

Review of Croatian selected scientific literature on species mostly exploited by the national small-scale fisheries*

Dulčić J.,[#] Soldo A.[#] and Jardas I.[#]

Abstract

The paper reviews and compiles selected scientific information on the Croatian species mainly exploited by the national small-scale fisheries. The document provides a description of each species including distribution, biological data and fishery exploitation information.

Keywords: artisanal fishing; fisheries resources; coastal fisheries; MED, Adriatic Sea; MED; Croatia

Pecten jacobaeus L.

Family: Pectiniidae

EN: Great Mediterranean scallop

HR: Jakovljeva kapica

Distribution and biological data

Although present throughout the Adriatic coastal waters *Pecten jacobaeus* occurs in commercially harvestable quantities in the Northern Adriatic only. Distribution is related to the bottom type and depth, i.e. the species occurs mostly on sandy, sandy-loamy, and sandy-muddy-loamy sea beds and does not descend below 69-72 m. The maximum size (shell length) is 15 cm, although shell lengths of 16.2 cm have been reported in the Adriatic. The upper shell is flat and brownish-red; the lower one being convex, whitish-brown and with 15-18 pronounced and angled ribs. Like most scallops, it is hermaphroditic. Based on results of investigations on the reproductive cycle, spawning was found to begin at the temperature of 13-14°C and to reach the maximum intensity in spring at 18°C. The minimum legal size for commercial harvesting of the species is 6 cm corresponding to the shell length at which sexual maturity is reached.

Exploitation

The results of the study done by Cetinić and Soldo (1999) show that this is not an endangered species in the eastern part of the northern Adriatic. The currently used commercial dredge is appropriately constructed because it does not catch overly large amounts of small, young scallops. Low catches, a limited fishing area and 3 months during which the species is not harvested together allow for continual recruitment of new generations.

* Publisher's note: interested readers may also refer to "Vrgoč, N., Arneri, E., Jukić-Peladić S., Krstulović Šifner, S., Mannini, P., Marčeta B., Osmani, K., Piccinetti, C., Ungaro, N. 2004. Review of current knowledge on shared demersal stocks of the Adriatic Sea. FAO-MiPAF Scientific Cooperation to Support Responsible Fisheries in the Adriatic Sea. GCP/RER/010/ITA/TD-12. *AdriaMed Technical Documents*, 12: 91 pp."

[#] Institute of Oceanography and Fisheries – Split. S. Ivana Meštrovica, 63 - 21000 Split, Croatia. Email: dulcic@izor.hr

Sepia officinalis Linnaeus, 1758

Family: Sepiidae

EN: Common cuttlefish

HR: Sipa

Species description

Body is oval, rounded at the posterior and bordered throughout its length by a narrow fin. The mouth is surrounded by 8 non-retractile arms and 2 long, retractile tentacles that are inserted laterally. In males the fourth left arm is hectocotylished. The cuttlebone is rounded at the anterior and posterior, with a weak spine visible in juveniles, but embedded in chiti in adults. Being a mimetic species, the colour of the body is very variable, i.e. specimens show different colour patterns according to the substrate. Specimens are generally yellowish or marked with blotches or long vinelike bands, depending on the state of expansion of the chromatophores (Jardas, 1996).

Distribution

The Common cuttlefish is found throughout the Mediterranean basin and the eastern Atlantic Ocean, from the Baltic Sea to about 17° N. It is a demersal species and is more abundant in coastal waters on muddy and sandy bottoms covered with seaweed and phanerogames, but its distribution can be extended to about 200 m (Jardas, 1996). Common cuttlefish inhabits the entire coastal part of the Adriatic Sea and it migrates seasonally. In winter it resides mostly in the circalittoral zone where it matures sexually. In spring, it migrates to the more shallow infralittoral region to spawn and lay eggs (Jardas, 1996). In the central and northern Adriatic it occurs predominantly on sandy and muddy bottoms up to 100-150 m depth (Županović and Jardas, 1989). In the southern Adriatic, in the colder part of the year, Common cuttlefish population is densest at a depth from 50 to 60 m, while during the warmer part of the year it migrates closer to the coast for spawning and tends to concentrate between 10 and 30 m depth. In autumn, it moves to deeper waters and at this time of year it is most abundant at depths between 40 and 50 m. In spring, the population density is uniform up to 60 m, but it can be also found, in small quantities, up to 110 m (Jardas, 1996).

Biological data

As with most cephalopod species, population dynamics and stock assessment characteristics of common cuttlefish are insufficiently investigated in the Adriatic Sea. This species can reach 35 cm maximum (mantle length, ML), but usual length ranges between 15 to 20 cm. Longevity is 18 to 30 months. This is a demersal, neritic species that inhabits muddy and sandy sediments. It is particularly active during the night. In daytime it adopts a sedentary lifestyle, often burrowing into the sand.

The (mantle) length-weight relationship shows negative allometry (for the eastern Adriatic coast): females $a=0.2326$, $b=2.7307$, males $a=0.2433$, $b=2.6938$, males and females $a=0.2366$, $b=2.7195$ (Jardas *et al.*, 2001). This relationship also shows negative allometry (for the western coast of Istra): both sexes $a=0.3384$ and $b=2.584$ (Cetinić *et al.*, 2003).

The spawning period of the species extends throughout the year with peaks in spring and summer. In the northern and middle Adriatic it reproduces in April and May, but females with mature eggs can even be found in June and July. In the southern Adriatic, it spawns

from February to September, but with a peak from April to June. Diameter of eggs is from 6 to 8 mm. The length of the mantle is about 10 cm at sexual maturity. The Common cuttlefish is an active predator. It feeds mostly on crustaceans, especially decapods, and fish. In absence of food it can adopt cannibalistic behaviour (Jardas, 1996).

Exploitation

Common cuttlefish is an important commercial resource and one of the most appreciated cephalopod species. It is caught mainly with bottom and «rapido» trawl nets but trammel nets, fyke nets and specific pots are used as well. In the Adriatic Sea, cuttlefish is also, together with squid, an important target of the small-scale, artisanal and recreational fishing activities. The trammel net proved to be the most efficient gear for fishing of the cuttlefish on the sandy-rock seabed. Grubišić (1982) reported that the national recorded average annual catch is of about 212 tonnes, but he also pointed out that it is probably much higher. Dujmušić (2000) approximated the catch of common cuttlefish in 1998 as of 65 415 kg (the largest part from the Zadar area, estimated at 41 392 kg).

Homarus gammarus (Linnaeus, 1758)

Family: Nephropidae

EN: European lobster

HR: Hlap

Distribution

Eastern Atlantic from north-western Norway (Lofoten Islands) south to the Azores and the Atlantic coast of Morocco. Also along the northwest coast of the Black Sea and in the Mediterranean (but lacking in the extreme eastern part, east of Crete). Not present in the Baltic Sea.

Biological data

The European lobster lives on the continental shelf between 0 and 150 m depth; usually not deeper than 50 m. Found on hard substrates, rock or hard mud. The animals are nocturnal and territorial, living in holes and crevices. Females with eggs are found throughout almost all the year. The eggs are laid around July and carried for 10 or 11 months. Maximum total body length is about 60 cm (weight 5 to 6 kg), large size specimens are usually 23 to 50 cm. Total length range of European lobster in catches of bottom trammel sets was between 19.2 and 47.1 cm, while in catches of «psare» nets from 21.0 to 49.0 cm TL. Total length range in catches of «komiška» pots (mesh size 55 mm) was from 28 to 50 cm TL (Cetinić *et al.*, 2001). Sex ratio (in catches of bottom trammel sets) was 1.89:1 in favour of males, 1.63:1 in favour of males (in catches of «psare»), and 1.13:1 in favour of males (in catches of pots) (Cetinić *et al.*, 2001).

Exploitation

Grubišić (1982) reported the national average annual catch of European lobster together with common spiny lobster at around 18 tonnes. It could be caught by bottom trammel nets, «psare» net and «komiška» pots (pots for catching lobsters). This species has a very high price on the market. The percentage of immature specimens (below 36 cm TL) was 88.09% in catches of «psare» nets and 76.74% in catches of bottom trammel sets (Cetinić *et al.*, 2001).

Nephrops norvegicus (Linnaeus, 1758)

Family: Nephropidae

EN: Norway lobster

HR: Škamp

Species description

Norway lobster is a medium to large sized crustacean decapod with well-calcified teguments, very pronounced rostrum, carapace and chelae, reduced pedunculated eyes and non-imbricated abdominal pleurae. The body is long and, more or less, laterally flat. There are 3 to 4 bones on the dorsal and 1 to 2 on the ventral side of cephalothorax. The belly is long and ends with a fan-shaped telson that enables lobster to swim. However, when moving, it walks more than it swims.

The first pair of cephalic appendices has composite eyes with a mobile peduncle. The first antennae are short and forked. The second ones are long and simple. The telson is long with two pronounced bones at the apex. The first pair of legs is well developed with strong chelae. The second and third are thinner and have chelae as well.

Norway lobster is orange coloured with orange-red bands on chelae and on the anterior part of the cephalothorax.

Distribution

According to Relini *et al.* (1999), the zoogeographic range of Norway lobster is the eastern Atlantic, from Morocco to Norway and Iceland, including parts of the Mediterranean Sea.

The species was recorded at depths of about 30 m in the northern Adriatic to 400 m in the south part of the Sea (Karlovac, 1953; Vrgoč, 1995). In the northern part of the open Adriatic it can be found off Ancona. The densest population is in the Jabuka/Pomo Pit region. There are rich settlements in the Velebit channel, Kvarner and Kvarnerić region (Crnković, 1963).

Since the distribution range of the species in the Adriatic is continuous, particular Norway lobster settlements cannot be regarded as isolated (Karlovac, 1953). Nevertheless some differences, primarily in length frequencies among the settlements around Ancona and the Jabuka/Pomo Pit, as well as among the settlements in the northeastern Adriatic channels and the Jabuka/Pomo Pit (Županović and Jardas, 1989) do exist.

Earlier, Norway lobster was seen as a boreal residue from the ice age. This hypothesis was later refuted (Karlovac, 1953). It was realised that the decisive factor for the diffusion of the species in the Adriatic was the type of sea sediment, not the temperature (Županović and Jardas, 1989). Norway lobster is a mud-dwelling species that is not restricted to a particular biocenosis, or a biocenotical zone. This is certainly related to its habit of digging burrows for shelter (Crnković, 1963).

Biological data

Nephrops norvegicus has separate sexes. Males are, in average, larger than females. Although Fisher *et al.* (1987) show its maximal size is 24 cm total length (TL), larger specimens can be caught, primarily in the northern Adriatic. Crnković (1963), for example, found specimens up

to 26.5 cm TL in northern Adriatic channels. Two different measures are used in fishery and biological research: total length and carapace length (CL). Cetinić *et al.* (1999) presented the TL-CL relationship for Norway lobster in the Velebit channel (for both sexes) with parameters: $a = -1.0035$ and $b = 3.5507$, while Šarčević (1992) reported CL-weight relationship for Norway lobster in Jabuka/Pomo Pit (for both sexes) with parameters: $a = 0.0098$ and $b=3.217$.

The growth of Norway lobster, as in other crustaceans, is a discontinuous process with a succession of moults separated by the intermoult periods. During each moult, the old exoskeleton is shed and the animal grows very quickly before the new exoskeleton hardens. A well-defined moulting periodicity was not found among juveniles, they seem to moult all year round. There is a moult synchronism in the adult population. It could be generally said that, in the Mediterranean, females have one moulting period a year (December-March), right after hatching the eggs. The moulting period of grown males is in late summer and autumn (August-October). In the Adriatic, grown males have moult peak between June and September. The frequency of gastroliths was always very low in adult females, so that little can be said about their moult cycle, except that adult females do not moult between August and January when they carry external eggs.

In the Adriatic, Norway lobster spawns once a year. The proportion of females with a mature ovary, i.e. in which ovoverdins storage is at maximum (dark green colour), peaks in spring or at the beginning of summer. The presence of berried females was found in October and November, but some specimens can be observed up to late spring. According to Karlovac (1953), Norway lobster larvae are present in the Adriatic plankton from January to April, that is late winter. The sex ratio changes through the year. The proportion of females in catch is lower when they carry external eggs because they are less active and hide more in burrows. On the other hand, the proportion grows and is higher than 1 in the mating period (Crnković, 1963; Jukić, 1971).

The sex ratio in Velebit channel was 1:1.34 in favour of females (Cetinić *et al.*, 1999). Data about the length at sexual maturity at different localities has been estimated at 95-100 mm TL (northern Adriatic, Karlovac, 1953), 35 mm CL (Velebit channel, Cetinić *et al.*, 1999). Males grow larger than females. Differences in growth dynamics among settlements could be observed. They are consequence of differences in ecological conditions of the habitats.

The parameters of Von Bertalanffy Growth Function (VBGF) are: Jabuka/Pomo Pit, males+females: $L_{\infty}=215$ mm TL, $K=0.215$ yr⁻¹, $t_0=-0.23$ (Bhattacharya method; Šarčević, 1992); Open Adriatic, males $L_{\infty}=227$ mm TL, $K=0.324$ yr⁻¹, $t_0=-0.29$ (Bhattacharya method), females: $L_{\infty}=179$ mm TL, $K=0.397$ yr⁻¹, $t_0=-0.03$ yr⁻¹ (Vrgoč, 1995). Norway lobster feeds mainly on other decapod crustaceans, and to a lesser extent with other crustaceans (euphausiids and peracarids) and fish. Parts of carapace, shells, gastropod, vertebra and fish otoliths were found in Norway lobster stomachs. It was also determined that the stomach was the least full in summer, that it is in the period when gonads grow most intensively and take up the maximal volume of the body cavity (Jardas, 1996).

Exploitation

In the Adriatic, catch of Norway lobster fluctuates significantly during day and night (circadian fluctuation), and during the year (seasonal fluctuation) (Crnković, 1970;

Županović and Jardas, 1989). Generally the catch is highest at sunrise and sunset most probably due to behaviour of the species. Norway lobster spends the greatest part of its life buried in burrows in the sea sediment and goes out only in search for food before dawn and at dusk. This kind of behaviour is more obvious in younger specimens and ovigerous females. Because of this, different parts of the population are vulnerable to fishing gear at different times of day.

Seasonal fluctuations exist for the same reason: the catch is biggest in spring, when the sex ratio is in favour of females, while in winter the catch is at a minimum. In the Adriatic Sea, Norway lobster is fished primarily with two types of gears: the majority of the catch is by bottom trawl nets and the rest by traps. Catch per pot was 19.76 g (0.57 specimens) and varied between 0.20 and 0.82 specimens per pot in Velebit channel (Cetinić *et al.*, 1999).

Palinurus elephas (Fabricius, 1787)

Family: Palinuridae

EN: Common spiny lobster

HR: Jastog

Distribution

Eastern Atlantic, from southwestern Norway to Morocco, also in the Mediterranean, except the extreme eastern and southeastern parts.

