparison with their collections.

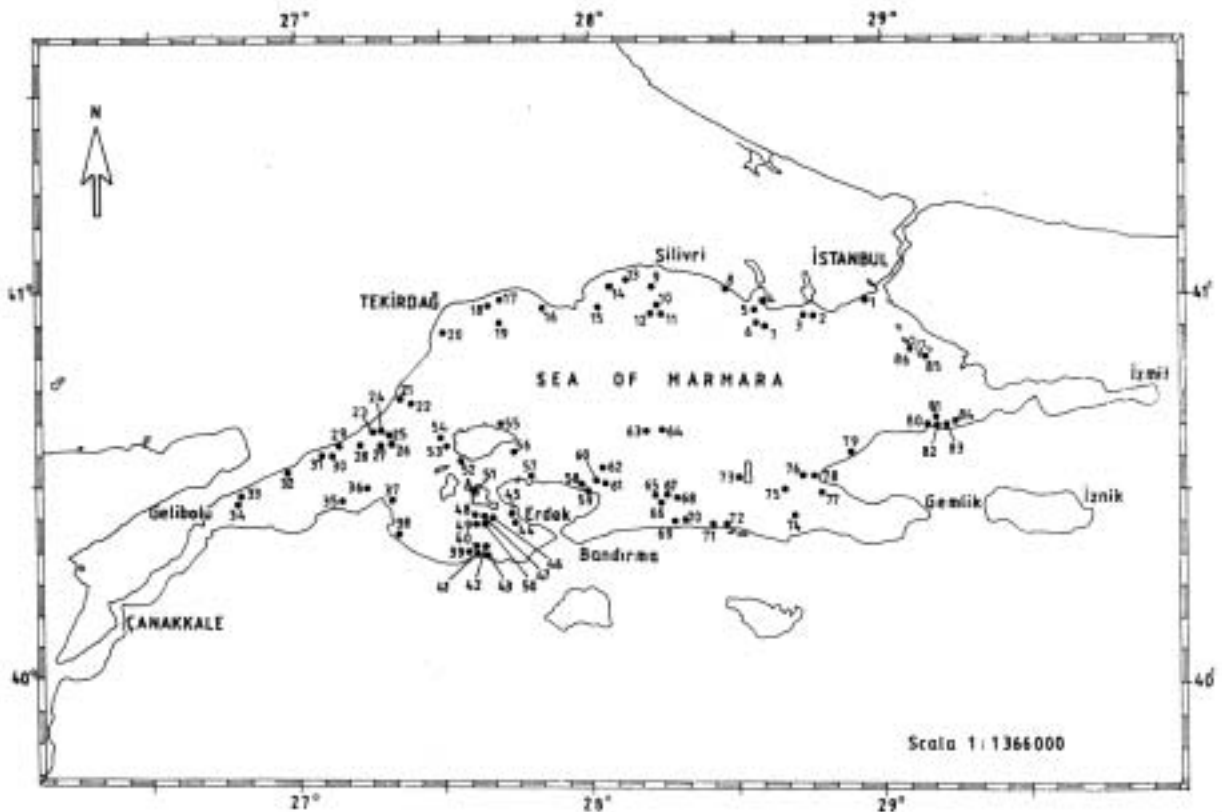


Fig. 1. Map of Sea of Marmara showing sampling stations

Table 1. Data about sampling stations

Station number	Sampling date (Day/Mo/Yr)	Depth (m)	Temperature (°C)	Salinity (psu)	Dissolved oxygen (mg ^l ⁻¹)	Bottom structure
1	17.09.1998	1	20.0	21.1	10.6	Mud&Sand
2	19.10.1992	63	15.0	38.3	1.6	Mud
3	16.07.1992	60	14.9	38.2	1.3	Mud&Shell
4	19.10.1992	18	15.4	32.1	3.4	Shell
5	11.07.1991	45	14.7	36.6	1.4	Mud
6	11.07.1991	67	14.7	38.2	2.1	Mud
7	19.10.1992	71	14.6	38.4	1.6	Mud
8	17.09.1998	1	22.0	19.9	8.9	Mud&Gravel
9	17.07.1992	56	14.8	38.4	1.4	Mud
10	17.07.1992	83	14.9	38.6	1.3	Mud
11	20.10.1992	91	14.7	38.5	1.5	Mud
12	12.07.1991	83	14.9	38.4	1.2	Mud
13	17.07.1992	29	15.1	35.6	1.9	Mud
14	28.06.1993	16	14.6	32.2	3.6	Sand
15	28.06.1993	79	14.6	38.3	2.2	Mud
16	20.10.1992	18	15.6	34.3	3.2	Shell
17	20.10.1992	16	15.7	34.0	3.4	Sand
18	18.07.1992	29	14.9	36.6	2.7	Mud
19	20.10.1992	77	14.7	38.4	1.6	Rock
20	28.06.1993	84	14.6	38.4	2.3	Sand
21	18.07.1992	38	14.9	38.3	2.5	Sand
22	18.07.1992	63	14.9	38.6	1.1	Mud
23	18.07.1992	58	14.9	38.2	2.3	Mud
24	13.07.1991	57	14.9	38.2	2.2	Mud
25	18.07.1992	82	14.9	38.6	1.6	Mud&Shell
26	13.07.1991	85	15.0	38.5	1.7	Mud
27	21.10.1992	85	14.8	38.6	2.0	Mud
28	16.04.1992	63	14.6	38.4	2.7	Mud
29	08.08.1999	1	23.4	22.7	7.1	Sand
30	13.07.1991	53	14.9	37.9	2.8	Mud
31	21.10.1992	13	16.4	24.2	6.7	Mud
32	21.10.1992	13	16.2	24.9	6.0	Sand
33	19.07.1992	13	17.5	24.7	6.8	Sand
34	29.06.1993	19	15.8	31.7	5.4	Sand &Shell
35	29.06.1993	52	14.6	38.4	2.1	Mud&Shell
36	29.06.1993	65	15.0	38.0	1.2	Mud

