FIRST EVALUATION OF *Mytilus galloprovincialis* LMK, NATURAL POPULATIONS IN THERMAIKOS GULF: STRUCTURE AND DISTRIBUTION

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SUMMARY

This study investigates the natural populations (stocks) of *Mytilus galloprovincialis* in Thermaikos Gulf (North Aegean Sea). Throughout 2000, 50 stations were closely inspected and 10 of them were selected to study the biometry and dynamics of the populations. Multi-dimensional scaling and common statistical methods were employed for data analysis. The Thermaikos Gulf seems to consist of a suitable environment for the growth and preservation of important stocks of *Mytilus galloprovincialis*, more than any other area around the Mediterranean Sea. However, the studied populations showed significant differences, mostly due to insufficient management of fisheries in the Gulf.

KEYWORDS: Mussels, natural stocks, *Mytilus galloprovincialis*, population dynamics.

INTRODUCTION

*Mytilus galloprovincialis* is a bivalve species with great commercial value, found throughout the Mediterranean and the Black Sea, but also on almost every European coast [1]. In recent years it has been the main focal point for a number of research projects, despite the great number of publications regarding the natural stocks [2-9] of both recruits and mature individuals, knowledge on local populations is very restricted. Such an example is Thermaikos Gulf, whose annual production of over 30,000 t over the last decade makes it the most important production area for mussels in Greece. Still, basic scientific knowledge, such as the recording of natural stock levels for the local mussel populations, is extremely limited and fragmented [10-15]. This kind of knowledge, though, especially when a native commercially important species is taken into consideration, is regarded as a milestone in the efficient management of the stock. Therefore, the primary aim of this study is to record the distribution of *Mytilus galloprovincialis* and assess the structure of the most important local populations. The relationships between these populations, with respect to external morphology and biometry, will also be investigated.

MATERIALS AND METHODS

Geographical and Spatial parameters: The length of the coastline, along which this study was carried out, exceeded 257 Km and covered the area between Cape of Poseidi, eastern Thermaikos coast and Cape Dermata, western Thermaikos coast (Figure 1).

Fifty stations were set up and grouped in seven sub-areas according to their type and to the structure of the *Mytilus galloprovincialis* populations found (Table 1). The presence of the mussels was significant only in ten of these stations, and, as a result, the study was focused in these specific sites (Figure 1).

According to literature, the flow of the water masses in the gulf is cyclonic, drifting from the eastern towards the western coasts [16, 17]. There are certain seasonal variations in this pattern, however, mainly during winter, when strong NNW winds turn the water masses eastern bounds [16-18]. The dynamics of these masses do not appear to affect the upper part of Thessaloniki Bay significantly (p.c. with Prof. I. Krestenitis), resulting in larger concentrations of nutrients in that particular area [19].

Physico-chemical factors: During sampling, abiotic factors such as salinity (‰), dissolved oxygen (DO₂ ppm), and temperature (°C) were measured. All measurements were carried out with WTW and Lovibond Checkit micro-electronic equipment. Transparency was determined via a Secchi disc.

Sampling: Preliminary sampling trials indicated that in most stations the vertical distribution of the mussel popu-
lations do not exceed a depth of 2.5 to 3 meters and that no size variations in their population resulted from it. Exceptions were those stations at which build-ups of young individuals (<20mm) were noted in the upper limits of the sublittoral zone (<0.30m). Samples were always collected within the limits of the median vertical distribution (1–2 m deep).

**FIGURE 1**
Map of Thermalkos Gulf and sampling stations.

**TABLE 1** - Initial breakdown of the 50 sampling stations, based on mussel abundance
(Gulf of Thermalkos, North Aegean Sea) (Abbrev.: bold numbers = stations, latin’s numbers = type of habitats).

