

## A review: Adriatic groupers - Status of natural populations and breeding perspectives

Branko GLAMUZINA and Boško SKARAMUCA

*Institute of Oceanography and Fisheries, Split, Laboratory for Ecology of Shellfish and Fish Rearing, P.O.Box 83, 20000 Dubrovnik, Croatia*  
*E-mail: branko@labdu.izor.hr*

*Short review about status of natural populations of four grouper species that live in the Adriatic is presented. All groupers belong to genus Epinephelus. There are: dusky grouper, Epinephelus marginatus, white grouper, Epinephelus aeneus, goldblotch grouper, Epinephelus costae and dog-tooth grouper, Epinephelus caninus.*

*The main biological characteristics, which influence the Adriatic groupers populations, are tropical origin and protogynic hermaphroditisms. As a tropical species living in the Adriatic on the edge of their distribution, they do not exhibit many of their characteristics, such as good growth rate and spawning during few months period. Protogynic hermaphroditism as a mode of reproduction is one of problems in our conditions, because elimination of male from population could influence whole spawning.*

*Among the four species only dusky grouper is of interest for Adriatic fishery. Mainly, because other three species are relatively rare. The yearly catch of dusky grouper in the Adriatic is estimated around 30 tons.*

*Presently, the three species: dusky, goldblotch and white grouper are objects of research on introduction in aquaculture. Dusky grouper is investigated in Croatia and Italy, goldblotch grouper in Croatia and white grouper in Israel. The main achievements of this research in our Laboratory are successfully induced spawning, description of early stages, and experiments on larval rearing. Furthermore, we made a sex-reversal of smaller females and immature fish and obtained small fertile males. Future research will concentrate on larval feeding and production of juveniles for growth experiments.*

**Key words:** Adriatic groupers, natural populations, breeding

### INTRODUCTION

Groupers are a widespread group of fish found globally in most warm seas. They are highly prized and exposed to intensive fishing by various methods and equipment. A number of characteristics make them easy prey. By nature they are very curious and therefore easy

target for underwater fishermen. They demonstrate a pronounced "home instinct", and use the same hole or rock shelter for extended periods, so that divers can easily locate and catch them. A number of grouper species, from Asia to the Caribbean, have been brought to extinction in this manner.

The most dramatic case has been noted with the Nassau grouper *Epinephelus striatus* (BLOCH, 1792), so that some states in the USA have taken exceptionally restrictive measures in order to protect them (SADOVY, 1989). The dusky grouper, *Epinephelus marginatus* (LOWE, 1834) was included among the endangered fish listed in Annex 3 of the Berne Convention. The reason is the dramatic reduction of wild populations in some parts of the Mediterranean over recent decades (ZABALA *et al.*, 1997 a,b).

The interest in the artificial rearing of the grouper has grown over the past twenty years due to its quality and market significance. For these reasons, research having as object introducing of the grouper to mariculture has started in different countries. The best results have been achieved in Asia and in the USA, where artificial breeding technologies and cage rearing have been developed and initiated for a few species (TUCKER, 1994; PILAY, 1995; WATANABE *et al.*, 1995). It has been demonstrated that groupers adapt exceptionally well to artificial rearing conditions and to be fed with artificial food, showing very good growth. However, a number of problems have been noted in the early phases of development, for which reason the commercial production of fingerlings hasn't been improved yet.

In Florida, due to the overfishing of natural population of the Nassau grouper, projects have been initiated for the active repopulation and fast recovery of endangered populations.

A similar research project concerning the dusky grouper has been ongoing since the end of the 80s at the Institute of Oceanography and Fisheries in Dubrovnik. It commenced with research on the fundamental biological characteristics of grouper populations in the South Adriatic, from the Elaphite to Lastovo Islands (SKARAMUCA *et al.*, 1989;1997). This research revealed significant overfished populations and the absence of fish that has weight over 15 kg. Some protection measures were offered. Later on, research was continued on the artificial breeding and rearing of early stages (GLAMUZINA, 1998; GLAMUZINA *et al.*,

1997, 1998 a,b,c). The fundamental objective of this research was to develop a basis for the production of larger quantities of fingerlings required both in intensive breeding and in the active restocking of overfished locations.

This paper describes the grouper species which dwell in the Adriatic Sea, their distribution and status of certain populations, and the level of scientific knowledge regarding their possible introduction to mariculture.