Table 1. cont'd

37	13.07.1991	45	14.9	38.2	2.3	Mud
38	22.10.1992	14	17.1	24.4	4.3	Mud
39	23.10.1997	32	14.5	37.0	2.8	Mud
40	17.04.1992	33	14.1	36.8	3.8	Mud
41	23.10.1997	13	18.9	24.2	7.0	Mud
42	14.07.1991	27	15.0	36.1	4.5	Mud
43	23.10.1997	12	19.0	24.1	6.6	Mud
44	23.10.1992	28	15.0	36.5	3.3	Mud
45	15.07.1991	30	14.9	36.1	6.3	Mud
46	20.07.1992	42	14.8	37.4	2.8	Mud&Shell
47	20.07.1992	42	14.8	37.5	3.0	Mud&Stone
48	14.07.1991	43	14.9	37.4	2.4	Mud
49	23.10.1992	41	14.8	37.3	3.1	Mud
50	30.06.1993	42	14.7	37.5	1.8	Mud
51	17.04.1992	18	13.5	33.7	7.2	Mud&Shell
52	10.08.1999	1	23.3	20.1	8.3	Sand
53	14.07.1991	65	14.8	38.5	2.0	Mud
54	14.07.1991	64	14.8	38.5	2.0	Mud&Shell
55	21.10.1992	15	16.0	27.9	4.1	Sand
56	15.04.1992	63	14.6	38.3	2.2	Mud
57	01.07.1993	24	15.2	36.0	4.5	Sand
58	15.07.1991	20	15.3	36.0	4.2	Sand
59	24.10.1992	13	16.0	24.4	5.3	Sand
60	15.07.1991	46	14.9	37.5	2.4	Mud
61	24.10.1992	45	14.9	37.5	3.7	Sand
62	15.07.1991	42	14.8	37.6	2.2	Mud
63	15.07.1991	105	14.7	38.6	1.3	Mud
64	22.07.1992	96	14.7	38.7	1.6	Mud
65	22.07.1992	52	14.8	38.3	2.2	Mud
66	24.10.1992	52	14.7	38.2	2.2	Mud
67	15.07.1991	52	14.9	38.2	2.1	Mud
68	15.07.1991	52	14.9	38.3	2.1	Mud
69	15.07.1991	24	15.1	35.0	4.3	Sand
70	22.07.1992	24	15.0	34.9	4.4	Mud
71	01.07.1993	22	15.1	34.7	4.7	Mud
72	22.07.1992	21	15.2	31.2	5.1	Mud
73	24.10.1992	14	16.4	24.5	5.2	Sand
74	01.07.1993	59	14.8	38.1	1.4	Mud
75	22.07.1992	43	14.9	37.1	1.6	Sand
76	16.07.1991	53	14.6	38.4	1.4	Mud

Table 1. cont'd

77	02.07.1993	42	15.1	37.3	1.8	Mud
78	16.07.1991	15	16.5	28.0	5.0	Sand
79	02.07.1993	82	14.7	38.4	1.1	Mud&Shell
80	16.07.1996	18	15.2	33.2	3.6	Sand
81	23.07.1992	88	14.6	38.6	0.9	Mud
82	16.07.1996	25	14.4	37.8	1.2	Mud
83	17.07.1996	20	15.0	34.6	1.4	Mud
84	17.07.1996	18	15.2	33.3	1.7	Mud
85	13.06.1999	1	22.7	20.3	10.0	Mud&Gravel
86	13.06.1999	1	22.7	20.3	10.0	Sand

RESULTS

Two hundred and five species belonging to 126 genera and 56 families were reported in previously conducted studies. Fifty-nine species

belonging to 49 genera and 28 families were identified during the course of this study. The species, station numbers at which they were found, and ecological characteristics of the find sites are provided in Table 2.

Table 2. Bivalve species found in the Sea of Marmara in previous studies and in this study*

	Station no.	Depth (m)	Temperature (°C)	Salinity (psu)	Dissolved oxygen (mg l ⁻¹)	Bottom substance
Solemyidae						
<i>Solemya togata</i> (Poli, 1795)						
Nuculidae						
<i>Ennucula aegeensis</i> (Forbes, 1844)						
<i>Ennucula tenuis</i> (Montagu, 1808)						
<i>Nucula nitidosa</i> (Winckworth, 1930)						
* <i>Nucula nucleus</i> (Linnaeus, 1758)	1, 8, 23, 47, 65	1-58	14.8-22.0	19.9-38.3	2.2-10.6	mud, muddy sandy bottom
* <i>Nucula sulcata</i> (Bronn, 1831)	9, 49, 65	41-56	14.8	37.3-38.4	1.4-3.1	mud bottom
Nuculanidae						
<i>Nuculana commutata</i> (Philippi, 1844)						
<i>Nuculana pella</i> (Linnaeus, 1767)						
Yoldiidae						
<i>Yoldiella philippiana</i> (Nyst, 1845)						

