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Molluscan species of minor commercial interest in Hellenic seas: Distribution, exploitation and conservation status

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Abstract

Recognising the need for data gathering at taxon level besides the taxa of commercial interest and those listed as endangered in the Protocol of the Barcelona Convention, but still exploited by Man, the present study attempts to gather and review the available scientific information on molluscs of minor commercial importance in order to assist in the adequate management and protection of their populations. Forty one species (18 gastropods, 13 bivalves, and 10 cephalopods) of minor commercial interest are treated in the present work with details on their biogeographic distribution, exploitation and conservation status in Hellas. Apart from a few species (e.g., Pinna nobilis, Lithophaga lithophaga, Donacilla cornea), and these only at a local scale, there is no population assessment in Hellenic seas. The existing legislation for eleven of these species is not enforced in practice, and seems insufficient to guarantee their conservation. It is suggested that targeted collection data, networked nationally and internationally, should be promoted so this invaluable source of biodiversity information can be accessed for conservation and planning purposes.

Keywords: Mollusca exploitation; Conservation; Hellas.

Introduction

Exploitation of mollusca as food and as ornaments in Hellas has a history dating back to the Paleolithic age (SHACKLETON & VAN ANDEL, 2007). However, the development of high density human populations near the coast has resulted in unprecedented and unsustainable levels of pressure nowadays. Unfortunately, seashells are collected in those areas least capable of withstanding exploitation. While

shelled mollusca are heavily exploited, some cephalopod species are impacted by uncontrolled and unreported fishing, which may have a significant effect on their populations.

A total of 1160 mollusc species (1 Solenogastra, 2 Caudofoveata, 771 Gastropoda, 308 Bivalvia, 19 Polyplacophora, 12 Scaphopoda and 47 Cephalopoda) have been recorded so far in Hellenic seas (KOUTSOUBAS, 2004; CHINTIROGLOU *et al.,* 2005; ZENETOS *et al.,* 2005; LEFKADITOU, 2007; DELAMOTTE & VARDALA-THEODOROU, 2007). A total of 27 of these species (seventeen bivalves, four gastropods and six cephalopods), comprising less than 2.5 % of the molluscan fauna of the Hellenic seas, have a commercial interest, particularly in fisheries and aquaculture since they are collected and/or cultivated for human consumption. The status of the fishing of these commercially important molluscs has been recently reviewed (KOUTSOUBAS *et al.,* 2007; LEFKADITOU, 2007).

However, apart from those commercially important species, there are many other molluscs, which, although not commercially exploited, are either systematically or occasionally collected for human consumption and other uses (fishing bait, jewellery, decoration, private and public collections). Furthermore, several species, for example some common small-sized cephalopods, constitute trawl fisheries bycatches which may have a marketable fraction. Bivalve and gastropod molluscs are also frequently used to biomonitor heavy metal pollution in the marine environment. In most cases, the distribution, the degree of exploitation, and the state of these populations have not been assessed in Hellenic seas. Uncontrolled and unreported fishing or other human activities have been destructive and have caused a significant decline in the Mediterranean populations of several species (e.g., *Pinna nobilis*) and have brought others to near extinction (e.g., *Patella ferruginea*) (BOUDOURESQUE, 2004). In addition, basic knowledge on the biology and ecology of these species is either lacking or is scattered in the literature.

The red list species approach to conservation requires detailed knowledge concerning individual taxa (distribution, declines, threatening processes, biological attributes, etc.). However, it addresses only the tip of the biodiversity iceberg. The first step in knowledge acquisition required for the taxon-based approach to biodiversity and conservation is the study and documentation of at least the major components of the fauna. Hence, the present study attempts to gather and review the available scientific information on molluscs of minor commercial importance in order to assist in the adequate management and protection of their populations.

Materials and Methods

Forty one species (18 gastropods, 13 bivalves, and 10 cephalopods) of minor commercial interest were reviewed in the present work (Table 1). The distribution of the listed species in Hellenic seas was generally based on ZENETOS (1986; 1996), KOUTSOUBAS (1992), KOUTSOUBAS *et al.* (1992, 1997, 1999, 2000a,b), ZENETOS *et al.* (2004, 2007), ANTONIADOU *et al.* (2005), DELAMOTTE & VARDALA-THEODOROU (2007), LEFKADITOU (2007), EVAGELOPOULOS & KOUTSOUBAS (2008), grey literature such as academic dissertations and HCMR or EU technical reports, and/or on unpublished/personal observations.

Table 1

Mollusc species (Gastropoda, Bivalvia and Cephalopoda) of minor commercial interest in Hellenic seas. Common Hellenic and English names, exploitation modes (ED = Edible, FB = Fishing Bait, JWL = Jewelry, COL = Shell Collections, BIOM = used for Biomonitoring), and the legislation for their protection (BC = Bern Convention, PBC = Protocol for Specially Protected Areas and Biological Diversity in the Mediterranean of the Barcelona Convention, 92/43/EC = EC Habitats Directive 92/43, 67/1981 = Presidential Decree 67/1981, 109/2002 = Presidential Decree 109/2002) are also given.

Scientific name	Common Hellenic /English names	Exploitation mode	Legislation
GASTROPODA			
Patella caerulea	Petalida /Rayed Mediterranean limpet	ED, FB, BIOM	109/2002
Patella rustica	Stiktopetalida /Ristic limpet	ED, FB, BIOM	109/2002
Patella ulyssiponensis	Agriopetalida /Rough limpet, China limpet	ED, FB, BIOM	109/2002
Osilinus articulatus	Salingaraki, Arthrotos trochos /Articulate monodont	ED, FB, BIOM	
Osilinus turbinatus	Salingaraki, Trochos fraoula /Turbinate monodont	ED, FB, BIOM	
Phorcus mutabilis	Salingaraki	ED, FB	
Bolma rugosa	Strovilos, Mati tis Panagias (the opperculum)/Rough turbo	JWL, COL	
Cerithium vulgatum	Skaltsini, Striftari, Kerato /Mediterranean cerithe	FB	
Strombus persicus	Konos tis Persias	ED, COL	
Erosaria spurca	Gourounitsa /Cowrie	COL, JWL	BC, PBC, 67/1981
Luria lurida	Gourounitsa /Cowrie	COL, JWL	BC, PBC, 67/1981
Zonaria pyrum	Gourounitsa /Cowrie	COL, JWL	BC, PBC, 67/1981
Tonna galea	Bouchona, Kochyla /Giant ton	ED, COL	BC, PBC, 67/1981
Ranella olearium	Agkathotritonas /Wandering triton, Olive trumpet	COL	BC, PBC
Charonia lampas	Tritonas /Knobed triton, lamp triton	COL	BC, PBC
Charonia variegata	Tritonas, Bourou /Variegated triton	COL	BC, PBC
Mitra zonata	Mitra /Zoned miter	ED, COL	BC, PBC
Conus mediterraneus	Konos /Cone shell	COL	
BIVALVIA			
Lithophaga lithophaga	Petrosolinas, Valanos,Chourmas /European date mussel	ED	92/43/EC, BC, PBC
Pinna nobilis	Pinna /Pen shell, Fan shell	ED, COL, BIOM	92/43/EC, PBC, 67/1981

(continued)

Table 1 (continued)

Scientific name	Common Hellenic /English names	Exploitation mode	Legislation
BIVALVIA			
Pinctada radiata	Margaritoforo stridi /Rayed pearl oyster	ED, JWL , BIOM	
Pteria hirundo	Fterostrido /European wing yster	ED, COL	
Chlamys varia	Kalogria, Chlamyda /Variegated scallop	ED, COL	
Crassadoma multistriata	Grammoto chteni /Little bay scallop	ED, COL	
Spondylus gaederopus	Gaidouropodaro, Vassiliko stridi /European thorny yster	ED, COL	
Crassostrea gigas	Portogaliko stridi /Giant (or Pacific) cupped oyster	ED, BIOM	
Donacilla cornea	Ammokochylo, Mikri ahivada /Banded wedge shell	ED, BIOM	
Solen marginatus	Solinas, Ammosolinas /European razor clam	ED, FB, BIOM	109/2002
Ensis minor	Solinas, Ammosolinas /Giant razor clam	ED, FB	109/2002
Solecurtus strigilatus	Samari, Zamponaki /Sandwich	ED, FB, COL	109/2002
Pholas dactylus	Daktilo, Ftera aggelon, Folada /Common piddock	ED, FB	BC, PBC
CEPHALOPODA			
Alloteuthis media	Kalamaraki /Midsize squid	ED	
Loligo forbesi	Kalamari /Veined squid	ED	
Todarodes sagittatus	Thrapsalo, Katamachi /European flying squid	ED, FB	
Todaropsis eblanae	Thrapsalo /Lesser flying squid	ED, FB	
Sepia elegans	Elegant cuttlefish	ED	
Sepia orbignyana	Kokkinosoupia /Pink cuttlefish	ED	
Rossia macrosoma	Mikrosoupia /Stout bodtail	ED	
Rondeletiola minor	Soupitsa /Lentil bodtail	ED	
Sepietta oweniana	Soupitsa /Common bodtail	ED	
Scaeurgus unicirrhus	Monokero chtapodi /Unihorned octopus	ED	

A general map of Hellas with the names of the gulfs and other locations mentioned in the text is given in Figure 1. General information on the biology and ecology of the species was gathered after a thorough search of international and national literature. Nomenclature for gastropods and bivalves followed the Check List of European Marine Mollusca CLEMAM (http://www.somali.asso.fr/clemam/biotaxis.php), whereas that for cephalopods followed the classification of living coleoid species of the Mediterranean Sea by MANGOLD & von BOLETZKY (1987).

Legislation concerning the conservation of each species is reported where available (Table 1). The existing legislation for the conservation of marine species includes the Presidential Decree 67/1981, the EC Habitats Directive 92/43, the Bern Convention, and the Protocol for Specially Protected Areas and Biological Diversity in the Mediterranean of the Barcelona Convention (hereafter: Protocol of the Barcelona Convention). For species included in Annex IV of the Directive 92/43/EC, all forms of deliberate capture or killing of specimens in the wild, deliberate disturbance, particularly during the period of breeding, deliberate destruction or taking of eggs from the wild, and deterioration or destruction of breeding sites or resting places are strictly prohibited. For species included in Annex II of the Bern Convention, the collection, keeping in captivity, killing, destruction or collecting of eggs, disturbance especially during the reproduc-

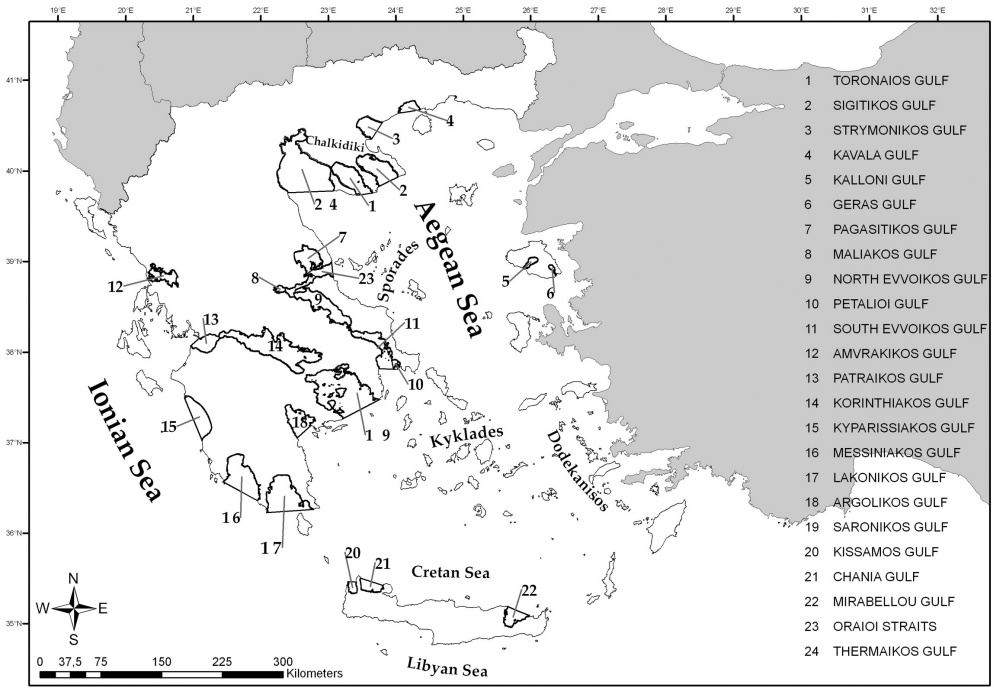

Fig. 1: A general map of Hellas, with indications of the main locations mentioned in the text.

tion period, possession or commerce of live or dead specimens are strictly prohibited. For species included in Annex II of the Protocol of the Barcelona Convention, collection, capture, killing, commerce, transportation and disturbance especially during reproduction should be prohibited or controlled. The Presidential Decree (PD) 67/1981 prohibits killing, causing injury, capture, collection, commerce and transportation of all included species. Furthermore, according to the PD 86/98 (regarding shell-fishing) as reformed by the PD 227/2003, and the PD 109/2002 (regarding fishing baits), fishing, transportation and commerce of any species of shelled mollusca not included in these PDs is prohibited. Thus, among the bivalves and gastropods of this study, exploitation is prohibited for all species except *Solecurtus strigilatus, Ensis siliqua, Solen marginatus, Pholas dactylus* and *Patella* spp., which are included in PD 109/2002.

