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The Bivalvia Mollusca of Thessaloniki & Thermaikos Gulfs (North Aegean Sea, Greece) with emphasis on new species for Hellenic waters

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The marine molluscan bivalve fauna of Thessaloniki Gulf (Thessaloniki Bay included) and Thermaikos Gulf was investigated and collected by diving and trawling during the period from March 2005 to October 2008, after three decades from the completion of the previous relevant study. 188 species belonging to 48 families were identified and their biodiversity was compared with the current checklists of marine molluscs for Northern Aegean Sea and Hellenic seas based on previous surveys. In this bivalve collection nine species are new for the Greek fauna, 18 are new for N Aegean Sea and six of them represent lessepsian migrants from the Red Sea (all of them new for the Hellenic waters). The occurrence of new species for the study area and Hellenic seas is discussed.

Key words: molluscs, marine bivalves, invasive species, Thermaikos Gulf, North Aegean Sea.

INTRODUCTION

The Mediterranean Sea comprises less than 1% in surface area and volume as compared with the world oceans but yet includes a total of around 8500 species of macroscopic organisms, which indicates a rich biodiversity (Bianchi & Morri, 2000). This could be explained by its geological history (Maldonado, 1985; Ruffel, 1997) and the conspicuous ecological and hydrological differences in various localities (Sará, 1985). Moreover, biodiversity, mainly in E Mediterranean Sea –close to the Suez Canal– and the Strait of Gibraltar, has undergone modifications during recent decades, following the introduction of non-indigenous species, attributed to the expansion of shipping traffic, aquaculture activities and migration (Por, 1978, 1990; Galil & Zenetos, 2002; Streftaris *et al*., 2005).

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Thessaloniki Gulf (Thessaloniki Bay included) and Thermaikos Gulf (NW Aegean Sea) are referred generally as Thermaikos Gulf by numerous papers and comprise one of the most complicated and multi-used ecosystems of the E Mediterranean Sea since i) it receives an input of nutrient-rich freshwater from five rivers and some protected wetlands (Ramsar convention and Natura 2000 network) resulting in very high productivity and biodiversity of its coastal waters, ii) it is a main navigation line leading to the city of Thessaloniki and iii) it is affected by human activities in all its coastal zone (i.e. urbanization, agriculture, fisheries, mussel farming and recreation). Currently, Thermaikos and Thessaloniki Gulfs are considered as a sensitive ecosystem (and rather is), according to the term "sensitive" that has been precisely defined by Hiscock & Tyler-Walters (2006) and Tyler-Walters *et al*. (2009). For such an ecosystem, although there are numerous environmental investigations, only a few are referred to its fauna and even to

its bivalve molluscs exclusively, i.e. Sakellariou (1957), Zenetos (1996) and Zenetos *et al*. (2005). Research over the last 50 years on the benthic fauna of Thermaikos gulf has revealed the presence of several bivalve species (Zarkanellas, 1980; Antoniadou *et al*., 2004).

The main goals of this study are: a) to contribute to the knowledge of bivalve biodiversity with an updated catalogue of bivalve species of Thermaikos Gulf, b) to compare the present biological diversity of the area with that recorded in publications of the past and c) to improve our knowledge on the distribution and expansion of invasive bivalve species. This purpose was facilitated by the use of i) several books, atlases and on-line services, such as Oliver (1992), Poppe & Goto (1993), Giannuzzi-Savelli *et al*. (2001), Cachia *et al*. (2004), Doneddu & Trainito (2005), Repetto *et al*. (2005), Delamotte & Vardala-Theodorou (2008), ELNAIS (https://services.ath.hcmr.gr/spec) and Natuurhistorisch Museum Rotterdam (www.nmr-pics.nl), ii) faunistic and review articles (i.e. Salas, 1996; Demir, 2003; Gofas & Salas, 2008) and iii) relevant studies of the Mollusca fauna in Hellenic areas (i.e. Zenetos *et al*., 2005, 2007, 2009a; Ovalis & Zenetos, 2007).

MATERIALS AND METHODS

Sampling of live, mainly, specimens was conducted in the coastal areas of Thessaloniki Bay, Thessaloniki Gulf and Thermaikos Gulf (NW Aegean sea, Greece) (Fig. 1) during the period from 2005 to 2008. The samples were collected by a) a van Veen type grab of a 1000 cm^2 sampled surface (all stations), b) a professional (traditional) shell fisheries dredge (130 cm wide, nylon drag net of 2.2 cm mesh) (stations C, D, E, H, I), c) a professional trawl (station area S) and d) snorkeling (stations K, L, M, N). Species were collected by sieving the soft substrate through a 5 mm, a 2 mm and a 0.5 mm mesh sieve. After rinsing with fresh water, shells were treated with 25% glycerin in ethanol and stored at room temperature. All species collected were accompanied by data regarding synonyms, shell sizes, habitat characters and collection depths and dates. The nomenclature followed in this study was that of European Register of Marine Species (ERMS) (www.marbef.org) and the species recognition was based on systematic guides and atlases listed in References. For the species nomenclature update (30 November 2009) beside the ERMS, the CLEMAM on-line Database was used. The specimens are deposited in the

FIG. 1. Map of the study area: **1**. Thessaloniki Bay (stations **F** and **G**); **2**. Thessaloniki Gulf (stations **D**, **E**, **H** and **I**); **3**. Thermaikos Gulf (stations **A-C**, **J-R** and **S**). Collection stations: **A**. Scala Litochorou; **B**. Kitros; **C**. Axios River Estuaries; **D**. Chalastra; **E**. Naziki; **F**. Paliomana; **G**. Micro Emvolo; **H**. MACEDONIA Airport; **I**. Ajia Triada; **J**. Aggelohori; **K**. Palioura; **L**. Paralia; **M**. Cape of Epanomi; **N**. Potamos; **O**. Nea Kallikratia; **P**. Nea Moudania; **Q**. Sani; **R**. Poseidi; **S**. Trawled area. ***w***. Wetlands.