<table>
<thead>
<tr>
<th>SUB - AREAS</th>
<th>TOPOGRAPHICAL RANGE</th>
<th>TYPES OF STATIONS</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Cape of Poseidi - Harbour of Moudania</td>
<td>I (ST: 1, 2, 3, 4, 5, 6, 7, 8) and II (ST: 9)</td>
</tr>
<tr>
<td>B</td>
<td>New Moudania - Cape of Epanomi</td>
<td>I (ST: 10, 11, 12, 13, 14)</td>
</tr>
<tr>
<td>C</td>
<td>Epanomi - Aeggelohori</td>
<td>II (ST: 15, 16) and III (ST: 17)</td>
</tr>
<tr>
<td>D</td>
<td>Aeggelohori - Mikro Emvolo</td>
<td>IV (ST: 18, 19, 20, 21, 22)</td>
</tr>
<tr>
<td>E</td>
<td>Mikro Emvolo - Kalohori</td>
<td>V (ST: 23, 24, 25, 26)</td>
</tr>
<tr>
<td>F</td>
<td>Kalohori - Makrygialos</td>
<td>VI (ST: 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40) and III (ST: 41, 42)</td>
</tr>
<tr>
<td>G</td>
<td>Makrygialos - Cape of Dermata</td>
<td>III (ST: 43, 46, 49), II (ST: 47, 48, 50), I (ST: 44) and IV (ST: 45)</td>
</tr>
</tbody>
</table>

1. Stations where no mussels were found.
2. Stations with scattered small pockets of mussels along the mid-littoral zone.
3. Stations, usually small fishing ports that provide a niche suitable for the establishment of a local mussel population.
4. Stations where mussel populations are very significant on natural or artificial hard substrata.
5. Stations where organic and industrial pollution is intense and the various mussel beds exhibit seasonal variations.
6. Stations where mussels are found on beds of organic fragments, also on artificial hard substrata of the mid-littoral and upper sub-littoral zone, but the structure of the populations are usually degraded.
All sampling runs were carried out by SCUBA diving, in the time period between 16th of August and 30th of October 2000. The series of actions in each sampling station was as follows: i) Exploration of a 500m² area for the presence of *Mytilus galloprovincialis* and a rough estimate on the extent of the population; ii) Quantitative sampling in triplicates (when population densities were typical of those of a local, naturally occurring mussel bed¹), using a 20x20cm sampler, as described by Chintiroglou and Koukouras [20] and iii) Preservation of samples in a 7.5% formalin solution.

**Sample processing and biometry:** The number of mussels in each sample was initially recorded. Mussel abundance was categorized according to size: large individuals (>20mm), young individuals (≤20mm) and an intermediate mixture of young and large individuals.

For the biometric study of the samples, sub-sampling equal to a quarter of the original sample was carried out, which would relate to an area of 10x10cm [21]. For each mussel the following biometric measurements were carried out: i) Maximum shell length (Max.L), ii) Maximum shell width (Max.W), iii) Maximum shell thickness (Max.Th), iv) Total weight (T.W), v) Wet tissue weight (Tis.w.W) and vi) Shell weight (Sh.W). Following the recording of the above measurements, each individual was stored in a separate sachet filled with 7.5% formalin solution.

**Data processing and statistical analysis:** Population structure was studied according to Harding [22]. The following calculation of order sizes was based according to the approach of Snetogor and Cochran [23].

Statistical analyses like one-way ANOVA and Fisher PLSD were employed to examine the population structure, after an initial logarithmic transformation of the data.

Based on the sum of biometric data the degree of similarity or dissimilarity between the mussel beds examined was calculated. This was based on multi-dimensional scaling (MDS) [24] and Cluster analysis according to Ward's method, in which the Euclidean Distance (ED) was used as the similarity level (multi dimensional) [25]. In order to calculate the results' level of significance ANOSIM and Stress values were used according to Clarke and Warwick [24].

**RESULTS**

**General observations on mussel distribution:** From the 50 stations sampled it was concluded that the initial estimation on the distribution of *Mytilus galloprovincialis* on the coastline of Thermaitkos Gulf was optimistic.

Nearly all southeastern shores of the Gulf (sub-areas A and B), from Cape Posidri to Cape N, Epanomi, belong to the soft substratum types with isolated pockets of physophytilus macroalgal biocenosis at medium depths, with phanerogams biocenosis (*Zostera and Posidonia*) at greater depths. Scattered along the mid-littoral zone of ST9 we find small pockets of mussels. A similar layout was encountered in sub-area C, with the exception of ST17, where a small fishing port existed, with its cement foundations, has provided as a “proper habitat” for the establishment of a local mussel population. From this station onwards, and up to the area of the commercial port of Thessaloniki (sub-areas D and E), mussel populations are very significant in their presence. In some of those areas the presence of mussel beds has been consistent for quite a few years now (mostly in sub-area D [13, 14, 26]). In contrast, on the northern shores of the Gulf (sub-area E), where organic and industrial pollution is intense, the various mussel beds exhibit seasonal variations, which can lead even to total disappearance of certain beds (unpublished data, C.C. Chintiroglou).