The species listed below are sorted first taxonomically (gastropods, bivalves and cephalopods) and then phyllogenetically. For each species, relevant information is categorized into four sections, i.e. *General,* with some diagnostic features of the species and useful information on its autecology, *Distribution* where the global and the Hellenic distribution of the species is given, *Exploitation,* where the mode of exploitation and the uses of the species in the past and at present are reported, and *Conservation Status,* in which possible population assessments of the species and relevant legislation for its conservation are presented. In *Exploitation,* the real mode of exploitation is presented and not that according to existing legislation, as in most cases legislation is violated and species for which fishing is prohibited may be extensively exploited. Con-generic species are treated together.

The selection of the forty-one species listed in this paper was based on data availability and the expert knowledge of the authors. Several other species, not included in this list might also be considered as molluscs of minor commercial interest, as for example, *Glycymeris glycymeris, Glycymeris bimaculata, Acanthocardia tuberculata, Glossus humanus, Phalium granulatum, Cassidaria echinophora,* which are collected in great numbers by shell collectors. In this review, we included those species that we subjectively considered as most important.

Results

1. Gastropods

Family Patellidae: *Patella caerulea* (Linnaeus, 1758), *P. rustica* (= *lusitanica*) (Linnaeus, 1758), *P. ulyssiponensis* (= *aspera*) (Gmelin, 1791)

General: Three species have been reported in Hellenic seas: *Patella caerulea, P. rustica* (= *lusitanica*), and *P. ulyssiponensis* (= *aspera*) (KOUTSOUBAS, 1992; DELAMOTTE & VARDALA-THEODOROU, 2007). Limpets (*Patella* sp.) are common inhabitants of the hard substrate communities in the intertidal and upper subtidal zones. They have a strong conical shell with radiating ridges, which may have epiphytes or epizooites growing on it. Limpets attach themselves to the substratum using their strong muscular foot, which enables them to withstand heavy wave action. They are herbivorous and feed mostly at night grazing on algae found on rocks. They use a very hard-toothed radula to scrape rock surfaces, often limiting algal growth on exposed and moderately

exposed shores. They have a homing behaviour and return to the same spot after eating, using sensitive chemoreceptors to find their way back; sometimes they use the same 'home' for their whole life. *P. caerulea* may reach a length of 70 mm, *P. ulyssiponensis* a length of 50 mm, while *P. rustica* is relatively smaller, attaining a length of 45 mm.

Distribution: P. caerulea is present throughout the Mediterranean Sea and in a few places in the eastern Atlantic (Bay of Biscay, Canary Islands, Moroccan coast). *P. ulyssiponensis* has the widest distribution, being abundant on Atlantic shores from Norway to Mauritania, in the Mediterranean and Black Sea, and in the Macaronesian Islands. *P. rustica* occurs in the Mediterranean Sea and on the Atlantic coasts from Biarritz (France) to Mauritania, in Cape Verde, the Canary Islands, Selvagens, Desertas, and Madeira. *P. caerulea* is the most common limpet in Hellenic seas. *P. rustica,* and *P. ulyssiponensis* are also common in most Hellenic coastal areas.

Exploitation: Limpets are widely collected for human consumption and as fishing bait. They are also used as bioindicators in heavy metal bioaccumulation studies (e.g., CONTI & CECCHETTI, 2003). Their fishing in Hellenic seas is regulated by the PD 109/2002.

Conservation Status: Although no population assessment has been conducted, all three species seem to be rather common.

Family Trochidae: *Osilinus turbinatus (= Monodonta turbinata)* (Von Born, 1778), *Osilinus articulatus (= Monodonta articulata)* (Lamarck, 1822), and *Phorcus mutabilis (= Monodonta mutabilis)* (Philippi, 1846)

General: Monodonts are common inhabitants of the hard substrate communities in the upper subtidal zone. The height of *Osilinus turbinatus, O. articulatus,* and *Phorcus mutabilis* may reach 30 mm, 30 mm and 18 mm respectively. They are herbivorous and feed mostly at night grazing on algae found on rocks.

Distribution: All three species are abundant in the Mediterranean basin, while *O. atriculatus* and *O. turbinatus* are also found in the eastern Atlantic. In Hellenic seas, *O. turbinatus* seems to be common everywhere, while *O. articulatus* has been reported in the Saronikos, Evvoikos and Pagasitikos Gulfs, along the Peloponnesian coasts, the Sporades, the N. Aegean and Ionian Sea, and *P. mutabilis* in the Saronikos, Korinthiakos and Evvoikos Gulfs, the N. Aegean, along the Peloponnesian coasts, Rodos and the Ionian Sea.

Exploitation: Small quantities of Monodonts (especially *O. turbinatus*) are collected for human consumption and sporadically offered in small taverns in fishing villages especially in the Dodekanisos islands (S Aegean Sea) and the Chalkidiki Peninsula (N Aegean Sea). They are also used as bioindicators in heavy metal bioaccumulation studies (e.g., CONTI & CECCHETTI, 2003).

Conservation Status: Presumably, the three species are abundant in Hellenic seas. There is no relevant legislation. No population assessment has been conducted in Hellenic seas.

***Bolma (= Astraea) rugosa* (Linnaeus, 1767)**

General: Bolma rugosa is an inhabitant of photophilic algae or coralligenous assemblages and *Posidonia oceanica* meadows (KOUTSOUBAS, 1992;

ANTONIADOU *et al.,* 2005; personal observations). Its shell may reach a height of 60 mm and it has a thick, glossy, cream to orange, calcified operculum, which in Hellas is called 'Mati tis Panagias' (i.e., 'the Virgin Mary's eye').

Distribution: Bolma rugosa is found in the Mediterranean and E Atlantic Ocean (around the Mediterranean basin), including Madeira, the Azores and the Canary Islands. *B. rugosa* is common and may be found almost everywhere in Hellenic seas.

Exploitation: In Hellenic seas, *B. rugosa* is exploited (especially on the islands of the Kyklades plateau) for its beautifully coloured calcified operculum, which is utilized in jewellery making.

Conservation Status: It is not protected by legislation. No population assessment has been conducted in Hellenic seas.

***Cerithium vulgatum* (Bruguière, 1792)**

General: Approximately 300 species belong to the family Cerithiidae, which are small and medium sized shells found in temperate and tropical seas. *C. vulgatum* adults may reach a height of 5–7 cm. *C. vulgatum* may be found in a variety of biotopes, mainly on muddy substrate, on rocky and pebble bottoms, and in seagrass beds. It prefers areas of low wave intensity, such as lagoons and embayments. It is a herbivore, feeding mainly on small algae.

Distribution: C. vulgatum lives in the Mediterranean Sea and E Atlantic, from the British Isles to the coast of Senegal. In Hellenic seas, *C. vulgatum* is abundant along most coastal areas.

Exploitation: Cerithium vulgatum, has been found in a range of habitats, dominating the archaeological record in the Franchthi Cave, an Upper Paleolithic find in the southern Peloponnisos, Hellas. Perhaps this small, gregarious snail was collected in such numbers not for food but for the purpose of conversion into body ornaments, as the perforations in most shells suggest (SHACKLETON & VAN ANDEL, 2007). Nowadays, there is only limited exploitation of the species and they are used as fishing bait.

Conservation Status: C. vulgatum is very common. However, there is no population assessment in Hellenic seas.

***Strombus (= Conomurex) persicus (= decorus raybaudii)* (Swainson, 1821)**

General: Strombus persicus may exceed a height of 75 mm, is gonochoristic with sexual dimorphism in its radula (MUTLU, 2004). Larvae are planktotrophic, ensuring long-distance dispersal. All *Strombus* species are herbivorous, feeding on algae. In the Indo-Pacific regions, *S. persicus* lives on sandy bottoms and in coral sand (ABBOTT, 1960). In the Mediterranean, adult *S. persicus* inhabit sandy or slightly gravelly bottoms and feed on seaweeds and detritus, while juveniles (shell length <2 cm) were found either living in colonies on small rocks covered by algae or on sandy bottoms with detritus (MUTLU, 2004).

Distribution: S. persicus is a subtropical species, initially restricted to the south Arabian and part of the Iranian coast, that has entered the Mediterranean presumably via shipping through the Suez Canal and has become locally invasive in the south-eastern Mediterranean (OLIVERIO, 1995; STREFTARIS & ZENETOS, 2006). *S. persicus* was first recorded in the Mediterranean Sea in 1978

in Iskenderum (southern Turkish coasts) (NICOLAY, 1986) and was successively found in Israel, Hellas, Cyprus, Syria and Lebanon (ZENETOS *et al.,* 2004). In Hellas, it has been established in Rodos, the south Peloponnisos coasts, Kriti, the Kyklades, the Argolikos, Evvoikos, and Saronikos gulfs (ZENETOS *et al.,* 2004; YOUNG, 2007; ZENETOS *et al.,* 2007; personal observations); it has not yet been reported in the Ionian or the N Aegean Sea (Fig. 2).

Exploitation: The species has been exploited in Rodos Island over recent years and sporadically offered for human consumption in fish restaurants.

Conservation Status: It is a successful invader in the Mediterranean Sea and its spatial distribution keeps increasing (ZENETOS *et al.,* 2004; YOUNG, 2007; ZENETOS *et al.,* 2007). There is no relevant legislation for its conservation. Although there are detailed records of its invasion into the Mediterranean and Hellenic seas, no population assessment has been conducted in Hellas.

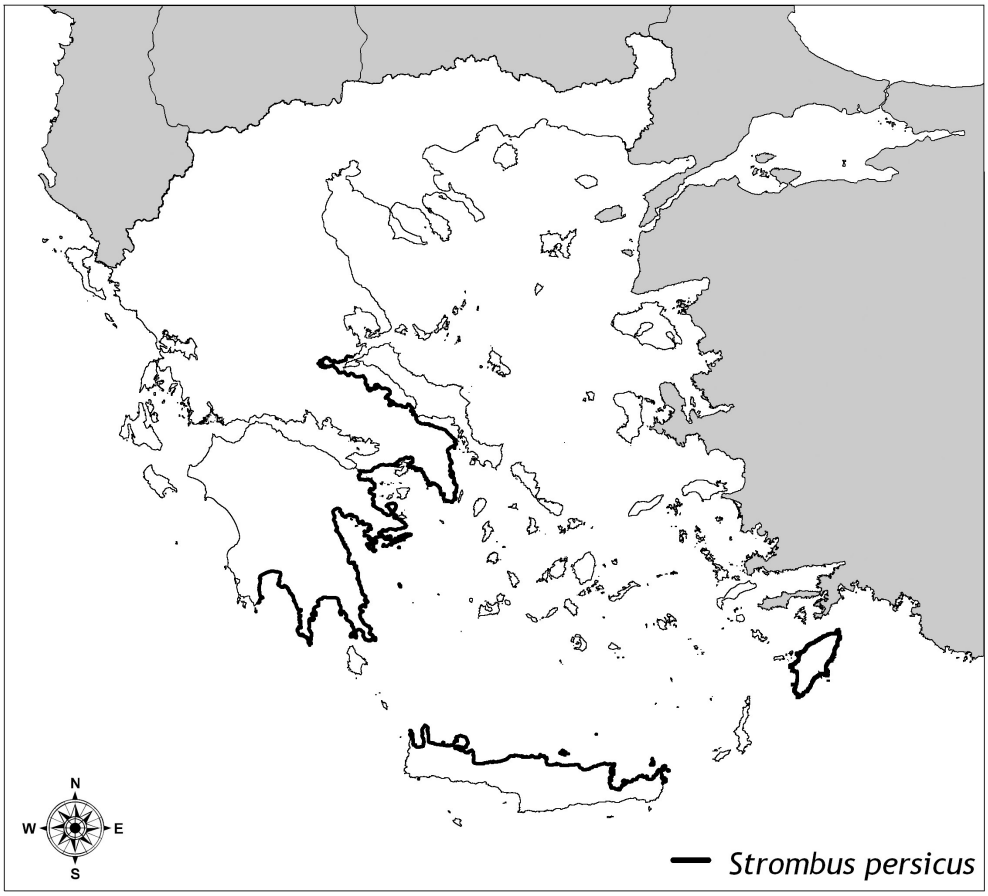

Fig. 2: Known distribution of *Strombus persicus* in Hellenic seas.