Table 2. cont'd

Arcidae*Anadara corbuloides*

(Monterosato, 1878)

* <i>Anadara diluvii</i> (Lamarck, 1805)	2, 3, 5, 7, 9, 10, 11, 12, 15, 22, 23, 24, 25, 27, 47, 48, 49, 50, 54, 60, 62, 64, 65, 66, 67, 68, 74, 75, 76, 79, 81	41-96	14.6-15.0	36.6-38.7	0.9-3.1	mud, sand bottom
--	--	-------	-----------	-----------	---------	---------------------

* <i>Arca noae</i> (Linnaeus, 1758)	47, 51	18-42	13.5-14.8	33.7-37.5	3.0-7.2	on stone and shell
-------------------------------------	--------	-------	-----------	-----------	---------	-----------------------

* <i>Arca tetragona</i> (Poli, 1795)	54	64	14.8	38.5	2.0	on shells
--------------------------------------	----	----	------	------	-----	-----------

Barbatia barbata (Linnaeus, 1758)*Bathyarca grenophia* (Risso, 1826)**Scapharca inaequalis*
(Bruguiera, 1789)**Noetiidae**

<i>Striarca lactea</i> (Linnaeus, 1758)	8, 85	1	22.0-22.7	19.9-20.3	8.9-10.0	mud&gravel bottom
---	-------	---	-----------	-----------	----------	----------------------

Glycymerididae*Glycymeris bimaculata* (Poli, 1795)

* <i>Glycymeris glycymeris</i> (Linnaeus, 1758)	33, 73	13-14	16.4-17.5	24.5-24.7	5.2-6.8	sand bottom
--	--------	-------	-----------	-----------	---------	-------------

Glycymeris insubrica (Brocchi, 1814)*Glycymeris pilosa* (Linnaeus, 1767)**Mytilidae***Lithophaga lithophaga*
(Linnaeus, 1758)*Modiolarca subpicta* (Cantraine, 1835)

* <i>Modiolula phaseolina</i> (Philippi, 1844)	16	18	15.6	34.3	3.2	on shells
--	----	----	------	------	-----	-----------

* <i>Modiolus adriaticus</i> (Lamarck, 1819)	21, 33, 40	13-38	14.1-17.5	24.7-38.3	2.5-6.8	mud, sand bottom
--	------------	-------	-----------	-----------	---------	---------------------

* <i>Modiolus barbatus</i> (Linnaeus, 1758)	35, 46	42-52	14.6-14.8	37.4-38.4	2.1-2.8	on shells
---	--------	-------	-----------	-----------	---------	-----------

Table 2. cont'd

* <i>Musculus costulatus</i> (Risso, 1826)	80	18	15.2	33.2	3.6	on corals
<i>Mytilaster lineatus</i> (Gmelin, 1791)						
<i>Mytilaster minimus</i> (Poli, 1795)						
<i>Mytilus edulis</i> (Linnaeus, 1758)						
* <i>Mytilus galloprovincialis</i> (Lamarck, 1819)	1, 3, 4, 8, 14, 15, 29, 31, 32, 38, 41, 43, 51, 52, 55, 59, 70, 71, 72, 80, 84, 85	1-79	13.5-23.4	19.9-38.3	1.3-10.6	mud, sand, muddy sand, shell, mud&shell, mud&gravel bottoms
Pinnidae						
<i>Atrina pectinata</i> (Linnaeus, 1767)						
* <i>Pinna nobilis</i> (Linnaeus, 1758)	3, 5, 7, 9, 10, 77, 79, 82, 83	20-83	14.4-15.1	34.6-38.6	1.1-1.8	mud bottom
<i>Pinna rudis</i> (Linnaeus, 1758)						
Pteriidae						
* <i>Pteria hirundo</i> (Linnaeus, 1758)	3, 19, 36, 79	60-82	14.7-15.0	38.0-38.4	1.1-1.6	on rock and shells
Pectinidae						
* <i>Aequipecten opercularis</i> (Linnaeus, 1758)	9, 13, 21, 40, 58, 70	20-56	14.1-15.3	34.9-38.4	1.4-4.4	mud, sand bottom
* <i>Delectopecten vitreus</i> (Gmelin, 1791)	3	60	14.9	38.2	1.3	on shells
<i>Hyalopecten similis</i> (Laskey, 1811)						
<i>Lissopecten hyalinus</i> (Poli, 1795)						
<i>Chlamys flexuosa</i> (Poli, 1795)						
<i>Chlamys multistriata</i> (Poli, 1795)						
<i>Chlamys pesfelis</i> (Linnaeus, 1758)						
<i>Chlamys proteus</i> (Dillwyn, 1817)						
* <i>Chlamys varia</i> (Linnaeus, 1758)	47, 48	42-43	14.8-14.9	37.4-37.5	2.4-3.0	mud bottom
* <i>Flexopecten glaber</i> (Linnaeus, 1758)	5, 9, 14, 21, 58	16-56	14.6-15.3	32.2-38.4	1.4-4.2	mud, sand bottom
<i>Palliolium incomparabile</i> (Risso, 1826)						
<i>Palliolium striatum</i> (Muller O.F., 1776)						
<i>Pecten jacobaeus</i> (Linnaeus, 1758)						

Table 2. cont'd

Propeamussium fenestratum

(Forbes, 1844)

