INFLUENCE OF DIFFERENT FOOD ON THE GROWTH OF EXPERIMENTALLY REARED HERBIVOROUS FISHES (SARPA SALPA L.)

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Abstract

The feeding habits of wild and cultured salpae *(Sarpa salpa)* were investigated. Immediately after salpae had been caught, the stomach contents of some of the specimens were dissected and analysed in order to determine the kind of food salpae consumed in their natural habitat. A total of 32 benthic algae were determined, mostly *Rhodophyta,* together with a few diatoms and a few harpacticoid copepods at an advanced growth phase.

The remaining salpae were placed to 50-*l* tanks constantly serviced with flowing seawater and fed for 120 days four various types of diets.

The salpae before subjected to the feeding test were acclimated to the laboratory conditions. The greatest length-weight increment recorded in those fed garden lettuce, *Ulva rigida,* pilchardus and pellets.

The preliminary results suggest that salpa is a mainly herbivorous fish, both under the natural and experimental conditions, which makes it a potentially comercially important species both for monoculture and polyculture.

Izvod

UTJECAJ RAZLIČITE ISHRANE NA RAST BILJOJEDIH RIBA (SARPA SALPA L.) U EKSPERIMENTALNOM UZGOJU

Istraživana je mogućnost uzgoja salpi hranjenih različitom hranom: potpuno biljnog, miješanog do životinjskog porijekla. Pokazalo se da salpa u eksperimentalnom uzgoju ne selektira hranu

ovisno od porijekla. Relativno se brzo prilagođava na uvjete bazenskog uzgoja. Za komercijalni uzgoj u monokulturi problem je njenog stalnog hermafroditizma.

INTRODUCTION

In spite of the importance of the plant-feeding fishes in marine population food chain, very little information regarding their diet as well as their adaption to the controlled conditions of growth is available. Information is particularly scarce on *Sarpa salpa*.

Sarpa salpa belongs to the family *Sparidae*. It can reach a length of about 51 cm and a weight of about 3 kg (Bini, 1968; Tortonese, 1975; Grubišić, 1982). It is most abundant in the Mediterranean, but is also found along the eastern Atlantic coast, reaching the Bay of Biscay and the South coast of Africa. Rocky shores with heavy plant cover are its principal habitat (Bini, 1968; Fisher, 1973; Joubert and Honekom, 1980; Smith, 1977).

The results of previous studies pointed out its digestion efficiency as higher than in other herbivorous (Gerking, 1984).

Its protein needs are rather low. It can consume both plant and animal proteins and large quantities of carbohydrates and lipids with no adverse effects on its growth (Pelivan, 1981). However, as indicated by Dubrovnik aquarists, salpae fed only small blue fish have higher survival and growth rates.

Numerous works have been reported on the possible reducing of costs of fish feed and improving growth performances in modern fish farming. In order to find such a food composition that would enable sufficient growth increments and would contain as much as possible of plant ingredients so as to reduce feed costs in a possible commercial culturing of salpa, we investigated its feeding habits under the natural and laboratory conditions.

Some ecological, biochemical and physiological characteristics of the specimens subjected to the feeding trial were also investigated. The survival rates as well as the behaviour of salpae during acclimatization to various chloride concentrations in blood serum were examined. Furthermore, we analysed Na, K and ATP-ases in the gills. These results will be presented in another paper.

MATERIALS AND METHODS

As many as 2,500 young salpae with an average length of 54 mm and a weight of 2.015 g were caught in the coastal area of Dubrovnik, the South Adriatic. A small net, 5-m long and 1-m with 0.5 cm mesh netting and a special hand net »ručijak« — a conically constructed hand net equipped with many ball-shaped lead plummets, were used.

In order to determine the type of food *S. salpa* consumed in its natural habitat, the digestive tracts of a few specimens were analysed. The remaining salpae were placed for 20 days in a large 3,000-*l* tank.

After 20 days long acclimatization period, salpae were divided into four groups consisting of 20 individuals and replaced to the each of 4 small, 50-*l* tanks (20 ind per tank). The tanks were supplied with 5 l/m of flowing seawater, constantly pumped-in fresh air and 12 h: 12 h light: dark regime. Ambiental sea water of 16-19 °C and salinity of 38‰ were kept constant.

Four various experimental diets were prepared for the feeding trial:

Diet I:	garden lettuce	100%
Diet II:	garden lettuce	35%
	Ulva rigida	35%
	pilchards	20%
	pellets	10%
Diet III:	pilchards	100%
Diet IV:	pellets	100%

The salpae were fed twice daily. The quantity of the feed administered was an estimated 10% of their body weight. The feeding trial lasted for 120 days. The weight and length were measured at 30 day-intervals.