TABLE 1. Bivalvia species in a taxonomic order and their occurrence in the collection stations: **A**. Scala Litochorou; **B**. Kitros; **C**. Axios River Estuaries; **D**. Chalastra; **E**. Naziki; **F**. Paliomana; **G**. Micro Emvolo; **H**. MACEDONIA Airport; **I**. Ajia Triada; **J**. Aggelohori; **K**. Palioura; **L**. Paralia; **M**. Cape of Epanomi; **N**. Potamos; **O**. Nea Kallikratia; **P**. Nea Moudania; **Q**. Sani; **R**. Poseidi; **S**. Trawled area. The substrate type is indicated by (**M**): Muddy; (**S**): Sandy; (**SM**): sandy and muddy. *indicates new species for N Aegean Sea and **new species for Hellenic waters. Thessaloniki Bay: stations **F** and **G**; Thessaloniki Gulf: stations **D**, **E**, **H** and **I**; Thermaikos Gulf: stations **A-C**, **J-R** and **S**

		STATION (SUBSTRATE TYPE)	**A. (S)**	**B. (SM)**	**C. (SM)**	**D. (SM)**	**E. (M)**	**F. (M)**	**G. (M)**	**H. (M)**	**I. (SM)**	**J. (SM)**	**K. (SM)**	**L. (SM)**	**M. (SM)**	**N. (S)**	**O. (SM)**	**P. (SM)**	**Q. (SM)**	**R. (S)**	**S. (M)**
		Depth (m)	**6-12**	**8-15**	**5-10**	**5-12**	**4-8**	**8-10**	**3-10**	**5-13**	**5-10**	**8-12**	**3-10**	**3-8**	**2-10**	**2-20**	**6-11**	**4-10**	**5-10**	**4-10**	**30-40**
FAMILY	**Species**																				
SOLEMYIDAE	*Solemya togata* (Poli 1795)														+				+	+	
NUCULIDAE	*Nucula nitidosa* Winckworth 1930						+			+	+		+			+				+	
	Nucula nucleus (Linné 1758)									+	+	+	+								
	Nucula sulcata Bronn 1831									+	+	+	+								
NUCULANIDAE	**Nuculana pella* (Linné 1767)									+		+	+								
	Nuculana illirica Carrozza 1987													+							
ARCIDAE	*Anadara polii (*Mayer 1868)														+						
	Anadara transversa (Say 1822)					+	+	+				+	+							+	
	Arca noae Linné 1758							+	+	+	+	+	+	+				+			
	Arca tetragona Poli 1795																	+			
	Asperarca nodulosa (Müler 1776)										+		+		+						
	Barbatia barbata (Linné 1758)											+	+		+		+			+	
	Barbatia clathrata (Defrance 1816)												+								
NOETIIDAE	*Striarca lactea* (Linné 1758)								+	+	+		+		+				+	+	
GLYCYMERIDIDAE	*Glycymeris bimaculata* (Poli 1795)														+						
	Glycymeris glycymeris (Linné 1758)													+	+					+	
	Glycymeris violacescens (Lamarck 1819)												+		+					+	
MYTILIDAE	*Gregariella petagnae* (Scacchi 1832)							+				+	+						+		
	Gregariella semigranata (Reeve 1858)						+														
	Lithophaga lithophaga (Linné 1758)										+				+						
	Modiolarca subpicta (Cartaine 1835)									+											
	Modiolula phaseolina (Philippi 1844)									+	+				+						
	Modiolus adriaticus (Lamarck 1819)												+								

TABLE 1. Continued

FAMILY	Species	STATION (SUBSTRATE TYPE)	A. (S)	B. (SM)	C. (SM)	D. (SM)	E. (M)	F. (M)	G. (M)	H. (M)	I. (SM)	J. (SM)	K. (SM)	L. (SM)	M. (SM)	N. (S)	O. (SM)	P. (SM)	Q. (SM)	R. (S)	S. (M)
		Depth (m)	6-12	8-15	5-10	5-12	4-8	8-10	3-10	5-13	5-10	8-12	3-10	3-8	2-10	2-20	6-11	4-10	5-10	4-10	30-40
	Modiolus barbatus (Linné 1758)					+	+	+	+	+	+	+	+	+	+					+	
	Musculus discors (Linné 1767)												+								
	Musculus costulatus (Risso 1826)						+		+	+	+			+	+					+	
	**Mytilaster lineatus* (Gmelin 1791)												+								
	**Mytilaster marioni* (Locard 1889)												+								
	Mytilaster minimus (Poli 1795)														+						
	Mytilus edulis Linné 1758													+							
	Mytilus galloprovincialis Lamarck 1819		+	+		+	+	+	+	+	+	+	+	+	+	+		+		+	
PINNIDAE	*Atrina pectinata* (Linné 1767)																				+
	Pinna nobilis Linné 1758					+	+			+	+	+	+		+						
PTERIIDAE	*Pinctada radiata* (Leach 1814)												+					+			
	Pteria hirundo (Linné 1758)											+	+								+
PECTINIDAE	*Aequipecten opercularis* (Linné 1758)									+						+					+
	Chlamys flexuosa (Poli 1795)												+								
	Chlamys glabra (Linné 1758)			+		+	+		+	+	+	+	+	+	+					+	
	Chlamys pesfelis (Linné 1758)										+				+						
	Chlamys proteus (Dillwyn 1817)					+							+								
	Chlamys varia (Linné 1758)					+	+		+	+	+	+	+		+				+	+	+
	Crassadoma multistriata (Poli 1795)										+		+		+						
	Delectopecten vitreus (Gmelin 1791)														+						
	Lissopecten hyalinus (Poli 1795)												+		+						
	Palliolum incomparabile (Risso 1826)																	+			
	Pecten jacobeus (Linné 1758)								+		+				+						+
	Pseudamussium clavatum (Poli 1795)																	+			
	Similipecten similis (Laskey 1811)																	+			