### GROUPER SPECIES WHICH LIVE IN THE ADRIATIC SEA

In the Adriatic, five species of fish have been noted up to now which are considered groupers. They are as follows:

1. dusky grouper, *Epinephelus marginatus* (LOWE, 1834)
2. goldblotch grouper, *Epinephelus costae* ((STEINDACHNER, 1878)
3. dogtooth grouper, *Epinephelus caninus* (VALENCIENNES, 1843)
4. white grouper, *Epinephelus aeneus* (E.GEOFFROY SAINT-HILAIRE, 1817)
5. wreckfish, *Polyprion americanus* (SCHNEIDER, 1801)

The wreckfish grouper lives in the greater depths of the South Adriatic, is very rare and rarely fished, and as such will not be examined in detail in this paper. It should be noted that this species is considered to be of interest to artificial rearing due to its fast growth, and is noted in the new listing of species being researched in the Mediterranean (CIHEAM, 1999). The main problem lies in the difficulties encountered in the formation of a broodstock.

Globally, the grouper from genus *Epinephelus* numbers about a hundred species (HEEMSTRA and RANDALL, 1993). Its main feature is that all of the species are exceptionally prized and expensive to purchase, thus become a target of intensive fishery in most seas. Due to their way of life and attitude towards divers, they are especially exposed to spear-gun fishing, standing nets, hooks and various other equipment used in sport fishing. A number of species found in Asian and American seas have been brought to a state of being over-

fished and to the problem of sustainment for certain populations.

### THE PRESENT STATUS OF NATURAL POPULATION SPECIES LIVING IN THE ADRIATIC SEA

The main characteristic of the genus *Epinephelus* is that most of the species described live in warm tropical waters. During evolution, some species spread and took over new locations, such as Caribbean and Mediterranean waters. However, the number of such species is significantly smaller, so that there are only five native species which dwell in Mediterranean waters, mostly in the southern parts. There are only a few species which live in the northern areas of the Mediterranean. A similar situation exists in the Adriatic, i.e. only four species are noted in the southern waters and the dusky grouper in the northern waters. Findings of the dusky grouper in the northern Adriatic and in waters along the coast of France are of recent date (FRANCOUR *et al.*, 1994; DULČIĆ and LIPEJ, 1997). The settlement of new locations by the dusky grouper, a typically warm water tropical species, is one of the most significant representations of biological data available which speaks for the recent warming up of Mediterranean waters.

### Dusky grouper, *Epinephelus marginatus* (LOWE, 1834)

It is the most numerous and frequent species (Fig.1) in the Mediterranean. The average annual catch for the entire Mediterranean is about 3000 tons (HEEMSTRA and RANDALL, 1993). There are no statistics available for the Adriatic as most are caught by spear-fishermen and are sold to restaurants. The annual catch is estimated at about thirty tons (JARDAS, 1996). The dusky grouper lives on rocky bottoms and along coasts, in holes between rocks, up to one hundred metres depth. It feeds mostly on octopus, and much less on fish and crustaceans (SMALÉ, 1986). As with other groupers, it is a protogynic hermaphrodite. Female sexual maturity is reached in the fifth year of life and at length of 38-58 cm. Sex reversal to male occurs from age of 9-16 years and at length of 68-90 cm (CHAUVET, 1988). The largest specimens noted weight about 35 kg from Tunisian waters (BOUAIN and SIAU, 1983) and 60 kg from Brazilian waters (FIGUERIDO and MENEZES, 1980).

Over the last decade, the dusky grouper has also been of interest for intensive rearing, and has been the subject of scientific research in a few Mediterranean countries, especially in Italy and in Spain. The first unsuccessful attempts at artificial spawning using hormonal treatments