Similar conditions were encountered in sub-area G, where, in addition, a vast extent of mussel shell fragments was recorded at a depth of 1.5 to 3m. At this depth, mussel beds were found established on beds of organic fragments, surrounded by sand-silt soft substrata. Mussel beds were also found on artificial hard substrata of the mid-littoral and upper sub-littoral, but at these locations the structure of the populations was usually degraded.

From the area of the deltas of the rivers at the northwestern part of the Gulf as far as Cape Dermatas (sub-area G), the coastline is of varying types, again with typical soft substrata biocenosis, amongst which we find scattered rocky patches and artificial hard substrata (fishing ports and small docks), which are covered by mussel beds.

From the above, it was concluded that the areas that sustained significant natural populations (whether these were located on natural or on artificial hard substrata) were those included in sub-areas C, D and F (the last two stations of sub-area G). Out of these stations, ten were selected based on the characteristics of the mussel population that they sustained. These were: ST17 in sub-area C, ST18, ST20 and ST22 in sub-area D, ST41 and ST42 in sub-area F and ST43, ST45, ST46 and ST49 in sub-area G (Fig. 1, Table 1).

**Abiotic parameters:** The values of the physico-chemical parameters throughout sampling were within the expected seasonal limits (Table 2). Small variations from these values were attributed to local micro-climatic variations, either due to variations in hydrodynamism, variation of fresh water run-offs that the Gulf received from the three rivers that lead into it, or from sewage run-offs from the city of Thessaloniki.

*Mytilus galloprovincialis abundance:* As stated before, the investigation of the normality of distribution of mean abundance (mAb) was carried out in three distinct stages: First, for large individuals (mussels ≥ 20mm), then, for young ones (mussels ≤20mm) and, finally, for all mussels (small and

¹A “naturally occurring mussel bed”, is “one in which population density is high, leading to a dense ‘bed’ of mussels with an area of over 15 m², in which mussel presence is continuous throughout the year.”
TABLE 2 - Abiotic parameters of the selected sampling stations in Thermoikos Gulf.

<table>
<thead>
<tr>
<th></th>
<th>Temperature</th>
<th>Salinity</th>
<th>Conductivity</th>
<th>DO (ml/l)</th>
<th>pH</th>
<th>Transparency</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>surface</td>
<td>bottom</td>
<td>surface</td>
<td>bottom</td>
<td></td>
<td></td>
</tr>
<tr>
<td>St17</td>
<td>27.6</td>
<td>27.4</td>
<td>33.5</td>
<td>33.5</td>
<td>48.1</td>
<td>48.1</td>
</tr>
<tr>
<td>St18</td>
<td>28.8</td>
<td>28.3</td>
<td>35.9</td>
<td>35.8</td>
<td>48.4</td>
<td>48.4</td>
</tr>
<tr>
<td>St20</td>
<td>21.0</td>
<td>21.0</td>
<td>35.9</td>
<td>35.8</td>
<td>48.4</td>
<td>48.4</td>
</tr>
<tr>
<td>St22</td>
<td>24.9</td>
<td>24.7</td>
<td>36.2</td>
<td>36.2</td>
<td>39.5</td>
<td>39.5</td>
</tr>
<tr>
<td>St41</td>
<td>26.8</td>
<td>27.4</td>
<td>34.3</td>
<td>34.7</td>
<td>46.5</td>
<td>47.0</td>
</tr>
<tr>
<td>St42</td>
<td>27.4</td>
<td>27.8</td>
<td>35.1</td>
<td>35.1</td>
<td>47.5</td>
<td>47.4</td>
</tr>
<tr>
<td>St43</td>
<td>27.2</td>
<td>27.0</td>
<td>35.2</td>
<td>35.2</td>
<td>47.8</td>
<td>47.7</td>
</tr>
<tr>
<td>St45</td>
<td>27.0</td>
<td>26.8</td>
<td>35.4</td>
<td>35.2</td>
<td>47.8</td>
<td>47.8</td>
</tr>
<tr>
<td>St46</td>
<td>27.3</td>
<td>27.3</td>
<td>35.5</td>
<td>35.5</td>
<td>48.0</td>
<td>48.0</td>
</tr>
<tr>
<td>St49</td>
<td>27.6</td>
<td>27.0</td>
<td>35.9</td>
<td>35.9</td>
<td>48.4</td>
<td>48.5</td>
</tr>
</tbody>
</table>

large). The mAb was evenly distributed between stations only in the case of large individuals (F=1.49, p=0.22). As regards the distribution of mAb of young individuals and the total population, it showed significant variation (F=4.63, p=0.02 and F=2.7, p=0.03 respectively) (Fig. 2a-c).