TABLE 1. Continued

FAMILY	Species	STATION (SUBSTRATE TYPE)	A. (S)	B. (SM)	C. (SM)	D. (SM)	E. (M)	F. (M)	G. (M)	H. (M)	I. (SM)	J. (SM)	K. (SM)	L. (SM)	M. (SM)	N. (S)	O. (SM)	P. (SM)	Q. (SM)	R. (S)	S. (M)
		Depth (m)	6-12	8-15	5-10	5-12	4-8	8-10	3-10	5-13	5-10	8-12	3-10	3-8	2-10	2-20	6-11	4-10	5-10	4-10	30-40
SPONDYLIDAE	*Spondylus gaederopus* Linné 1758										+	+			+						
ANOMIIDAE	*Anomia ephippium* Linné 1758					+	+		+	+	+	+	+	+	+		+		+		
	Heteranomia squamula (Linné 1758)								+				+								
	Pododesmus aculeatus (Müller 1776)						+						+								
	Pododesmus patelliformis (Linné 1761)								+				+							+	+
LIMIDAE	*Lima lima* (Linné 1758)												+								
	Limaria hians (Gmelin 1791)					+									+						
	Limaria tuberculata (Olivi 1792)					+						+	+		+						
	Limea loscombii (Sowerby G.B. I 1823)												+								
OSTREIDAE	*Ostrea edulis* Linné 1758										+	+	+		+					+	
	Ostreola stentina (Payraudeau 1826)									+			+								
GRYPHAEIDAE	*Neopycnodonte cochlear* (Poli 1795)																+				
LUCINIDAE	*Anodontia fragilis* (Philippi 1836)										+				+						
	Ctena decussata (Costa O.G. 1829)							+			+	+	+		+		+	+	+	+	
	Loripes lacteus (Linné 1758)						+	+		+	+	+	+		+		+		+		
	Lucinella divaricata (Linné 1758)						+				+	+			+						
	Lucinoma borealis (Linné 1767)							+			+										
	Myrtea spinifera (Montagu 1803)								+				+								
THYASIRIDAE	*Thyasira subovata* (Jeffreys 1881)													+							
UNGULINIDAE	** *Diplodonta bogii* van Aartsen 2004													+							
	Diplodonta brocchii (Deshayes 1850)													+							
	***Diplodonta globosa* (Forsskål 1775)													+							
	Diplodonta rotundata (Montagu 1803)												+			+				+	

TABLE 1. Continued

FAMILY	Species	STATION (SUBSTRATE TYPE) / Depth (m)	A. (S) 6-12	B. (SM) 8-15	C. (SM) 5-10	D. (SM) 5-12	E. (M) 4-8	F. (M) 8-10	G. (M) 3-10	H. (M) 5-13	I. (SM) 5-10	J. (SM) 8-12	K. (SM) 3-10	L. (SM) 3-8	M. (SM) 2-10	N. (S) 2-20	O. (SM) 6-11	P. (SM) 4-10	Q. (SM) 5-10	R. (S) 4-10	S. (M) 30-40
CHAMIDAE*	*Chama asperella* Lamarck 1819							+	+				+				+				
	**Chama aspersa* Reeve 1846													+							
	Chama gryphoides Linné 1758						+	+	+		+		+	+	+		+			+	
	***Chama pacifica* Broderip 1834								+												
	**Pseudochama corbieri* (Jonas 1846)								+						+						
	Pseudochama gryphina (Lamarck 1819)								+	+	+	+	+		+		+		+		
GALEOMMATIDAE	*Galeomma turtoni* Sowerby in Turton 1825													+	+						
KELLIIDAE	*Bornia sebetia* (Costa O.G. 1829)												+		+						
	Kellia suborbicularis (Montagu 1803)												+					+			
LASAEIDAE	*Hemilepton nitidum* (Turton 1822)														+						
	Scacchia oblonga (Philippi 1836)														+						
MONTACUTIDAE	*Epilepton clarkiae* (Clark W. 1852)														+						
	Kurtiella bidentata (Montagu 1803)									+			+		+						
	Tellimya ferruginosa (Montagu 1808)												+								
	Tellimya tenella (Lovén 1846)												+								
CARDITIDAE	*Cardita calyculata* (Linné 1758)														+						
	**Cardites akabana* (Sturany 1899)										+				+						
	Glans aculeata (Poli 1795)										+			+							
	Glans trapezia (Linné 1767)										+	+	+		+		+				
	Venericardia antiquata (Linné 1758)										+	+	+		+	+	+	+			
ASTARTIDAE	*Digitaria digitaria* (Linné 1758)						+	+			+	+								+	

TABLE 1. Continued

FAMILY	Species	STATION (SUBSTRATE TYPE)	A. (S)	B. (SM)	C. (SM)	D. (SM)	E. (M)	F. (M)	G. (M)	H. (M)	I. (SM)	J. (SM)	K. (SM)	L. (SM)	M. (SM)	N. (S)	O. (SM)	P. (SM)	Q. (SM)	R. (S)	S. (M)
		Depth (m)	6-12	8-15	5-10	5-12	4-8	8-10	3-10	5-13	5-10	8-12	3-10	3-8	2-10	2-20	6-11	4-10	5-10	4-10	30-40
CARDIIDAE	*Acanthocardia aculeata* (Linné 1758)															+					+
	Acanthocardia echinata (Linné 1758)																+				
	Acanthocardia paucicostata (Sowerby G.B.II 1841)												+								+
	Acanthocardia spinosa (Lightfoot in Solander 1786)													+							
	Acanthocardia tuberculata (Linné 1758)												+			+	+		+	+	
	Cerastoderma edule (Linné 1758)												+								
	Cerastoderma glaucum (Poiret 1789)										+	+			+			+	+		
	Laevicardium crassum (Gmelin 1791)												+	+	+						
	Laevicardium oblongum (Gmelin 1791)													+	+						+
	Parvicardium exiguum (Gmelin 1791)						+		+		+		+								
	Parvicardium minimum (Philippi 1836)												+								
	Parvicardium ovale (Sowerby G.B. II 1840)												+								
	Parvicardium scabrum (Philippi 1844)										+				+						
	**Parvicardium scriptum* (Bucquoy, Dautzenberg & Dollfus 1892)														+				+		
	**Parvicardium trapezium* Cecalupo & Quadri 1996										+				+						
	Plagiocardium papillosum (Poli 1795)											+		+	+		+		+		
MACTRIDAE	*Mactra stultorum* (Linné 1758)										+	+	+	+					+		
	Mactra glauca Von Born 1778											+	+	+	+		+			+	+
	Spisula subtruncata (da Costa 1778)									+	+	+	+	+	+	+	+		+	+	
MESODESMATIDAE	*Donacilla cornea* (Poli 1795)										+	+	+	+	+	+	+			+	
	***Monterosatus primus* (Locard 1899)												+								
SOLENIDAE	*Solen marginatus* Pulteney 1799										+	+	+	+	+	+				+	
PHARIDAE	*Ensis ensis* (Linné 1758)												+	+	+	+					
	**Ensis minor* (Chenu 1843)												+								
	Phaxas pellucidus (Pennant 1777)				+																

