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Research Article

"Protected" marine shelled molluscs: thriving in Greek seafood restaurants

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Abstract

International agreements as well as European and national legislation prohibit exploitation and trading of a number of edible marine shelled molluscs, due to either significant declines in their populations or destructive fishing practices. However, enforcement of existing legislation in Greece is ineffective and many populations of 'protected' species continue to decline, mainly due to poaching. The extent of illegal trading of protected bivalves and gastropods in Greek seafood restaurants was investigated by interviewing owners or managers of 219 such restaurants in 92 localities. Interviews were based on questionnaires regarding the frequency of availability in the menus and the origin of twenty-one species or groups of species, among which eight are protected - illegally exploited. Forty-two percent of the surveyed restaurants were found to serve at least one of the protected - illegally exploited species. Among the illegally traded species, *Lithophaga lithophaga, Pecten jacobaeus,* and *Pinna nobilis* were served in a relatively high proportion of the surveyed restaurants (22.8%, 19.2%, and 16.4% respectively), outrunning many commercial species. In many cases these species were always or often available (11.4%, 4.6% and 5.0% respectively). There was substantial spatial variation in the proportion of restaurants that illegally served protected species with different patterns for each species; very high proportions of illegal trading were observed in some marine regions (e.g. date mussels were served in >65% of the seafood restaurants along the coastline of Evvoikos Gulf). In most cases the illegally traded species were of local origin, while there was no finding of illegally imported molluscs from other countries. The strategy for enforcement of existing legislation should be greatly improved otherwise protection of shelled molluscs will remain ineffective.

Keywords: Marine conservation; Endangered molluscs; Habitats Directive; Enforcement; Poaching.

Introduction

Exploitation of marine molluscs in Greece has a history dating back to the Paleolithic age (SHACKLETON & VAN ANDEL, 2007; VOULTSIADOU *et al*., 2010; STINER & MUNRO, 2011). Aristotle was the first to describe the morphology, reproduction and life-cycle characteristics of some mainly edible gastropod and bivalve species. The works by Aristotle, Hippocrates, Xenocrates, Galen, Dioscorides and Athenaeus showed that among the 35 exploited marine invertebrates recorded in the texts, 20 were molluscs (VOULTSIADOU *et al*., 2010). Later on, Plenius provided information on certain molluscs that were exploited by the ancient Romans either for food or for jewellery making. The same species targeted by ancient Greeks and Romans are still exploited today in the Mediterranean Sea, often with similar fishing practices.

Among the ~1,100 bivalve and gastropod species that have been recorded from the Greek Seas (DELAMOTTE & VARDALA-THEODOROU, 2007), twenty-one are of commercial importance for fisheries and aquaculture (KOUTSOUBAS *et al*., 2007). Apart from those species, a few other edible bivalves and gastropods used to be exploited in the past but their harvesting is now banned due to either significant declines in their populations (e.g. in the fan mussel *Pinna nobilis*) or destructive fishing practices (e.g. the fisheries of the date mussel *Lithophaga lithophaga*) (KATSANEVAKIS *et al*., 2008).

The existing legislation for the conservation of marine species includes the European Habitats Directive (92/43/EC), the Bern Convention, the Protocol for Specially Protected Areas and Biological Diversity in the Mediterranean of the Barcelona Convention (hereafter: Protocol of the Barcelona Convention), and national regulations, such as the Presidential Decrees (PD) 67/1981, 86/98, 227/2003, and 109/2002. For species included in Annex IV of the Habitats Directive, all forms of deliberate capture or killing of specimens in the wild, deliberate disturbance, deliberate destruction or collection 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 collection of eggs, disturbance especially during the reproduction period, possession or commerce of live or dead specimens are strictly prohibited (however, although Greece has ratified the Bern Convention, invertebrates were excluded from the relevant national law 1335/1983). 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 (however, Greece has not yet ratified the relevant part of the protocol, including Annex II). The Presidential Decree (PD) 67/1981 prohibits killing, causing injury, capturing, 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 molluscs not included in the lists of these PDs is prohibited.