* <i>Pseudamussium clavatum</i> (Poli, 1795)	6, 10, 11, 12, 25, 26, 30, 47, 49, 53, 61, 63, 64, 76	41-105	14.6-15.0	37.3-38.7	1.2-3.7	mud, sand bottom
---	---	--------	-----------	-----------	---------	------------------

Spondylidae*Spondylus gaederopus* (Linnaeus, 1758)*Spondylus gussonii* (Costa O.G., 1829)**Anomiidae**

* <i>Anomia ephippium</i> (Linnaeus, 1758)	1, 85	1	20.0-22.7	20.3-21.1	10.0-10.6	on algae
--	-------	---	-----------	-----------	-----------	----------

Pododesmus aculeatus (Mueller O.F., 1776)*Pododesmus patelliformis* (Linnaeus, 1761)*Pododesmus squamus* (Gmelin, 1791)**Limidae***Lima lima* (Linnaeus, 1758)*Limaria hians* (Gmelin, 1791)

* <i>Limaria tuberculata</i> (Olivi, 1792)	33, 51	13-18	13.5-17.5	24.7-33.7	6.8-7.2	mud, sand bottom
--	--------	-------	-----------	-----------	---------	------------------

Limatula subauriculata (Montagu, 1808)*Limea loscombii* (Sowerby G.B.I., 1823)**Ostreidae***Crassostrea gigas* (Thunberg, 1793)

* <i>Ostrea edulis</i> (Linnaeus, 1758)	2, 3, 9, 10, 11, 15, 22, 23, 24, 25, 26, 27, 28, 47, 48, 49, 51, 52, 63, 64, 65, 66, 67, 68, 76, 79, 82, 85	1-105	13.5-23.3	20.1-38.7	1.1-10.0	mud, sand, mud&shell, mud&gravel bottom
--	---	-------	-----------	-----------	----------	---

Gryphaeidae*Neopycnodonte cochlear* (Poli, 1795)

Table 2. cont'd

Lucinidae*Anadontia fragilis* (Philippi, 1836)*Ctena decussata* (Costa O.G., 1829)*Divaricella angulifera* (Von Martens, 1880)

* <i>Loripes lacteus</i> (Linnaeus, 1758)	8, 29, 85	1	22.0-23.4	19.9-22.7	7.1-10.0	sand, mud&gravel bottom
---	-----------	---	-----------	-----------	----------	-------------------------

Lucinella divaricata (Linnaeus, 1758)*Lucinoma boreale* (Linnaeus, 1767)

* <i>Myrtea spinifera</i> (Montagu, 1803)	3, 9, 47, 63, 85, 86	1-105	14.7-22.7	20.3-38.6	1.3-10.0	mud, sand, mud&gravel bottom
---	----------------------	-------	-----------	-----------	----------	------------------------------

Thyasiridae*Leptaxinus eumyrius* (Sars M., 1870)*Thyasira flexuosa* (Montagu, 1803)*Thyasira granulosa* (Monterosato, 1874)**Ungulinidae***Diplodonta brocchii* (Deshayes, 1850)*Diplodonta rotundata* (Montagu, 1803)**Chamidae***Chama circinata* (Monterosato, 1878)

* <i>Chama gryphoides</i> (Linnaeus, 1758)	19, 25	77-82	14.7-14.9	38.4-38.6	1.6	on rock and shell
--	--------	-------	-----------	-----------	-----	-------------------

Pseudochama gryphina (Lamarck, 1819)**Galeommatidae***Galeomma politum* (Deshayes, 1855)*Galeomma turtoni* (Turton, 1825)**Kelliidae***Bornia sebetia* (Costa O.G., 1829)

Table 2. cont'd

Kellia suborbicularis (Montagu,
1803)

Lasaeidae

Hemilepton nitidum (Turton,
1822)

Leptonidae

Lepton squamosum (Montagu,
1803)

Montacutidae

Mancikellia pumila (Sowerby J.
de C., 1846)

Mysella bidentata (Montagu,
1803)

Tellimya ferruginosa (Montagu,
1808)

Neoleptonidae

Neolepton sulcatulum (Jeffreyes,
1859)

Sportellidae

Sportella recondita (Fischer P.,
1872)

Carditidae

Cardita calyculata (Linnaeus,
1758)

Glans aculeata (Poli, 1795)

Glans trapezia (Linnaeus, 1767)

Venericardia antiquata
(Linnaeus, 1758)

Astartidae

Astarte fusca (Poli, 1795)

Gonilia calliglypta (Dall, 1903)

Cardiidae

Acanthocardia aculeate
(Linnaeus, 1758)

Acanthocardia deshayesi
(Payraudeau, 1826)

**Acanthocardia echinata* 35, 37, 46, 18-52 14.6-15.2 33.3-38.4 1.7-3.1 mud bottom
(Linnaeus, 1758) 47, 49, 50,
62, 67, 68,
84

Acanthocardia mucronata (Poli,
1795)