Biological data

The common spiny lobster lives on rocky bottoms, rarely on sand, in depths from 5 to 160 m, mostly between 10 and 70 m. Ovigerous females are present from September-October to February-March. Maximum total body length is 50 cm, but usually not larger than 40 cm. Total length range of spiny common lobster in catches of bottom trammel sets was between 10.8 and 43.8 cm, while in catches of «psare» nets from 10.1 to 45.0 cm TL. Total length range in catches of «komiška» pots (mesh size 55 mm) was from 20 to 39.8 cm TL (Cetinić *et al.*, 2001). Sex ratio (in catches of bottom trammel net) was 1.31:1 in favour of males, 1.24:1 in favour of males (in catches of «psare»), and 1.58:1 in favour of males (in catches of pots) (Cetinić *et al.*, 2001). The parameters of the length-weight relationship (for the Palagruža Island) are: $a=0.0459$ and $b=2.85$, indicating negative allometric growth (Dulčić *et al.*, 1995a). The parameters of the length-weight relationship (lobsters caught by pots): $a=0.0437$ and $b=2.857$, indicating negative allometric growth (females; Cetinić *et al.*, 1997). The sex ratio was established as 2.1:1 in favour of males (Cetinić *et al.*, 1997).

Exploitation

Grubišić (1982) reported that the national average annual catch of the common spiny lobster together with common spiny lobster is around 18 tonnes. It could be catch by bottom trammel sets, «psare» net and «komiška» pots (pots for catching lobsters). It has a very high price on the market. The percentage of immature specimens (below 27 cm TL) was 80.77% in catches of «psare» nets, 77.33% in catches of bottom trammel sets (Cetinić *et al.*, 2001), and 57.19% in catches of pots.

Atherina (Hepsetia) hepsetus Linnaeus, 1758

Family: Atherinidae

EN: Mediterranean sand smelt

HR: Gavun, brfun

Species description

The body is rather long, slender and moderately flattened. The mouth is protrusible, upwardly directed with small teeth; the head and body are scaly. The lower jaw has an upper expansion within the mouth (high dentary bone). Two separate dorsal fins, all rays of first and 1-2 anterior rays of second dorsal fin are unsegmented, the remaining rays segmented. The anal fin is similar to the second dorsal fin while the caudal fin is forked. There are no teeth on pterygoid bones. Dorsal finrays VII-X, I+10-12, anal finrays I+II-13. Scales in longitudinal series 59-65.

Distribution

It is common in the Mediterranean, Black Sea and Caspian Sea. It also occurs in Atlantic, from Spain to Morocco including Madeira (rather rare) (Jardas, 1996). It is common in the Adriatic Sea (especially in lagoons and estuaries) (Jardas, 1996).

Biological data

Mediterranean sand smelt is a small pelagic species in littoral areas, often near the shore (Jardas, 1996). It is gregarious, sometimes in marine lagoons and estuaries. As a carnivorous species, it feeds on pelagic copepods and benthic crustaceans. It spawns from December to May (in the Mediterranean). It can reach 3-4 years old. The maximum size is 20 cm, but usually in catches it is about 15 cm (Jardas, 1996).

Exploitation

The catch of the sand smelt in 1998 (Croatian waters) was 14 827 kg (Dujmušić, 2000). The major small-scale fishing gears exploiting this species in Croatian waters are the coastal beach seines, small mesh size (10 mm) gill nets and liftnets.

Atherina (Hepsetia) boyeri Risso, 1810

Family: Atherinidae

EN: Big-scale sand smelt

HR: Oliga

Species description

Body rather long, slender, moderately flattened. Mouth protractible, upwardly directed, small teeth. Head and body scaly. Lower jaw with an upper expansion within mouth (dentary bone high). Two separate dorsal fins, all rays of first and 1-2 anterior rays of second dorsal fin unsegmented, the remaining rays segmented. The anal fin is similar to the second dorsal fin while the caudal fin is forked. The first dorsal fin has 6-10 flexible spines.

There is no distinct lateral line, there are rather large cycloid scales. Back is bluish or greenish, translucent, with small black dots chiefly on rear edge of each scale. Belly is whitish, often iridescent. D (VI) VII-VIII (IX), I+ (9) 10-13 (15), A I+ (12) 13-15 (18). Scales in longitudinal series (39) 4-48 (49).

Distribution

The Big-scale sand smelt is very common in the whole Mediterranean (Adriatic included) and adjacent seas (the Azov and the Black Sea) and along north-eastern Atlantic coast from Scotland to Morocco and Azores (Jardas, 1996).

Biological data

Big scale sand-smelt is a small pelagic, very eurihalyne fish species which occurs near the surface in the littoral estuarine zone: in lagoons, salt marshes (77 psu), shallow brackish areas (2 psu) and inland waters which are rather unsuitable for other fish species, due to their high ionic strength and salinity (Jardas, 1996).

It is a carnivorous species feeding on zooplankton and small bottom-living animals (crustacean gammarids, polychaete worms and molluscs).

Reproduction takes place in spring months (from April to July) in brackish (2 psu) and hyperhaline waters (42 psu) (Jardas, 1996). Individuals of big scale sand-smelt were collected monthly during the spawning season from March to July 2000 in the Pantana lagoon (eastern central Adriatic, near the city of Split). Specimens ranged between 4.3 and 11.8 cm TL.

Age determination based on scale reading showed that the population has a life cycle of four years. Growth in length for both sexes was expressed through the following VBGF parameters: $L_{\infty}=17.21$, $K=0.201 \text{ yr}^{-1}$ and $t_0=-1.0285$ (Pallaoro *et al.*, 2002). The slopes (b-values) of the total length-weight regressions, which do not differ significantly between sexes, indicate isometric growth for both females ($b=2.942$) and males ($b=2.947$). The overall ratio was 1:1.03 in favour of females. Males were dominant in smaller and females in larger length classes. All individuals larger than 10.9 cm TL were females (Pallaoro *et al.*, 2002). The maximum size of this specimen is 13 cm (usually in catch 7-9 cm) (Jardas, 1996).

Exploitation

The total mortality rate of the big-scale sand smelt in Pantana Lagoon was $Z=1.891 \text{ yr}^{-1}$ and the natural mortality $M=0.867 \text{ yr}^{-1}$. The exploitation rate, $E=0.542$, revealed a high fishing pressure on the stock in the studied area (Pallaoro *et al.*, 2002). This species is a relatively important commercial fish in the Croatian coastal fisheries. Jardas (1996) reported that the annual catch of big-scale sand smelt does not exceed 30 tonnes.

According to Dujmušić (2000), the catch in 1998 (in Croatian waters) was 9 291 kg of which the most, about 6 800 kg, from the Split area.

The major small-scale fishing gears exploiting this species in Croatian waters are coastal beach seines, small mesh size (10 mm) gill nets and liftnets.

***Seriola dumerili* (Risso, 1810)**

Family: Carangidae

EN: Greater amberjack

HR: Gof

Species description

The teeth in both jaws are minute in a broad band anteriorly, tapering posteriorly. The end of the upper jaw is broad. The soft anal fin base is distinctly shorter than dorsal fin base; in adults, length of dorsal fin lobe almost equal or slightly longer than pectoral fin and 13-18% of fork length. The anterior margin of first pterygiophore of anal fin is moderately concave. Caudal peduncle grooves present; lateral line without scutes.

Distribution

It occurs in the eastern Atlantic, from Mediterranean to Gulf of Biscay and reported as a rare vagrant to British coast; Nova Scotia to Brazil, South Africa, Arabian Gulf, Australia, Japan and Hawaiian Islands. It is present along the eastern Adriatic coast, most abundant in the southern Adriatic (Jardas, 1996).

Biological data

Seriola dumerili is both an epibenthic and a pelagic species, often near reefs or at depth offshore holes or drop-offs, usually in small to moderate schools but may be solitary. It is usually found from 18 to 72 m depth, but may occur up to 360 m; small juveniles associate with flotsam in oceanic or offshore neritic waters. It feeds primarily on fish and also on invertebrates (Jardas, 1996). It could reach 188 cm TL (80.6 kg), but commonly reaches 110 cm (Jardas, 1996). The sex ratio is (eastern Adriatic) 1.06:1 in favour of males (Kožul *et al.*, 2001). The parameters of the length-weight relationship are $a=0.000123$ and $b=2.847$, indicating negative allometric growth (Kožul *et al.*, 2001). The parameters of the VBGF are: $L_{\infty}=174.6$ cm, $K=0.190$ yr⁻¹, $t_0=-0.314$, while maximum age is estimated to be 10 years (Kožul *et al.*, 2001).

Exploitation

Total mortality has been estimated to be $Z=0.41$ yr⁻¹, natural mortality $M=0.30$ yr⁻¹ and fishing mortality as $F=0.11$ yr⁻¹. The exploitation rate $E=0.27$ would indicated a low fishing pressure on the population in the investigated region (Kožul *et al.*, 2001). Grubišić (1982) reported the average annual catch (in the eastern Adriatic) at about 30 tonnes.

Spicara smaris (Linnaeus, 1758)

Family: Centracanthidae

EN: Picarel

HR: Gira oblica

Species description

A rather elongated fish with a single dorsal and a forked caudal fin. Premaxillaries are very protractile; small and conical teeth, arranged in more than 1 row in the jaws. No opercular spines, scales ctenoid. Colour is grey-brown above while silvery below.

Distribution

The picarel inhabits seagrass beds and muddy bottoms at about 15-100 m depth. It is distributed in the Mediterranean and Black Seas, and in the Atlantic from Portugal to Morocco and Canary Islands (Jardas, 1996). It is common in the eastern Adriatic, especially in the central part (Jardas, 1996).

Biological data

A sequential protogynous hermaphrodite, picarel shows sexual dimorphism only during reproductive period (Zei, 1941, 1949). Spawning takes place from February to May (Jardas, 1996). The maximum standard length is 15 cm for females, while 20 cm SL for males (Tortonese, 1986). The slopes (b values) of the total length-weight regression indicated negative allometric growth for females ($b=2.8$) and isometric growth for males ($b=3.08$) for the period April-May 1999 in the eastern central Adriatic. In a study by Dulčić *et al.* (2003) the length of sampled individuals ranged from 6.3 to 19.8 cm TL, and the weight from 2.2 to 78.3 g. The oldest female and male were 4 and 6 years, respectively. The von Bertalanffy growth function parameters for the sexes combined were $L_{\infty}=22.76$ cm, $K=0.277$ yr⁻¹ and $t_0=-0.739$. The overall sex ratio was 1:4.1 in favour of females, probably a result of protogynous hermaphroditism. Individuals larger than 17.9 cm TL were all males.

Exploitation

The picarel is very important for Mediterranean fishery production as well as for the national fishery production of Croatia (the number of fisherman in the small-scale fishery in Croatia was 9 060 in 1999). Between 1995 and 1999, the mean annual Croatian picarel landings were around 600 metric tonnes (Jardas, 1996). In 1998, the catch of picarel was 91 033 kg of which the largest part (38 805 kg) was from the Zadar area in the central Adriatic (Dujmušić, 2000). The natural mortality is high $M=0.62$ yr⁻¹, while total mortality was $Z=0.98$ yr⁻¹ and the fishing mortality $F=0.36$ yr⁻¹ (Dulčić *et al.*, 2003).

***Spicara maena* (Linnaeus, 1758)**

Family: Centracanthidae

EN: Blotched picarel

HR: Modrak, tragalj

Species description

A rather elongated fish with a single dorsal and a forked caudal fin. Premaxillaries are very protractile; small and conical teeth, arranged in more than 1 row in the jaws. Head elevated posteriorly in large specimens. Colour is bluish-grey above, sides silvery, usually with some dark spots, one of which is larger than in other picarel species.

Distribution

It occurs in the Mediterranean, Black Sea, in the Atlantic from Portugal to Morocco and the Canaries; common fish species along the Croatian coast (Jardas, 1996).

Biological data

The blotched picarel is usually found on *Posidonia* beds, rocks and mud down to about 100 m depth. It is a protogynous hermaphrodite species (Jardas, 1996). Reproduction is from August to October, according to the area (Tortonese, 1986). In a study by Dulčić *et al.* (2000) in the eastern central Adriatic, length size in samples ranged from 7.8 to 27.5 cm TL, while weight varied between 5.2 and 298 g. The von Bertalanffy growth equation was fitted on the basis of mean length-at-age data resulting in parameter values of $L_{\infty}=24.82$, $K=0.532 \text{ yr}^{-1}$, and $t_0=-0.089$. Weight increased allometrically for both sexes together with $b=3.12$ (Dulčić *et al.*, 2000). The blotched picarel is a relatively long-lived species. The oldest male and female were estimated to be 8 and 3 years old, respectively. The sex ratio was skewed in favour of males 1.41:1. Sex reversal was mainly observed between 17.5 and 18.0 cm TL. Females were observed up to a total length of 19.8 cm (Dulčić *et al.*, 2000). Dulčić and Kraljević (1996a) presented the values of the length-weight relationship of blotched picarel for the Croatian coastal waters: $a=0.0122$ and $b=3.037$.

Exploitation

Blotched picarel make a significant component of the beach seine catch in Croatian coastal fishery (around 60 t annually; Jardas, 1996). It represents in number 2.74 % (1.59% in weight) of the catches of tramata fishing (Cetinić *et al.*, 2002). Total (Z) and natural (M) mortality were 1.18 and 0.98 yr^{-1} , respectively. The exploitation rate $E=0.17$ indicated the picarel stock as lightly exploited (Dulčić *et al.*, 2000).

***Labrus merula* Linnaeus, 1758**

Family: Labridae

EN: Brown wrasse

HR: Vrana

Species description

Body moderately elongate. Head broad, shorter or equal to body depth. Strong canine-like teeth (rounded in old specimens). Lips with 6-9 folds. Soft part of dorsal fin higher than long and higher than spiny part. D XVII-XIX + 11-14; A III + 8-12. Colour in young is green with light spots or brownish, belly paler, yellowish, greyish or silvered, sometimes an opalescent blue-whitish longitudinal stripe on sides. Old specimens are habitually dark blue, sometimes dark green or brownish, belly paler. Soft part of dorsal, anal and caudal fins outlined with light blue; some light blue spots on head.

Distribution

It occurs in the Mediterranean and eastern Atlantic from Portugal to Morocco and the Azores (Jardas, 1996). It is common in the middle and southern Adriatic (Jardas, 1996).

Biological data

Brown wrasse inhabits the littoral zone (1-50 m) around rocks and seaweed (Jardas, 1996). It feeds on sea urchins, ophiuroids, molluscs, crabs and worms (Dulčić, 1999). It could reach 45 cm SL, but is usually 30-40 cm. It is mature at the age of when 2 years (15-20 cm SL) and maximum age is 16-17 years (when 7 years old males measure 31.5 cm and females 30 cm) (Jardas, 1996).

Exploitation

Grubišić (1982) reported the average annual catch (Croatian coast) to be around 7 tonnes.

Symphodus (Crenilabrus) tinca (Linnaeus, 1758)

Family: Labridae

EN: Peacock wrasse

HR: Lumbrak

Species description

Body oval, laterally flattened. Mouth rather small, more or less protrusible. Head generally longer than body depth. Snout longer or equal to post-orbital. Rather strong canine-like teeth. There are a few cephalic pores on the snout; lips with 6-9 folds. Colour reflects sexual dimorphism. Both sexes with a small dark spot at base of caudal fin and a dark blotch just above pectoral fin; absent in juveniles, more or less evident in adults. Many darker spots on body forming 3 or 4 indistinct longitudinal stripes. Females and juveniles are grey-greenish or brownish, fading to a silvery colour on the belly. Males are more brightly coloured, especially in the breeding season. Pale green, green-bluish or green-yellowish, longitudinal rows of red spots, upper part of head dark blue.

