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New and uncommon Bivalvia Mollusca of Thermaikos Gulf (NW Aegean Sea)

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The molluscan bivalve fauna of Thermaikos Gulf was investigated and collected with emphasis on the minor in size species during the period from October 2008 to June 2013. Forty six species belonging to 23 families were identified and their biodiversity was compared with the current checklists of marine bivalve molluscs for the Hellenic seas based on previous surveys. In this collection of bivalves, nine are new for the Eastern Mediterranean Sea, 15 are new for the Hellenic fauna (three of which are alien) and 39 are new for Thermaikos Gulf (five of which are alien). These records raise the Hellenic and Thermaikos Gulf bivalve fauna by approximately 5.5% and 21%, respectively. The main identification characteristics and ecological information such as habitat, distribution and origin are given and discussed.

Key words: alien species, Greece, Mediterranean Sea, molluscs, N Aegean Sea, Thermaikos Gulf, uncommon marine bivalves.

INTRODUCTION

The Thermaikos Gulf (NW Aegean Sea) comprises one of the most complicated and multi-used ecosystems of the Eastern Mediterranean Sea. For such an ecosystem, although there are numerous environmental investigations, only a few are referred exclusively to its fauna and even to its bivalve molluscs (e.g. Sakellariou, 1957; Zenetos, 1996; Zenetos *et al*., 2005; Manousis *et al*., 2010). As alien species are rapidly changing the marine ecosystems (Por, 1978, 1990; Galil & Zenetos, 2002; Zenetos *et al*., 2003; Pancucci-Papadopoulou *et al*., 2005; Streftaris *et al*., 2005; Streftaris & Zenetos, 2006; Zenetos *et al*., 2007) and as the Thermaikos Gulf has not been intensively searched, a more thorough investigation of its malacofauna could lead to new findings. Apparently, Thermaikos Gulf is a marine basin on the navigation line to the second largest port of Greece with recorded traffic of more than 3000 ships per year; therefore, it is expected that alien species occur continuously. A dynamic evidence of this fact is the recent record of six alien bivalve species from the same area (Manousis *et al*., 2010). Thus, the main purpose of this study is: a) to further contribute to the knowledge of (mainly small in size) bivalve biodiversity of Thermaikos Gulf and re-describing and comparing its significant systematic characteristics, b) to compare the present biological diversity of the area with that recorded in publications of the past, and c) to improve the knowledge on the distribution and expansion of alien bivalve species.

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MATERIALS AND METHODS

The sampling of specimens was conducted from October 2008 to June 2013 in E Thermaikos and Thessaloniki Gulfs (Fig. 1) by methods describe in Manousis *et al.* (2012) with the addition of a fourth sampling approach, i.e. the searching of only fresh trawled

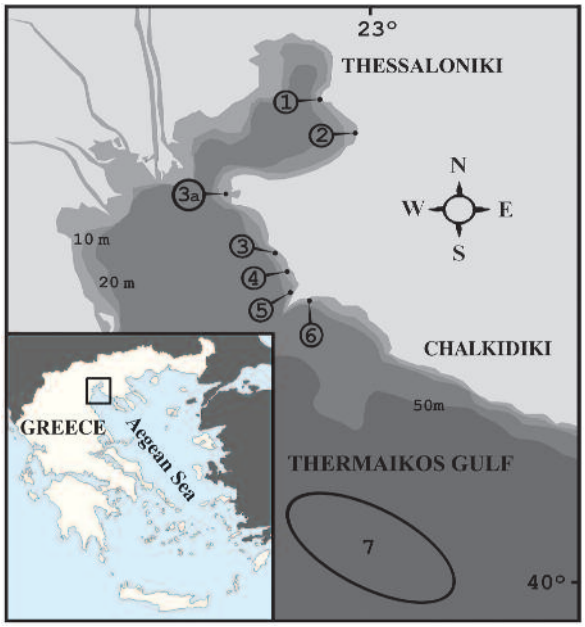

FIG. 1. Map of studied area: 1. Micro Emvolo; 2. "Macedonia" Airport; 3. Palioura; 3a. Aggelochori; 4. Paralia; 5. Cape of Epanomi; 6. Potamos; 7. Central Thermaikos Gulf.

and discarded material from small scale fishing nets taken from the vessels. Wood-eaters were dissected out of submerged infested wood by means of fine scalpels and a pair of tweezers. After cleaning with fresh water, shells were treated with 25% glycerin in ethanol and examined under a stereoscope with a magnification of up to ×80. For each species collected, the following data have been recorded: location, depth, type of habitat and size (length, unless otherwise stated). The species recognition was based on literature provided in Manousis *et al.* (2012). For the species nomenclature update (30 June 2013), the Marine Biodiversity and Ecosystem Functioning EU Network of Excellence – The European Register of Marine Species (MarBEF – ERMS) (www.marbef.org) and the CLEMAM (www.somali.asso.fr) were used. The taxonomic order followed the guides provided in CLEMAM. In addition, the Ellenic Network on Aquatic Invasive Species (ELNAIS, https://services.ath.hcmr.gr/) was used for the alien species status in the Hellenic Seas.

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

RESULTS

As a result of this investigation, approximately 700 specimens were collected and 46 species belonging to 23 families were identified. They are listed in phylogenetic order within families in Table 1, with their last recorded distribution and mode of life. Among the identified species, nine are new for the Eastern Mediterranean Sea, 15 are referred for the first time for the Hellenic fauna (Table 2), three of which are alien and 39 species are new for Thermaikos Gulf (five of which are alien). In the study area, three known alien species (*Fulvia australis, Fulvia fragilis* and *Pinctada imbricata radiate*) and six of West Mediterranean or Atlantic origin are recognized. Brief text with information and discussion for each species within families follows:

NUCULIDAE

Nucula sp. (Fig. 2A). One right valve (0.7 mm) and one left valve (1.0 mm) were found in discarded material brought to the surface from about 25 m depth at station 3. The almost ovate right valve has a prominent and flat umbo (as if cut), smooth margin, weak growth lines and microscopic radial striae. Internally it is glossy, with a trigonal chondrophore under the prodissoconch. The hinge of the right valve bears four large trapezoidal anterior teeth as well as one posterior, while that of the left valve four anterior and two posterior teeth. Externally, the valves resemble those of *Austronucula perminima* (Monterosato, 1875) in their overall shape, the flat prodissoconch and the axial striation but internally they lack the characteristic for *A. perminima* two types of hinge teeth (Gofas *et al*., 2011). Moreover, comparing the samples with same size juveniles of the sympatric species *N. nitidosa* Winckworth, 1930, *N. nucleus* (Linnaeus, 1758) and *N. sulcata* Bronn, 1831 it was found out that none of them shares the same type of prodissoconch and shell's shape with our specimens.

Ennucula aegeensis (Forbes, 1844) (Fig. 2B). One left valve (1.2 mm) was found in rocky material trawled from silty bottom at a depth of 70 m of station 7 (central Thermaikos Gulf). The fragile, grey-white and transparent shell is equivalve, inequilateral and tumid with a trapezoidal oval outline. Its anterior dorsal margin is slightly rounded and slopes gently, while its posterior dorsal margin is slightly rounded and slopes steeply. The anterior margin is widely rounded, while the ventral margin is deeply rounded. The escutcheon is broad, raised, elliptical and long, and the lunule is elliptical, long and raised. The umbos are broad and prominent as they project above the dorsal margin. The outer surface is smooth with fine concen-

TABLE 1. Bivalvia species in a taxonomic order and their occurrence in the collection stations. The substrate type is indicated by: (S); Sandy, (SM); Sandy and Muddy, (M); Mixed. T1: new record for Thermaikos Gulf; R1: new record species for the Hellenic Seas; E1: new record species for the East Mediterranean Sea; A1: alien with geographical expansion in the Hellenic seas. (*): casual search (visits < 5 times); (**): intensive search (visits > 50 times)

Family	Species	Record type	1. Micro Emvolo (Mixed) 0.2-10 m	2. "Macedonia" Airport (S) beached	3. Palioura (SM) 0.2 -10 m	3a. Aggelochori 8.5-13 m	4. Paralia (SM) 0.2-10 m	5. Cape of Epanomi (SM) 0.2-10 m	6. Potamos (S) 0.2-10 m	7. Central Thermaikos Gulf 70 m	Zone/ Depth	Habitat	Mode of life (Todd, 2001)	Found	Origin
NUCULIDAE **	*Nucula* sp.				+						25 m	unknown	subsurface deposit feeder – endobentic	shells	Unknown
*	*Ennucula aegeensis* (Forbes, 1844)	T1								+	70 m	unknown	subsurface deposit feeder – endobentic	shell	Mediterranean Sea
NUCULANIDAE **	*Nuculana* cf. *pella* (Linnaeus 1767)	E1 R1 T1			+						8 m	mixed bottom	subsurface deposit feeder – endobentic	shell	Unknown
**	*Saccella commutata* (Philippi, 1844)	T1						+			10-70 m	unknown	subsurface deposit feeder – endobentic	alive + shells	Mediterranean Sea
ARCIDAE **	*Asperarca secreta* La Perna, 1998	E1 R1 T1			+						15-20 m	mixed bottom	suspension feeder epibenthic	alive + shells	Central Mediterranean Sea
*	*Bathyarca pencunculoides* (Scacchi, 1834)	T1								+	70 m	unknown	suspension feeder epibenthic	shell + valves	Mediterranean Sea
**	*Bathyarca philippiana* (Nyst, 1848)	T1			+					+	70 m	unknown	Mediterranean Sea	shell	Mediterranean Sea

TABLE 1. continued

Family	Species	Record type	1.	2.	3.	3a.	4.	5.	6.	7.	Zone/ Depth	Habitat	Mode of life (Todd, 2001)	Found	Origin
MYTILIDAE **	*Crenella arenaria* Monterosato, 1875	T1			+						20-70 m	mixed bottom	suspension feeder epibenthic	alive + shells	Mediterranean Sea
**	*Dacrydium hyalinum* Monterosato, 1875	T1			+						20-70 m	mixed bottom	suspension feeder epibenthic	alive + shells	Mediterranean Sea
**	*Idas* sp.						+				beached	unknown	suspension feeder epibenthic	alive	Unknown
**	*Septifer cumingii* Récluz, 1849	T1 A1							+		0.2 m	*Zostera* bed	suspension feeder epibenthic	shell	Red Sea
PTERIIDAE **	*Pinctada imbricata radiata* (Leach, 1814)	A1		+	+		+	+			–	rocky bottom	suspension feeder epibenthic	alive + shells	Red Sea
PROPEAMUSSIIDAE **	*Cyclopecten brundisiensis* Smriglio & Mariottini, 1990	E1 R1 T1			+						25 m	mixed bottom	suspension feeder epibenthic	shell	Adriatic Sea
**	*Cyclopecten hoskynsi* (Forbes, 1844)	T1			+						25 m	mixed bottom	suspension feeder epibenthic	shell	Mediterranean Sea
SPONDYLIDAE **	*Spondylus cf. multisetosus* Reeve, 1856	R1 A1 T1						+			5 m	rocky bottom	suspension feeder epibenthic	alive	Red Sea
ANOMIIDAE **	*Monia squama* (Gmelin, 1791)	R1 T1			+						6 m	mixed bottom	suspension feeder epibenthic	alive	Central and West Mediterranean Sea
LIMIDAE **	*Limatula gwyni* (Sykes, 1903)	T1			+						20 m	mixed bottom	suspension feeder epibenthic	shell	Mediterranean Sea

TABLE 1. continued

Family	Species	Record type	1.	2.	3.	3a.	4.	5.	6.	7.	Zone/ Depth	Habitat	Mode of life (Todd, 2001)	Found	Origin
**	*Limatula subauriculata* (Montagu, 1808)	T1			+						20 m	mixed bottom	suspension feeder epibenthic	shell	Mediterranean Sea
*	*Limatula subovata* (Monterosato, 1875)	T1								+	70 m	mixed bottom	suspension feeder epibenthic	shell	Mediterranean Sea
*	*Notolimea crassa* (Forbes, 1844)	T1								+	70 m	mixed bottom	suspension feeder epibenthic	alive + shells	Mediterranean Sea
OSTREIDAE *	*Crassostrea gigas* (Thunberg, 1793)	T1 A1		+							2 m	anchor rope	suspension feeder epibenthic	alive	Indopacific
THYASIRIDAE **	*Thyasira alleni* Carrozza, 1981	T1						+			5 m	mixed bottom	chemo-symbiotic	alive	Mediterranean Sea
**	*Thyasira biplicata* (Philippi, 1836)	R1 T1			+						20 m	mixed bottom	chemo-symbiotic	shell	Mediterranean Sea
**	*Thyasira flexuosa* (Montagu, 1803)				+			+			20 m	mixed bottom	chemo-symbiotic	shell	Mediterranean Sea
GALEOMMATIDAE **	*Vasconiella* cf. *jeffreysiana* (Fischer P in de Folin & Périer, 1873)	E1 R1 T1					+				0.2 m	*Zostera* bed	symbiont	alive	West Mediterranean Sea
LEPTONIDAE **	*Litigiella glabra* (Fischer P in de Folin & Périer, 1873)	T1						+	+		0.2-8 m	*Zostera* bed + mixed bottom	commensal	alive + shells	West Mediterranean Sea
LASAEIDAE **	*Lepton squamosum* (Montagu, 1803)	T1					+				35 m	unknown	commensal	shell	Mediterranean Sea
MONTACUTIDAE **	*Coracuta obliquata* (Chaster, 1897)	T1			+						35 m	mixed bottom	commensal	shell	Mediterranean Sea
**	*Devonia perrieri* (Malard, 1904)	E1 R1 T1						+			0.2 m	*Zostera* bed	commensal	alive	Mediterranean Sea