Table 2. cont'd

* <i>Acanthocardia paucicostata</i> (Sowerby G.B.II, 1834)	8, 31, 32, 35, 38, 39, 41, 43, 44, 57, 71, 79, 85	1-82	14.5-22.7	19.9-38.4	1.1-10.0	mud, sand, mud&shell, mud&gravel bottom
<i>Acanthocardia spinosa</i> (Solander, 1786)						
* <i>Acanthocardia tuberculata</i> (Linnaeus, 1758)	8, 12, 29, 32, 38, 43, 52, 59, 61, 75	1-83	14.9-23.4	19.9-38.4	1.2-8.9	mud, sand, mud&gravel bottom
<i>Cerastoderma edule</i> (Linnaeus, 1758)						
* <i>Cerastoderma glaucum</i> (Poiret, 1789)	1, 8, 29, 52, 85	1	20.0-23.4	19.9-22.7	7.1-10.6	mud, sand, muddy sand bottom
* <i>Laevicardium crassum</i> (Gmelin, 1791)	57, 62	24-42	14.8-15.2	36.0-37.6	2.2-4.5	mud, sand bottom
<i>Laevicardium oblongum</i> (Gmelin, 1791)						
* <i>Parvicardium exiguum</i> (Gmelin, 1791)	52	1	23.3	20.1	8.3	sand bottom
<i>Parvicardium minimum</i> (Philippi, 1836)						
<i>Parvicardium ovale</i> (Sowerby G.B.II, 1840)						
<i>Parvicardium roseum</i> (Lamarck, 1819)						
<i>Parvicardium scabrum</i> (Philippi, 1844)						
* <i>Plagiocardium papillosum</i> (Poli, 1795)	32, 43, 55	12-15	16.0-19.0	24.1-27.9	4.1-6.6	mud, sand bottom
Mactridae						
<i>Mactra glauca</i> (Born, 1778)						
<i>Mactra stultorum</i> (Linnaeus, 1758)						
<i>Spisula solida</i> (Linnaeus, 1758)						
* <i>Spisula subtruncata</i> (Da Costa, 1778)	1, 8, 29, 31, 47, 52, 86	1-42	14.8-23.4	19.9-37.5	3.0-10.6	mud, sand, muddy sand bottom
Mesodesmatidae						
<i>Donacilla cornea</i> (Poli, 1795)						
Solenidae						
* <i>Solen marginatus</i> (Pulteney, 1799)	29, 31, 45, 69, 70, 79	1-82	14.7-23.4	22.7-38.4	1.1-7.1	mud, sand bottom

Table 2. cont'd

Pharellidae

**Ensis ensis* (Linnaeus, 1758) 29, 52, 57, 1-105 14.7-23.4 20.1-38.6 1.1-10.0 mud, sand
58, 59, 63, bottom
70, 79, 85

Ensis minor (Chenu, 1843)

Ensis siliqua (Linnaeus, 1758)

Phaxas adriaticus (Coen, 1933)

Phaxas pellucidus (Pennant, 1777)

Tellinidae

**Gastrana fragilis* (Linnaeus, 1758) 29 1 23.4 22.7 7.1 sand bottom

Tellina balaustina (Linnaeus, 1758)

Tellina distorta (Poli, 1791)

Tellina donacina (Linnaeus, 1758)

Tellina fabula (Gmelin, 1791)

Tellina incarnata (Linnaeus, 1758)

Tellina nitida (Poli, 1791)

Tellina planata (Linnaeus, 1758)

Tellina pulchella (Lamarck, 1818)

Tellina pygmaea (Loven, 1846)

**Tellina serrata* (Brocchi, 1814) 18 29 14.9 36.6 2.7 mud bottom

**Tellina tenuis* (Da Costa, 1778) 1, 29, 52, 1 20.0-23.4 20.1-22.7 7.1-10.6 sand, muddy
86 sand bottom

Donacidae

**Donax trunculus* (Linnaeus, 1758) 1, 8, 29, 52, 1 20.0-23.4 19.9-22.7 7.1-10.6 mud, sand,
86 muddy sand
bottom

Donax variegatus (Gmelin, 1791)

Donax venustus (Poli, 1795)

Psammobiidae

Gari costulata (Turton, 1822)

**Gari depressa* (Pennant, 1777) 33, 52, 85 1-13 17.5-23.3 20.1-24.7 6.8-10.0 sand,
mud&gravel
bottom

**Gari fervensis* (Gmelin, 1791) 86 1 22.7 20.3 10.0 sand bottom

Scrobiculariidae

Scrobicularia plana (Da Costa, 1778)

Table 2. cont'd

Semelidae

**Abra alba* (Wood W., 1802) 1 1 20.0 21.1 10.6 muddy sand bottom

Abra longicallus (Scacchi, 1834)

**Abra nitida* (Mueller O.F., 1776) 56 63 14.6 38.3 2.2 mud bottom

Abra prismatica (Montagu, 1808)

Abra renierii (Bronn, 1831)

Abra segmentum (Recluz, 1843)

Solecurtidae

**Azorinus chamasolen* (Da Costa, 1778) 39, 43, 47, 57 12-42 14.5-19.0 24.1-37.5 2.8-6.6 mud, sand bottom

Solecurtus multistriatus (Scacchi, 1834)

Solecurtus scopula (Turton, 1822)

Solecurtus strigilatus (Linnaeus, 1758)

Kelliellidae

Kelliella abyssicola (Forbes, 1844)

Trapeziidae

**Coralliophaga lithophagella* (Lamarck, 1819) 20 84 14.6 38.4 2.3 in holes of corals

Glossidae

Glossus humanus (Linnaeus, 1758)

Veneridae

Callista chione (Linnaeus, 1758)

**Chamelea gallina* (Linnaeus, 1758) 1, 8, 14, 17, 29, 43, 52, 55, 84, 86 1-18 14.6-23.4 19.9-34.0 1.7-10.6 mud, sand, muddy sand bottom

Chamelea striatula (Da Costa, 1778)