Family Cypraeidae: *Luria (= Cypraea) lurida* (Linnaeus, 1758), *Erosaria (= Cypraea) spurca* (Linnaeus, 1758), *Zonaria (= Cypraea) pyrum* (Gmelin, 1791)

General: The shells are extremely smooth and shiny and exhibit a great variety of colouration, size, and sculpture. The French call them 'porcelains' because of their texture. The mantle of the animal usually covers most of the shell surface keeping it in excellent condition throughout its life and without epibionts. Cowries have no operculum and a long, very narrow, aperture which is lined with 'teeth'. *Luria lurida* may exceed 65 mm in height. It lives in rocky areas of the subtidal zone and is a nocturnal animal. During daylight it usually remains hidden in crevices or in sponge colonies, while at night it is active searching for its prey. *L. lurida* selectively feeds on sponges having a strong preference for *Aplysina aerophoba.* It has also been observed to prey on the sponges *Chondrosia reniformis, Chondrilla nucula,* and *Suberites domuncula,* while the ascidian *Ciona intestinalis* is also preyed on occasionally, when of small size (DONEDU & MANUNZA, 1995). In the N Aegean, *L. lurida* specimens have been found in colonies of *A. aerophoba* and *Petrosia ficiformis* (KOUTSOUBAS, 1992). Although its longevity is not accurately known, *L. lurida* specimens have been kept alive in aquariums for more than 11 years. *Erosaria spurca* may reach 39 mm in height. It is a nocturnal animal, remaining hidden during daylight hours, and lives in rocky subtidal areas and in seagrass beds. In Messina (Sicily) it is normally found on substrates such as shaded walls covered by chlorophyceans (*Cladophora prolifera*), pheophyceans (*Padina pavonica, Colpomenia sinuosa*), encrusting demosponges (*Spirastrella cunctatrix, Cacospongia* sp.), and colonial hydrozoans (*Eudendrium* sp.) (LIPPARINI & NEGRA, 2002). *Zonaria pyrum* may exceed 50 mm in height. Specimens from the N Aegean were found on rocky substrate with many *Axinella* spp. sponges, at a depth of 25 m (KOUTSOUBAS, 1992).

Distribution: The family Cypraeidae (cowries) includes approximately 190 species, mostly distributed in tropical and subtropical waters. *Luria lurida* is the most common cowry of the Hellenic seas. Its distribution extends to the Mediterranean Sea and E and W Atlantic Ocean, while after the opening of the Suez Canal it has also invaded the Red Sea and is considered as an anti-lessepsian migrant (KOUTSOUBAS, 1992; DELAMOTTE & VARDALA-THEODOROU, 2007). *L. lurida* has been reported in the Saronikos, Evvoikos, Pagasitikos, Lakonikos, and Korinthiakos gulfs, the Kyklades, the Dodekanissa, Kriti, the N Aegean, and the Ionian Sea. *Erosaria spurca* is found in the Mediterranean, the Red Sea and the Atlantic Ocean. It is less common in Hellenic seas than *L. lurida* and it has been reported in the Saronikos, Evvoikos, Messiniakos and Korinthiakos gulfs, the Kyklades, the Dodekanisos, Kriti, Rodos, Samos, and the N Aegean. *Zonaria pyrum* appears to be the least abundant of the three species. It is found in the Mediterranean Sea and E Atlantic. In Hellenic seas it has been reported in the Evvoikos Gulf, along the Peloponnisos coasts, the Kyklades, the Dodekanisos, Samos, the N Aegean, Kriti, and the Ionian Sea.

Exploitation: All three species are among the most beautiful shells in Hellenic seas and are very popular among shell collectors. They are not edible and

are exploited to be used in jewellery or to be sold to shell collectors.

Conservation Status: All three species are under strict protection according to the Bern Convention (Annex II), the Protocol of the Barcelona Convention (Annex II), and the Presidential Decree 67/1981. However, they are still illegally collected and sold, and the relevant legislation has in practice never been implemented. No population assessment has been conducted in Hellenic seas for any of the three species.

***Tonna (= Dolium) galea* (Linnaeus, 1758)**

General: T. galea is one of the largest Mediterranean gastropods with a height that may exceed 29 cm. It is gonochoristic and has no operculum. It lives in sandy/muddy bottoms and seagrass beds, at depths from a few meters to 120 m. It is an active carnivore, mostly predating on holothurians but also on sea urchins and starfish. *T. galea* is equipped with a partially invaginable and highly extensible proboscis, which is capable of engulfing prey that rarely manages to escape. *T. galea* has enlarged salivary glands whose secretion contains 2.20–4.88 % sulfuric acid in addition to hydrochloric acid (FÄNGE & LIDMAN, 1976) that can mediate the dissolving of the prey integuments. The acquisition of enlarged salivary glands capable of secreting acid was first discovered in 1853 by Troschel who found that after the mollusc shell was crushed it protruded the proboscis over a distance of 13-16 cm and released a jet of clear fluid inducing active dissolution of a marble floor (FÄNGE & LIDMAN, 1976). *T. galea* is a nocturnal species and is usually buried in the sand during daylight hours for protection. The common octopus is its main natural predator.

Distribution: The family Tonnidae includes approximately 30 species living in temperate and tropical seas. *T. galea* is a cosmopolitan species. It has a wide distribution in Hellenic seas and has been recorded in the Saronikos, Korinthiakos, and Evvoikos gulfs, the N Aegean Sea (SE Thermaikos Gulf, Chalkidiki - SE Toronaios Gulf), the Kyklades, the Ionian Sea and the Cretan Sea.

Exploitation: T. galea is edible and is sporadically collected in many Hellenic areas (Evvoikos Gulf, Gulf of Kavala, Thracian Sea) by divers for its flesh and also for its shell or as a by-catch by fishing gear (e.g. trawlers, nets). In a fisheries' survey using bottom nets in the SE Thermaikos Gulf during summer, 1 individual per 1500 m nets per day was caught in 25 % of the cases (GALINOU MITSOUDI, unpublished data).

Conservation Status: Although, no population assessment has been conducted in Hellenic seas, it is believed that its populations have greatly declined in the last decades. It is a protected species according to Annex II of the Bern Convention, the Protocol of the Barcelona Convention (Annex II), and the Presidential Decree 67/1981; however, it is still exploited.

***Family Ranellidae: Charonia lampas* (Linnaeus, 1758), *Charonia variegata (= tritonis variegata)* (Lamarck, 1816)**

General: Charonia lampas and *C. variegata* (tritons) are among the largest gastropods of the Mediterranean Sea with a height that may exceed 35 cm. They are gonochoristic gastropods and have a corneous operculum. Adult tritons are active predators and mainly feed on starfish, sea urchins, sea cucumbers, and molluscs. Tri-

ton locates its prey by chemoreception of current-born prey substances. It grips its prey with its muscular foot and uses its radula to saw through the prey's integuments. Once it has penetrated, its paralyzing saliva subdues the prey and the snail feeds on it.

Distribution: C. variegata lives in rocky shores of temperate and tropical waters in the Atlantic Ocean and the Mediterranean Sea. It occurs mainly in the warm waters of the western Atlantic, in the Azores, the Canary and Cape Verde Islands (eastern Atlantic) and in the eastern Mediterranean; in the western Mediterranean it has been observed only sporadically (TEMPLADO, 1991). In Hellenic seas, *C. variegata* has been reported in the Saronikos, Korinthiakos, Lakonikos and Evvoikos gulfs, the Kyklades, Kriti, Dodekanisos, the N Aegean, and the Ionian Sea. *C. lampas* is found in the E Atlantic Ocean and the Mediterranean Sea. In Hellenic seas, it has been reported in the N Aegean Sea and the coasts of the Peloponnisos, Samos, and Kriti.

Exploitation: From ancient times, people of many different cultures, mainly fishermen, have removed the tip of the shell of the triton or drilled a hole in the tip and then utilized the shell as a trumpet to communicate over long distances. Many people find triton shells striking and attractive and so they are collected and sold as part of the international shell trade. This has contributed to the overfishing and depletion of many triton populations worldwide.

Conservation Status: Nowadays, tritons are protected in many areas of the world. In the Mediterranean, both *C. lampas* and *C. variegata* have been declared as endangered species and are strictly protected according to the Bern Convention (Annex II) and the Protocol of the Barcelona Convention (Annex II). No population assessment has been conducted in Hellenic seas.

***Ranella (= Argobuccinum) olearium* (Linnaeus, 1758)**

General: Ranella olearium is an outer shelf–upper bathyal species of the family Ranellidae. It is a large probosciferous gastropod with a height that may exceed 22 cm. Ranellinae are generalist predators, mostly feeding on echinoderms, ascidians, and polychaetes; however, little is known about the specific feeding habits of *R. olearium.*

Distribution: R. olearium is a cosmopolitan species and is mostly found in the NE Atlantic (SW British Isles to Mauretania, including the Azores, Canary Islands, Lusitanian and Meteor group seamounts), the Mediterranean Sea, S Africa (Indian Ocean) and New Zealand, while it has also been recorded occasionally in the W and SE Atlantic, the Caribbean Sea, the S Indian Ocean, and the SW Pacific (SCARABINO, 2003). In Hellenic seas, it has been reported around the Sporades Islands, in the Evvoikos, on the Kymi coasts, and Chalkidiki.

Exploitation: It is a by-catch species of trawl fishery. It is popular among shell collectors.

Conservation Status: The species is strictly protected according to the Bern Convention (Annex II) and the Protocol of the Barcelona Convention (Annex II). However, its populations are probably greatly affected by trawling. In a study of the effects of commercial trawling on the malacological communities on the continental shelf and slope of Portugal (MALAQUIAS *et al.,* 2006), *R. olearium* accounted for 7.3 % of the total number of

individuals caught in the fish trawls. Although most of the individuals caught by trawlers are discarded, mortality may occur as a consequence of aggressive handling by fishers, thermal stress, or from settling on unsuitable substratum. The status of *R. olearium* populations has not been assessed in Hellenic seas or anywhere else.

***Mitra zonata* (Marryat, 1818)**

General: Mitra zonata belongs to the family Mitridae and is well differentiated from the other congeneric species due to its larger size. It seems to be rather rare, and lives in sandy, coralligenous, or muddy bottoms of deep waters. KOUTSOUBAS (1992) has reported the collection of three samples that were on a red coral (*Corallium rubrum*) colony at a depth of 75 m. It may exceed a height of 85 mm. Species of the family Mitridae are carnivores usually feeding on sipunculans and small gastropods; however, the specific diet of *M. zonata* is unknown.

Distribution: M. zonata occurs in a few localities of the E Atlantic Ocean (e.g. the Canary Islands, the Azores, Madeira, Angola) and the Mediterranean Sea. In Hellenic seas, it has been reported in the Saronikos and Evvoikos gulfs, Chalkidiki, Kymi (Evvoia), the Ionian Sea, and N Sporades Islands.

Exploitation: The startling contrast of its beautiful colours and its rarity make *M. zonata* very appreciated and popular among shell collectors. It is edible and is eaten in Croatia; it is not eaten in Hellas.

Conservation Status: M. zonata is under strict protection according to the Bern Convention (Annex II) and the Protocol of the Barcelona Convention (Annex II). No population assessment has been conducted in Hellenic seas.