**Biometric variations of the mussel beds**

**Structure of the mussel beds:** The distribution of the size classes of the mussel beds in the sampling sites is not even, as depicted in Figure 3. The variations are present across all 3 main size classes (derived from the grouping of various size classes): Class I = individuals of 20.0 to 29.9mm, Class II = individuals of 30.0 to 49.9mm and Class III = individuals larger than or equal to 50mm. More specifically, Class I participates to a larger degree in St17 (68%) and St22 (62%), whereas Class II in St20, 41, 42, 43, 45, 46 and 49 (47-82%). The absence of large individuals (Class III) from almost all stations is notable, but it may be attributed mainly to the intensified fishing effort.

The uneven distribution of size classes is also indicated by the comparison of the mean length (mL) of the mussels (F=65.125, p=0.0001). Even distribution of size classes is observed only at stations St18 vs st42, St18 vs St43, St43 vs St45, St17 vs St22 and St49 vs St20. The interpretation of such results is not simple, especially in the case of the Thermoikos Gulf, where dealing with managerial problems is rather complicated.

The analysis of the biometric data (according to the ANOSIM test and the Stress value - R=0.1 and S.V. = 0.054, respectively) revealed that the results were appropriate and significant. From Figure 4 it can be seen that the mussel populations studied are initially divided into two groups, namely, A and B (level of similarity 45%). Group A can be further subdivided into two subgroups, AI with stations 49 and 43 and AII with station 41. Group B subdivides into three subgroups; BI with stations 22 and 17, BII with station 42 and BIII with stations 20, 46, 45 and 18). Similar results are obtained also by multi-dimensional MDS analysis (Figure 5).
FIGURE 3
Frequency distribution of size classes (based on the mL) for mussels populations of 10 stations in Thermaikos Gulf.
The area of Thermaikos Gulf can be subdivided into two sub-areas. The first one contains the West coasts of the gulf (stations 41, 43 and 49) and the second one, the Northeastern ones (stations 17, 18, 20 and 22). This division of the Gulf contains some irregularities as it groups stations 42, 45 and 46 (which are stations of the Western coasts) with the stations of the eastern coasts.

**DISCUSSION**

The most important factors that affect the growth and conservation of the natural stocks of mussels in an area are the annual fluctuations of temperature, salinity, dissolved oxygen, primary production (phytoplankton, chlorophyll a) and also the (qualitative and quantitative) com-
position of nutrients [27, 28]. The lowest temperature values in Thermaikos gulf are recorded in winter (11±2 - 13±2°C) and the highest in summer (26±2°C) [16, 17, 26, 29-31]. The fluctuation of salinity values ranges around 28.5-34‰, while that of dissolved oxygen (with the exception of extreme conditions of stillness) ranges around 6 ± 1 ppm [26, 30, 32]. According to Patocheas and Stamou[1] the species richness and population density of benthos in Thermaikos gulf is reduced from winter to summer, and this reduction seemed to be correlated with oxygen depletion. The composition of nutrients (Nitrate, Nitrite, Ammonium, Phosphates, Silicates) and the abundance of phytoplankton and chlorophyll a ( > 1µm m²) indicate that the marine ecosystem of the gulf is eutrophic [16, 18, 19, 31, 32]. The comparison of these data with other from various Mediterranean regions (Italy, France, Adriatic Sea, NW Africa) revealed no significant differentiations [4, 7, 8, 27, 28, 34-41]. The only place that showed similar conditions with Thermaikos Gulf was the mar Grande of Taranto (Ionian Sea) [8]. On the other hand, the abiotic environment of the Thermaikos gulf is entirely different from that of the Black Sea [42].

The measurements of the most important abiotic factors in this study produced similar results with those previously recorded in the relevant literature. A review of the literature reveals that the region of Thermaikos Gulf constitutes an ideal environment for the growth of *Mytilus galloprovincialis*.