However, enforcement of existing legislation by the Greek authorities is largely lacking and many populations of "protected" species in Greek waters continue to decline, mainly due to poaching (KATSANEVAKIS *et al*., 2008; KATSANEVAKIS, 2009a). Recreational fishing for food or shell collection are probably the two major causes of mor-

tality of many shelled molluscs. Nevertheless, many of the "protected" shelled molluscs are still commercially exploited and illegally traded, ending up in seafood restaurants. The aim of this study was to investigate the extent of illegal trading of protected bivalves and gastropods in Greek seafood restaurants and to reveal potential spatial patterns within Greek coastal regions.

Materials and Methods

The survey protocol was based on structured interviews of owners or managers of seafood restaurants in Greek coastal areas. A questionnaire was filled by the interviewer including information on the location of the restaurant (marine region and locality), the date, the frequency of availability of the target species, and their origin (if known), i.e. the marine region where they have been fished.

Twenty species or groups of species (when identification on species level was not certain) were included in the list of target species, consisting of both legally exploited and protected species (Table 1). Alien shelled molluscs that are exploited and served in Greek restaurants, such as *Pinctada radiata* and *Conomurex persicus* (ZENETOS *et al*. 2010), were excluded from the analysis. There is a paradox in the existing legislation concerning their exploitation: they are not included in the lists of the PDs (86/98, 227/2003, and 109/2002) regulating shelled molluscs exploitation and thus their exploitation is prohibited; however these invasive species should not be considered as being in need of protection.

Identification on species level was uncertain for mussels, oysters, razor clams, abalones, limpets, and monodonts. Mussels served in the Greek restaurants include the native *Mytilus galloprovincialis* (wild or farmed) and the imported *Mytilus edulis*, *Mytilus trossulus*, *Perna canaliculus*, and perhaps other species. Oysters served in Greece mainly belong to the native species *Ostrea edulis* but the alien species *Crassostrea gigas* is imported and served as well. Three species of abalones are native of the Mediterranean Sea, *Haliotis tuberculata*, *H. mikonosensis*, and *H. stomatiaeformis*, of which the first two are common in the Greek Seas (CROCETTA & RISMONDO, 2009). Two species of razor clams (*Solen marginatus* and *Ensis minor*), three species of limpets (*Patella caerulea*, *Patella rustica*, and *Patella ulyssiponensis*), and three species of monodonts (*Osilinus articulatus*, *Osilinus turbinatus*, and *Phorcus mutabilis*) are present in the Greek Seas and have been exploited for food (KATSANEVAKIS *et al*., 2008).

The interviewer asked for the availability and origin of each target species using its common name(s) and showing its picture to the interviewee to avoid misidentifications. Five levels were used to categorize the frequency of availability: *never*, *rare* (at least once in the last three years), *occasionally* (only on certain days, e.g. weekends, or periods, e.g. during Lent), *often* (available during >50% of the working days), *always/almost always* (available during >80% of the working days). The interviewees were also given the chance to make any comments they wished on shelled molluscs exploitation and trading, which was also noted in the questionnaires.

To reduce the possible hesitation by some of the interviewees to give honest answers: (1) we kept the questionnaires anonymous and no personal data of the interviewee or the restaurant were asked or kept; (2) it was stated that "the survey aimed to quantify the variety of traded marine molluscs in seafood restaurants" and there was no mention of "protected species" or "leg-

islation"; (3) the questionnaire did not focus on protected - illegally exploited species; the majority of the included species were legally exploited and traded (Table 1).

The survey was conducted between June 2009 and June 2011 and a total of 219 interviews were conducted in 92 localities. These interviews were spatially distributed in

Table 1

Mollusc species included in the survey questionnaires. The legislation regulating their exploitation (for commercially exploited species) or for their protection (for protected - illegally exploited species) is indicated. BC = Bern Convention, PBC = Protocol for Specially Protected Areas and Biological Diversity in the Mediterranean of the Barcelona Convention, HD = Habitats Directive (92/43/EC), PD = Presidential Decree, B = Bivalve, G = Gastropod.

