original scientific paper UDK 597.587.2:591.16(262.3-11)

EARLY LIFE HISTORY STAGES OF FAMILY SCOMBRIDAE IN THE EASTERN ADRIATIC

Jakov DULČIĆ
Ph.D., biol. sci., Institute of Oceanography and Fisheries, HR-21000 Split, P.O.BOX 500
Dr. biol. znan., Institut za oceanografiju i ribarstvo, HR-21000 Split, P.O.BOX 500

ABSTRACT

Use of early life history stages of fish in systematic and ecological studies has increased in recent years. It is now recognized that eggs and larvae present a wide array of characters that are largely independent of adult characters and suitable for a systematic analysis. Fisheries recruitment studies focus on the survival of eggs and larvae as the most important factor influencing variations in population abundance. A requisite to these studies is detailed information on the appearance of fish eggs and larvae in order to identify them in plankton samples. Family Scombridae is a of a great interest to the Croatian fishery. This paper reviews all available information on the early developmental stages of the family Scombridae found in the eastern Adriatic.

Key words: early developmental stages, Scombridae, eastern Adriatic
Ključne besede: zgodnji razvojni stadiji rib, Scombridae (skuše), vzhodni Jadran

INTRODUCTION

The importance of early-life-history studies to fisheries investigations and phylogenetic research has increased dramatically during the last decade. Early-life-history stages are now routinely used in fisheries studies to investigate the interannual variation in recruitment (Wooster, 1983), and in studies of the phylogeny of fishes (Moser *et al.*, 1984). The study of fish eggs and larvae is a key component in research into the biology, systematics and even population dynamics of fishes, in that it provides information on spawning areas and periods of many species. By combining the location of the eggs, larvae and adults of a species with information on the surrounding environment, possible environmental effects on spawning (egg and larval transport, etc.) can be inferred. Studies of this type contribute to our understanding of the early stages of development of fishes, which for certain species are still completely unknown. Consideration of the factors that affect egg and larval survival is fundamental, since it is the early stages of development that will eventually determine the existence of good or bad year classes. This is one of the main thrusts of ichthyoplankton studies in those areas in which the requisite basic information is available (egg and larval surveys in spawning areas during the spawning season, etc.) for the species of interest.

Family Scombridae is of great interest to the Croatian fishery. It forms a significant component of the total catch. It is not possible to get new data on catch for every species now, but Grubišić (1982) reported that it is between 200 and 700 tons per year for Spanish mackerel *(Scomber japonicus)*, 20 and 30 tons for plain bonito *(Auxis rochei)*, around 350 tons for tunny *(Thunnus thynnus)* and around 5 tons for mackerel *(Scomber scombrus)*.

The object of this paper is to compile and present all available information on both the early development stages of the eggs and larvae of the family Scombridae found in the eastern Adriatic and possible spawning areas and seasons of some species from the family.

MATERIAL AND METHODS

The present paper sets out descriptions of the eggs, yolk-sac larvae and larvae of the family Scombridae likely to be collected in plankton samples in the eastern Adriatic, together with information on the possible spawning areas and seasons for some species. The egg and larval descriptions have mostly been taken from the existing literature. In some cases the descriptions were done by the author himself based on material collected during surveys; in other instances the descriptions were published by other researchers, either for eggs and larvae actually collected in the eastern Adriatic itself or for egg and larval material collected in other areas but for species that also inhabit the waters of the eastern Adriatic. Notochord (NL) lenght was measured for preflexion and standard lenght (SL) for flexion larvae.

RESULTS AND DISCUSSION

Scomber scombrus Linnaeus, 1758.

Eggs

Spherical, 1.0-1.38 mm in diameter, yolk unsegmented, oil globule 0.28-0.36 mm in diameter (Fig. 1). These measures were obtained from the material collected during the surveys in March 1990 in the area of Blitvenica (middle Adriatic) (Dulčić, unpublished data). The eggs of mackerel were found during winter and spring cruises; in February in greater quantities on profile island Vis - Palagruža archipelago and in smaller quantities along the Italian coast from Cape Gargano to Brindisi (Gamulin & Hure, 1983). The existence of the winter spawning ground adjacent to Palagruža archipelago was confirmed for the mackerel (Gamulin & Hure, 1983). It is uncertain whether the small number of eggs recorded along the Italian coast indicate a widespread distribution of the Palagruža spawning ground. Isolated catches of eggs in mid-spring off the island Vis to Rovinj indicate the movement of the scomber along the east coast. The most intensive spawning was also recorded in Rijeka Bight, Kvarner and northern Kvarnerić (Lissner, 1939).

The egg of the mackerel was first fully described by Cunningham (1889) from artificially fertilized eggs obtained by fishermen off Plymouth. Buchanan-Wollaston (1911) gave the average diameter of eggs from the southern North Sea as 1.186 mm, and that of the oil globule as 0.319 mm. Ehrenbaum (1921) gave the following mean sizes for the egg: southern North Sea - end of May 1.276 mm; mid-July - 1.101 mm; north west of Dogger Bank - end of June - 1.139 mm; northern North Sea - 1.210 mm. Sella & Ciacchi (1925) found that the mean diameter of mackerel egg in the Mediterranean (Ligurian Sea) is 1.139 mm (1.071 mm - 1.193 mm) and the mean diameter of oil globule is 0.32 mm (0.285 mm - 0.360 mm).

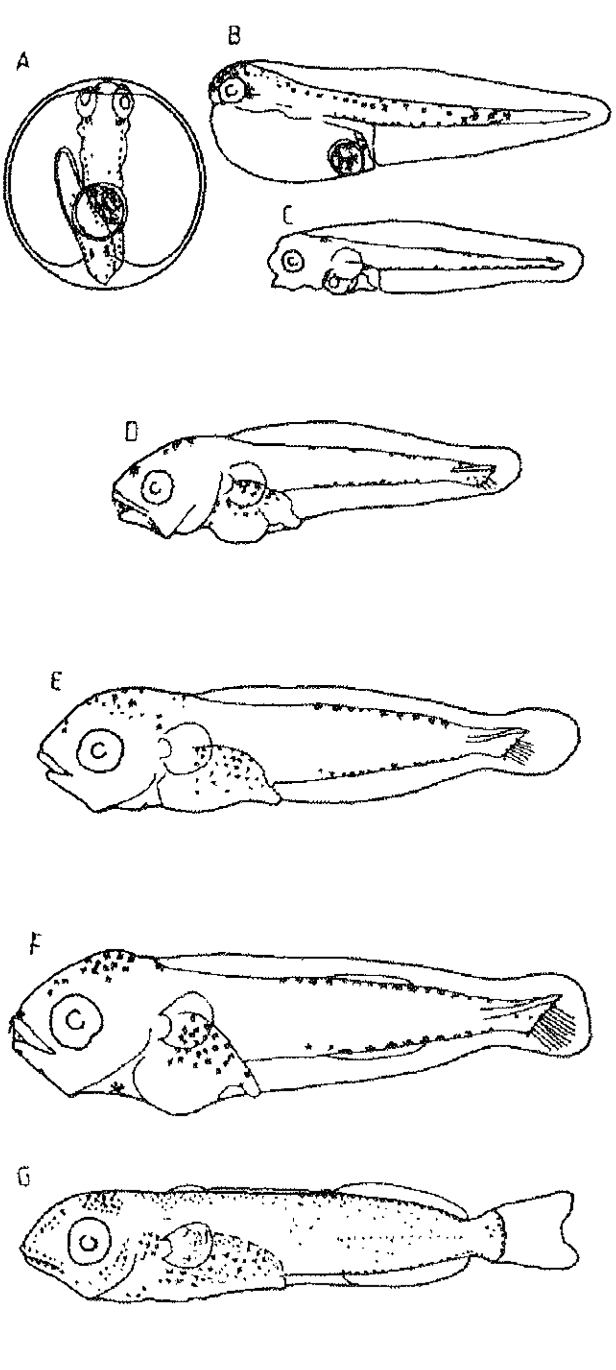


Fig. 1: *Scomber scombrus* ***L. (A) Egg, 1-2 mm in diameter (original drawn by author); (B) Yolk-sac larva, 2.4 mm (original drawn by author); (C) Larva, 3.7 mm; (D) Larva, 5.2 mm; (E) Larva, 7.0 mm; (F) Larva, 8.0 mm; (G) Larva, 14.0 mm (after Russell, 1976).***
Sl. 1: *Scomber scombrus* ***L. (A) ikra, 1-2 mm v premeru (originalna risba); (B) ličinka z rumenjakovo vrečo 2,4 mm (originalna risba); (C) ličinka, 3,7 mm; (D) ličinka, 5,2 mm; (E) ličinka, 7,0 mm; (F) ličinka, 8,0 mm; (G) ličinka 14,0 mm (po Russelu, 1976).***

Yolk-sac larvae

Dulčić (unpublished data) found mackerel yolk-sac larvae (n=3; range 3.7-4.1 mm length; oil globule is between 0.21-0.23 mm in diameter) in the area of Kvarner and Rijeka Bight in April (stations 44° 51'33"N 14° 12'E - depth 46 m and 45° 14'N 14° 25' 30" E - depth 62.5 m). Cunningham (1892) described the newly hatched yolk-sac larva and succeeded in keeping some alive for 4 days until the yolk was almost entirely absorbed. Subsequently, Holt (1893, 1898) also described the larva. When newly hatched, yolk-sac larva is 3.3-3.9 mm long. Holt (1893) recorded a preanal length of 1.67 mm in a specimen 3.63 mm long. The pigmentation is characteristic. There is a group of melanophores on the head (Fig. 1). Double rows of irregularly distributed melanophores occur along the dorsal and ventral contours of the posterior half of the body starting a certain distance behind the anus. The ventral row is the more regular and continuous. Peritoneal black, pigment occurs on the upper half of the abdomen, and there are a few small melanophores on the snout and below the eye. In life there is a patch of yellow pigment behind the eye, and there are yellow chromatophores as well as melanophores on the oil globule. The eye is unpigmented (Fig. 1).

Larvae

Karlovac (1962) presented data about the food of mackerel larva. The length of larvae were betwen 4.73 mm and 15.69 mm. In the eastern Adriatic mackerel larvae occur in the areas of island Dugi otok, Blitvenica, island Vis and Palagruža archipelago during January, February, March, April and June (Karlovac, 1962). Karlovac (1967) found mackerel larvae at the stations in the Brač channel. Regner (1982) found mackerel larvae at the station Stončica (43° 00' N 160 20'E) in the middle Adriatic in January and March with frequency 0.26%, and Dulčić (1992) only in January with frequency 0.04%.

Holt (1898) described a specimen 7 days old in which the yolk was fully absorbed; it can thus be regarded as an early larva. This was 4.46 mm long with a preanal length of 1.73 mm. Later larvae were described and figured by Holt (1898), Ehrenbaum (1905-09), 1921, 1923) and Allen (1917), among others.

The larval pigmentation is quite distinctive and shows little change during growth of the larvae until it reaches a size of 13-14 mm when the young fish may begin to assume its mackerel-like form. The salient features of the pigmentation are the contour rows of dorsal and ventral melanophores on either side of the body. These rows start a definite distance behind the anus, resulting in a pigment-free zone dorsally above the abdomen and a clear space ventrally. The rows extend practically to the tail. In the earliest stages there may be fewer melanophores in the dorsal row than in the ventral row, but as the larva grows, equal numbers may be developed in the two rows, up to about 14-15 melanophores in each. Sometimes the dorsal and sometimes the ventral row appears to have the larger melanophores. There are a few melanophores along the urostyle and on the base of the developing caudal fin. There are never any melanophores on the sides of the body between the dorsal and ventral contour rows.There is a group of melanophores on the crown of the head, and there may be one or two in front of the eyes and sometimes on the snout and lower jaw (Fig. 1). There is rather heavy peritoneal pigmentation confined to the upper half of the abdomen. The bending up of the urostyle is gradual and probably begins at a length of about 6 mm, when the rudiments of the caudal fin are beginning to appear. Dorsal and ventral interspinous areas begin to develop at a length of 8-9 mm. The following are characteristic morphological features: the presence of sharp teeth on upper and lower jaws, which become apparent already at a length of under 5 mm; the pointed anterior profile of the head when the mouth is closed; the flask-shaped form of the stomach and rectum. When the larva has reached a length of about 12-13 mm, dorsolateral melanophores begin to appear, and at a length of 16 mm these cover the upper half of the body. Myomere counts give 14 preanal elements and 17 postanal elements for larvae between 5 mm and 13 mm. length (Ehrenbaum, 1924).

Scomber japonicus Houttuyn, 1782

Eggs

The eggs are spherical, on average ranging in diameter from 1.06 to 1.14 mm, with an oil globule 0.26 mm in diameter (Kramer, 1960) (Fig. 2). The yolk is unsegmented and under magnification (40x) can be seen to be filed with a large number of tiny vacuoles. The perivitelline space is narrow. In advanced stages of development both the dorsum of the embryo and the oil globule are pigmented, the latter on the hemisphere facing the head. The spawning period of Spanish mackerel in the eastern Adriatic is at the end of summer and first half of autumn, and possible spawning grounds are around the islands of Mljet, Vis, Dugi otok, Premuda and Jabuka (Milišić, 1994).

Larvae

Larvae of this species were caught during previous surveys in the eastern Adriatic (Karlovac, 1967; Regner, 1980), especially in its middle part (Kaštela Bay - 43° 31'N 16° 19'E - depth 42 m). Dulčić (1991, unpublished data) found Spanish mackerel larva at the station (43° 55' 30" N 14° 49' E - depth 66.5 m) at the high sea of island Dugi otok.

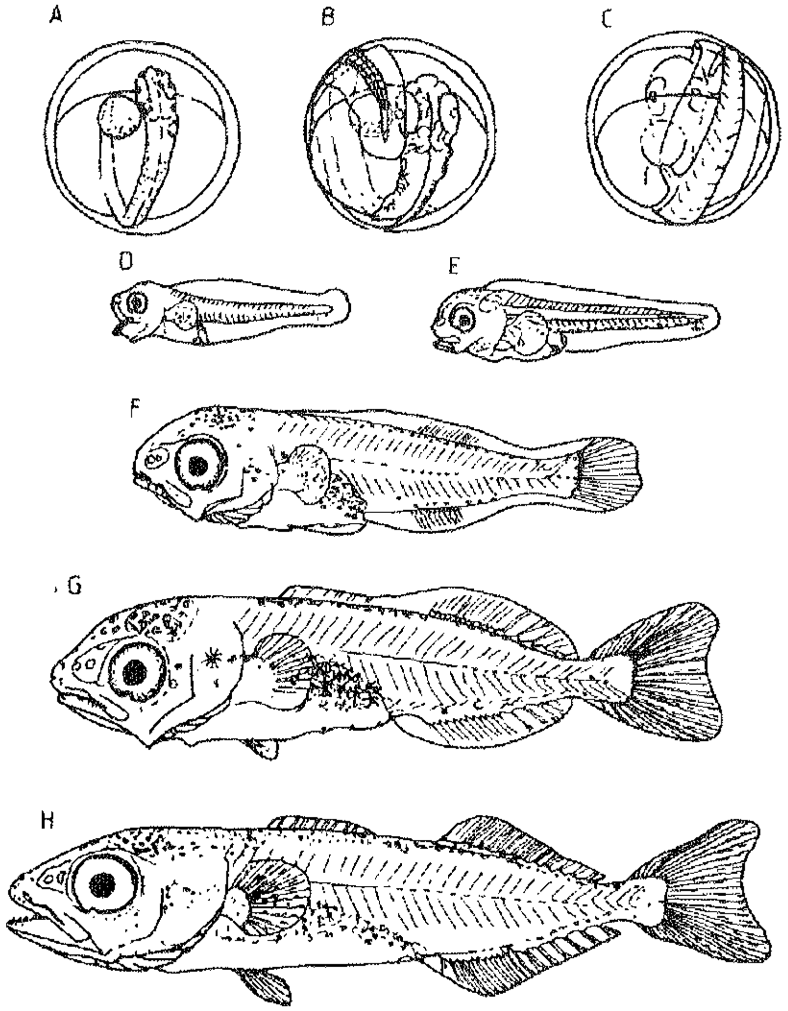


Fig. 2: Scomber japonicus ***Houttuyn, 1782 (A), (B), (C) Eggs, 1.06-1.14 mm in diameter; (D) Larva, 4.0 mm; (E) Larva, 5.0 mm; (F) Larva, 7.8 mm; (G) Larva, 10.0 mm; (H) Larva, 16.5 mm (after Kramer, 1960).***
Sl. 2: *Scomber japonicus* ***Houttuyn, 1782 (A), (B), (C) ikre, 1,06-1,14 mm v premeru; (D) ličinka, 4,0 mm; (E) ličinka, 5,0 mm; (F) ličinka, 7,8 mm; (G) ličinka, 10,0 mm; (H) ličinka, 16,5 mm (po Kramerju, 1960).***

After yolk absorption the larvae are deep-bodied and stubby, although body shape is more fusiform in individuals approaching the juvenile stage. In preflexion larvae body depth at the cleithrum is 23-24% of NL (notochord length); body depth increases slightly to 25-26% of SL (standard length) in flexion larvae and up to 13 mm SL and then falls back in following stages, to 21% SL at 18 mm. The gut extends to somewhat less than the midpoint of the body in preflexion larvae, to the midpoint in flexion and early post-flexion larvae, and up to around 63% in the late larval stages. Head length also increases over development, representing 23-25% of SL in preflexion larvae and 28% of SL in post-flexion larvae and late larval stages. The principal body regions of the larvae of this species that display pigmentation are the head, peritoneum, and the midventral line of the tail (Fig. 2). Flexion and postflexion larvae also bear pigmentation on the dorsal contour of the body. Pigmentation on the midventral line of the tail in first-feeding larvae consists of two lines of melanophores that fuse into a single line from 7.5 mm SL. Pigmentation on the head becomes more abundant and outspread with larval growth, although it never reaches the cleithral symphysis.

Pigmentation spreading out onto the lateral walls of the gut in postflexion larvae. At about 5 mm NL pigmentation appears on developing caudal fin, at about 7 mm SL on the dorsal margin of the body, and at 7.5 mm SL along the lateral line. The urostyle is turned upwards dorsally at 6 mm SL. Myomere counts give 31 elements for larvae between 5 mm and 13 mm length (Ehrenbaum, 1936).