**Clausinella fasciata* (Da Costa, 1778) 18, 62 29-42 14.8-14.9 36.6-37.6 2.2-2.7 mud bottom

**Dosinia exoleta* (Linnaeus, 1758) 17, 73 14-16 15.7-16.4 24.5-34.0 3.4-5.2 sand bottom

Dosinia lupinus (Linnaeus, 1758)

Globivenus effosa (Philippi ex Bivona ms., 1836)

**Gouldia minima* (Montagu, 1803) 1, 17, 32, 85 1-16 15.7-22.7 20.3-34.0 3.4-10.6 sand, muddy sand, muddy&gravel bottom

Table 2. cont'd

Irus irus (Linnaeus, 1758)*Pitar mediterranea* (Tiberi, 1855)

* <i>Pitar rudis</i> (Poli, 1795)	1, 8, 14, 17, 29, 33, 41, 42, 43, 45, 57, 71, 72, 73, 78, 79, 80, 83, 84	1-82	14.6-23.4	19.9-38.4	1.1-10.6	mud, sand, muddy sand, muddy&gravel, mud&shell bottom
-----------------------------------	---	------	-----------	-----------	----------	---

* <i>Paphia aurea</i> (Gmelin, 1791)	43, 55	12-15	16.0-19.0	24.1-27.9	4.1-6.6	mud, sand bottom
--------------------------------------	--------	-------	-----------	-----------	---------	---------------------

Paphia lucens (Locard, 1886)

* <i>Paphia rhomboides</i> (Pennant, 1777)	29	1	23.4	22.7	7.1	sand bottom
--	----	---	------	------	-----	-------------

* <i>Ruditapes decussatus</i> (Linnaeus, 1758)	29	1	23.4	22.7	7.1	sand bottom
--	----	---	------	------	-----	-------------

Timoclea ovata (Pennant, 1777)*Venerupis geographica* (Gmelin, 1791)*Venus casina* (Linnaeus, 1758)*Venus nux* (Gmelin, 1791)

* <i>Venus verrucosa</i> (Linnaeus, 1758)	8, 14, 18, 29, 43, 52, 85	1-29	14.6-23.4	19.9-36.6	2.7-10.0	mud, sand, mud&gravel bottom
---	---------------------------------	------	-----------	-----------	----------	------------------------------------

Petricolidae

* <i>Mysia undata</i> (Pennant, 1777)	29	1	23.4	22.7	7.1	sand bottom
---------------------------------------	----	---	------	------	-----	-------------

Petricola lithophaga (Retzius, 1786)**Myidae***Mya arenaria* (Linnaeus, 1758)*Sphenia binghami* (Turton, 1822)**Corbulidae**

* <i>Corbula gibba</i> (Olivi, 1792)	8, 9, 30, 32, 41, 47, 52, 71	1-56	14.8-23.3	19.9-38.4	1.4-8.9	mud, sand, mud&gravel bottom
--------------------------------------	------------------------------------	------	-----------	-----------	---------	------------------------------------

Lentidium mediterraneum (Costa O.G., 1839)**Gastrochaenidae***Gastrochaena dubia* (Pennant, 1777)**Hiatellidae**

* <i>Hiatella arctica</i> (Linnaeus, 1767)	34	19	15.8	31.7	5.4	on shells
--	----	----	------	------	-----	-----------

* <i>Hiatella rugosa</i> (Linnaeus, 1767)	14, 16, 51	16-18	13.5-15.6	32.2-34.3	3.2-7.2	in crevices of shells
---	------------	-------	-----------	-----------	---------	--------------------------

Table 2. cont'd

Saxicavella jeffreysi
(Winckworth, 1930)

Pholadidae

Barnea candida (Linnaeus, 1758)

Pholas dactylus (Linnaeus, 1758)

Teredinidae

Bankia carinata (Gray J.E.,
1827)

Lyrodus pedicellatus
(Quatrefages, 1849)

Nototeredo norvegica (Spengler,
1792)

Teredo navalis (Linnaeus, 1758)

Xylophagidae

Xylophaga dorsalis (Turton,
1819)

Thraciidae

Thracia convexa (Wood W., 1815)

Thracia corbuloides (Deshayes,
1830)

Thracia distorta (Montagu, 1803)

Thracia papyracea (Poli, 1791)

Thracia pubescens (Pulteney,
1799)

Pandoridae

Pandora inaequivalvis
(Linnaeus, 1758)

Pandora pinna (Montagu, 1803)

Poromyidae

Poromya granulata (Nyst and
Westendorp, 1839)

Cuspidariidae

Cardiomya costellata (Deshayes,
1835)

Cuspidaria abbreviata (Forbes,
1843)

Cuspidaria cuspidata (Olivi,
1792)

**Cuspidaria rostrata* (Spengler, 9, 10, 63 56- 14.7-14.9 38.4-38.6 1.3-1.4 mud bottom
1793) 105

* Ecological characteristics are given for sites at which species were found in this study.

DISCUSSION AND CONCLUSIONS

The Bivalvia class is represented by 409 species in the Mediterranean region (SABELLI *et al.*, 1990) and 244 species in the Turkish seas (ÖZTÜRK & ÇEVİK, 2000; DEMİR, 2003). So far, 205 bivalve species have been identified in the Sea of Marmara and its straits. Eleven of the 205 species (*Solemya togata*, *Mytilus edulis*, *Pinna rudis*, *Atrina pectinata*, *Crassostrea gigas*, *Lucinoma boreale*, *Cerastoderma edule*, *Spisula solida*, *Ensis siliqua*, *Chamelea striatula*, *Pitar mediterranea*) appear in our list although their presence in the Sea of Marmara is questionable. In this study, 59 species were identified. Bivalvia fauna of the Sea of Marmara could not be contributed, but, detailed data about ecological characteristics of these 59 species were provided.