Species scientific name		Greek/English common names	Legislation
COMMERCIALLY EXPLOITED			Legislation regulating exploitation
Mytillus spp., *Perna canaliculus*	B	mydia/mussels	PD 227/2003
Ostrea edulis, Crassostrea gigas	B	stridia/oysters	PD 227/2003
Callista chione	B	gyalisteri/smooth callista	PD 227/2003
Arca noae	B	kalognomi/Noah's ark	PD 227/2003
Solen marginatus, Ensis minor	B	solinas, ammosolinas/razor clam	PD 109/2002
Vennus verrucosa	B	kydoni/warty venus	PD 227/2003
Modiolus barbatus	B	chavaro/bearded horse mussel	PD 227/2003
Flexopecten glaber	B	gialistero chteni/smooth scallop	PD 227/2003
Solecurtus strigilatus	B	samari, zamponaki /sandwich	PD 109/2002
Haliotis spp.	G	afti tis thalassas/lamellated haliotis	PD 227/2003
Hexaplex trunculus	G	strobos/banded murex	PD 227/2003
Bolinus brandaris	G	agathotos strobos/spined murex	PD 227/2003
Patella spp.	G	petalides/limpets	PD 109/2002
PROTECTED - ILLEGALLY EXPLOITED			Legislation for protection
Lithophaga lithophaga	B	petrosolinas, valanos,chourmas /European date mussel	HD, BC, PBC, PD 109/2002, PD 227/2003
Pinna nobilis	B	pinna /pen shell, fan shell	HD, PBC, PD 67/1981, PD 109/2002, PD 227/2003
Pholas dactylus	B	daktilo, ftera aggelon, folada /common piddock	BC, PBC, PD 227/2003, [PD 109/2002]*
Spondylus gaederopus	B	gaidouropodaro, vassiliko stridi /European thorny oyster	PD 109/2002, PD 109/2002, PD 227/2003
Pecten jacobaeus	B	megalo chteni /Jacob scallop	PD 109/2002, PD 227/2003
Tonna galea	G	bouchona, kochyla /giant ton	BC, PBC, PD 67/1981, PD 109/2002, PD 227/2003
Oscilinus spp., *Phorcus mutabilis*	G	salingarakia/monodonts	PD 109/2002, PD 227/2003

*Although *Pholas dactylus* is protected by the BC and PBC, it is included in the list of legally exploited species for bait.

all marine regions of Greece. For the needs of the present analysis Greek waters were divided into seven marine regions (sample size in parentheses): North Aegean (46), South Aegean (25), Ionian Sea (30), Korinthiakos & Patraikos Gulfs (23), North & South Evvoikos Gulf (21), Saronikos & Argolikos Gulfs (44), and Kriti (30) (Fig. 1).

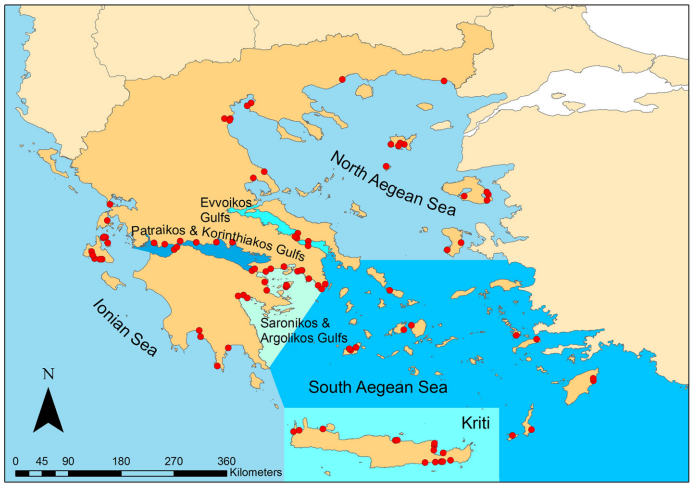

Fig. 1: Map of the study area, subdivided into 5 marine regions. All surveyed localities are indicated with red dots.