TABLE 1. continued

Family		Species	Record type	1.	2.	3.	3a.	4.	5.	6.	7.	Zone/ Depth	Habitat	Mode of life (Todd, 2001)	Found	Origin
	*	*Kelliopsis jozinae* (van Aartsen & Carrozza, 1997)	E1 R1 T1						+		+	70 m	unknown	commensal	alive + shells	West and Central Mediterranean
	**	*Kurtiella tumidula* (Jeffreys, 1866)	T1					+				35 m	mixed bottom	commensal	alive + shells	Mediterranean Sea
	**	*Montacuta goudi* (van Aartsen, 1996)	E1 R1 T1						+			0.2 m	*Zostera* bed	commensal	alive + shells	Central Mediterranean Sea
	**	*Montacuta phascolionis* Dautzenberg & Fischer H, 1925	E1 R1 T1						+			0.2-5 m	*Zostera* bed	commensal	alive + shells	Mediterranean Sea
CARDIIDAE	**	*Acanthocardia deshayesii* (Payraudeau, 1826)	T1			+						10 m	mixed bottom	suspension feeder endobenthic	alive	Mediterranean Sea
	*	*Fulvia australis* (Sowerby II, 1834)	R1 T1 A1			+	+		+			8.0-13.5 m	sandy bottom	suspension feeder endobenthic	shells	Red Sea
	*	*Fulvia fragilis* (Forsskål in Niebuhr, 1775)	A1		+	+						5 m and beached	mixed bottom + beached	suspension feeder endobenthic	alive + shells	Red Sea
	**	*Parvicardium hauniense* (Peterson & Russel, 1971)	E1 R1 A1 T1						+			0.2 m	*Zostera* bed	suspension feeder endobenthic	alive	North Atlantic
TELLINIDAE	*	*Arcopella balaustina* (Linnaeus, 1758)				+						18 m	mixed bottom	suspension feeder endobenthic	shell	Mediterranean Sea
TRAPEZIDAE	**	*Coralliophaga lithophagella* (Lamarck, 1819)	T1			+						20 m	mixed bottom	suspension feeder endolithic	alive + shells	Mediterranean Sea

TABLE 1. continued

Family	Species	Record type	1.	2.	3.	3a.	4.	5.	6.	7.	Zone/ Depth	Habitat	Mode of life (Todd, 2001)	Found	Origin
MYIDAE **	*Sphenia binghami* Turton, 1822	T1						+		+	0.2-5 m	sandy muddy bottom	suspension feeder – endolithic	alive + shells	Mediterranean Sea
TEREDINIDAE *	*Bankia carinata* (JE Gray, 1827)	R1 T1						+			7 m	submerged wood	wood-boring	alive + shells	West Mediterranean
**	*Lyrodus pedicellatus* (de Quatrefages, 1849)	R1 T1			+		+		+		0.2-5 m	submerged wood	wood-boring	alive + shells	Mediterranean Sea
**	*Nototeredo norvagica* (Spengler, 1792)	T1			+						7 m	submerged wood	wood-boring	alive + shells	West Mediterranean Sea
XYLOPHAGIDAE **	*Xylophaga dorsalis* (Turton, 1819)	T1						+			5 m	submerged wood	wood-boring	alive + shells	Mediterranean Sea
THRACIIDAE **	*Thracia* sp.							+			0.2 m	*Zostera* bed	suspension feeder – endobenthic	alive + shells	Unknown
CUSPIDARIIDAE *	*Cardiomya costellata* (Deshayes, 1833)	T1								+	70 m	unknown	carnivorous	shells	Mediterranean Sea

TABLE 2. The 15 new species (in taxonomical order) from the Hellenic Seas

Nuculana cf. *pella* (Linnaeus 1767)
Asperarca secreta La Perna, 1998
Cyclopecten brundisiensis Smriglio & Mariottini, 1990
Spondylus cf. *multisetosus* Reeve, 1856
Monia squama (Gmelin, 1791)
Thyasira biplicata (Philippi, 1836)
Vasconiella cf. *jeffreysiana* (Fischer P in de Folin & Périer, 1873)
Devonia perrieri (Malard, 1904)
Kelliopsis jozinae (van Aartsen & Carrozza, 1997)
Montacuta goudi (van Aartsen, 1996)
Montacuta phascolionis Dautzenberg & Fischer H., 1925
Fulvia australis (Sowerby II, 1834)
Parvicardium hauniense (Peterson & Russel, 1971)
Bankia carinata (JE Gray, 1827)
Lyrodus pedicellatus (de Quatrefages, 1849)

tric growth lines. The prodissoconch is also smooth, prominent and well defined. The shell's inner margin is smooth. The ligament is internal, opisthodetic and inserted in a deep and wide resilifer. The taxodont hinge is formed on a wide and continuous hinge plate bearing 3 anterior and 2 posterior short and blunt teeth. A deep water species recorded from all the Hellenic Seas and now from Thermaikos Gulf. *Ennucula aegeensis* is similar in its outlook to *E. corbuloides*. When comparing *E. aegeensis* with *E. corbuloides*, the late exhibits a different in size and orientation chondrophore, has narrower crenulation and lacks the wide space next to it on the hinge plate.

NUCULANIDAE

Nuculana cf. *pella* (Linnaeus 1767) (Fig. 2C). One shell (4.7 mm) was collected at 8 m in mixed bottom at station 3. The specimen is slightly more rounded but very similar to the elliptic *Nuculana pella.* Its main difference is in the posterior area which is demarcated by two ribs at the junction with the middle area of the shell. According to Cachia *et al*. (2004), some variation in the radial ribs has been noted for *N. pella* without any additional information.

Saccella commutata (Philippi, 1844) (Fig. 2D). One live specimen (4.8 mm) was found in discarded material brought to the surface from about 10 m depth at station 5, and several juvenile shells (1.0-1.2 mm) in rocky material trawled from silty bottom from a depth of 70 m at station 7 (central Thermaikos Gulf). The species is common in the Mediterranean Sea (Zenetos, 1996; Cachia *et al*., 2004; Repetto *et al*., 2005; Zenetos *et al*., 2005) and this is the first record from Thermaikos Gulf.

ARCIDAE

Asperarca secreta La Perna, 1998 (Fig. 2E). Two live specimens (2.4 mm and 2.9 mm) and a shell (2.3 mm) was collected from discarded material of a small scale fishing boat fishing at 15-20 m depth of mixed bottom at station 3. The shell is sub rectangular, equivalve and inequilateral. The umbos are situated at the anterior area of the shell. The light brown scaly periostracum becomes more wide and extended at the posterior-ventral area. The hinge bears large teeth, 4 anterior and 6 posterior. The species is found for the first time in Greece and it is already known from the Central Mediterranean Sea (Cachia *et al*., 2004; Repetto *et al*., 2005; Cossignani & Ardovini, 2011).

Bathyarca pectunculoides (Scacchi, 1834) (Fig. 3A). One shell (2.0 mm) and several valves (2.0-3.0 mm) were found in rocky material trawled from 70 m at station 7. The species is common in the Mediterranean Sea (Cachia *et al*., 2004) and this is the first record from Thermaikos Gulf. The species has been referred from all the Hellenic Seas by Tenekidis (1989), Zenetos (1996) and Zenetos *et al*. (2005) as *B. grenophia* (Risso, 1826).

Bathyarca philippiana (Nyst, 1848) (Fig. 2E). One live individual (5.0 mm) and one left valve (4.5 mm) were found in two different instances in rocky material trawled from 70 m depth at station 7. The species has a similar outline with that of *B. pencunculoides* but is more oblique rectangular, the margin is finely crenulated and the sculpture is reticulated with fine radiating and concentric ribs that are slightly stronger in the posterior area. The taxodont hinge line is wide bearing 6 anterior strong teeth and 10 also strong posterior plus one vestigial tooth at the posterior end of the hinge. The species which is referred as rare (Dogan *et al*., 2009) or rather uncommon (Repetto *et al*., 2005) is also known from the Aegean and Mediterranean Seas (Zenetos *et al*., 2005; Dogan *et al*., 2009; Cossignani & Ardovini, 2011).

MYTILIDAE

Crenella arenaria Monterosato, 1875 (Fig. 3B). Several live specimens, shells and valves (1.0-2.5 mm) were found in detritus material trapped in small scale fishing nets at 20 m depth from mixed bottom at station 3 and in trawled material from the muddy bottom of

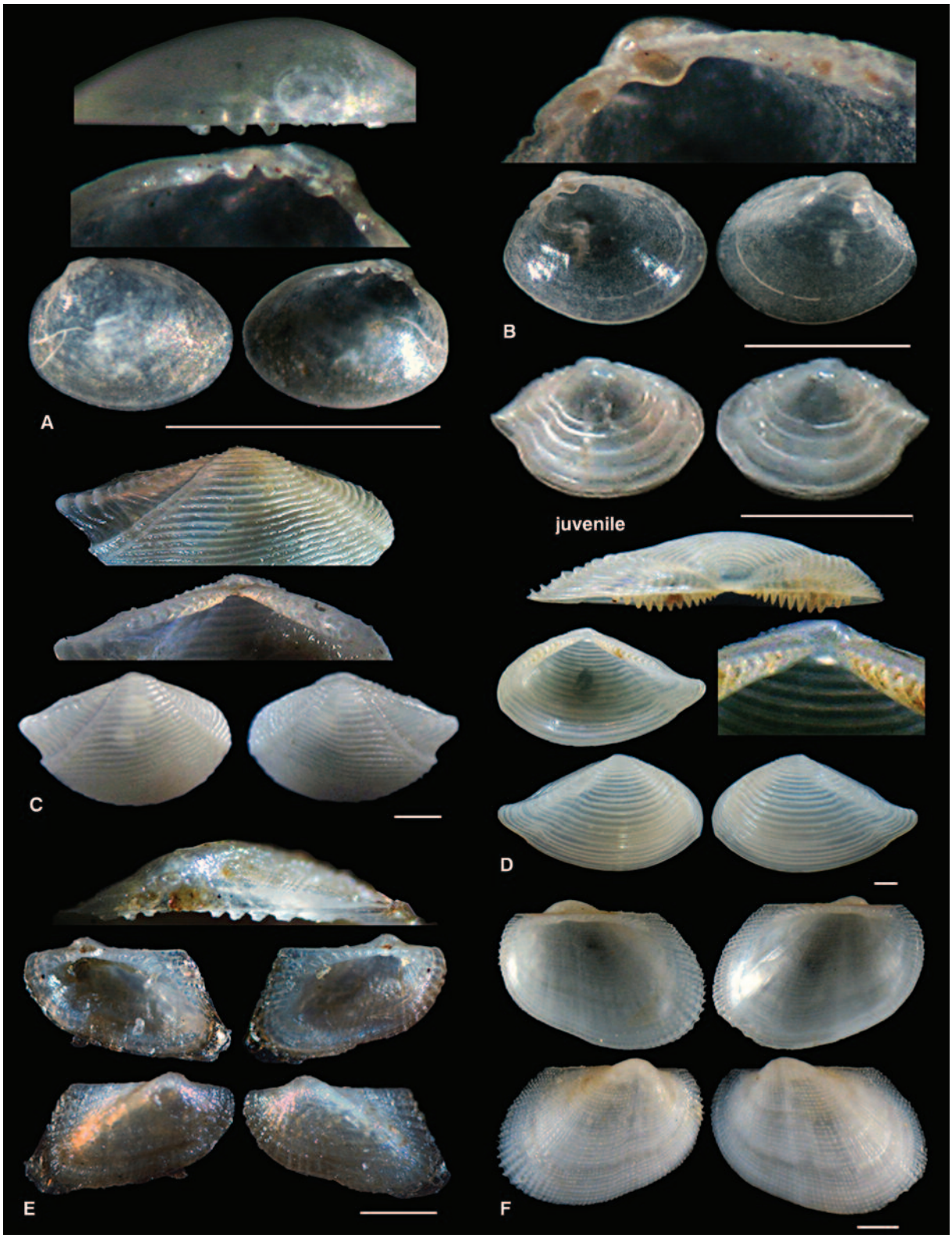

FIG. 2. A. *Nucula* sp.; B. *Ennucula aegeensis*; C. *Nuculana* cf. *pella*; D. *Saccella commutata*; E. *Asperarca secreta*; F. *Bathyarca philippiana.*