Thunnus thynnus thynnus **(Linnaeus, 1758)**

Eggs

Spherical, 1.00-1.12 mm in diameter, yolk unsegmented, oil globule 0.25-0.28 mm in diameter, without perivitelline space, the oil globule and embryo are pigmented (Sanzo, 1932) (Fig. 3). The spawning period is in spring in the coastal waters along the eastern Adriatic, especially in the northern Adriatic (Hrvatsko Primorje and Kvarner)(Milišić, 1994) and the middle Adriatic (Piccinetti, 1973; Piccinetti *et al.*, 1981).

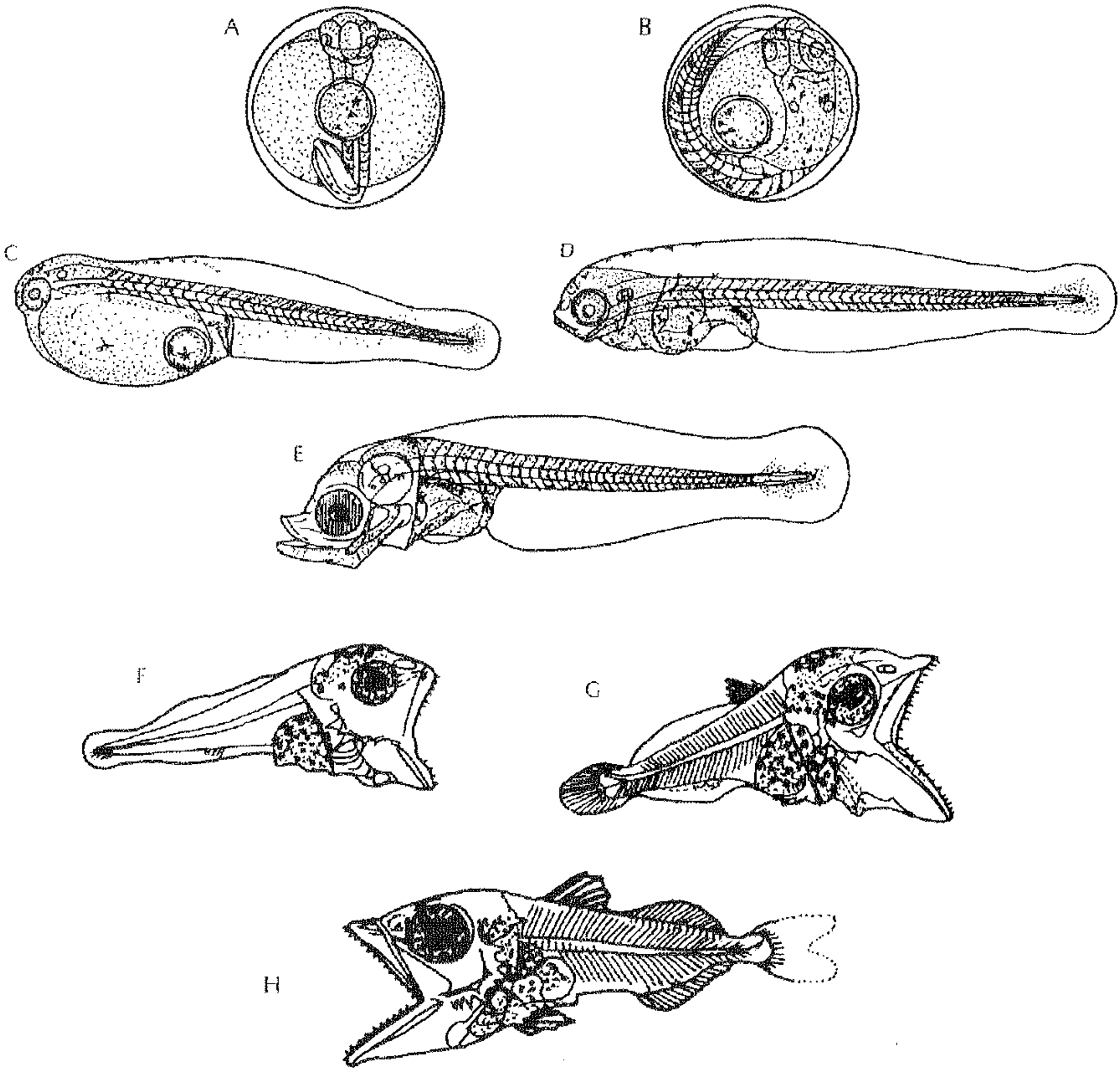


Fig. 3: *Thunnus thynnus thynnus* ***(Linnaeus, 1758) (A), (B) Eggs, 1.00-1.12 mm in diameter; (after Sanzo, 1932); (C) Yolk-sac larva, 3.00 mm; (D) Yolk-sac larva, 3.84 mm; (E) Larva, 3.90 mm; (F) Larva, 4.70 mm; (G) Larva, 6.80 mm; (H) Larva, 9.40 mm (originals drawn by author).***

Sl. 3: *Thunnus thynnus thynnus* ***(Linnaeus, 1758) (A), (B) ikre, 1,00-1,12 mm v premeru; (po Sanzu, 1932); (C) ličinka z rumenjakovo vrečo, 3,00 mm; (D) ličinka z rumenjakovo vrečo, 3,84 mm; (E) ličinka, 3,90 mm; (F) ličinka, 4,70 mm; (G) ličinka, 6,80 mm; (H) ličinka, 9,40 mm (originalne risbe avtorja).***

Larvae

Larvae of this species were caught during previous surveys in the eastern Adriatic, at the high sea of the middle Adriatic (station Stončica, 43° 00' N 16° 20' E) in July and September with frequency 0.10% (Regner, 1982). Dulčić (1990, unpublished data) found tuna larvae in the Kvarner area (station 44° 51' 30'' N 14° 12' E - depth 46 m), Rijeka Bight (45° 14' N 14° 25' 30'' E- depth 62.5 m) and near island Susak (station 44° 30' 30'' N 14° 11' E - depth 47 m) (n=4, range 7.40 - 9.00 mm length). Larvae were also found in the open middle Adriatic (Piccinetti, 1973; Piccinetti & Piccinetti-Manfrin, 1973, 1979; Piccinetti *et al.*, 1977, 1981; Scaccini, 1953, 1959, 1961). Standard length of tuna larvae were between 5.3 and 6.3 mm (n=8) (Piccinetti, 1973). Piccinetti *et al.* (1981) found larvae in the Ionian Sea and southern Adriatic from mid-June to 20 July, and according to that they presumed that spawning grounds in the middle Adriatic are in connection with ones in the Mediterranean Sea. When newly hatched, yolk-sac larva is 3.0 mm long and the yolk-sac is almost entirely absorbed at 3.8 mm Sanzo, 1932) (Fig. 3). Melanophores are distributed along the dorsal and ventral contours of the body at newly hatched yolk-sac larvae and after that there are only along ventral part. Peritoneal black pigment occurs on its dorsal side. There is a group of melanophores on the crown of the big head and at upper half of peritoneum. One great spine appeared on the margine of preoperculum at 4.7 mm larval length. There is rather heavy peritoneal pigmentation at 6.8 mm larval length (Ehrenbaum, 1924). Eight spines appeared (one great in centre, four medium and three small) at 9.3 mm larval length. There are no more visible melanophores along the body (Fig. 3). Myomere counts give 18 preanal and 21 postanal elements for larvae between 5 and 13 mm length (Ehrenbaum, 1924).

***Auxis rochei* (Risso, 1810)**

Larvae

This species is distributed in the middle Adriatic (island Jabuka) (Viličić, 1985) and in the nothern Adriatic (Milišić, 1994). Piccinetti (1973) found 28 larvae (60.9%) in the wider area of the middle Adriatic during summers in 1972 and 1973. Standard length was between 2.8 and 49 mm. Five larvae were also found in the southern Adriatic. According to the numerous findings of larvae in the middle Adriatic, Piccinetti (1973) supposed that this species spawn in that area. Milišić (1994) reported that bullet tuna spawn in spring in the Rijeka Bight, Kvarner and in the southern Adriatic. Piccinetti & Piccinetti-Manfrin (1979) recorded a great number of bullet tuna larvae in the wider area of the middle Adriatic and in the part of the southern Adriatic, including the Jabuka pit, during 1972, 1973 and 1975-1977 period. Dulčić (unpublished data) found larva of bullet tuna at station in the Rijeka Bight (45° 14' N 14° 25' 30'' E - depth 62.5 m) in July 1990. Standard length was 12.7 mm.

When newly hatched, yolk sac larva is 3.0 mm long (Sanzo, 1932). Preanal region is about 2/5 of total length at a length of 5.0 mm. There are 5 spines on the preoperculum (Ehrenbaum, 1924) (Fig. 4). Only two or three melanophores are on the dorsal and six or seven on the ventral side of body at a short distance from the base of the caudal fin. When larva reached 5.7 mm, seven spines appeared on the preoperculum. There is a heavy pigmentation on the head and on the peritoneum at larval length of 12 mm. Myomere counts give 20 preanal elements and 19 postanal elements for larvae between 5 and 13 mm length (Ehrenbaum, 1924).

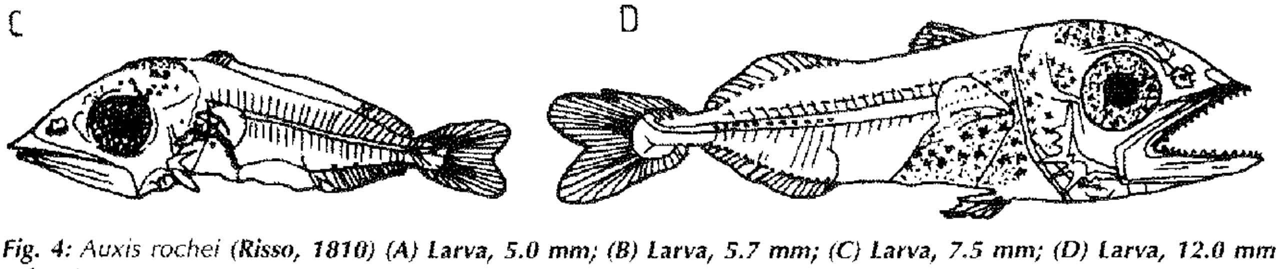


Fig. 4: Auxis rochei ***(Risso, 1810) (A) Larva, 5.0 mm; (B) Larva, 5.7 mm; (C) Larva, 7.5 mm; (D) Larva, 12.0 mm (after Sanzo, 1932).***
Sl. 4: Auxis rochei ***(Risso, 1810) (A) ličinka 5,0 mm; (B) ličinka, 5,7 mm; (C) ličinka, 7,5 mm; (D) ličinka, 12,0 mm (po Sanzu, 1932).***

Genetic species identification of tunas is useful since morphological identification especially of the larval and juvenile stages can be difficult. Pigment patterns are used to distinguish larvae (Matsumoto *et al.*, 1972; Nishikawa, 1985), but these changes with developmental stage and can be difficult to apply with confidence (Nishikawa & Rimmer, 1987; Richards *et al.*, 1990).

POVZETEK

Raziskovanje zgodnjih razvojnih stadijev rib je v zadnjih letih doživelo precejšen razmah, tako kot tudi sistematične in ekološke študije o njih. Danes se zavedamo, da je preživetje iker in mladic najpomembnejši dejavnik, ki vpliva na spremembe v številčnosti populacije neke ribje vrste. Prvi pogoj za takšno preučevanje so podrobni podatki o pojavljanju iker in mladic v vzorcih planktona. Družina skuš (Scombridae) je izredno pomembna za ribištvo v državah ob Jadranskem morju. V tem članku so obdelani vsi razpoložljivi podatki o zgodnjih razvojnih stadijih družine skuš v vzhodnem delu jadranskega morja.

LITERATURE

Allen, E.J. 1917. Post-larval teleosteans collected near Plymouth during the summer of 1914. J. mar. biol. Ass. U.K., 56: 471-486.

Buchanan-Wollaston, H.J. 1911. Report on the results of the fish-egg cruise made by S.S."Huxley" in June 1909. Rep. N. Sea. Fish. Invest. Comm., 1906-1908: 207-234.

Cunningham, J.T. 1889. Studies of the reproduction and development of teleostean fishes occurring in the neighbourhood of Plymouth. J. mar. biol. Ass. U.K., 1: 10-54.

Dulčić, J. 1992. Istraživanje sastava i brojnosti ihtioplanktona u srednjem Jadranu. Morsko ribarstvo, 3: 73-78.

Ehrenbaum, E. 1905-09. Eier und larven von Fischen der Deutschen Bucht. III. Fische mit festsitrenden. Giem. Wiss. Meeresunt. Helgoland, vol VI: p. 127.

Ehrenbaum, E. 1921. Ueber die Makrele. Laichverhältruisse larven und jugendformen. Nahrung und Feinde. Arh. Deutsch Wiss. Kommn. Meeresforsch., In Wiss. Meeresuntersuch. Helgoland, N.F., 15, (1923-30) No. 2: 1-30.

Ehrenbaum, E. 1923. Ueber die Makrele. Laichverhältruisse larven und jugendformen. Wiss. Meeresunt. Helgoland, vol. 15: pp. 32.

Ehrenbaum, E. 1924. Scombriformes. Rep. Dan. Ocean. Exp. 1908-1910, vol 2 A11: pp. 42.

Ehrenbaum, E. 1936. Naturgeschichte und wirtseliaftliche Bedeutung der Seefische Nordeunges. Stuttgart.

Gamulin, T. & Hure, J. 1983. Mriješćenje i mrestilišta pelagičnih riba u Jadranskom moru *(Sardina pilchardus, Engraulis encrasicolus, Scomber scombrus, Sardinella aurita, Sprattus sprattus).* Acta Adriat. 24 (1/2): 97-131.

Grubišić, F. 1982. Ribe, rakovi i školjke Jadrana. ITRO-Naprijed, Zagreb-GRO Liburnija, Rijeka: 240 pp.

Holt, E.W.L. 1893. Survey of fishing grounds, west coast of Ireland, 1890-91: on the eggs and larval and post-larval stages of teleosteans. Scient. Trans. R. Dublin Soc., Ser. 2, 5: 121 pp.

Holt, E.W.L. 1898. Notes on the reproduction of teleosteans fishes in the south-western district. J. mar. biol. Ass. U.K., 5: 107-155.

Karlovac, J. 1962. Ispitivanje sadržaja probavnog trakta kod planktonskog stadija skuše *(Scomber scombrus)* u Jadranu. Izvješća rib-biol. eksp. "Hvar" 1948-1949, Vol. IV, No. 41, Split.

Karlovac, J. 1967. Etude de l'ecologie de la sardine, *Sardina pilchardus* Walb., dans la phase planctonique de sa vie en Adriatique moyenne. Acta Adriat., 2: 1-101.

Kramer, O. 1960. Development of eggs and larvae of the Pacific mackerel and distribution and abundance of larvae 1952-56. Fish. Bull. U.S. 60: 393-438.

Lissner, H. 1939. Ueber die Makrele des Adriatischen Meeres. Thalassia, vol 3, 8: 82 pp.

Matsumoto, W.M., Ahlstrom, E.H., Jones, S., Kuawe, W.L., Richards, W.J. & Ueyanagi, S. 1972. On the classification of larval tuna identification particularly in the genus *Thunnus.* Fish. Bull. U.S. 70: 1-12.

Milišić, N. 1994. Sva riba jadranskoga mora. NIVA d.o.o. Split, 448 pp.

Moser, H.G., Richards, W.J, Cohen, D.M., Fahey, M.P., Kendall, A.W. Jr. & Richardson, S.L. (editors) 1984. Ontogeny and systematics of fishes. Spec. Publ. 1, Am. Soc. Ichthyol. Herpetol. Allen Press, Laurence KS: 760 p.

Nishikawa, Y. & Rimmer, D.W. 1985. Identification for larvae of three species of genus *Thunnus* by melanophore patterns. Bulletin of the Far Seas Fisheries Research Laboratory 22: 119-125.

Nishikawa, Y. & Rimmer, D.W. 1987. Identification of larval Tunas, Billfishes and other Scombroid Fishes (suborder Scombroidei): an Illustrated Guide, Hobart: CSIRO Marine Laboratories Report 186 p.

Piccinetti, C. 1973. Stades larvaires et juveniles de thons en Adriatique. Ichthyologia, 5: 129-134.

Piccinetti, C. & Piccinetti Manfrin, G. 1973. Forme larvali di Tunnidi in Adriatico. Atti V Congr. Naz. Soc. It. Biol. Mar., Ed. Salentino, Nardo: 163-168.

Piccinetti, C. & Piccinetti Manfrin, G. 1978. Larve di Tunnidi in Adriatico. Nova Thalassia, 3: 163-173.

Piccinetti, C. & Piccinetti Manfrin, G. & Dicenta, A. 1977. Premiéres pêches quantitative de larves de thonidés en Adriatique. Rapp. Comm. int. Mer Médit. 24 (5): 43-44.

Piccinetti, C. & Piccinetti Manfrin, G. & Dicenta, A. 1981. Nouvelles donnés sur la réproduction des thonidés en Mediteranée. Rapp. Comm. int. Mer Médit. 27(5): 165-166.

Regner, S. 1980. The larval stages of fish in Kaštela Bay. Acta Adriat. 21(2): 123-136.

Regner, S. 1982. Istraživanja sastava i brojnosti larvalnih stadija riba u planktonu otvorenog mora srednjeg Jadrana. Studia Marina 11-12: 45-60.

Richards, W.J., Rotthoff, T. & Kim J-M. 1990. Problems identifying tuna larvae species (Pisces: Scombridae: *Thunnus)* from the Gulf of Mexico. Fish. Bull. U.S. 88: 607-609.

Sanzo, L. 1932. Scombridae. Uova, stadi larvali e giovanili di Teleostei. Mem. R. Com. Talassogr. Ital.

Scaccini, A. 1953. La campagna di studio della biologia e della pesca dei giovani tonni nell'Adriatico compiuto dal Laboratorio di Biologia Marina di Fano nell'state 1952. Boll. Pesca. 1: p.18.

