



## Management paradox of groupers (*Epinephelinae*) fishing in the Gökova Bay (Eastern Mediterranean), Turkey

Vahdet Ünal <sup>1\*</sup>, Mustafa Erdem <sup>2</sup>, Huriye Göncüoğlu <sup>1</sup>, Harun Güçlüsoy <sup>3</sup> and Zafer Tosunoğlu <sup>1</sup>

<sup>1</sup>Ege University, Faculty of Fisheries, 35100, Bornova, İzmir, Turkey. <sup>2</sup>Muğla University, Faculty of Fisheries, 48000, Kötekli, Muğla, Turkey. <sup>3</sup>Dokuz Eylül University, Institute of Marine Sciences and Technology, 35340, İnciraltı, İzmir, Turkey.

\*e-mail: vahdetunal@gmail.com, huriye\_gng@yahoo.com, zafer.tosunoglu@ege.edu.tr, merdem@mugla.edu.tr, harun.guclusoy@deu.edu.tr

Received 9 June 2009, accepted 8 October 2009.

### Abstract

The present study attempts to find out the paradox in management of grouper fishing in southern Aegean Sea, Turkey. The study also proposes some suggestions for a more rational and more effective management of this species. Material of the study is composed of records of fishing cooperatives in the area, interview with the cooperative managers, annual grouper length values and catch-effort data. Throughout the season, 2411 fishing operations have been carried, 383 of which have been focused on especially groupers. The total catch has been recorded as 1448 kg, with a CPUE value of 3.78 kg per vessel. The study also reveals that the ratio of groupers caught below legally allowed length is 13.3%, however, considering outputs of the studies made on the biology of the species, it has also been observed that 85% of the sampled groupers in Gökova bay are prematurely caught before they reach the sexual maturity required for guaranteed sustainability, and thus the species is endangered. Hence, it is very essential to determine the reproductive cycle of groupers, which are the most important species in the fishery of Gökova Bay. However, species selectivity is impossible with the currently used gears. Therefore it would be more rational and effective to determine the reproduction areas of the related species and declare these areas "No Take Zones" which is going to affect positively not only the species but also whole ecosystem they live in.

**Key words:** Artisanal fishery, groupers, *Epinephelus* spp., fisheries management, Aegean Sea.

### Introduction

According to the 2006 records, total catch of groupers (*Epinephelus* spp.) has been reported as 481 tons with a value of 9.329.000 TRL. The contribution of these species to the overall catch is 0.11% and 0.67% of the total catch value. Of the total catch 30% is obtained from the Aegean coasts <sup>19</sup>. Despite its superficial impact on the Turkish fisheries in general, fishing of groupers is essential throughout Gökova Bay in Eastern Mediterranean, especially for traditional fishers. Most common grouper species caught in this bay are white grouper (*Epinephelus aeneus*), goldblotch grouper (*E. costae*) and dusky grouper (*E. marginatus*). However, for the same bay, through one-year sampling period, only two dusky groupers (*E. marginatus*) were observed <sup>2</sup>. One third of the total income of fishery cooperatives in Gökova bay comes from the catch of groupers, and in contrast to Turkey in general, income of most of the fishers depend on groupers in this area. High economical value of groupers has caused an increase in the fishing pressure and even the rise of illegal fishing and black market. Revision and improvement in the management of these species have become a necessity due to the current state of illegal fishing of groupers <sup>20</sup>, ambiguous deaths every year between August and October <sup>8</sup>, decreasing fishing income in recent years <sup>21</sup>, decrease in length <sup>2</sup>, decrease in catch per unit effort (CPUE) quantities, struggle between fishers and the insufficient measures taken by traditional managements against all of these negativities.

There is no local-level or species-based fisheries management carried in Turkey, and fishing activities are regulated according to

two notifications on commercial and amateur fishing, both published bi-annually.

Fisheries management has been established on an input-based strategy as in the entire Mediterranean region and covers some legal restrictions and prohibitions in terms of numbers of vessels, fishing gears, species, fishing areas and fishing periods. The notification that regulates commercial fishing activities also contains the regulations on the management of the fishing of groupers around Gökova bay. These regulations and prohibitions are traditional preventive measures on fish size, hook size, closed area, closed season and fishing gears <sup>3</sup>.