Results

All target species or groups of species were included among the served dishes in Greek seafood restaurants with frequencies varying from 93% (for mussels) to 1.4% (for *Tonna galea* and *Solecurtus strigilatus*) (Fig. 2). Forty-two percent of the surveyed restaurants were found to have served (even rarely) at least one of the illegally exploited species. Among the illegally traded species, *L.lithophaga*, *P. jacobaeus*, and *P. nobilis* were served in a relatively high proportion of the surveyed restaurants (22.8%, 19.2%, and 16.4% respectively), outrunning many commercial species. *L.lithophaga* had been systematically served (i.e. reported frequencies were either *often* or *always/almost always*) in 11.4% of the surveyed restaurants, while for *P. jacobaeus* and *P. nobilis* the corresponding percentages were 4.6% and 5.0%. One restaurant (in North Aegean), had often served the gastropods *Charonia lampas* and *Charonia variegata* (not included in the questionnaires); these species are protected by the Bern Convention and the Protocol of the Barcelona Convention.

There was substantial variation in the trading of protected molluscs through seafood restaurants among the Greek marine regions (Fig. 3). Date mussels were served in >65% of the seafood restaurants along the Evvoikos Gulfs (systematically in nearly 50% of the restaurants), where they are considered a great delicacy and there is a long standing tradition of date mussel exploitation and trading. High values were also found in the Sa-

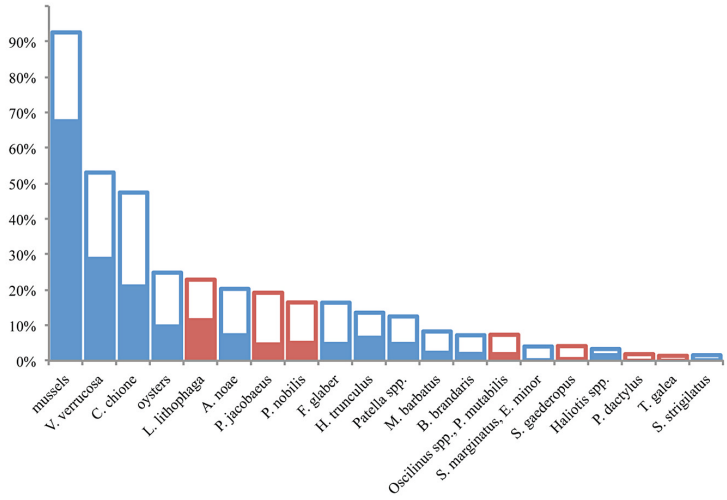

Fig. 2: Percentage of surveyed seafood restaurants that served the target species. Blue colour indicates commercially exploited species, while red colour indicates protected - illegally exploited species. The filled portion of each bar corresponds to restaurants that serve the species *often* or *always/almost always,* while the unfilled portion corresponds to restaurants that serve the species *occasionally* or *rare.*

ronikos & Argolikos Gulfs (date mussels had been served in 25% of the restaurants; systematically in 16%), in North Aegean (served in 24% of the restaurants but systematically in just slightly over 2%), and in Korinthiakos & Patraikos Gulfs (served in 17.4% of the restaurants; systematically in 13%). For *P. nobilis*, *P. jacobaeus*, *Oscilinus* spp. & *P. mutabilis* the highest percentages were observed in the North and South Aegean Seas. In these regions, *P. nobilis* was served in 37% and 32% respectively of the seafood restaurants.

In almost every case the protected - illegally exploited species being served were of local origin, i.e. they had been harvested in the same marine region as the locality of the restaurant. There were very few exceptions where the illegally exploited species served had been harvested in other marine regions (13% of the cases for *P. jacobaeus*, 6.1% of the cases for *L. lithophaga*, 4.2% of the cases for *P. nobilis*, and 0% for all other species). There was no finding of illegally imported species from other countries.

Discussion

It was evident from the questionnaires' results that enforcement of existing legislation for the protection of marine molluscs is ineffective. An astonishing large percentage of Greek seafood restaurants have been serving protected species. It is quite possible that this percentage is even higher, as some of the interviewees were very cautious and it is likely they did not give truthful replies for illegally traded species.