TABLE 1. Continued

FAMILY	Species	STATION (SUBSTRATE TYPE)	A. (S)	B. (SM)	C. (SM)	D. (SM)	E. (M)	F. (M)	G. (M)	H. (M)	I. (SM)	J. (SM)	K. (SM)	L. (SM)	M. (SM)	N. (S)	O. (SM)	P. (SM)	Q. (SM)	R. (S)	S. (M)
		Depth (m)	6-12	8-15	5-10	5-12	4-8	8-10	3-10	5-13	5-10	8-12	3-10	3-8	2-10	2-20	6-11	4-10	5-10	4-10	30-40
TELLINIDAE	*Arcopagia balaustina* (Linné 1758)												+								
	Arcopagia crassa (Pennant 1777)												+								
	Gastrana fragilis (Linné 1758)						+	+		+	+	+	+		+		+			+	+
	Macoma cumana (Costa O.G. 1829)												+								
	Tellina distorta Poli 1791												+	+	+	+					
	Tellina donacina Linné 1758											+	+	+	+	+				+	
	Tellina fabula Gmelin 1791														+						
	Tellina incarnata Linné 1758											+	+	+	+	+				+	
	Tellina nitida Poli 1791												+	+	+	+				+	
	Tellina planata Linné 1758											+	+	+	+	+	+		+	+	
	Tellina pulchella Lamarck 1818														+						
	Tellina pygmaea Lovén 1846														+						
	Tellina serrata Brocchi 1814												+								
	Tellina tenuis da Costa 1778										+	+	+	+	+	+					+
DONACIDAE	*Capsella variegata* (Gmelin 1791)										+				+					+	
	Donax semistriatus Poli 1795										+	+	+	+	+	+	+		+		
	Donax trunculus Linné 1758			+							+	+	+	+	+	+			+		+
	Donax venustus Poli 1795										+	+	+				+		+		
PSAMMOBIIDAE	*Gari costulata* (Turton 1822)														+						
	Gari depressa (Pennant 1777)										+	+	+	+	+	+	+			+	
	Gari fervensis (Gmelin 1791)									+						+					
	Gari tellinella (Lamarck 1818)											+									
SCROBICULARIIDAE	*Scrobicularia cottardi* (Payraudeau 1826)												+	+	+						
SEMELIDAE	*Abra alba* (Wood W. 1802)		+				+	+		+	+				+					+	
	Abra longicallus (Scacchi 1834)														+						
	Abra nitida (Müller O.F. 1776)												+								
	Abra prismatica (Montagu 1808)				+								+								

TABLE 1. Continued

FAMILY	Species	STATION (SUBSTRATE TYPE)	A. (S)	B. (SM)	C. (SM)	D. (SM)	E. (M)	F. (M)	G. (M)	H. (M)	I. (SM)	J. (SM)	K. (SM)	L. (SM)	M. (SM)	N. (S)	O. (SM)	P. (SM)	Q. (SM)	R. (S)	S. (M)
		Depth (m)	6-12	8-15	5-10	5-12	4-8	8-10	3-10	5-13	5-10	8-12	3-10	3-8	2-10	2-20	6-11	4-10	5-10	4-10	30-40
SOLECURTIDAE	*Azorinus chamasolen* (da Costa 1778)												+		+						
	Solecurtus scopula (Turton 1822)												+								
	Solecurtus strigilatus (Linné 1758)												+	+	+					+	
KELLIELLIDAE	*Kelliella abyssicola* (Forbes 1844)														+						
GLOSSIDAE	*Glossus humanus* (Linné 1758)																				+
VENERIDAE	*Callista chione* (Linné 1758)											+	+	+	+				+	+	
	Chamelea gallina (Linné 1758)										+	+	+	+	+	+			+	+	
	Chamelea striatula (da Costa 1778)										+	+		+			+		+		
	***Circenita calipyga* (Born 1778)								+												
	Clausinella fasciata (da Costa 1778)												+			+					
	***Clausinella punctigera* (Dautzenberg & Fischer H. 1906)								+		+										
	***Dosinia erythraea* Roemer 1860											+									
	Dosinia exoleta (Linné 1758)									+	+	+	+	+	+					+	+
	Dosinia lupinus (Linné 1758)										+		+	+	+	+					
	Gouldia minima (Montagu 1803)							+		+	+	+			+		+			+	
	Irus irus (Linné 1758)											+	+		+					+	
	Paphia aurea (Gmelin 1791)										+	+	+	+		+	+		+		
	Paphia lucens (Locard 1886)														+						
	Paphia rhomboides (Pennant 1777)										+	+	+	+	+	+			+		+
	Pitar mediterranea (Tiberi 1855)																			+	
	Pitar rudis (Poli 1795)						+			+	+		+		+		+			+	
	Ruditapes decussatus (Linné 1758)											+	+	+					+		
	Timoclea ovata (Pennant 1777)												+								+
	Venerupis senegalensis (Gmelin 1791)											+	+	+	+	+			+		
	Venus casina Linné 1758												+					+			
	Venus verrucosa Linné 1758						+	+	+	+	+	+	+	+	+	+	+				

TABLE 1. Continued

FAMILY	Species	STATION (SUBSTRATE TYPE) / Depth (m)	A. (S) 6-12	B. (SM) 8-15	C. (SM) 5-10	D. (SM) 5-12	E. (M) 4-8	F. (M) 8-10	G. (M) 3-10	H. (M) 5-13	I. (SM) 5-10	J. (SM) 8-12	K. (SM) 3-10	L. (SM) 3-8	M. (SM) 2-10	N. (S) 2-20	O. (SM) 6-11	P. (SM) 4-10	Q. (SM) 5-10	R. (S) 4-10	S. (M) 30-40
PETRICOLIDAE	*Petricola lajonkairii* (Payraudeau 1826)											+	+		+		+	+			+
	Petricola lithophaga (Philippson 1788)									+			+		+						
CORBULIDAE	*Corbula gibba* (Olivi 1792)						+			+	+		+		+					+	+
	Lentidium mediterraneum (Costa O.G. 1829)												+								
GASTROCHAENIDAE	*Gastrochaena dubia* (Pennant 1777)						+	+	+	+	+	+	+		+					+	
	**Gastrochaena cymbium* Spengler 1783							+	+	+	+		+							+	
HIATELLIDAE	*Hiatella arctica* (Linné 1767)		+					+	+	+	+		+	+	+					+	
	Hiatella rugosa (Linné 1767)															+					
PHOLADIDAE	*Barnea candida* (Linné 1758)													+							
	Pholas dactylus Linné 1758										+	+	+								
TEREDINIDAE	*Teredo navalis* Linné 1758														+						
THRACIIDAE	*Thracia corbuloides* Deshayes 1830														+					+	+
	Thracia distorta (Montagu 1803)														+						
	Thracia papyracea (Poli 1791)												+		+						
	Thracia pubescens (Pulteney 1799)											+									
	Thracia villosiuscula (MacGillivray 1827)														+						
PANDORIDAE	*Pandora inaequivalvis* (Linné 1758)																			+	
CUSPIDARIIDAE	*Cuspidaria cuspidata* (Olivi 1792)											+									

premises of the Alexander Technological Educational Institute of Thessaloniki and in the premises of Dr. T. Manousis. Scientists are welcome to have access to the biological material at will.