Legal fishing size of groupers is 30 cm. Longline fishing of groupers between 15<sup>th</sup> June and 31<sup>st</sup> July is prohibited using hooks smaller than No.9, i.e. only bigger size hooks are allowed in this season. Catching these species with speargun, fish trap, fyke nets etc. are strictly prohibited. It is prohibited also to use longline hooks smaller than No.14 in size.

There is no closed area for longline and gillnet; and fishing with these gears is allowed all over Gökova bay. However, fishing is prohibited throughout the year within 500 m of perimeter from harbour and creek mouths in any fashion inside harbors and creek mouths. Regulation on closed areas also covers trawlers and purse seiners.

There is no closed season; longline and gillnet fishing is allowed throughout the year. It is prohibited to use speargun, traps and fyke-net in grouper fishing. Any trawling activity is prohibited in the areas that are in the east of the line connecting Mersincik

Point to Gerence Point and in the east of the line connecting Oren Point (37°01'055"N – 27°56'751"E) to Teke Point (36°54'410"N – 28°00'921"E). Any purse seine fishing is prohibited in the area that is in the east of the line connecting Akbuk Point (37°00'971"N – 28°06'918"E) to Kargılı Point (36°56'2501"N – 28°05'822"E).

None of these measures, competency of some of which are also questionable, are sufficient to guarantee the sustainable fishing of groupers since there are no studies done in Gökova Bay or other coasts of Turkey that can be set as a basis for these regulations. Scarce national studies<sup>2,7,13,14</sup> such as gonad histology, pathology, fishing gears and length-weight relationships of groupers provide limited support on the sustainable management of these species. There are indeed studies on Gökova bay on physical marine water characteristics<sup>9</sup>, seaweeds, marine phanerogams<sup>10</sup>, biodiversity<sup>18</sup> and illegal fishing activities<sup>20</sup>, however, these studies are far from establishing a source for regulations on grouper fishing either. Therefore the studies made in other countries of the Mediterranean<sup>1,4-6,11,15,16,22</sup> could be considered. However, regulations in the aforementioned notification are also incompatible with these studies. Above contradictions pertaining to management of grouper fishing has called a necessity to revisit the subject.

The purpose of this study was to convey the problems and contradictions on the management of traditional grouper fishing practiced in Gökova Bay, to query the catch sustainability of the species in the area with traditional methods in the light of the studies made in the past and present. The study also proposes that grouper management solutions can be applied for other areas that have similar characteristics with the bay.

### Material and Methods

The study was carried between the years 2006 and 2007 in Gökova Bay in Eastern Mediterranean region to the south of Aegean Sea (Fig. 1). In Gökova Bay, one of Turkey's specially protected areas (SPA), fishing is one of the most noteworthy economical activities. Dominant fishing activity in the area is the small-scale fishery using traditional gears such as longline and gillnets, and fishing is generally done with 8 m vessels. Majority (80%) of the fishers are organized under three fishery cooperatives, one of which exists

nominally and are unable to offer any member services yet.

We used several types of data to review management of groupers in the study area. First, catch and value records of active cooperatives were gathered. Second, we used survey data collected by interviews in the field. During the study period from January to September 2007, face-to-face interviews of heads of fishery cooperatives were conducted. Third, we used catch-effort data as well as length-based data related to the groupers in order to assess fishing pressure on the species. Same data were also used to determine the catch ratio below 80 cm, which is necessary for the sustainability of the species, and catch ratio of 30 cm, which is the minimum legal landing size of the species. Catch Per Unit Effort (CPUE) of longline for groupers throughout the season has been calculated with below formula.

$$CPUE = \left( \frac{\sum Catch(kg)}{\sum Operation} \right)$$

### Results

In Gökova Bay SPA, there are about 100 active traditional vessels. Twentyfive percent of these vessels lay a total of 50 km long thick nets to catch primarily groupers, common dentex (*Dentex dentex*), amberjack (*Seriola dumerili*) and ping dentex (*Dentex gibbosus*) half of the year when fishing is not prohibited. In the four-month season between June and September, which also includes the 15<sup>th</sup> June-1<sup>st</sup> August period when grouper fishing with thick nets is prohibited, however, almost 50% of all the vessels catch groupers with thick longlines. There are two different forms of grouper nets, as gill nets and trammel nets. Gill nets have a mesh size of 140-200 mm with twine thickness of 210 d/25-30 no, made of polyamid material. Trammel nets have an inner net of 110-140 mm mesh size, twine thickness of 210 d/12-18 no, and an outer net with 400 mm of mesh size and trammel thickness of 210 d/9-12 no. Thick longlines generally have 300 hooks per basket with No.7 to 9 in size. These gears have Ø 0.80 mm main line and Ø 0.70 mm snoods (branchline). Grouper vessels have an average length of 8.1 m, average age of 11.6 years and average engine power of 25 HP. Full-time fishing vessels have a minimum and maximum length of 7.2 and 9.4 m, respectively. All grouper catches in Gökova Bay are marketed locally. Table 1 shows the amount of fish marketed by the fishery cooperatives in the area and their values. Groupers constitute 12.2% of the total catch, and their catch value is 32.3% of the total value marketed.