Continuing exploitation of protected species has serious implications:

(1) The populations of all protected molluscs included in this survey (with the exception of monodonts for which there is no assessment) are declining in the Mediterranean and in Greek coastal areas (KATSANEVAKIS *et al*., 2008). Protection through international agree-

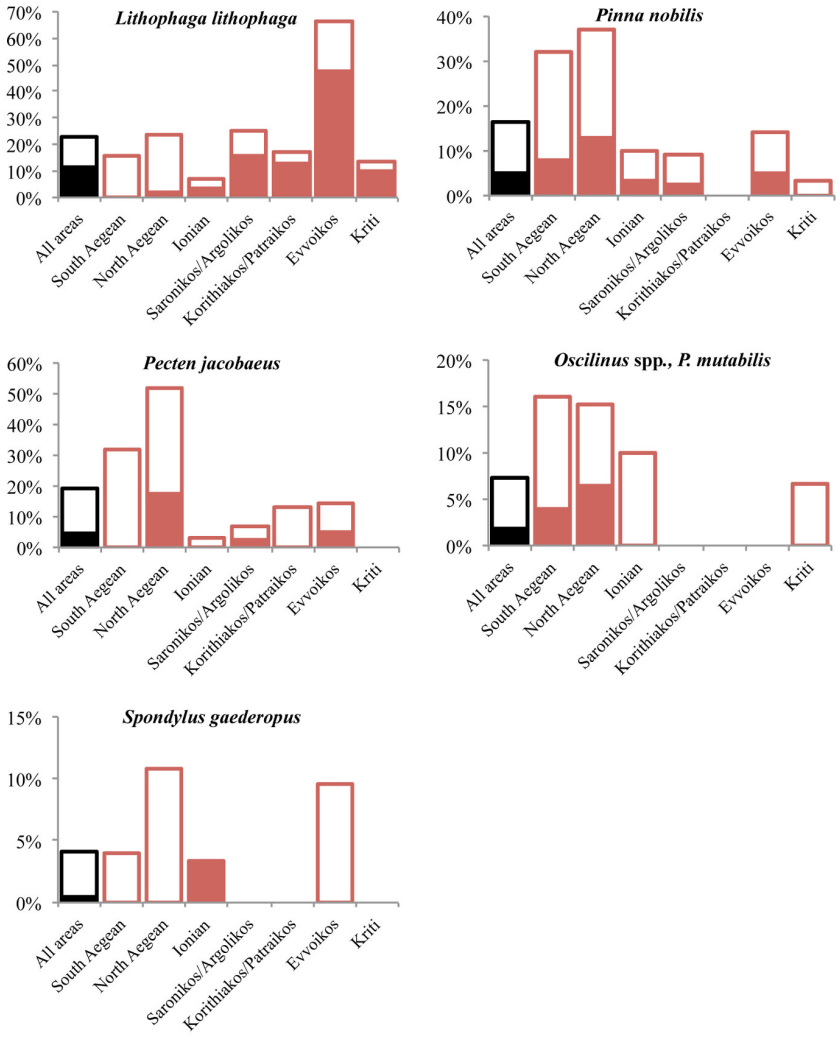

Fig. 3: Trading of protected - illegally exploited molluscs through seafood restaurants among the Greek marine regions (as defined in Fig. 1). The percentage of the surveyed restaurants that have been serving the target species is given. The filled portion of each bar corresponds to restaurants that serve the species *often* or *always/almost always,* while the unfilled portion corresponds to restaurants that serve the species *occasionally* or *rare. P. dactylus* and *T. galea* were excluded due to a low sample size.

ments and European or national legislation was decided on the basis of a need to reduce mortality and to allow these populations to recover. Continuing intense exploitation for trading in seafood restaurants might render the achievement of this goal unfeasible.

(2) Weak enforcement and ineffective surveillance leads to an overall bad mentality of non-compliance. Stakeholders

(fishermen, traders, restaurant owners) that complied with regulations and restricted their former range of activities feel deceived and adopt a sceptical or negative attitude towards legislation for protection of marine species. Restaurant owners, who might not wish to illegally serve protected species, are forced to do so in order to face competition.

(3) The country faces the risk of defamation by other European and Mediterranean countries due to the infringement of its international commitments to the protection of vulnerable marine species and habitats. It also takes the risk of penalties by EU for the violation of the Habitats Directive (in the case of *L. lithophaga* and *P. nobilis*).