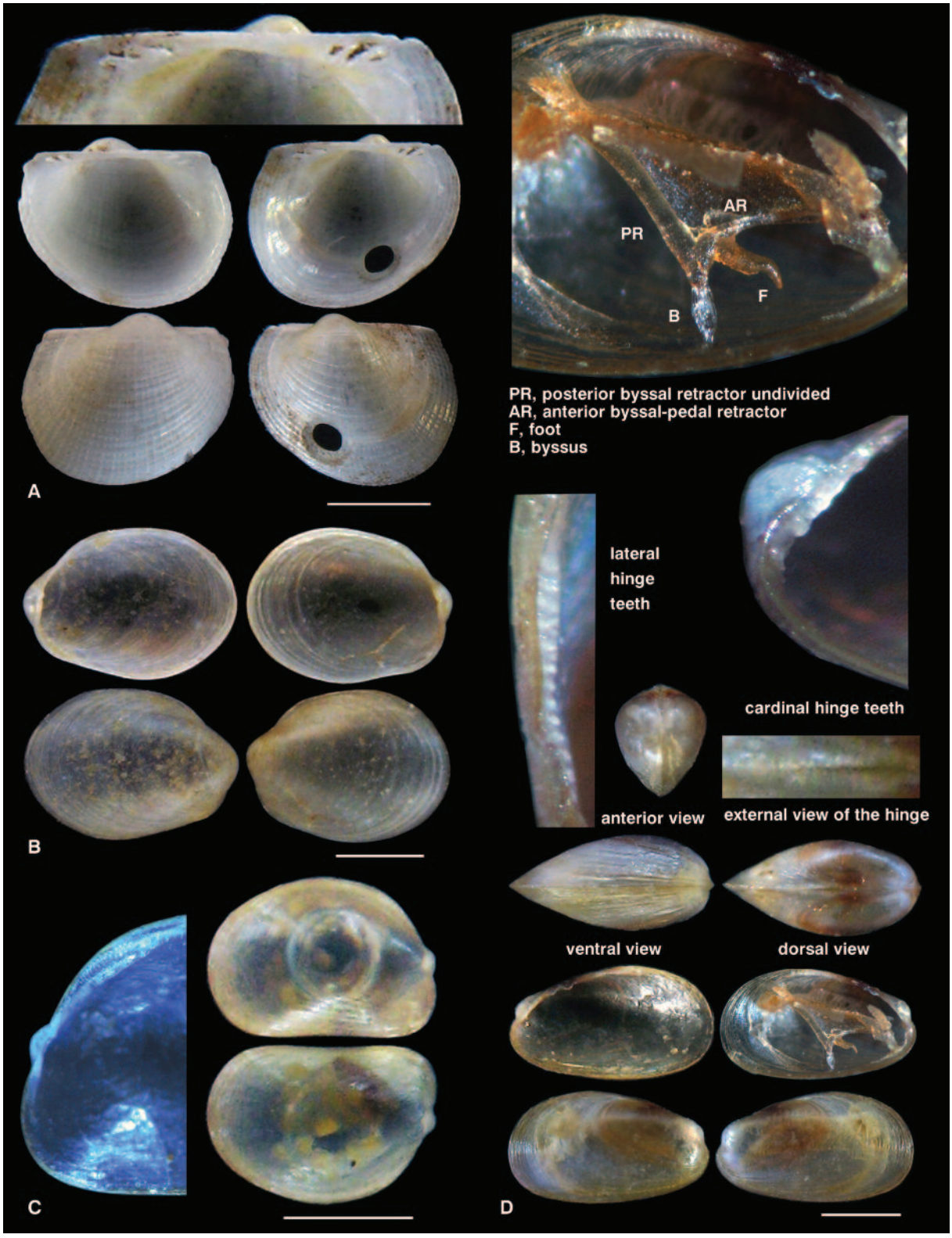

FIG. 3. A. *Bathyarca pencunculoides*; B. *Crenella arenaria*; C. *Dacrydium hyalinum*; D. *Idas* sp.

station 7 at 70 m depth. The convex shells with smooth margins are oval, glossy, semi-transparent, white to cream in color and with fine growth lines. The hinge is finely crenulated. The species has been recorded from the S Aegean Sea (Zenetos *et al*., 2005) while it is also known from the Central and W Mediterranean Sea (Cachia *et al*., 2004; Repetto *et al*., 2005; Cossignani & Ardovini, 2011).

Dacrydium hyalinum (Monterosato, 1875) (Fig. 3C). One live specimen (1.7 mm) and several valves (1.8-2.5 mm) were found in trapped detritus material from 20 m depth in small scale fishing nets from mixed bottom at station 3 and also several valves of the same lengths in trawled material from muddy bottom and 70 m depth at station 7. The rather large umbos are situated almost at the middle area of the hinge. The external surface is smooth or with conspicuous growth lines. Hinge with a narrow ligament beneath the umbos. Small teeth are situated on both sides of the ligament followed after a toothless interval by a series of 12-13 larger teeth on the two thirds of the dorsal buttress. A species is referred as a) *D. vitreum* (Hollboll, 1842), with *D. hyalinum* Monterosato, 1875 as a synonym, from the seas of S Greece (Zenetos, 1996) and N Aegean Sea (Zenetos *et al*., 2005). According to Salas & Gofas (1997), *D. vitreum* (Holbøll in Møller, 1842) or (Møller, 1842) (CLEMAM, www.somali.asso.fr) is an Atlantic species while in the literature on Mediterranean shells (i.e. Giannuzzi-Savelli *et al*., 2001; Cachia *et al*., 2004; Cossignani & Ardovini, 2011) the species *D. hyalinum* (Monterosato, 1875) is the only *Dacrydium* species referred. *Dacrydium hyalinum* (Monterosato, 1875) has been also recorded from the Turkish E Aegean Sea by Önen & Doğan (2007).

Idas sp. (Fig. 3D). One small live specimen (2.3 mm) was collected from the surface of a live *Pinctada imbricata radiata* (Leach, 1814) beached after a storm at station 4. The shell is modioliform of yellowish-white color and tumid. The beaks are situated close to and behind the anterior end. The hinge has 5-6 teeth under the umbo area as well as 13-14 teeth behind the ligament. The mantle is quite wide mainly at the posterior-ventral area. The byssus muscle is undivided as it is referred for the genus *Idas* according to Gustafson *et al.* (1998).

Septifer cumingii Récluz, 1849 (Fig. 4A). A left valve (2.1 mm) was collected from a shallow *Zostera* bed at station 5. The mytiliform shell with red and green blots over a whitish background is solid with subterminal umbos – a distinguishing characteristic of the species from *S. bilocularis* (Albayrak & Çağlar, 2006). Internally, it is shinny and bears a septum across the umbonal cavity. The sculpture consists of many strong radial ribs, occasionally bifurcating and crossed by finer concentric lines showing a nodulous appearance. Hinge with 3 large teeth under the umbo and 8 large teeth behind the ligament. Inner margin crenulate. The light brown periostracum bears scattered simple long fine hairs. The species is known from S Greece since 2010 (ELNAIS, https://services.ath.hcmr.gr/; Zenetos *et al*., 2011) and this is the first record from the N Aegean Sea.

PTERIIDAE

Pinctada imbricata radiata (Leach, 1814) (Fig. 4B). Since the last recorded reference of the species in Thermaikos Gulf (Manousis *et al*., 2010), the species is now recorded further north in E Thessaloniki Gulf and its abundance seems to rise rapidly as 20 live specimens of different sizes (0.5-7 cm in length) were collected in December 2011. The majority (15 individuals) of small size shells (< 3 cm) were attached to fished *Flexopecten glaber* shells and the rest five were bigger (3-7 cm). Dead animals of a length ranging from 2 to 5 cm were found in a long beach of E Thessaloniki Gulf after a medium storm in January 2012, some of which with remnants of the soft parts of their body.

PROPEAMUSSIIDAE

Cyclopecten brundisiensis Smriglio & Mariottini, 1990 (Fig. 4C). Three left valves (1.7-2.1 mm) were collected from trapped detritus material in small scale fishing nets at 25 m depth from mixed bottom of station 3. The external surface of the valves bear a number of 17 primary, secondary and tertiary radial ribs densely covered with convex scales. The bases of the scales extend on both sides in a form of down curved lirae, which in combination with the radial ribs give the shell's surface an imbricate appearance. The large and almost equal ears bear ribs, with a similar sculpture as of the rest of the shell. The species is referred from the Gulf of Lion as well as from the Central Mediterranean Sea (Ligurian, N Adriatic Sea and Sicily) (Cachia *et al*., 2004; Repetto *et al*., 2005; Cossignani & Ardovini, 2011), while the current reference is the first from the E Mediterranean Sea.

Cyclopecten hoskynsi (Forbes, 1844) (Fig. 4D). One right valve (2.45 mm) was collected from trapped detritus material in small scale fishing nets at 25 m depth from mixed bottom of station 3. The sub circular valve is fragile and transparent. The valve in-between

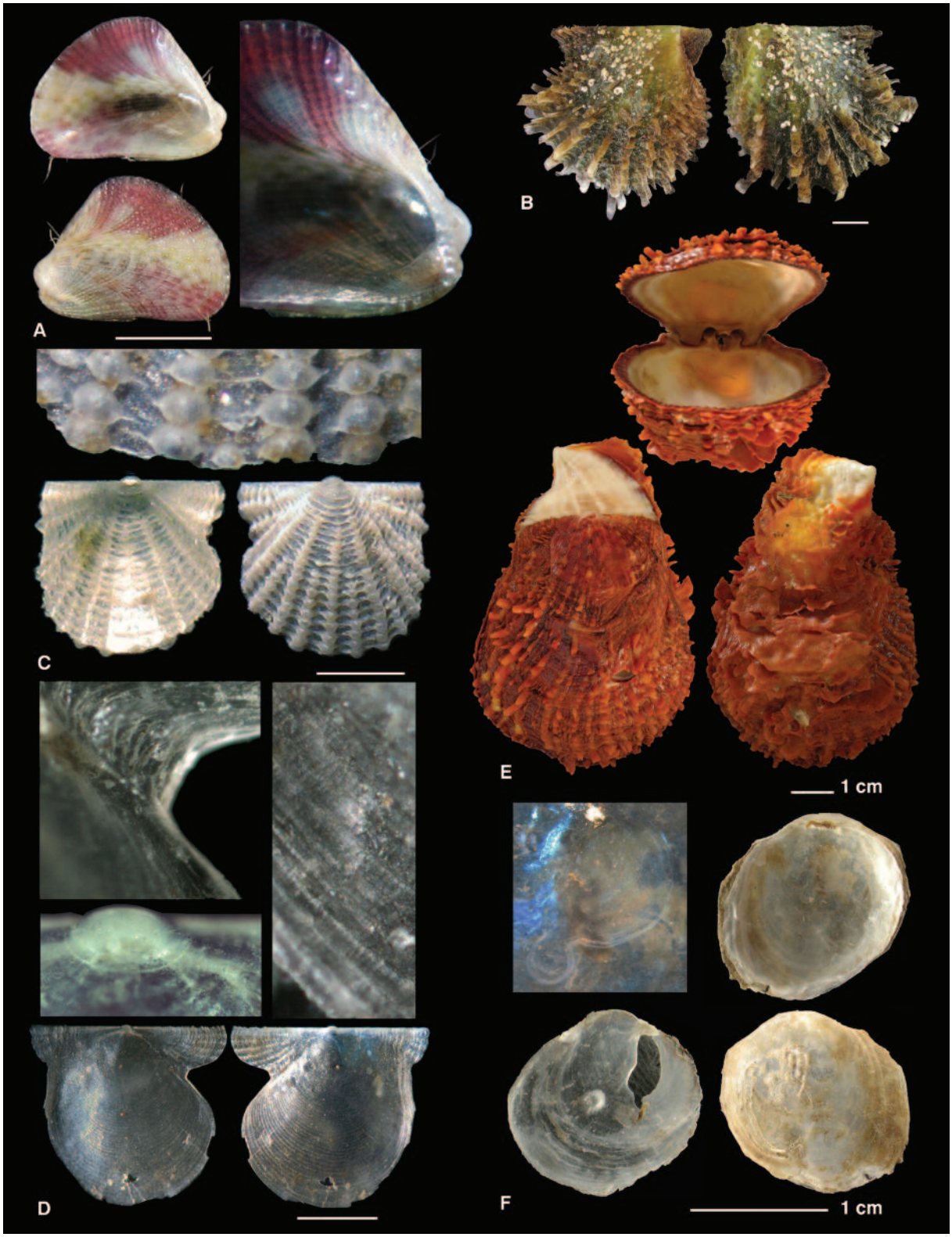

FIG. 4. A. *Septifer cumingii*; B. *Pinctada imbricata radiata*; C. *Cyclopecten brundisiensis*; D. *Cyclopecten hoskynsi*; E. *Spondylus* cf. *multisetosus*; F. *Monia squama.*

the com-marginal granulated lines is decorated by very fine radial lines. The anterior ear is wider and longer than the posterior decorated with evenly spaced co-marginal lirae which turn into weak co-marginal ridges of a very fine granular aspect. The species has been referred from S and W Greece (Zenetos *et al*., 2005) as well as, as a rare species, from the Mediterranean Sea (Reppeto *et al*., 2005; Gofas *et al.*, 2011) while it is known from N Atlantic (Dijkstra *et al*., 2009), N and W Europe (MarBEF, www.marbef.org).

SPONDYLIDAE

Spondylus cf. *multisetosus* Reeve, 1856 (Fig. 4E). One live specimen (58.0 mm length, 88.0 mm height) was found on a rock at 5 m depth in the sublittoral zone of station 5. The specimen was cemented to the substrate by a small area of its right (lower) valve. The sculpture of the left (upper) valve consists of numerous dominant radial ribs with regularly spatulate dark orange upstanding spines that are hollow underneath. In between these ribs, there are finer ribs with smaller sharp spines. The external color of the shell is burgundy red and the internal is dull cream-yellow with vivid burgundy-red crenulated margin. As the shell grows, the umbo of the right (lower) valve distances away from the umbo of the left one leaving behind a large, ivory white and triangular cardinal area. The current reference is the first from Greece. The species was referred from Israel and Turkey by Zenetos *et al*. (2003), Repetto *et al*. (2005) and Cossignani & Ardovini (2011), while its presence in the Mediterranean Sea is disputed as its shell's characteristics are similar to those of *Spondylus spinosus* (Zenetos *et al*., 2003).