Grouper species have the highest catch value in Gökova Bay. For 218 individuals sampled between the years 2006 and 2007, average length and standard deviation has been 50.3±21.2 cm (Min-Max.: 18.5 - 99 cm). Groupers have been found to gather more in 40 and 80 cm length ranges. Randomly sampled grouper species show that 13.3% of these species are being caught below 30 cm, which is the legal length allowed for this fish (Fig. 2).

Although groupers are caught with longlines and gill nets in Gökova Bay, CPUE calculations have been made based on solely the longline vessels fishing in the area.

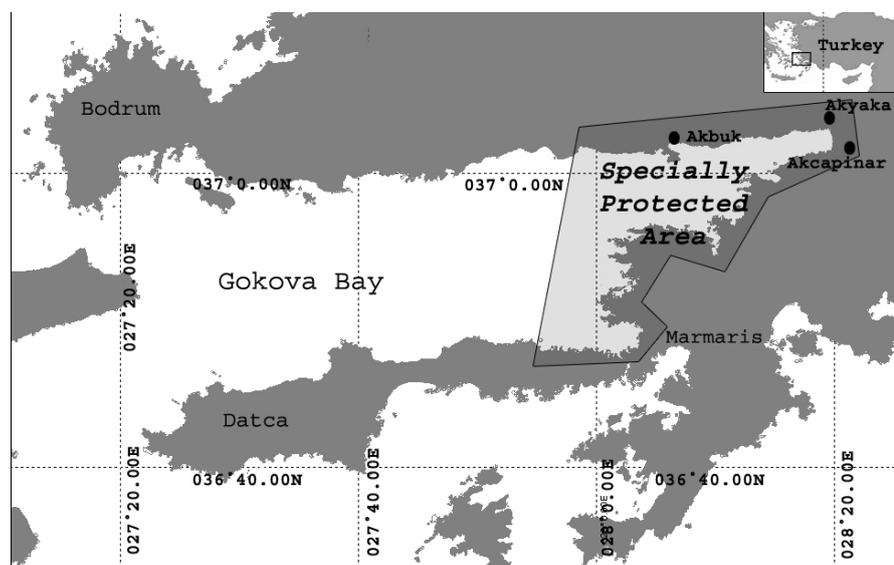


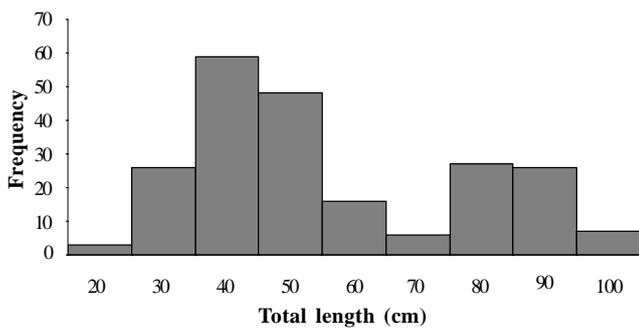
Figure 1. Map of study area, Gökova Bay (Turkey).