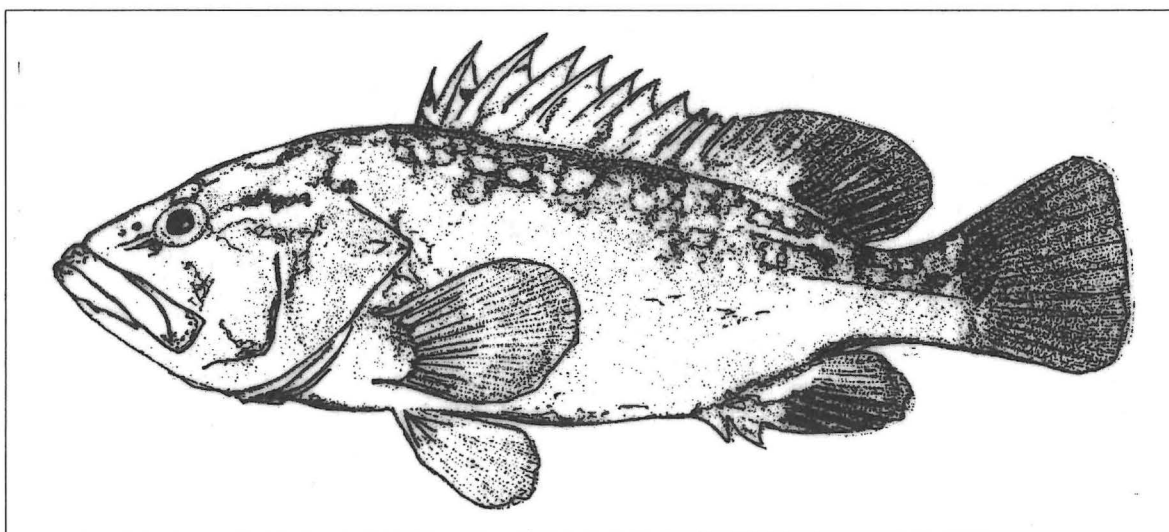


Fig 1. Dusky grouper, *Epinephelus marginatus* (drawings from HEEMSTRA and RANDALL, 1993, modified by V. KOŽUL)

were described in Italy (SPEDICATO *et al.*, 1995), and experiments with rearing at various temperatures in Spain (GRACIA LOPEZ and CASTELLO-ORVAY, 1995). In Croatia during 1996, research on the artificial spawning of the dusky grouper was commenced as well at the Institute of Oceanography and Fisheries in Dubrovnik. In 1997, after a number of unsuccessful attempts, the dusky grouper was successfully spawned and the first experiments involving larval rearing were initiated. The first successful results on artificial spawning and the obtaining of fertilized eggs and larvae were described (GLAMUZINA, 1998; GLAMUZINA *et al.*, 1998a,b), including a detailed description of the larval stages needed for ichthyoplanktonic research (GLAMUZINA *et al.*, 1998c). The reproductive cycle in captivity was also described, which is the fundamental basis for the development of a successful protocol for artificial hormonal spawning (GLAMUZINA *et al.*, in press). Induced sex reversal in the female was completed successfully, as well as directing the sex of immature fish through the application of the male hormone 17 methyltestosterone, and obtaining fertile males whose sperm was used in the successful fertilization of eggs (GLAMUZINA *et al.*, 1998a). This work has created the basis for future research which should result in the first production of fingerlings for aquaculture and the restocking of this interesting species. Italian authors have published similar results, describing artificial spawning (MARINO *et al.*, 1998 a,b; SPEDICATO *et al.*, 1998) and sex reversal (MARINO *et al.*, 1998), which indicates the quick progress of research. Nonetheless, so far, it is only known that fingerlings (60 of them) have been successfully produced at a commercial hatchery in Cyprus, but research has been halted (T. ATACK, personal communication).

Data based on the observations of divers in the southern Adriatic indicates how a greater number of fingerlings have been appearing around the island of Mljet over recent years, pointing towards good spawning results. However, the greater portion of these fingerlings are falling prey to longlines and hooks, at sizes of 100-500 grams. A particular danger for

the sustainment of natural grouper populations lies in the harem structure of the local population, evidenced by a number of other species, including the dusky grouper (ZABALA *et al.*, 1997b). The harem structure of the local population, in which only one male fertilizes up to ten females during spawning, represents a very fragile biological feature of the grouper. Especially under colder water conditions where spawning lasts only one month. In case such a male is caught a few months prior to spawning, the spawning of the entire population is ruined as the period is too short a time for sex reversal with some other fish. In tropical waters, the spawning of the dusky grouper lasts several months, such that this feature is not quite so dangerous, as enough time remains for sex reversal with the largest remaining fish.

For this reason, it is suggested that legislation should restrict the catching of grouper with weight over 12 kg in Croatian waters, which would permanently protect each population and its successful spawning. Preserving mature males can only be achieved through prohibiting spear-fishing in selected areas and creation of Marine Protected Areas. Anyhow, good results of such management have been observed only after two years of sport-fishing ban in Cabrera Archipelago (Spain) (COLL *et al.*, 1995). This approach, alongside the restriction of catching immature fish smaller than 40 cm in length, would represent a significant step towards the protection and increase of dusky grouper stocks. On the contrary, disturbances in the normal sustainment of populations and recruiting of new fingerlings can occur.