Length and weight increments were subjected to statistical analysis and represented graphically. According to these results, the condition factor (C F) was calculated by means of the following formula:

$$C\ F = \frac{Wg \times 100}{Lx^3\ (cm)}$$

RESULTS

Immediately after salpae had been caught, their stomach contents were analysed and a total of 32 benthic algae were recorded.

The most numerous were *Rhodophyta* with 21 species or 65% of the total number of algae, *Chlorophyta* with 9 species or 28.1% and *Phaeophyta* with 2 species or 6.3%.

The most frequent species of *Rhodophyta* were *Gelidium spathulatum, Hypnea musciformis* and *Laurencia pinnatifida,* while among *Chlorophyta, Enteromorpha prolifera, Ulva rigida* and *Cladophora hutchinisiae* were most abundantly present. The following species of *Chlorophyta* dominated the biomass: *Ulva rigida, Ente-*

romorpha prolifera and *Cladophora hutchinisae*, whereas of *Rhodophyta, Hypnea musciformis* was abundantly present. A few epiphyte species, mostly diatoms were registered as well: *Grammatophora marina, Achnanthes longipes, Licmophora flabellata, Licmophora sp.*

Unfortunately, we were not able to designate some diatoms of the group *Penatae* that were also present in the stomach contents. Of animal organisms, a few harpacticoid copepods at an advanced growth phase were present.

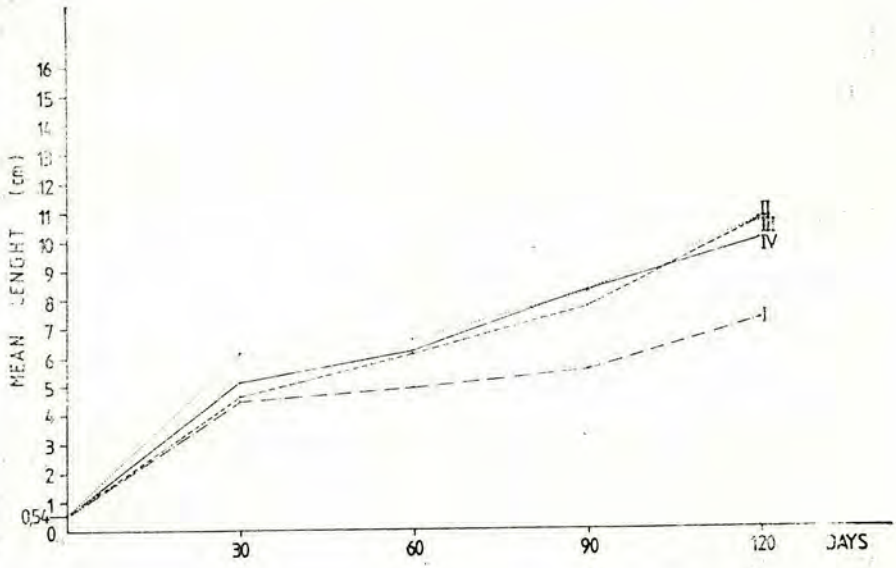

Figure 1: Length increment of salpae fed four various types of food throughout 120 days: -.- Diet I; ... Diet II; - - - Diet III; —— Diet IV.

Slika 1: Dužinski prirast salpi hranjenih s četiri različite hrane u toku 120 dana: -.- hrana I; ... hrana II; - - - hrana III; —— hrana IV.