**Table 1.** Landing volume and values in Gökova Bay, 2006.

Common name	Latin name	Landing volume (kg)	Landing volume (%)	Landing value (TRL)*	Landing value (%)
Goldblotch grouper	<i>Epinephelus costae</i>	170	1	3,729	1
White grouper	<i>Epinephelus aeneus</i>	2905	11	100,782	31
Dusky grouper	<i>Epinephelus marginatus</i>	56	0.2	1,038	0.3
Caramote prawn	<i>Penaeus kerathurus</i>	1106	4	33,516	10
Common octopus	<i>Octopus vulgaris</i>	3842	15	27,762	9
Common pandora	<i>Pagellus erythrinus</i>	1549	6	24,778	8
Common sole	<i>Solea solea</i>	824	3	24,643	8
Sea bream	<i>Sparus aurata</i>	938	4	23,295	7
Two-banded sea bream	<i>Diplodus vulgaris</i>	792	3	10,113	3
Striped mullet	<i>Mugil spp.</i>	900	3	10,499	3
Dentex	<i>Dentex dentex</i>	148	1	5,036	2
Goldband goatfish	<i>Upeneus molluccensis</i>	761	3	7,538	2
European hake	<i>Merluccius merluccius</i>	1642	6	5,711	2
Barracuda	<i>Sphyraena sp.</i>	1517	6	5,084	2
Other species		8901	33.5	40,636	12
<b>Total</b>		<b>26051</b>	<b>100</b>	<b>324,160</b>	<b>100</b>

\*At the time of the readings 1 TRL equaled 0.5 EUR.

Throughout the season, 2411 fishing operations have been carried, however, only 383 of these operations were for groupers. Total amount of groupers caught have been found to be 1448 kg, with 3.78 kg CPUE per vessel.



**Figure 2.** Length frequency of the groupers landed in Gökova Bay, 2006.

### Discussion

Groupers have the most economic value in Gökova Bay and constitute 12.2% of the total catch of the fishery cooperatives, with a catch value of 32.3%. They are also the main catch of traditional fishery (especially longline). Despite the importance they bear, the sustainability of grouper fishing is in danger and the stocks are in the verge of collapsing.

The scientific grounds and criteria for the 30 cm length limit for which groupers are allowed to be caught in Turkish coasts are unknown, since there is no study in Turkish waters about the lengths at which groupers are expected to reach reproductive maturity, there is no satisfactory study to base regulations for fishing seasons and gears on. However, the findings of researches conducted in Mediterranean since 1970's could be considered. Brusle<sup>5</sup> reviewed the biology of *E. aeneus*, and several authors<sup>1, 4, 6, 11, 22</sup> described the reproductive cycle of the species in the Mediterranean. According to the aforementioned studies, females of *E. aeneus* are mature at 5 to 7 years (1.5-3 kg, 50-60 cm total length) and sex change occurs at 10 to 13 years (6 to 15 kg, 80 to 110 cm total length). Therefore, for instance, minimum legal catch size of female and male *E. aeneus* should be at least 50-60 cm and 80 cm, respectively. It is very essential to determine the reproductive cycle of groupers. However, species selectivity is

impossible with the currently used gears. Therefore, it would be more rational and effective to determine the reproduction areas of the related species and declare these areas "No Take Zones".

Among the species caught between 2006 and 2007, random samples (n = 218) show that 88% of these species are caught above 30 cm, which is the minimum legal size allowed, and that the catching of the species is at least done legally. This would prove that an improvement has been achieved in the lengths and considered positive when compared to the findings of Akyol *et al.*<sup>2</sup>. Nevertheless, an evaluation of studies based on the biology of the species<sup>2, 4-6, 11, 22</sup> reveals that 85% of groupers in Gökova Bay are caught before they reach the sexual maturity that will guarantee the sustainability of the species (sexual maturity size for male is 80-90 cm) and thus the grouper species are in danger of being extinct. As a matter of fact, *Epinephelus* is in danger through the entire Mediterranean. According to Fricke *et al.*<sup>12</sup> and Morris *et al.*<sup>17</sup>. *Epinephelus* are very sensitive to human activities, show significantly decline as well as high priority for conservation action. In addition, they are indeed listed under the endangered species by International Union for Conservation of Nature and Natural Resources (IUCN).

Illegal fishing with spearfishing is practiced by professional divers by the help of a light source in night times. Cooperative authorities reported that 2.5 tons of groupers are caught this way in one season. It is learned through the reports of cooperative authorities that the amount of illegally caught groupers is almost equal or larger than the cooperative's annual catch of these species<sup>20</sup> (Görgün C. pers. Comm.). Control and inspection onboard or on the shore are in practice. If judged to be in infringement of fishing laws, individuals are subject to penalties such as the seizing of illegal fishing gears, loss of catch or payment of fines. These penalties are enforceable by different authorities. However, current control and inspection services are incapable of solving the problem of illegal fishing of groupers. Therefore, land-based combating should be preferred as a more effective and low-cost solution. Preventing the catches obtained through illegal fishing from being sold in restaurants or by middlemen could stop spearfishing and illegal marketing of groupers. Although there are deterrent laws in action, effective results are far from being obtained due to lack of enforcement.