Scaccini, A. 1959. Bio-écologie des jeunes thons dens les mers italiennes. Proc. gen. Fish. Comm. Medit. 5(70): 449-495.

Scaccini, A. 1961. Considération sur les déplacements et la distribution des jeunes thons en Adriatique. Proc. Gen. Fish. Comm. Médit. 6(45): 293-294.

Sella, M. & Ciacchi, O. 1925. Uova e larve dello sgombro del Mediterraneo *(Scomber scombrus)* ottenuti per fecondazione artificale, con notizie biologiche. Mem. R. Com. Talass. It. CXIV: p. 52.

Wooster, W.S. 1983. From year to year: International variability of the environment and fisheries of the Gulf of Alaska and the eastern Bering Sea. Rep. WSG-WO 83-3, Wash. Sea Grant Prog., Univ. Wash., Seattle, NA 98195: 208 p.

izvirno znanstveno delo

UDK 594.5(262.3 Tržaški z.)"1995/1996"
597(262.3 Tržaški z.)"1995/1996"

POJAVLJANJE NEKATERIH VRST GLAVONOŽCEV IN RIB V SLOVENSKEM MORJU

Bojan MARČETA
dipl. biolog, Inštitut za biologijo, SI-1000 Ljubljana, Večna pot 111
B.Sc. in biology, Institute of biology, SI-1000 Ljubljana, Večna pot 111

IZVLEČEK

V obdobju od aprila 1995 do septembra 1996 smo v slovenskem morju s pridneno povlečno mrežo ulovili 8 vrst glavonožcev in 56 vrst rib, ki jih navajam v seznamu. Časovno pojavljanje navajam za 8 pridnenih vrst glavonožcev, 4 vrste rib hrustančnic in 42 vrst rib kostnic. Natančnejše podatke o pojavljanju navajam za lignja (Loligo vulgaris), *moškatno hobotnico* (Eledone moschata), *navadnega morskega psa* (Mustelus mustelus), *morskega goloba* (Myliobatis aquila), *osliča* (Merluccius merluccius), *mola* (Merlangius merlangus), *moliča* (Trisopterus minutus), *kovača* (Zeus faber), *volčiča* (Serranus hepatus), *špageta* (Cepola rubescens), *bradača* (Mullus barbatus), *bukvo* (Boops boops), *špara* (Diplodus annularis), *ribona* (Pagellus erythrinus), *menolo* (Spicara flexuosa) *in morsko plosčo* (Platichthys flesus).

Ključne besede: Tržaški zaliv, Cephalopoda, Selachii-Chondrichthyes, Osteichthyes, dinamika pojavljanja, seznam vrst
Key words: Gulf of Trieste, Cephalopoda, Selachii-Chondrichthyes, Osteichthyes, occurrence, species checklist

UVOD

Slovenski del Tržaškega zaliva je bil na področju raziskav rib, verjetno zaradi zanimivejšega preostalega dela Jadrana, vseskozi zapostavljen. Biološko raziskovanje ribištva se je v tem delu Jadrana pričelo šele ob koncu osemdesetih let. Razlog za takratno raziskovanje je bil politične narave. Sporazum z Italijo o skupnem izkoriščanju osrednjega dela Tržaškega zaliva je povzročil nezadovoljstvo med lokalnimi ribiči, čemur je sledila odločitev o raziskavi zalog pridnenih rib in drugih užitnih organizmov (Štirn & Bolje, 1989). Žal je omenjeno raziskovanje po nekaj letih zamrlo. Pozneje je osamosvojitev Slovenije botrovala ponovnemu zagonu na področju ekoloških raziskav lovnih organizmov. Mlada obmorska država se je zavedela, da se bo morala po zgledu drugih držav, ki izkoriščajo morske dobrine, lotiti lastnega raziskovanja lovnih virov. Od začetka leta 1995 v ta namen deluje dvočlanska raziskovalna skupina na Inštitutu za biologijo v Ljubljani.

Vsakemu slovenskemu morskemu ribiču je znano sezonsko nihanje števila lovnih organizmov v našem morju, žal pa je natančnejših podatkov o tem malo. V raziskovalni nalogi Štirna & Boljeta (1989) so zbrani edini dosedanji podatki o dinamiki pojavljanja pridnenih lovnih organizmov v našem morju. Pomanjkljivi so tudi podatki o številu vrst glavonožcev in rib v našem morju. Edini seznam vrst, ki obravnava tudi to območje, je delo Matjašiča *et al.* (1975). Dinamika pojavljanja glavonožcev in rib je poleg seznama ulovljenih vrst osnova za nadaljnje ekološke raziskave teh skupin v slovenskem morju.

V članku navajam rezultate o vrstah, ulovljenih s pridneno povlečno mrežo (PPM), in o dinamiki njihovega pojavljanja v ribolovnem morju Republike Slovenije. Osnovni namen dela je bil ugotoviti, (i) katere vrste glavonožcev in rib se ulovijo s PPM in (ii) kakšna je njihova letna dinamika pojavljanja.

datum vzorčenja	število vzorcev	dolžina potegov		trajanje vzorčenja	povprečna hitrost	tip PPM/dolžina zgornje vrvi ustja PPM
		(km)	(Nm)	(min.)	(Nm/h)	
28. 6. 1995	2	6,50	3,50	60	3,53	MEDITS /28,2 m
25. 7. 1995	3	13,00	7,00	184	2,00	KOM /36,8 m
3. 8. 1995	2	11,13	6,00	158	2,25	KOM /36,8 m
22. 8. 1995	3	13,75	7,43	206	2,16	KOM /36,8 m
18. 9. 1995	3	21,52	11,62	356	1,96	KOM /30 m
12. 10. 1995	3	6,57	3,55	119	1,79	KOM /36,8 m
22. 11. 1995	3	8,26	4,46	120	2,23	KOM /39 m
20. 12. 1995	3	9,10	4,91	120	2,46	KOM /39 m
22. 1. 1996	3	8,54	4,61	125	2,22	KOM /39 m
27. 2. 1996	3	8,86	4,79	122	2,36	KOM /52 m
10. 4. 1996	3	8,48	4,58	121	2,29	KOM /39 m
16. 6. 1996	2	5,63	3,04	60	3,04	MEDITS /28,2 m
16. 7. 1996	2	6,11	3,30	80	2,48	KOM /36,8 m
21. 8. 1996	3	7,67	4,14	124	2,01	KOM /39 m
24. 9. 1996	3	7,80	4,21	120	2,11	KOM /39 m
	41	142,92	77,14	2075		

Tabela 1: Podatki o potegih s pridneno povlečno mrežo, na katerih temelji raziskava o pojavljanju glavonožcev in rib v slovenskem morju. Legenda: PPM = pridnena povlečna mreža, MEDITS = PPM, izdelana za raziskovalne namene (MEDITS, 1995, 1996), KOM = PPM lokalnega ribiča.
Table 1: Data on pulls with bottom trawling gear, on which the research into the occurrence of cephalopod and fish species in the Slovene part of the Adriatic Sea is based.
datum vzorčenja = sampling date, število vzorcev = No. samples, dolžina potegov = length of pulls, trajanje vzorčenja = sampling duration, povprečna hitrost = average speed, tip PPM/dolžina zgornje vrvi ustja PPM = PPM type/length of upper rope mouth of PPM. Key: PPM = bottom trawling gear, MEDITS = PPM made for research purposes (MEDITS, 1995, 1996), KOM = PPM of a local fisherman.

MATERIAL IN METODE

Material

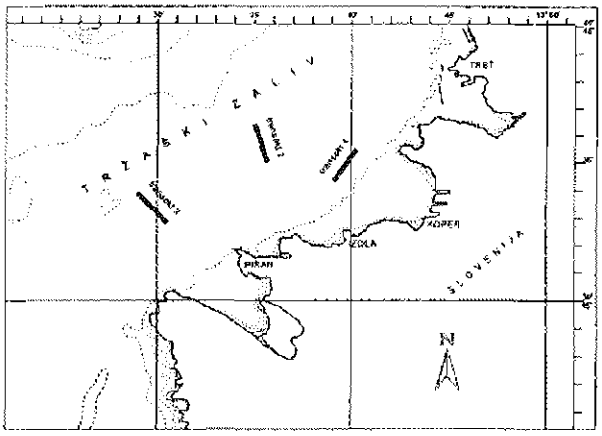
V raziskavi sem zajel glavonožce in ribe, ki so predmet ribolova s PPM. V PPM so se ulovili predvsem predstavniki pridnenih vrst. V ulovu je bilo vselej tudi manjše število osebkov nekaterih pelaških vrst. Pelaške vrste sem upošteval v seznamu vrst, izpustil pa sem jih iz dinamike pojavljanja. Za določanje vrst sem uporabil naslednje ključe: Roper *et al.* (1984) - za glavonožce ter Šoljan (1965) in Whitehead *et al.* (1986a, 1986b, 1989) - za ribe.

Obravnavano območje

Vzorčili smo v delu ribolovnega morja Republike Slovenije, v katerem je dovoljena uporaba PPM. Območje je proti obali omejeno s črto, ki je od obale oddaljena eno navtično miljo. Proti odprtemu morju je območje omejeno z mejo teritorialnih voda Republike Slovenije. Dno na tem območju je v glavnem ravno, globina morja pa je v večjem delu od 22 do 24 metrov. Za vzhodni del je značilno ilovnato-muljasto dno (severovzhodno od strunjanskega polotoka), v zahodnem delu je dno muljasto-peščeno, med oba tipa dna pa se vriva območje muljasto-detritnega dna (Štirn & Bolje, 1989).

Vzorčna mesta in časovna razporeditev vzorčenja

Vzorčili smo v obdobju od 24. 4. 1995 do 24. 9. 1996. Za raziskavo dinamike pojavljanja glavonožcev in rib sem uporabil podatke 41 vzorcev iz obdobja od 28. 6. 1995 do 24. 9. 1996 (tabela 1). Potege s PPM smo opravili na treh transektih, ki so bili postavljeni bolj ali manj pravokotno na obalo. Transekt 1 je bil v vzhodnem delu (severozahodno od Koprskega zaliva od točke 45° 35,55' N, 13°40,30' E proti točki 45°34,37' N, 13° 39,18' E); transekt 2 je bil v osrednjem delu (severno od rtiča Ronek od točke 45°36,40' N, 13°35,00' E proti točki 45°35,00' N, 13°35,65' E) in transekt 3 v zahodnem delu (severozahodno od Piranskega zaliva od točke 45°32,88' N, 13°30,45' E proti točki 45°33,90' N, 13° 28,98' E) (slika 1). V enem vzorčevalnem dnevu smo praviloma opravili tri potege s PPM. Vzorčili smo enkrat na mesec, včasih pa je zaradi slabega vremena prišlo do večjih razmikov med dvema vzorčevalnima dnevoma ali do manjšega števila vzorcev v enem dnevu. Potege s PPM do do 18. 9. 1996 smo opravili na območjih transektov, vendar pa so bili potegi daljši (tab. 1).



Slika 1: Zemljevid obravnavanega območja z označenimi transekti, na katerih smo vzorčili s pridneno povlečno mrežo.
Fig.1: Map of the dealt with area with marked transects in which sampling was carried out with bottom trawling gear.

Metode vzorčenja

Vsa vzorčenja smo opravili v svetlem delu dneva. Junija smo vzorčili v okviru mednarodnega programa za raziskovanje pridnenih komercialnih organizmov v Sredozemlju (MEDITS). Pri tem smo uporabili metodiko, ki jo predpisuje omenjeni program (MEDITS, 1995, 1996). Za metodološko izhodišče lastnih vzorčenj smo se držali protokola programa MEDITS, ki pa smo ga morali nekoliko prirediti. Obe vzorčenji sta se razlikovali predvsem po tipu uporabljene PPM, času trajanja vzorčenja (MEDITS: 30 minut; naše vzorčenje: 40 minut) in hitrosti vleke (MEDITS: 3,3 Nm/h; naše vzorčenje: 2,2 Nm/h). Natančnejši podatki o vzorčenju so v tabeli 1.

Lovili smo z dvema plovilioma in mrežama. V okviru programa MEDITS smo vzorčili z ribiško ladjo dolžine 32 metrov in močjo motorja 500 kilovatov. Obakrat smo uporabili PPM (diagonala očesa saka = 20 mm), izdelano v raziskovalne namene (MEDITS, 1995). Lastna vzorčenja smo opravili z najetim ribiškim čolnom dolžine 11,46 metrov in močjo motorja 80 kilovatov, ki tudi sicer lovi na tem območju s PPM. Uporabili smo srednje težko mrežo, izdelano za komercialni ribolov (diagonala očesa saka = 37 mm). V času raziskave je ribič spreminjal dolžino kril mreže, kar pa sem pri izračunih vselej upošteval.

Analiza vzorcev ter ocena abundance in biomase

Vrstno sestavo vzorcev sem ugotavljal s pregledovanjem celotnih vzorcev. Ribe in glavonožce sem razvrstil po vrstah. Za vsako vrsto sem preštel osebke in jih stehtal. Glavonožcem sem meril dolžino plašča (Roper *et al.*, 1984), ribam pa celotno telesno dolžino (Sparre & Vanema, 1992).

Površino potega s PPM sem izračunal po obrazcu:

$$a = s \times h \times X_2 \ [km^2]$$

kjer je **s** pot, ki jo je opravilo plovilo, **h** dolžina zgornje vrvi ustja koče in $\mathbf{X_2}$ faktor zmanjšanja ustja mreže. Po Shindo (1972) sem uporabil faktor zmanjšanja 0,66. Dolžino poti sem odčital z GPS na osnovi treh točk za vsak vzorec. Prva točka je bila mesto začetka vleke, druga točka je bila časovno na sredini vleke in tretja na koncu vleke.

Biomaso za posamezno vrsto sem izračunal po obrazcu:

$$b = (Cw/a)/X_1 \ [kg\ km^{-2}]$$

kjer je **Cw** teža organizmov posamezne vrste v vseh vzorcih, opravljenih na isti dan, **a** površina vseh potegov s PPM in $\mathbf{X_1}$ faktor uhajanja rib z območja ustja mreže (Sparre & Vanema, 1992). Po zgledu Štirn in Bolje (1989) sem uporabil faktor uhajanja rib 0,4.

Abundanco osebkov posamezne vrste sem izračunal po obrazcu:

$$Ab = (Ex/a)/X_1 \ [Ex\ km^{-2}]$$

kjer je **Ex** število osebkov posamezne vrste v vseh vzorcih, opravljenih na isti dan.

REZULTATI IN RAZPRAVA

Seznam ulovljenih vrst

Seznam 64 ulovljenih vrst temelji na 55 vzorcih. Ulovili smo 8 vrst glavonožcev in 56 vrst rib. Od rib hrustančnic (Selachii - Chondrichthyes) smo ulovili 4 vrste, od rib kostnic (Osteichthyes) pa 52 vrst (tabela 2). Med glavonožci je bilo 7 pridnenih vrst in 1 polpelaška. Tri vrste rib hrustančnic so bile pridnene, ena pa bentopelaška. Od rib kostnic je bilo 37 pridnenih, 11 pelaških, 3 bentopelaške in 1 polpelaška vrsta.

Seznam vretenčarjev severnega Jadrana (Matjašić *et al.*, 1975) dopolnjujem z eno vrsto glavonožca *(Sepia orbignyana)* in osmimi vrstami rib (*Raja asterias, Mullus surmuletus, Pagellus bogaraveo, Deltentosteus quadrimaculatus, Parablennius tentacularis, Trigloporus lastoviza, Phrynorhombus regius* in *Monochirus hispidus).*

Seznam ugotovljenih vrst se v glavnem ujema s seznamom, ki ga navaja Bolje (1992). Večji odmik je bil pri ribah hrustančnicah. V vzorcih, ki jih je obdelal Bolje, so bili še *Scyliorhinus canicula, Squalus acanthias, Raja miraletus, Torpedo marmorata.* V mojem seznamu rib kostnic manjkajo vsi predstavniki družine Scorpaenidae, ki jih je ugotovil Bolje. Vsi omenjeni odmiki so verjetno povezani z raziskovalnim območjem, saj je Bolje vzorčil tudi bolj jugozahodno.