Distribution

It occurs in the whole Mediterranean, including the Black Sea and the eastern Atlantic from northern Spain to Morocco (Jardas, 1996). It is very common in the Adriatic Sea (Jardas, 1996).

Biological data

This gregarious littoral fish is found on rocky reefs covered by algae or in sea-grass meadows, sometimes in salty lagoons, at depths ranging from 1 to 50 m (Jardas, 1996). Peacock wrasse feeds on sea urchins, ophiuroids, bivalves, shrimps and crabs (Jardas, 1996). It reproduces from April to May in the Adriatic Sea (Jardas, 1996). In a study by Pallaoro and Jardas (2003) the overall sex ratio was found 1.43:1 in favour of males. All individuals larger than 28.9 cm TL were males as an effect of faster growth. The oldest females were 12 and the oldest males 13 years old. The parameters of the VBGF were estimated for females ($L_{\infty}=28.18$, $K=0.293 \text{ yr}^{-1}$, $t_0=-0.7821$) and males ($L_{\infty}=42.24$, $K=0.214 \text{ yr}^{-1}$, $t_0=-0.629$). The slopes (b values) of total length-weight regression indicated allometric growth for males $b=2.705$ ($a=0.0296$) and both sexes $b=2.8147$ ($a=0.0220$) and isometric growth for females $b=2.9901$ ($a=0.0131$) (Pallaoro and Jardas, 2003).

Exploitation

Although very common in the Adriatic, this species is of little commercial value along the Croatian coast and annual catch is about 10 tonnes (Grubišić, 1982; Jardas, 1996). Trammel net is the main fishing gear catching peacock wrasse. Estimated survival rate (Chapman and Robson equation) of males ($S=0.80$) was slightly greater than that for females ($S=0.76$) (Pallaoro and Jardas, 2003).

***Merluccius merluccius* (Linnaeus, 1758)**
(Sin. *Merluccius vulgaris* Fleming, 1818)
Family: Merlucciidae

EN: European hake
HR: Oslić, mol

Species description

Body is long and cylindrical. The widest part is behind head. Mouth is large. There are two dorsal fins. The first one is short and triangular and the second one is long. The anal fin is similar in shape and size to the second dorsal fin. The ventral fins are placed before the pectoral ones. The caudal fin is cut in a straight line. The colour is slate grey above and lighter on sides. Belly is whitish. The number of rays in particular fins as follows: D1: 8-10, D2: 35-40, A: 36-40, P: 12-14, V: 7 (Jardas, 1996).

Distribution

European hake inhabit the northeastern Atlantic from Norway to Mauritania and the entire Mediterranean. In the Black Sea it occurs along the southern coasts only (Jardas, 1996). According to available data, hake is distributed throughout the Adriatic. It is a distinctively eurytopic species.

Bathymetric distribution of the species in the Adriatic is from only several meters in the coastal area to 800 m in the South Adriatic Pit (Županović and Jardas, 1986). It is not fished in limited areas to the north of the Po delta. This nektobenthonic species is most abundant from 100 to 200 m depth. In daytime it stays on the bottom and moves to higher strata in the night (Jardas, 1996). In spring months, there are local movements of sexually immature adolescent hakes to more shallow channel waters of the central eastern Adriatic. The adult hake can mostly be found at depths between 100 and 150 m. In spring, the adults migrate to more shallow coastal waters because of spawning, the immature hake in search of food. In the winter period, after spawning, adult fish migrate to deeper water, wintering together with the juveniles (Županović and Jardas, 1989). In the southern Adriatic, the largest individuals are fished in water deeper than 200 m, whereas medium-sized fish occur within the 100 m depth stratum.

European hake prefers muddy bottoms, but it is well distributed on other types of bottom as well (muddy-sandy and sandy bottoms). It is most abundant in the open central Adriatic (the Jabuka/Pomo Pit) and further southwards (Županović and Jardas, 1986).

Biological data

According to Jardas (1996) hake can grow to 130 cm TL. However usual length is from 10 to 60 cm TL. In Velebit channel the length range of hake was observed between 11 and 63 cm TL (from catches of nets for hake called «oslićare») (Cetinić *et al.*, 1999). This is a long-lived species, it can live more than 20 years. In the Adriatic, however, the exploited stock is composed mainly of 2-year-old individuals. Jardas (1976) found out that the length-weight

relationship could be divided into three phases according to coefficient b: juvenile, adolescent and adult (Males: juvenile-adult = 2.625-3.235; Females: juvenile-adult = 3.033-2.862). In the Adriatic, hake spawns throughout the year, but with different intensity.

The spawn peaks are in the summer and winter period (Županović, 1968; Županović and Jardas, 1986, 1989). Hake is a partial spawner. Females spawn usually 4 or 5 time without the ovaries resting. Ovaries of about 70 cm long females in the pre-spawning stage can contain more than 400 000 oocytes. The earliest spawning in the Jabuka/Pomo Pit occurs in winter in deeper water (up to 200 m). As the season progresses, in the spring-summer period spawning takes place in shallower water. Recruitment of young hakes into the stock has two maxima: the first one is in spring and second one in autumn.

In the Jabuka/Pomo Pit, both of these maxima can be linked to hake's more intense summer and winter spawning period in the central Adriatic (Županović and Jardas, 1989). Nursery areas are located close to the Jabuka/Pomo Pit, between 150 and 200 m, on the upper part of slope and off the Gargano Cape (Županović and Jardas, 1989). Different data about the size at sexual maturity of hake in the Adriatic Sea, given by different authors, are shown in Table 1.

Table 1. Length at sexual maturity of European hake in the Adriatic Sea.

Authors	Sex	Total length (TL) (cm)
Ze (1949)	Males	22-30
Županović (1968)	Males	20-28
	Females	26-33
Jukić and Piccinetti (1981)	Males	26-33
Županović and Jardas (1986)	Males	20-28
	Females	23-33
Cetinić <i>et al.</i> (1999)	Males+Females (Velebit channel)	24

Differences in the growth dynamics between males and females are reported in Table 2. Females usually attain larger size than males, who grow more slowly after maturation (during the third or fourth year of life). Consequently, proportion of males in the population is higher in lower length classes and proportion of females is higher at greater lengths. In the central and northern Adriatic, females already start dominating the population at the length of about 30-33 cm TL. Over 38-40 cm, almost all the specimens are females (Vrgoč, 2000).

Table 2. Growth parameters (VBGF) for European hake.

Authors	Sex	L_{∞} (cm)	K (yr ⁻¹)	t_0 (yr)
Jukić and Piccinetti (1988)	M+F	85.0	0.12	-
Alegria-Hernandez and Jukić (1990)	M+F	92.83	0.097	-0.629
Vrgoč (1995)	M+F	83.27	0.125	-0.73
Vrgoč (2000)	M+F	77.95	0.130	
Marano (1996)	M	57	0.17	-0.83
	F	67.5	0.159	-0.436
	M+F	67.5	0.144	-0.877

Until about the length of 16 cm TL, the European hake feeds mostly on crustaceans (euphasiacea, mysidacea, amphipoda). During that period, it occurs mostly in the Jabuka/Pomo Pit and the southern Adriatic Pit region. Their migration to the eastern Adriatic channel regions is linked to the change of the feeding regime as they start feeding on fish, primarily *Sardina pilchardus*, *Sprattus sprattus phalericus*, *Engraulis encrasicolus*, *Scomber scombrus*, *Trachurus trachurus* etc. Cephalopods were found in hake stomachs as well (Jukić, 1972; Jardas, 1976).

Exploitation

Grubišić (1982) reported the average annual catch (Croatian coast) of hake at about 200 tonnes. Dujmušić (2000) approximated the catch of hake in 1998 as of 106 411 kg (the largest catch was approximated from the Zadar area: 62 088 kg).

The mean catch by passive nets targeting hake in the Velebit channel (catch per 100 m of net) is about 1.30 kg (Cetinić *et al.*, 1999).

Liza aurata (Risso, 1810)

Family: Mugilidae

EN: Golden grey mullet

HR: Cipal zlatac

Species description

The body is elongated, more or less cylindrical, the head is broad, space between eyes is about equal to the width of the mouth cleft; adipose eyelid rudimentary. The upper lip is thin, less than pupil diameter. No pectoral axillary scale. Scales on the head extend forward to the level of the posterior nostril. The colour is back grey/blue, flanks and belly pale or silvery with a golden blotch on operculum.

Distribution

Liza aurata inhabits Atlantic coasts from the Azores and Madeira northward to the British Isles and southern coasts of Norway and Sweden (but not Baltic). It is present in the whole Mediterranean and Black Sea, and has been introduced into the Azov and Caspian Seas. Elsewhere, to the south, Cape Verde Islands and Senegal and in the northern part of the Red Sea. It is common in the Adriatic Sea (along the Croatian coast), especially in the estuary areas (Morović, 1960; Jardas, 1996).

Biological data

Golden grey mullet is a pelagic species, usually inshore, entering lagoons and estuaries, but rarely moves into freshwater. It feeds on small benthic organisms, detritus, occasionally insects and plankton (Jardas, 1996). The data of a series of authors on the spawning season of golden grey mullet differ considerably. Jug-Dujaković (1988) indicated the spawning season from mid-October to December (in the Adriatic). Morović (1960) reported spawning season from December to February, while Grubišić (1982) from January to March. Finally, Kraljević *et al.* (1994) pointed it is from October to December in the eastern Adriatic.

The parameters of the length-weight relationship for the golden grey mullet from the Mirna Estuary-Tar cove (Istra) varied between years: $a=0.0088$, $b=2.951$ (1989), $a=0.0046$, $b=3.143$ (1990) and $a=0.0054$, $b=3.122$ (1991) (Kraljević *et al.*, 1994). The values of the length-weight relationship from samples collected along the Croatian coast were $a=0.0091$ and $b=2.952$ (Dulčić and Kraljević, 1996a). The theoretical maximum length was estimated (for Mirna Estuary, Tar cove) to be $L_{\infty}=398$ mm (Kraljević and Dulčić, 1996) and it is not unrealistic since the largest specimen sampled during the surveys was 418 mm. Jardas (1996) reported the maximum size of 50 cm SL (standard length). The growth coefficient was computed as $K=0.21 \text{ yr}^{-1}$. The maximum age was 11+ years; most of the specimens were between 3+ and 8+ years old. The mean condition factor was estimated to be 0.77 (Kraljević and Dulčić, 1996).

Exploitation

The golden grey mullet is the target of commercial fishery along the eastern Adriatic coast, the total catch has been reported at about 280 tonnes in 1991 according to FAO statistics and makes a significant component of Croatian coastal catches. Grubišić (1982) reported the

average annual Croatian catch at about 50 tonnes. Family Mugilidae was numerically dominant in the catches in the Mirna Estuary (Tar Cove) contributing to 93.6% of the total catch (over the period of eight years) of which *L. aurata* constituted about 89%.

The values of the total mortality (Z), natural mortality (M), fishing mortality (F) and exploitation rate (E), for the Mirna Estuary have been estimated as: $Z=0.649 \text{ yr}^{-1}$, $M=0.387 \text{ yr}^{-1}$, $F=0.262 \text{ yr}^{-1}$ and $E=0.404$ (Kraljević *et al.*, 1994). Subsequently total (Z) and natural (M) mortality rates were estimated at 1.12 yr^{-1} and 0.44 yr^{-1} , respectively.

The exploitation rate ($E=0.61$) indicates that the fishing pressure on the golden grey mullet was high in the Mirna Estuary (Kraljević and Dulčić, 1996).

***Liza ramada* (Risso, 1826)**

Family: Mugilidae

EN: Thinlip grey mullet

HR: Cipal balavac

Species description

The body is cylindrical, the head broad, a little rounded between the eyes. The space between the eyes is about equal to the width of the mouth cleft. Adipose eyelid poorly developed. The upper lip is thin, less than pupil diameter, corner of mouth cleft reaching to below posterior nostril; hind edge of pre-orbital round. Pectoral axillary scale rudimentary or absent. Scales on head extend forward to the level of the front nostril. The back is a grey/blue colour, the flanks and belly pale or silvery, usually with feeble longitudinal stripes along scale rows. Black axillary spot is at pectoral fin base.

Distribution

Thin-lip grey mullet is distributed along the Atlantic coasts from the Azores and Madeira northwards to the British Isles (except northern parts of Scotland), North Sea and southern part of Baltic, mainly appearing in summer-time in northern parts of range. It is also present in the whole Mediterranean and Black Sea. Southward is present to Cape Verde Islands and Senegal (Jardas, 1996). It is common in the eastern Adriatic (Jardas, 1996).

Biological data

It is a pelagic species, usually occurring inshore, entering lagoons and estuaries and rivers. It feeds on epiphytic algae, detritus and small benthic or planktonic organisms (Jardas, 1996). The analysis of gonad state and the occurrence of juveniles showed that the spawning season (in the eastern central Adriatic) extended at least over December and January (Sinovčić *et al.*, 1986). The length-weight relationship shows (Šibenik area, eastern middle Adriatic) negative allometry during the time of sexual inactivity ($a=0.0102$, $b=2.931$) (Sinovčić *et al.*, 1986). The parameters of the VBGF are: $L_{\infty}=52.5$ cm, $K=0.25$ yr⁻¹ and $t_0=-0.1$, the maximum age is estimated at 8+ years and the length at sexual maturity at 18 cm (Sinovčić *et al.*, 1986).

Exploitation

Natural mortality estimate is $M=0.25$ yr⁻¹, total mortality (Z) varied from 0.29 (for age class 3+ to 4+) to 1.27 yr⁻¹ (for age class 5+ to 6+) and the exploitation rate (E) varied from 0.626 (7+ to 8+) to 0.814 (5+ to 6+) indicating that fishing pressure on the thinlip grey mullet is very high (Sinovčić *et al.*, 1986). Grubišić (1982) reported the national average annual catch at about 50 tonnes.

***Mullus barbatus* Linnaeus, 1758**

Family: Mullidae

EN: Red mullet

HR: Trlja blatarica

Species description

The body is long, strong, and laterally slightly flat. The head is relatively short, the snout is short as well, with a steep anterior profile. The eyes are positioned near the top of the head. The mouth is small, positioned low on the head. There are two barbells under the mouth aperture. They have a sensory function and are used in searching for prey. Number of rays in fins is the following: D1 VII-VIII, D2 I + 7-8, A: II + 6-7, P: 15-17, V: I+5 (Jardas, 1996). The colour is rather uniformly pink. Back is darker and belly white. Fins are without any well-defined coloration (Jardas, 1996).

Distribution

Red mullet is distributed in the eastern Atlantic, from the North Sea and England to Senegal, and in the Mediterranean. It is uniformly distributed in all parts of the Adriatic (Jardas, 1996).