#### **Dogtooth grouper, *Epinephelus caninus* (VALENCIENNES, 1843)**

This species (Fig.2) has settled in the northernmost waters of the Mediterranean. It is distributed in the Central and South Adriatic, but it is significantly seldom in comparison with the dusky grouper. It rarely appears in catches. According to data obtained from underwater sport fishermen, it is rarely seen in this region. It inhabits on hard substrata surrounded by mud or sand, at depths of 30-400 meters. It grows up to

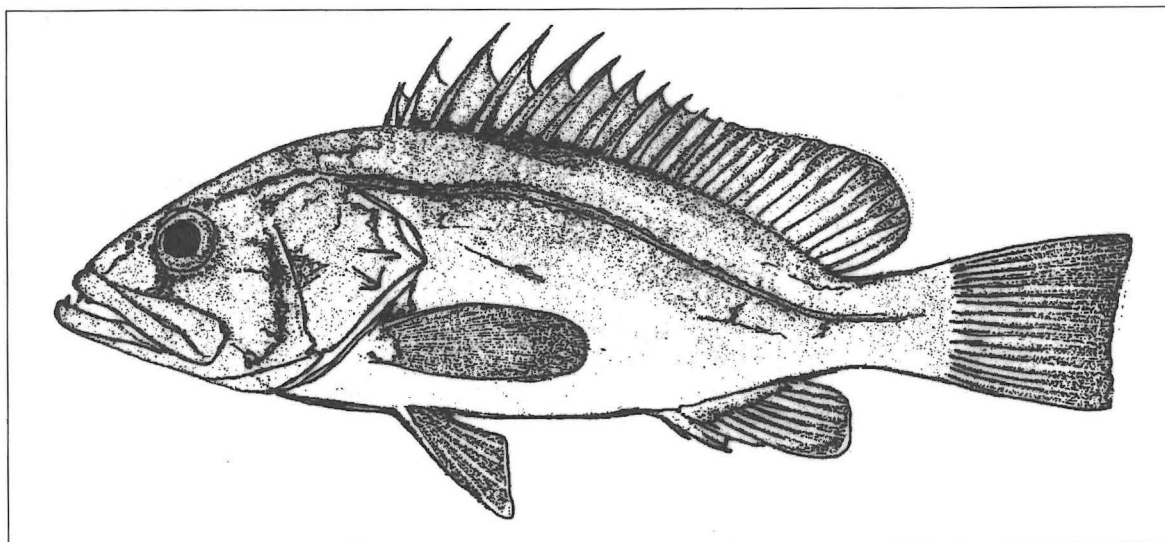


Fig 2. Doogtooth grouper, *Epinephelus caninus* (drawings from HEEMSTRA and RANDALL, 1993, modified by V. KOŽUL)

length of 1.5 m and could weight up to 35 kg in the Adriatic (JARDAS, 1996), but individuals of 90 kg and havier have been observed in the Western Mediterranean (RIERA *et al.*, 1995). The biology of this species is less known as compared to the dusky grouper.

It has not been the subject of any research whatsoever aimed at its introduction to mariculture. In our research, only a few examples of fingerlings adapted to tank conditions. Attempts at obtaining males with these fingerlings (weight around 250 g) by the method of injecting 17 methyltestosterone into the muscle tissue

did not result in the occurrence of milt (GLAMUZINA *et al.*, 1999a). Even though the species is interesting for rearing purposes, further work will depend upon successfully forming a main broodstock.

**White grouper, *Epinephelus aeneus***  
(E. GEOFROY SAINT-HILAIRE, 1817)

This is a species (Fig.3) which is very frequent in the southern regions of the Mediterranean, significantly rarer in central areas, and not found in northern regions. According to HEEMSTRA and RANDALL