Taxa	št. osebkov	pogostnost (%)	bivališče
CEPHALOPODA			
Sepiidae			
Sepia elegans Blainville, 1827	3	7	D[1]
Sepia officinalis Linnaeus, 1758	36	26	D[1]
Sepia orbignyana Ferussac, 1826	2	5	D
Sepiolidae			
Sepiola sp.	9	7	D
Loliginidae			
Alloteuthis media (Linnaeus, 1758)	1590	98	D[1]
Loligo vulgaris Lamarck, 1798	853	95	PP[1]
Octopodidae			
Octopus vulgaris Cuvier, 1797	1	2	D[1]
Eledone moschata (Lamarck, 1799)	1641	86	D[1]
CHONDRICHTHYES			
Triakidae			
Mustelus mustelus (Linnaeus, 1758)	214	43	D[2]
Rajidae			
Raja asterias Delaroche, 1809	3	5	D[3]
Dasyatidae			
Dasyatis pastinaca (Linnaeus, 1758)	1		D[4]
Myliobatidae			
Myliobatis aquila (Linnaeus, 1758)	7	14	BP
OSTEICHTHYES			
Clupeidae			
Alosa fallax (Lacepede, 1803)	1	2	P[5]
Sardina pilchardus (Walbaum, 1792)	81	17	P[5]
Sprattus sprattus (Linnaeus, 1758)	24	14	P[5]
Engraulidae			
Engraulis encrasicolus (Linnaeus, 1758)	6	12	P[6]
Congridae			
Conger conger ([Artedi, 1738] Linnaeus, 1758)			D[7]
Syngnathidae			
Hippocampus ramulosus Leach, 1814	1	2	D
Syngnathus acus Linnaeus, 1758			D
Merlucciidae			
Merluccius merluccius (Linnaeus, 1758)	103	43	PP[8]
Gadidae			
Merlangius merlangus (Linnaeus, 1758)	2670	86	D[9]
Trisopterus minutus (Linnaeus, 1758)	2936	55	D[9]
Zeidae			
Zeus faber Linnaeus, 1758	123	52	D[10]
Serranidae			
Serranus hepatus (Linnaeus, 1758)	3450	86	D[10]
Moronidae			
Dicentrarchus labrax (Linnaeus, 1758)	1	2	BP
Cepolidae			
Cepola rubescens Linnaeus, 1766	249	52	D[11]
Carangidae			
Trachurus mediterraneus (Steindachner, 1868)	6	10	P[13]
Trachurus trachurus (Linnaeus, 1758)	51	31	P[13]
Sciaenidae			
Umbrina cirrosa (Linnaeus, 1758)	1	2	D[14]
Mullidae			
Mullus barbatus Linnaeus, 1758	195	50	D[15]
Mullus surmuletus Linnaeus, 1758	1	2	D[15]
Sparidae			
Boops boops (Linnaeus, 1758)	41	33	D, PP[16]
Dentex dentex (Linnaeus, 1758)	3	2	D[16]
Diplodus annularis (Linnaeus, 1758)	844	69	D[16]
Lithognathus mormyrus (Linnaeus, 1758)			BP[16]
Pagellus bogaraveo (Brunnich, 1768)	2	2	D[16]
Pagellus erythrinus (Linnaeus, 1758)	1984	74	D[16]
Pagrus pagrus (Linnaeus, 1758)	1	2	D[16]
Sparus aurata Linnaeus, 1758	1	2	D[16]
Centracanthidae			
Spicara flexuosa Rafinesque, 1810	3934	95	BP[17]
Labridae			
Symphodus cinereus (Bonnaterre, 1788)	12	7	D
Trachinidae			
Trachinus draco Linnaeus, 1758	5	7	D[18]
Uranoscopidae			
Uranoscopus scaber Linnaeus, 1758	1	2	D[19]
Scombridae			
Scomber japonicus Houttuyn, 1782	2	5	P[20]
Scomber scombrus Linnaeus, 1758	2	5	P[20]
Gobiidae			
Deltentosteus quadrimaculatus (Valenciennes, 1837)	317	55	D
Gobius niger Linnaeus, 1758	361	48	D
Callionymidae			
Callionymus sp.	1	2	D[21]
Blenniidae			
Blennius ocellaris Linnaeus, 1758	1	2	D
Parablennius gattorugine (Brunnich, 1768)	5	10	D
Parablennius tentacularis (Brunnich, 1768)	1	2	D
Mugilidae			
Liza aurata (Risso, 1810)	11	12	P[22]
Atherinidae			
Atherina hepsetus Linnaeus, 1758	15	10	P[23]
Atherina boyeri Risso, 1810	2	5	?
Triglidae			
Trigla lucerna Linnaeus, 1758			D
Trigloporus lastoviza (Brunnich, 1768)	1	2	D
Scophthalmidae			
Phrynorhombus regius (Bonnaterre, 1788)	4	5	D
Bothidae			
Arnoglossus laterna (Walbaum, 1792)	16	12	D[24]
Pleuronectidae			
Platichthys flesus (Linnaeus, 1758)	35	17	D[25]
Soleidae			
Buglossidium luteum (Risso, 1810)	5	7	D[26]
Monochirus hispidus Rafinesque, 1814	8	7	D[26]
Solea kleinii [Risso] Bonaparte, 1833	1	2	D[26]
Solea vulgaris Quensel, 1806	5	7	D[26]
Lophiidae			
Lophius piscatorius Linnaeus, 1758	2	2	D[26]

Tabela 2: Seznam vrst, ulovljenih s pridneno povlečno mrežo v slovenskem morju. Seznam vrst temelji na 55 vzorcih iz obdobja od 24. 4. 1995 do 24. 9. 1996. Število ulovljenih osebkov in pogostnost pojavljanja vrste v vzorcih pa temeljijo na 41 vzorcih (28. 6. 1995 do 24. 9. 1996).
D = pridneno (bentoške ali demerzalne vrste);
P = pelaško; PP = polpelaško; BP = bentopelaško.
Table 2: List of fish species caught with bottom trawling gear in the Slovene part of the Adriatic Sea. The list is based on 55 samples taken from April 24th 1995 to September 24th 1996. Numbers of caught individuals and frequency of occurrence in samples are based on 41 samples (June 28th 1995 to September 24th 1996).
št. osebkov = No. individuals
pogostnost (%) = frequency (%)
bivališče = habitat
D = demersal species
P = pelagic, PP = semipelagic, BP = benthopelagic.

[1]Roper in sod., 1984; [2]Branstetter, 1989; [3]Stehmann & Burkel, 1989; [4]McEachran & Capape, 1989; [5]Whitehead, 1989a; [6]Whitehead, 1989b; [7]Bauchot & Saldanha, 1986; [8]Svetovidov, 1986a; [9]Svetovidov, 1986b; [10]Quero, 1986; [11]Tortonese, 1986a; [12]Tortonese, 1986b; [13]Smith-Vaniz, 1986; [14]Labbish Ning Chao, 1986; [15]Hureau, 1986a; [16]Bauchot & Hureau, 1986; [17]Tortonese, 1986c; [18]Tortonese, 1986d; [19]Hureau, 1986b; [20]Collette, 1986; [21]Fricke, 1986; [22]Ben-Tuvia, 1986; [23]Quignard & Pras, 1986; [24]Nielsen, 1986a; [25]Nielsen, 1986b; [26]Quero *et al.*, 1986; [27]Caruso, 1986.

Pojavljanje pridnenih vrst

1. Mala sipa *(Sepia elegans* Blainville, 1827)

Posamezne male sipe so bile v poletnih vzorcih, od junija do septembra (tabela 3). Tudi v vzorcih Boljeta (1992) male sipe v zimskem času ni bilo, iz česar sklepam, da se pojavlja le v toplejšem delu leta.

2. Navadna sipa *(Sepia officinalis* Linnaeus, 1758)

Navadne sipe so bile v spomladanskih, poletnih in jesenskih vzorcih, in sicer od aprila do junija, od septembra do oktobra 1995 in od aprila do septembra 1996 (tab. 3). Občasno pojavljanje navadne sipe v vzorcih si razlagam z uporabo prelahkih PPM. Po navedbah ribičev se število sip poveča v zimskem in spomladanskem času, kar je verjetno povezano z njihovo selitvijo proti obalnim območjem, kjer naj bi se spomladi in poleti drstile (Bolje, 1992). Navadna sipa se na obravnavanem območju verjetno pojavlja vse leto. Dolžina plašča: 72 mm (39-117, SD=26, N=10).

3. Bodičasta sipa *(Sepia orbignyana* Ferussac, 1826)

Po eno bodičasto sipo smo ulovili 22. 8. 1995 in 10. 4. 1996 (tab. 3). Avgusta smo bodičasto sipo ulovili severozahodno od Piranskega zaliva, aprila pa severozahodno od Koprskega zaliva.

4. Sipica *(Sepiola* sp.)

Posamezne sipice so bile v spomladanskih vzorcih (tab. 3) na območjih vseh treh transektov. Bolje (1992) je imel v ulovih vrsto *Sepiola rondeleti*, ki je bila v vseh vzorcih redka, v februarskih vzorcih pa je ni bilo.

5. Pritlikavi ligenj *(Alloteuthis media* (Linnaeus, 1758))

Pritlikavi ligenj se je pojavljal vse leto, največje število osebkov pa je bilo od zgodnje jeseni do pozne pomladi (tab. 3). Zaradi majhnosti je bilo število pritlikavih lignjev v ulovih vselej podcenjeno. Dolžina plašča: 56 mm (15-166, SD=17, N=152).

6. Navadni ligenj *(Loligo vulgaris* Lamarck, 1798)

Navadni ligenj se je pojavljal vse leto (tab. 3), v večjem številu pa konec poletja in jeseni (slika 2). Največji delež biomase vzorca so lignji dosegli novembra (35%), ko je bil največji tudi delež osebkov (21%). Zaradi polpelaškega načina življenja je bilo število lignjev v vzorcih verjetno podcenjeno. Dolžina plašča: 109 mm (33-405, SD=59, N=425).

7. Navadna hobotnica *(Octopus vulgaris* Cuvier, 1797)

Eno navadno hobotnico smo ulovili 18. 9. 1995 severozahodno od Koprskega zaliva. Ulov hobotnice s PPM je prej izjema kot pravilo, saj se hobotnica navadno zadržuje bližje obali.

8. Moškatna hobotnica *(Eledone moschata* (Lamarck, 1799))

Moškatna hobotnica se je pojavljala vse leto (tab. 3). Njena abundanca in biomasa sta bili največji v poletnih in jesenskih mesecih (slika 3). Največji delež biomase v vzorcih je moškatna hobotnica dosegla julija (41%) in septembra 1995 (44%), medtem ko je bil njen delež leta 1996 največji avgusta (31%). Dolžina plašča: 80 mm (35-140, SD=17, N=297).

9. Navadni morski pes *(Mustelus mustelus* (Linnaeus, 1758))

Navadni morski pes se je pojavljal v toplejših mesecih (slika 4, tab. 3). Takrat se je zgodilo, da so ribiči z enim potegom zajeli tudi do nekaj deset osebkov, medtem ko v drugih potegih navadnega morskega psa ni bilo ali pa so bili le posamezni osebki. Delež biomase navadnega morskega psa je bil največji avgusta 1995, ko je dosegel 41 odstotkov ulova. Naslednje leto je bil največji delež biomase navadnega morskega psa v juniju, ko je dosegel 14 odstotkov. Odsotnost navadnega morskega psa v vzorcih, dobljenih v hladnejšem delu leta, si razlagam z manjšim številom osebkov in premajhnim številom opravljenih vzorcev. Glede na to, da je Bolje (1992) navadnega morskega psa ulovil tudi pozimi, menim, da se vrsta pri nas pojavlja vse leto. Celotna dolžina: 379 mm (278-805, SD=121, N=25).

10. Zvezdasta raža *(Raja asterias* Delaroche, 1809)

V obeh letih smo zvezdasto ražo ulovili junija (tab. 3) v območju severozahodno od Piranskega zaliva. Obakrat smo uporabili težjo PPM, kar je verjetno vzrok, da zvezdaste raže ni bilo v drugih vzorcih. Verjetno se, podobno kot druge ribe hrustančnice, tudi zvezdasta raža pojavlja v toplejših mesecih. To potrjujejo tudi rezultati Boljeta (1992), ki je zvezdasto ražo ulovil samo julija.

11. Morski bič *(Dasyatis pastinaca* (Linnaeus, 1758))

Enega morskega biča smo ulovili dne 21. 8. 1996. V takratnem ulovu je bilo tudi več morskih golobov in navadnih morskih psov, iz česar sklepam, da se posamezni morski biči pojavljajo skupaj z drugimi vrstami hrustančnic.

12. Morski golob *(Myliobatis aquila* (Linnaeus, 1758))

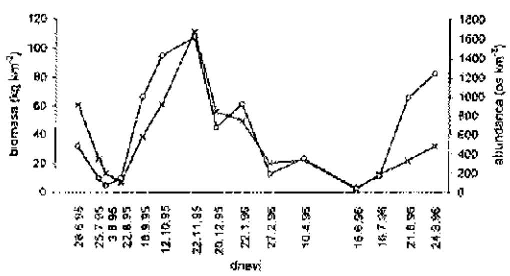
Morskega goloba smo ujeli v drugi polovici poletja in zgodaj jeseni (slika 5, tab. 3). Njegovo pojavljanje se je v glavnem ujemalo s pojavljanjem navadnega morskega psa. Največji delež biomase v ulovu je morski golob dosegel avgusta 1995, ko je dosegel 9 odstotkov.

13. Ugor *(Conger conger* ([Artedi, 1738] Linnaeus, 1758))

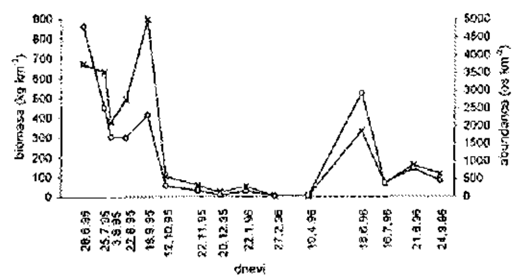
Enega ugorja smo ulovili dne 24. 4. 1995 severozahodno od Piranskega zaliva. Po navedbah ribičev ugorja pred letom 1994 ni bilo v ulovih s PPM, leta 1994 in 1995 pa so pogosto ulovili posamezne osebke.

14. Veliko morsko šilo *(Syngnathus acus* Linnaeus, 1758)

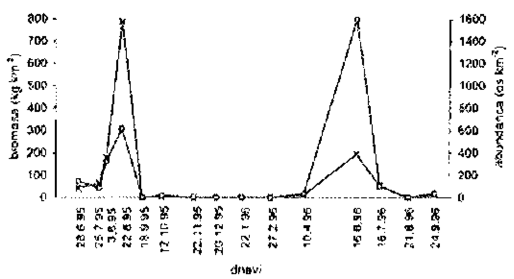
Eno veliko morsko šilo smo ulovili dne 21. 8. 1996. Po navedbah ribičev se posamezni osebki velikega morskega šila občasno ulovijo v PPM.



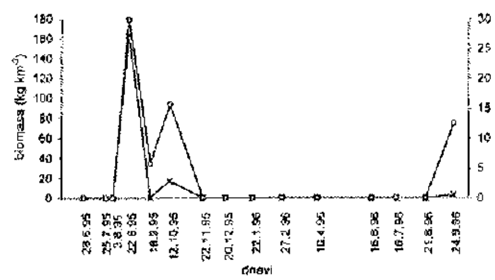
Slika 2: ***Abundanca (o) in biomasa (x) lignja*** *(Loligo vulgaris* ***Lamarck, 1798) na območju ribolova s pridneno povlečno mrežo v slovenskem morju (os = število osebkov).***
Fig. 2: ***Abundance (o) and biomass (x) of Common Squid*** *(Loligo vulgaris* ***Lamarck, 1798) caught with bottom trawling gear in the Slovene part of the Adriatic (os = No. individuals).***



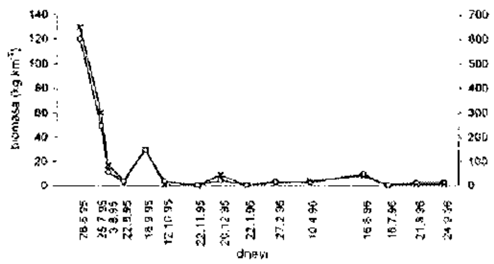
Slika 3: ***Moškatna hobotnica*** *(Eledone moschata* ***(Lamarck, 1799)). Glej podnapis pod sliko 2 za razlago.***
Fig. 3: ***Musky Octopus*** *(Eledone moschata* ***(Lamarck, 1799)) (see fig. 2 for explanation).***



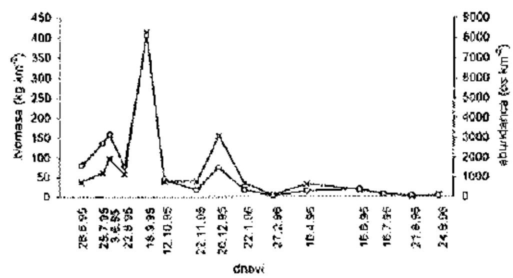
Slika 4: ***Navadni morski pes*** *(Mustelus mustelus* ***(Linnaeus, 1758)).***
Fig. 4: ***Smoothhound*** *(Mustelus mustelus* ***(Linnaeus, 1758)).***



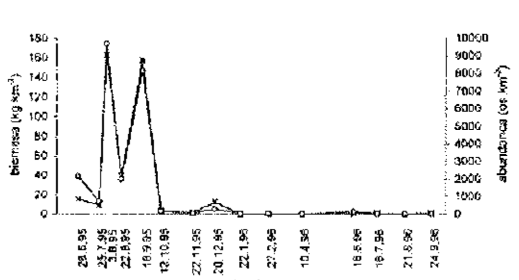
Slika 5: ***Morski golob*** *(Myliobatis aquila* ***(Linnaeus, 1758)).***
Fig. 5: ***Common Eagle Ray*** *(Myliobatis aquila* ***(Linnaeus, 1758)).***



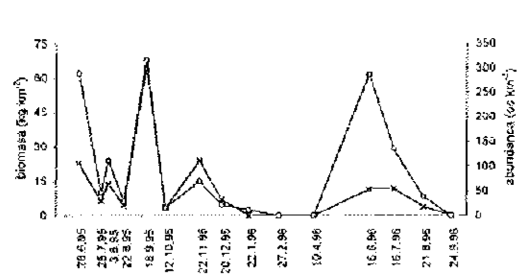
Slika 6: ***Oslič*** *(Merluccius merluccius* ***(Linnaeus, 1758)).***
Fig. 6: ***Hake*** *(Merluccius merluccius* ***(Linnaeus, 1758)).***



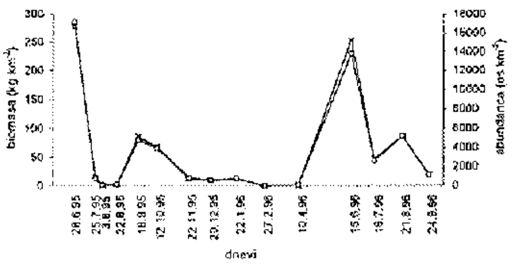
Slika 7: ***Mol*** *(Merlangius merlangus* ***(Linnaeus, 1758)).***
Fig. 7: ***Whiting*** *(Merlangius merlangus* ***(Linnaeus 1758)).***



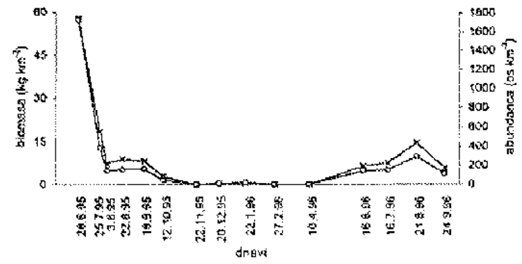
Slika 8: ***Molič*** *(Trisopterus minutus* ***(Linnaeus, 1758)).***
Fig. 8: ***Poor-Cod*** *(Trisopterus minutus* ***(Linnaeus, 1758)).***



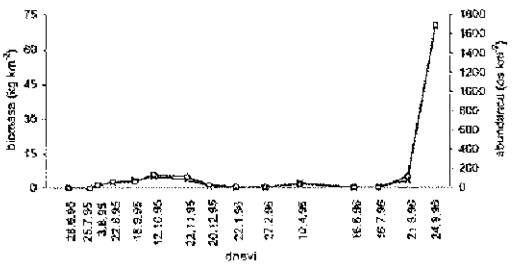
Slika 9: ***Kovač*** *(Zeus faber* ***(Linnaeus, 1758)).***
Fig. 9: ***John Dory*** *(Zeus faber* ***(Linnaeus, 1758)).***



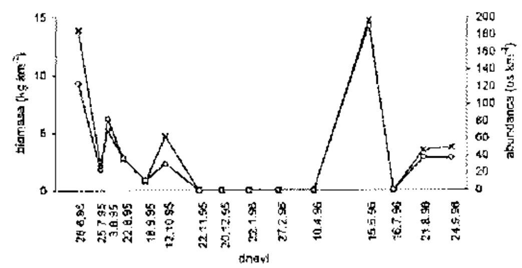
Slika 10: Volčič** (Serranus hepatus **(Linnaeus, 1758)).
Fig. 10: Brown Comber** (Serranus hepatus **(Linnaeus, 1758)).