***Conus mediterraneus (= ventricosus)* (Hwass in Bruguière, 1792)**

General: Conus mediterraneus has a distinctively conical shape and can grow up to 7 cm. It has a brown, elliptical, corneous operculum of length about 30 % of the aperture length. *C. mediterraneus* is a predatory, vermivorous species, being active mostly at night. It catches its prey using singular, venomous, barbed, harpoon type radular teeth that are thrust into their prey with the use of their long and highly maneuverable proboscis. In a study of its feeding ecology in Tunisia, *C. mediterraneus* was found to eat fourteen species of polychaete which together with a gastropod of the Nereididae species were the most common food items (TAYLOR, 1987). Cone snails possess a large, coiled venom gland, and use their composite venom to envenomate their prey and to defend themselves from predators and competitors. This venom contains a wide array of cysteine-rich, neuroactive oligopeptides (named conopeptides), which interfere with neuromuscular transmission (MASSILIA *et al.,* 2001). *C. mediterraneus* crude venom extracts have a paralytic effect on polychaete worms and on molluscs (FAINZILBER & KLEIMAN, 1989).

Distribution: The family Conidae has many representatives in tropical and subtropical seas (approximately 400 species) but *C. mediterraneus* is the single *Conus* species living in the Mediterranean Sea; it is also found on the coasts of western Africa. It is a very common species of the rocky upper subtidal zone in Hellenic seas and may be found everywhere, from the N Aegean to the Libyan Sea, and from the Ionian Sea to the Dodekanisos.

Exploitation: Its exploitation is very

limited, for private or public collections. It is not edible.

Conservation Status: Presumably, the species is abundant. There is no relevant legislation. No population assessment has been conducted in Hellenic seas.

2. Bivalves

***Lithophaga lithophaga* (Linnaeus, 1758)**

General: The European date mussel *Lithophaga lithophaga* is an endolithic species and an inhabitant of hard substrata (calcified) communities in the midlittoral and upper sublittoral zones (GALINOU-MITSOUDI & SINIS, 1994). The autoecology (ecology, population dynamic, biology) of *L. lithophaga* has been extensively studied in the Evvoikos Gulf (GALINOU-MITSOUDI & SINIS, 1994, 1995). The population density of this species, which seems to be dependent on the substratum type (limestones), the presence of other organisms (e.g. endolithic), predation and environmental conditions, is higher in the N. Evvoikos Gulf (36 inds/dm^3). The age of first reproduction is 2+ years and the reproductive activity is annual and continuous. The main reproductive period is during the summer and autumn at water temperatures > 14˚C. *L. lithophaga* is a long-lived species (> 54 years) and its growth rate is one of the slowest among bivalves. The highest growth rate is observed at the end of spring and early summer. In the Evvoikos Gulf, the annual productivity of *L. lithophaga* was 1659.6 g/m^2 and the annual turnover ratio (P/B) was 0.845, which is among the lowest values reported in the literature.

Distribution: L. lithophaga is endemic in the Mediterranean Sea. In Hellenic seas, the species is found in the Evvoikos Gulf, the Ionian islands, the Ipeiros coast, the Korinthiakos Gulf, the Sea of Kythira, the N Sporades Islands, the Dodekanisos, Kriti, Lesvos island., Maliakos, Argolikos and Chalkidiki (Fig. 3) (ZENETOS 1986; 1996; GALINOU-MITSOUDI & SINIS, 1994, 1997; GEROVASILEIOU *et al.,* 2007; personal observations).

Exploitation: In the past, *L. lithophaga* was extensively exploited in Hellenic seas and it was found in seafood markets and fish restaurants in many locations. The species is still exploited by divers (illegally) as a delicious food resource, especially in Evvoia.

Conservation Status: The species is under strict protection according to the 92/43/EC Directive (Annex IV), the Bern Convention (Annex II), and the Protocol of the Barcelona Convention (Annex II). The population of Evvoikos Gulf has been assessed in the past (GALINOU-MITSOUDI & SINIS, 1994).

***Pinna nobilis* (Linnaeus, 1758)**

General: The fan mussel *Pinna nobilis* occurs at depths of between 0.5 and 60 m, typically in soft-bottom areas overgrown by seagrass (mostly *Posidonia oceanica* and *Cymodocea nodosa* meadows) but also in unvegetated sandy bottoms (KATSANEVAKIS, 2006; 2007a). It is the largest Mediterranean bivalve and one of the largest in the world, attaining lengths of up to 120 cm. *P. nobilis* is long-lived and may live over 20 years (GALINOU-MITSOUDI *et al.,* 2006). Fan mussels live partially buried (usually >35 % of their length) by the anterior portion of the shell and attached by their byssus threads to the substratum. Reproduction of *P. nobilis* takes place by means of external fertilization and its success

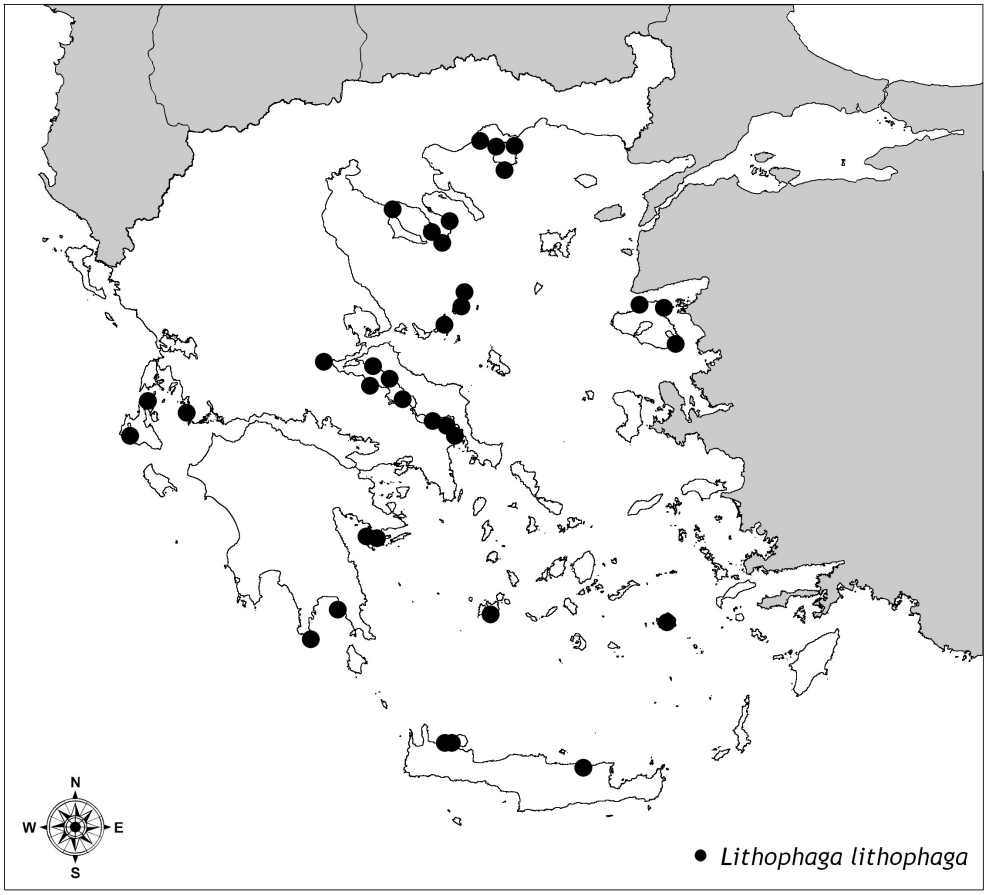

Fig. 3: Population density hotspots of *Lithophaga lithophaga.*

depends on the proximity of other individuals spawning synchronously. When a population becomes sparse (as is the case for most fan mussel populations in the Mediterranean) failure of fertilization becomes a critical issue for the survival of the species. The planktonic period is short, hence populations (especially in closed embayments), which are relatively isolated are not easily recolonised if depleted. Natural mortality is strikingly size dependent and *P. nobilis* suffers high natural mortality during the first year of life; the probability of death by natural causes quickly diminishes as the fan mussels grow in size (KATSANEVAKIS, 2007b). Growth rates have a seasonal pattern, with an extended period of very slow growth between late autumn and early spring and a peak in growth rates during late spring - early summer, probably related to an optimum combination of temperature and food availability (KATSANEVAKIS, 2007b).

Distribution: P. nobilis is endemic to the Mediterranean Sea. The global population of *P. nobilis* has been greatly reduced over the past few decades as a

result of recreational and commercial fishing for food, the use of its shell for decorative purposes, and incidental mortality by trawlers, bottom nets, or anchoring. Although *P. nobilis* has become rare in many parts of the Mediterranean, important local populations still exist in Hellenic seas (Fig. 4), especially in the Korinthiakos, Evvoikos, and Thermaikos gulfs, the islands of Chios and Lesvos (NE Aegean), NW Kriti, N Karpathos, as well as the Ionian Sea (ZENETOS, 1986; 1996; HAMES *et al.,* 2001; GALINOU-MITSOUDI *et al.,* 2006; KATSANEVAKIS, 2006; 2007a; GEROVASILEIOU *et al.,* 2007; personal observations).

Exploitation: From ancient times until early in the 20th century, *P. nobilis* was exploited for its byssus, from which an extremely fine and valuable fabric was produced, called 'sea silk'. *P. nobilis* has also been extensively exploited for human consumption and use of its shell for decorative purposes. 'Semi-quality' pearls may be found in some aged fan mussels. Nowadays it has been declared an endangered species and its exploitation has been banned. However, it is still illegally exploited and in cer-

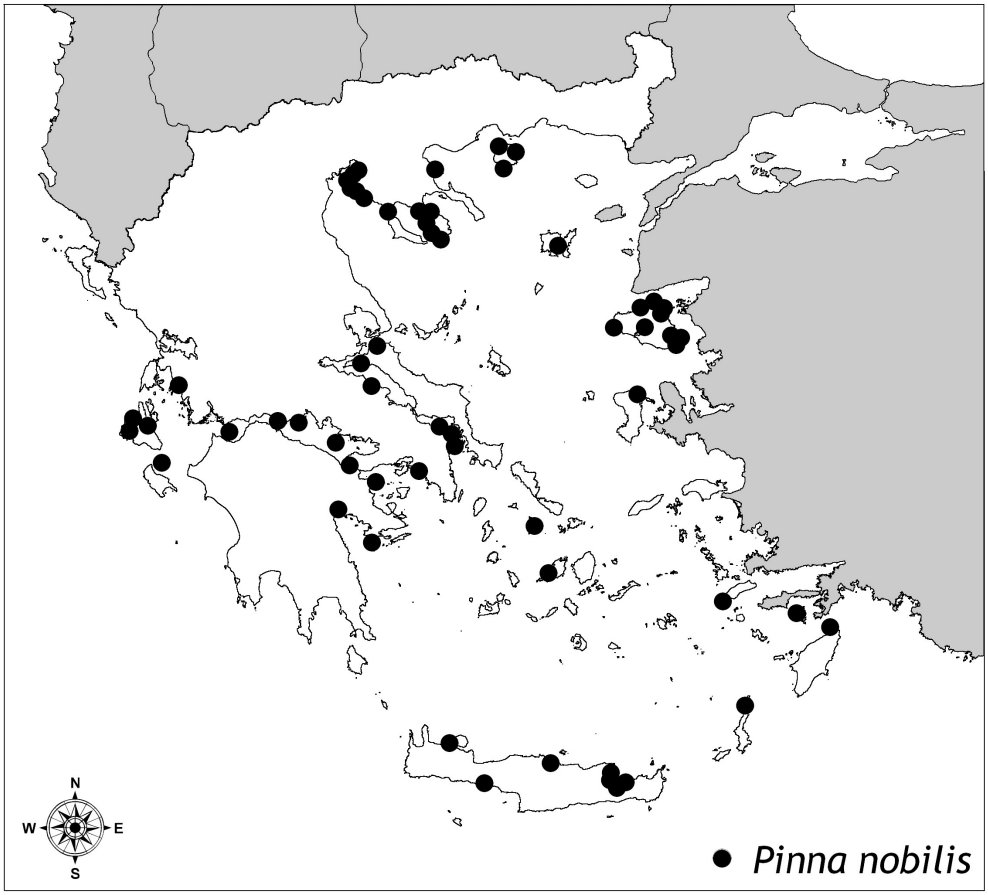

Fig. 4: Population density hotspots of *Pinna nobilis.*

tain areas fishing mortality greatly exceeds natural mortality and is a critical determinant of the spatial distribution of the species. In Lake Vouliagmeni, mortality due to illegal fishing by free divers has caused a very low population density of the species in shallow areas (KATSANEVAKIS, 2007b). *P. nobilis* has been used as a bioindicator in heavy metal bioaccumulation studies. In Hellenic seas, it was selected as an indicator species to study chromium contamination in a gulf receiving tannery wastes (CATSIKI *et al.,* 1994).