The fan mussel, *Pinna nobilis*, is a good example of the failure of the Greek authorities to enforce the existing protection measures. *P. nobilis* is an emblematic species of the Mediterranean Sea, as it is endemic and the largest bivalve in the region, attaining total anterio-posterior lengths of up to 120 cm (KATSANEVAKIS *et al*., 2008). Fan mussels live with the anterior portion of their shell partially buried, at depths between 0.5 and 60 m typically in soft-bottom areas overgrown by seagrass or in unvegetated sandy bottoms (KATSANEVAKIS *et al*., 2008). Since ancient times, *P. nobilis* has been exploited for its byssus, from which an extremely fine and valuable fabric is produced, the so-called 'sea silk'. It has also been exploited for human consumption and the collection of its shell. Due to overexploitation and incidental killing by trawlers, bottom nets, or anchoring, the global population of *P. nobilis* has been greatly reduced during the past few decades. Consequently, it has been listed as a protected species in the Mediterranean Sea and is under strict protection (Table 1). Despite its protection by Greek legislation since the early 80s, its population keeps declining and it was recently assessed as vulnerable, according to the national IUCN criteria (KATSANEVAKIS, 2009b). However, as demonstrated in this study, *P. nobilis* is still commercially exploited and served in Greek fish restaurants. In addition, poaching by recreational or professional fishers and divers for personal consumption or collection of its shell is quite significant and appears to be a major threat to the conservation of the species (KATSANEVAKIS, 2009a).

The European date mussel, *Lithophaga lithophaga*, is an endolithic species living inside carbonate rocks (limestone) in the midlittoral and upper sublittoral zones. Date mussel harvesting is usually conducted by SCUBA divers equipped with special sledgehammers, who break rocky substrates removing the first centimeters of rock to collect the bivalves (DEVESCOVI *et al*., 2005). Such fishing practices cause direct damages to benthic assemblages by eradicating sessile animals and algae, alter biotic interactions, and favour local increase in sea urchin population densities and the persistence of rocky barrens (FANELLI *et al*., 1994; GUIDETTI, 2011). To prevent a large scale degradation of shallow rocky habitats, the date mussel fishery was banned in most Mediterranean countries. However, in many areas of the Mediterranean Sea illegal date mussel fishing is still practiced (FRASCHETTI *et al*., 2011; GUIDETTI, 2011). In the past, *L. lithophaga* was extensively exploited in the Greek seas and it was found in seafood markets and fish restaurants in many locations (KATSANEVAKIS *et al*., 2008). As demonstrated herein, despite its protection status, extensive exploitation continues.

Recreational poaching might be difficult to control in a country of 16,000 km of coastline, with >2,000 islands and islets, nu-

merous coastal villages, and many thousands of recreational fishermen. However, commercial exploitation, transportation, commerce, and supply in fish restaurants are much easier to control. The enforcement strategy in the case of seafood restaurants may encompass a range of discursive and coercive measures, ranging from shelf-regulation to aggressive enforcement activities. Discursive (or preventive) enforcement through environmental education and awareness of both related stakeholders and the public (consumers) aims to increase community capacity, which refers to the rules, procedures and values that people hold, predisposing them to work collectively for mutual benefit (RUDD, 2000). If community capacity is low, illegal activities are likely to occur.

However, discursive enforcement will not suffice alone. Economic gains from illegal exploitation of protected species can be very high and thus the potential for poaching will always exist. By increasing the severity and likelihood of sanctions (criminal or civil penalties, restaurant permit sanctions) and thus raising the opportunity cost of non-compliance, enforcement systems act directly upon resource users to foster adherence to established rules (MASCIA, 2004). There are many examples where aggressive enforcement dramatically increased compliance (MASCIA, 2004). Enforcement systems also affect compliance indirectly by affecting rates of "contingent compliance", where individuals base their decision to comply with regulations upon the perceived rate of compliance by others (MASCIA, 2004).

It is clear that if the current low levels of enforcement carry on, the targets set by European and national conservation policies as regards marine shelled molluscs will not be met. The populations of "protected" marine shelled molluscs will continue to decline, with consumption in seafood restaurants being one important contributing factor.

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