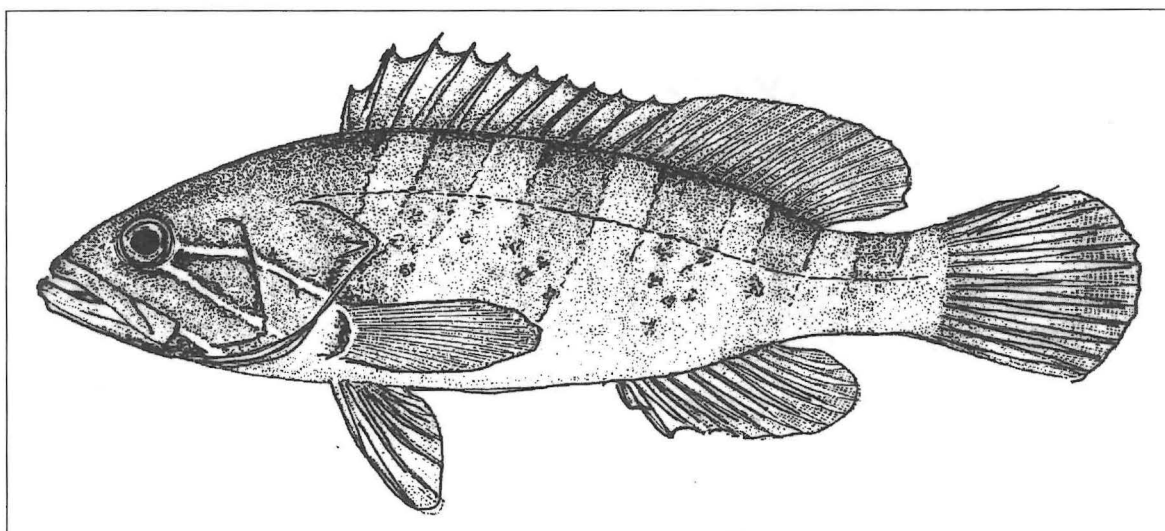


Fig 3. White grouper, *Epinephelus aeneus* (drawings from HEEMSTRA and RANDALL, 1993, modified by V. KOŽUL)

(1993), the border of its distribution reach the Ionian sea. It has not been noted in the Adriatic, and as such has not been included in the latest listing of Adriatic fish (JARDAS, 1996). However, during 1998 and 1999, some specimens were caught by Dubrovnik fishermen and adapted to the tank conditions of our laboratory, which indicates its spread into Adriatic waters as well.

The white grouper inhabits rocky and muddy bottoms up to depths of 200 m, while fingerlings are found in estuaries and lagoons. It feeds mainly on fish, crustaceans and octopus. As with other groupers, it is a protogynic hermaphrodite. Females mature at length of 50-60 cm and weight of 3 kg. Sex reversal to male occurs at weight of 9 kg (BRUSLE, 1985). The largest specimen with weight of 25 kg was caught in Tunisian waters (BOUAIN and SIAU, 1983). The species is very frequent in catches from African-Mediterranean waters and is economically significant. As such, since the early 90's, it has been included in aquaculture research. Particularly good results have been achieved in Israel (HASSIN *et al.*, 1997). In anyway, a rearing technology has not yet been fully developed. A few fingerling specimens of this species in our laboratory have undergone experiments with hormonal sex reversal. One specimen of fish (weight 280 grams) gave a larger quantity of fertile milt, used in the fertil-

ization of dusky grouper eggs, resulting in a hybrid combination of larvae (GLAMUZINA *et al.*, 1999b).

#### Goldblotch grouper, *Epinephelus costae* (STEINDACHNER, 1878)

This species (Fig. 4) is characteristic in the southern regions of the Mediterranean. It has also been noted in the southern regions of the Adriatic. Ten specimens of this species have been living for the past twenty years in the Aquarium in Dubrovnik. In recent years, a larger number of fingerlings are being caught in the vicinity of Dubrovnik. Therefore, 50 specimens with 100 g weight each were caught for research purposes. The fingerlings have adapted well to tank conditions and are actively feeding on fish and pelleted food.

The goldblotch grouper lives on various bottoms, from sandy, rocky to muddy, at depths between 20 to 80 meters. Divers see it around the wrecks of metal ships and other metal waste, and for this reason it is frequently called an "iron grouper". The greatest length noted is about 140 cm (JARDAS, 1996).

As a relatively rare species in the southern regions of the Adriatic as well, it is not especially significant in fishery. The quantities caught in the waters around Dubrovnik are insignificant. It is relatively frequent in the