Conservation Status: The species is under strict protection according to the 92/43/EC Directive (Annex IV), the Protocol of the Barcelona Convention (Annex II), and the Presidential Decree 67/1981. A few populations of *P. nobilis* have been assessed in Hellenic seas, and some synoptic results of reported population density or abundance are given in Table 2. In two of these areas (Vouliagmeni Lake and Souda Bay) total abundance of *P. nobilis* has been estimated using Density Surface Modelling with Distance Sampling (KATSANEVAKIS, 2007a), while in another three areas population densities have been estimated (Table 2). Specific mtDNA regions were genetically characterized in pinnids from the Thessaloniki and Thermaikos gulfs, Vouliagmeni Lake and NE Chios. These results could contribute to screening genetic variability and population dynamics, as well as for conservation plans for species protection and/or aquaculture investigations (KATSARES *et al.,* 2008).

***Pinctada radiata* (Leach, 1814)**

General: Pinctada radiata is an epifaunal suspension feeder of the subtidal zone and a fouling species, living attached by its byssus to hard substrata. Usually it attains a

Table 2
Estimated population density or abundance of *Pinna nobilis* in Hellenic sites.

Location	Study Area (hectares)	Year	Density (inds/m^2) mean	max	Abundance (inds) estimate	95%CI	Reference
Lake Vouliagmeni (Korinthiakos)	150.4	2004	0.0057	0.17	8500	4200 –12900	KATSANEVAKIS, 2006
Lake Vouliagmeni (Korinthiakos)	150.4	2006	0.0045	0.24	6770	5450 –8400	KATSANEVAKIS, 2007a
Souda Bay (Kriti)	1471.5	2007	0.0089	0.53	130900	100600 –170400	KATSANEVAKIS, unpublished data
NE Chios Isl.(Aegean)	0.088	2006	0.06	0.07			GALINOU-MITSOUDI, unpublished data
NE Kefallonia Isl.(Ionian)		2000		0.08			HAMES *et al* ., 2001
Epanomi (Thermaikos Gulf)	0.007	2004	1.04	1.3			GALINOU-MITSOUDI *et al* ., 2006

length of 50-65 mm, but may exceed 100 mm in length. It is a protandric hermaphrodite species with sex inversion occurring in shells of 32-57 mm length. Gonad maturity is controlled by temperature (TLIG ZOUARI & ZAOUALI, 1994).

Distribution: Pinctada radiata originates from the Indo-Pacific and the Red Sea. Following the opening of the Suez Canal, *P. radiata* has entered the far eastern Mediterranean. It was also intentionally imported for mariculture in many areas of Hellas and Italy during the last century. Up to date, it has been recorded as common in the eastern Mediterranean with sporadic occurrences in the western basin (ZENETOS *et al.,* 2004). Besides its adaptation to the subtropical environment of the south-eastern Mediterranean, its tolerance to chemical contamination has enhanced its expansion in enclosed polluted ecosystems. In Hellenic seas (Fig. 5), it is mostly reported close to areas where it was originally introduced for aquaculture (mainly in the Dodekanisos islands, Argolikos, the Saronikos, Evvoia, and the island of Lesvos in the N Aegean Sea). Recently, the species was also recorded in the Kyklades Isles complex (in 2006) and in Kriti (in 2003) (ZENETOS *et al.,* 2007).

Exploitation: Pearl shells (mother-of-pearl) have been used by the people of the Pacific and other regions as utensils, implements and ornamentation, while the oyster itself has been a basic food item. Pearl oyster meat is a delicacy in many western cultures. However, mother-of-pearl shells are of little commercial value in the Mediterranean. Because of its tolerance to chemical contamination and the ability of oysters to accumulate metals to several orders of magnitude higher than the background medium, it has been used as a bioindicator of heavy metal pollution (e.g., AL-MADFA, *et al.,* 1998; GÖKSU *et al.,* 2005).

Conservation Status: It is a successful invader into the Mediterranean Sea and its spatial distribution keeps increasing (ZENETOS *et al.,* 2004; ZENETOS *et al.,* 2007). There is no relevant legislation for its conservation and there is no need for protective measures. Although there are detailed records of its invasion in the Mediterranean and Hellenic seas, no population assessment has been conducted in Hellas.

***Pteria hirundo* (Linnaeus, 1758)**

General: Pteria hirundo may reach 10 cm in length. It has an aggregated distribution and usually many individuals are found attached by their robust byssus to gorgonians, on rocky bottoms, or in clumps of many individuals on muddy bottoms in the sublittoral and bathyal zones.

Distribution: P. hirundo is found in the Mediterranean Sea and the E Atlantic from the British Isles south to the coasts of Portugal. In Hellenic seas, it has been reported in the Saronikos, Patraikos, Pagasitikos, and N Evvoikos gulfs, Astakos, the Kyklades, the N Sporades Islands, and Chalkidiki (Toronaios and S Sithonia).

Exploitation: Its exploitation is very limited, for private or public collections.

Conservation Status: No population assessment has been conducted in Hellenic seas.

Family Pectinidae: *Chlamys varia* (Linnaeus, 1758), *Crassadoma (Chlamys) multistriata* (Poli, 1795)

General: Chlamys varia is a scallop with a thin, narrow, elongated oval shell

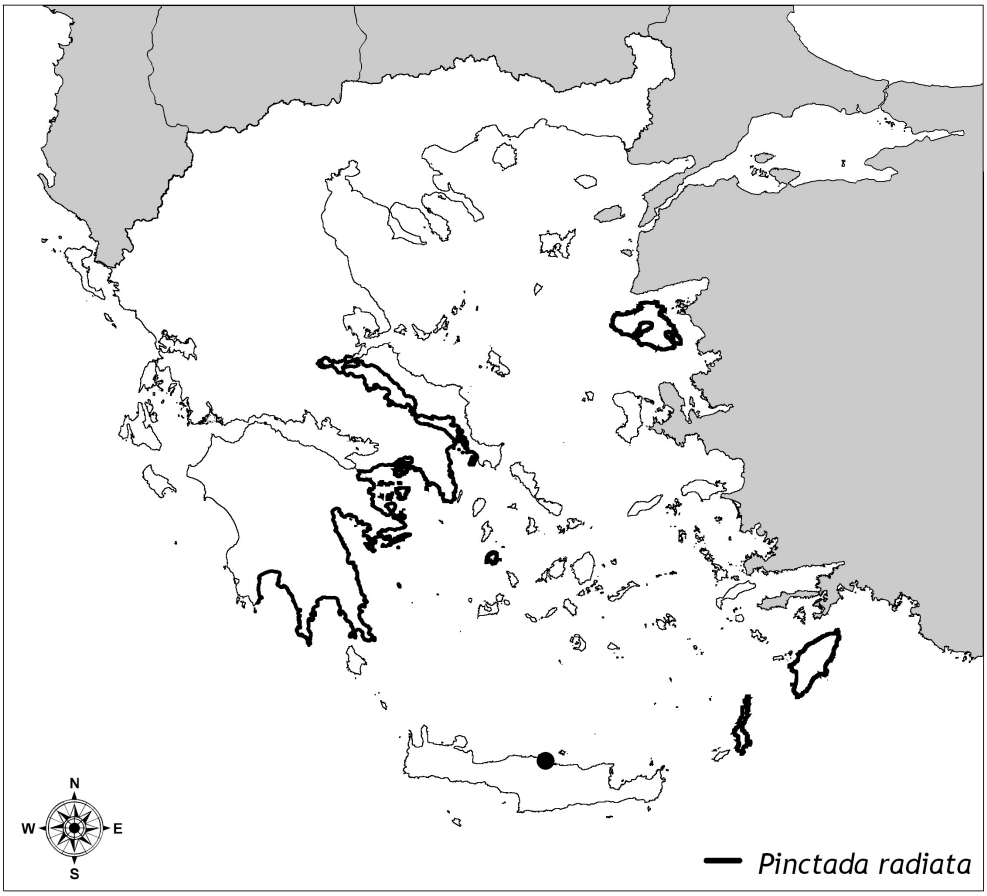

Fig. 5: Known distribution of *Pinctada radiata* in Hellenic seas.

that may reach a length of 80 mm. Its colour is very variable and may be white, yellow, orange, pink, red, purple, or brown. *Crassadoma multistriata* looks like *C. varia* but is shorter and with distinctive decoration. It usually attains a length of 15–30 mm. Both species live on sandy, muddy, or rocky bottoms of the sublittoral zone. Young individuals are either free-living or attached by byssus threads, while adults are usually permanently cemented to hard surfaces by their right valve. Both species are commonly found in *Posidonia oceanica* beds. The spat settlement occurs during late spring and summer (PEÑA *et al.,* 1996).

Distribution: C. varia is found in the Mediterranean Sea and the E Atlantic Ocean from the British Isles south to Senegal, while *C. multistriata* is found in the Mediterranean Sea and the E Atlantic Ocean from the Faroe Islands to the coasts near the Mediterranean. In Hellenic seas, *C. varia* is quite common and seems to be present everywhere on the Hellenic coasts. *C. multistriata* has been reported in the Saronikos, Patraikos, Korinthiakos, Evvoikos, and Messiniakos gulfs, the Sporades, the

Kyklades, the Dodekanisos, Kymi (Evvoia), Kavo Doro, and Chalkidiki.

Exploitation: Both species are edible and in a few European locations (e.g., on the French Atlantic coasts) *C. varia* is targeted by a commercial fishery. In Hellenic seas *C. varia* is locally exploited for human consumption. *C. varia* has been reported to highly concentrate trace metals and radionuclides and has been used as a biomonitor of marine pollution (BUSTAMANTE *et al.,* 2002; BUSTAMANTE & MIRAMAND, 2005). Because of their beautiful and variable colouration both *C. varia* and *C. multistriata* are popular among shell collectors.

Conservation Status: No population assessment has been conducted in Hellenic seas.

***Spondylus gaederopus* (Linnaeus, 1758)**

General: Spondylous gaederopus may exceed a height of 15 cm. It lives on rocky bottoms of the sublittoral zone from 1 m to about 50 m depth, permanently cemented to hard surfaces by its right valve. It prefers exposed positions on vertical rocks with slow but steadily moving currents (POPPE & GOTO, 1993). The species is often accompanied by the sponge *Crambe crambe* that covers the upper valve and camouflages its shell.

Distribution: S. gaederopus is found in the Mediterranean and the Atlantic Ocean near Gibraltar, including Madeira, the Azores, the Canaries, and the Cape Verde Islands. In Hellenic seas, it has been recorded in the Saronikos, Lakonikos, Messiniakos, Thermaikos, Evvoikos, Patraikos, and Korinthiakos gulfs, the Peloponnisos, the Kyklades, the Dodekanisos, Kriti, Astakos, Kymi (Evvoia), Kefallonia, and the Chalkidiki peninsula.

Exploitation: Archaeological evidence shows that people in Neolithic Europe traded the shells of *S. gaederopus* to make bangles, bracelets, belt-buckles and other ornaments as long as 5000 years ago. The shells were mostly harvested from the Aegean Sea and then transported into continental Europe. *S. gaederopus* ornaments from the Neolithic age have been found in many caves and archeological sites in Hellas (IFANTIDIS, 2006). It is edible and has been collected for human consumption since antiquity. In some areas it is considered a delicacy and for this reason was named the 'royal oyster'. It is also popular among shell collectors.

Conservation Status: No population assessment has been conducted in Hellenic seas. POPPE & GOTTO (1993) pointed out that the species was rather common till the beginning of the 1980s, when (for unknown reasons) its populations markedly declined or even disappeared in some areas.

***Crassostrea gigas (= angulata)* (Thunberg, 1793)**

General: Crassostrea gigas is a large oyster whose size may exceed 30 cm (and may reach 40 cm in exceptional cases). The shell surface is extremely rough, coarsely sculptured with concentric ridges and 6–7 thick and bold ribs that commonly give the shell edges an undulating appearance. The shape of the shell varies depending on the environmental conditions. It prefers firm substrates of the sublittoral zone usually at depths between 5 and 40 m and occasionally to depths of about 80 m. It may also be found on mud or mud-sand bottoms attached to debris, rocks, or other bivalve shells. It is an estuarine species and optimal salinity range is between 20 and 25‰.