ANOMIIDAE

Monia squama (Gmelin, 1791) (Fig. 4F). Two live specimens (14.0 mm and 7.0 mm) attached to bivalve shells were collected from 6 m depth at station 3. The main distinguishing characteristic among Anomiidae species is the position to each-other of the adductor muscle scars of their left (upper) valve (Poppe & Goto, 2000). The two unequal adductor muscle scars *of M. squama* left (upper) valve are completely coalescent to form one large impression. The species is referred from the Central and the Western Mediterranean Sea (Repetto *et al*., 2005; Cossignani & Ardovini, 2011) and this is a confirmed reference from Greece.

LIMIDAE

Limatula gwyni (Sykes, 1903) (Fig. 5A). One right valve (2.2 mm) was found in trapped detritus material in small scale fishing nets at 20 m depth from mixed bottom of station 3. The valve bears 30 radial riblets the two central of which are thicker. The hinge plate on either side of the triangular wide resilifer is smooth with a narrow but distinct sinus behind the ears. The species is similar to *L. subovata* but the late has much more radial riblets (about 50) (Marine Bivalve Shells of the British Isles, www.naturalhistory.museumwales.ac. uk) in contrast to *L. gwyni* which has 30 (Gofas *et al*., 2011). *Limatula gwyni* is referred from all over the Mediterranean Sea (Repetto *et al*., 2005; Zenetos *et al*., 2005) and now, for the first time, from Thermaikos Gulf.

Limatula subauriculata (Montagu, 1808) (Fig. 5B). One right valve (2.9 mm) was found in trapped detritus material in small scale fishing nets at 20 m depth from mixed bottom of station 3. The valve is ovate, translucent, with one central thicker rib and 30 radial riblets. The hinge plate is smooth with a triangular less wide than *L. gwyni* resilifer on the cardinal area. The species is known from allover the Mediterranean Sea (Repetto *et al*., 2005; Zenetos *et al*., 2005) and now from Thermaikos Gulf.

Limatula subovata (Monterosato, 1875) (Fig. 5C). A right valve (2.0 mm) was found in rocky material trawled at 70 m from station 7. The valve bears 40 fine radial riblets and a thicker one at the center. Some of these riblets do not start from the umbones. The hinge plate is situated over an arc and bears a triangular smooth resilifer for the ligament on its cardinal area. The species is similar to *L. gwyni* but the late has 30 radial riblets (Gofas *et al*., 2011) and wider resilifer in contrast to *L. subovata* which has about 50 radial riblets (Marine Bivalve Shells of the British Isles, naturalhistory.museumwales.ac.uk) and smaller resilifer. The species is distributed all over the Mediterranean Sea (Repetto *et al*., 2005; Zenetos *et al*., 2005) while this is the first record from Thermaikos Gulf. Allen (2004) redescribing the species refers that the distribution depths of the species in the Mediterranean Sea is unknown.

Notolimea crassa (Forbes, 1844) (Fig. 5D). A live specimen (2.2 mm) and two valves, one right (2.0 mm) and one left (1.5 mm), were found in rocky material trawled at 70 m from station 7. The shell is tumid, ovate, with rather small ears. The ribs are thicker at the middle area and with laminate ridges. The hinge bears eight teeth on both sites of a triangular pit. The

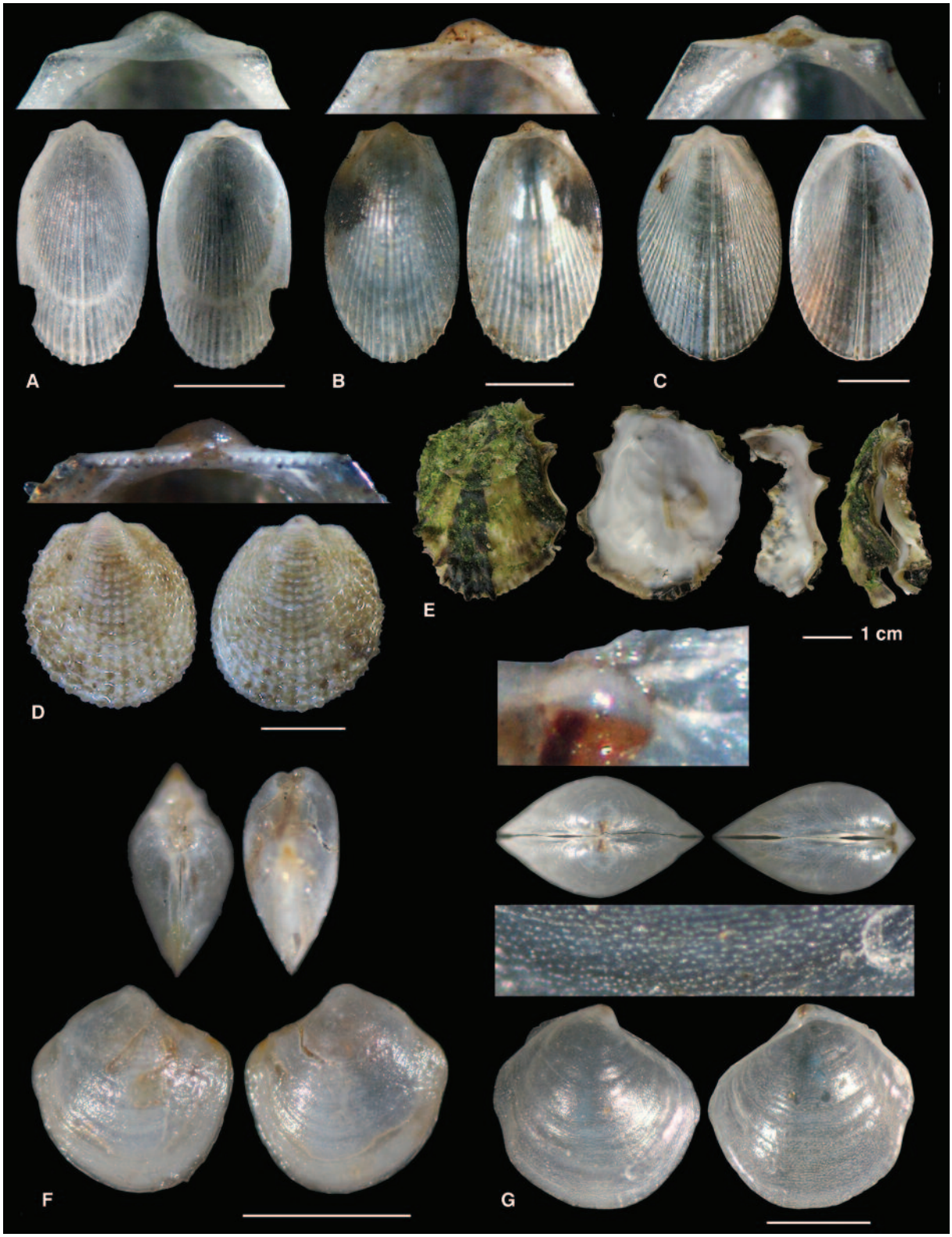

FIG. 5. A. *Limatula gwyni*; B. *Limatula subauriculata*; C. *Limatula subovata*; D. *Notolimea crassa*; E. *Crassostrea gigas*; F. *Thyasira alleni*; G. *Thyasira biplicata*.

species is considered as common in Malta (Cachia *et al.*, 2004) and rare in the Mediterranean Sea (Repetto *et al*., 2005), while it is also distributed in the Hellenic Seas (Zenetos *et al*., 2005).

OSTREIDAE

Crassostrea gigas (Thunberg, 1793) (Fig. 5E). A live specimen (39 mm) was collected from an anchor rope at station 1 at 2 m depth. According to Minchin & Gollasch (2008), this alien species has expanded in the S Aegean and the Ionian Sea. According to Zenetos *et al.* (2003) and ELNAIS database (https://services.ath.hcmr.gr/), the species is established in the Ionian Sea and particularly in Patraikos and Korinthiakos Gulfs. This is the first documented record from the N Aegean Sea. There is unconfirmed information that the species was imported for aquaculture into Thermaikos Gulf in 2007 (Katsanevakis *et al*., 2008).

THYASIRIDAE

Thyasira alleni Carrozza, 1981 (Fig. 5F). One live specimen (1.2 mm) was collected at 5 m from mixed bottom of station 5. The shell outline is subequilateral-rhomboidal and weakly sinuate posteriorly. The external surface is rough with visible growth lines. The lunule is well demarcated, sung below the umbones and with two creases. The lanceolate escutcheon and the auricle are distinct with a shallow sub-marginal sulcus and a weak posterior sulcus. It is a rare species (Repetto *et al*., 2005) known from the Mediterranean Sea and the N Aegean Sea, Evoikos Gulf (Zenetos, 1996), Strymonikos Gulf (Simboura & Zenetos, 2002) and now from Thermaikos Gulf.

Thyasira biplicata (Philippi, 1836) (Fig. 5G). Two right and four left valves (1.5-4.0 mm) were collected from trapped detritus material in small scale fishing nets at 20 m depth from mixed bottom of station 3 and from Maerl material trawled at 70 m from station 7. The external surface of the right valve is rough, characteristically granulate and translucent. The valve is subequilateral-rhomboidal, trisinuate, posterior profile distinctly biangulate, tumid and higher than long. The umbo and auricle are projecting. The auricle is a prominent crest while the posterior sulcus is well developed and the submarginal sulcus strongly demarcated. The broad cordiform lunule is weakly excavated. The escutcheon is lanceolate and well marked. The hinge bears one obsolete cardinal tooth. The anterior shell margin runs all along the prodissoconch length – a characteristic that differs from *T. flexuosa* while is similar to *T. granulosa* (Oliver & Killeen, 2002). The species resembles *T. granulosa* in its general outlook and particularly in the granulate sculpture but *T. granulosa* lacks the auricle. According to Scaperrotta *et al.* (2010), *T. biplicata* has been referred for long in the literature as *T. flexuosa* or *T. polygona*, while MarBEF (www.marbef.org) and CLEMAM (www.somali.asso.fr) accept *T. polygona* as a junior synonym of *T. biplicata.* The species is uncommon in the Mediterranean Sea (Scaperrotta *et al.*, 2010), has been referred from Albania (Dhora, 2012) and this is the first record from Greece.

Thyasira flexuosa (Montagu, 1803) (Fig. 6A). Three live individuals (1.2-3.1 mm), several shells (1.4-3.5 mm) and two left valves (1.5 mm and 1.8 mm) were found in trapped detritus material in small scale fishing nets at 20 m depth from mixed bottom of the stations 3 and 4. Its right valve is equilateral ovate, tumid and higher than long. The external surface is rough with visible growth lines. The umbo and auricle are projecting, the posterior profile is distinctly biangulate, the posterior sulcus is well developed and the submarginal sulcus strongly demarcated. The first posterior fold is prominent and the posterior sulcus well developed. The broad lunule is weakly excavated. The escutcheon is lanceolate with shallow sub-marginal sulcus and weak posterior sulcus. The ligament is sunken. The species is common in the Mediterranean Sea (Cachia *et al*., 2004) and the Aegean Sea (Zenetos, 1996) and is already recorded from Thermaikos by Zarkanellas (1980) and Zenetos *et al.* (1993 cited in Zenetos, 1996).

GALEOMMATIDAE

Vasconiella cf. *jeffreysiana* (Fischer P in de Folin & Périer, 1873) (Fig. 6B). One live juvenile specimen (2.4 mm) was collected from 0.2 m at station 4. This small sub ovate shell bears a light orange periostracum. The hinge plate of the right valve bears a single cardinal tooth and a single thin lateral just over the ligament, while the left one bears two cardinals: the tuberculous anterior and the sphenoid posterior. The overall appearance of the hinge is very similar to that of *Vasconiella jeffreysiana* shown clearly by Coney (1990), but the right valve does not show the typical notch known for the species. *Vasconiella jeffreysiana* is a rare species known from the northern part of the Gibraltar straight (Coney, 1990; Repeto *et al*., 2005; Cossignani & Ardovini, 2011) and from the SW Mediterranean Sea according to Repetto *et al*. (2005). In case that