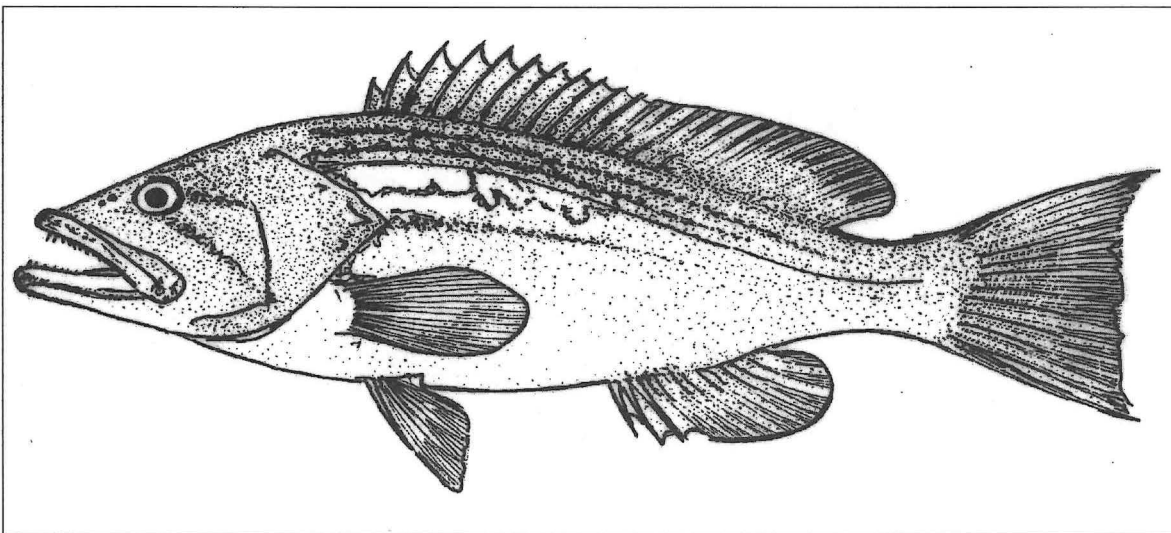


Fig 4. Goldblotch grouper, *Epinephelus costae* (drawings from HEEMSTRA and RANDALL, 1993, modified by V.KOŽUL)

southern regions of the Mediterranean (Tunis, Egypt), and therefore significant for fishery in these regions.

The goldblotch grouper is of interest to mariculture due to its quick growth and good market prices. It has been included in the latest listing of potential Mediterranean candidates for research and rearing purposes (CIHEAM, 1999). We started research on artificial spawning and larval rearing of this species in 1999 and obtained fertilised eggs and hatched larvae. Future research will concentrate on larval rearing.

### **GROUPE BIOLOGICAL CHARACTERISTICS IMPORTANT TO FISHERY AND MARICULTURE**

There are a few basic characteristics common to all four above-described species, which are important for the successful maintenance of natural populations and for potential rearing and active restocking purposes.

The first feature is growth, which is of vital importance to rearing and restocking. In-depth research on the growth of grouper in our waters has not been done. Based on the growth results obtained from some of our experiments, it can be concluded how dusky grouper growth under our conditions are significantly poorer as compared to growth in warmer regions. In research where the dusky grouper was reared at constantly high temperatures, a 93% better growth was achieved at 25°C as compared to 20°C (GRACIA LOPEZ and CASTELLO-ORVAY, 1995). Experiments in the tropical regions of Brazil proved how the dusky grouper can grow up to 1 kg in two years (BENETTI, personal communication), and it is the author opinion that growth could be faster under better conditions. Under a constant temperature of 24°C, a growth from 7 to 458 grams in 15 months was determined (GRACIA LOPEZ and CASTELLO-ORVAY, 1995). Based on the poor intake of food during April and May, meaning the period in which i.e. the seabass *Dicentrarchus labrax* under intensive rearing is already actively feeding, it can be concluded

how the refusal of food is the main reason for poorer growth in the ambient conditions of the South Adriatic. This is directly connected with temperatures lower than 20°C, an environmental situation which doesn't change until early June, when feeding activity of dusky grouper increases with water temperature. This indicates that under the ambient conditions of our sea, the dusky grouper will have only four months, from June to September, for intensive growth, which is too short period of time to offer the growth characteristics of species in tropical waters and already noted high temperatures. Temperature is the factor limiting the growth of tropical species of grouper which stop feeding when temperatures fall below 15°C, and the optimal temperature for rearing fluctuates between 22-28°C (BOONNYARATPALIN, 1997).

The average daily growth of smaller dusky grouper (100-500 grams) in captivity and in the ambient conditions of the South Adriatic amounted to 0.52 grams daily (GLAMUZINA, 1998), which is significantly lower than growths achieved under tropical conditions (BENETTI, personal communication). However, a similar growth of 0.48-0.69 grams daily was shown with the species *Epinephelus morio* in Mexico reared in a recycling system (BRULE *et al.*, 1996). The growth of Asian species in Malaysian waters where the average temperature is about 30°C, was from 2.5 to 3.5 grams daily in cage rearing (PILAY, 1995). It is therefore evident how grouper growth are significantly higher in warmer seas, and it drops significantly in colder seas. It is obvious that under the ambient conditions of the Adriatic Sea, the dusky grouper will not be able to demonstrate the growth potential evident with genetically-g geared tropical species, and that for successful rearing, it will be necessary to use higher temperatures throughout certain phases or throughout the entire rearing cycle.

