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FEEDING HABITS OF JUVENILE STAGES OF *SPARUS AURATUS* L., *DICENTRARCHUS LABRAX* L. AND MUGILIDAE IN A BRACKISH EMBAYMENT OF THE PO RIVER DELTA

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ABSTRACT

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The feeding habits of juvenile stages of gilthead (*Sparus auratus* L.), sea bass (*Dicentrarchus labrax* L.) and three species of grey mullets (*Liza ramada* Risso, *Liza aurata* Risso and *Liza saliens* Risso) in a Po Delta embayment (Sacca di Scardovari) were studied. Samples were taken over two years, 1977 (from April to June) and 1978 (from February to December). The stomach contents of a total of 858 individuals were examined. The feeding habits of fish fry of the five species did not differ noticeably in the smaller-sized stages (standard length (SL) < 30 mm), which are carnivorous with a prevalently planktophagous diet; Cirripedia nauplii, Copepoda and Polychaeta larvae are the most important food items. The food preferences tend to change when the size is over a SL of 30 mm; gilthead feed preferentially on macrobenthos (Polychaeta and Amphipoda) and macrophyte detritus, and sea bass on macroplankton (Mysidacea, Decapoda larvae and fish larvae); grey mullets have a mixed diet including benthic microalgae, sand and silt, zoobenthos and zooplankton organisms. The diet of young grey mullets is furthermore characterized by the presence of adult insects. The composition of the stomach contents of the different fry species was also analyzed in relation to the composition of some zooplankton and zoobenthos taxocoenoses in the embayment.

INTRODUCTION

Juvenile stages of grey mullets (Mugilidae), gilthead (*Sparus auratus* L.) and sea bass (*Dicentrarchus labrax* L.) are important biological resources and the object of specialized fishing along the North Adriatic coast and in particular in the brackish lagoons of the Po Delta (Gandolfi et al., 1981). The fry are bought by fish farmers and sown in brackish water fish ponds. The dietary composition of these young fish in a Delta embayment, Sacca di Scardovari, has been studied as part of a research on the ecological characteristics and biological productivity of the embayment (Colombo et al., 1979a; 1979b). The aim of this study was to define the role of fish fry in the trophic structure of the ecosystem and, furthermore, to provide useful information on the fry feeding in fish-cultures.

There are a considerable number of studies on the natural diet of grey mullets and specifically on that of their juvenile stages (Pillay, 1953; Ezzat, 1965; Suzuki, 1965; Thomson, 1966; Odum, 1970; Albertini-Berhaut, 1973; 1974; 1979; Chervinsky, 1975; Zismann et al., 1975; Payne, 1976; De Silva and Vijeyaratne, 1977; Chan and Chua, 1979; De Silva, 1980). Some of these studies (Albertini-Berhaut, Chervinski, Zismann et al.) dealt with the feeding habits of young grey mullets along the Mediterranean coast.

Ktari et al. (1978) performed research on the feeding habits of two species of sea bass of the Tunisian coast, mainly examining individuals over 2 years old. We are not aware of any research carried out in the Mediterranean sea on the natural diet of young gilthead and sea bass.

This paper reports the results of stomach content analysis of fish fry of five species (*Sparus auratus* L., *Dicentrarchus labrax* L., *Liza ramada* Risso, *Liza aurata* Risso, *Liza saliens* Risso) which are most commonly caught in Sacca di Scardovari. The change in feeding habits during growth has been studied in relation to size variations for each species. Some of the preliminary results of the research were already presented at the X and XI Congress of the Italian Society of Marine Biology (SIBM).

THE ENVIRONMENT

The Sacca di Scardovari (Fig. 1) is a large embayment of about 32 km^2 between the Tolle and Gnocca branches of the Po river; it is connected to the sea through a wide mouth barred by partly submerged sand banks. Ecological research carried out by Ceccherelli and Cevidalli (1981), Cavallini and Paesanti (1979) and Colombo et al. (1979b) has shown a zonation of the embayment in two areas with clearly different hydrodynamic and trophic characteristics. Water renewal in the northern area is more sluggish than in the southern one, which is directly influenced by the tidal currents and by the water flow from the terminal branches of the river; and zooplankton and zoobenthos have higher biomass and lower diversity in the northern area.