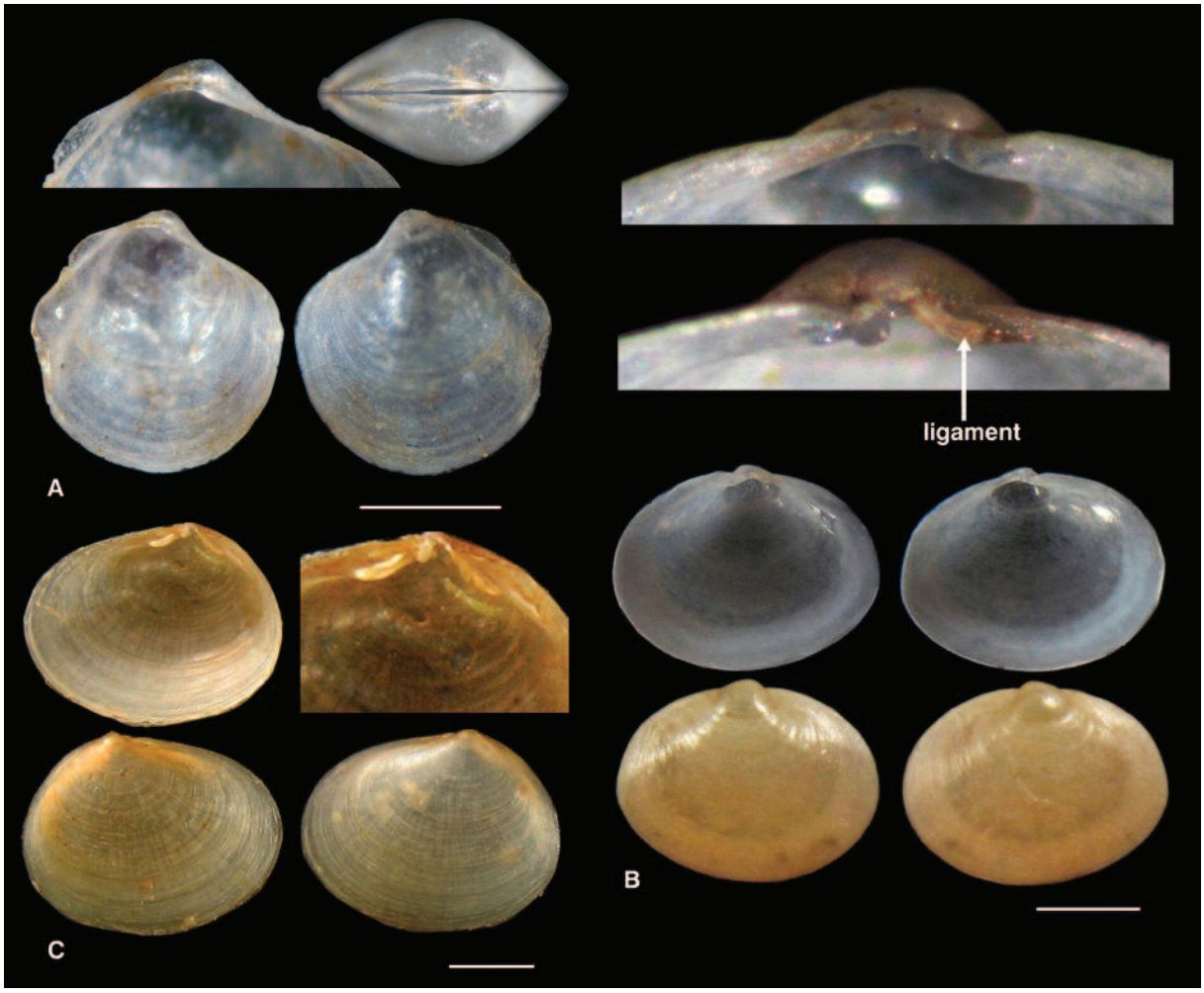

FIG. 6. A. *Thyasira flexuosa*; B. *Vasconiella* cf. *jeffreysiana*; C. *Litigiella glabra.*

the characteristic notch of the RV is not present in juveniles of *V. jeffreysiana*, the specimen presented here is the first collected *V. jeffreysiana* from the rest (Central and East) of the Mediterranean Sea.

LEPTONIDAE

Litigiella glabra (Fischer P in de Folin & Périer, 1873) (Fig. 6C). Three live specimens (1.0-6.8 mm) and several individual valves (0.9-5 mm) were collected at stations 5 and 6 from 0.2 m and 8.0 m depth, respectively. The species is common in the Mediterranean Sea and these must be the first records from the N Aegean as Zenetos *et al.* (2005) only refer the species in detail from the Ionian and S Aegean Seas.

LASAEIDAE

Lepton squamosum (Montagu, 1803) (Fig. 7A). One right valve (1.2 mm) was collected from material trapped in nets at approximately 35 m and brought to the surface from the mixed bottom of station 4 and one left valve (4.5 mm) was trawled from 70 m at station 7. The right valve is white, transparent, thin and fragile, sub equilateral and with the beak just in front of the midline. It is compressed, rhomboidal in its outline, with its dorsal and ventral margins parallel. The anterior and posterior margins slope obliquely with the anterior slightly more narrow. The outer surface is densely punctuate and bears prominent growth lines and fine co-marginal lines. The inner margin is smooth. The hinge has a paired anterior and posterior lateral teeth and a very small cardinal. The left valve, which is partially damaged, is also thin and fragile with small umbo just anterior to the midline. The sculpture of its outer surface consists of fine concentric lines, most conspicuous close to the distinct growth lines, and dense punctulations showing through from

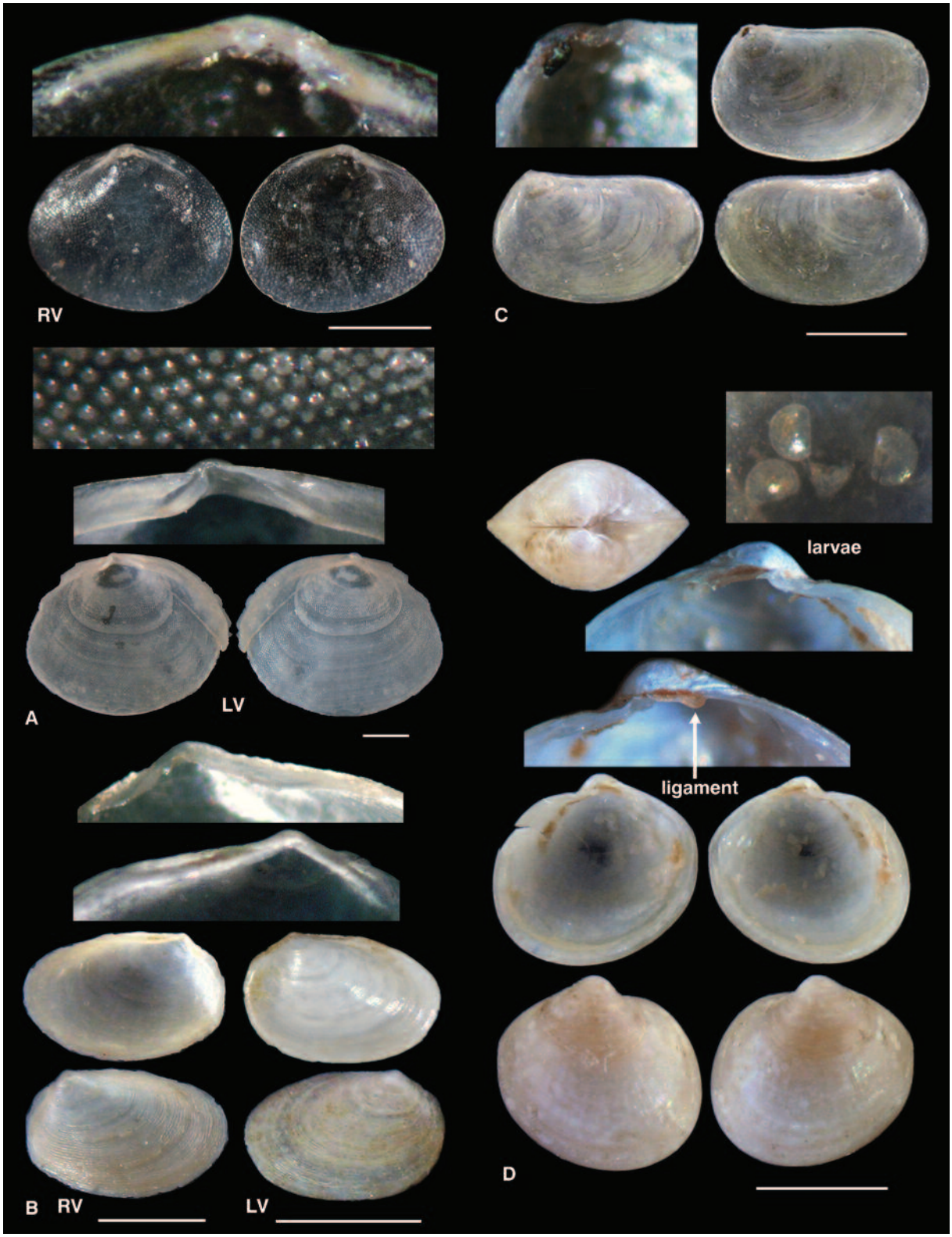

FIG. 7. A. *Lepton squamosum*; B. *Coracuta obliquata*; C. *Devonia perrieri*; D. *Kelliopsis jozinae.*

the inside. The hinge bears two small cardinal teeth and single anterior and posterior laterals. An Atlantic and Mediterranean rare species (Repeto *et al*., 2005; Marine Bivalve Shells of the British Isles, http://naturalhistory.museumwales.ac.uk), already known from the Ionian and the N Aegean Sea (Zenetos *et al*., 2005) and now reported for the first time from Thermaikos Gulf.

MONTACUTIDAE

Coracuta obliquata (Chaster, 1897) (Fig. 7B). Six valves (1.2 mm to 2.2 mm) were collected from material brought to the surface trapped in nets at approximately 35 m from mixed bottom at station 4. The inequilateral valve (left) bears beaks situated at approximately the 2/3 of the shell, is obliquely subovate, with anterior margin prominent sloping gently and slightly angled at the junction with the anterior margin which is rounded. The ventral margin is gently curved and the posterior one is subtruncate. The posterior dorsal margin is short, steeply angled and slightly convex. The outer surface bears fine, concentric and occassionaly dichotomous ridges. The valve bears no laterals but dorsal margins extended as marginal flanges in contrast to those of the right valve which are narrow, elongate and separated from the shell margin. The color is creamy, the inner surface glossy and the prodissoconch smooth. This rare species (Repeto *et al*., 2005) is referred from Greece as *Neolepton obliquatum* (Monterosato in Chester, 1897) (Zenetos *et al*., 2005).

Devonia perrieri (Malard, 1904) (Fig. 7C). One live specimen (1.9 mm) was found in sandy-muddy bottom of station 5 at 0.2 m depth. The shell is sub quadrate, compressed, with the beaks close to the posterior end. There are distinct co-marginal and indistinct radial lines. The ligament is small, internal, on a shallow resilifer in the proximity of a faint tubercle. The thin and transparent reriostracum covers the ivory white shell, while the umbos are tinted light brown. The species is referred from the NE Atlantic, the W Mediterranean (www.marbef.org) and now from the E Mediterranean Sea.

Kelliopsis jozinae (van Aartsen & Carrozza, 1997) (Fig. 7D). One live specimen (1.7 mm) partially filled with a mass of larvae in the ontogenetic stage of D shape was collected from material trawled from sandy-muddy bottom at station 7. In addition, two live juveniles (both 0.9 mm), one shell (1.9 mm) and one left valve (1.0 mm) were found in rocky material trawled from 70 m at station 7. The prosogyrate, thin and translucent shell is equivalve, subequilateral, with prominent beaks situated just behind the midline. The shell is tumid, sub circular, posteriorly narrow, with dorsal margin slightly depressed and bears thin pale brown periostracum. Externally the shell's surface is decorated with fine co-marginal lines. The ligament is internal on a shallow resilifer. The hinge is weak, with a small cardinal tooth, a short anterior lateral flange and a longer posterior lateral tooth behind the resilifer of the right valve. The left valve bears a posterior long groove, a poorly differentiated cardinal tooth and an anterior distinctive lateral tooth. The species has been referred from the NE Atlantic (van Aartsen & Carrozza, 1997; Marine Bivalve Shells of the British Isles, http://naturalhistory.museumwales.ac.uk) and the West and Central Mediterranean Sea (Cachia *et al*., 2004; Repeto *et al*., 2005; Cossignani & Ardovini, 2011). This record seems to be the first for the E Mediterranean Sea.

Kurtiella tumidula (Jeffreys, 1866) (Fig. 8A). One live specimen (1.5 mm) as well as two left valves were collected from material brought to the surface trapped in nets at approximately 35 m from mixed bottom at station 4. The thin and fragile shell, is equivalve and inequilateral with light brown prodissoconch in its posterior 1/4. It is sub-ovate in its outline and expanded anteriorly with the anterior dorsal margin long and straight while the anterior area is widely rounded. The posterior dorsal margin is straight sloping steeply to the rounded posterior. It bears fine, co-marginal lines on its surface and its inner margin is smooth. The ligament is internal in a wide pit beneath the beaks and inserted deep inside the umbos. The hinge consists of two diverging lateral teeth in each valve; those in the right valve are narrow, elongate, separated from the shell margin and with an angle of divergence of approximately 110˚ while those of the left valve appear as extensions of the shell margin, with an angle of divergence of approximately 130˚. The pallial line is entire, the periostracum is light yellow and the color is whitish. The inner surface of the valves is highly shiny. The species, already referred from Greece (Koukouras, 2010) and known from the Aegean Sea as *Mysella tumidula* (Jeffreys 1866) (Zenetos *et al*., 2005), is now reported from Thermaikos Gulf.

Montacuta goudi (van Aartsen, 1997) (Fig. 8B). One live specimen (1.3 mm) as well as two right valves (both 1.2 mm) were collected from a shallow *Zostera* bed at station 5. The transparent, convex and smooth shell is trapezoidal in shape, fragile and has large beaks situated close to its anterior end. The prominent prodissoconches are of light chestnut brown color.