Most of the 205 species known to exist in the Sea of Marmara are of Atlanto-Mediterranean origin whereas 24 species (*Nuculoma aegeensis*, *Anadara corbuloides*, *Glycymeris bimaculata*, *G. pilosa*, *Mytilaster lineatus*, *M. minimus*, *Pinna nobilis*, *Delectopecten vitreus*, *Spondylus gussonii*, *Pododesmus aculeatus*, *Thyasira granulosa*, *Bornia sebetia*, *Mancikellia pumila*, *Sportella recondita*, *Gonilia calliglypta*, *Acanthocardia deshayesi*, *A. mucronata*, *A. spinosa*, *Phaxas adriaticus*, *Tellina fabula*, *Abra renierii*, *Solecurtus multistriatus*, *Kelliella abyssicola*, *Lentidium mediterraneum*) are endemic to the Mediterranean, 15 (*Bathyarca grenophia*, *Lithophaga lithophaga*, *Lima lima*, *Crassostrea gigas*, *Divaricella angulifera*, *Kellia suborbicularis*, *Cerastoderma edule*, *Ensis ensis*,

Venus verrucosa, *Ruditapes decussatus*, *Hiatella arctica*, *Pholas dactylus*, *Lyrodus pedicellatus*, *Bankia carinata*, *Cuspidaria rostrata*) are cosmopolitan, 4 (*Hemilepton nitidum*, *Mya arenaria*, *Hiatella rugosa*, *Xylophaga dorsalis*) are boreal and 1 (*Scapharca inaequalvis*) is Indo-Pacific.

Of the 244 species in the Turkish seas, 29 are Mediterranean endemic, 15 are cosmopolitan, 4 are boreal and 12 are Indo-Pacific. Only one Indo-Pacific species is known to exist in the Sea of Marmara although all the cosmopolitan and boreal species and a great portion of the Mediterranean endemic that exist in Turkish seas are also present in the Marmara.

Approximately half of the Mediterranean species have been found in the Sea of Marmara. DEMİR (2003) determined that 145 species were present but he collected material from 1951 to 1982. Therefore, his findings do not necessarily represent the present situation in the Sea of Marmara. Only 59 species were found in our current study, indicating that species richness has been negatively impacted by habitats damaged by the construction of new ports and motorways along the edge of the sea and by domestic and industrial pollution.

ACKNOWLEDGEMENTS

The authors are grateful to Dr. J.M. POUTIERS from Museum National d'Histoire Naturelle, Paris, and Dr. S. SCHIAPARELLI from Istituto di Scienze Ambientali Marine, Genova, for their valuable help in confirmation of determined species and in providing some literature.