The second important feature which influences natural populations and artificial spawning is protogynic hermaphroditism. Most groupers, including our four species, mature as females at weights of about 3 kg and more. Only at weight greater than 10 kg there is a sex rever-

sal to male. However, the time for sex reversal in various dusky grouper populations varies significantly. In this manner, variously aged groups and sizes reach sex reversal, and there is a frequent appearance of very old females, as well as very young males (BARNABE, 1974; SKARAMUCA *et al.*, 1989). In recent times, it has been discovered that the gonads of the species *Epinephelus striatus* go through a bisexual phase in the early stages, but later in life demonstrate a hermaphroditism similar to other species (SADOVY and COLIN, 1995). This bisexuality, totally unresearched in other species, indicates the possibility of other models of sex reversal with the grouper, conditioned by factors other than fish size, as is the case with the discovery of small dusky grouper males weigh only 5 kg in the waters around the island of Lastovo (SKARAMUCA *et al.*, 1989).

The problem of protogynic hermaphroditism appears in research on artificial spawning as well. It is very difficult to catch large males without major injury and to maintain them in captivity. For this reason, induced sex reversal was researched using the females and immature fish of all four grouper species. Induced sex reversal was successfully achieved, resulting in fertile males for the dusky grouper and the white grouper (GLAMUZINA *et al.*, 1999a). Their milt successfully fertilized dusky grouper eggs, which gave dusky grouper larvae and hybrids (GLAMUZINA *et al.*, 1998b). Successful attempts of induced sex reversal of the dusky grouper by administering

17-methyltestosterone was also reported by MARINO *et al.* (1998a) and SPEDICATO *et al.* (1998). The problems of obtaining large males from the wild have been solved by this. The problem with such males lies in the fact that following the spawning season and the discontinuation of hormone treatments, the fish once again revert to female (MARINO *et al.*, 1998a).

The third important feature of the grouper is their "home instinct", evidenced by the fact that they spend the greater part of their lives in the same holes or rock shelters. However, recent investigations (ZABALA *et al.*, 1997) describe that dusky grouper appear and disappear in the

breeding areas in the warm and cold season, showing that this home instinct is not so strict. Aboveall, this makes them easy prey for all fishing methods, especially the underwater spear-gun. This feature has proven to be of benefit in the rearing of grouper. Automobile tires were placed in the rearing cages as a substitute for natural shelters. Groupers adapted quite well to them and spent most of their time within the tires (CHUA and TENG, 1979). This characteristic will be useful for future projects involving the active restocking of fish, as the fingerlings released will remain in the close vicinity of chosen localities. Even though it was thought that the grouper migrates very little, new research in Italy using the telemetric method has indicated significant migration (SPEDICATO, personal communication), which threatens the conceived projects on the restocking of fish.

#### TEMPERATURE INFLUENCE ON THE STATE OF GROUPER POPULATIONS IN THE ADRIATIC SEA

The groupers which inhabit the Adriatic are warm water species whose further distribution in colder areas is limited. On the outer regions of their distribution, as is the case with Adriatic populations, a potential for disturbances in the functioning of the reproductive cycle and spawning exists in unsatisfactory years when the temperature varies. This could possibly explain the frequent variations occurring during the recruiting of dusky grouper fingerlings in the sea around Dubrovnik, noted by fishermen and divers during the last decade. During 1997, lower temperatures of 7°C were noted during July and August from normal summer temperatures of 23 -24°C to only 16-17°C. This cooling lasted up to ten days. Attempts of artificial spawning gave very poor results, while no research was carried out on natural spawning (GLAMUZINA, 1998).

During 1998, specimens of the white grouper *Epinephelus aeneus* were caught for the first time in the Adriatic. Up to this year, there have been no sightings of this species in our waters. Juveniles were caught weighing from



100-300 grams. There have been observations made by divers, not scientifically confirmed, how adult specimens can be found on the muddy bottoms between Zaton-Slano. The significance of finding this species, as well as the appearance of the dusky grouper in the northern regions of the Adriatic, is that they offer some of the important biological evidence supporting the increase of Mediterranean water temperatures. The increase of water temperatures in the Adriatic, especially its southern region, results in the settlement of new species, previously unregistered or registered only in the warm waters of the South Mediterranean, as well as the spread of existing autochthon population species, originating from warmer seas (DULČIĆ *et al.*, 1999). Even though this spreading of the grouper can contribute significantly to fishery, as a highly valuable market species, it, on the other hand, can endanger the relationship of existing species in sea ecosystems. Groupers are quite a carnivorous and aggressive species, which have very few natural enemies, and which can competitively affect other carnivorous species of fish. In this battle for territory, groupers are an absolute favorite, so that it is difficult to assume in which way other species of fish with similar feeding habits will behave.