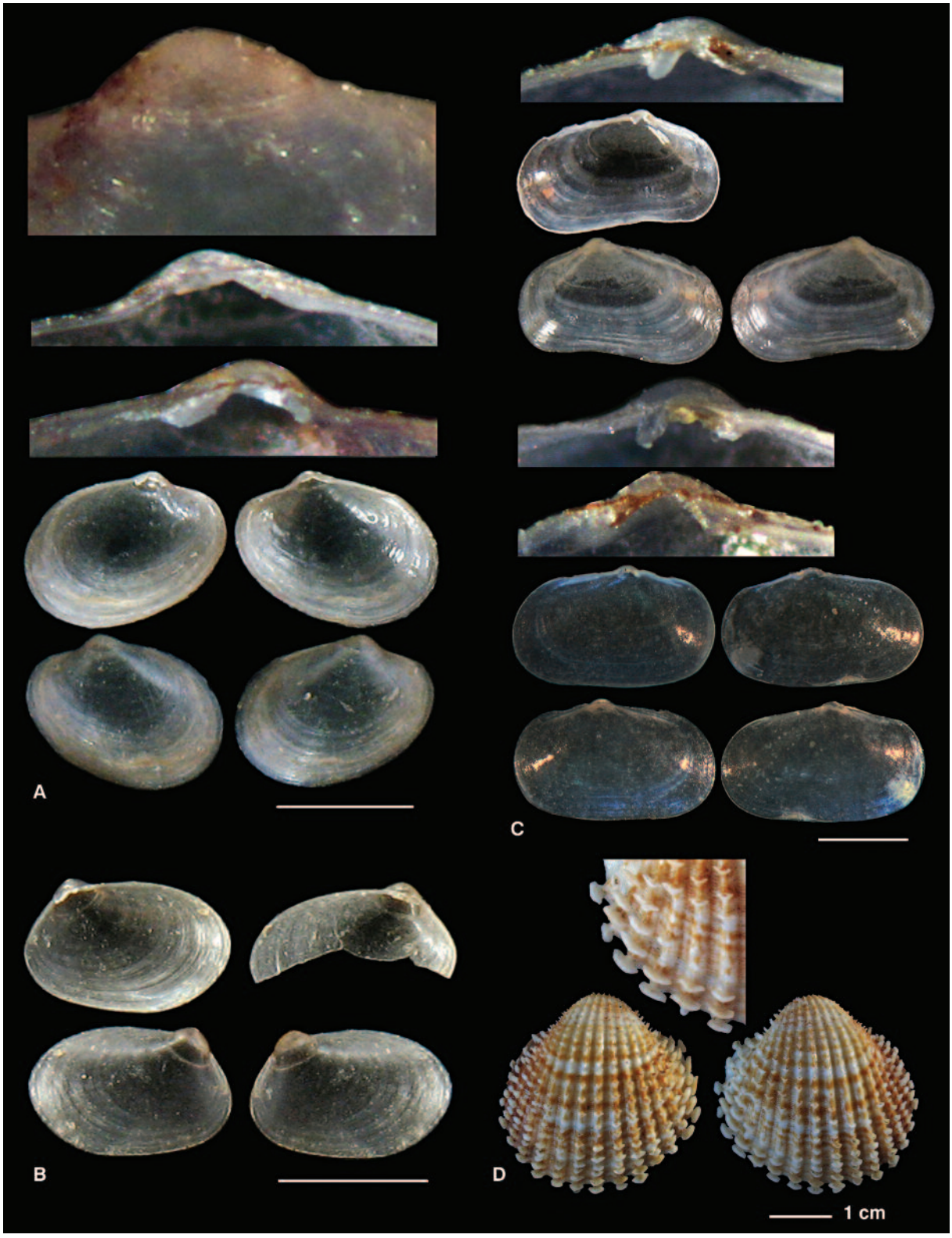

FIG. 8. A. *Kurtiella tumidula*; B. *Montacuta goudi*; C. *Montacuta phascolionis*; D. *Acanthocardia deshayesii.*

The hinge plate is very narrow with tooth-like tuberculate projections. This rather recently described species is known only from the Central Mediterranean Sea (Cachia *et al*., 2004; Associazione Naturalistica Malachia, www.malachia.it).

Montacuta phascolionis Dautzenberg & H. Fischer, 1925 (Fig. 8C). Two live specimens (1.9 mm and 2.4 mm) were collected from fine sand and mud bottom at station 5 and seven individual valves (1.5-3.0 mm) were found in shallow (0.2 m) *Zostera* beds at the same station. The white, thin and rather fragile shell is almost equivalve and equilateral (with shorter the posterior part) with the left valve slightly smaller and fitting within the right valve. The posterior and anterior sides are rounded and the ventral edge straight or even concave. Each valve bears a single anterior cardinal tooth with that of the right one obliquely elongated. Shell surface smooth with fine concentric growth lines and faint radials. Known from the E Atlantic Ocean and the W and Central Mediterranean Sea (Cachia *et al.*, 2004; Repeto *et al*., 2005; Cossignani & Ardovini, 2011) it is now reported from the E Mediterranean Sea.

CARDIIDAE

Acanthocardia deshayesii (Payraudeau, 1826) (Fig. 8D). One live specimen (30.8 mm) was collected from material brought to the surface trapped in nets at approximately 10 m from mixed bottom at station 3. The shell bears 22-23 radial ribs with spatulate tubercules, mainly by the margin area, and the interspaces in between the radial ribs with wavy concentric striae. The species which is considered as rare according to Poppe & Goto (2000), Cachia *et al.* (2004) and La Perna & D'Abramo (2009), is distributed all over the Mediterranean Sea and has been generally referred from the N Aegean Sea (Zenetos *et al*., 2005) and Evoikos Gulf (W Central Aegean Sea) (Tenekidis, 1989; Zenetos, 1996).

Fulvia australis (Sowerby II, 1834) (Fig. 9A). Five right valves (10.5-11.2 mm) were found at 8.0-12.5 m depth at Stations 3, 3a and 5 of the E Thermaikos Gulf. The valve is rather thin but not fragile, ovate, slightly higher than long with truncated posterior. On its outer surface it bears 40 weakly marked flat ribs, more prominent at the posterior area. The color is cream white with light pinkish purple blotches. The hinge is strongly arched, in comparison with the angulated hinge of the species *F. fragilis*, and bears two rounded cardinal teeth, a single posterior lateral and two long anterior laterals. The lateral teeth are at equal distances from the umbo (equilateral) while the posterior lateral tooth of *F. fragilis* is more distant from the umbo than the anteriors (inequilateral). The inner periphery of the shell is crenulated. This lessepsian migrant, though rare, is established in the coasts of Israel (Zenetos *et al*., 2003; www.ciesm.org) and now is reported for the fist time from the Greek waters.

Fulvia fragilis (Forsskål in Niebuhr, 1775) (Fig. 9B). One live individual (30.6 mm), one shell (17.0 mm) as well as one broken right valve with intact hinge were collected from a depth of 5 m at Station 2 (NE Thermaikos Gulf) in December 2010 after a severe NW wind of 10 Bf during 10 and 11 December 2010 (National Observatory of Athens, www.meteo.gr) and in the same area where the species was also recorded by Angelidis (2013) on February 2012. Moreover, a left valve was collected at the beach of Palioura (Station 3) (E Thermaikos Gulf). The beige fragile shells are slightly longer than high with 35-39 smooth ribs bearing small calcareous spines in the posterior part, are in morphological accordance with the described form of the specimens from Izmir Gulf by Öztürk & Poutiers (2005). Radial periostracum lamellae arise from the mid-line of the ribs, becoming more prominent towards the anterior part of the valves. Internally, the margin is evidently crenulated and the color is creamy white at the anterior part, yellowish pink with a longitudinal blotch under the umbo and violet across the posterior part. *Fulvia fragilis* is an already established alien species in Saronikos and Evoikos Gulfs (Zenetos *et al*., 2003; ELNAIS, https://services.ath.hcmr.gr/; Angelidis, 2013).

Parvicardium hauniense (Peterson & Russel, 1971) (Fig. 9C). One live juvenile specimen (1.5 mm) was collected from shallow (0.2 m) *Zostera* beds at station 5. The reddish brown shell is thin, equivalve, inequilateral, slightly inflated, with prosogyrate beaks in front of the midline. It is oval in its outline and a little expanded posteriorly. Its sculpture consists of 23 radial low ribs of the same width as that of the interspaces. A few blunt spines decorate the posterior dorsal ribs. The margin is crenulate and the parivincular short ligament sits on a prominent nymph. The hinge is rather weak and bears on the right valve one anterior and a pair of posterior laterals as well as two small cardinals and on the left valve single almost marginal laterals and two small cardinal teeth. A North Atlantic species restricted to the Baltic Sea (Marine Bivalve Shells of the British Isles, http://naturalhistory. museumwales.ac.uk) but was recorded for the first time from the W Medi-

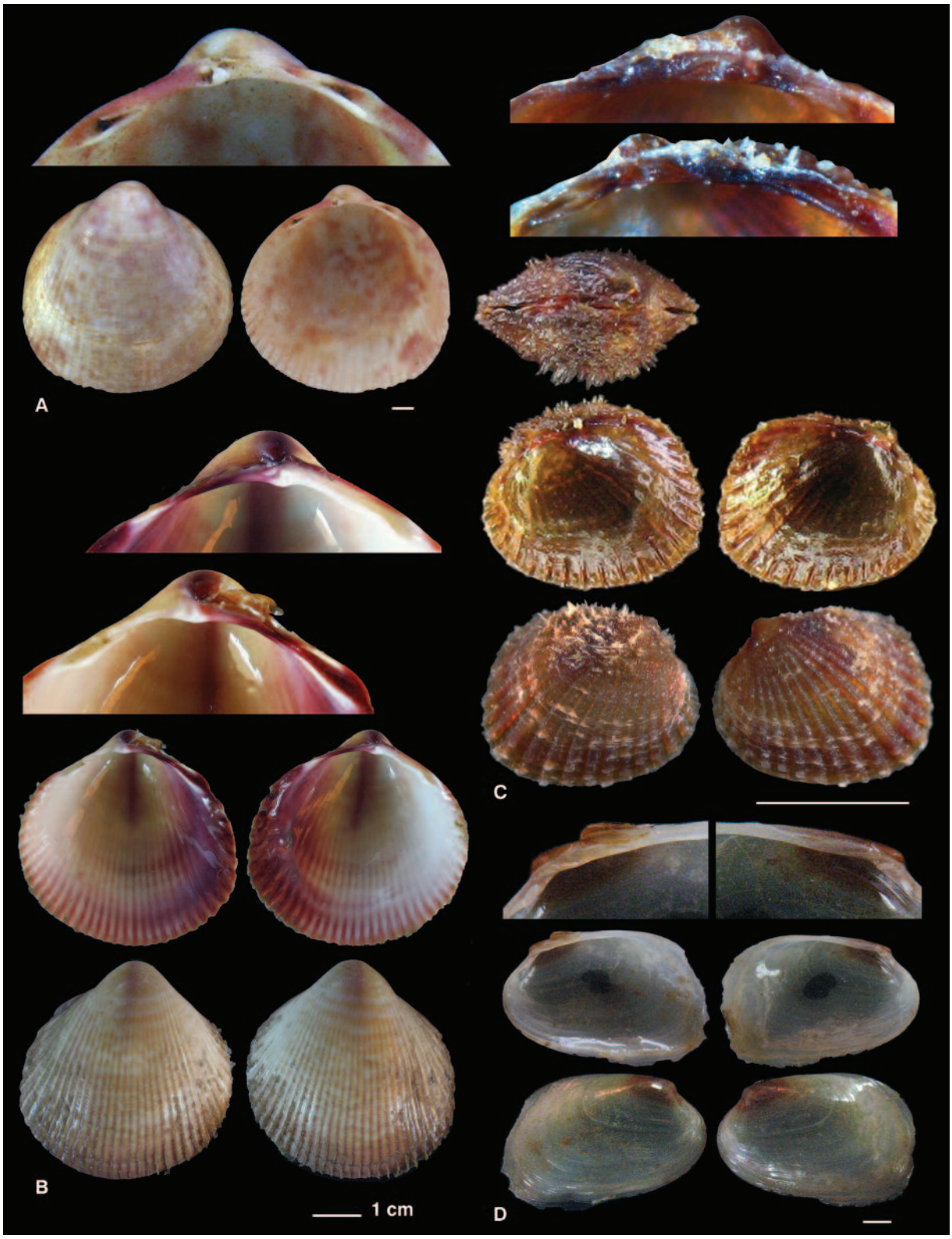

FIG. 9. A. *Fulvia australis*; B. *Fulvia fragilis*; C. *Parvicardium hauniense* bearing an epibiont on the beak area of its right valve; D. *Coralliophaga lithophagella.*

terranean Sea (The Conchological Society of Great Britain and Ireland, www.conchsoc.org) and now is referred for the first time from the Greek waters.

TRAPEZIDAE

Coralliophaga lithophagella (Lamarck, 1819) (Fig. 9D). One live specimen (11 mm) and a shell (7 mm) were dissected out of a calcareous block trawled at 20 m from mixed bottom at station 3. The equivalve and strongly inequilateral prosogyrate shell is solid and modioliform with anterior end reduced and rounded and posterior end expanded and slightly truncated. The ventral line is rather straight while the dorsal one is almost straight. The sculpture consists of concentric lines, growth stops and ridges. The inner margin is smooth and the ligament is external, behind the beaks and set on a shallow nymph. A pale yellow periostracum covers a white shell. Already known from the Greek seas, it is now referred for the first time from Thermaikos Gulf.

