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Distribution of juvenile anchovy *Engraulis encrasicolus* (L.) in an estuarine habitat and influence of year–class strength on its catch value

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Distribution and growth of anchovy, Engraulis encrasicolus (L.) and year – class strength appearance were investigated in the Zrmanja river estuary (middle part of the Eastern Adriatic). Influence of anchovy strong age - class on the exploitation of adults was studied as well. Monthly representative samples were taken from the eastern (Croatian) part of the Middle Adriatic (Novigrad Sea) from the initial appearance of strong year classes in August 1989 in other words July 1990 up to March 1991. Catch data obtained during the 1979 – 1993 period were used as well.

INTRODUCTION

Usually, recruitment of fish population is predicted more reliably by abundances of life stages other than eggs and larvae (Sissenwine, 1984; Smith, 1985; Sale, 1990; Bailey, 1994). Year class strength is primarily estimated during the first year of life and depends on the conditions for fish reproduction and survival during the early developmental stages of ontogeny (Hjort, 1914; Deckhnik *et al.*, 1985). Survival during the early stages of pelagic fish is usually attributed to environmental factors, but may in part be also due to fluctuations in the abundances of particular age classes of predators on the eggs, larvae and

juveniles of either the parent stock or some other species. Therefore potential causes of variations in recruitment to fish stocks are:

- variations in environmental factors including climate, tidal conditions, etc.
- variations in the abundance of the parent stock as a whole (the stock-recruitment effect)
- variations in the abundance of predators on, or competitors of the pre-recruit stages (ecological interactions)

The perceived abundance of the stock will be influenced primarily by the variations of recruitment, compounded by the effects of fishing and possible shifts of geographical range. It is difficult to predict year-class strength until the weather that affects it has actually happened. This would therefore give us an advantage of most a year of two on use a 0- or 1- group survey.

Anchovy landings have decreased greatly since 1985 without a considerable change in the fishing effort (Sinovčić *et al.*, 1991, Sinovčić, 1992). Attempts have been made to explain these fluctuation in a variety of ways (Regner *et al.*, 1981; Sinovčić *et al.*, 1991; Sinovčić, 1992; Sinovčić and Alegria-Hernandez, 1997).

The main objectives of this study were, first, to determine the year-class strength of juvenile anchovy in the estuarine habitat (Zrmanja river estuary), its distribution, and second, to identify its effect on the catch of adults in forthcoming years.

Area characteristics

The values of phosphate which totalled 0.25 μmol l^{-1} and especially silicates which amounted to 12.8 μmol l^{-1} in the Novigrad Sea and 30.8 μmol l^{-1} in the Karin Sea (Table 1) make this area one of the richest in the eastern part of the Adriatic, which, is generally speaking, oligotrophic due to the quantity of nutrients.

Considering the categorization of some eastern parts of the Adriatic ecosystem on the basis of the phytoplankton cell volume, Viličić (1989) noted the higest values in the Novigrad Sea and the Karin Sea bays as well as, in an urban area of Šibenik bay. Based on the phytoplankton quantity, the Novigrad Sea and the Karin Sea bays are classed among the highest category of naturally eutrophicated areas. In that respect, only the Gruž and Šibenik harbour are richer. However, high production in these areas is the result of urban eutrophication, while the Novigrad Sea and the Karin Sea bays are naturally eutrophicated

Table 1. Physical-chemical characteristics and nutrient concentrations in the Karin and the Novigrad Sea (Buljan, 1969) as well as, in the Velebit Channel and the Nin Bay (Škrivanić and Barić, 1979)

Area	S x 10^{-3}	Temp.^{0}C Min-max	PO_4-P µmol l^{-1}	NO_3-N µmol l^{-1}	SiO_2-Si µmol l^{-1}
Karin Sea	19.52-36.60	4.1-23.4	0.00-0.25	-	3.89-30.80
Novigrad Sea	11.72-36.92	4.6-23.0	0.00-0.25	-	10.00-12.80
Velebit Channel	34.10-37.92	8.0-23.1	0.02-0.05	0.02-0.60	0.60-4.00
Nin Bay	36.50-38.10	7.9-24.7	0.02-0.06	0.14-0.40	1.00-4.00

MATERIAL AND METHODS

During the periods of study, 2564 juvenile anchovy from the interconnected bays of the Novigrad Sea and Karin Sea (Fig. 1) were collected.

Montly representative anchovy samples were obtained by purse seine catches from August 1989 to March 1991.

The total length of each fish was determined, to a mm below its actual length. The gonads and gut content were than removed and the fish weighed to the nearest 0.1 g. A total of analyzed juvenile anchovy specimens ranged from 4.4 to 12.5 cm and from 0.4 to 13.8 g.

The otoliths were extracted, washed and placed in denoted envelopes.

For studies of the anchovy state under exploitation, fishermen were requested to fill up the forms recording daily catch by fishing ground in the Novigrad Sea.

Total catch data of the eastern and western Adriatic were available from FAO yearbooks of fishery statistics.

RESULTS AND DISCUSSION

Distribution of juvenile anchovy

Juvenile anchovy started to appear in mass (year – class strength) and to be fished along the eastern Adriatic in July 1989 and August 1990. The species of small pelagics react very quickly to the increase of

phytoplankton and zooplankton production. Due to their position in the trophic chain, they influence the trophic relations in the sense that they carry organic matter from lower to higher trophic levels.

All analyzed juvenile anchovy specimens ranged from 4.4. to 12.5 cm and from 0.4 to 13.8 g. They are in first year of life.