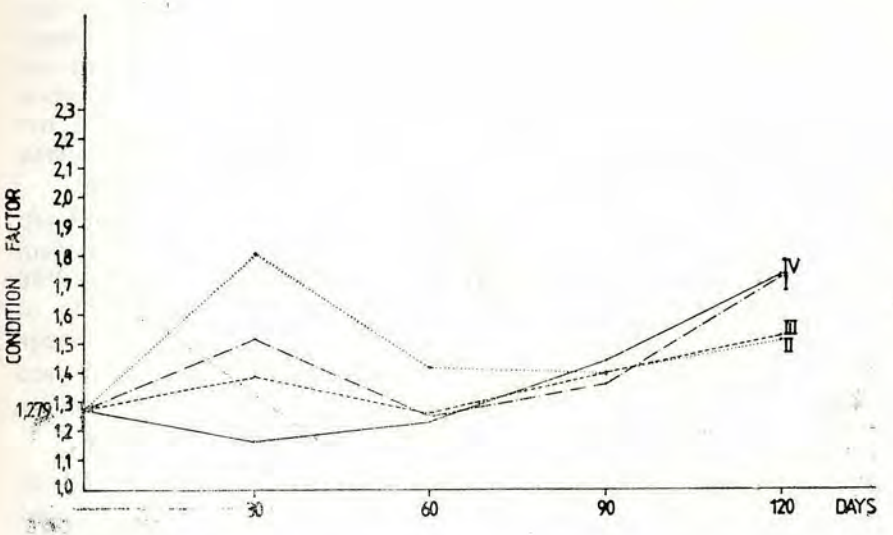

Figure 2: Weight increment of salpae fed four various types of food throughout 120 days: -.- Diet I; ... Diet II; - - - Diet III; —— Diet IV.
Slika 2: Težinski prirast salpi hranjenih s četiri različite hrane u toku 120 dana: -.- hrana I; ... hrana II; - - - hrana III; —— hrana IV.

However, since salpae subjected to the feeding trial were caught in summer, no data concerning the kind od food they consume in other seasons is available.

The salpae subjected to the trial were observed to acclimate quickly to the changes in the food composition.

Their length increment was somewhat more pronounced in the first 30 days of the feeding (Fig. 1) with the weight increment in all the tanks being more pronounced in the 60 to 120 days period (Fig. 2).

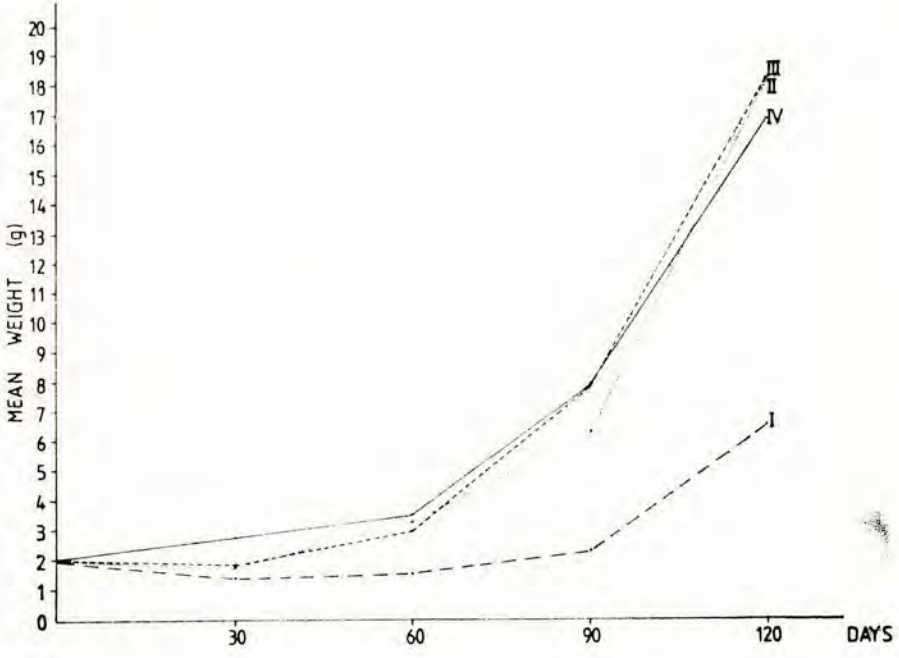

Figure 3: The changes in the condition factor of salpae fed four various types of food throughout 120 days: -.- Diet I; ... Diet II; - - - Diet III; —— Diet IV.

Slika 3: Promjene u indeksu salpi hranjenih s četiri različite hrane u toku 120 dana: -.- hrana I; ... hrana II; - - - hrana III; —— hrana IV.

The best results were achieved with Diets 2 and 3. Nevertheless, according to the condition factor, almost the same values were achieved with the Diets I and IV on the one hand, and with the Diets II and III on the other (Fig. 3).

Salpae were observed to have fed continously during the day. Larger quantities of the food administered increased the quantities of digested and undigested food at the tank bottom. The salpae consumed food more readily while it floated at the surface than

when already settled at the bottom. They more readily consumed garden lettuce than *Ulva rigida*.

Throughout the experiment, a minimum mortality rate was recorded. However, at the end of the trial, 50% the fish fed pellets died. These were exclusively the smaller specimens that looked as if they had been dried. Before expiring, they lost equilibrium and their bellies shrank.

DISCUSSION AND CONCLUSIONS

As has already been reported by Joubert and Hanekom (1980), salpa is a herbivore, but not an obligate plant eater, which means that it doesn't exclude selectively the animal food from the diet. Christensen (1978) reported that the diet changed with the size of the fish. Small fish of 10-25 cm fed mainly on harpacticoid copepods. As they grew to 25-35 mm, they began feeding mostly on red algae and diatoms, whereas animal material contributed only partly to their diet.