REFERENCES

- ALBAYRAK, S. & N. BALKIS. 1996. Bivalve fauna of the Bosphorus. *İstanbul Üniversitesi Fen Fakültesi Biyoloji Dergisi*, 59: 1-15.
- BALKIS, H. 1992. Marmara Adası littoralinin makrobentosu üzerine bir ön araştırma. *Bülten*, 9: 309-327.
- BEŞİKTEPE, Ş.T., H.İ. SUR, E. ÖZSOY, M.A. ABDUL LATIF, T. OĞUZ & Ü. ÜNLÜATA. 1995. The circulation and hydrography of the Marmara Sea. *Pro. Oceanog.*, 34: 285-334.
- CASPERS, H. 1968. La macrofaune benthique du Bosphore et les problèmes de l'infiltration des éléments méditerranéens dans la Mer Noire. *Rapp. Comm. int. Mer Médit.*, 19 (2): 107-115.
- CLEMAM. 2003. Check List of European Marine Mollusca. Paris. <http://www.mnhn.fr/base/malaco.html>
- COLOMBO, A. 1885. Raccolte zoologiche eseguite dal R. Piroscapo Washington nella campagna abissale Talosso dell'anno, 1885. *Rivista Marittima*: 22-53.
- DEMİR, M. 1952. Boğaz ve adalar sahillerinin omurgasız dip hayvanları. *Osman Yalçın Matbaası, İstanbul*, 615 pp.
- DEMİR, M. 2003. Shells of Mollusca collected from the seas of Turkey. *Turk. J. Zool.*, 27: 101-140.
- DEVEDJIAN, K. 1926. Mollusques Pélécy-podes ou Lamellibranches. Pêche et pêcheries en Turquie. İstanbul, Imprimerie de l'Administration de la Dette Publique Ottomane: 271-283.
- ERYILMAZ, L.S. 1997. A preliminary study on the macrobenthos of littoral of the Island of Paşalimanı in the Sea of Marmara. *Istanbul University Journal of Biology*, 60: 47-59.
- KANEVA-ABADJIEVA, V. 1959. La faune des Mollusques de la région du Bosphore. *Comptes Rendus de l'Académie Bulgare des Sciences*, 12 (5): 439-442.
- MARION, A.F. 1898. Notes sur la faune des Dardanelles et du Bosphore. *Ann. Mus. Hist. nat. Marseille*, (Sér. 2), *Bull. Notes Zool. Géol., Paléontol.*, 1 (1): 163-182.
- NINNI, E. 1923. Crostacei e Molluschi eduli che comunemente vengono portati sul mercato di Constantinopoli. Primo contributo allo studio dei pesci e della pesca nelle acque dell'Impero Ottomano. Venezia, Premiate Officine Grafiche Carlo Ferrari, V: 61-64.
- OBERLING, J. 1969-1971. On the littoral Mollusca of the Sea of Marmara. *Jahrb. Naturhist. Mus. Stadt Bern*, 4: 183-218.
- OKUŞ, E. 1989. Marmara Adası (Kuzey) littoralinde yapılan araştırmalar. *Bülten*, 6: 143-166.
- OSTROUMOFF, A. 1896. Comptes rendus des dragages et du plancton de l'expédition de "Selanik". *Bull. Acad. Sci. St. Petersb.*, 5 (5): 33-92.
- ÖZTÜRK, B. & C. ÇEVİK. 2000. Molluscs fauna of Turkish seas. *Club Conchylia Informationen*, 32 (1/3): 27-53.
- PALLARY, P. 1917. Mollusques marins des Dardanelles colligés par M. Claude Bravard. *Journal de Conchyl.*, 63 (2): 142-147.
- PARENZAN, P. 1974. Carta d'identità delle conchiglie del Mediterraneo. Vol. II. Bivalvi, Prima Parte. Ed. Bios Taras, Taranto, 277 pp.
- PARENZAN, P. 1976. Carta d'identità delle conchiglie del Mediterraneo. Vol. II. Bivalvi, Seconda Parte. Ed. Bios Taras, Taranto, 283-546 pp.
- PINAR, E. 1974. Türkiye'nin bazı limanlarında fouling-boring organizmalar ve antifouling-antiboring boyaların bunlar üzerindeki etkisi. *Ege Üniversitesi Fen Fakültesi İlmî Raporlar Serisi*, 170, *Biyoloji* 113: 1-67.
- POPPE, G. T. & Y. GOTO. 1993. European seashells. Vol. II (Scaphopoda, Bivalvia, Cephalopoda). *Werlag Christa Hemmen, Wiesbaden*, 221 pp.
- POUTIERS, J. M. 1987. Bivalves (Acephales, Lamellibranches, Pelecypodes). In: Fischer, W., Bauchot, M. L. & Schneider, M. (Editors). *Fiches FAO d'identification des espèces pour les besoins de la pêche (Révision 1). Méditerranée et Mer Noire. Zone de Pêche 37. Végétaux et Invertébrés. Rome*, 1: 369-512.
- SABELLI, B., R. GIANNUZZI-SAVELLI & D. BEDULLI. 1990. Annotated check-list of

- Mediterranean marine mollusks. Vol. 1. Libreria Naturalistica Bolognese, Bologna, 348 pp.
- TEBBLE, N. 1966. British bivalve seashells. Trustees of the British Museum (Natural History), London, 212 pp.
- TORTONESE, E. 1959. Osservazioni sul bentos del Mar di Marmara e del Bosforo. Riv. Scienze Naturali "Natura", Milano, 50: 18-26.
- TUĞRUL, S. & POLAT, S.C. 1995. Quantitative comparison of the influxes of nutrients and organic carbon into the Sea of Marmara both from antropogenic sources and from the Black Sea. Wat. Sci. Tech. 32 (2): 115-121.
- UYSAL, A., A. YÜKSEK & E. OKUŞ. 1998. İstanbul Boğazı, Marmara ve Karadeniz girişlerindeki bentik organizmaların tür çeşitliliği ve dağılımları. Büyükşehirlerde Atıksu Yönetimi ve Deniz Kirlenmesi Kontrolü Sempozyumu, 18-20 Kasım 1998, İstanbul: 139-155.
- ÜNLÜATA, U., T. OĞUZ, M.A. LATİF & E. ÖZSOY. 1990. The physical oceanography of the Turkish Straits. In: L. J. Pratt (Editors). The Physical Oceanography of Sea Straits. Kluwer, Dortrecht, 318: 25-60.
- YÜKSEK, A. 1989. Marmara Adası güney sahillerinin littoral biotası üzerinde bir araştırma. Bülten, 6: 203-216.

Received: 8 January 2002

Accepted: 9 December 2003

Fauna školjkaša (mekušaca) Mramornog mora

Serhat ALBAYRAK, Hüsamettin BALKIS i Neslihan BALKIS

*Sveučilište u Istanbulu, Fakultet Znanosti, Odsjek Biologije,
34118 Vezneciler-Istanbul, Turska
E-mail: serhatal@istanbul.edu.tr*

SAŽETAK

Cilj ovih istraživanja je bio odrediti faunu školjkaša u Mramornom moru kao i neke njihove ekološke karakteristike. Materijal je prikupljen na 86 od 254 proučavane postaje u periodu od 1990. do 1999. godine. Pronađeno je 59 vrsta iz 49 rodova i 28 porodica. Popis ovih vrsta je dat zajedno s 205 prethodno nađenih vrsta. Iznose se podaci o hidrografskim uvjetima kao što su salinitet, temperatura i otopljeni kisik. Zabilježen je manji broj vrsta u usporedbi s prethodnim uzorkovanjima, iz čega se zaključuje da gradnja luka i cesta uz obalu doprinosi uništavanju habitata kao što to također čine industrijski i urbani otpad.

Ključne riječi: Bivalvia, mekušci, Mramorno more