It is a protandrous hermaphrodite and the timing of sex change is erratic and seasonal. Spawning usually depends on a rise in water temperatures above 20°C, giving approximately 50-100 million eggs in a single spawning; larvae are planktonic (FAO, 2008). The biology, ecology, and especially the aquaculture of the species have been extensively studied (~1000 related published papers in the Science Citation Index between 1970 and 2007).

Distribution: C. gigas originates in the coastal and marine waters of Japan, North West Pacific ocean. It has been introduced for mariculture into North America, and is now found from SE Alaska to Baja California. In Europe, it was first introduced in the Atlantic (Portugal, Spain, France, Ireland, U.K.), and may be found from Morocco to Norway. It is also widespread in the Mediterranean (France, Adriatic lagoons, Malta, Spain, Tunisia, Italy, Hellas, Turkey). In Hellenic seas, it has been reported in the Patraikos and Korinthiakos gulfs (Zenetos *et al,* 2004). There is also unconfirmed information that the species was imported for aquaculture into the Thermaikos Gulf in 2007.

Exploitation: It is both fished and cultivated for human consumption in many countries. Through its potential for rapid growth and its wide ranging tolerance to environmental conditions, it has become the oyster of choice for cultivation in many regions of the world. It is the dominant shellfish in a growing United States aquaculture industry along the Pacific Coast. By 2003, global production of this species had expanded to 4.38 million tonnes, more than any other species of fish, mollusc or crustacean. Nearly 84 % of global *C. gigas* production was in China (FAO, 2008). *C. gigas* has also been used as a bioindicator of heavy metal pollution (e.g., SHULKIN *et al.,* 2003). It is not a target species in Hellenic seas, as it has low population densities and narrow distribution.

Conservation Status: It is classified as one of the Worst Invasive Species in Europe (EEA, 2007). Its dense aggregations limit food and space for other benthic species (competition), it destroys habitats and causes eutrophication of water. It also causes causes serious decline in macrofauna and zooplankton, but enhances bacteria, microfauna and meiofauna. No population assessment has been conducted in Hellenic seas.

***Donacilla (= Mactra) cornea* (Poli, 1791)**

General: Donacilla cornea is an inhabitant of the midlittoral soft substratum and is found mostly in moderately exposed beaches with medium to very coarse sand (MAVIDIS *et al.,* 2006). It is a relatively small bivalve and its maximum length may reach 25 mm. The individuals of *D. cornea* are distinctively patterned and coloured, exhibiting one of the most striking examples of massive polymorphism in nature (OWEN & WHITELEY, 1988). *D. cornea* is gonochoristic, its life expectancy is 3–4 years, has an annual reproductive cycle, is mature at a length of approximately 10 mm, and spawning (in the Thermaikos Gulf) occurs between March and July with a peak in June (MAVIDIS & KOUKOURAS, 2001a). In a study of the midlittoral soft substratum assemblages of the North Aegean Sea (KOUKOURAS & RUSSO, 1991), among the five different assemblages that were described, one assemblage was characterized by the very high dominance of *D. cornea* and the polychaete *Ophelia bicornis.* This assemblage was dominant in the greatest part of the Thermaikos and Strymonikos gulfs and

was located on coarse sandy substrates. Mean densities of *D. cornea* (± SE) were 1993 (± 350) inds/m^2 and 1255 (± 205) inds/m^2 in the *D. cornea–O. bicornis* assemblages of the Thermaikos and Strymonikos gulfs, respectively. On Korinos beach (Thermaikos Gulf) the abundance of *D. cornea* had two peaks, one at the mean sea level (with a density that exceeded 12000 inds/m^2) and a second below the low tide level (MAVIDIS & KOUKOURAS, 2001b).

Distribution: It is found in the Mediterranean, the Black Sea, and the E Atlantic in areas close to the Mediterranean basin. In Hellenic seas, *D. cornea* is very abundant in the N Aegean and is also found in the Evvoikos, Saronikos, Lakonikos, Amvrakikos, and Patraikos gulfs, the Kyklades, the Ionian and the Cretan Seas.

Exploitation: The species is collected by hand in very small quantities and used occasionally as fishing bait and rather rarely for human consumption. There is ample evidence that *Donacilla cornea* along with *Tapes decussatus* and, *Donax trunculus* were among the marine molluscan resources available to Franchthi's inhabitants around 13,000 BC (SHACKLETON & VAN ANDEL, 2007). *D. cornea* has been used as a bioindicator of heavy metal pollution (e.g., REGOLI *et al.,* 1991).

Conservation Status: It is very abundant in many midlittoral soft substratum areas. The populations of the Thermaikos and Strymonikos gulfs have been assessed in the past (KOUKOURAS & RUSSO, 1991; MAVIDIS & KOUKOURAS, 2001b). There is no relevant legislation. The regional IUCN status of Critically Endangered species was proposed for *D. cornea* in the Black Sea (MICU & MICU, 2006).

***Solen marginatus* (Pulteney, 1799)**

General: Solen marginatus is a large, shallow-water, elongate clam, which may reach a length of 13 cm. It is an inhabitant of the midlittoral and upper sublittoral zone, living burried in the sand. It is a filter feeder and lives in a vertical position in the sediment in more or less permanent tubes in which they can ascend or descend. With its specially adopted piston-like foot, which can be inflated with blood, it is able to burrow rapidly in its tube or even dig a new tube.

Distribution: S. marginatus is found in the eastern Atlantic from Mauretania to the North Sea, including the Mediterranean and the Black Sea. In Hellenic seas, *S. marginatus* has been reported from the coasts of the Peloponnisos (both in the Ionian Sea and the Aegean Sea) and from the Amvrakikos, Thermaikos, Pagasitikos and Saronikos gulfs.

Exploitation: In Hellenic seas, it is exploited locally both for human consumption and as fishing bait. Its fishing is regulated by the PD 109/2002. *S. marginatus* has been used as a bioindicator of marine pollution by organochlorine compounds such as PCBs and DDTs (THOMPSON *et al.,* 1999).

Conservation Status: No population assessment has been conducted in Hellenic seas.

***Ensis minor* (Chenu, 1843)**

General: Ensis minor is a large burrowing, shallow-water, elongate clam, which may reach a length of 20 cm. It is an inhabitant of the midlittoral and upper sublittoral zone, living buried in the sand mostly at depths shallower than 4 m, but in the Mediterranean may be found down to

about 25 m (VAN URK, 1964). It is a filter feeder and lives in a vertical position in the sediment in more or less permanent tubes. In the Gulf of Trieste, gametogenesis begins in September and the maximum reproductive activity occurs between January and March (VALLI *et al.,* 1983).

Distribution: E. minor is distributed in the eastern Atlantic, from Norway to Portugal, including the Mediterranean Sea. In Hellenic seas, *E. minor* has been reported from Kriti and the Saronikos, Pagasitikos and Thermaikos gulfs.

Exploitation: In Hellenic seas, it is exploited locally both for human consumption and as fishing bait. In Italy it is extensively fished and is one of the most important fishery resources of the Gulf of Trieste (DEL PIERO & DACAPRILE, 1998). Its fishing in Hellenic seas is regulated by the PD 109/2002.

Conservation Status: No population assessment has been conducted in Hellenic seas.

***Solecurtus strigilatus* (Linnaeus, 1758)**

General: Solecurtus strigilatus may exceed 10 cm in length. It lives buried in the soft substrata of the sublittoral and, rarely, of the bathyal zones. It burrows rapidly and to relatively great depths. Adults may live 50 cm below the sea floor and attempts to excavate them from their burrows release rapid escape reactions whereby the animals descend obliquely still further into the sediment (BROMLEY & ASGAARD, 1990). The location of *S. strigilatus* individuals on the seafloor is marked by two conspicuous round orifices about 1 cm in diameter and 2 cm apart, with siphons never observed to project from these openings. When in danger of predation *S. strigilatus* will abort parts or all of its siphons, which contract rhythmically as they float away in the water column; this is probably part of the escape strategy of the animal, as the aborted parts will attract the predator and the bivalve will have the chance to escape, while its siphons will soon regenerate (BROMLEY & ASGAARD, 1990).

Distribution: S. strigilatus is found in the Mediterranean Sea and on neighbouring E Atlantic coasts. In Hellenic seas, it has been reported in the Saronikos, Thermaikos, Evvoikos, Patraikos, Korinthiakos, and Kavala gulfs, and the coasts of the Peloponnisos, Kefallonia, and Kriti.

Exploitation: Its exploitation is very limited, for human consumption and for private or public collections. It is also used as fishing bait, especially in the North Evvoikos Gulf. Its fishing in Hellenic seas is regulated by the PD 109/2002.

Conservation Status: No population assessment has been conducted in Hellenic seas.

***Pholas dactylus* (Linnaeus, 1758)**

General: Pholas dactylus grows up to 15 cm long. It lives in midlittoral and shallow sublittoral areas bored into soft rocks such as, shale, peat, chalk, sandstone, stiff clay, or wood. It creates a conical burrow, which has a narrow entrance and a larger rounded chamber. Where abundant, its borings can severely compromise the structural stability of the shore, and can result in increased rates of coastal erosion (PINN *et al.,* 2005). *P. dactylus* gives off a blue, luminous secretion when irritated. Its luminescence has been known since ancient times (e.g., Pliny the Elder documented the luminescence of *P. dactylus* even whilst being eaten) and has a historic place in the biochemistry of biolumines-

cence, since it was the first organism used to describe the oxygen-requiring luciferin-luciferase reaction that is universal in bioluminescence. It is a gonochoristic species with a spawning period during summer and a life span of 14 years (HILL, 2006).

Distribution: It is found in the Mediterranean, the Black Sea, the Red Sea, and in the E Atlantic from the British Isles south to the coasts of Morocco. In Hellenic seas, it has been reported in the Thermaikos, Kalloni, Maliakos, Evvoikos, Saronikos, Amvrakikos, and Argolikos gulfs, on the Ionian coasts of the Peloponnisos, and Kefallonia.

Exploitation: It has been extensively fished for human consumption and as fishing bait.

Conservation Status: P. dactylus was once prevalent across the entire Mediterranean and on the Atlantic coast of Europe, but it has disappeared from most sites due to human collection for food and bait and/or as a result of marine pollution. The species is under strict protection according to the Bern Convention (Annex II), and the Protocol of the Barcelona Convention (Annex II). Surprisingly, it is included as legally collected fishing bait in PD 109/2002 but the Bern Convention (adopted by the Hellenic Law 1335/1983) and the Barcelona Convention prevail over the PD. No population assessment has been conducted in Hellenic seas.

3. Cephalopods

Alloteuthis media (Linnaeus, 1758)

General: A. media is a small-sized member of the family Loliginidae, with females attaining a mantle length up to 12 cm and males up to 9 cm. The duration of its life cycle is about one year (ALIDROMITI, 2007). *A. media* is among the main cephalopod species of the continental shelf community (GONZALEZ & SÁNCHEZ, 2002; LEFKADITOU *et al.,* 2004) and is mostly found on sandy and muddy grounds and also in brackish waters (UNSAL *et al.,* 1999). It inhabits a wide depth range from the surface down to 600 m, but is mostly found at depths <150 m (LEFKADITOU, 2007). It performs seasonal migrations between offshore (in winter) and inshore (in summer) areas (ROPER *et al.,* 1984), as well as diel vertical migrations (ZUEV & NESIS, 1971). Maturation takes place over a wide range of mantle lengths. Spawning in the Mediterranean occurs at depths of 10-100 m mostly in sandy areas or seagrass meadows. Spawning period lasts from March to October in the western part of the Mediterranean and potential fecundity (PF) has been estimated to be about 950-1400 eggs (MANGOLD-WIRZ, 1963), whereas in the eastern part spawning occurs all year round and PF is some 1000-4000 eggs, most of which are released during multiple spawning with female growth continuing between spawning events (LAPTIKHOVSKY *et al.,* 2002). The diet of *A. media* consists of larvae and juveniles of fishes, copepods and euphausiids (ZUEV & NESIS, 1971). *A. media* is preyed on by demersal fish of medium and large size, mostly by gadids and some elasmobranchs (ZUEV & NESIS, 1971; BELLO, 1997; VELASCO *et al.,* 2001).

Distribution: A. media is common in the Mediterranean Sea including the Sea of Marmara. In the E Atlantic its range extends from 60° to 21° N, but it is mainly found in the southern part of the North Sea, the Irish Sea, the English Channel, the Bay of Biscay and off the south coast of the Iberian peninsula. It is widespread in

Hellenic seas and has been reported as the most frequently caught cephalopod species on the shelf of the N. Aegean (LEFKADITOU, 2006), S. Aegean (LEFKADITOU *et al.,* 2003b), and the Ionian Sea (Table 3).