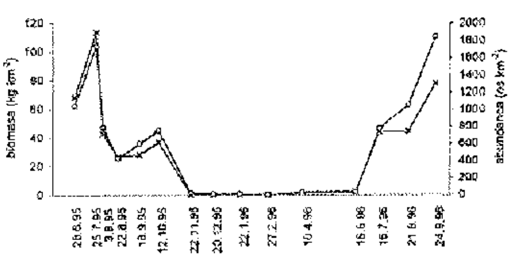
Slika 11: Špaget** (Cepola rubescens **Linnaeus, 1766).
Fig. 11: Red Bandfish** (Cepola rubescens **Linnaeus, 1766).



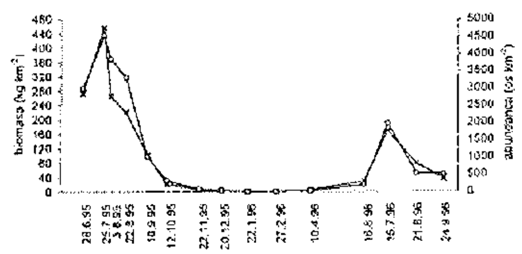
Slika 12: Bradač** (Mullus barbatus **Linnaeus, 1758).
Fig. 12: Red Mullet** (Mullus barbatus **Linnaeus, 1758).



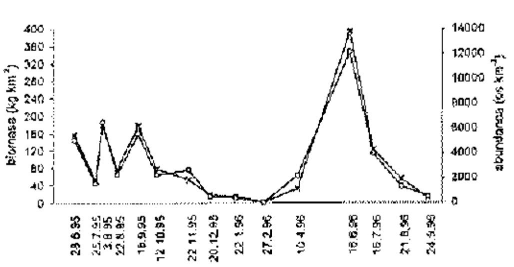
Slika 13: Bukva** (Boops boops **(Linnaeus, 1758)).
Fig. 13: Bogue** (Boops boops **(Linnaeus, 1758)).



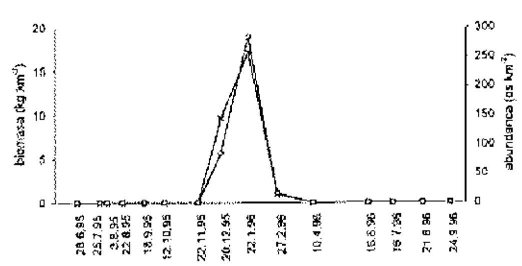
Slika 14: Špar** (Diplodus annularis **(Linnaeus, 1758)).
Fig. 14: Annular Sea Bream** (Diplodus annularis **(Linnaeus, 1758)).



Slika 15: Ribon** (Pagellus erythrinus **(Linnaeus, 1758)).
Fig. 15: Common Pandora** (Pagellus erythrinus **(Linnaeus, 1758)).



Slika 16: Menola** (Spicara flexuosa **Rafinesque, 1810).
Fig. 16: Menola** (Spicara flexuosa **Rafinesque, 1810).



Slika 17: Morska plošča** (Platichthys flesus **(Linnaeus, 1758)).
Fig. 17: Flounder** (Plattichthys flesus **(Linnaeus, 1758)).

15. Dolgonosi morski konjiček *(Hippocampus ramulosus* Leach, 1814)

Enega dolgonosega morskega konjička smo ulovili 24. 4. 1995 severozahodno od Piranskega zaliva, enega pa 22. 1. 1996 severozahodno od Koprskega zaliva. Po navedbah ribičev se posamezni osebki dolgonosega morskega konjička občasno ulovijo v PPM.

16. Oslič *(Merluccius merluccius* (Linnaeus, 1758))

Abundanca in biomasa osliča sta nihali (slika 6, tab. 3). Čeprav v vzorcih treh vzorčevalnih dni osliča ni bilo, menim, da je bil prisoten vse leto. Njegov delež biomase v vzorcih je bil največji junija 1995, ko je dosegel šest odstotkov. Tudi Bolje (1992) je ugotovil, da se je oslič pojavljal vse leto, pri čemer je bilo nekaj posebnega večja ugotovljena abundanca in biomasa te vrste leta 1987. Celotna dolžina: 277 mm (143-375, SD=76, N=8).

17. Mol *(Merlangius merlangus* (Linnaeus, 1758))

Mol se je pojavljal vse leto (tab. 3). Največ jih je bilo v toplejših mesecih leta 1995, po tistem pa sta tako biomasa kot abundanca pričeli upadati (slika 7). Delež biomase mola v ulovu je bil največji v jesenskih in zimskih mesecih, ko je decembra 1995 dosegel 47 odstotkov. Celotna dolžina: 209 mm (78-312, SD=51, N=261).

18. Molič *(Trisopterus minutus* (Linnaeus, 1758))

Moličev je bilo največ poleti 1995, nato pa sta biomasa in abundanca te ribe naglo upadli (slika 8, tab. 3). Naslednje poletje moliča v ulovih skorajda ni bilo. Delež biomase v ulovu je bil največji v začetku avgusta 1995, ko je dosegel 12 odstotkov. Po podatkih Boljeta (1992) se molič pojavlja vse leto, v zimskih mesecih pa je ulov moliča večji. Celotna dolžina: 129 mm (55-210, SD=30, N=85).

19. Kovač *(Zeus faber* Linnaeus, 1758)

Pojavljanje kovača je doseglo višek v poletnih mesecih (slika 9, tab. 3). Kljub temu da kovača ni bilo v vzorcih treh vzorčevalnih dni, se na obravnavanem območju verjetno pojavlja vse leto. Novembra 1995 je bil delež biomase kovača v vzorcih največji in je dosegel sedem odstotkov. Celoletno pojavljanje kovača potrjujejo tudi podatki Boljeta (1992). Celotna dolžina: 182 mm (64-305, SD=65, N=35).

20. Brancin *(Dicentrarchus labrax* (Linnaeus, 1758))

Enega brancina smo ulovili dne 20. 12. 1995 v območju severozahodno od Koprskega zaliva. Po navedbah ribičev brancina redkokdaj ulovijo s PPM, saj se zadržuje bližje obali. Celotna dolžina: 435 mm.

21. Volčič *(Serranus hepatus* (Linnaeus, 1758))

Volčič se je pojavljal vse leto, pogostejši pa je bil poleti in jeseni (slika 10, tab. 3). Med posameznimi vzorčevalnimi dnevi je delež biomase volčiča močno nihal, največjo vrednost pa je dosegel junija 1996, ko je bil njegov delež 18 odstotkov. Podobno je nihal tudi delež osebkov v vzorcu, ki je svojo največjo vrednost (46%) dosegel avgusta 1996. Celotna dolžina: 99 mm (77-123, SD=9, N=160).

22. Špaget *(Cepola rubescens* Linnaeus, 1766)

Špaget se je pogosteje pojavljal v toplejših mesecih (slika 11, tab. 3). Takrat je bil tudi delež njegove biomase v ulovu največji, ni pa presegel treh odstotkov. Po podatkih Boljeta (1992) se špaget v obravnavanem območju pojavlja vse leto. Celotna dolžina: 395 mm (270-515, SD=98, N=6).

23. Korbel *(Umbrina cirrosa* (Linnaeus, 1758))

Enega korbela samo ulovili 20. 12. 1995 (tab. 3) severozahodno od Koprskega zaliva. Po navedbah ribičev se posamezni korbeli pojavljajo samo v zimskem času. Celotna dolžina: 404 mm.

24. Bradač *(Mullus barbatus* Linnaeus, 1758)

Za bradače je bilo značilno, da so se v manjšem številu pojavljali poleti in jeseni 1995, septembra 1996 pa sta njihova abundanca in biomasa naglo narasli (slika 12, tab. 3). Povečanje števila bradačev se je zdelo nenavadno tudi ribičem. Značilno je bilo, da biomase bradačev do septembra 1996 niso presegle dveh odstotkov vzorca. V drugi polovici septembra je delež biomase bradačev dosegel 17 odstotkov, delež osebkov pa 19 odstotkov. Tudi Bolje (1992) je ugotovil, da se bradači v Tržaškem zalivu v večjem številu pojavijo jeseni, medtem ko jih je v drugih obdobjih leta malo. Celotna dolžina: 143 mm (90-215, SD=21, N=129).

25. Progasti bradač *(Mullus surmuletus* Linnaeus, 1758)

Progastega bradača smo ulovili 24. 9. 1996 (tab. 3) severozahodno od Piranskega zaliva. Dva osebka sta bila v vzorcih, ki so zbujali pozornost zaradi velikega števila bradača *(Mullus barbatus)*. Njuni celotni dolžini sta znašali 186 in 231 milimetrov.

26. Bukva *(Boops boops* (Linnaeus, 1758))

Za bukvo je bilo značilno precejšnje nihanje abundance in biomase v poletnih in jesenskih mesecih, medtem ko je v hladnem delu leta v vzorcih ni bilo (slika 13, tab. 3). Tudi ko je bilo bukev največ, je delež njihove biomase komaj presegel en odstotek. Glede na podatke, ki jih je navedel Bolje (1992), lahko sklepam, da se bukva kljub odsotnosti v vzorcih iz hladnejših mesecev na obravnavanem območju pojavlja vse leto. Celotne dolžine 4 bukev so bile med 207 in 226 milimetri.

27. Zobatec *(Dentex dentex* (Linnaeus, 1758))

Enega zobatca smo ulovili 24. 9. 1996 (tab. 3) severozahodno od Piranskega zaliva. Ribiči ga s PPM ulovijo zelo redko, saj se zadržuje bolj ob obali. Celotna dolžina je bila 131 milimetrov.

28. Špar *(Diplodus annularis* (Linnaeus, 1758))

Špari so se pojavljali vse leto, bolj množično pa poleti in jeseni (slika 14, tab. 3). Deleži biomase v vzorcih so se poleti in jeseni gibali med 7 in 8 odstotki, največjo vrednost pa je delež biomase dosegel konec septembra 1996, ko je dosegel 19 odstotkov. Celotna dolžina: 138 mm (72-189, SD=23, N=113).

29. Ovčica *(Lithognathus mormyrus* (Linnaeus, 1758))

Edini ulov ovčice je bil 24. 4. 1995 v območju severozahodno od Piranskega zaliva, ko je bilo v vzorcu 6 osebkov.

30. Okati ribon *(Pagellus bogaraveo* (Brunnich, 1768))

Dva okata ribona smo ulovili 18. 9. 1995 (tab. 3) v območju severno od rtiča Ronek. Celotni dolžini sta znašali 137 in 145 milimetrov.

31. Ribon *(Pagellus erythrinus* (Linnaeus, 1758))

Riboni so se v večjem številu pojavljali v poletnih mesecih (slika 15, tab. 3). Takrat je delež biomase v vzorcih dosegal 30 odstotkov. Glede na podatke Boljeta (1992) sklepam na celoletno pojavljanje ribona. Celotna dolžina: 181 mm (82-393, SD=48, N=221).

32. Pagar *(Pagrus pagrus* (Linnaeus, 1758))

Enega pagra smo ulovili 22. 11. 1995 (tab. 3) v območju severozahodno od Piranskega zaliva. Tega dne so se posamezni osebki ulovili tudi pri rednem ribolovu s PPM. Celotna dolžina je bila 171 milimetrov.

33. Orada *(Sparus aurata* Linnaeus, 1758)

Eno orado smo ulovili 20. 12. 1995 (tab. 3) na območju severozahodno od Piranskega zaliva. Orada je bila tudi po podatkih Boljeta (1992) redko ulovljena vrsta s PPM. Celotna dolžina je bila 220 milimetrov.

34. Menola *(Spicara flexuosa* Rafinesque, 1810)

Menola se je v obravnavanem območju pojavljala vse leto, večjo abundanco in biomaso pa je dosegla v toplejših mesecih (slika 16, tab. 3). Delež njene biomase v ulovu je bil največji aprila in junija 1996, ko je dosegel 27 odstotkov. Aprila je bil največji tudi delež osebkov (43%). Celoletno pojavljanje menole v Tržaškem zalivu potrjujejo tudi podatki Boljeta (1992). Celotna dolžina: 143 mm (70-230, SD=27, N=671).

35. Rumena ustnača *(Symphodus cinereus* (Bonnaterre, 1788))

Tri rumene ustnače smo ulovili 18. 9. 1995 severozahodno od Koprskega zaliva in severno od rtiča Ronek. 16. 6. 1996 smo severozahodno od Piranskega zaliva ulovili 9 rumenih ustnač (tab. 3). Glede na podatke Boljeta (1992) se rumena ustnača na obravnavanem območju verjetno pojavlja vse leto. Celotna dolžina: 93 mm (61-111, SD=16, N=12).

36. Morski zmaj *(Trachinus draco* Linnaeus, 1758)

Morskega zmaja smo ulovili v treh vzorčevalnih dneh med junijem in oktobrom (tab. 3), vselej v območju severozahodno od Piranskega zaliva. V vzorcih so bili vselej le posamezni osebki. Celotne dolžine 3 morskih zmajev so bile med 248 in 285 milimetri.

37. Zvezdogled *(Uranoscopus scaber* Linnaeus, 1758)

Enega zvezdogleda smo ulovili 25. 7. 1995 (tab. 3) na območju severozahodno od Koprskega zaliva.

38. Pegasti glavač *(Deltentosteus quadrimaculatus* (Valenciennes, 1837))

Pegasti glavač se je na obravnavanem območju pojavljal vse leto (tab. 3). Številnejši je bil v toplejšem delu leta. Največ osebkov smo ulovili junija 1996, ko jih je bilo v dveh vzorcih 213. Število pegastega glavača je bilo v vseh vzorcih, razen v junijskih, podcenjeno zaradi uporabe lažje PPM. Celotna dolžina: 75 mm (62-84, SD=6, N=23).

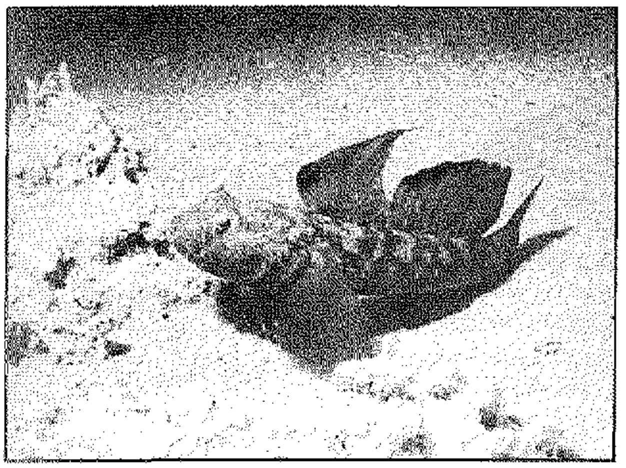
39. Črni glavač *(Gobius niger* Linnaeus, 1758)

Črni glavač je bil v mreži vse leto, občasno pa je v katerem od vzorčevalnih dni manjkal (tab. 3). Število črnega glavača je bilo v vseh vzorcih, razen v junijskih, podcenjeno zaradi uporabe lažje PPM. Celotna dolžina: 104 mm (70-138, SD=18, N=18).