Biological data

This is a benthic species mostly found on muddy grounds in the depth range from 5 to 250 m. It prefers more shallow waters of the northern and central Adriatic, i.e. depth above 100 m, while only few specimens may be caught in deeper waters. Red mullet can attain the length of about 30 cm TL (about 0.5 kg), but usual size in the catch is from 10 to 20 cm (Jardas, 1996). On average, females have larger body length than males. This is because they grow faster, which can already be noticed in the first year of their life. The length-weight relationship shows that the species grows almost isometrically (males: $a=0.0065$, $b=3.179$; females: $a=0.00847$, $b=3.082$, Županović, 1963; both sexes: $a=0.0076$, $b=3.136$, Dulčić and Kraljević, 1996a). Red mullet spawns in the Adriatic Sea in late spring and summer (Županović, 1963; Jardas, 1996). The sex ratio is extremely variable and depending on the different zones investigated. The parameters of the VBGF are: $L_{\infty}=27.0$ cm and $K=0.18$ yr⁻¹ (Jukić and Piccinetti, 1988) and $L_{\infty}=26.86$ and $K=0.295$ yr⁻¹ (Vrgoč, 2000). It is a carnivorous species, and bulk of its food is made of endo, meso and epibiontic sea organisms. Its food is constituted of Polychaeta, Lamellibranchiata and Crustacea (Jardas, 1996).

Exploitation

Grubišić (1982) reported the average annual catch (Croatian coast) of *M. barbatus* and *M. surmuletus* together at about 266 tonnes.

***Mullus surmuletus* Linnaeus, 1758**

Family: Mullidae

EN: Striped red mullet

HR: Trlja kamenjarka

Species description

The body is moderately compressed. The snout is longer and less deep than *Mullus barbatus*. Maxilla at most reaching below anterior eye margin. A pair of stout barbells under chin, their length greater than that of pectoral fins. Opercle without spine. Small villiform teeth on lower jaw; upper jaw toothless; teeth also present on vomer and palatines. Colour is reddish with brown edges on the scale margins, pink on the sides with three lengthwise yellow bands; the first dorsal fin yellowish with dark markings, mainly on the upper part of the fin membrane.

Distribution

Mullus surmuletus is distributed along the coasts of Europe from the English Channel (rare in the North Sea) to Gibraltar, also northern part of West Africa to Dakar and in the Mediterranean, Black and Adriatic Seas (Jardas, 1996).

Biological data

It is a benthic species on broken and rough ground but also taken in fair quantities over sand and soft bottoms at depths less than 100 m. It feeds on bottom organisms (crustaceans, chiefly shrimps and amphipods, polychaetes, molluscs and benthic fishes (Jardas, 1996). Striped red mullet could reach 40 cm Standard Length (SL), but usually 20-25 cm specimens are found. It spawns from May to July (Jardas, 1996). The parameters of the length-weight relationship (for the eastern Adriatic) are: $a=0.025$ and $b= 3.512$, indicating positive allometric growth (Dulčić and Kraljević, 1996a).

Exploitation

Grubišić (1982) reported the average annual catch (Croatian coast) of *Mullus surmuletus* and *Mullus barbatus* together at about 266 tonnes.

***Chromis chromis* (Linnaeus, 1758)**

Family: Pomacentridae

EN: Damselfish

HR: Crnelj

Species description

The body is oval, deep, laterally flattened. The head short, obtuse. There is a single nostril on each side, the mouth is small, protractile; jaws with small teeth. The eye is large. Small canine-like teeth in 3 rows on jaws. D XIII-XIV + 10-11; A II 10-12. Head fully scaled. Colour: very young specimens brilliant iridescent blue; young specimens with blue stripes and dorsal and anal fins outlined with blue and adults dark brown (Jardas, 1996).

Distribution

It occurs in the Mediterranean and from Portugal southwards to Angola (Jardas, 1996). It is very common in the Adriatic (Jardas, 1996).

Biological data

Chromis chromis inhabits littoral mainly in rocky areas from 3 to 35 m depth in small shoals in midwater above or near rocky reefs and above sea-grass meadows (*Posidonia*). It feeds on small or benthic species (Jardas, 1996). The main food components are Copepoda, Appendicularia, Cladocera, Gastropod larvae, Bivalve larvae, fish eggs and fish larvae (Dulčić, 1996). The parameters of the length-weight relationship are: $a=0.0164$ and $b=3.10$ (for both sexes), $a=0.0172$ and $b=3.08$ (for females), and $a=0.0138$ and $b=3.12$ (for males) (Dulčić and Kraljević, 1995; Dulčić *et al.*, 1994). The parameters of the VBGF have been estimated as $L_{\infty}=142$ mm, $K=0.26$ yr⁻¹, $t_0=-0.30$, while maximum age is 9 years (Dulčić and Kraljević, 1995). Fecundity ranged from 6 050 to 73 688 eggs (Dulčić and Kraljević, 1994). It could reach 15 cm SL, but usually from 8 to 10 cm.

Exploitation

Grubišić (1982) reported that the average annual catch (Croatian coast) is around 30 tonnes. The total mortality and natural mortality estimates are $Z=1.07$ yr⁻¹ and $M=0.72$ yr⁻¹. Fishing mortality was estimated as $F=0.35$ yr⁻¹ and the exploitation rate $E=0.35$ (Dulčić and Kraljević, 1995). The main fishing gear for damselfish is the coastal beach seine («migavica»).

Scorpaena porcus Linnaeus, 1758

Family: Scorpaenidae

EN: Black scorpionfish

HR: Škrpun

Species description

Head is large, snout slightly smaller than orbit diameter; preorbital bone usually with 2 spinous points over axilla; sub-orbital ridge with 2 or 3 spinous points; upper post-temporal spine present; other spines as for the genus. Occipital pit well developed. Pores at symphysis of lower jaw are small and separate. Supra-ocular tentacle usually about equal to orbit diameter; skin appendages well developed; no flaps on lower jaws; small dermal flaps associated with preorbital, preocular, parietal, nuchal and preopercular spines; other tentacles at anterior nostril, below sub-orbital ridge, on eye opercle flap, rarely on some body scales and some lateral line scales. D XII + 9; P 16-18. Colour is generally brownish, a light pigmented area between dorsal spines 8 and 9; fins variously spotted with brown; 3 vertical bars on caudal fin (Jardas, 1996).

Distribution

It is distributed in the Eastern Atlantic from the British Isles to Morocco, rare to Senegal; the Azores, the Canaries; Mediterranean including Black Sea. It is common in the Adriatic Sea (Jardas, 1996).

Biological data

The black scorpionfish is a benthic littoral species common among rocks and algae and may be found down to 800 m bottom depth (it could be solitary and sedentary) (Jardas, 1996). The diet includes small fishes (gobies, blennies), crustaceans and other invertebrates. It feeds on Phycophyta, Spermatophyta, Polychaeta, Mollusca, Crustacea and Pisces (Pallaoro and Jardas, 1991). It could reach the length of 25 cm, but usually of 15 cm (Jardas, 1996). The parameters of the length-weight relationship (eastern Adriatic) are: $a=0.0171$ and $b=3.034$, indicating isometric growth (Jardas and Pallaoro, 1992). The parameters of the VBGF are: $L_{\infty}=28.2$ cm, $K=0.182$ yr⁻¹, $t_0=-0.80$, while the maximum age was estimated as 11 years (Jardas and Pallaoro, 1992).

Exploitation

Grubišić (1982) reported the annual average catch in Croatia, together with that of the red scorpionfish, is of 178 tonnes.

Scorpaena scrofa Linnaeus, 1758

Family: Scorpaenidae

EN: Red scorpionfish

HR: Škrpina

Species description

Head large, snout longer than orbit diameter; preorbital bone with 3-4 spinous points over maxilla; sub-orbital ridge with 2-4 spinous points; upper post-temporal spine present. Occipital pit moderate. The pores at symphysis of lower jaw are small and separate. Supraocular tentacle usually small or absent; numerous tentacles present on the lower jaw, large skin flap associated with posterior preorbital spine and flaps on fourth and fifth preopercle spines. D XII + 9; A 18-20. Colour is variable from brick red to light pink with dark mottling or blotches; fins blotched with brown; distal part of pelvic fins usually dusky; dorsal fin with a back spot frequently present between spines 6 and 11.

Distribution

Red scorpionfish is present in the Eastern Atlantic from British Isles (rare) to Senegal, Madeira, Canary Islands, Cape Verde Islands; throughout Mediterranean except Back Sea (Jardas, 1996). It is common in the central and southern Adriatic (Jardas, 1996).

Biological data

Scorpaena scrofa is a benthic species occurring on rocky, sandy or muddy bottoms from 20 to 200 m bottom depth. It is a sedentary and solitary fish (Jardas, 1996). It feeds on fishes, crustaceans and molluscs (Šoljan and Karlovac, 1932). It could reach the length of 50 cm, usually up to 30 cm (Jardas, 1996). The parameters of the length-weight relationship (for the southern Adriatic) are: $a=7 \times 10^{-6}$ and $b=3.298$ indicating positive allometric growth (Dulčić *et al.*, 1995c).

Exploitation

Grubišić (1982) reported the annual average catch in Croatia, together with that of the black scorpionfish, is of 178 tonnes.

Solea solea
Family: Soleidae

EN: Common sole

HR: List, šfoja

Species description

The body is oval and flat; the upper eye less than its own diameter from dorsal profile of head. Anterior nostril on blind side not enlarged, its distance from front margin of head 1.5-1.9 times in its distance from cleft of mouth; anterior nostril on eyed side with a backward-pointing tube not or only barely reaching front border of lower eye. The dorsal fin begins on the upper profile of the head. Colour is greyish-brown on eyed side to reddish brown, with large and diffuse dark spots; pectoral fin on eyed side with a blackish blotch at posterior end of fin; hind part of caudal fin generally darker than the rest.

Distribution

The Common sole occurs in the eastern Atlantic (southward from Trondheim Fjord, also North Sea and western Baltic) and Mediterranean (also Sea of Marmora, Bosphorus and south-western Black Sea), and southward to Senegal (Jardas, 1996). It is common in the Adriatic, particularly in the northern and central part (Jardas, 1996).

Biological data

It is a demersal species dwelling on sandy and muddy bottoms, from the shore down to 200 m bottom depth. It feeds on polychaete worms, molluscs and small crustaceans (Jardas, 1996). Spawning takes place from January to April, with two peaks in February (Mediterranean), December-May (Bay of Biscay), April-June (North Sea). Common sole could reach 70 cm SL (Jardas, 1996). The parameters of the length-weight relationship (northern Adriatic-western Istrian coast) were estimated as $a=0.0016$ and $b=3.510$ (Cetinić *et al.*, 2003), indicating positive allometric growth. The parameters of the VBGF are: $L_{\infty}=40.1$ cm and $K=0.68$ yr⁻¹; the length at sexual maturity was estimated to be 30 cm (western Istrian coast) (Cetinić *et al.*, 2003). It could reach the maximum age of 7 years in the northern Adriatic (Croatian coast) (Cetinić *et al.*, 2003).

Exploitation

Total mortality is high with $Z=1.40$ yr⁻¹, while natural mortality values is estimated as $M=0.895$ yr⁻¹ and fishing mortality as $F=0.505$ yr⁻¹ (Cetinić *et al.*, 2003). Grubišić (1982) reported at that time the national average annual catch as about 30 tonnes.

***Boops boops* (Linnaeus, 1758)**

Family: Sparidae

EN: Bogue

HR: Bukva

Species description

The body is elongated and fusiform, moderately compressed: Eye large, diameter longer than snout. Mouth small, oblique; lips very thin. The teeth are incisiform, uniserial in both jaws. D XIII-XV + 12-16; A III + 14-16. Pectoral fin short, ending before anus. Colour is back greenish or bluish, sides silvery or golden with 3-5 longitudinal golden lines with small dark spot at the pectoral axil; lateral line is dark while fins are light (Jardas, 1996).

Distribution

Boops boops is distributed in the whole of the Mediterranean, rare in the Black Sea. In the eastern Atlantic it occurs from Norway (occasional) to Angola and oceanic islands; common from Bay of Biscay to Gibraltar. Elsewhere, it is present in the western Atlantic in Gulf of Mexico and Caribbean Sea. It is very common in the Adriatic Sea (Jardas, 1996).

Biological data

Bogue is a relatively common species in inshore waters, demersal or semipelagic above various bottoms (sand, mud, rocks, *Posidonia* beds), to 200 m (Mediterranean) or 300 m (Atlantic) (Jardas, 1996). It is a gregarious species that moves toward the surface during the night.

Bogue is omnivorous species whose juveniles are mostly carnivorous while the adults are mainly herbivorous.

It spawns from February to April (eastern Mediterranean), from April to May (western Mediterranean), from March to May (Atlantic) and in summer (Black Sea). The species is hermaphroditic (generally protogynous). The fecundity is about 350 000 eggs (at the size of 32 cm TL). Maturity is at the first year (about 13 cm length) in western Mediterranean. Bogue could reach a maximum of 36 cm TL, but usually the range is between 15 and 20 cm TL. The sex ratio has been reported in favour of males (1.25:1) (in the eastern central Adriatic), while it is about 60% females at range between 10 and 25 cm TL in the Mediterranean.

The allometric coefficient of the length-weight relationship $b=3.113$ indicates positive allometry in the eastern Adriatic ($a=0.0000644$) (Alegria-Hernandez, 1989). The parameters of the VBGF as estimated from eastern Adriatic samples are: $L_{\infty}=33.89$ cm, $K=0.167$ yr⁻¹ and $t_0=-1.296$ (Alegria-Hernandez, 1989). The oldest specimens were estimated to be 6 years old (Alegria-Hernandez, 1989). Length at sexual maturity has been estimated to be 13.2 cm for males and 14.7 cm TL for females (Alegria-Hernandez, 1990).

The bogue feeds on Spermatophyta, Thallophyta, Copepoda, Copelata, Chaetognatha, Decapoda larvae and fish eggs (Jukić, 1972; 1973). It feeds on a variety of animal groups.

Copepoda constitute the bulk (55.5%), followed by Copelata (38.3%) which characterizes it as a planktonphagous species (Jukić, 1972; 1973).

Exploitation

The values of natural mortality was calculated to be $M=0.207 \text{ yr}^{-1}$ (Alegria-Hernandez, 1986; 1989). Grubišić (1982) reported the national average annual catch at about 700 tonnes (about 2% of total catch of marine fishes) of which 500 t from the fish market of Split.

Fishing gears for catching bogue are purse seine and beach seine (during summer) and trawl and bottom trammel set (during winter). Dujmušić (2000) approximated the catch of bogue in 1998 as 81 884 kg (the largest part, 38 750 kg, was estimated to be from the Ploče and Dubrovnik area). Numerical abundance of bogue in the catch of the coastal fishing gears along the Croatian coast was 21.26% in coastal beach seine catch and 0.59% in "strašin" fishing catch (Jardas *et al.*, 1998). Bogue weight composition was 13.08% in trammel net and 0.35% in "strašin" fishing catch (Jardas *et al.*, 1998).