RESULTS

As a result of this investigation, approximately 10000 specimens were collected from variable substrates such as sandy (stations N and R), muddy (station S) and sandy and muddy in all the rest of the stations (Fig. 1). A total of 188 species belonging to 48 families were identified (Table 1). Among the 48 families, the most species-rich was VENERIDAE with 21 species followed by CARDIIDAE (16 species), TELLINIDAE and MYTILIDAE (14 species each) and PECTINIDAE (13 species). The number of bivalve species that are reported for the first time from the study area is approximately 100, increasing the number of species in a percentage close to 100%. Among the identified species, nine are referred for the first time to the Hellenic fauna while these nine species together with nine more species are referred for the first time to the N Aegean Sea. In the study area, six invasive species originated from the Red Sea and three of W Mediterranean Sea or Atlantic origin are recognized. The majority of the new species for the Hellenic waters is endobenthic of soft substrates and one, *Gastrochaena cymbium*, of calcareous substrates like empty bivalve or gastropod shells.

The new species (for Hellenic fauna and N Aegean Sea), their origin and mode of life are presented in Table 2.

New records for Hellenic waters

Basic eco-geographical information for the new records per family in the Hellenic seas is given below:

1. NUCULANIDAE. Only one shell of the species *Nuculana illirica* Carrozza 1987 was found in the littoral zone of E Thermaikos in sandy-muddy bottom, 6.8 mm in length (Fig. 2A).
2. UNGULINIDAE. Two species of this family were collected: *Diplodonta bogii* van Aartsen 2004 (Fig. 2B) (one live specimen of 7 mm) and *Diplodonta globosa* (Forsskål 1775) (Fig. 2C) (one live specimen of 14 mm) in sandy-muddy bottom.
3. CHAMIDAE. One species of this family was collected live from rocky bottom: *Chama pacifica* Broderip 1834 (Fig. 2D) (one specimen of 6.7 mm in length).
4. CARDITIDAE. *Cardites akabana* (Sturany 1899), collected from sandy-muddy bottoms of the sublittoral zone of S Thessaloniki Gulf and E Thermaikos Gulf. A total of seven live specimens and two shells were collected with their lengths ranging from 1.6 mm to 7.6 mm (some bearing their periostracum) (Fig. 2E).
5. MESODESMATIDAE. Two live specimens of the very characteristic species *Monterosatus primus* (Locard 1899) (Fig. 2F) was collected from sandy-muddy bottom of the littoral zone of E Thermaikos (3.2 mm and 4.4 mm in length, respectively).
6. VENERIDAE. Three species of this family were collected from sandy-muddy bottoms of the sublittoral zone from the east coasts of the study area: *Circenita calipyga* (Born 1778) (one shell 8.6 mm in length) (Fig. 3A), *Clausinella punctigera* (Dautzenberg & Fischer H. 1906) (Fig. 3B) (two live specimens, 7.3 mm and 10 mm in length, respectively), and *Dosinia erythraea* Roemer 1860 (Fig. 3C) (two live specimens with length of 35 mm and 44 mm, respectively).

New records for N Aegean Sea

Apart from the nine new species for the Greek waters, nine more bivalve species are referred for the first time for N Aegean.

1. MYTILIDAE. Two species of Mytilidae were collected live from sandy-muddy bottoms of the sublittoral zone of E Thermaikos: *Mytilaster lineatus* (Gmelin 1791) (Fig. 3D) (10 live specimens with lengths ranging from 3.3 mm to 5.0 mm) and *Mytilaster marioni* (Locard 1889) (Fig. 3E) (one live specimen, 4.9 mm in length).
2. CHAMIDAE. Two species of this family were collected from rocky bottoms (live specimens): *Chama asperella* Lamarck 1819 (Fig. 4A) (four live specimens with length ranging from 8.2 mm to 17.6 mm), *Chama aspersa* Reeve 1846 (Fig. 4B) (two live specimens 15 mm and 26 mm in length, respectively) and *Pseudochama corbieri* (Jonas 1846) (Fig. 4C) (two live specimens of 13.1 mm and 19.1 mm, respectively).
3. CARDIIDAE. Two small species of this family were collected: *Parvicardium scriptum* (Bucquoy, Dautzenberg & Dollfus 1892) (Fig. 4D) (three live specimens ranging from 2.0 to 3.9 mm in length), and *Parvicardium trapezium* Cecalupo & Quadri 1996 (Fig. 4E) (four live specimens with lengths ranging from 2.0 mm to 6.2 mm).

TABLE 2. Bivalvia species new for Greek waters** and for N Aegean Sea*. **F**. Paliomana; **G.** Micro Emvolo; **H**. MACEDONIA Airport; **I**. Ajia Triada; **J**. Aggelohori; **K**. Palioura; **L**. Paralia; **M**. Cape of Epanomi; **O**. Nea Kallikratia; **R**. Poseidi. The substrate type is indicated by (**M**). Muddy, (**S**). Sandy, (**SM**). Sandy and muddy. Thessaloniki Bay: station **F** and **G**; Gulf of Thessaloniki: stations **H**, **I**; Thermaikos Gulf: stations **J**-**M**, **O** and **R**