Exploitation: A. media is a by-catch of bottom trawlers and beach-seiners that is mostly discarded by Hellenic trawlers (MACHIAS *et al.,* 2001), whereas its discard percentage by Italian and Spanish trawlers fishing in the western Mediterranean ranges from 10 to 50 % and is considered accidental due to the fast sorting operations on deck (SARTOR *et al.,* 1998).

Conservation Status: No population assessment has been conducted in Hellenic seas.

Loligo forbesi (Steenstrup, 1856)

General: Loligo forbesi is a large-sized loliginid; males generally grow larger than females and have higher growth rates (PIERCE *et al.,* 1994a,b). Adult body size usually reaches 100–650 mm ML in males (weight range 155–3700 g) and 175–350 mm ML in females (weight range 200–1150 g), while maximum values of 937 mm ML and 8308 g for males, and 462 mm ML and 2184 g for females have been reported from the Azores (MARTINS, 1982). It has an annual life-cycle and is semelparous, exhibiting 'intermittent terminal spawning', in which the females lay 1000 to 23000 eggs in batches and die shortly after spawning (PIERCE *et al.,* 1994b). *L. forbesi* migrates to shallower waters to spawn. A large number of prey species, including various polychaetes, molluscs, crustacean and fish have been identified in *L. forbesi* stomachs, with crustaceans being relatively more important in the diet of small squid while larger squid prey predominantly on fish (MARTINS, 1982; PIERCE *et al.,* 1994b). Among cephalopod remains, those of *L. forbesi*

Table 3
Indicative population density (in number of individuals per square km)of cephalopod species of minor importance,estimated during the MEDITS survey of 2005, on shelf (10-200 m)and upper slope (200-500)of the Ionian Sea and the region of Argosaronikos.

	Ionian Sea		Argosaronikos	
Species	**10-200 m**	**200-500 m**	**10-200 m**	**200-500 m**
Alloteuthis media	2948	82	453	95
Loligo forbesi	2	38	2	112
Todarodes sagittatus	0	13	0	14
Todaropsis eblanae	26	124	0	17
Sepia elegans	259	24	231	163
Sepia orbignyana	46	5	777	238
Sepietta oweniana	40	428	35	53
Rondeletiola minor	7	296	8	34
Rossia macrosoma	5	17	0	277*
Scaeurgus unicirrhus	59	3	232	126

*exceptionally high value observed only in 1995

have also been occasionally identified. Large demersal fish and some marine mammals have been reported to prey on *L. forbesi* (DALY *et al.,* 2001; SANTOS *et al.,* 2001).

Distribution: L. forbesi occurs in the Mediterranean Sea and the NE Atlantic from 20 ˚N to 63 ˚N, where it is more abundant in the northern part of its range. In the temperate part of its distributional range it is mainly found over the shelf, but in subtropical areas and in the Mediterranean in deeper waters, reaching depths of 720 m in the Ionian Sea (LEFKADITOU *et al.,* 2003a). It is widespread in Hellenic seas, being more common in the neritic zone of regions with abrupt waters like the Ionian Sea and the area of the Kyklades, Kriti and the Dodekanisos islands, while it is scarce north of 40˚ N in the Aegean Sea (KOUTSOUBAS *et al.,* 1999; LEFKADITOU, 2006).

Exploitation: L. forbesi is largely fished as a by-catch from bottom trawl fisheries. Fishery statistics do not distinguish *L. forbesi* from *L. vulgaris,* since they are of similar appearance and equal commercial value. However, landings in Scottish waters can generally be assumed to be *L. forbesi* (PIERCE *et al.,* 1994a), while those in the Mediterranean mainly consist of *L. vulgaris* (GUERRA *et al.,* 1994). There is no estimation of the marketable proportion of *L. forbesi* in the landings of loliginids in Hellenic fisheries.

Conservation Status: Since the early 1990s, *L. forbesi* has apparently disappeared from much of the southern part of its range in the eastern Atlantic (France and Portugal), while at the same time its abundance in northern waters (Scotland) has increased. This shift in its distribution range may be associated with the increase in sea surface temperature after 1993 and subsequent high levels (CHEN *et al.,* 2004). No population assessment has been conducted in Hellenic seas.

***Todarodes sagittatus* (Lamarck, 1798)**

General: T. sagittatus is a large squid of the family Ommastrephidae. Its mantle length attains 75 cm, but usually in trawl catches it does not exceed 35 cm, as immature individuals make up the vast majority of specimens (BORGES & WALLACE, 1993; QUETGLAS *et al.,* 1998; LORDAN *et al.,* 2001; LEFKADITOU, unpublished data). This neritic and oceanic squid occurs from surface to near-bottom water layers over the continental shelf and slope up to 2500 m. It carries out vertical movements between the surface at night and near the sea bottom during the day (MANGOLD-WIRZ, 1963; KORZUM *et al.,* 1979). Estimates of its life span range from 9 to 14 months. Its life span was found longer in higher latitudes and about a month longer in females than in earlier maturing males. *T. sagittatus* is a fast growing and early maturing squid, its maturation found earlier and subsequently its growth rate lower in NW African waters (ARKHIPKIN *et al.,* 1999) compared with those of northernmost areas (LORDAN *et al.,* 2001; QUETGLAS & MORALES-NIN, 2004). Mature individuals are present all year round but spawning appears to peak in autumn-winter (QUETGLAS *et al.,* 1998; ARKHIPKIN *et al.,* 1999). Potential fecundity estimates range from 200000 to 950000 eggs (LAPTIKHOVSKY & NIGMATULLIN, 1999; LORDAN *et al.,* 2001). Its diet consists of fish, crustaceans and cephalopods (in decreasing order of importance), with cannibalism also identified (QUETGLAS *et*

al., 1999; LORDAN *et al.,* 2001). Younger *T. sagittatus* in some areas have shown preference for small pelagic prey in comparison to specimens in more advanced adult stages (PIATKOWSKI *et al.,* 1998), a fact that indicates their preying mostly in upper water layers. *T. sagittatus* is the most abundant prey in the stomachs of swordfish from the eastern Mediterranean suggesting a high abundance of the species particularly during summer (PERISTERAKI *et al.,* 2005). Apart from swordfish, other large pelagic fishes, sharks and cetaceans are important predators of this species (ROPER *et al.,* 1984).

Distribution: T. sagittatus is broadly distributed throughout the north and northeast Atlantic, from the Arctic Ocean to about 13˚S and to approximately 40˚W, including the North Sea and the Mediterranean Sea, where it is more abundant off the Tunisian and Libyan coasts, in the straits of Sicily and Messina, in the northern Tyrrhenian Sea and in the central Adriatic (BELLO, 1985; JEREB & RAGONESE, 1994; RELINI *et al.,*1999). In Hellenic seas it has been reported in the Aegean (N< 40˚ 30′) and the Ionian Seas, being caught at depths between 120 and 800 m, more frequently during summer and autumn, but never exceeding 10 individuals per hour of trawling (LEFKADITOU *et al.,* 2003a).

Exploitation: A directed fishery by jigging machines exists for this species off Norway, with highly variable annual yields, which peaked in the early 1980s reaching 10,000 metric tons. It usually constitutes of a by-catch of trawl fisheries and occasionally of long-line and pelagic net fisheries, while it is also fished with hand-jigs by artisanal and sports fishermen, mainly during summer over deep waters. In some Mediterranean countries it has a relatively high commercial value. It is marketed fresh, frozen, salted or dried and is also used as bait in finfish fisheries.

Conservation Status: No population assessment has been conducted in Hellenic seas. No official statistics are available for *T. sagittatus* in any ICES area or the Mediterranean Sea, because landings of ommastrephid species (*Illex coindetii, Todaropsis eblanae, Todarodes sagittatus,* and *Ommastrephes bartramii*) are all pooled together (PEREIRA *et al.,* 1998; JEREB, 2000). Thus, no population assessment is possible based on commercial catches.

***Todaropsis eblanae* (Ball, 1841)**

General: T. eblanae is a demersal mid-sized ommastrephid squid, with a maximum recorded mantle length 29 cm for females and 23 cm for males (ROBIN *et al.,* 2002). It is associated with sandy and muddy bottoms and it mostly occurs on the shelf break and upper slope, not ascending to the surface or approaching the shore. Its populations have been considered as indicative of the cephalopod community at these depths, in the south-eastern Atlantic (ROELEVELD *et al.,* 1992), the Balearic Sea (QUETGLAS *et al.,* 2000), the north Tyrrhenian (SANCHEZ *et al.,* 1998), the south-eastern Adriatic (KRSTULOVIC-SIFNER *et al.,* 2005) and the eastern Ionian Sea (LEFKADITOU *et al.,* 2001). Mature individuals are found all year round, with maximum incidence of mature females from mid-spring to early autumn (GONZALEZ *et al.,* 1994; RELINI *et al.,* 1999; ROBIN *et al.,* 2002). *T. eblanae* follows the multiple pattern of spawning, its PF decreasing with latitude and reaching 275 000 for larger females off West Africa (LAPTIKHOVSKY & NIGMATULLIN,

1999) but not exceeding 28 000 in Scottish waters (HASTIE *et al.,* 1994). Teleostean fish have been found to compose the major part of its stomach contents, with crustacean and cephalopod (including its own species) percentages varying by geographic area and specimen size (RASERO *et al.,* 1996; LORDAN *et al.,* 1998). Its most important predators are teleost fish, toothed whales and selachians.

Distribution: T. eblanae is distributed in the Mediterranean Sea and E Atlantic, from 61˚ 15' N to 40˚ S, as well as in the SW Pacific and the SW Indian Oceans off Australia. It is widespread in Hellenic seas, where it has been recorded from 100 to 850 m of depth, being more abundant on the upper slope of regions with steep waters, like the Toroneos Gulf (LEFKADITOU, 2006) and the Ionian Sea (Table 3).

Exploitation: T. eblanae is a by-catch in bottom trawl fisheries that is either discarded or landed with *Illex coindetii.* No official statistics or research estimates exist on the landed catch of *T. eblanae* from Hellenic waters. Studies of trawl fishery landings have shown a marked seasonality of the species catches, with a peak during summer in the northern Tyrhenian Sea (BELCARI *et al.,* 1998) and almost equal levels of *T. eblanae* and *I. coindetii* landings from northern Spanish Atlantic waters (GONZALEZ *et al.,* 1994).

Conservation Status: Due to its pooling with other ommastrephid species in fishery statistics, it is not possible to assess catch levels as an index of stock biomass. Indicative trends of density and biomass indices for this species on the fishing grounds across the north coasts of the Mediterranean Sea might probably be feasible through the database of the MEDITS (International Bottom Trawl Surrvey in the Mediteranean) surveys, which have been conducted during the summer over the continental shelf and slope since 1994.

Sepia elegans (Blainville, 1827)

General: Sepia elegans is a small cuttlefish; males attain a mantle length of 72 mm and females up to 89 mm, their maximum weight not exceeding 60 g (REID *et al.* 2005). *S. elegans* is a sublittoral species of sandy and sandy-muddy bottoms of the continental shelf and the upper slope, being among the dominant cephalopod species on the upper shelf (SANCHEZ *et al.* 1998; KRSTULOVIC-SIFNER *et al.,* 2005; LEFKADITOU, 2007). In the Sea of Marmara, *S. elegans* has also been recorded in brackish waters (18-25 psu) (UNSAL *et al.,* 1999), which indicates a high degree of salinity tolerance. Mature individuals are present all year round, with maximum incidence during summer and autumn in the north Aegean Sea (D' ONGHIA *et al.,* 1996), while during spring and summer in the western Mediterranean (MANGOLD-WIRZ, 1963). A seasonal migration has been reported in some areas with individuals spending their winter in deep waters (200–400 m) and then migrating into shallower waters in spring and summer, which however, has not been observed in other areas (RELINI *et al.,* 1999). Feeding studies conducted in the E. Atlantic have shown the preference of *S. elegans* for small crustaceans, fish and polychaetes (REID & JEREB, 2005). Its remains have been frequently found in the stomach contents of *Scyliorhinus canicula* and *Raya clavata* from the Aegean Sea (KABASAKAL, 2002).

Distribution: S. elegans is found in the eastern Atlantic from Ireland and western Scotland (~ 50˚N) to the Sahara Bank and Namibia (21˚S) and throughout the

Mediterranean Sea including the brackish waters of the Sea of Marmara (UNSAL *et al.,* 1999) It is common in Hellenic seas where it has been reported at depths of between 20 and 600 m.