Throughout our feeding trial, salpae acclimated quickly to all the types of the food administered, with the most balanced increment recorded with fish fed Diet II (garden letuce 35%, *Ulva rigida* 35%, pilchards 20%, pellets 10%). Therefore, due to its being able to consume various food mixture, salpa is a comercially important species both for monoculture where it would be fed plants (a low cost feed cultivated on the land), and for polyculture where it would be reared with another fishes and fed animal diets.

It has been observed that due to its life mode, salpa could be used as an efficient fish cage browser as well. Although its being a permanent hermaphrodite makes the possibilities of its reproduction under laboratory conditions difficult, it is worth noting that in the South Adriatic salpa's fry abounds and can easily be collected for the purposes of fish farming.

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S a d r ž a j

I pored važnosti biljojedih riba u prehrambenom lancu morskih zajednica, malo se zna o sastavu njihove hrane, te adaptaciji na uzgoj u kontroliranim uvjetima, posebno o salpi *(Sarpa salpa* L.).

U radu se donose rezultati analize želučanog sadržaja tek izlovljenih salpi, te njihove prilagodbe i ishrane u laboratorijskim uvjetima.

Salpa pripada obitelji ljuskavki *(Sparidae).* Tijelo ovalno i produženo, boje žuto-srebrenkaste, sa žuto-zelenim longitudinalnim linijama. Naraste do cca 51 cm dužine i do 3 kg težine (Bini, 1968; Tortonese, 1975; Grubišić, 1982). Najrasprostranjenija je u Mediteranu, a nađe se i uz istočnu Atlantsku obalu dopirući do zaljeva Biscay i do obale južne Afrike. Kamenita obala obrasla bogatom vegetacijom njeno je glavno prebivalište (Bini, 1968; Fisher, 1973; Smith, 1977; Joubert i Hanekon, 1980).

Prema mišljenju nekih uzgajivača, salpa bi mogla miti zahvalan organizam kao čistač kaveza u kojima se uzgajaju ostale vrste riba, a mogla bi se uzgajati i u čistoj kulturi.

U cilju istraživanja mogućnosti njenog uzgoja pristupilo se ovom eksperimentu, da bi se odgovorilo da li je salpa izraziti ili pretežni biljojed te kako se ponaša u uvjetima laboratorijskog uzgoja.

Salpe korištene u ovom eksperimentu bile su prosječne dužine 54 mm i težine 2.015 gr. Odmah po ulovu izvršili smo analizu želučanog sadržaja određenog dijela malih salpica, a jedan dio je stavljen u bazen sa morskom vodom kako bi se adaptirale na promijenje uvjete.

Analizom želučanog sadržaja konstatitrali smo da su u ishrani salpi najčešće vrste algi iz skupine *Rhodophyta,* dok su biomasom dominirale alge iz skupine *Chlorophyta.* Pored bentoskih algi konstatirano je i nekoliko epifitskih organizama, uglavnom dijatomeja, te nekoliko životinjskih organizama iz skupine *Harpacticoida.*

Poslije 20 dana, salpice su prebačene u serije manjih (50 *l)* bazena i otpočeo je eksperiment ishrane. Hranu smo pripremili u vlastitoj režij izuzev peleta:

Hrana br. I	— zelena (vrtna) salata	100%
Hrana br. II	— zelena (vrtna) salata	35%
	— *Ulva rigida*	35%
	— meso srdele	20%
	— peleti	10%
Hrana br. III	— meso srdele	100%
Hrana br. IV	— peleti	100%

Svu pripremljenu i ponuđenu hranu salpe su rado konzumirale. Mjerenje dužine i težine riba vršili smo na početku eksperimenta i svakih 30 dana. Najintenzivniji dužinski rast u svim bazenima postignut je u prvih 30 dana, a težinski u drugoj polovici uzgoja od 60-120 dana. Na kraju eksperimenta najbolji rezultati postignuti su kod hrane br. II i III (sl. 1 i 2). Izračunati koeficijent kondicije pokazuje veće vrijednosti kod hrane br. I i IV, nego kod onih hranjenih hranom br. II i III (sl. 3).

Pokazalo se da je salpa u prirodi pretežni biljojed, a u laboratorijskim uvjetima konzumira svu ponuđenu hranu, te da se relativno brzo prilagođava na bazenski uzgoj. Mogla bi biti pogodan organizam za uzgoj, bilo u polikulturi ili u monokulturi. Obzirom da je stalni hermafrodit, to bi bilo teško riješiti problem umjetne oplodnje, no u južnom Jadranu moguće je dobiti dovoljne količine mlađi iz prirodnog izlova u svrhu uzgoja u polikulturi.