		Station (Subtrate type)	**F. (M)**	**G. (M)**	**H. (M)**	**I. (SM)**	**J. (SM)**	**K. (SM)**	**L. (SM)**	**M. (SM)**	**O. (SM)**	**R. (S)**			
FAMILY	**Species**	**Depth (m)**	**8-10**	**3-10**	**5-13**	**5-10**	**8-12**	**3-10**	**3-8**	**2-10**	**6-11**	**4-10**	**Mode of life (Todd, 2001)**	**Found**	**Origin**
NUCULANIDAE	***Nuculana illirica* Carrozza 1987								+				Subsurface deposit feeder - endobenthic	shell	Adriatic Sea
MYTILIDAE	**Mytilaster lineatus* (Gmelin 1791)							+					Suspension feeder - epibenthic	alive	South Aegean
	**Mytilaster marioni* (Locard 1889)							+					Suspension feeder - epibenthic	alive	Red Sea
UNGULINIDAE	***Diplodonta bogii* van Aartsen 2004								+				Suspension feeder - endobenthic	alive	Red Sea
	***Diplodonta globosa* (Forsskål 1775)								+				Suspension feeder - endobenthic	alive	Red Sea
CHAMIDAE	**Chama asperella* Lamarck 1819		+	+				+			+		Suspension feeder - epibenthic	alive	Red Sea
	**Chama aspersa* Reeve 1846								+				Suspension feeder - epibenthic	alive	Red Sea
	***Chama pacifica* Broderip 1834			+									Suspension feeder - epibenthic	alive	Red Sea
	**Pseudochama corbieri* (Jonas 1846)			+						+			Suspension feeder - epibenthic	alive	South Aegean
CARDITIDAE	***Cardites akabana* (Sturany 1899)					+				+			Suspension feeder - endobenthic	alive	Red Sea
CARDIIDAE	**Parvicardium scriptum* (Bucquoy, Dautzenberg & Dollfus 1892)									+		+	Suspension feeder - endobenthic	alive	South Aegean
	**Parvicardium trapezium* Cecalupo & Quadri 1996					+				+			Suspension feeder - endobenthic	alive	Rare

TABLE 2. Continued

FAMILY	Species	Station (Subtrate type)	F. (M)	G. (M)	H. (M)	I. (SM)	J. (SM)	K. (SM)	L. (SM)	M. (SM)	O. (SM)	R. (S)	Mode of life (Todd, 2001)	Found	Origin
		Depth (m)	8-10	3-10	5-13	5-10	8-12	3-10	3-8	2-10	6-11	4-10			
MESODESMATIDAE	****Monterosatus primus** (Locard 1899)							+					Suspension feeder - endobenthic	alive	West Mediterranean
PHARIDAE	***Ensis minor** (Chenu 1843)							+					Suspension Feeder - endobenthic	alive	South Aegean
VENERIDAE	****Circenita calipyga** (Born 1778)			+									Suspension feeder - endobenthic	shell	Red Sea
	****Clausinella punctigera** (Dautzenberg & Fischer H. 1906)			+		+							Suspension feeder - endobenthic	alive	Atlantic Ocean
	****Dosinia erythraea** Roemer 1860						+						Suspension feeder - endobenthic	shell	Red Sea
GASTROCHAENIDAE	***Gastrochaena cymbium** Spengler 1783		+	+	+	+		+				+	Suspension feeder - endolithic in calcareous substrates	alive	South Aegean

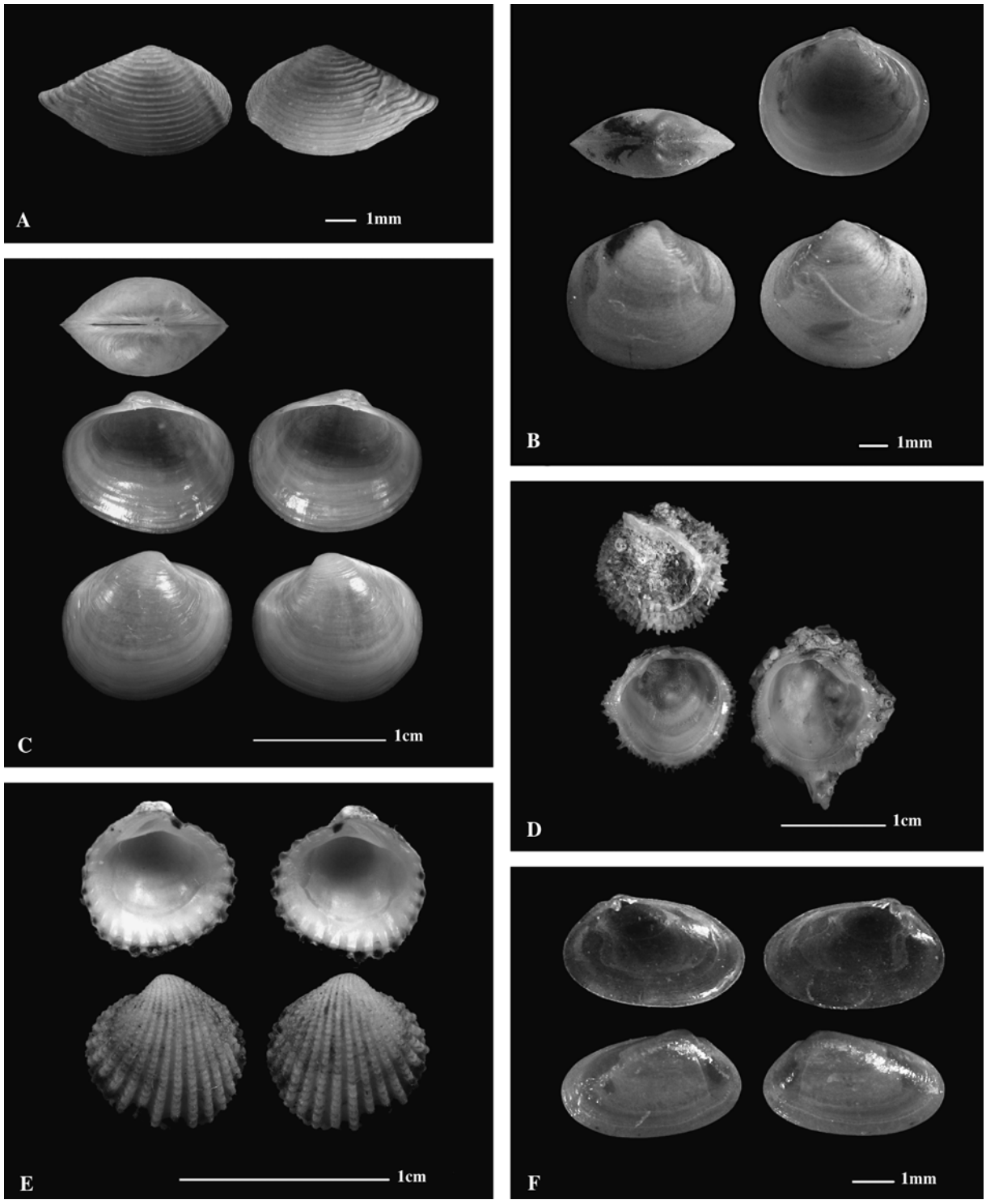

FIG. 2. New records for Hellenic waters: A. *Nuculana illirica*. B. *Diplodonta bogii*. C. *Diplodonta globosa*. D. *Chama pacifica*. E. *Cardites akabana*. F. *Monterosatus primus.*