***Dentex (Dentex) dentex* (Linnaeus, 1758)**

Family: Sparidae

EN: Common dentex

HR: Zubatac

Species description

Body oblong, rather deep. Upper profile of head regularly convex in adults, almost straight in the young. Slight hump at forehead in the oldest specimens. D XI + 11-12; A III + 7-9. The length of dorsal spines increases to fourth or fifth then sub-equal. In young the colour is greyish, dorsally black spotted, pinkish at maturity, grey-blue in the oldest specimens; dorsal spots more or less shaded with age.

Distribution

The common dentex is present in the Mediterranean, most common south of 40° N (Spain, North Africa); Black Sea (very rare); Atlantic from Bay of Biscay to Cape Blanc and Madeira, exceptionally to the British Isles; elsewhere, southward to Senegal (Jardas, 1996). It is common in the Adriatic Sea (Jardas, 1996).

Biological data

Dentex dentex inhabits inshore waters on rocky bottoms to 200 m depth; it is more common between 15 and 50 m. Juveniles are gregarious, while the oldest individuals are solitary. It is a carnivorous species feeding on fish and molluscs. It reproduces in May (Mediterranean), and it is gonochoric fish, some specimens are hermaphrodite (Jardas, 1996). The common dentex could reach 100 cm SL, but is usually 35 or 50 cm. The parameters of the length-weight relationship (for the eastern Adriatic) are: $a=0.064$ and $b=3.172$ (Dulčić and Kraljević, 1996a), indicating positive allometric growth.

Exploitation

Numerical contribution of common dentex to the coastal fishing gear catch along the Croatian coast was 0.37% in trammel net and 0.18% in tramata catches (Jardas *et al.*, 1998). Weight participation was 0.54% in trammel net and 2.05% in tramata catches (Jardas *et al.*, 1998). Grubišić (1982) reported the national average annual catch at about 60 tonnes. Dujmušić (2000) approximated for the year 1998 the pooled catch of common Pandora, common dentex, sharpsnout seabream, gilt-head seabream and common two-banded seabream as of 105 458 kg (the largest part, 67 262 kg, from the area of Zadar).

Dentex gibbosus (Rafinesque, 1810)

Family: Sparidae

EN: Pink dentex

HR: Zubatac krunaš

General information

The body is oblong, rather deep; upper profile of head regularly convex in the young, strong hump on the forehead in the largest specimens. D XII + 10-11; A III + 7-9; two first dorsal spines are very short, the two or three following very long and filamentous in the young; first pelvic ray filamentous. Colour is reddish-silver; a little black spot behind the posterior end of dorsal fin; small dark areas at the pectoral axil and at the upper opercular margin; the caudal fin is pink with a narrow black margin.

Distribution

It inhabits the Mediterranean, more common south of 40° N and in the eastern Mediterranean (absent in the Gulf of Lion and in the Black Sea) and the Atlantic from Portugal to Angola, abundant from Cape Juby to Cape Verde (Jardas, 1996). In the Adriatic it can be found in the central and southern basins (Jardas, 1996).

Biological data

Dentex gibbosus occurs in inshore waters on rocky bottoms and sand around rocks between 20 and 220 m depth; young specimens stay closer to the shore than the adults. It is a carnivorous species (crustaceans, fish, cephalopods). Spawning takes place during spring; the species is hermaphroditic protandrous (50-70% males up to 50 cm body length) (Jardas, 1996). It could reach 100 SL, but usually from 35 to 60 cm (Jardas, 1996). The sex ratio is 1:1.21 in favour of females (eastern Adriatic) (Grubišić, 2002). The parameters of the length-weight relationship are: $a=0.088$ and $b=3.13$ (for both sexes), indicating positive allometric growth (Grubišić, 2002). The parameters of the VBGF are: $L_{\infty}=107.24$ cm, $K=0.12$ yr⁻¹ and $t_0=-0.90$, the maximum age is estimated of 16 years (Grubišić, 2002). Mean absolute fecundity of pink dentex (eastern Adriatic) is 1672×10^6 eggs, while the length at sexual maturity is estimated to be 41.5 cm (Grubišić, 2002).

Exploitation

Numerical occurrence of the pink dentex in trammel net catch from the Croatian coast was 0.02% and the weight share 0.02% (Jardas *et al.*, 1998). Grubišić (1982) reported the national average annual catch as about 2 tonnes. Total and natural mortality were found to be $Z=0.47$ yr⁻¹ and $M=0.23$ yr⁻¹ in the eastern Adriatic (Grubišić, 2002). The value of fishing mortality was calculated as $F=0.24$ yr⁻¹, the exploitation rate $E=0.51$ suggests that the stock was almost fully fished (Grubišić, 2002).

***Diplodus annularis* (Linnaeus, 1758)**

Family: Sparidae

EN: Annular seabream

HR: Špar

Species description

The body is oblong, the mouth terminal, 8 incisors in each jaw, molars at back of jaws in 2-4 upper and 2-3 lower series; 1-3 rows of small molars just behind incisors. D XI + 11-13; A III + 11-12. Colour is silvery grey, yellowish; one almost annular dark band around caudal peduncle just behind dorsal and anal fins; pelvis yellow, other fins light; small dark spot at the upper pectoral axil (Jardas, 1996).

Distribution

Diplodus annularis is common in the Mediterranean, Black Sea and Azov Sea, and in the Atlantic from Bay of Biscay to Gibraltar, Madeira and Canaries (Jardas, 1996). It is also very common in the Adriatic Sea (Jardas, 1996).

Biological data

Annular seabream is very common along the littoral area, on *Posidonia* beds and sandy bottoms, rarely on rocky bottoms, from 0 to 3 m (Atlantic and northern Mediterranean) or from 0 to 90 m (southern Mediterranean). It is a carnivorous species feeding on worms, crustaceans, molluscs, echinoderms and hydrozoans (Jardas, 1996). It feeds on macrobenthic algae, bivalves, marine phanerogames, Anthozoa, Polychaeta and Crustacea (juveniles), while adults on mollusca, decapoda, bivalvia, green algae and fish eggs (Matić-Skoko, 2003). Normally sexes are separate although some individuals can be hermaphroditic (protandrous). Sex ratio (in the eastern Adriatic) is 1:1.12 in favour of females (Matić-Skoko, 2003). The parameters of the length-weight-relationship are: $a=0.014$ and $b=3.073$ (Matić-Skoko, 2003). The parameters of the VBGF are: $L_{\infty}=22.6$ cm, $K=0.173$ yr⁻¹ and $t_0=-1.460$ (Matić-Skoko, 2003). The maximum age was estimated of 13 years (Matić-Skoko, 2003). Mean relative fecundity has been reported of 65389 eggs (Matić-Skoko, 2003). The length at sexual maturity is estimated to be 9.0 cm TL (Matić-Skoko, 2003).

Exploitation

Total and natural mortality (in the eastern Adriatic) were found to be $Z=0.725$ yr⁻¹ and $M=0.392$ yr⁻¹, while fishing mortality was $F=0.333$ yr⁻¹ (Matić-Skoko, 2003). The exploitation rate $E=0.459$ suggests that the stock was almost fully fished (Matić-Skoko, 2003). Grubišić (1982) reported the national average annual catch at about 30 tonnes. Fishing gears catching annular sea bream are: trawl, pots, coastal beach seine and trammel nets. Numerical participation of the Annular seabream in the catch of the coastal fishing gears along the Croatian coast was 12.50% in trammel net and 6.55% in "kogol" fishing catches and weight contribution was 5.25% in trammel net and 3.982% in "tramata" fishing catches (Jardas *et al.*, 1998).

***Diplodus puntazzo* (Cetti, 1777)**

Family: Sparidae

EN: Sharpsnout seabream

HR: Pic

Species description

The body is oblong, the snout conical, lips thin. In each jaw, 8 incisors inclined forward (light brownish coloured); 1 or 2 series of rudimentary molars at back of jaws. D XI + 12-15; A III + 11-13. The first dorsal spin is very short. The colour is silvery grey, 11 to 13 transverse stripes, alternately very dark and paler; dark band in caudal peduncle; hind caudal edge dusky; other fins greyish, distally darker; very dark spot at the upper base of pectoral fin; general coloration fading with age and after death.

Distribution

It is very common throughout the Mediterranean, rare in Black Sea; Atlantic, common from Gibraltar to Sierra Leone, rare to the north (Bay of Biscay); absent in Madeira, present in the Canaries and the Cape Verde Islands (Jardas, 1986). It is common in the Adriatic Sea (Jardas, 1996).

Biological data

Diplodus puntazzo lives in littoral waters on rocky bottoms to 150 m depth (more abundant around 60 m); juveniles occur near the coast and sometimes in brackish waters (deep lagoons); adults in breakers. It is an omnivorous species (algae, worms, mussels, shrimps) (Jardas, 1996). Maximum length is 60 cm SL, but usually 25-30 cm (Jardas, 1996). The parameters of the length-weight relationship (for the eastern Adriatic) are: $a=0.0161$ and $b=2.951$, indicating isometric growth (Dulčić and Kraljević, 1996a).

Exploitation

Numerical participation of sharp-snout seabream in the coastal fishing gear catch along the Croatian coast was 0.46% in «tramata» and 0.30% in trammel net catches (Jardas *et al.*, 1998). Weight composition was 1.79% in «tramata» and 0.37% in coastal beach seine catches (Jardas *et al.*, 1998). Grubišić (1982) reported the average annual catch (in the eastern Adriatic) at about 15 tonnes. Dujmušić (2000) approximated for the year 1998 the pooled catch of common pandora, common dentex, sharpsnout seabream, gilt-head seabream and common two-banded seabream as 105 458 kg (the largest part, 67 262 kg, from the area of Zadar).

***Diplodus sargus sargus* (Linnaeus, 1758)**

Family: Sparidae

EN: White seabream

HR: Šarag

Species description

The body is oblong, the lips thin; in each jaw, 8 incisors (exceptionally 10 in upper one); molars behind incisors and at back of jaws in several series, 3-4 (rarely 5) in upper, 2-3 (rarely 4) in lower jaw. D XI-XII (rarely XIII) + 12-15; A III + 12-14. Colour is silvery grey, inter-ocular space and snout darker; 9 transverse stripes alternately very dark and paler; dark saddle on caudal peduncle, just behind last dorsal rays; black spot at upper pectoral axil; dorsal and anal dusky, distally darker; hind caudal edge black.

Distribution

It is common in the Mediterranean and rare in the Black Sea (Jardas, 1996). It is common in the Adriatic Sea (Jardas, 1996).

Distribution

White seabream occurs in littoral waters on rocky bottoms and sand close to rocks, up to 50 m in Mediterranean, deeper in the Atlantic; young euryhaline, entering brackish waters and lagoons in spring, returning to sea at the end of autumn, where they live on *Posidonia* beds. Young specimens (to 10 cm) are omnivorous mainly feeding on algae and worms, small molluscs and hydrozoans, adults are carnivorous including worms, molluscs, crustaceans and echinoderms in their diet. It spawns from January to March (eastern Mediterranean), from March to June (western Mediterranean). This species is gonochoric or hermaphroditic protandrous. Individuals reach the sexual maturity at 2 years of age (about 17 cm). White seabream could reach 45 cm SL, but usually 20 or 25 cm (Jardas, 1996). The parameters of the length-weight relationship (for the eastern Adriatic) are: $a=0.0149$ and $b=3.038$, indicating isometric growth (Dulčić and Kraljević, 1996a).

Exploitation

Numerical abundance of the white seabream in the coastal fishing gear catches along the Croatian coast was: 0.20% in «tramata» and 0.02% in trammel net catches (Jardas *et al.*, 1998). Weight composition was: 0.64% in «tramata» 0.37% in trammel net catches (Jardas *et al.*, 1998). Grubišić (1982) reported the average annual catch from the eastern Adriatic (Croatian) coast at about 15 tonnes.

***Diplodus vulgaris* (E. Geoffrey Saint-Hilaire, 1817)**

Family: Sparidae

EN: Common two-banded seabream

HR: Fratar

Species description

The body is oblong, lips rather thick; in each jaw, 8 narrow incisors (light brownish coloured). D XI-XII + 13-16; A III + 12-15. Colour is generally grey, brownish to greenish; broad black band from nape to axil of pectorals and on upper margin of opercle; broad black band across caudal peduncle overlapping posterior bases of anal and dorsal fins; black spot at the upper pectoral axil, caudal fin dark, black distally; other fins dusky, darker distally.

Distribution

Diplodus vulgaris is common in all the Mediterranean, recorded in the Black Sea off Bulgaria; in the Atlantic from south of Brittany to Cape Verde Islands, Madeira and the Canaries; elsewhere, off Angola (Jardas, 1996). It is common in the Adriatic Sea (Jardas, 1996).

Biological data

The Common two-banded seabream is widespread species in littoral waters on rocky or sandy bottoms to 90 m (Atlantic), to 70 m depth (Mediterranean); juveniles occur on *Posidonia* beds and can enter into lagoons (Atlantic and exceptionally Mediterranean). This species is carnivorous feeding on crustaceans, molluscs and worms. It reproduces generally in October-November in the western Mediterranean and in December-January in the eastern Mediterranean. *Diplodus vulgaris* reaches sexual maturity at the age of 2 years (17 cm TL), it is potentially hermaphrodite. Maximum length is 45 cm TL, but usually 20-25 cm (Jardas, 1996). The parameters of the length-weight relationship (for the eastern Adriatic) are: $a=0.0138$ and $b=3.028$, indicating isometric growth (Dulčić and Kraljević, 1996a).

Exploitation

Numerical occurrence of the common two-banded sea bream in coastal fishing gear catches along the Croatian coast was 4.53% in «tramata» and 1.47% in bottom trammel net catches (Jardas *et al.*, 1998). Weight composition was 6.16% in «tramata» and 4.17% in coastal beach seine catches (Jardas *et al.*, 1998). Grubišić (1982) reported the average annual catch (from Croatian coast) at about 15 tonnes. Dujmušić (2000) approximated for the year 1998 the pooled catch of common Pandora, common dentex, sharpsnout seabream, gilt-head seabream and common two-banded seabream as 105 458 kg (the largest part, 67 262 kg, from the area of Zadar).

Lithognathus mormyrus (Linnaeus, 1758)

Family: Sparidae

EN: Sand steenbras (also Striped sea bream)

HR: Ovčica, arkaj

Species description

The body is elongated and ovoid, well compressed. Upper profile of head gently curved, the snout is elongated and pointed. Posterior nostril is an oblique slit, just in front of eye. Scales on cheek and opercle, while peropercle is broad and scaleless. The eye is rather small. In front of each jaw, the outer series of conical teeth is slightly enlarged, followed by inner bands of shorter teeth. At the back of the jaw there are molariform teeth in 3-6 upper and 2-4 lower rows. D XI-XII+11-12, A III+10-11. The pectoral fin is short, ending well before anus. Lateral line scales 59-65 to caudal base. Colour is silvery grey, darker dorsally. There are 14-15 narrow, more or less dark. Transverse stripes. Interocular space and snout are dark brown. Dorsal and caudal fins are generally brownish, while other fins are lighter.

Distribution

The sand steenbras is widely distributed in the Mediterranean Sea (except the Black Sea), Atlantic (from Bay of Biscay to Cape of Good Hope), Red Sea and south-western Indian Ocean (Jardas, 1996).