vrsta	VI	VII	VIII	IX	X	XI	XII	I	II	IV	VI	VII	VIII	IX
Sepia elegans	2	-	-	1	-	-	-	-	-	-	-	2	-	-
Sepia officinalis	3	-	-	2	2	2	-	-	-	2	3	-	2	2
Sepia orbignyana	-	-	1	-	-	-	-	-	-	2	-	-	-	-
Sepiola sp.	-	-	-	-	-	-	-	-	-	2	3	-	-	-
Alloteuthis media	4	4	3	3	4	4	3	4	4	4	4	3	3	4
Loligo vulgaris	3	3	3	3	4	4	3	3	3	3	2	3	3	4
Octopus vulgaris	-	-	-	1	-	-	-	-	-	-	-	-	-	-
Eledone moschata	4	4	4	4	3	3	2	3	2	2	4	3	3	3
Mustelus mustelus	3	2	3	-	2	-	-	-	-	2	4	3	-	2
Raja asterias	2	-	-	-	-	-	-	-	-	-	2	-	-	-
Myliobatis aquila	-	-	2	1	2	-	-	-	-	-	-	-	-	2
Hippoc. ramulosus	-	-	-	-	-	-	-	2	-	-	-	-	-	-
Merluc. merluccius	3	3	2	3	2	-	2	-	2	2	2	-	2	2
Merlan. merlangus	4	4	4	4	3	3	4	3	2	3	3	3	2	2
Trisopterus minutus	4	3	4	4	3	2	3	-	1	-	3	2	-	2
Zeus faber	3	2	2	3	2	2	2	2	-	-	3	3	2	-
Serranus hepatus	5	3	3	4	4	3	3	3	-	2	5	4	4	4
Dicentrar. labrax	-	-	-	-	-	-	2	-	-	-	-	-	-	-
Cepola rubescens	4	3	3	3	2	-	2	2	-	-	3	3	3	3
Umbrina cirrosa	-	-	-	-	-	-	2	-	-	-	-	-	-	-
Mullus barbatus	-	-	2	2	3	3	2	2	1	2	-	-	3	4
Mullus surmuletus	-	-	-	-	-	-	-	-	-	-	-	-	-	2
Boops boops	3	2	2	2	2	-	-	-	-	-	3	-	2	2
Dentex dentex	-	-	-	-	-	-	-	-	-	-	-	-	-	2
Diplodus annularis	4	4	3	3	3	2	2	2	-	2	2	3	4	4
Pagellus bogaraveo	-	-	-	2	-	-	-	-	-	-	-	-	-	-
Pagellus erythrinus	4	4	4	4	3	2	2	-	-	2	3	4	3	3
Pagrus pagrus	-	-	-	-	-	2	-	-	-	-	-	-	-	-
Sparus aurata	-	-	-	-	-	-	2	-	-	-	-	-	-	-
Spicara flexuosa	4	4	4	4	4	4	3	3	2	4	5	4	4	3
Sympho. cinereus	-	-	-	2	-	-	-	-	-	-	3	-	-	-
Trachinus draco	-	-	-	-	2	-	-	-	-	-	2	-	2	-
Uranosco. scaber	-	1	-	-	-	-	-	-	-	-	-	-	-	-
D. quadrimaculatus	3	1	2	2	2	2	3	2	-	3	4	3	3	2
Gobius niger	4	2	1	3	-	2	-	2	-	2	3	2	3	2
Callionymus sp.	-	-	-	-	-	-	-	-	-	-	2	-	-	-
Blennius ocellaris	2	-	-	-	-	-	-	-	-	-	-	-	-	-
Parab. gattorugine	2	-	-	-	-	-	-	-	-	-	2	2	-	-
Parab. tentacularis	-	-	-	-	-	-	-	-	-	-	2	-	-	-
Liza aurata	2	2	-	-	-	-	-	-	-	-	-	-	2	2
Triglop. lastoviza	-	-	-	-	2	-	-	-	-	-	-	-	-	-
Phrynorhom. regius	-	-	-	-	-	-	-	-	-	-	2	-	-	-
Arnoglossus laterna	3	1	-	-	-	-	-	-	-	-	3	-	-	-
Platichthys flesus	-	-	-	-	-	-	2	3	2	-	-	-	-	-
Buglos. luteum	2	2	-	-	-	-	-	-	-	-	2	-	-	-
Monoch. hispidus	2	-	-	-	-	-	-	-	-	-	3	-	-	-
Solea kleinii	-	-	-	-	2	-	-	-	-	-	-	-	-	-
Solea vulgaris	2	-	-	-	-	-	2	-	-	-	-	-	-	-
Lophius piscatorius	-	2	-	-	-	-	-	-	-	-	-	-	-	-

***Tabela 3:** Mesečno pojavljanje pridnenih, bentopelaških in polpelaških vrst glavonožcev in rib v območju ribolova s pridnenimi povlečnimi mrežami v slovenskem morju. Analiza abundance vrst temelji na 41 vzorcih iz obdobja od 28. 6. 1995 do 24. 9. 1996. Abundance so prikazane v naslednji lestvici: - (0); 1 (1-9); 2 (10-99); 3 (100-999); 4 (1000-9999) in 5 (10000-99999 osebkov).*

***Table 3:** Monthly occurrence of demersal, benthopelagic and semipelagic cephalopod and fish species caught with bottom trawling gear in the Slovene part of the Adriatic Sea. Analysis of the species abundance is based on 41 samples taken from June 26th 1995 to September 24th 1996. Abundances are shown on the following scale: - (0); 1 (1-9); 2(10-99); 3 (100-999); 4 (1,000-9,999) and 5 (10,000-99,999 individuals).*



Gobius niger **(Foto: M. Richter).**
Gobius niger **(Photo: M. Richter).**

40. Zmajček *(Callionymus sp.)*

Zmajčka smo ulovili 16. 6. 1996 (tab. 3) v območju severozahodno od Koprskega zaliva. Verjetno bi se zmajčki pogosteje pojavljali v vzorcih, ko bi bili uporabljali težjo PPM.

41. Okata babica *(Blennius ocellaris* Linnaeus, 1758)

Po eno okato babico smo ulovili 24. 4. in 28. 6. 1995 (tab. 3), obakrat v območju severozahodno od Piranskega zaliva. Verjetno bi se okate babice pogosteje pojavljale v vzorcih, ko bi bili uporabljali težjo PPM.

42. Rjasta babica *(Parablennius gattorugine* (Brunnich, 1768))

Posamezne rjaste babice smo ulovili v času od junija do julija (tab. 3) na območjih severozahodno od Koprskega zaliva in severozahodno od Piranskega zaliva. Verjetno bi se rjasta babica pogosteje pojavljala v vzorcih, ko bi bili uporabljali težjo PPM.

43. Rogata babica *(Parablennius tentacularis* (Brunnich, 1768))

Eno rogato babico smo ulovili 16. 6. 1996 (tab. 3) v območju severozahodno od Piranskega zaliva.

44. Zlati cipelj *(Liza aurata* (Risso, 1810))

Zlati ciplji so se pojavljali v ulovu v času od junija do septembra, večinoma na območju severozahodno od Koprskega zaliva. V vzorcih so bili vselej le posamezni osebki. Celotne dolžine sedmih zlatih cipljev so bile med 275 in 378 milimetri.

45. Rumeni krulec *(Trigla lucerna* Linnaeus, 1758)

Enega rumenega krulca smo ulovili pri rednem ribolovu 20. 12. 1995 v območju severozahodno od Pirana. V ulovih Boljeta (1992) je bil rumeni krulec redek, vendar se je pojavljal vse leto.

46. Progasti krulec *(Trigloporus lastoviza* (Brunnich, 1768))

Enega progastega krulca smo ulovili 12. 10. 1995 (tab. 3) v območju severozahodno od Piranskega zaliva. Njegova celotna dolžina je bila 153 milimetrov.

47. Kosmati romb *(Phrynorhombus regius* (Bonnaterre, 1788))

Štiri kosmate rombe smo ulovili 16. 6. 1996 (tab. 3) v območjih severozahodno od Koprskega zaliva in severozahodno od Piranskega zaliva. Po podatkih Boljeta (1992) so bili kosmati rombi redki, vendar pa so se pojavljali vse leto. Verjetno bi bili kosmate rombe pogosteje ulovili s težjo PPM.

48. Pataraća *(Arnoglossus laterna* (Walbaum, 1792))

Posamezne pataraće so bile v vzorcih od aprila do julija (tab. 3). Po podatkih Boljeta (1992) se je pataraća pojavljala vse leto. Verjetno bi bili pataraćo pogosteje ulovili s težjo PPM.

49. Morska plošča *(Platichthys flesus* (Linnaeus, 1758))

Morska plošča se je pojavljala v zimskih mesecih (slika 17, tab. 3). Delež njene biomase je bil največji v januarskem vzorcu, ko je dosegel devet odstotkov. Pojav morske plošče v Tržaškem zalivu v zimskih mesecih je ugotovil tudi Bolje (1992). Pozimi prihajajo morske plošče v Tržaški zaliv zaradi drstitve. Celotna dolžina: 185 mm (141-276, SD=36, N=35).

50. Pritlikavi morski list *(Buglossidium luteum* (Risso, 1810))

Posamezne pritlikave morske liste smo ulovili v junijskih in julijskih vzorcih (tab. 3). Verjetno bi se bili pritlikavi morski listi pojavljali pogosteje v vzorcih, ko bi bili uporabljali težjo PPM. Celotni dolžini dveh osebkov sta bili 90 milimetrov.

51. Hrapavi morski list *(Monochirus hispidus* Rafinesque, 1814)

Posamezne hrapave morske liste smo ulovili aprila in junija (tab. 3). V vzorcih Boljeta (1992) je bil hrapavi morski list redek, vendar se je pojavljal vse leto. Verjetno bi se bil hrapavi morski list pogosteje pojavljal v vzorcih, ko bi bili uporabljali težjo PPM.

52. Črnorobi morski list *(Solea kleinii* [Risso] Bonaparte, 1833)

Posamezne črnorobe morske liste smo ulovili med aprilskim in oktobrskim vzorčenjem (tab. 3). Obakrat je bil črnorobi morski list v vzorcih, ujetih v območju severozahodno od Piranskega zaliva. Podatki Boljeta (1992) kažejo, da se črnorobi morski list v našem morju pojavlja vse leto, več pa jih je v zahodnem delu. Verjetno bi se črnorobi morski list pogosteje pojavljal v vzorcih, ko bi bili uporabljali težjo PPM.

53. Morski list *(Solea vulgaris* Quensel, 1806)

Posamezni morski listi so bili v aprilskih, junijskih in decembrskih vzorcih (tab. 3). Podatki Boljeta (1992) kažejo, da se morski list v našem morju pojavlja vse leto, več pa jih je v zahodnem delu. Verjetno bi se morski list pogosteje pojavljal v vzorcih, ko bi bili uporabljali težjo PPM.

54. Morska žaba *(Lophius piscatorius* Linnaeus, 1758)

Dve morski žabi smo ulovili 25. 7. 1995 (tab. 3) v območju severno od rtiča Ronek. Verjetno so v obravnavanem območju posamezne morske žabe le v toplejših mesecih, na kar kažejo tudi podatki Boljeta (1992).

Spreminjanje abundance

V slovenskem morju se je abundanca obravnavanih vrst med letom bolj ali manj spreminjala. Spremembe so bile po eni strani posledica sezonskih selitev (Pitcher & Hart, 1994), po drugi strani pa je na zmanjševanje abundance verjetno vplival tudi ribolov. Sezonske selitve živali v območju Tržaškega zaliva so verjetno povezane z razmnoževanjem, količino hrane in nekaterimi fizikalno kemijskimi dejavniki, kot so temperatura, slanost in količina raztopljenega kisika, žal pa selitev in njihovih vzrokov v tem območju še niso raziskali.

Pojav morske plošče v našem morju je nedvomno povezan z razmnoževanjem (Bolje, 1992). Tudi nekatere druge vrste rib, na primer ribon, se v večjih količinah pojavijo v času, ko imajo zrelejše gonade. Abundanca pridnenih vrst rib, z izjemo borealne morske plošče, je bila v hladnejšem obdobju leta nižja. To je verjetno posledica nizkih temperatur v zimskem času, saj pade temperatura vode na dnu v zimskih mesecih tudi pod 10°C (Vukovič *et al.*, 1995). Vzrok za začasno zmanjšanje abundance osebkov bentoških vrst (na primer moškatna hobotnica) je lahko tudi hipoksija. Zmanjšane količine raztopljenega kisika v pridnenem sloju vode so v tem območju značilne za konec poletja in jesen (Vukovič *et al.*,1995).

Viri napak pri oceni abundance in biomase

Struktura vzorcev, vzetih z lažjo in težjo PPM, se je nekoliko razlikovala. V vzorcih, vzetih z lažjo PPM, je bilo bolj podcenjeno število bentoških organizmov, predvsem predstavnikov skupin Sepiidae, Sepiolidae, Octopodidae, Rajidae, Myliobatoidei, Trachinidae, Uranoscopidae, Gobiidae, Callionymidae, Blenniidae in Heterosomata (Pleuronectiformes). Zaradi manjšega očesa mreže v končnem delu (saku) je bilo v ulovu raziskovalne mreže tudi več osebkov manjših vrst oziroma nedoraslih organizmov. Največja velikostna selekcija je namreč ravno v končnem delu mreže (Sparre & Venema, 1992).

Mullus surmuletus **(Foto: M. Richter).**
Mullus surmuletus **(Photo: M. Richter).**

SUMMARY

Ichthyological research in the Slovene part of the Gulf of Trieste has been somewhat neglected in the past, for the biological research in this part of the Adriatic began not until the late 80's. The article presents the results of the research into the dynamics of occurrence of certain cephalopod and fish species and could serve as a basis for a further ecological research on these groups in our waters.

From April 1995 to September 1996, 8 cephalopod and 56 fish species were caught with bottom trawling gear in the Slovene part of the Adriatic Sea. Details on the occurrence of 8 bathyal cephalopod species, 4 species of cartilaginous fish and 42 species of bony fish are listed, with more detailed descriptions of the following species: Common Squid (Loligo vulgaris), *Musky Octopus* (Eledone moschata), *Smoothhound* (Mustelus mustelus), *Common Eagle Ray* (Myliobatis aquila), *Hake* (Merluccius merluccius), *Whiting* (Merlangius merlangus), *Poor-Cod* (Trisopterus minutus), *John Dory* (Zeus faber), *Brown Comber* (Serranus hepatus), *Red Bandfish* (Cepola rubescens), *Red Mullet* (Mullus barbatus), *Bogue* (Boops boops), *Annular Sea Bream* (Diplodus annularis), *Common Pandora* (Pagellus erythrinus), *Menola* (Spicara flexuosa) *and Flounder* (Platichthys flesus).

LITERATURA

Bauchot, M. -L. in Hureau, J. -C., 1986, Sparidae. V: P. J. P. Whitehead, M. -L. Bauchot, J. -C. Hureau, J. Nielsen in E. Tortonese (uredniki), Fishes of the North-eastern Atlantic and the Mediterranean. Vol. II, UNESCO, UK, pp. 883-907.

Bauchot, M. -L. in Saldanha, L., 1986, Congridae. V: P. J. P. Whitehead, M. -L. Bauchot, J. -C. Hureau, J. Nielsen in E. Tortonese (uredniki), Fishes of the North-eastern Atlantic and the Mediterranean. Vol. II, UNESCO, UK, pp. 567-574.

Ben-Tuvia, A., 1986, Mugilidae. V: P. J. P. Whitehead, M. -L. Bauchot, J. -C. Hureau, J. Nielsen in E. Tortonese (uredniki), Fishes of the North-eastern Atlantic and the Mediterranean. Vol. III, UNESCO, UK, pp. 1197-1204.

Bolje, A., 1992, Kvantitativna i kvalitativna analiza kočarskih naselja u Tršćanskom zaljevu. Magistrski rad. PMF, Sveučilište u Zagrebu.

Branstetter, S, 1989, Triakidae. V: P. J. P. Whitehead, M. -L. Bauchot, J. -C. Hureau, J. Nielsen in E. Tortonese (uredniki), Fishes of the North-eastern Atlantic and the Mediterranean. Vol. I, UNESCO, UK, pp. 117-121.

Caruso, J. H., 1986, Lophiidae. V: P. J. P. Whitehead, M. -L. Bauchot, J. -C. Hureau, J. Nielsen & E. Tortonese (uredniki), Fishes of the North-eastern Atlantic and the Mediterranean. Vol. III, UNESCO, UK, pp. 1362-1363.

Collette, B. B., 1986, Scombridae. V: P. J. P. Whitehead, M. -L. Bauchot, J. -C. Hureau, J. Nielsen in E. Tortonese (uredniki), Fishes of the North-eastern Atlantic and the Mediterranean. Vol. II, UNESCO, UK, pp. 981-997.

Fricke, R., 1986, Callionymidae. V: P. J. P. Whitehead, M. -L. Bauchot, J. -C. Hureau, J. Nielsen & E. Tortonese (uredniki), Fishes of the North-eastern Atlantic and the Mediterranean. Vol. III, UNESCO, UK, pp. 1086-1093.

Hureau, J. -C., 1986a, Mullidae. V: P. J. P. Whitehead, M. -L. Bauchot, J. -C. Hureau, J. Nielsen & E. Tortonese (uredniki), Fishes of the North-eastern Atlantic and the Mediterranean. Vol. II, UNESCO, UK, pp. 877-882.

Hureau, J. -C., 1986b, Uranoscopidae. V: P. J. P. Whitehead, M. -L. Bauchot, J. -C. Hureau, J. Nielsen & E. Tortonese (uredniki), Fishes of the North-eastern Atlantic and the Mediterranean. Vol. II, UNESCO, UK, pp. 955-956.

Labbish Ning Chao, 1986, Sciaenidae. V: P. J. P. Whitehead, M. -L. Bauchot, J. -C. Hureau, J. Nielsen & E. Tortonese (uredniki), Fishes of the North-eastern Atlantic and the Mediterranean. Vol. II, UNESCO, UK, pp. 865-874.

Matjašič, J., Štirn, J., Avčin, A., Kubik, L., Valentinčič, T., Velkovrh F., Vukovič, S., 1975, Flora in favna Severnega Jadrana - prispevek 1. SAZU, Ljubljana, pp. 1-54.

McEachran, J. D. & Capape, C, 1989, Dasyatidae. V: P. J. P. Whitehead, M. -L. Bauchot, J. -C. Hureau, J. Nielsen & E. Tortonese (uredniki), Fishes of the North-eastern Atlantic and the Mediterranean. Vol. I, UNESCO, UK.

MEDITS, 1995, Campagne internationale de chalutage demersal en Mediterranee (MEDITS). Manuel des protocoles, pp. 1-28.

MEDITS, 1996, Campagne internationale de chalutage demersal en Mediterranee (MEDITS 95). II Manuel des protocoles.

Nielsen, J. G., 1986a, Bothidae. V: P. J. P. Whitehead, M. -L. Bauchot, J. -C. Hureau, J. Nielsen & E. Tortonese (uredniki), Fishes of the North-eastern Atlantic and the Mediterranean. Vol. III, UNESCO, UK, pp. 1294-1298.

Nielsen, J. G., 1986b, Pleuronectidae. V: P. J. P. Whitehead, M. -L. Bauchot, J. -C. Hureau, J. Nielsen & E. Tortonese (uredniki), Fishes of the North-eastern Atlantic and the Mediterranean. Vol. III, UNESCO, UK, pp. 1299-1307.

Pitcher, T. J., Hart, P. J. B., 1994, Fisheries Ecology. Chapman & Hall, London, pp. 1-414.

Quero, J. -C., 1986, Zeidae. V: P. J. P. Whitehead, M. - L. Bauchot, J. -C. Hureau, J. Nielsen & E. Tortonese (uredniki), Fishes of the North-eastern Atlantic and the Mediterranean. Vol. II, UNESCO, UK, pp. 769-772.