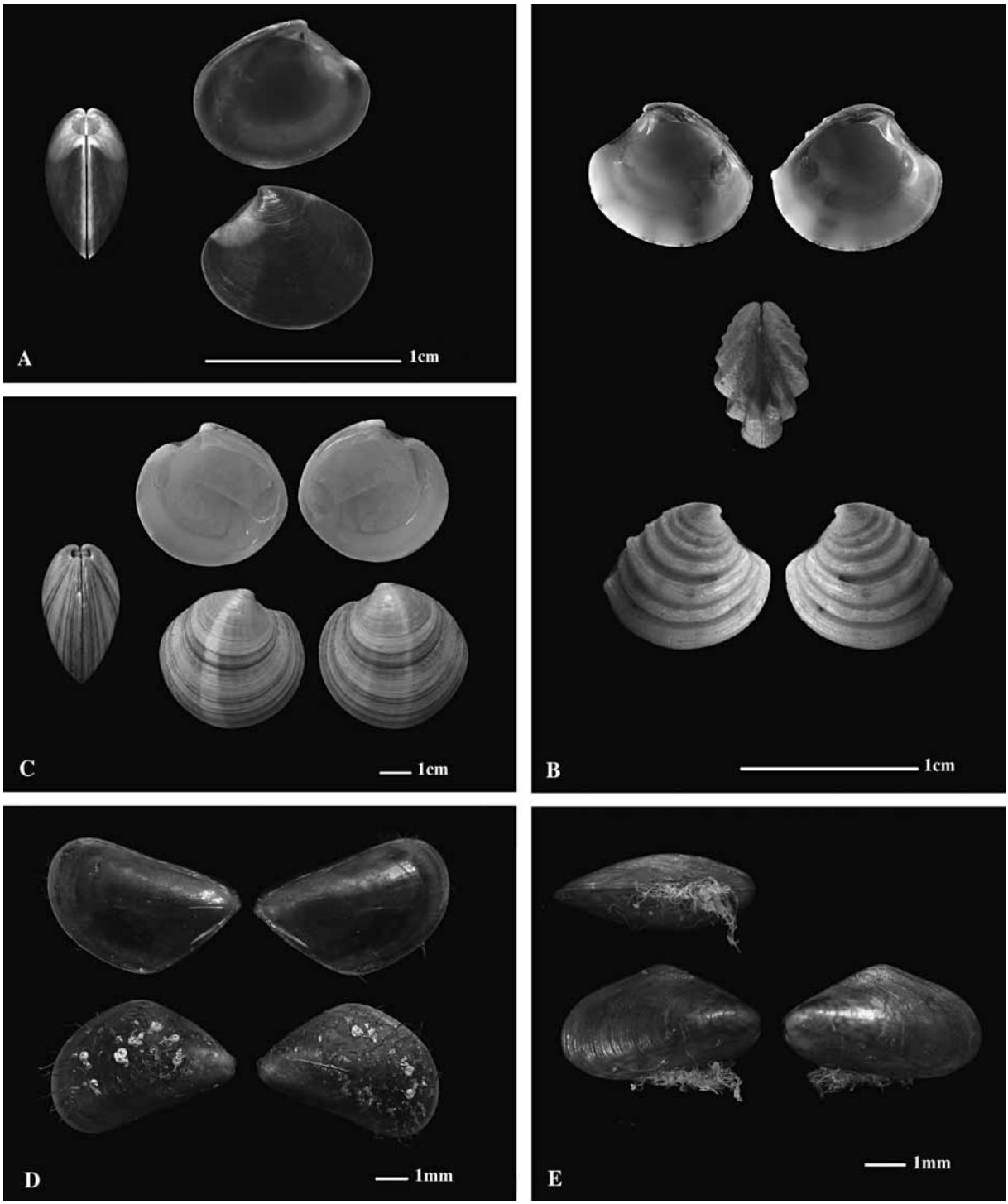

FIG. 3. New records for Hellenic waters (A-C) and N Aegean Sea (D-E): A. *Circenita calipyga*. B. *Clausinella punctigera*. C. *Dosinia erythraea*. D. *Mytilaster lineatus*. E. *Mytilaster marioni*.