Biological data

Lithognathus mormyrus inhabits littoral waters on sandy or sandy-muddy bottoms down to a maximum depth of 50 m (in the western Mediterranean), 80 m (eastern Mediterranean) or 150 m (Atlantic), but predominantly between 10 and 30 m (Jardas, 1996). It exceptionally enters Mediterranean lagoons. It is a protandrous hermaphrodite fish (Jardas, 1996). It is gregarious, sometimes in large schools. As a carnivorous species, it feeds on crustaceans, worms, molluscs and sea urchins (Jardas, 1996). The maximum size is 55 cm SL but usually in catches it is about 25 cm (Jardas, 1996). Spawning takes place in spring and summer. Sex ratio are given for length and age classes, indicating the males change sex mainly at the lengths between 25 and 32.5 cm, in age classes from 4 to 7, with more than 30% of the population changing sex in age class from 6 to 7 on the eastern coast of the Adriatic (Croatian coast) (Kraljević *et al.*, 1995). Males were also observed up to a length of 34.5 cm. Length-weight relationship shows no significant difference from isometric growth in winter ($b=3.05$) and a negative allometric growth in summer ($b=2.69$). The age composition has been estimated using the Bhattacharya method and additional observations of annual rings on scales. Six age classes were obtained from Kaštela Bay (age 3+: 21.7 cm, age 4+: 26.5 cm, age 5+: 28.4 cm, age 6+: 30.3 cm, age 7+: 31.6 cm, age 8+: 33.4 cm) and from Mirna Bay (age 2.5+: 19.4 cm, age 3.5+: 24.1 cm, age 4.5+: 26.9 cm, age 5.5+: 29.4 cm, age 6.5+: 31.3 cm, age 7.5+: 32.8 cm). Von Bertalanffy's growth function fitted to these mean length-at-age data resulted in the following parameter values: $L_{\infty}=36.2$ cm, $K=0.297$ yr⁻¹ and $t_0=-0.08$ (yr) for Kaštela Bay and $L_{\infty}=37.3$ cm, $K=0.262$ yr⁻¹ and $t_0=-0.39$ for Mirna Bay (Kraljević *et al.*, 1995). In a study conducted in the Northern Adriatic (west Istrian peninsula) the total length in the samples ranged from 19.4 to 37.6 cm (Kraljević *et al.*, 1996). The length-weight relationship was described for males ($a=0.0106$, $b=3.023$) and females ($a=0.0094$, $b=3.063$).

Fish aged 3-12 years were present in the samples (Kraljević *et al.*, 1996). Growth parameters were: $L_{\infty}=40.05$ cm, $K=0.196$ yr⁻¹ and $t_0=-0.945$. The overall male to female ratio was 1:1.62. Sex inversion occurred mainly at lengths between 24.1 and 35.2 cm, in age classes 4-8, males were observed up to a length of 34.5 cm TL (Kraljević *et al.*, 1996). Parameters of the length-weight relationship for the sand steenbras along the Croatian coast were: $a=0.0115$ and $b=3.022$ (Dulčić and Kraljević, 1996a). The length range in the catches of "tramata" fishing was from 21.1 to 41.6 cm TL, while the parameters of the length-weight relationship were: $a=0.0155$ and $b=3.022$ (Cetinić *et al.*, 2002).

Exploitation

Total and natural mortality were found to be $Z=0.77$ yr⁻¹ and $M=0.42$ yr⁻¹ in the Northern Adriatic (Croatian coast) (Kraljević *et al.*, 1996). The exploitation rate $E=0.45$ suggests that the stock was almost fully fished (Kraljević *et al.*, 1996). Grubišić (1982) reported that the annual catch of sand steenbras along the Croatian coast never exceeded 5 tonnes, while in the study area (Mirna Estuary) it ranged between 0.02 to 4.47 tonnes per year for the period 1983-1991 (Kraljević *et al.*, 1994). Numerical occurrence of the sand steenbras in the coastal fishing gear catches along the Croatian coast was: 0.50% in trammel net catches, and 0.38% in "tramata" fishing catches (Jardas *et al.*, 1998). Weight composition in the coastal fishing gear catches was: 1.22% in trammel net catches, and 0.82% in "tramata" fishing catches (Jardas *et al.*, 1998).

Oblada melanura (Linnaeus, 1758)

Family: Sparidae

EN: Saddled seabream

HR: Ušata, očada

Species description

Body elongated and ovoid; eye large and its diameter twice suborbital depth. Snout is short, mouth small; in each jaw an outer series of 8-10 frontal incisors followed by lateral small conical teeth. Colour is silvery grey, in back darker. It has fine longitudinal dark lines along rows of scales. On the caudal peduncle there is a large black saddle surrounded by a white ring. D XI+13-14; A III + 12-14. Lateral line scales 64-67 to caudal base.

Distribution

The saddled seabream is common throughout the Mediterranean (very rare in the Black sea) and the Atlantic (from the Bay of Biscay to Angola, Madeira, the Canaries and Cape Verde Islands) (Jardas, 1996). It is very common in the Adriatic Sea (Jardas, 1986).

Biological data

Oblada melanura inhabits littoral waters above rocky bottoms, and *Posidonia* beds to 30 m depth (Jardas, 1996). Spawning takes place from April to June, it is a gonochoric species but some individuals are hermaphroditic protogynous (Jardas, 1996). The spawning period in the Adriatic is from June to July (Cetinić *et al.*, 2002). It is omnivorous species (mostly small invertebrates). The slopes (b values) of the total length-weight regressions, which differ significantly between sexes, indicate positive allometric growth for females ($b=3.123$) and isometric growth for males ($b=3.017$) in the eastern Adriatic (Pallaoro *et al.*, 1998). The VBGF parameters have been estimated (both sexes) as $L_{\infty}=34.13$, $K=0.208 \text{ yr}^{-1}$, $t_0=0.750$. Females grow slower ($K=0.201 \text{ yr}^{-1}$) than males ($K=0.233 \text{ yr}^{-1}$). The overall sex ratio was found 1:1.20 in favour of females. Males dominated in the length range 11-20 cm, females in length classes 21-33. All individuals larger than 29.3 cm were found to be female. Cetinić *et al.* (2002) reported parameters of the length-weight relationship ($a=0.0099$, $b=3.081$) for individuals caught by tramata fishing.

Exploitation

In 1998 the Croatian catch of the saddled seabream was 106 411 kg of which the largest part, 62 088 kg, was from the Zadar area (Dujmušić, 2000). Jardas (1996) reported that the annual catch of this species in the eastern Adriatic is around 200 tonnes. Saddled bream is the dominant species in the catches of tramata fishing in both number (81.79%) and weight (70.16%) (Cetinić *et al.*, 2002). Total and natural mortality have been estimated as $Z=1.08 \text{ yr}^{-1}$ and $M=0.47 \text{ yr}^{-1}$, then fishing mortality as $F=0.61 \text{ yr}^{-1}$. The exploitation rate $E=0.56$ indicated a high fishing pressure on the stock in the area studied (Pallaoro *et al.*, 1998).

Pagellus erythrinus (Linnaeus, 1758)

Family: Sparidae

EN: Common pandora

HR: Arbun, rumenac

Species description

The body is long, oval and laterally flat. The eye diameter is much shorter than length of snout. Pectoral fins are pointed, of the same length as the head. The caudal fin is big and forked. The number of fin rays is the following: D: XII+9-11, A: III+8-9, P: 15, V: I+5. The colour is pink-red with silvery glint. Sides are paler and belly is whitish. There are several small bluish spots on back and sides of grown specimens. The inside of mouth is whitish or greyish. Sometimes a dark red mark is present at the base of the last dorsal rays (Jardas, 1996).

Distribution

The common pandora is distributed in the eastern Atlantic, from Scandinavia to Senegal, and the entire Mediterranean. It is rare in the Black Sea (Jardas, 1996). It is spread throughout the Adriatic, more common in the eastern Adriatic channels than in open waters (Jardas, 1996). This species can occur up to 150 m depth, mostly among coastal sandy sediments. However, Županović and Rijavec (1980) showed that the distribution of the species in the central Adriatic is strictly limited by the 100 m isobath. According to this, the common pandora seems to be a typical species of the circalittoral zone. The edaphic factors do not seem to play a decisive role in distribution of this species, but primarily the kind and amount of accessible food and hydrography (Županović and Rijavec, 1980). Seasonal migration of pandora inside shallow waters was observed in the insular zone of the central Adriatic (Županović and Rijavec, 1980).

Biological data

Pagellus erythrinus can grow up to 60 cm TL (about 3 kg), but its usual length in the catch is from 10 to 30 cm. It is a protogynous hermaphroditic species. Because of this, proportion of females among the small specimens is 100% (to about 13 cm TL) decreasing with the increase of length. Males are dominant over 16 cm. Above 23 cm TL their proportion is 100% (Rijavec and Županović, 1965). Females are always dominant in the population. Length at sexual maturity and sex inversion is given in Table 3.

Table 3. Length at sexual maturity and sex inversion for common pandora.

Authors	Area	Sexual maturity	Sex inversion	
			Length (TL, cm)	Age (yr)
Zei and Županović (1961)	Central Adriatic		17	3-4
Rijavec and Županović (1965)	Central Adriatic	11-12	16-17	
Županović and Rijavec (1980)	Central Adriatic	11-12	16-17	2-3
Vrgoč (2000)	Northern and Central Adriatic	12.5	16	

Two inflection points can be seen in the length-weight relationship of the common pandora. The first one, between 11 and 12 cm TL corresponds to the first stage of females' sexual maturity. The second point is situated between 16 and 17 cm, and is a linked to the sex inversion (Županović and Rijavec, 1980). Table 4 reports the length-weight relationship parameters.

Table 4. Length-weight relationship parameters of common pandora.

Authors	Area	<i>a</i>	<i>b</i>
Rijavec and Županović (1965)	Central Adriatic	0.134	2.981
Županović and Rijavec (1980)	Central Adriatic	0.134	2.981
Dulčić and Kraljević (1996a)	Croatian Coast	0.0139	2.944
Cetinić <i>et al.</i> (2003)	Western coast of Istria	0.0232-«prostice» net 0.0249-«listarice» net	2.787-«prostice» net 2.758-«listarice» net

The estimated growth parameters (VBGF) for common pandora are presented in Table 5.

Table 5. The growth parameters of common pandora in the Adriatic Sea.

Authors	Sex	L_{∞} (cm)	K (yr ⁻¹)	t_0 (yr)
Rijavec and Županović (1965)	M+F	37.88	0.20	
Rijavec (1975)	M+F	30.91	0.239	
	M+F	30.0	0.245	
Županović and Rijavec (1980)	M+F	37.88	0.20	-0.093
	M+F	37.7	0.201	
	M		0.165	
	F		0.30	
Jukić and Piccinetti (1988)	M+F	60.0	0.20	
Vrgoč (1995)	M+F	29.32	0.229	-1.004
Vrgoč (2000)	M+F	31.05	0.205	

Common pandora spawns once a year in the Adriatic Sea; in spring and at the beginning of summer (Jardas, 1996). By analysing hydrographic changes and common pandora population abundance, regular movements from shallow coastal water toward deep sea (limited to within 100 m isobath) were observed, in the period from October to April and in the opposite direction from May to October. The movement toward deeper sea in the winter-spring period has reproductive nature and the opposite one in the summer-autumn period is of trophic origin (Županović and Jardas, 1989).

The species is essentially carnivorous and feeds on crustaceans, worms and other marine invertebrates. By analysing its diet in the Kaštela Bay, Jukić (1972) found that the bulk of the food was made of invertebrates from epi- and endofauna: Polychaeta, Crustacea Decapoda and Lamellibranchiata, whereas other groups of organisms like, for example Isopoda, Ophiuroida, Pisces and Cephalopoda could rarely be found in stomachs. Rijavec and Županović (1965) came to similar conclusions in channels of the central Adriatic.

Exploitation

Grubišić (1982) reported the average annual catch (Croatian coast) at around 50 tonnes. Total mortality was calculated as $Z=1.50 \text{ yr}^{-1}$ (Rijavec and Županović, 1965), $Z=0.63 \text{ yr}^{-1}$ (Rijavec, 1975), $Z=1.50-1.57 \text{ yr}^{-1}$ (Županović and Rijavec, 1980), $Z=1.10 \text{ yr}^{-1}$ (Jukić and Piccinetti, 1988) and $Z=0.83 \text{ yr}^{-1}$ (Vrgoč, 2000). Natural mortality was calculated as $M=0.44 \text{ yr}^{-1}$, while fishing mortality $F=0.38 \text{ yr}^{-1}$ (Vrgoč, 2000).

***Pagrus pagrus pagrus* (Linnaeus, 1758)**

Family: Sparidae

EN: Red porgy (also Common seabream)

HR: Pagar

Species description

The body is oblong moderately deep, preopercle scaleless. In front of jaws there are 4 upper, 6 lower canine like teeth; at the back, smaller and obtuse canines, becoming molars in the posterior third; the two outer series of molars the strongest. D XI-XII + 9-10; A III + 7-8. Colour is silvery pink; head darker from nape to rictus; sometimes minute blue spots on upper sides, especially in young; a dusky area often present at the pectoral axil; caudal fin dark pink, with distal part of lobes white and central margin of fork dark; other fins pinkish.

Distribution

It inhabits the Mediterranean, common in warmer waters, rarer in the north; absent in Black Sea; Atlantic from British Isles (records only) to 15⁰N (rare south of 20⁰N), Madeira and the Canary Islands (Jardas, 1996). It is relatively common in the Adriatic Sea (Jardas, 1996).

Biological data

Pagrus pagrus is a species of inshore waters on hard or sandy bottoms (young individuals are found on *Posidonia* beds), demersal on shelf and continental slope to 250 m depth, mainly to 100 m. It is a carnivorous species (mainly crustaceans, molluscs and fish) (Jardas, 1996). Spawning takes place from April to June, sexual maturity is reached at about 24 cm. Sex ratio is about 75% (Atlantic) and 93 % (Mediterranean) of females. The parameters of the length-weight relationship are: $a=0.0001$ and $b=2.946$ (for the eastern Adriatic) indicating almost isometric growth (Kraljević, unpublished data). The parameters of the VBGF are: $L_{\infty}=74.41$ cm, $K=0.109 \text{ yr}^{-1}$ and $t_0=-1.53$, and the maximum age is estimated as 24 years (Kraljević, unpublished data).

Exploitation

Numerical and weight composition of red porgy in the trammel net catch from the Croatian coast were estimated as 0.04% and 0.05% respectively (Jardas *et al.*, 1998). Grubišić (1982) reported the national average annual catch as about 5 tonnes. Total and natural mortality were found to be $Z=0.46 \text{ yr}^{-1}$ and $M=0.25 \text{ yr}^{-1}$ in the eastern Adriatic (Kraljević, unpublished data). The value of fishing mortality was calculated as $F=0.21 \text{ yr}^{-1}$, while the exploitation rate $E=0.46$ suggests that the stock was almost fully fished (Kraljević, unpublished data).