Quero, J. -C., Desoutter, M., Lagardere, F., 1986, Soleidae. V: P. J. P. Whitehead, M. -L. Bauchot, J. -C. Hureau, J. Nielsen & E. Tortonese (uredniki), Fishes of the North-eastern Atlantic and the Mediterranean. Vol. III, UNESCO, UK, pp. 1380-1324.

Quignard, J. -P. & PRAS, A., 1986, Atherinidae. V: P. J. P. Whitehead, M. -L. Bauchot, J. -C. Hureau, J. Nielsen & E. Tortonese (uredniki), Fishes of the North-eastern Atlantic and the Mediterranean. Vol. III, UNESCO, UK, pp. 1207-1210.

Roper, C. F. E., Sweeney, M. J., Nauen, C. E., 1984, FAO species catalogue. Vol. 3. Cephalopods of the world. An annotated and illustrated catalogue of species of interest to fisheries. FAO Fish. Synops. 3(125): 1-277.

Shindo, S., 1972, General review of the trawl fishery and the demersal fish stocks of the South China Sea. FAO Fish. Techn. Pap. 120: 49.

Smith-Vaniz, W. F., 1986, Carangidae. V: P. J. P. Whitehead, M. -L. Bauchot, J. -C. Hureau, J. Nielsen & E. Tortonese (uredniki), Fishes of the North-eastern Atlantic and the Mediterranean. Vol. II, UNESCO, UK, pp. 815-844.

Sparre, P., Venema, S. C., 1992, Introduction to tropical fish stock assessment. Part I - Manual. FAO, Rome, pp. 1-376.

Stehmann, M & Burkel, D. L., 1989, Rajidae. V: P. J. P. Whitehead, M. -L. Bauchot, J. -C. Hureau, J. Nielsen & E. Tortonese (uredniki), Fishes of the North-eastern Atlantic and the Mediterranean. Vol. I, UNESCO, UK, pp. 163-196.

Svetovidov, A. N., 1986a, Merlucciidae. V: P. J. P. Whitehead, M. -L. Bauchot, J. -C. Hureau, J. Nielsen & E. Tortonese (uredniki), Fishes of the North-eastern Atlantic and the Mediterranean. Vol. II, UNESCO, UK, pp. 677-679.

Svetovidov, A. N., 1986b, Gadidae. V: P. J. P. Whitehead, M. -L. Bauchot, J. -C. Hureau, J. Nielsen & E. Tortonese (uredniki), Fishes of the North-eastern Atlantic and the Mediterranean. Vol. II, UNESCO, UK, pp. 680-710.

Šoljan, T., 1965, Ribe Jadrana. Zavod za izdavanje udžbenika SR Srbije, Beograd, pp. 1-451.

Štirn, J. & Bolje, A., 1989, Fondi pridnenih rib in drugih užitnih organizmov obalnih vod SFRJ v Tržaškem zalivu. Zaključno poročilo. Raziskovalna naloga. Droga Portorož in IBU, MBP, Ljubljana, Piran, pp. 1-243.

Tortonese, E., 1986a, Serranidae. V: P. J. P. Whitehead, M. -L. Bauchot, J. -C. Hureau, J. Nielsen & E. Tortonese (uredniki), Fishes of the North-eastern Atlantic and the Mediterranean. Vol. II, UNESCO, UK, pp. 780-792

Tortonese, E., 1986b, Cepolidae. V: P. J. P. Whitehead, M. -L. Bauchot, J. -C. Hureau, J. Nielsen & E. Tortonese (uredniki), Fishes of the North-eastern Atlantic and the Mediterranean. Vol. II, UNESCO, UK, pp. 810-811.

Tortonese, E., 1986c, Centracanthidae. V: P. J. P. Whitehead, M. -L. Bauchot, J. -C. Hureau, J. Nielsen & E. Tortonese (uredniki), Fishes of the North-eastern Atlantic and the Mediterranean. Vol. II, UNESCO, UK, pp. 908-911.

Tortonese, E., 1986d, Trachinidae. V: P. J. P. Whitehead, M. -L. Bauchot, J. -C. Hureau, J. Nielsen & E. Tortonese (uredniki), Fishes of the North-eastern Atlantic and the Mediterranean. Vol. II, UNESCO, UK, pp. 951-954.

Vukovič, A., Lipej, L., Mozetič, P., Planinc, R., Turk, V., 1995, Program spremljanja kakovosti obalnega morja v Republiki Sloveniji. Poročilo za leto 1994. NIB, MBP Piran, Ljubljana, Piran, pp. 1-8.

Whitehead, P. J. P, 1989a, Clupeidae. V: P. J. P. Whitehead, M. -L. Bauchot, J. -C. Hureau, J. Nielsen & E. Tortonese (uredniki), Fishes of the North-eastern Atlantic and the Mediterranean. Vol. I, UNESCO, UK, pp. 268-281.

Whitehead, P. J. P, 1989b, Engraulidae. V: P. J. P. Whitehead, M. -L. Bauchot, J. -C. Hureau, J. Nielsen & E. Tortonese (uredniki), Fishes of the North-eastern Atlantic and the Mediterranean. Vol. I, UNESCO, UK, pp. 282-283.

Whitehead, P. J. P., Bauchot, M. -L., Hureau, J. -C., Nielsen, J., Tortonese, E. (eds.), 1989, Fishes of the North-eastern Atlantic and the Mediterranean. Vol. I. Unesco.

Whitehead, P. J. P., Bauchot, M. -L., Hureau, J. -C., Nielsen, J., Tortonese, E. (eds.), 1986a, Fishes of the North-eastern Atlantic and the Mediterranean. Vol. II. Unesco.

Whitehead, P. J. P., Bauchot, M. -L., Hureau, J. -C., Nielsen, J., Tortonese, E. (eds.), 1986b, Fishes of the North-eastern Atlantic and the Mediterranean. Vol. III. Unesco.

original scientific paper UDK 597.5:591.13(262.3-11)

FOOD AND FEEDING HABITS OF THE DAMSELFISH *CHROMIS CHROMIS* (TELEOSTEI: POMACENTRIDAE) IN THE EASTERN ADRIATIC

Jakov DULČIĆ
Ph.D., fisheries biologist, Institute of Oceanography and Fisheries - Split, HR-21000 Split, Šet. I. Meštrovića 63
dr., ribiški biolog, IOR, HR-21000 Split, Šet. I. Meštrovića 63

ABSTRACT

The stomach contents of 964 damselfish Chromis chromis *collected in the eastern central Adriatic in 1992 and 1993 were examined to assess the diet, as influenced by season and fish size. Damselfish is carnivorous from the juvenile stage onward, feeding on a narrow range of plankton and benthic prey items. Higher intensity of feeding activity in spring could be related to temperature and/or gonadal maturation. During all seasons copepods constituted the most important food resource by weight, number and frequency of occurrence. Appendicularia and cladocerans were the second most important food category. Dietary overlap was relatively high, indicating that the feeding spectrum of damselfish changed little across seasons, but for size groups was small, indicating greater changes in feeding spectrum.*

Ključne besede: črnik, *Chromis chromis*, prehrana, prehranjevalne navade, ceponožci, vzhodni Jadran
Key words: damselfish, *Chromis chromis*, food, feeding habits, copepods, Eastern Adriatic

INTRODUCTION

The damselfish, *Chromis chromis* (Linnaeus, 1758) is a small fish found in shoals in mid-water above or near rocky reefs or above sea grass *(Posidonia)* meadows at depths ranging from 3 to 35 m. It occurs in the Mediterranean and from Portugal southwards to Angola (Quignard & Pras, 1986).

In the Eastern Adriatic, the damselfish is abundant (Grubišić, 1982; Milišić, 1994), but it is of no commercial value along the eastern coast (except on the central Adriatic islands of Šolta, Hvar, Korčula and Lastovo, where it is much appreciated). In coastal fishery of Dalmatia, damselfish form a small but significant component of the coastal beach seine and gill net catch that is used as delicious food and as bait for lobsters. We have no new data on catch, but Grubišić (1982) reported that it is around 30 tons per year.

There are some data about the biology and ecology of this species from the eastern Adriatic. Dulčić *et al.* (1994a) presented data on the length-weight relationship in damselfish during spawning in the Eastern Adriatic. Dulčić *et al.* (1994b) analysed the vertebral number of damselfish. Age, growth and mortality of damselfish were presented by Dulčić & Kraljević (1995).

Despite its abundance, very little is known about the trophic ecology of damselfish in the Mediterranean Sea. The present study deals with food and feeding habits of the damselfish off the Eastern Adriatic. The purpose was to examine the feeding habits and intraspecific resource partitioning across seasons and during developmental life stages of damselfish in the Eastern Adriatic.

MATERIAL AND METHODS

A total of 964 specimens of damselfish were obtained during four seasonal beach seine survey cruises, from summer 1992 to spring 1993. Samples were taken near the island of Trstenik in the central Adriatic (Fig. 1). Damselfish were fixed in 4% formalin immediately after capture. The fish were processed promptly after collection. Processing included measurements and weighing to nearest 0.1 cm and 0.01 g respectively and gut removal prior to which both ends of the stomach were tied off. The contents of the dietary material were identified to the specific level where possible, but most items were identifiable only to the generic level. Presence of inorganic matter and detritus in the stomachs was recorded, but excluded from the analysis. After identification, preys were weighed to the nearest 0.01 g.

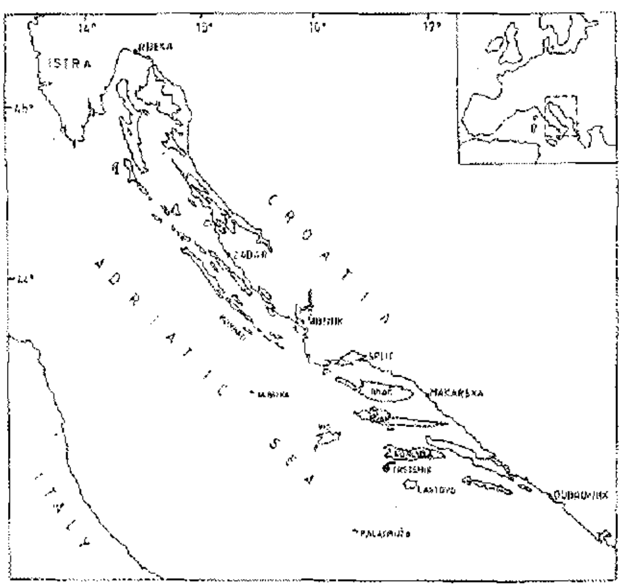


Fig. 1: Location of sampling station in the eastern central Adriatic, where damselfish** (Chromis chromis) **were collected (Trstenik Island).
***Slika 1: Zemljevid obravnavanega območja z označeno vzorčevalno postajo (otok Trstenik), kjer so bili ulovljeni črniki** (Chromis chromis).*

The contribution of the prey categories to the diet of damselfish was calculated as (1) the percentage of wet weight (C_w) of a prey category (pooled) to the weight of the total stomach contents, (2) the percentage abundance (C_n) of individuals of a prey category to the total number of prey individuals in the stomachs, (3) the frequency of occurrence (f) of stomachs in which a prey category occurred to the total number of stomachs examined (Hyslop, 1980). George & Hadley (1979) employed the "relative importance index" (RI) which is based on the "absolute importance index" (AI) as follows: AI = % frequency occurrence + % total numbers + % total weight; RI = 100 AI / ni$\sum$ AI, where n is the number of i different food types.

Seasonal variations were analyzed using Fischer's least significant difference (LSD) test (Zar, 1984). The analysis of changes in feeding habits in different seasons and in different length classes was performed by the use of the fullness index (Hureau, 1970): %Jr = fullness index: weight of digested food/fish weight x 100.

Proportional food overlap between size classes and seasons for the species was calculated using the overlap index of Schoener (1970): Cih = 1 - 0.5 ($\sum$j Pij - Phj), where Pij and Phj are the proportions of prey j found in the diets of groups i and h respectively. This index has a minimum of 0 (no overlap of prey) and a maximum of 1 (all items in equal proportions). Schoener's index values above 0.60 are usually considered to be "biologically significant" (Zaret & Rand, 1971; Wallace, 1981), indicating a high dietary overlap (Langton, 1982).

RESULTS AND DISCUSSION

Fish lengths in the sample ranged from 8 to 134 mm caught (Fig. 2). Data sampled in 3 areas were aggregated for the analysis since there was no significant difference between them (ANCOVA). The specimens were divided into two size groups, to examine feeding habits of the fish developmental stages. Group 1 comprised fishes smaller than 65 mm (juvenile stage) and Group 2 fishes longer than 65 mm (adult stage). The proportion of empty stomachs among fish up to 65 mm long is 6.9%, while this proportion in longer fish is 5.0%. Feeding intensity expressed by the fullness index (Jr) was higher in smaller (Jr=6.83) than in larger fish (Jr=3.80).

In Group 1, polychaetes, ostracods, copepods and mysids constitued the bulk of the diet, while copepods, appendicularins and cladocerans were dominant in Group 2 (Table 1). Stomachs of larger individuals contained all mentioned prey taxa ingested by smaller fish, but in different proportions. Copepods were the dominant prey of damselfish in both size-classes, *Clausocalanus pergens* being the dominant species. As fish grew older there was a difference in the "relative index" (RI) of polychaetes, copepods, ostracods and mysids. Polychaetes exhibited a greater presence in the stomachs of smaller fish, corroborating the view that small damselfish select prey of low mobility.

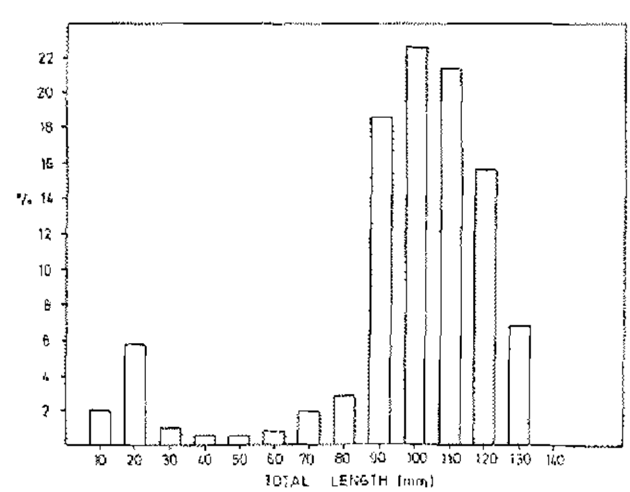


Fig. 2: Length frequency distribution of damselfish** (Chromis chromis) **collected in the eastern central Adriatic for dietary studies in 1992 and 1993 (n = 964).
Slika 2: Velikostna porazdelitev dolžine črnikov** (Chromis chromis), **ulovljenih v vzhodnem srednjem Jadranu v obdobju 1992-1993 (n = 964).

Size groups	8-65 mm					> 65 mm				
Contribution of the prey categories	f	C_n	C_w	AI	RI	f	C_n	C_w	AI	RI
Polychaeta	34.3	7.7	30.5	72.5	13.03	2.4	0.1	0.5	3	0.25
Appendicularia						76.2	27	13.8	117	9.93
Ostracoda	38.9	27.4	19.5	85.8	15.42	10.8	0.9	3.2	14.9	1.27
Copepoda	94.7	55.6	12.7	163	29.30	93.1	37.7	25.7	156.5	13.29
Paracalanus parvus						76.2	7.6	5.4	89.2	7.57
Clausocalanus pergens	36.8	23	5.3	65.1	11.70	51.7	10.1	6.1	67.9	5.77
C. furcatus	21.1	15	3.4	39.5	7.10	37.1	6.2	4.3	47.6	4.04
C.helgolandicus						11.6	1.1	1.1	13.8	1.17
C.parapergens						15.6	5.2	2.9	23.7	2.01
C.tenuicornis	19	10.5	2.4	31.9	5.73	3.3	0.1	0.1	3.5	0.30
Eucalanus elongatus	10.9	5	1.2	16.7	3	2.3	0.1	0.1	2.5	0.21
Euterpina acutiformis						4.6	0.1	0.1	4.8	0.41
Centropages typicus						62.5	6.8	5	74.3	6.31
Acartia clausi	7.4	2.1	0.5	10	1.80	14.2	0.6	0.8	15.6	1.33
Cirripedia (nauplii)						3.1	0.6	1.5	5.2	0.44
Decapoda (larvae)						26.3	6.1	7.1	39.5	3.35
Mysidacea	25.3	9.4	37.2	11.9	12.92	11.2	0.6	4.6	16.4	1.39
Cladocera						86.1	22.5	12.3	120.9	10.27
Penilia avirostris						12.8	1.8	1	15.6	1.32
Podon intermedius						40.2	12.7	6.8	59.7	5.07
Evadne spinifera						38.4	8.5	4.6	51.5	4.37
Gastropoda (larvae)						10.9	0.7	12.2	23.8	2.02
Bivalvia (larvae)						8.8	1.5	12.2	22.5	1.91
Pisces										
Eggs						30.5	1.7	3.8	36	3.07
Chromis chromis						6.7	0.2	0.4	7.3	0.62
Serranus hepatus						6.6	0.2	0.4	7.2	0.61
Cepola rubescens						9.2	0.4	0.8	10.4	0.88
Engraulis encrasicolus						9.8	0.5	1.1	11.4	0.97
Sardina pilchardus						8.1	0.5	1.2	9.8	0.83
Larvae						44.8	1	3.4	49.2	4.18
Chromis chromis						13.4	0.2	0.5	14.1	1.20
Serranus hepatus						1.9	0.1	0.1	2.1	0.18
Cepola rubescens						7.3	0.1	0.4	7.8	0.66
Gobius sp.						10	0.2	0.7	10.9	0.93
Oblada melanura						7.2	0.2	0.8	8.2	0.70
Diplodus vulgaris						0.3	0.01	0.1	0.41	0.04
Atherina hepsetus						12.2	0.3	1	13.5	1.15
Digested food	5.2		1.8			5.9		2.4		
No of stomachs		102					862			
No of empty stomachs		7					43			
% of empty stomachs		6.9					5.0			

Table 1: Contribution of the prey categories for damselfish stomach contents according to size groups.
Tabela 1: Delež posameznih kategorij plena v želodcih črnika glede na velikost.