The dispersion of the natural stocks of *Mytilus galloprovincialis* is related to the availability of hard substratum in the biotopes studied in the gulf. Even though the ten studied populations are generally similar, some differentiations were observed regarding their abundance, especially of the juveniles in St42 (Makrygialos). The limited size of the hard substratum is the reason for high-congregated concentrations of the juveniles. It is also possible that the geomorphology of an area, along with the circulation of the water masses, favours such concentrations of juveniles [43].

A review of the global literature revealed that, despite the abundance of the available information on the *Mytilus galloprovincialis* populations, this kind of information is not consistent, when quantity is considered. According to Seed and Suchanek [6] the communities that host (any species of) mussels, show the highest productivity among the marine ecosystems. The mean density of the musselbeds worldwide ranges from 459 to 11,098 ind./m² [6]. However, Thompson [44] noted that *Mytilus edulis* in Holland may form dense populations of 36,000 – 158,000 ind./m² (probably including juveniles and adults). The values of mussels' density in the selected areas of Thermaikos Gulf lie inside the common range observed in the Mediterranean Sea (Tab. 3).

The same applies for the size of the mussels (measured in length), as could be judged from a review of the relevant literature, concerning the Mediterranean Sea. Della Ricca and Gnes [8] reported that the mussel length in Taranto populations reached 64mm. Hrs-Brenko [45] reported mussel lengths of 32-102 mm in the Adriatic coasts. Apart from these studies, Hrs-Brenko [46] recorded mussel lengths of 59mm, for East Adriatic mussels of one year of age. Bellan-Santini [46] and Tsuchiya and Bellan-Santini [21] recorded lengths of 65mm in the coasts of Marseille, Abada-Boudjema and Daouvin [41] reported that because of the human activities in Algerian coasts, no mussel larger than 49mm was found. They also suggested that the lifespan of the Algerian mussels is limited, since it did not exceed 11-28 months in their study.

### TABLE 3 - Abundance of natural mussel populations (*Mytilus galloprovincialis*) in several localities in the Mediterranean Sea (* probably juvenile and adults).

<table>
<thead>
<tr>
<th>REFERENCE</th>
<th>LOCALITY</th>
<th>SEASONS</th>
<th>Indiv/m²</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abada-Boujema and Daouvin [41]</td>
<td>ALGERIAN COAST</td>
<td>summer 1987</td>
<td>5.000</td>
</tr>
<tr>
<td></td>
<td></td>
<td>summer 1988</td>
<td>12.500</td>
</tr>
<tr>
<td></td>
<td></td>
<td>summer 1994</td>
<td>10.950</td>
</tr>
<tr>
<td></td>
<td></td>
<td>winter 1995</td>
<td>3.118</td>
</tr>
<tr>
<td>Boubezari and Abada-Boudjema [40]</td>
<td>ALGERIAN COAST</td>
<td>summer 1995</td>
<td>5.810</td>
</tr>
<tr>
<td></td>
<td></td>
<td>region A</td>
<td>2.982</td>
</tr>
<tr>
<td></td>
<td></td>
<td>region B</td>
<td>1.736</td>
</tr>
<tr>
<td>Bellan-Santini [47]</td>
<td>FRANCE COAST</td>
<td>region C</td>
<td>1.332</td>
</tr>
<tr>
<td></td>
<td></td>
<td>winter</td>
<td>7.935</td>
</tr>
<tr>
<td>Kocatas [48]</td>
<td>AEGEAN COSTS (IZMIR)</td>
<td>summer</td>
<td>17.927</td>
</tr>
<tr>
<td></td>
<td></td>
<td>winter</td>
<td>5.400</td>
</tr>
<tr>
<td>Arizzone et al. [7]</td>
<td>TYRRHENIAN COAST (ITALY)</td>
<td>summer</td>
<td>13.625</td>
</tr>
<tr>
<td></td>
<td></td>
<td>autumn 1981</td>
<td>12.624</td>
</tr>
<tr>
<td>Tursi et al. [49]</td>
<td>TARANTO (ITALY)</td>
<td>winter 1981</td>
<td>12.450</td>
</tr>
<tr>
<td>Topaloglou and Kihara [50]</td>
<td>FRANCE COAST</td>
<td>winter 1980</td>
<td>7.000</td>
</tr>
<tr>
<td>Tsuchiya and Bellan-Santini [21]</td>
<td>high density</td>
<td>max annual</td>
<td>11.536</td>
</tr>
<tr>
<td>Present study</td>
<td>low density</td>
<td>mean annual</td>
<td>850</td>
</tr>
<tr>
<td></td>
<td></td>
<td>mean annual</td>
<td>37.000*</td>
</tr>
<tr>
<td></td>
<td></td>
<td>autumn 2001</td>
<td>18.200*</td>
</tr>
<tr>
<td></td>
<td></td>
<td>autumn 2001</td>
<td>2.300*</td>
</tr>
</tbody>
</table>
The (cultured) mussels in Thermaikos Gulf, according to Kravva [12], reach a length of 70mm within 12 months, probably as a consequence of eutrophication in the area. However, the presence of the commercially exploitable individuals (mL>5cm) is quite limited in the studied stations. Their presence is relatively high only in stations St41 and St42 (55.3 and 16%, respectively). The comparison of the populations’ size classes in this study with those observed by Le Breton and Chintiroglou [13] showed only small variations. More specifically, the main size classes reported by these researchers are 15-30mm for summer and 35-55mm for their winter populations. The small variation of values between the two studies should be attributed to the season in which sampling took place, but also to rigorous police protection of the Northeastern areas of the Bay of Thessaloniki (as areas of tourist and recreational value), which is high in comparison to the rest of the Gulf. Nevertheless, natural mussel populations in other areas of the N. Aegean Sea have been reported to contain large individuals of 33-52mm size range [11]. Similar values are also reported for the south shores of Italy and France by various researchers [3, 8, 47].