One of the possible proofs on the warming up of the Mediterranean is shown by dusky grouper juveniles found at locations where they were never found before, such as areas of the French coast (FRANCOUR *et al.*, 1994) and in Slovenian waters (DULČIĆ and LIPEJ, 1997). A similar situation also exists in the South Adriatic waters from Molunat to Lastovo, where great numbers of young dusky grouper have been spotted in recent years. The present status of the dusky grouper in the Adriatic is characterized by the significant number of immature groupers in the southern regions and the frequent findings of adult groupers in the Central and North Adriatic (ZANKI, personal communication). Although, these facts are not verified through scientific investigations, seems that the

colonization of new regions is started by adult groupers which take over the new habitats. But, spawning in these colonised areas was not noticed yet. In case of successful spawning events in future, it will be necessary to undertake research on the influence of this settlement on other species of fish and other components of the ecosystem.

Nonetheless, these indicators of change in the content of the ichthyofauna of the Adriatic Sea, supported by the findings of other authors, demonstrates the significance of undertaking new research in the aim of better understanding the effects of global warming on the Adriatic Sea and foreseeing potential changes in the ecosystem, as its primary consequence.

## CONCLUSIONS

1. There are five species of grouper which live in the Adriatic Sea: the dusky grouper, *Epinephelus marginatus*, the goldblotch grouper, *Epinephelus costae*, the dog-tooth grouper, *Epinephelus caninus*, the white grouper, *Epinephelus aeneus* and the deep-sea grouper, *Polyprion americanus*. Of them all, only the dusky grouper is presently of economic importance to fishery.

2. For now, the white grouper, dusky grouper and goldblotch grouper have been researched as potential species for mariculture, and other species are also of interest for rearing purposes.

3. The last decade has shown the trend of a spreading distribution area of the dusky grouper to northern regions of the Adriatic, as well as the appearance of larger numbers of young groupers to southern regions.

4. In 1998, the white grouper *Epinephelus aeneus*, was noted for the first time in Adriatic waters, with a catch of young juveniles weighing about 200 grams each, and which were adapted to aquarium conditions in Dubrovnik. Adult white grouper were observed on the muddy bottoms along the shores north of Dubrovnik.

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## Kirnje Jadranskog mora – stanje prirodnih populacija i perspektive njihova uzgoja

Branko GLAMUZINA and Boško SKARAMUCA

*Institut za oceanografiju i ribarstvo, Split,  
Laboratorij za ekologiju školjaka i uzgoj ribe, P.P. 83, 20000 Dubrovnik, Hrvatska  
E-mail: branko@labdu.izor.hr*

### SAŽETAK

U radu je prikazan status prirodnih populacija četiri vrste kirnji koje žive u Jadranskom moru. To su: kirnja golema, *Epinephelus marginatus*, bijela kirnja, *Epinephelus aeneus*, kirnja zubaša, *Epinephelus caninus* i kirnja zlatice, *Epinephelus costae*.

Glavne biološke značajke koje utječu na stanje jadranskih populacija kirnji su njihovo tropsko podrijetlo i protoginični hermafroditizam. Kao tropske vrste koje u Jadranu žive na granicama svog areala, kirnje ne mogu ispoljiti mnoge svoje značajke poznate iz tropskih voda, kao što su brzi rast i višemjesečna sezona mriješćenja. Protoginični hermafroditizam kao model reprodukcije predstavlja značajan problem u jadranskim uvjetima, jer eliminacija dominantnog mužjaka iz populacije može omesti sveukupan mrijest.

Od četiri vrste kirnji, samo je kirnja golema zanimljiva za ribarstvo. Uglavnom poradi činjenice da su ostale tri vrste razmjerno rijetke. Godišnji ulov kirnje goleme u Jadranu se procjenjuje na 30 tona.

Tri vrste kirnji su predmet istraživanja uvođenja u akvakulturu, i to kirnja golema u Hrvatskoj i Italiji, kirnja zlatice u Hrvatskoj i bijela kirnja u Izraelu. Glavna dostignuća istraživanja u našem Laboratoriju su uspješno umjetno mriješćenje, opis ranijih razvojnih stadija i pokusi s uzgojem ličinki kirnje goleme i zlatice. Uspješno je promijenjen spol manjih ženki i nedoraslih riba i dobijeni su plodni mužjaci više vrsta kirnji. Buduća istraživanja će se koncentrirati na hranidbu ličinki i proizvodnju mlađi za pokuse rasta.