Season	Winter					Summer				
Contribution of the prey categories	f	C_n	C_w	AI	RI	f	C_n	C_w	AI	RI
Polychaeta						14.1	0.2	1.3	15.6	2.49
Appendicularia	53.8	22.1	27.5	103.4	19.72	89.6	32.1	16.7	138.4	22.13
Ostracoda						11.5	0.8	3.2	15.5	2.48
Copepoda	100	58.2	33.8	192	36.61	75.6	34.2	24.6	134.4	21.50
Cirripedia (nauplii)						3.7	0.7	2	6.4	1.02
Decapoda (larvae)						25.2	5.6	7.4	38.2	6.10
Mysidacea						6.2	0.1	2.1	8.5	1.36
Cladocera	100	12.7	26.8	139.5	26.60	84.1	22.4	12	118.5	18.93
Gastropoda (larvae)						11.8	0.9	17	29.7	4.74
Bivalvia (larvae)						5.9	0.9	7.3	14.1	2.25
Pisces										
Eggs	47.3	6.4	8.7	62.4	11.90	33.6	1.6	4.1	39.3	6.28
Larvae	23.1	0.8	3.2	27.1	5.17	61.6	1.6	4.2	67.4	10.77
Digested food	8.8		4.3			10.4		9.8		
	Spring					Autumn				
Polychaeta	3.1	0.2	2.1	5.4	0.80					
Appendicularia	78.2	26.8	22.8	127.8	18.87	78.7	30.5	23.3	132.5	24.85
Ostracoda	34.5	1.4	3.1	39	5.76					
Copepoda	95.8	43	33.8	172.6	25.48	100	44.4	27.8	172.2	32.30
Cirripedia (nauplii)	17.2	0.2	2.6	20	2.95					
Decapoda (larvae)	32.7	2.3	2.3	37.3	5.51					
Mysidacea	19.2	0.2	2.1	21.5	3.97					
Cladocera	75.9	23.3	18.8	118	17.42	85.1	21.9	34.2	141.2	26.48
Gastropoda (larvae)	24.9	0.3	2.9	28.1	4.15					
Bivalvia (larvae)	28.7	0.4	3.2	32.3	4.77					
Pisces										
Eggs	36.4	0.3	2.3	39	5.76	47.9	3.2	12.9	64	12
Larvae	30.7	1.6	4.1	36.4	5.37	21.3	0.2	1.8	23.3	4.37
Digested food	19.6		3.7							

Table 2: Contribution of the prey categories for damselfish stomach contents according to season.
Tabela 2: Delež posameznih kategorij plena v želodcih črnikov v različnih letnih časih.

Seasons	Winter	Spring	Summer	Autumn
% Jr	1.91	5.67	3.69	2.10
Group	8 - 65 mm		> 65 mm	
% Jr	6.83		3.80	

Table 3: Fullness index (Jr) in specimens analyzed by seasons.
Tabela 3: Hureaujev indeks (Jr) primerkov, raziskanih v različnih letnih časih.

Season	Winter	Spring	Summer	Autumn
Winter		0.70	0.67	0.93
Spring			0.80	0.71
Summer				0.69
Autumn				

Size group	8 - 65 mm	> 65 mm
8 - 65 mm		0.58
> 65 mm		

Table 4: Proportional food overlap coefficients (Schoener index) of damselfish between seasons.
Tabela 4: Količnik prekrivanja v prehrani (Schoenerjev indeks) črnika v posameznih letnih časih.

Feeding intensity was lowest in winter, indicated by the higher frequency of empty stomachs in each group (14% for Group 1 and 11% for Group 2).

Copepods constited the bulk of diet throughout the year (Table 2), exhibiting their highest values by number during spring and summer. Cladocerans and Appendicularia were the second important food categories. They were eaten regularly during all seasons.

Seasonal changes in RI were examined to detect which prey accounted for the differences in the diet. This analysis indicated a great importance of copepods in all seasons.

Food quantity in analyzed guts, expressed as the fullness index (Jr), was highest in spring (Jr = 5.67) and a significant drop was recorded for winter (Jr = 1.91) (Table 3).

Fischer's LSD test indicated that the mean fullness index was significantly higher in spring and summer. The application of ANOVA and multiple range tests to the seasonal data indicated significantly higher values in spring (ANOVA: $F = 12.424$, $P < 0.001$).

Values of Schoener's (1970) index of dietary overlap were obtained from a comparison (by weight) between the different size groups (0.58) and seasons (Table 4). Almost all the values were > 0.60, indicating high dietary overlap. Thus, the feeding spectrum of damselfish depends little across season of capture. The small variations of the principal prey items between the different seasons contributed to the high level of inter-season proportional overlap.

Damselfish in the eastern Adriatic fed primarily on crustaceans, mostly copepods (such as *Paracalanus parvus, Clausocalanus pergens* and *Centropages typicus)* and cladocerans *(Podon intermedius)*, but also consumed Appendicularia, Gastropoda (larvae) and Bivalvia (larvae), fish eggs and fish larvae, mainly at larger lengths. Polychaetes, Cirripedia (nauplii), Mysidacea and Decapoda (larvae) were also occasionally found in the stomachs. These results are generally in accordance with the observation of Duka & Shevchenko (1980) off the Mediterranean coast of island Lampedusa and for damselfish from the Black Sea. Same authors mentioned that copepoda (Calanoida, Cyclopoida - 15 species) were the most abundant food items, that Appendicularia *(Oikopleura dioica)* ranked second in the Mediterranean, and that damselfish eggs and Appendicularia *(Oikopleura dioica)* were the most abundant food items in the Black Sea. Although no quantitative data on prey consumption of damselfish were given, it is not possible to compare the data on that basis. Mapstone & Wood (1975) revealed that damselfish feeds both on planktonic and benthic organisms; eight out of 11 individuals contained predominantly planktonic and three predominantly benthic organisms in the Azores.

The stomachs of both size groups were significantly fuller in spring and summer, while the lowest feeding intensity coincided with winter. Many factors could result in the reduction of feeding activity in fish (Nikolsky, 1976). Many of the demersal fishes show a decrease in the feeding rate as the temperature drops (Tyler, 1971). In the study area, the lower temperature of the water occurs during winter (February) and beginning of spring (Zore-Armanda *et al.,* 1991). Because of the reduced abundance of prey and the lowered metabolism of the fish, predation on plankton and benthos was probably at a minimum during winter. Regner (1985) presented, for the central Adriatic, that copepods showed larger number of annual maxima predominantly during the warmer part of the year: in spring, summer and autumn. This occurrence of a larger number of maxima may be due either to natural fluctuations or to the enrichment of coastal area by nutrients (eutrophication) as well as to the sufficient food available over a larger part of the year. Favourable environmental conditions during the warmer months and abundant food supply support the expanded fish community without competitive interactions. However, the effect of temperature may be confounded with the effects on other abiotic factors and/or in change in food availability (Worobec, 1984). Warren & Davis (1967) discussed the profound effects of temperature and seasons on food consumption rates. More food is consumed in summer than in winter, this was demonstrated (Davis & Warren, 1965) from the experiments with *Cottus perplexus*.

Reproduction, which takes place at the end of spring and during summer (Dulčić & Kraljević, 1995), seems to have effect on feeding intensity (gonadal maturation). Feeding behaviour of most of fish species considerably oscillates during the year as a consequence of a physiological changes during reproduction. Jardas & Pallaoro (1991) found that feeding intensity of *Scorpaena porcus* expressed by the index of gut fullness showed markedly lower values during spawning, whereas it was at almost the same level during the rest of the year, with slight intensity increase in the postspawning period. Similarly to damselfish, high degrees of stomach fullness were reported for other demersal fish in the same area, such as

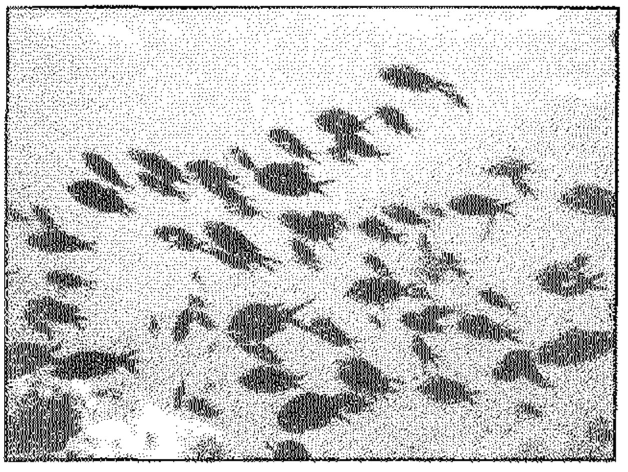


Fig. 3: ***School of Damselfish*** *(Chromis chromis)* ***(Photo: M. Richter).***
Slika 3: Jata črnikov *(Chromis chromis)* ***(Foto: M. Richter).***

Scorpaena porcus (Jardas & Pallaoro, 1991), indicating an abundance of food in this region even though this region contributes to oligotrophic area according to Buljan & Zore-Armanda (1976). The abundance of food in this region is connected with the upwelling in the area of Palagruža sill which is in vicinity of the studied area (Regner *et al.*, 1987). This occurs certainly more strongly during years with increased Mediterranean inflow at the time of strong advection of the intermediary water and also during the upwelling periods in spring and summer (Buljan, 1965). In the open central Adriatic the zooplankton (dry weight) shows a distinct spring maximum in March and April (Vučetić, 1973). Upwelling may be caused later in the spring-summer period by dominant coastward wind direction (the maestral). The spring maximum of the zooplankton is characterized by the presence of typical deep sea species; the maximal population densities at the beginning and by the end of summer are attained by the typical neritic species (Vučetić, 1973). The maximal quantities of zooplankton occurs firstly in the open sea and then farther towards the coast.

Dietary overlap is lower between summer and winter, when the metabolic demands are higher than for the rest of the year. This fact indicates that intraspecific competition for food between fish of the two groups is small, probably because of the different bathymetrical distribution of damselfishes at different size. The study of the bathymetrical distribution of the two groups revealed that younger specimens tended to inhabit smaller depths (Dulčić, unpublished data).

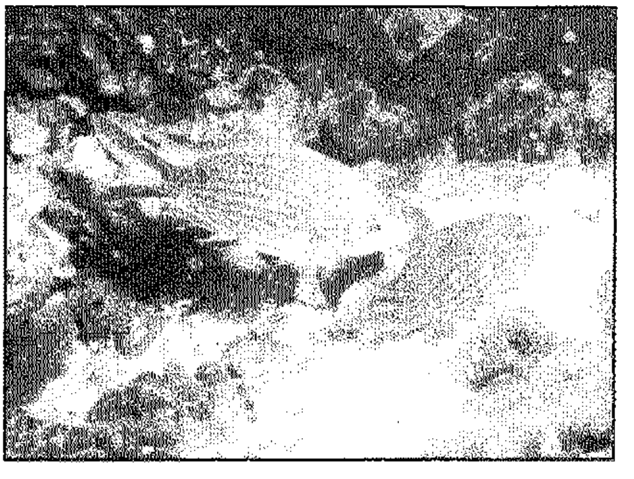


Fig. 4: Male and female damselfish. The male is waiting for the proper moment to fecundate the eggs (Photo: M. Richter).
Slika 4: Samec in samica črnika. Samec čaka, da se samica umakne, da lahko oplodi izmetana jaca (Foto: M. Richter).

POVZETEK

Črnik Chromis chromis *(Linnaeus 1758) je majhna riba, ki jo najdemo v plitvih vodah nad ali v bližini čeri ali pa nad travniki morske trave pozejdonke* (Posidonia oceanica), *in sicer v globini od 3 do 35 metrov. Živi v Sredozemskem morju in v vodah južno od Portugalske do Angole (Quignard & Pras 1986). V vzhodnem Jadranu je črnik številčen (Grubišić, 1982; Milišić 1994), vendar tam komercialno ni zanimiv (razen na otokih Šolti, Hvaru, Korčuli in Lastovem v srednjem Jadranu, kjer je zelo cenjen). V dalmatinskem obalnem ribištvu so črniki majhen, a pomemben sestavni del ulova z mrežami, uporabni predvsem kot slastna jed in vaba za jastoge.*

Da bi ocenili, s čim se črniki prehranjujejo glede na različne letne čase in velikost, je bila raziskana vsebina želodcev 964 osebkov, ujetih v vzhodnem srednjem Jadranu v letih 1992 in 1993. Črnik je mesojeda riba že od svojega mladostnega stadija naprej, hrani pa se le z določenimi planktonskimi in bentoškimi organizmi. Večjo prehranjevalno intenzivnost v spomladanskem času bi lahko pripisali temperaturnim spremembam in dozorelosti *spolnih žlez. Po biomasi, številu in pogostosti pojavljanja v celoletnem obdobju so bili ceponožci najpomembnejši vir hrane. Drugi najpomembnejši prehranjevalni vir so bili repati plaščarji in morske bolhe. Prehransko prekrivanje je bilo razmeroma izrazito, kar pomeni, da so razlike v prehranjevalnem spektru črnikov prek vseh štirih letnih časov majhne, medtem ko je bilo za velikostne skupine neznatno, kar kaže na večje spremembe v prehranjevalnem spektru.*

REFERENCES

Buljan, M. (1965) Anomalies of temperature and chlorinity of sea water on the station Stončica (middle Adriatic). *Pomorski zbornik* 6: 949-995.

Buljan, M. & Zore-Armanda, M. (1976) Oceanographical properties of the Adriatic Sea. *Oceanogr. Mar. Biol. Ann. Rev.* 14: 11-98.

Davis, G.E. & Warren, C.E. (1965) Trophic relations of a sculpin in laboratory stream communities. *J. Wildl. Mgmt.* 29: 846-871.

Duka, L.A. & Shevchenko, N.F. (1980) Morphology and nutrition of *Chromis chromis* (Linne) in the Mediterranean and Black Seas. *Ekhol. Morya* 3: 26-33. (in Russian)

Dulčić, J., Kraljević, M. & Cetinić, P. (1994a) Length-weight relationship in damselfish *(Chromis chromis* L. 1758) from the eastern Adriatic during spawning. *Acta Ichthyologica et Piscatoria* 2: 147-154.

Dulčić, J., Cetinić, P. & Kraljević, M. (1994b) Analysis of the vertebral number of damselfish *Chromis chromis* (L.) in the central Adriatic. *Acta Ichthyologica et Piscatoria* 2: 141-146.

Dulčić, J. & Kraljević, M. (1995) Age, growth and mortality of damselfish *(Chromis chromis* L.) in the eastern middle Adriatic. *Fish. Res.* 22: 255-264.

George, E.L & Hadley, W.F. (1979) Food and habitat partitioning between rock bass *(Ambloplites rupestris)* and smallmouth bass *(Micropterus dolomieui)* young of the year. *Trans.Am.Fish.Soc.* 108: 253-261.

Grubišić, F. (1982) Ribe, rakovi i školjke Jadrana. ITRO Naprijed, Zagreb-GRO Liburnija, Rijeka. 240 p.

Hureau, J.C. (1970) Biologie compareé de quelques Poissons antartiques (Nototheniidae). *Bull. Inst. Oceanogr. Monaco 68: 89p.*

Hyslop, E.J. (1980) Stomach contents analysis - a review of methods and their application. *J. Fish. Biol.* 17: 411-429.

Jardas, I. & Pallaoro, A. (1991) Food and feeding habits of black scorpionfish *(Scorpaena porcus* L. 1758) (Pisces: Scorpaenidae) along the Adriatic coast. *Acta Adriat.* 32: 885-898.

Langton, R.W. (1982) Diet overlap between atlantic cod, *Gadus morhua*, silver hake, *Merluccius bilinearis,* and fifteen other Northwest Atlantic finfish. *Fish. Bull.U.S.* 80: 745-759.

Mapstone, G.M. & Wood; E.M. (1975) The ethology of *Abudefduf luridus* and *Chromis chromis* (Pisces: Pomacentridae) from Azores. *J.Zool.London* 175: 179-199.

Milišić, N. (1994) Sva riba Jadranskog mora. NIVA-Split.

Nikolsky, G.V. (1976) The Ecology of Fishes. London. Academic Press.

Quignard, J.P. & Pras, A. (1986) Pomacentridae. In: Fishes of the north-eastern Atlantic and Mediterranean. Whitehead P.J., Bauchot M.L, Hureau J.C., Nielsen J.& Tortonese E. II, UNESCO, United Kingdom.

Regner, D. (1985) Seasonal and multiannual dynamics of copepods in the middle Adriatic. *Acta Adriat.* 26: 11-99.

Regner, S., Regner D., Marasović, I., & Kršinić, F. (1987) Spawning of sardine, *Sardina pilchardus* (Walbaum, 1792), in the Adriatic under upwelling conditions. *Acta Adriat.* 28: 161-198.

Schoener, T.W. (1970) Non-synchronous spatial overlap of lizards in patchy habitats. *Ecology* 51: 408-418.

Tyler, A.Y. (1971) Monthly changes in stomach contents of demersal fishes in Passamaquoddy Bay (N.B.). *Fish.Res.Board Can. Techn.Pap.* 288: 114 p.

Vučetić, T. (1973) Zooplankton and circulation pattern of the water masses in the Adriatic. *Neth.J.Sea Res.* 7: 112-121.

Wallace, R.K. (1981) An assessment of diet overlap indexes. *Trans.Am.Fish.Soc.* 110: 71-76.

Warren, C.E. & Davis, G.E. (1967) Laboratory studies on the feeding bioenergetics and growth of fish. In: The biological basis of freshwater fish production. Ed. Gerking S.D. Blackwell Scientific Publications, London: 123-135.

Worobec, M.N. (1984) Field estimates of the daily ration of winter flounder *Pseudopleuronectes americanus* (Walbaum) in a southern New England salt marsh. *J.Exp.Mar.Biol.Ecol.* 77: 183-196.

Zar, J.H. (1984) Biostatistical analysis. 2nd edn. Prentice-Hall, Englewood Cliffs, NJ.

Zarret, T.M. & Rand, A.S. (1971) Competition in tropical stream fishes: support for the competitive exclusion principle. *Ecology* 52: 336-342.

Zore-Armanda, M., Bone, M., Dadić, V., Morović, M., Ratković, D., Stojanoski, L. & Vukadin, I. (1991) Hydrographic properties of the Adriatic Sea in period from 1971 through 1983. *Acta Adriat.* 32: 6-554.