As regards the structure of the natural populations of Mytilus galloprovincialis in Thermaikos Gulf, there are significant differentiations. One possible interpretation of this fact is that the increased population densities of the mussels of the Northeastern coasts are supplying with spat the entire North, Northwest and Southwest coasts of the Gulf, which could benefit the growth of mussel cultures in the area. The larvae could be dispersed in this way by utilizing the Gulf’s surface current movements. Local conditions, such as topography and resulting hydro dynamism variations, but also different succession stages of the artificial hard substrata at the fishing ports of stations 41, 43 and 49, differentiate these areas from those of the Northeastern coasts. The interpretation of these results appears to be difficult, mainly due to the various management problems of Thermaikos Gulf [15]. This complexity may be the result of four combined factors. The first is pollution: industrial and domestic sewage effluents enter the Gulf from the North [26, 51], while substantial pollution problems arise from the effluents of the rivers entering the Gulf in the Northwest [12]. The second is the high fishing effort that is put on the beds, without any managerial plan or project, something that is obvious and by the study of the mussel beds’ abundance (see corresponding paragraph). An example of the results of such activities can be seen at ST18, 43, 45, 46 and 49, where the fishing activity clearly shows a seasonality (pers. obs. Dr Chintiroglou). Third is directly related to the morphology of the bay and the availability of hard substrata. Human interventions in the last years, in the form of construction of new fishing ports (of small and medium sizes), have introduced structures that can locally influence the hydrodynamism of areas of the Gulf [52]. Such a case is ST17, where a small fishing port has been built in the last five years. And, lastly, the presence of the natural marine predators of mussels. Three kinds of Mytilus galloprovincialis predators have been detected so far in Thermaikos Gulf, two gastropods, Hexaplexa trunculus (Linnaeus) and Stramonita haemastoma (Linnaeus) (=Thais haemastoma Linnaeus) and one decapod, Pachygrapsus marmoratus (Fabricius). According to Seed and Suchanek [6], the representatives of these genera are well-known predators of Mytilus species all over the world. They also note that the gastropods have never been reported as predators that lead to mass extinctions of Mytilus populations. As regards the Thermaikos Gulf, the mussels are largely consumed by H. trunculus [13, 14]. Densities of 500 ind./m² for H. trunculus and 1,100 ind./m² for P. marmoratus were observed (unpublished data). Even though the presence of S. haemastoma in Thermaikos Gulf has been previously reported [53], this is the first time it was found in great densities of 15 ind./m² in the NE coasts.

CONCLUSIONS

The sea region of Thermaikos Gulf constitutes an ideal environment for the growth of natural populations of Mytilus galloprovincialis, as favourable as those of Italy and southern France. The natural stock of mussels, however, is not consistent at all sites, as regards the biometry. There are certain biotic and abiotic factors, and also the human influence, which affect the structure of the stock. Therefore, the rational management of the natural resources of Thermaikos Gulf is a top priority in order to secure the viability of the gulf.

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