MYIDAE

Sphenia binghami Turton, 1822 (Fig. 10A). Three live specimens (1.5 mm, 2.0 mm and 2.1 mm, respectively) were collected from sandy muddy bottom of station 4 at 0.2 m and several individual valves (0.9-3.2 mm) were found in shallow *Zostera* beds at station 4. Moreover a valve (3.0 mm) was collected from trawled bottom material from 70 m at station 7. The rather thin and brittle shells are equivalve, inequilateral with prosogyrate beaks situated at the middle of the anterior part. Their outline varies; they are irregular, roughly rectangular and longer than high. The anterior part slopes steeply towards a rounded anterior ventral margin. The posterior dorsal line is long and sub parallel to the ventral sloping to a broad or narrow subtruncate posterior. The posterior area is defined by an angular ridge running from the umbo to the posterior ventral junction. The sculpture consists of irregular undulations and co-marginal lines. The inner margin is smooth and the ligament is internal lying on a shallow and small chondrophore. Hinge without teeth. The periostracoum is persistent, of straw yellow color and the shell itself is white. It is an uncommon inhabitant of the Mediterranean Sea (Gofas *et al*., 2011) and the Greek waters (Zenetos *et al*., 2005).

TEREDINIDAE

Bankia carinata (J.E. Gray, 1827) (Fig. 10B). Several live specimens (2.2-3.5 mm) were dissected out of submerged wood from 7 m depth at station 5. The main characteristic of the species are its pallets which consist of a long white cylindrical stylet with a series of cones covered with a brown unserrated periostracal sheath. The species is cosmopolitan (Gofas *et al*., 2011), it has been recently collected in Thermaikos Gulf (www.shellauction.net, but with no figure available) and now its occurrence is documented from E Thermaikos Gulf for the first time for Greece.

Lyrodus pedicellatus (de Quatrefages, 1849) (Fig. 10C). Several live specimens (3.2-6.4 mm) were dissected out of submerged woods beached at the stations 3, 4 and 6. The pallets consist of a white cylindrical stylet connected with a suture to a blade of equal length which is elongate, oval and with a brown periostracal sheath on its tip. This cosmopolitan species (Gofas *et al*., 2011) is distributed all over the Mediterranean Sea (Reppeto *et al*., 2005). Recently it was collected in Korinthiakos Gulf, S Greece (www.shellauction.net, but with no figure available) and now its occurrence is documented from E Thermaikos Gulf for the first time.

Nototeredo norvagica (Spengler, 1792) (Fig. 10D). Several live specimens (4.0-12.2 mm) were dissected out of submerged wooden poles of fish traps from 7 m depth at station 3. The shell outline and sculpture are very variable. Nevertheless, the pallets are quite distinct with a more or less oval blade, obscurely segmented, having a ribbed or striated appearance and a short stylet (1/3-1/4 the length of the blade). The species is known from the Atlantic Ocean and Mediterranean Sea (Shipway *et al*., 2011; Borges *et al*., 2012) and has also been referred for Greece from the Aegean Sea (Natuurhistorich Museum Rotterdam, http://nlbif.eti.uva.nl/nmr).

XYLOPHAGIDAE

Xylophaga dorsalis (Turton, 1819) (Fig. 11A). Several live specimens (7.5-9.2 mm) were dissected out of a submerged old wooden door found at station 5. The species has been referred from S and W Greece (Zenetos *et al*., 2005) and this is the first record from the N Aegean Sea.

THRACIIDAE

Thracia sp. (Fig. 11B). Two live specimens (1.94 mm and 1.50 mm) and 8 valves (1.55-2.10 mm) were collected at 0.2 m from a *Zostera* bed at station 5. The shell is equilateral, slightly inequivalve, with the dorsal margins of the left valve fitting inside those of the

FIG. 10. A. *Sphenia binghami*; B. *Bankia carinata*; C. *Lyrodus pedicellatus*; D. *Nototeredo norvagica.*

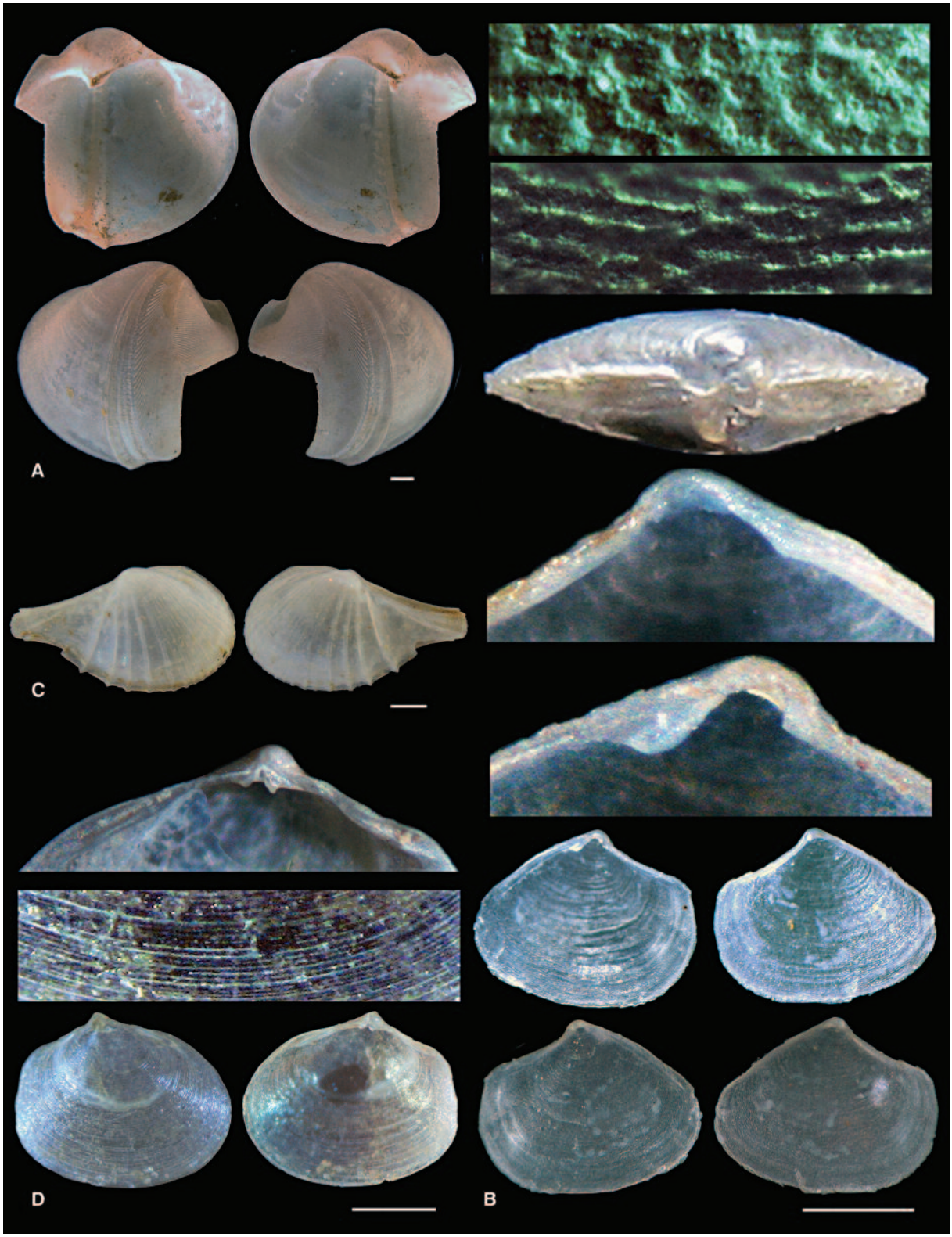

FIG. 11. A. *Xylophaga dorsalis*; B. *Thracia* sp.; C. *Cardiomya costellata*; D. *Arcopella balaustina.*

right valve, and compressed. It is subtrigonal in its outline and truncated posteriorly. The beaks are prominent and the anterior dorsal margin is straight sloping steeply towards the narrowly rounded anterior margin. The ventral margin is straight, the posterior margin is broadly truncate while the posterior dorsal margin is straight with a slope less steeply than the anterior dorsal margin. Its posterior dorsal area is developed as a flat escutcheon and its anterior dorsal area is slightly cleft. The hinge is weak with the right valve bearing a well-developed anterior tooth which continuous with a weak ridge more prominent at the anterior end of the dorsal slope, and a weaker posterior tooth. The left valve bears no teeth. The ligament is internal and attached to a poorly developed sub-umbonal plate. The prodissoconch, of 190 μm in diameter, is simple with a well-demarcated rim. Seen from the inner surface it gives the impression of sugar grains stack together to form the valves, while the outer surface under high magnification seems to consist of uneven series of fine papillae (8-10 μm in diameter) to form ridges interrupted usually every three or two papillae. When compared with the relevant photographs of Oliver & Holmes (2004), the shell strongly resembles in its outlook and the umbo type and size that of *Thracia arianatoma* Oliver & Holmes, 2004 and *T. myopsis* Møller, 1842 with photographs shown in Coan (1990) and World Register of Marine Species (WoRMS) (www.marinespecies.org), while in its outer surface microsculpture it is closer to that of *T. myopsis* Møller, 1842 (Coan, 1990) or *T. kowiensis* Turton, 1932 (Oliver & Holmes, 2004).

CUSPIDARIIDAE

Cardiomya costellata (Deshayes, 1833) (Fig. 11C). Three shells (1.5-5.5 mm) and two broken left valves were found in rocky material trawled from 70 m at station 7. The very thin, fragile and rather inflated shell is slightly inequivalve with the left valve overlapping the right valve. The beaks are situated slightly behind the midline. The body of the shell is ovate, oblique, with its ventral extremity well in front of the line through the beaks and with the anterior dorsal margin sloping steeply. The rostrum is short, slightly turned upwards, triangular and with its dorsal margin concave. The ventral margin is weakly concave corresponding to a weak sulcus at the junction between the rostrum and the body. The shell body bears several radial riblets increasing in size posteriorly. Already known from the Greek seas (Zenetos *et al.*, 2005) it is now referred for the first time from Thermaikos Gulf.

DISCUSSION

The new records

The last list of the known species of bivalves from Thermaikos Gulf (Manousis *et al.*, 2010) included 188 species. This survey increases that number by > 20%, as it adds 39 new species, brings the total number to 227 and presents new data on the biodiversity of the area. At the same time, it reveals the presence of 15 new species from the Hellenic Seas. The current addition of those new records (Table 2) increases the bivalve biodiversity of the Hellenic fauna from 319 (Zenetos *et al*., 2005, 2007; Manousis *et al*., 2010) to the total number of 334 species, or by approximately 5.5%. As the majority of all those new species are of small size (< 5 mm), their finding is attributed to the intensive, frequent and thorough sampling effort as well as to the careful sorting under magnification and the appropriate and delicate handling of the material.

Out of the two nuculanid species recorded, *Nuculana* cf. *pella* (Linnaeus 1767) comprises a temptation to be considered as a variant of the known in the area *Nuculana pella* (Linnaeus 1767) but as the members of this family separate from each other often on the basis of minor morphologic differences, such a "variant" should be kept separate from its close relative.

The finding of a number of minute and rare montacutids reported in this work for the first time from Greece, namely, *Devonia perrieri* (Malard, 1904), *Kelliopsis jozinae* (van Aartsen & Carrozza, 1997), *Montacuta goudi* (van Aartsen, 1997) and *M. phascolionis* Dautzenberg & Fischer H., 1925, as well as the small and fragile species *Cyclopecten brundisiensis* Smriglio & Mariottini, 1990, *Monia squama* (Gmelin, 1791) and *Thyasira biplicata* (Philippi, 1836), known inhabitants of the West and/or Central Mediterranean Sea, indicates that the sorting of delicate bivalve fauna necessitates the appropriate handling in order to survive treatment.

It should be pointed out that a considerable number of the presented miniature bivalve species are collected from the station 5 and particularly from 10 m^2 of a *Zostera* bed (protected from the waves, not exciding the 20 m^2 in its total surface). This is reminiscent of another great biodiversity "hot spot" harboring a remarkable association of, similar to those of this publication, miniature bivalves of the Lower Pliocene in Peloponnesus, Greece (Schneider & Hochleitner, 2006).

Among the wood eating members of the family TEREDINIDAE, the presence of *Bankia carinata* (Je Gray, 1827) and *Lyrodus pedicellatus* (de Quatrefages,

1849) in the Greek waters is now documented. Their identification is mainly based on the morphological characteristics of their pallets which are only present in live and intact biological material. After the death of the wood inhabiting organisms, their pallets are lost (either due to drifting or they are cemented in the wooden substrate) and thus complicate the systematic study these xylophages organisms.

The alien species status

From the three new alien species for Greece, *Fulvia australis* seems to have started expanding from the coasts of Israel towards the NW Aegean (Thermaikos Gulf) or it has been introduced by shipping as there is no reference from the rest of the Aegean Sea yet, while the congeneric and very similar species *F. fragilis* is well established in Thessaloniki and Thermaikos Gulfs according to the existing information by Zenetos *et al.* (2003), Angelidis (2013) and the current study.

Pinctada imbricata radiata is now successfully established in the S Aegean (ELNAIS, https://services.ath.hcmr.gr). The specimens of this study, with age up to three years, all with a rather high growth rate which is very similar to that of individuals from Israel and the Red Sea (Fig. 12) show establishment and a quick expansion in the E Thessaloniki Gulf (N Aegean, E Mediterranean Sea) perhaps due to appropriate ambient conditions of the area.

Beside *Pinctada imbricata radiata*, *Crassostrea gigas* is another commercial alien that is recorded in the E Thessaloniki Gulf where the alien gastropod *Bursatella leachii* was also found (Manousis *et al*., 2012) in coincidence with a massive expansion of the alien alga *Caulerpa racemosa* which is recorded in quantities along almost all the eastern littoral zone of Thessaloniki and Thermaikos Gulfs during the current study.