Juvenile anchovies remain in the Novigrad Sea throughout the year using it as a nursery area. Juveniles remain in this area before migrating into deeper waters as they increase in size. Data of realized juvenile anchovy catches which are represented on Fig. 1. simultaneously show their spatial – temporal distribution in this area.

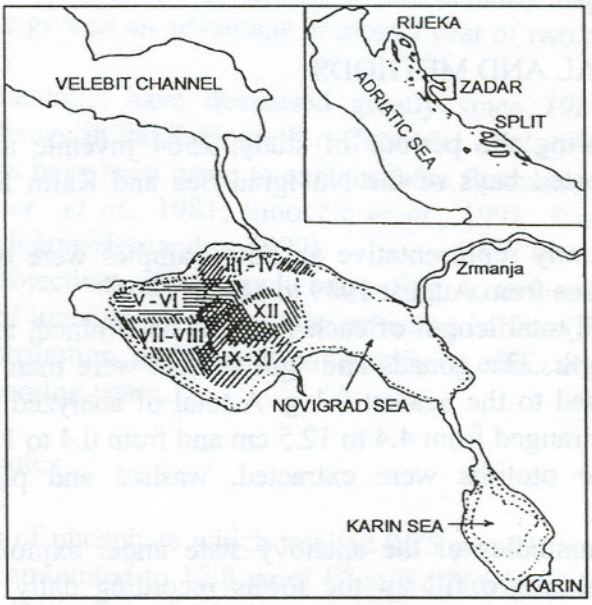

Fig. 1. Map showing the investigation area as well as the spatial and temporal distribution of juvenile anchovy in the Novigrad Sea during 1990

In spring, schools of this species were located near the entrance to Novigrad Sea.

During the summer, they extended their presence to the south and the west coasts of the bay, which are better afforested and hence, the more productive coasts of the bay. Organic matter accompanies the rain,

enriching the area with nutrients which fulfil the basic precondition of phytoplankton, as well as zooplankton swelling. The south and west coasts are the most afforested. They are the richest and most productive parts of the area. Results of the tintinnines quantity, which comprise the food of the juvenile anchovy (Ercegović, 1940), showed increased amounts in the Novigrad Sea, particularly during spring and summer, when compared with other parts of the eastern Adriatic (Kršinić, 1987). The amounts show that these groups of organisms make this aquatorium one of the richest areas, which is very important due to the fact that plankton organisms provide basic food for pelagic species.

In autumn they migrate to deeper waters; but in winter they move to the deepest, central part of the bay, where they find the most favorable temperature conditions.

Catches

Figure 2. shows how the strong age-class which appeared in 1989

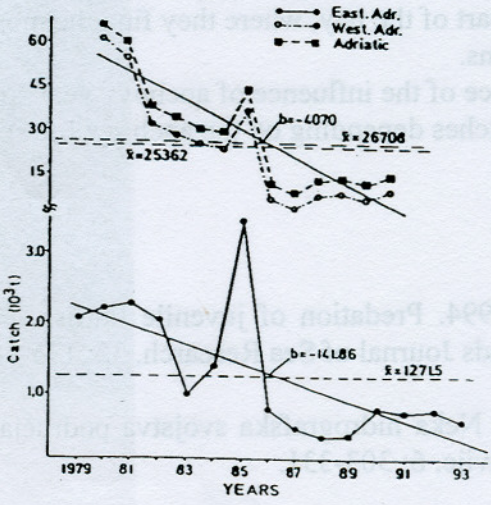

Fig. 2. Fluctuations of annual anchovy catches in the Adriatic during 1979 – 1993 period

and 1990 and observed during constant monitoring, influenced the overall catches of this species in the eastern part of the Adriatic, since these fish later become (under normal conditions) the bulk of the Adriatic anchovy stock. It is therefore expected that this year – class strength of anchovy recorded in 1989 and 1990 will significantly reflect upon increased catches during subsequent fishing seasons depending on anchovy life – span. The catches realized in the western part of the Adriatic as well as catches for the entire Adriatic Sea are shown as well. Since 1989 and 1990, with results of the existence of strong year classes, anchovy catches have been increased. As the anchovy life span is five years (Sinovčić, 1988, 1991, 1992), the year – class strength appearance has influenced the catch value during the period 1990 to 1993. (Fig. 2).

CONCLUSIONS

The results of this study showed the following: Novigrad Sea and Karin Sea bays constitute a favourable nursing habitat for juvenile anchovy.

Juvenile anchovy have a coastal distribution during and summer. During autumn they migrate to deeper waters, but in winter they move to the deepest, central part of the bay, where they find the most favourable temperature conditions.

The importance of the influence of anchovy year – class strength and its successive catches depending on the anchovy life span was asserted.

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Rasprostranjenost juvenilna brgljuna *Engraulis encrasicolus* (L.) u estuariju i utjecaj pojave snažne dobne skupine na njegovo iskorištavanje

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SAŽETAK

U radu se iznose rezultati istraživanja rasprostranjenosti juvenilna brgljuna, *Engraulis encrasicolus* (L.) u estuariju rijeke Zrmanje (Novigradsko i Karinsko more – središnji dio istočnoga dijela Jadrana). Prati se utjecaj snažne dobne skupine brgljuna, od njezine prve pojave (kolovoz 1989) do prelaska juvenilna brgljuna u adultnu fazu (ožujak 1990, odnosno 1991), na ukupni ulov ove značajne pelagičke vrste.

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