## Conclusions

National scientific studies on grouper species are insufficient to prepare a sustainable management of these species. There are also no studies on sexual maturity length, reproduction area, migration, stock availability or catch power. Without such information, any precautions to accomplish sustainable fishing of the species shall be also insufficient and pointless. Therefore, the traditional preventive tools and measures offered in the notification that regulates commercial fishing are paradoxical. In addition to the aforementioned basic studies, traditional thick longline fishing, which is a more selective gear in terms of grouper fishing, should be encouraged and net fishing should be limited. The negative impact of spearfishing with light sources on the local fishers and marine ecosystem should also be stopped through strict land-based combat. To prevent all sorts of illegal fishing, awareness among shareholders and public should be settled through educational studies, and the combat should be carried out on the land as well as in the sea. Periodical inspection of restaurants and middlemen could be the most effective and cheapest way of solving this problem. In addition, pollution of lost or abandoned gears that threatens the marine ecosystem in Gökova Bay and the resulting ghost fishing are harming the habitat. Therefore, the sea floor should be cleaned from these lost gears through retrievals once every 3-5 years. Most importantly, protected areas in the form of No Take Zones should be established in Gökova Bay in order to provide refuge for groupers and increase grouper numbers (as in Medes Island Marine Reserve near L'Estartit, Spain). Consideration of these proposals may yield some results in the short term, but a permanent solution can only be reached via conducting a new and local fishery management approach. This approach should include all fishers and shareholders in decision-making, involve the entire ecosystem instead of a particular species and be constructed in a way that guarantees control and enforcement.