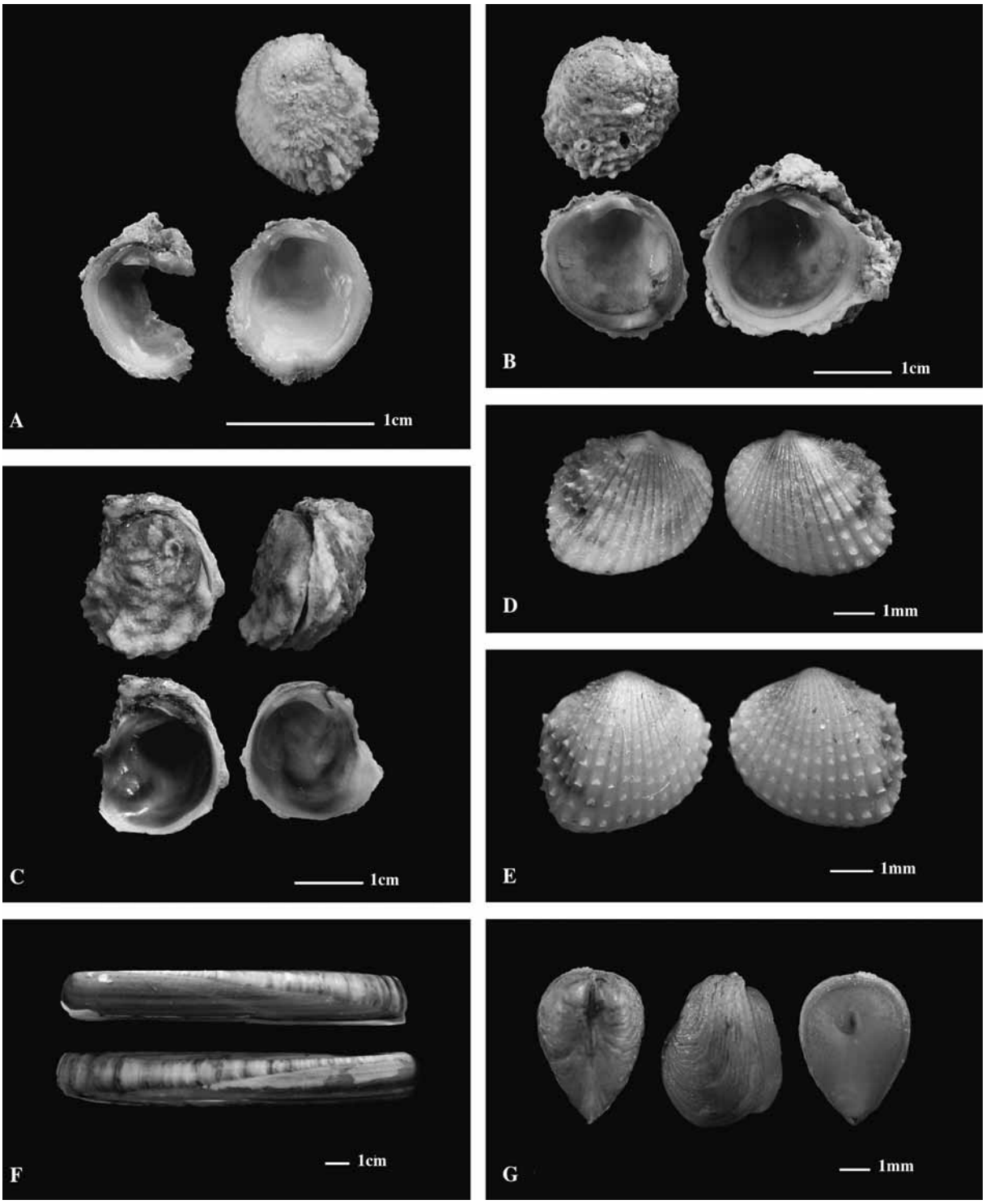

FIG. 4. New records for N Aegean Sea: A. *Chama asperella*. B. *Chama aspersa*. C. *Pseudochama corbieri*. D. *Parvicardium scriptum*. E. *Parvicardium trapezium*. F. *Ensis minor*. G. *Gastrochaena cymbium*.

4. PHARIDAE. One specimen of *Ensis minor* (Chenu 1843), 121 mm in length (Fig. 4F) was collected live from the littoral zone of E Thermaikos.
5. GASTROCHAENIDAE. From six stations of the sublittoral zone of E Thermaikos Gulf, Thessaloniki Gulf and Thessaloniki Bay, more than 30 live specimens of *Gastrochaena cymbium* Spengler 1783, 5.4-5.7 mm in length, were dissected out of their calcareous capsules (Fig. 4G).

DISCUSSION

The last list of bivalves included 96 species from Thermaikos Gulf (Zenetos, 1996). The present survey has almost doubled the number of the known species from that area and presents new data on the biodiversity of Thermaikos Gulf. At the same time, it reveals the presence of 18 new species from the N Aegean Sea and, among them, nine new species for Greece (Table 2). This means that approximately 3% of the registered species in this work is not included in the latest checklists for Hellenic bivalves (Zenetos *et al*., 2005, 2007). Six new species for Greece, namely *Diplodonta bogii* van Aartsen 2004, *Diplodonta globosa* (Forsskål 1775), *Chama pacifica* Broderip 1834, *Cardites akabana* (Sturany 1899), *Circenita calipyga* (Born 1778) and *Dosinia erythraea* Roemer 1860, are new lessepsian migrants in Hellenic waters raising the number of marine alien species from 14 (ELNAIS, Zenetos *et al*., 2009a) to 20. Except of *D. globosa,* the other five species from the Red Sea have been already recorded from the coasts of Levantine Sea (Zenetos *et al*., 2003; Çinar *et al*., 2005; Çeviker & Albaryak, 2006; Galil, 2007).

Gastrochaena cymbium was firstly referred from S Aegean by Tenekidis (1989) and was characterized and listed as "casual" alien species (ELNAIS, Zenetos *et al*., 2009a). After the frequent occurence of *G. cymbium* along the north-east coasts of the study area, its characterization as "casual" should be rather changed to "established".

The four Chamidae species collected in the study area and originated from the Red Sea seem to be well expanded and established, sinse large size shells belonging to each one of them have been found (besides of the mentioned alive specimens). Thus, the expansion of *Chama aspersa* and *C. asperella* from the Red Sea to the E Mediterranean in 2004 and to S Aegean Sea in 2007 presented by Ovalis & Zenetos (2007) continuous to the N Aegean Sea.

The presence of the non-native *Cardites akabana* in the Mediterranean waters was first reported by Çeviker & Albaryak (2006), while that of *Pseudochama corbieri* in the S Aegean Sea has been reported by Zenetos *et al*. (2003).

The occurrence of *Claucinella punctigera* (two live specimens in Thessaloniki Bay and Thermaikos Gulf) is reported for the first time from E Mediterranean and has already been referred from W Mediterranean Sea (Repetto *et al.*, 2005). The gap of this species distribution between W and E Mediterranean could be attributed either to its rather recent transfer with ships ballasts (for similar cases, see also Zenetos *et al*., 2008, 2009b) or due to its rarity.

The invasion progress of an alien species may be attributed to its life strategy and history, hydrodynamics (currents), geo-climatic status and changes and anthropogenic activities, although certain mediated parameters for invasion success of bivalves, such as the body size, the growth rate and fecundity (Roy *et al*., 2002), may have contributed to their expansion. For eight out of the nine new records for Hellenic seas, two species have previously been found in W Mediterranean Sea or E Atlantic Ocean and six in the Red Sea; these seas represent the major pathways for the alien bivalves to the Greek waters due to a) ships ballasts, b) northwards currents in Suez Gulf (Rady *et al*., 1998) and c) water entrance from the Atlantic Ocean in the Mediterranean Sea, distributing larvae to the E and W Mediterranean, respectively (Shefer *et al*., 2004). Besides the ships ballasts, Pancucci-Papadopoulou *et al*. (2005) referred the Black Sea as the main source of alien species for Thessaloniki Bay, although this could not be supported any longer according to the recent information presented in the research effort of Zenetos *et al.* (2009a).

The distribution of *Pinctada radiata* has expanded north to the E Thermaikos along the navigation line to the harbour of Thessaloniki. This may be attributed to the same reasons, namely shipping and mariculture activities as well as to epibiosis on the sea turtle *Caretta caretta* that is believed to be responsible for its distribution to the Hellenic seas (Oliverio *et al*., 1992; Zenetos *et al*., 2003).

We feel that further research emphasizing on small in size species (most of the new records of this study were < 5 mm), symbionts, epibionts and rare species needs to be contucted in order to further explore the present biodiversity of bivalves in the area.

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