Sarpa salpa (Linnaeus, 1758)

Family: Sparidae

EN: Salema

HR: Salpa

Species description

The body is oblong, the head is short. Snout obtuse, mouth sub-terminal and small; upper jaw slightly prominent. In both jaws incisors uniserial, upper ones notched, lower ones depressed on their outer face and ending in a single triangular point and all incisors with well visible roots inside of mouth. D XI-XII + 14-17; A III + 13-15. Pectoral fin is short ending before anus. Colour is grey-bluish with 10-11 fine longitudinal golden lines along rows of scales. Caudal fin is dark grey, other fins light.

Distribution

It is a common species throughout the Mediterranean (rare in Black sea), in the Eastern Atlantic from the Bay of Biscay (rare) to Sierra Leone including Madeira, Canary Islands Cape Verde (common); it is also present from Congo to South Africa (Jardas, 1996).

Biological data

Sarpa salpa inhabits littoral waters near rocks with algal coverage, beds of *Posidonia*, *Zostera*, and *Caulerpa* (warm waters) and also on sandy mud to 70 m depth (Jardas, 1996). It is an omnivorous species, young salema are mainly carnivorous (crustaceans) and adults are almost exclusively herbivorous. The Rhodophyta taxa seem to be most important component of the diet. Food of animal origin is very poorly represented in the diet and mainly composed by epibionts, presumably taken by chance (Antolić *et al.*, 1994). Sex ratio (in the eastern Adriatic) is 2.03:1 in favour of males (Mardešić, 2002). The parameters of the length-weight-relationship are: $a=0.0177$ and $b=2.897$ (both sexes), $a=0.0087$, $b=3.108$ (males) and $a=0.0103$ and $b=3.051$ (females) indicating positive allometry for sexes separately and negative allometry for both sexes combined (Mardešić, 2002). The maximum age is 14 years (Mardešić, 2002). The parameters of the VBGF have been estimated as $L_{\infty}=40.84$ cm, $K=0.221$ yr⁻¹ and $t_0=-0.693$ (Mardešić, 2002).

Exploitation

Numerical occurrence of salema in the catch of coastal fishing gears along the Croatian coast was 8.09% in «tramata» and 0.26% in coastal beach seine catches (Jardas *et al.*, 1998). Weight composition was 17.46% in «tramata» and 1.01% in coastal beach seine catches (Jardas *et al.*, 1998). Grubišić (1982) reported the national average annual catch at about 154 tonnes.

Sparus aurata Linnaeus, 1758

Family: Sparidae

EN: Gilthead seabream

HR: Komarča, lovrata, orada

Species description

The body is oblong, rather deep. Preopercle is scaleless. In both jaws, in front there are 4-6 canines with behind them and at back 2-4 rows of teeth, more obtuse, gradually becoming molars, the two outer rows much stronger. D XI+13-14, A III + 11-12. Lateral line scales 73-85 to caudal base. Colour is silvery grey, large dark patch at the origin of the lateral line, overlapping upper part of opercle and underlined by a reddish area. There is a golden curved bar across forehead, bordered by two dark zones, especially in adults.

Distribution

Sparus aurata occurs in the eastern Atlantic from British Isles to the Cape Verde and Canary Islands. It is common throughout the Mediterranean, although less frequent in the eastern and the south-eastern part and very rare in the Black Sea (Jardas, 1996). It is relatively common in the eastern Adriatic (Croatian waters) (Jardas, 1996).

Biological data

The gilthead seabream is a euryhaline and eurythermal species and a relatively common fish of inshore waters on littoral sandy bottoms and *Posidonia* beds, up to depths of 30 m (juveniles) and 150 m (adults) (Jardas, 1996). Adult specimens usually enter estuaries and lagoons and seasonally migrate out of them. It is a hermaphroditic protandrous species (Jardas, 1996). *Sparus aurata* is carnivorous and feeds on molluscs, mainly mussels, crustaceans, fishes, but it is additionally herbivorous (Jardas, 1996). It spawns from October to December (Jardas, 1996). The maximum standard length of the species is 70 cm, but usually in catches is between 30 and 35 cm SL (Jardas, 1996). The age and growth of the gilthead seabream were determined from specimens collected in the Mirna Estuary (northern Adriatic) from 1990 to 1993 (Kraljević and Dulčić, 1997). Mean length at age data, as obtained through scale readings, were used to estimate the growth parameters of the von Bertalanffy function: $L_{\infty}=59.8$ cm, $K=0.15$ yr⁻¹, $t_0=-1.71$; $W_{\infty}=5554$ g, $K=0.09$ yr⁻¹ and $t_0=-2.64$. The length-weight relationship was estimated in the form $W=0.0112L^{3.052}$ (Kraljević and Dulčić, 1997). Twelve age classes, ranging from 1 to 12 years were defined by scale readings. The mean condition factor was estimated as 1.322 (Kraljević and Dulčić, 1997). In samples from the eastern Adriatic (Croatian coast) the total length ranged from 15 to 70 cm and the weight from 40 to 5900 g (Kraljević *et al.*, 1998). Sixteen age classes, ranging from 1 to 22 years were defined by scale readings (Kraljević *et al.*, 1998). Weight increase is positively allometric with size ($b=3.087$). The mean condition factor was estimated as 1.36. Von Bertalanffy growth parameters are: $L_{\infty}=84.98$ cm, $K=0.073$ yr⁻¹, $t_0=2.823$; $W_{\infty}=12879.4$ g, $K=0.062$ yr⁻¹ and $t_0=-2.728$ (Kraljević *et al.*, 1998).

Exploitation

It is a target of commercial fishers along the Croatian coast (about 56 t per year according to 1994 FAO statistics), it varied from 0.4 to 1.6% of the Mediterranean total catch of this species for the period from 1983 to 1992. The Croatian total catch of common pandora, common dentex, sharpsnout seabream, common two-banded seabream and gilthead seabream together in 1998 was 105 458 kg of which 67 262 kg from the Zadar area (Dujmušić, 2000). Natural mortality was estimated as $M=0.32 \text{ yr}^{-1}$ (Pauly's formula, 1980) and $M=0.41 \text{ yr}^{-1}$ (Rikhter and Efanov's formula, 1976) in the Mirna Estuary (northern Adriatic) (Kraljević and Dulčić, 1997). The age at which 50% of the gilthead seabream population is sexually mature is 4 years (Kraljević and Dulčić, 1997). Even though this species is of great interest and is a target of the commercial fishery, its presence in the total catch of sparids from gill nets (0.2%; Jardas *et al.*, 1998) and "ludar" (only 0.05%; Cetinić and Pallaoro, 1993) is very low. The length range of the gilthead seabream in the catch of "tramata" fishing was from 13.4 to 45.4 cm, while the parameters of the length-weight relationship were: $a=0.0128$ and $b=3.093$ (Cetinić *et al.*, 2002). Numerical presence of the gilthead seabream in the coastal fishing gear catches along the Croatian coast was 0.28% in trammel net, 0.01% in coastal beach seine and 0.04% in "tramata" fishing catches (Jardas *et al.*, 1998). Weight composition was 2.24% in trammel net, 0.21% in the coastal beach seine and 0.24% in "tramata" fishing catches (Jardas *et al.*, 1998).

Spondyliosoma cantharus (Linnaeus, 1758)

Family: Sparidae

EN: Black seabream

HR: Kantar

Species description

The body is ovoid, rather deep; the upper profile of the head depressed above the eye. The snout is short. Scales on cheek and opercle, preopercle scaleless. In each jaw there are 4-6 rows of conical and rather slender teeth, the outer enlarged, especially in front of jaw. D XI+11-13, A III+9-11. Lateral line scales 66-75 to caudal base. Colour is silvery grey with bluish, greenish and pinkish tints; interorbital space and snout darker; on sides, longitudinal golden lines more or less discontinuous.

Distribution

In the eastern Atlantic it occurs from Scandinavia to Angola, Madeira, Canary Islands and Cape Verde Islands. It is very rare in the Black Sea, but common in the Mediterranean Sea and in the eastern Adriatic (Jardas, 1996).

Biological data

Black seabream is a relatively common species of inshore waters on rocky or sandy bottom and *Posidonia* beds at depths down to 50 m (juveniles) and 300 m (adults).

It is gregarious and sometimes found in large schools.

The black sea bream is a hermaphroditic, protogynous fish. It spawns from February to May (Jardas, 1996). Growth of the black seabream from the Croatian coast was studied using data from scales, length and weight of 745 fish. Total length ranged between 6.2 and 46.5 cm, while weight varied between 3 and 2165 g (Dulčić and Kraljević, 1996b).

The von Bertalanffy growth function was fitted on the basis of mean length-at-age data resulting in parameter values of $L_{\infty}=47.7$ cm, $K=0.178$ yr⁻¹ and $t_0=-0.27$. Weight increased allometrically for both sexes together ($b=3.12$) and in females alone ($b=3.14$), while it increased isometrically in males ($b=2.99$) (Dulčić and Kraljević, 1996b).

The black seabream is a long-lived species. The oldest male and female were estimated to be 14 and 9 years old respectively. The sex ratio rapidly becomes skewed in favour of females (3.12:1). Sex reversal was mainly observed in age classes 7 and 8. Females were found only up to a total length of 37.7 cm (Dulčić and Kraljević, 1996b). Dulčić *et al.* (1995b, 1995c) presented the length-weight relationship from southern Adriatic samples with parameters: $a=0.000436$ and $b=3.093$. Cetinić *et al.* (2002) reported parameters of the length-weight relationship ($a=0.0112$, $b=3.052$) for individuals caught by tramata fishing.

The fecundity of the black seabream from the eastern central Adriatic (Croatian coast) was assessed by the volumetric method using 59 ovaries in pre-spawning stage from fish between 18.5 and 33.5 cm TL (Dulčić *et al.*, 1998). Estimates of total potential annual fecundity varied between 31 670 and 554 070 eggs per female. Relative fecundity is constant, reaching a maximum of 850 eggs g⁻¹ in the 30.5-31 cm length class (Dulčić *et al.*, 1998).

Exploitation

Black seabream forms a significant component of the gill net and fish trap catch in Croatian coastal fishery and it is a very appreciated fish species for consumption (especially on the island of Vis).

There are no recent data on catch levels; Grubišić (1982) reported that it was then around 60 tonnes per year. Black seabream was assessed to represent in number 0.13% (0.33% in weight) of the catch by tramata fishing (length range 22.1-38.3 cm) (Cetinić *et al.*, 2002). Numerical composition is 0.39% in trammel net and 0.36% in coastal beach seine catches.

Zeus faber Linnaeus, 1758

Family: Zeidae

EN: John dory

HR: Kovač, Šanpjero

Species description

The body is deep, strongly compressed, caudal peduncle is as long as it is deep; head deep, its dorsal profile flat or convex over eye, no serrations on bony ridge above eye. Mouth large and very protractile, with small conical teeth in jaws (Jardas, 1996). Pectoral fins short, pelvic fins at least twice as long. D IX-XI + 21-25; A III-V + 20-24; P I + 6-7. Body covered with very small, rudimentary scales, appearing naked; scutes present along belly, with spines. Colour is golden green-grey or silvery bronze, with a large yellow-edged black spot on flank; membranes of spinous anal and pelvic fins black, spinous dorsal fin dark (Jardas, 1996).

Distribution

Zeus faber occurs in the Atlantic from Norway to Madeira, also Mediterranean, Black Sea and Adriatic Sea. Elsewhere, south to the Azores and southern Africa, also Australia, New Zealand, Japan and Korea (Jardas, 1996).

Biological data

John dory lives near the bottom or in midwater, from inshore down to 400 m depth, mainly from 50 to 150 m; it is solitary species which feeds on fish, Crustacea and Cephalopoda (Jardas, 1973). It could reach a maximum of 66 cm SL, but usually 20-50 cm. In the open Adriatic sea males could reach the maximum length of 43 cm, while females 52 cm SL, and in the channels area males could reach 42 cm, while females 51 cm (Županović and Jardas, 1989). Sex ratio (in Jabuka/Pomo Pit) is 2.27:1 in favour of males, while in channels of the central Adriatic is 1:2.31 in favour of females (Županović and Jardas, 1989). The parameters of the length-weight relationship are: $a=0.0164$ and $b=2.941$, indicating isometric growth (Županović and Jardas, 1989).

Exploitation

Grubišić (1982) reported the average annual catch (Croatian coast) at around 25 tonnes.

References

- Alegria-Hernandez, V. (1986) A note on growth and natural mortality of *Boops boops* (L.) from the Adriatic Sea. *Rapp. Comm. int. Mer Medit.*, 30 (2): 231 p.
- Alegria-Hernandez, V. (1989) Study on the age and growth of bogue (*Boops boops* L.) from the middle Adriatic Sea. *Cybium*, 13: 281-288.
- Alegria-Hernandez, V. (1990) Some aspects of reproductive biology of bogue *Boops boops* L., Pisces Sparidae) from the mid-Adriatic channels. *Acta Adriat.*, 31 (1/2): 301-313.
- Alegria-Hernandez, V. & Jukić, S. (1990) Some aspects of biology and population dynamics of hake (*Merluccius merluccius*) from the middle Adriatic Sea. *Bull. Inst. Oceanogr., Monaco*, 11: 161 p.
- Antolić, B., Skaramuca, B., Špan, A., Mušin, D. & Sanko-Njire, J. (1994) Food and feeding habits of a herbivore fish *Sarpa salpa* (L.) (Teleostei, Sparidae) in the southern Adriatic. *Acta Adriat.*, 35 (1/2): 45-52.
- Cetinić, P. & Pallaoro, A. (1993) Eksploatacijske karakteritike, značenje i ocjena djelovanja ribolova tramatom. *Pomorski zbornik*, 31 (1): 605-626.
- Cetinić, P. & Soldo, A. (1999) Dredge catches of pilgrim's scallop (*Pecten jacobaeus* L.) in eastern Adriatic. *Fol. Univ. Agric. Stetin. 192, Piscaria*, 25: 37-43.
- Cetinić, P., Dulčić, J. & Božanić, J. (1997) Ocjena lova jastoga, *Palinurus elephas* (Fabricius, 1787), vršama u srednjem Jadranu. *Ribarstvo*, 55: 1-9.
- Cetinić, P., Soldo, A., Dulčić, J. & Pallaoro, A. (2002) Specific method for Sparidae species in the eastern Adriatic. *Fish. Res.*, 55: 131-139.
- Cetinić, P., Dulčić, J., Jardas, I., Jukić-Peladić, S., Kraljević, M., Krstulović-Šifner, S., Pallaoro, A., Soldo, A., Tonković, M. & Vrgoč, N. (1999) *Istraživanje kompetitivnih odnosa između ribolova pridnenom povlačnom mrežom (koćom), vršama za lov škampa i jednostrukih mreža stajačica za lov oslića u Velebitskom kanalu, s posebnim osvrtom na populaciju škampa i oslića*. Institut za oceanografiju i ribarstvo, Split, 53 pp.
- Cetinić, P., Dulčić, J., Jardas, I., Kraljević, M., Matić, S., Pallaoro, A. & Soldo, A. (2001) *Istraživanje stanja naselja jastoga i hlapa*. Institut za oceanografiju i ribarstvo, Split, 58 pp.
- Cetinić, P., Soldo, A., Dulčić, J., Jardas, I., Pallaoro, A., Kraljević, M. & Matić-Skoko, S. (2003) *Ocjena stanja biozaliha bentoskih naselja ribolovnog područja sjevernog dijela zapadne obale Istre*. Institut za oceanografiju i ribarstvo, Split, 84 pp.
- Crnković, D. (1963) *Ispitivanje ekologije i mogućnosti racionalnog unaprijeđenja eksploatacije raka Nephrops norvegicus L. u kanalskom području sjeveroistočnog Jadrana.*, PMF Sveučilište u Zagrebu., Zagreb. (PhD Thesis)
- Crnković, D. (1970) Prilog biološkoj i ekonomskoj problematici koćarenja u kanalskom području sjeveroistočnog Jadrana. *Thalassia Jugosl.*, 6: 5-90.
- Dujmušić, A. (2000) *Hrvatsko ribarstvo. Ispod površine*. Rabus Media, Zagreb. 215 pp.
- Dulčić, J. (1996) Food and feeding habits of the damsel fish *Chromis chromis* (Teleostei: Pomacentridae) in the eastern Adriatic. *Annals for Istrian and Mediterranean Studies*, 9: 31-36.
- Dulčić, J. (1999) The diet of the brown wrasse *Labrus merula* (Labridae) in the eastern Adriatic. *Cybium*, 23 (4): 381-389.
- Dulčić, J. & Kraljević, M. (1994) The fecundity of damsel fish (*Chromis chromis*) in the eastern middle Adriatic. *Acta Adriat.*, 35 (1/2): 53-57.