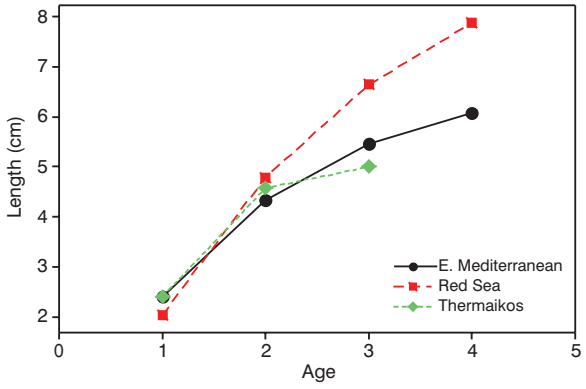

FIG. 12. Growth rate of *Pinctada radiata* in Red Sea and E. Mediterranean (Mohammed & Yassien, 2003) and in the study area for 14 specimens.

Apart from the different collection stations of the recorded alien species in Thermaikos Gulf (NW part of the Aegean Sea), their successful establishment is also indicated by the collection of live juveniles, live individuals filled with D shape larvae, intact shells and individual valves. This success could be attributed to an adaptability of their populations to the Hellenic marine environment as it was also referred for *Parvicardium hauniense* (Peterson & Russel, 1971) (The Conchological Society of Great Britain and Ireland, www.conchsoc.org) or/and to the fact that the environment in the E Mediterranean Sea has changed during the last decade and became warmer (Saaroni *et al*., 2003; Hansen *et al*., 2010) with the N Aegean Sea being more rapidly warmed than the rest of the Mediterranean sea basin (Skliris *et al*., 2011)

The goal set in a previous publication (Manousis *et al*., 2010) to "further research emphasizing on small in size species, symbionts, epibionts and rare species needs to be contacted in order to further explore the present biodiversity of bivalves in the area" seems to be accomplished. The present and the previous findings consist a reference base for any future study of the bivalve malacofauna of Thermaikos and Thessaloniki Gulfs.

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REFERENCES

Albayrak S, Çağlar S, 2006. On the presence of *Siphonaria belcheri* Hanley, 1858 [Gastropoda: Siphonariidae] and *Septifer bilocularis* (Linnaeus, 1758) [Bivalvia: Mytilidae] in the Iskenderun Bay (SE Turkey). *Aquatic Invasions*, 1: 292-294.

Allen JA, 2004. The recent species of the genera *Limatula* and *Limea* (Bivalvia, Limacea) present in the Atlantic, with particular reference to those in deep water. *Journal of Natural History*, 38: 2591-2653.

Angelidis A, 2013. *Fulvia fragilis* (Forsskal in Niebuhr, 1775) (Bivalvia: Cardiidae), first record of an alien mollusk in the Gulf of Thessaloniki (Inner Thermaikos Gulf, North Aegean Sea, Greece). *Journal of Biological Research-Thessaloniki*, 20: 228-232.

Borges LMS, Sivrikaya H, le Roux A, Shipway JR, Cragg SM, Costa FO, 2012. Investigating the taxonomy and systematics of marine wood borers (Bivalvia: Teredini-

dae) combining evidence from morphology, DNA barcodes and nuclear locus sequences. *Invertebrate Systematics*, 26: 572-582.

Cachia Ch, Mifsud C, Sammut PM, 2004. *The marine mollusca of the Maltese Islands, part IV: Caudofoveata, Solenogastres, Bivalvia, Scaphopoda & Cephalopodahe*. Backhuys Publishers, Leiden.

Coan EV, 1990. The recent Eastern Pacific species of the bivalve family Thraciidae. *The Veliger*, 33: 20-55.

Coney CC, 1990. *Bellascintilla parmaleeana* new genus and species from the tropical eastern Pacific, with a review of the other, ventrally notched Galeommatid genera (Bivalvia: Galeommatacea). *The Nautilus*, 104: 130-144.

Cossignani T & Ardovini R, 2011. *Malacologia Mediterranea*. *Atlante delle conchiglie del Mediterraneo*. L' Informatore Piceno, Ancona, Italia.

Dhora Dh, 2012. Marine and non-marine molluscs of Albania (2012). *Buletin Shkencor, Seria e Shkencave të Natyrës*, 62: 92-123.

Dijkstra HH, Warén A, Gudmundsson G, 2009. Pectinoidea (Mollusca: Bivalvia) from Iceland. *Marine Biology Research*, 5: 207-243.

Doğan A, Önen M, Öztürk B, Bitlis B, 2009. Two rare deep-sea bivalve species from the Levantine coast of Turkey: *Bathyarca philippiana* (Nyst, 1848) and *Verticordia granulata* Seguenza G., 1860. *Turkish Journal of Zoology*, 33: 225-230.

Galil BS, Zenetos A, 2002. A sea change. Exotics in the Eastern Mediterranean Sea. In: Leppakoski E, Gollasch S, Olenin S, eds. *Invasive Aquatic Species of Europe. Distribution, Impacts and Management*. Kluwer Scientific Publications, Dordrecht: 325-336.

Giannuzzi-Savelli R, Pusateri F, Palmeri A, Ebreo C, Coppini M, Margelli A, Bogi C, 2001. *Atlante delle conchiglie marine del Mediterraneo*. Evolver, Roma.

Gofas S, Moreno D, Salas C, 2011. *Clase Gastropoda (Heterobranchia), clase Bivalvia, clase Scaphopoda, clase Cephalopoda, glosario e índices*. *Vol. II*. Servicio de Publicaciones e Intercambio Cientifico, Universidad de Malaga, Málaga.

Gustafson RG, Turner RD, Lutz RA, Vrijenhoek RC, 1998. A new genus and five new species of mussels (Bivalvia, Mytilidae) from deep-sea sulfate/hydrocarbon seeps in the Gulf of Mexico. *Malacologia*, 40: 63-112.

Hansen J, Ruedy R, Sato M, Lo K, 2010. Global surface temperature change. *Reviews of Geophysics*, 48: RG4004.

Katsanevakis S, Lefkaditou E, Galinou-Mitsoudi S, Koutsoubas D, Zenetos A, 2008. Molluscan species of minor commercial interest in Hellenic seas: Distribution, exploitation and conservation status. *Mediterranean Marine Science*, 9: 77-118.

Koukouras A, 2010. Check-list of marine species from Greece. Aristotle University of Thessaloniki (http://www.marinespecies.org/aphia.php?p=sourcedetails&id=142068).

La Perna R, D'Abramo M, 2009. Morphometric and systematic study on three *Acanthocardia* species from the Mediterranean Pleistocene (Mollusca, Bivalvia, Cardiidae). *Geodiversitas*, 31: 669-682.

Manousis T, Mpardakis G, Paraskevopoulos C, Galinou-Mitsoudi S, 2010. The Bivalvia Mollusca of Thessaloniki and Thermaikos Gulfs (North Aegean Sea, Greece) with emphasis on new species for Hellenic waters. *Journal of Biological Research-Thessaloniki*, 14: 161-179.

Manousis T, Mpardakis G, Zamora Silva A, Paraskevopoulos K, Manios D, Galinou-Mitsoudi S, 2012. New findings of Gastropods in the Hellenic Seas with emphasis on their origin and distribution status. *Journal of Biological Research-Thessaloniki*, 18: 249-264.

Minchin D, Gollasch S, 2008. DAISIE European Invasive Alien Species Gateway, 2008. *Crassostrea gigas* (http://www.europe-aliens.org/pdf/*Crassostrea_gigas*.pdf).

Mohammed SZ, Yassien MH, 2003. Population parameters of the pearl oyster *Pinctada radiata* (Leach) in Qatari Waters, Arabian Gulf. *Turkish Journal of Zoology*, 27: 339-343.

Oliver PG, Holmes AM, 2004. Cryptic bivalves with descriptions of new species from the Rodrigues lagoon. *Journal of Natural History*, 38: 3175-3227.

Oliver PG, Killeen IJ, 2002. The Thyasiridae (Mollusca: Bivalvia) of the British continental shelf and North Sea oil fields. An identification manual. *Studies in Marine Biodiversity and Systematics from the National Museum of Wales*. BIOM R Reports, Natural Museums & Galleries of Wales.

Önen M, Doğan A, 2007. *Dacrydium hyalinum* (Monterosato, 1875) and *Musculus discors* (Linnaeus, 1767): Two new Mytilidae (Bivalvia) species for the Turkish mollusc fauna. *Turkish Journal of Zoology*, 31: 235-239.

Öztürk B, Poutiers J-M, 2005. *Fulvia fragilis* (Bivalvia: Cardiidae): a lessepsian mollusc species from Izmir Bay (Aegean Sea). *Journal of the Marine Biological Association of the United Kingdom*, 85: 351-356.

Pancucci-Papadopoulou MA, Zenetos A, Corsini-Foka M, Politou C-Y, 2005. Update of marine alien species in Hellenic waters. *Mediterranean Marine Science*, 6: 147-158.

Poppe GT, Goto Y, 2000. *European seashells, Vol. II*. ConchBooks, Hachenheim.

Por FD, 1978. *Lessepsian migration. The influx of Red Sea biota into Mediterranean by way of the Suez Canal*. Springer-Verlag, Heidelberg.

Por FD, 1990. Lessepsian migration. An appraisal and new data. *Bulletin de l'Institut Oceanographique Monaco*, 7: 1-10.

Repetto G, Orlando F, Arduino G, 2005. *Conchiglie del Mediterraneo*. Amici del Museo "Federico Eucebio", Alba, Torino.

Saaroni H, Ziv B, Edelson J, Alpert P, 2003. Long-term variations in summer temperatures over the Eastern Mediterranean. *Geophysical Research Letters*, 30: 1946

(doi:10.1029/2003GL017742).

Sakellariou E, 1957. Living Mollusca of the Gulf of Thessaloniki and their contribution in stromatography. Ph. D. Thesis, University of Athens.

Salas C, Gofas S, 1997. Brooding and non-brooding *Dacrydium* (Bivalvia: Mytilidae): A review of the Atlantic species. *Journal of Molluscan Studies*, 63: 261-283.

Scaperrotta M, Bartolini S, Bogi C, 2010. *Stadi di accrescimento dei molluschi marini del Mediterraneo*, *Vol. II*. L' Informatore Piceno, Ancona, Italy.

Schneider S, Hochleitner R, 2006. Great diversity in small space – A remarkable bivalve association from the Lower Pliocene of Harokopio (SW Peloponnesus, Greece). In: Malchus N, Pons JM, eds. *Bivalvia 2006*, *International Congress on Bivalvia (23.07.-27.07.2006) – Scientific program and abstracts*. Universitat Aut noma de Barcelona, Barcelona.

Shipway R, Cragg S, Borges L, Sivrikaya H, Müller J, 2011. The rapid destruction of a wreck in Turkish waters by a suspected invasive teredinid (Teredinidae, Bivalvia). *The Malacologist*, 56: 12.

Simboura N, Zenetos A, 2002. Benthic indicators to use in ecological quality classification of Mediterranean soft bottom marine ecosystems, including a new biotic index. *Mediterranean Marine Science*, 3: 77-111.

Skliris N, Sofianos SS, Gkanasos A, Axaopoulos P, Mantziafou A, Vervatis V, 2011. Long-term sea surface temperature variability in the Aegean Sea. *Advances in Oceanography and Limnology*, 2: 125-139.

Streftaris N, Zenetos A, 2006. Alien marine species in the Mediterranean – the 100 "worst invasives" and their impact. *Mediterranean Marine Science*, 7: 87-118.

Streftaris N, Zenetos A, Papathanassiou E, 2005. Globalization in marine ecosystems: the story of non-indigenous marine species across European seas. *Oceanography and Marine Biology: an Annual Review*, 43: 419-453.

Tenekidis N, 1989. *A Sea Shell Collection from the Greek Seas*. Brothers Protopara Ltd, Athens (in Greek).

Todd JA, 2001. Introduction to molluscan life habits databases. NMiTA (http://eusmilia.geology.uiowa.edu/database/mollusc/mollusclifestyles.htm).

Van Aartsen JJ, Carrozza F, 1997. On "*Lasea" pumila* (S.V. Wood, 1851) and two new bivalves from European waters: *Mancikellia divae* n. sp. and *Kelliopsis jozinae* n. sp. (Bivalvia: Condylocardiidae and Montacutidae). *La Conchiglia*, 285: 28-34.

Zarkanellas A, 1980. Ecological study of the macrobenthic fauna of Thermaikos Gulf. Ph. D. Thesis, Aristotle University of Thessaloniki, Thessaloniki.

Zenetos A, 1996. The marine Bivalvia (Mollusca) of Greece. *Fauna Graeciae VII*, Athens: N.C.M.R.

Zenetos A, Gofas S, Russo G, Templado J, 2003. *Atlas of exotic Mediterranean Molluscs*. *Vol. 3*. CIESM Publications, Monaco.

Zenetos A, Vardala-Theodorou E, Alexandrakis C, 2005. Update of the marine Bivalvia Mollusca checklist in Greek waters. *Journal of the Marine Biological Association of the United Kingdom*, 85: 993-998.

Zenetos A, Vassilopoulou V, Salomidi M, Poursanidis D, 2007. Additions to the marine alien fauna of Greek waters (2007 update). *JMBA2-Biodiversity Records*, 5928.

Zenetos A, Katsanevakis S, Poursanidis D, Crocetta F, Damalas D, Apostolopoulos G, Gravili C, Vardala-Theodorou E, Malaquias M, 2011. Marine alien species in Greek seas: Additions and amendments by 2010. *Mediterranean Marine Science*, 12: 95-120.