## References

- <sup>1</sup>Aboussovan, A. 1972. Oeufs et larves de Téléostéens de l'Ouest Africain. XI. Larves serraniformes. Bull. Inst. Fr. Afr. Noire, Séri A 4:485-502.
- <sup>2</sup>Akyol, O., Kinacıgil, T. and Şevik, R. 2007. Longline fishery and length-weight relationships for selected fish species in Gökova Bay (Aegean Sea). International Journal of Natural and Engineering Sciences 1:1-4.
- <sup>3</sup>Anonymous 2008. Denizlerde ve iç sularda amatör (sportif) amaçlı su ürünleri avcılığını düzenleyen 2/2 numaralı tebliğ (in Turkish). Tebliğ no: 2008/49. T.C. TKB, KKG, Ankara, 112 p.
- <sup>4</sup>Bouain, A. and Siau, Y. 1983. Observation on the female reproductive cycle and fecundity of three species of groupers (*Epinephelus*) from the Southeast Tunisian sea shores. Mar. Biol. 73:211-220.
- <sup>5</sup>Brusle, J. 1985. Exposé synoptique des données bibliographiques sur les merous *Epinephelus aeneus* (Geoffroy Saint Hilaire, 1809) et *E. guaza* (Linnaeus, 1758) de l'Océan Atlantique et de la Méditerranée, Rome, FAO.
- <sup>6</sup>Brusle, J. and Brusle, S. 1975. Ovarian and testicular intersexuality in two protogynous Mediterranean groupers, *Epinephelus aeneus* and *Epinephelus guaza*. Intersexuality in the Animal Kingdom. Springer, Berlin, pp. 222-227.
- <sup>7</sup>Cengizler, İ., Gökçe, M.A., Pasco, L., Laurencin, B., Şahan, A., Ozak, A. and Genç, E. 2001. Doğu Akdeniz'de Süregelen Lagos (*Epinephelus aeneus*)'un Ölüm Nedenleri ve Bazı Biyo-Ekolojik Özelliklerinin İncelenmesi. TUBITAK Proje Raporu, Proje No. TARP-20042.
- <sup>8</sup>Cengizler, İ., Gökçe, M.A., Şahan, A., Ozak, A.A. and Genç, E. 2003. A research on the death of white grouper (*Epinephelus aeneus*) occurring along the Turkish coast of eastern Mediterranean. A Regional Workshop on Fisheries, Aquaculture and Environment. Trisheen University-Lattakia, 20-30 April 2003, Syria.
- <sup>9</sup>Cihangir, B., Benli, H.A., Cirik, S., Ünluoğlu, A. and Sayın, E. 1998. Gökova Körfezi'nin Biyo-ekolojik Özellikleri. Bodrum Yarımadası Çevre Sorunları Sempozyumu, pp. 647-662.
- <sup>10</sup>Cirik, S., Akçalı, B. and Bilecik, N. 2001. Gökova Körfezi (Ege Denizi) deniz bitkileri. Piri Reis Bilim Serisi No 4, DEÜ-DBTE, Yayın No: 098888.6000/DK.01.001.260. 295 p.
- <sup>11</sup>Ezzat, A.A., Wadie, W.F., Mikhail, M.Y. and Hashem, M.T. 1981. Age and growth of *Epinephelus aeneus* in the Egyptian Mediterranean waters. Bull. Inst. Oceanogr. Fish. Cairo 7:395-406.
- <sup>12</sup>Fricke, R., Bilecenoglu, M. and Sarı, H.M. 2007. Annotated checklist of fish and lamprey species of Turkey, including a Red List of threatened and declining species. Stuttgarter Beitrage zur Naturkunde, Serie A (Biologie) 706:1-169.
- <sup>13</sup>Genç, E., Genç, M.A., Genç, E., Cengizler, İ. and Can, M.F. 2005. Seasonal variation and pathology associated with heminthes infecting two serranids (Teleostei) of Iskenderun Bay (Northeast Mediterranean Sea), Turkey. Turkish Journal of Fisheries and Aquatic Science 5:29-33.
- <sup>14</sup>Gökçe, M.A., Cengizler, İ. and Özak, A.A. 2003. İskenderun Körfezi'nden yakalanan Lagos (*Epinephelus aeneus*)'larda üreme modeli ve gonat histolojisi. Turk. J. Vet. Anim. Sci. 27:957-964.
- <sup>15</sup>Hassin, S., de Monbrison, D., Hanin, Y., Elizur, A., Zohar, Y. and Popper, D.M. 1997. Domestication of the white grouper, *Epinephelus aeneus*. I. Growth and reproduction. Aquaculture 156:305-316.
- <sup>16</sup>Heemstra, P.C. and Randall, J.E. 1993. FAO Species Catalogue. Vol. 16. Groupers of the world (Family Serranidae, Subfamily Epinephelinae). An Annotated and Illustrated Catalogue of the Grouper, Rockcod, Hind, Coral Grouper and Lyretail Species Known to Date. FAO Fisheries Synopsis, No. 125, Rome, 82 p.
- <sup>17</sup>Morris, A.V., Roberts, C.M. and Hawkins, J.P. 2000. The threatened status of groupers (Epinephelinae). Biodiversity and Conservation, pp. 919-942.
- <sup>18</sup>Okuş, E., Yüksek, A., Yokeş, B., Yılmaz, İ.N., Aslan-Yılmaz, A., Karhan, S.U., Demirel, N., Demir, V., Zeki, S., Tas, S., Sur, H.İ., Altıok, H., Müftüoğlu, A.E., Balkıs, N., Aksu, A., Doğan, E. and Gazioğlu, C. 2006. Gökova Özel Çevre Koruma Bölgesinin Kıyı ve Deniz Alanlarının Biyolojik Çeşitliliğinin Tespiti Projesi Final Raporu, (Sunulan Kuruluş, T.C. Çevre ve Orman Bakanlığı Özel Çevre Koruma Kurumu Başkanlığı).
- <sup>19</sup>TUIK 2007. Fishery Statistics 2006. Prime Ministry Republic of Turkey, Turkish Statistical Institute, 62 p.
- <sup>20</sup>Ünal, V. and Erdem, V. 2009. Combating illegal fishing in Gökova Bay (Aegean Sea), Turkey. Çiçek, B.A. and Öniş, H. (eds). Proceedings of the 3<sup>rd</sup> International Symposium on Underwater Research, 19-21 March, 2009, Eastern Mediterranean University, Famagusta, Turkish Republic of Northern Cyprus, 125 p.
- <sup>21</sup>Ünal, V., Güçlusoy, H. and Franquesa, R. 2009. A comparative study of success and failure of fishery cooperatives in the Aegean, Turkey. Journal of Applied Ichthyology 25:394-400.
- <sup>22</sup>Vadiya, V. 1984. Reproductive system of *Epinephelus aeneus* and *Epinephelus alexandrinus* (Serranidae) from the southeastern Mediterranean. J. Ichthyol. 24:77-81.