- Dulčić, J. & Kraljević, M. (1995) Age, growth and mortality of damselfish (*Chromis chromis* L.) in the eastern middle Adriatic. *Fish. Res.*, 22: 255-264.
- Dulčić, J. & Kraljević, M. (1996a) Weight-length relationships for 40 fish species in the eastern Adriatic (Croatian waters). *Fish. Res.*, 28: 243-251.
- Dulčić, J. & Kraljević, M. (1996b) Growth of the black sea bream *Spondyliosoma cantharus* (L.) in the eastern middle Adriatic. *Arch. Fish. Mar. Res.*, 44: 279-293.
- Dulčić, J., Kraljević, M. & Cetinić, P. (1994) Length-weight relationship in damselfish (*Chromis chromis* L. 1758) from the eastern Adriatic during spawning. *Acta Ichthyologica et Piscatoria*, 24: 147-154.
- Dulčić, J., Cetinić, P. & Kraljević, M. (1995a) Neki biološki parametri jastoga, *Palinurus elephas* Fabr., s područja otoka Palagruže. *Morsko ribarstvo*, 47: 1-4.
- Dulčić, J., Kraljević, M. & Cetinić, P. (1995b) Dužinsko-maseni odnos kantara (*Spondyliosoma cantharus*) iz obalnih voda šireg područja N.P. «Mljet». Priopćenje sa simpozija «Prirodne značajke i društvena valorizacija otoka Mljeta», *Ekološke monografije*, 6, Pomena, otok Mljet, 4-10. rujna, 577-578.
- Dulčić, J., Kraljević, M. & Cetinić, P. (1995c) Dužinsko-maseni odnos kantara i škrapine u južnom Jadranu. *Naše more*, 42: 263-267.
- Dulčić, J., Skakelja, N., Kraljević, M. & Cetinić, P. (1998) On the fecundity of the Black Sea bream, *Spondyliosoma cantharus* (L.), from the Adriatic Sea (Croatian coast). *Sci. Mar.*, 62 (3): 289-294.
- Dulčić, J., Kraljević, M., Grbec, B. & Cetinić, P. (2000) Age, growth and mortality of blotched picarel *Spicara maena* L. (Pisces: Centranchidae) in the eastern central Adriatic. *Fish. Res.*, 48: 69-78.
- Dulčić, J., Pallaoro, A., Cetinić, P., Kraljević, M., Soldo, A. & Jardas, I. (2003) Age, growth and mortality of picarel, *Spicara smaris* L. (Pisces, Centranchidae), from the eastern Adriatic (Croatian coast). *J. Appl. Ichthyol.*, 19: 10-14.
- Fisher, W., Schneider M., & Bauchot M.L. (eds.) (1987) *Fishes FAO d'identification des espèces pour les besoins de la pêche. Méditerranée et mer Noire*. Vol. I – II., Rome, FAO. 1-2: 760 pp.
- Grubišić, F. (1982) Ribe, rakovi i školjke Jadrana. Liburnija i Naprijed, Rijeka, Split. 239 pp.
- Grubišić, L. (2002) *Biološke i ekološke značajke zubatca krunaša (Dentex gibbosus Rafinesque, 1810)*. Doktorska disertacija, Zagreb: 204 pp.
- Jardas, I. (1973) O ishrani kovača, *Zeus faber-pungio* C.V., u Jardanskom moru. *Ekologija*, 8 (1): 147-161.
- Jardas, I. (1976) Contribution to the knowledge of the biology of hake in the Adriatic Sea. *Rev. Trav. Inst. Pêches marit.*, 40: 615-618.
- Jardas, I. (1986) Trammel bottom set catches along eastern Adriatic coast (1971-1984). *FAO Rep. Pêches/FAO Fish Rep.*, 345: 189-199.
- Jardas, I. (1996) *Jadranska ihtiofauna*. Školska knjiga, Zagreb, 553 pp.
- Jardas, I. & Pallaoro, A. (1992) Age and growth of black scorpionfish, *Scorpaena porcus* L., 1758, in the Adriatic Sea. *Rapp. Comm. int. Mer Médit.*, 33: 296 p.
- Jardas, I., Pallaoro, A., Cetinić, P. & Dulčić, J. (2001) Cuttlefish, *Sepia officinalis* L., 1758, in the trammel bottom set catches along the Eastern Adriatic coast (Croatia). *Rapp. Comm. int. Mer Médit.*, 36: 277 p.

- Jardas, I., Cetinić, P., Pallaoro, A., Dulčić, J. & Kraljević, M. (1998) Sparidae in catches of the coastal fishing gears in the eastern Adriatic Sea. *Rapp. Comm. int. Mer Médit.*, 35: 450-451.
- Jug-Dujaković, J. (1988) *Prilog poznavanju ekologije mlađi gospodarski interesantnih vrsta riba u šibenskom priobalju*. University of Zagreb, Zagreb. 84 p. (M.Sc. thesis)
- Jukić, S. (1971) Studies on the population and catchability of Norway lobster in the central Adriatic. *GFCM Stud. Rev.*, 48: 27-52.
- Jukić, S. (1972) Ishrana oslića (*Merluccius merluccius*), bukve (*Boops boops*), trlje (*Mullus barbatus*) i arbuna (*Pagellus erythrinus*) u Kaštelanskom zaljevu. *Acta Adriat.*, 4: 3-40.
- Jukić, S. (1973) The contribution to the knowledge of bogue's (*Boops boops*) nourishment in the Bay of Kaštela. *Acta Adriat.*, 11: 3-15.
- Jukić, S. & Piccinetti, C. (1981) Quantitative and qualitative characteristics of demersal resources in the Adriatic sea with a some population dynamic estimates. *FAO Fish Rep.*, 253: 73-91.
- Jukić, S. A & Piccinetti, C. (1988) Contribution to the knowledge on the short and long-term effects of the application of 40 mm codend mesh size in Adriatic trawl fishery – Eastern Adriatic coast. *FAO Fish. Rep.*, 394: 282-290.
- Karlovac, O. (1953) An ecological study of *Nephrops norvegicus* of the high Adriatic. *Izv. Rep. Rib. biol. eksp. «Hvar» 1948-49*: 1-50.
- Kožul, V., Skaramuca, B., Kraljević, M., Dulčić, J. & Glamuzina, B. (2001) Age, growth and mortality of the Mediterranean amberjack *Seriola dumerili* (Risso, 1810) from the south-eastern Adriatic Sea. *J. Appl. Ichthyol.*, 17: 134-141.
- Kraljević, M. & Dulčić, J. (1996) Age, growth and mortality of the golden grey mullet *Liza aurata* (Risso, 1810) in the eastern Adriatic. *Arch. Fish. Mar. Res.*, 44: 69-80.
- Kraljević, M. & Dulčić, J. (1997) Age, growth and mortality of gilthead sea bream *Sparus aurata* L. in the Mirna estuary, Northern Adriatic. *Fish. Res.*, 31: 249-255.
- Kraljević, M., Dulčić, J. & Tudor, M. (1998) Growth parameters of the gilt-head sea bream *Sparus aurata* L. in the eastern Adriatic (Croatian waters). *Periodicum Biologorum*, 100: 87-91.
- Kraljević, M., Dulčić, J., Cetinić, P. & Pallaoro, A. (1996) Age, growth and mortality of the striped sea bream, *Lithognathus mormyrus* L., in the Northern Adriatic. *Fish. Res.*, 28: 361-370.
- Kraljević, M., Dulčić, J., Pallaoro, A., Cetinić, P. & Jug-Dujaković, J. (1995) Sexual maturation, age and growth of striped sea bream, *Lithognathus mormyrus* L., on the eastern coast of the Adriatic Sea. *J. Appl. Ichthyol.*, 1-8.
- Kraljević, M., Dulčić, J., Kačić, I., Pallaoro, A. & Jardas, I. (1994) Ichthyological analysis of catches from the Mirna Estuary-eastern Adriatic. *Acta Adriat.*, 35 (1/2): 69-82.
- Marano, G. (Ed.). (1996) *Valutazione delle risorse demersali dell'Adriatico meridionale dal promontorio del Gargano al capo d'Otranto: relazione finale triennio '94-'96*. M.R.A.A.F., Roma.
- Mardešić, M. (2002) *Starost i rast salpe, Sarpa salpa (Linnaeus, 1758) iz istočnog Jadrana*. Diplomski rad, Sveučilište u Splitu, Odjel za studij mora i pomorstva, 45 pp.
- Matić-Skoko, S. (2003) *Ribarstveno-biološke i ekološke osobitosti špara (Diplodus annularis L.) u istočnom dijelu Jadrana*. Sveučilište u Zagrebu, PMF, Biološki odsjek, 165 pp.

- Morović, D. (1960) Contribution a la connaissance de la croissance annuelle du muge *Mugil chelo* Cuv. dans l'etage «Pantan» (Dalmatie). *Rapp. Proc. verb. Reun. CIESM*, 15 (3): 115-118.
- Pallaoro, A. & Jardas, I. (1991) Food and feeding habits of black scorpionfish (*Scorpaena porcus* L., 1758) (Pisces, Scorpaenidae) along the Adriatic coast. *Acta Adriat.*, 32 (2): 885-898.
- Pallaoro, A. & Jardas, I. (2003) Some biological parameters of the peacock wrasse, *Symphodus (Crenilabrus) tinca* (L. 1758) (Pisces: Labridae) from the middle eastern Adriatic (Croatian coast). *Scientia Marina*, 67 (1): 33-41.
- Pallaoro, A., Franičević, M. & Matić, S. (2002) Age, growth and mortality of big-scale sand smelt, *Atherina (Hepsetia) boyeri* Risso, 1810 in the Pantana lagoon, Croatia. *Periodicum biologorum*, 104 (2): 175-183.
- Pallaoro, A., Cetinić, P., Dulčić, J., Jardas, I. & Kraljević, M. (1998) Biological parameters of the saddlehead bream *Oblada melanura* in the eastern Adriatic. *Fish. Res.*, 38: 199-205.
- Relini, G., Bertrand, J. & Zamboni, A. (1999) Synthesis of the knowledge on bottom fishery resources in the Central Mediterranean (Italy and Corsica). *Biol. Mar. Medit.*, 6.
- Rijavec, L., (1975) Biologija i dinamika populacije *Pagellus erythrinus* L. in the middle Adriatic. *Studia Marina*, 8: 3-109.
- Rijavec, L. & Županović, Š. (1965) A contribution to the knowledge of biology of *Pagellus erythrinus* L. in the middle Adriatic. *Rapp. -v. Reun. Comm. int. Explor. Scient. Mer Medit.*, 18 (2): 195-200.
- Sinovčić, G., Alegria-Hernandez, V., Jug-Dujaković, J., Jukić, S., Kačić, I., Regner, S. & Tonković, M. (1986) Contribution to the knowledge of ecology of grey mullet *Liza (Liza) ramada* (Risso, 1826) from the middle Adriatic (Šibenik area). *Acta Adriat.*, 27 (1-2): 147-162.
- Šarčević, M. (1992) *Ocjena obimnosti i biološke razine dopuštenog iskorištavanja populacije škampa (Nephrops norvegicus) u Jabučkoj kotlini*. Sveučilište u Zagrebu, Zagreb, 72 pp. (MSc Thesis)
- Šoljan, T. & Karlovac, O. (1932) Untersuchungen uber die Ernährung der Adriatischen *Scorpaena*. Arten. *Acta Adriat.*, 1 (1): 1-22.
- Tortonese, E. (1986) Centracanthidae. In: P.J.P. Whitehead, M.L. Bauchot, J.-C. Hureau, J. Nielsen and E. Tortonese (eds.) *Fishes of the north-eastern Atlantic and the Mediterranean*. UNESCO, Paris. Vol. 2: 908-911.
- Vrgoč, N. (1995) *Obilježja rasta populacije oslića (Merluccius merluccius), trlje blatarice (Mullus barbatus), arbuna (Pagellus erythrinus) i škampa (Nephrops norvegicus) Jadranskog mora*. Sveučilište u Zagrebu, Zagreb, 101 pp. (Master thesis)
- Vrgoč, N. (2000) *Struktura i dinamika pridnenih zajednica riba Jadranskog mora*. Disertacija. Sveučilište u Zagrebu, 198 pp.
- Zei, M. (1941) Studies on the morphology and taxonomy of the Adriatic species of Maenidae. *Acta Adriat.*, 2 (4): 134-191.
- Zei, M. (1949) Typical sex-reversal in Teleosts. *Proc. Zool. Soc.*, 119 (4): 917-920.
- Zei, M. & Županović, Š. (1961) Contribution to the sexual cycle and sex reversal in *Pagellus erythrinus* (L.). *Rapp. P.-v. reun. Comm. int. Explor. Scient. Mer Medit.*, 17 (2): 263-267.
- Županović, Š. (1963) Utjecaj inteziteta ribolova na riblji fond u Jadranu. *Pomorski zbornik*, 1: 693-716.

- Županović, Š. (1968) Study of the hake (*Merluccius merluccius* L.) biology and population dynamics in the central Adriatic. *GFCM Stud. Rev.*, 32: 1-24.
- Županović, Š. & Jardas, I. (1986) A contribution to the study of biology and population dynamics of the Adriatic hake, *Merluccius merluccius* (L.). *Acta Adriat.*, 27 (1/2): 97-146.
- Županović, Š. & Jardas, I. (1989) *Fauna i Flora Jadrana*. Jabučka kotlina. Druga knjiga. Logos, Split, 526 pp.
- Županović, Š. & Rijavec, L. (1980) Biology and population dynamics of *Pagellus erythrinus* (L.) in the insular zone of the middle Adriatic. *Acta Adriat.*, 21 (2): 203-226.