Exploitation: S. elegans is a by-catch species of trawl fisheries; its catches exhibiting a marketable proportion in Portugal, Spain, Italy and Hellas (SARTOR *et al.,* 1998; MACHIAS *et al.,* 2001; SENDAO *et al.,* 2002) depending on the landing port and sale perspectives of the species, which is usually marketed mixed with *S. orbignyana* and small *S. officinalis.* In some areas *S. elegans* represents a significant percentage of the catch and constitutes a valuable resource locally (REID *et al.,* 2005).

Conservation Status: No population assessment has been conducted in Hellenic seas or other geographical areas.

***Sepia orbignyana* (Ferussac, 1826)**

General: Sepia orbignyana is a cuttlefish of medium size, with maximum mantle length recorded in the Mediterranean Sea 9.3 cm for males and 9.6 cm for females (REID *et al.,* 2005). Mature females are caught from spring to autumn while mature males are collected during all seasons (RELINI *et al.,* 1999; LEFKADITOU, 2006), a fact that indicates earlier maturation of the males. Mature females carry about 400 oocytes and males about 100 spermatophores (REID *et al.,* 2005). According to a study of its feeding in the Tuscan waters, crustaceans constitute its preferred prey, followed by fish, cephalopods and echinoderms (RELINI *et al.,* 1999).

Distribution: Sepia orbignyana extends from Irish waters south to Angola (17˚ S) in the eastern Atlantic and throughout the Mediterranean Sea, existing also in the brackish waters of the Sea of Marmara (REID *et al.,* 2005). Its bathymetric range extends from a few meters down to middle slope, with its deepest record from a haul at 700-770 m in the southern Aegean Sea (MEDITS – International bottom trawl survey in the Mediterranean, unpublished data). However, *S. orbignyana* is more frequently caught on lower continental shelf, being an indicative species of cephalopod assemblages at these depths (SANCHEZ *et al.,* 1998; QUETGLAS *et al.,* 2002; LEFKADITOU, 2006). Its remains have been noted among prey species of *Raya clavata* from the Aegean Sea (KABASAKAL, 2002) and the demersal fish community in the Bay of Biscay (VELASCO *et al.,* 2001).

Exploitation: Sepia orbignyana represents a common trawl by-catch, regularly present in Italian and Spanish markets (RELINI *et al.,* 1999), being marketable also in Hellas (MACHIAS *et al.,* 2001). It is marketed frozen and fresh, usually mixed with *S. elegans* and small individuals of the common cuttlefish *Sepia officinalis,* so that there are no separate statistical data for this species' landings.

Conservation Status: Density and biomass data have been collected systematically for *Sepia orbignyana* during the trawl surveys conducted in the Mediterranean waters of European countries since the summer of 1994, but are not sufficient for stock assessment of this short-lived species.

***Rossia macrosoma* (Delle Chiaje, 1830)**

General: Rossia macrosoma is the largest sepiolid species in the Mediterranean Sea; its mantle length attaining 5.4 cm for males and 8.4 cm for females

(MANGOLD-WIRTZ, 1963; LEFKADITOU, 2006). Mature specimens of both sexes are found during all seasons, indicating an extended spawning period that probably peaks in spring and autumn (REID & JEREB, 2005). Potential fecundity reaches 208 eggs, while counts of spermatophores inside a male's Sac of Needham do not exceed 150 (LEFKADITOU, unpublished data). No information is available on its feeding habits. Remains of *R. macrosoma* have been identified among the stomach contents of demersal fishes and chondrichthyans (BELLO, 1997; VELASCO *et al.,* 2001).

Distribution: It is widespread in the Mediterranean Sea and across the northeastern Atlantic, extending also into waters around Greenland (REID & JEREB, 2005). It has been reported at depths ranging between 32 and 900 m, caught more frequently on upper slopes. It has been found in the Aegean Sea and the Ionian Sea, at depths between 72 and 700 m. Mature individuals of both sexes are distributed mainly on upper slopes whereas younger individuals are mainly found on the lower shelf (LEFKADITOU & KASPIRIS, 2004; ROSA *et al.,* 2006).

Exploitation: It consistently exhibits both a marketable and discarded amount in Hellenic, Italian and Spanish trawl fisheries (SARTOR *et al.,* 1998; MACHIAS *et al.,* 2001). There are no official statistics for *R. macrosoma* commercial catches, which are usually landed mixed with other sepiolids and small eledonids.

Conservation Status: There are no studies targeting assessment of this species' stocks. Data on the number of individuals and their total weight by haul have been collected in the framework of the International bottom trawl survey in the Mediterranean (MEDITS), conducted during the summer over the continental shelf and slope of European countries since 1994.

***Rondeletiola minor* (Naef, 1912)**

General: Rondeletiola minor is one of the smaller members of the family Sepiolidae, attaining a mantle length up to 2.3 cm (REID & JEREB 2005) and recognized by the roundish pair of light organs present inside the mantle cavity on the ventral side of the ink sac, easily seen from the ventral mantle opening. Mature individuals are found throughout the year, with females maturing at 1.3-1.7 cm and males at 1.1-1.3 cm (SALMAN & KATAGAN, 1996; LEFKADITOU & KASPIRIS, 2004), a fact explaining the almost exclusive presence of mature individuals among males collected by selective bottom trawl nets. Potential fecundity of females reaches 160 eggs (LEFKADITOU unpublished data) while in males 280 spermatophores have been counted on average (SALMAN & KATAGAN, 1996). *R. minor* shows an aggregation forming behaviour, being among the cephalopod species characterizing shelf-break areas (GONZALEZ & SANCHEZ, 2002; LEFKADITOU, 2006). *R. minor* remains have been reported in the stomach content of Raya clavata (BELLO, 1997).

Distribution: Rondeletiola minor is widespread in the Mediterranean Sea including the brackish waters of the Sea of Marmara (UNSAL *et al.,* 1999) and in the eastern Atlantic from the north coast of the Iberian Peninsula up to the waters off Namibia (30oS) (REID & JEREB 2005). It has been reported at depths ranging from 17 to 900 m, with its deepest records reported from the northeastern Ionian Sea

(LEFKADITOU *et al.,* 2003a). In the Aegean Sea it has been caught down to 770 m, with the greatest part of its population distributed over the continental slope (LEFKADITOU *et al.,* 2003b, LEFKADITOU & KASPIRIS, 2004).

Exploitation: Rondeletiola minor is a by-catch species of trawl fisheries, known to be consumed only in Italy (SARTOR *et al.,* 1998).

Conservation Status: No population assessment has been conducted for this species across its distributional range.

***Sepietta oweniana* (Pfeffer, 1908)**

General: Sepietta oweniana is the most abundant species of the Sepiolidae family. Its mantle length reaches 5 cm in the North Sea but does not exceed 4 cm in the Mediterranean Sea, with females generally maturing at around 2.5 cm and males at around 2.0 cm. Mature individuals are present throughout the year with maximum incidence of mature females observed from spring to autumn (RELINI *et al.,* 1999; LEFKADITOU & KASPIRIS, 2004). Fecunded eggs are released in one or several spawning events and potential fecundity ranges from 50 to 240 eggs, while counts of male's spermatophores range between 50 and 824 (SALMAN, 1998; LEFKADITOU, 2006). *S. oweniana* feeds primarily on crustaceans, while cephalopod and fish proportions in their stomach contents vary considerably by geographic area and depth of capture (LEFKADITOU, 2006). *S. oweniana* has been found in the stomachs of *Stenella coeruleoalba* (SANTOS *et al.,* 1995), *Galeus melastomus* (BERGSTROM & SUMMERS, 1983; BELLO, 1997), *Chimaera monstrosa* (BELLO, 1997), *Raya clavata* (KARABASAKAL, 2002) and *Aristaeomorpha foliacea* (BELLO & PIPITONE, 2002).

Distribution: Sepietta oweniana is widespread in the Mediterranean Sea including the southwestern part of the Sea of Marmara (UNSAL *et al.,* 1999) and in the northeastern Atlantic from Norway to Mauritania (15° N), while its occurrence in the Indian Ocean is doubtful (REID & JEREB, 2005). It is present on soft bottom, of continental shelf and slope, but more abundant on the upper slope, where it has usually been found among the dominant species of cephalopod assemblages (SANCHEZ *et al.,* 1998; BIAGI *et al.,* 2002; GONZALEZ & SANCHEZ, 2002; LEFKADITOU, 2006). It is common in Hellenic seas, where it has been recorded at depths of between 20 and 820 m, being the most abundant cephalopod species on the eastern Ionian slope (Table 3).

Exploitation: Sepietta oweniana constitutes the major part of landed sepiolids, particularly appreciated in some markets of the western Mediterranean, representing a significant by-catch of trawl fisheries, especially in Norwegian lobster fishing grounds (RELINI *et al.,* 1999). According to the results of a study of Hellenic trawl fisheries' discards for 1995-1998, by-catches of this species were only discarded (MACHIAS *et al.,* 2001).

Conservation Status: Studies on the state of its exploitation and population assessment are lacking.

***Scaeurgus unicirrhus* (Orbigny, 1840)**

General: Scaeurgus unicirrhus is a medium-sized octopus, with mantle length reaching 12 cm for females (MANGOLD –WIRTZ, 1963) and 8 cm for males (LEFKADITOU, 2006). Mature males are met throughout the year but mature

females have been caught in the Mediterranean Sea from early spring to early autumn (MANGOLD –WIRTZ, 1963; LEFKADITOU, unpublished data). Potential fecundity of females is about 1000 eggs, while counts of spermatophores in the males' spermatophoric sac do not exceed 10. Prey spectrum of the species indicates its association with the bottom, made up mainly of carideans crustaceans and in smaller proportions of teleosts, cephalopods and polychaetes (RELINI *et al.,* 1999).

Distribution: Scaeurgus unicirrhus is a cosmopolitan species, scattered in tropical and warm temperate waters, associated with sandy and coralline bottoms (ROPER *et al.,* 1984). It has been reported at depths between 30 and 850 m, being relatively more abundant on lower shelf and upper slope (SANCHEZ *et al.,* 1998; QUETGLAS *et al.,* 2000; GONZALEZ & SANCHEZ, 2002; LEFKADITOU *et al.,* 2003a). It is widespread in Hellenic seas, presenting a wider depth range in the Ionian Sea (43-850 m) in comparison to that (30-550 m) in the Aegean Sea, where it seems to be relatively more abundant (Table 3).

Exploitation: Scaeurgus unicirrhus is a by-catch of bottom trawlers that is mostly discarded by Hellenic trawlers (MACHIAS *et al.,* 2001) and only occasionally marketed with musky octopuses (LEFKADITOU, unpublished data). In the western Mediterranean, its discard percentage by Italian and Spanish trawlers ranges from 0 to 50 % (SARTOR *et al.,* 1998), but its economic value is lower than that of other commercial octopod species (RELINI *et al.,* 1999).

Conservation Status: No population assessment has been conducted in Hellenic seas or other geographic areas.

Conclusion

People who exploit marine resources choose among them according to technological, economic, and social considerations. Prehistoric selectivity in their exploitation has often been postulated. Many molluscs, although not commercially important, have been exploited for human consumption or for other uses (fish bait, shell collections, the jewellery industry). Although for some species there are indications of substantial population decline, there is a lack of scientific effort towards a better understanding of their ecology and assessing the status of their populations. The situation is even worse for species of no importance for humans (not evaluated in this review). Scientific effort and financing targeted a few commercial species (KOUTSOUBAS *et al.,* 2007; LEFKADITOU, 2007), while molluscs of minor or no commercial importance are neglected. For most of these species there is no population assessment in Hellenic seas with only a few exceptions on a local scale (e.g., *Pinna nobilis, Lithophaga lithophaga, Donacilla cornea*). However, many of these species are important constituents of the Mediterranean ecosystems and as they are under a variety of pressures nowadays (marine pollution, alien species' invasions, climate change, destructive fishing methods, overexploitation) there is a pressing need to assess the status of their populations and act towards their conservation. Existing legislation is not enforced in practice and is extensively violated, thus the conservation of the molluscan species is not ensured. In addition, a good knowledge of the ecology and status of the aforementioned species and appropriate conservation plans are needed.

An important goal in the next decade is to network targeted collection data nationally and internationally so this invaluable source of biodiversity information can be accessed for conservation and planning purposes.

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