Fishing records covering several years were analyzed by Rossi (1981). Gandolfi et al. (1981) and Rossi (1980) examined series of samples of fry collected in the embayment in 1977 and 1978 (the same samples utilized for the present research) and studied inwards migration, abundance and growth of the main species. We report from Rossi's (1980) paper some essential information on the inwards migration periods of the different fry species in Sacca di Scardovari. Juvenile stages of gilthead and sea bass appear in the embayment from February until June—July. Early stages of *L. ramada* and *L. aurata* begin their inwards migration at the end of the autumn but they are present in considerable numbers only from February onwards; their abundance then decreases. Juveniles of *L. ramada* during 1978 were found in the embayment until June, and those of *L. aurata* until August. *L. saliens* has a long reproductive period which starts in June and goes on until the autumn; juveniles of this species are present during the whole year. During winter and spring

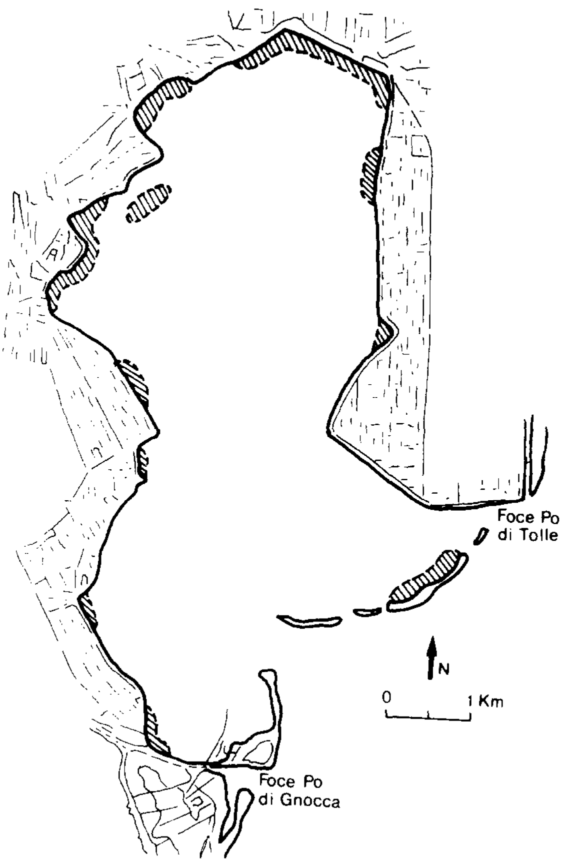


Fig. 1. Map of Scardovari embayment (Po Delta). The dashed areas are those mainly exploited by fry fishermen.

there is a particularly high range of size values. In July and August two different cohorts are evident, one of small-sized, recently hatched, individuals, the other of large-sized individuals presumably hatched at the end of the previous year's reproductive period.

MATERIALS AND METHODS

The samples of fish fry were collected in the embayment, mainly in the northern area (Fig. 1), with the help of specialized fishermen. In 1977, three different sampling techniques were adopted: a 70 cm diameter circular net, a small 7 m handtrawled net, and a 30 to 200 m long net trawled by a motor boat. In 1978 the fry were collected using only a large trawl net which allows a higher catch efficiency (Rossi, 1980). Six samplings were made in 1977, from 15 April to 20 June, and 17 in 1978, from 18 February to 30 December. The fry were caught during daylight, generally between 9.00 and 13.00 hours.

The samples were fixed and preserved in 5% formaldehyde solution buffered with hexamethylentetramine. Taxonomic identification and measurement of the standard length (SL) of all the sampled individuals were then performed. The grey mullet identification was effected by observing the number and shape of the pyloric caeca (Perlmutter et al., 1957; Farrugio, 1977). The stomach contents were fixed in a buffered 10% formaldehyde solution.

In the first year (1977) the analysis of the stomach contents was made of each individual of the original sample or of random subsamples for each species. The stomach contents of a total of 230 fish fry were examined: 16 gilthead, 52 sea bass, 108 *L. ramada*, 42 *L. aurata* and 12 *L. saliens.*

In 1978 a pool of stomach contents of the fry of each original sample or subsample were analyzed separately for each species; each subsample included at least 10 randomly drawn individuals. Following this method, the stomach contents of 628 fish fry were examined: 116 gilthead, 73 sea bass, 100 *L. ramada*, 99 *L. aurata* and 240 *L. saliens.* For this last species, the subsamples were drawn from the original samples which had formerly been subdivided in three size groups: SL < 30 mm, 30 mm < SL < 50 mm, SL > 50 mm; this was done because of the large range of size in several samples.

The plant and animal forms found in the stomachs were identified at the level of the major taxonomic groups; for some taxa, such as Copepoda and Cladocera, identification was also made, when possible, at the species level.

From the samples collected during 1977 the presence of the different food items in each stomach was noted. It was then possible to determine, for each food item, a frequency index (*f*) as the ratio between the number of stomachs containing that item and the total number of examined stomachs.

On the pools of stomach contents of the fish fry sampled in 1978, a count was made of the ingested organisms. This was not possible for the microphytes and some animal forms, such as Polychaeta, which rarely preserve their individual integrity in the stomach. In the presentation of the results the non-counted forms are given abundance indices (+ rare, ++ abundant, +++ very abundant).

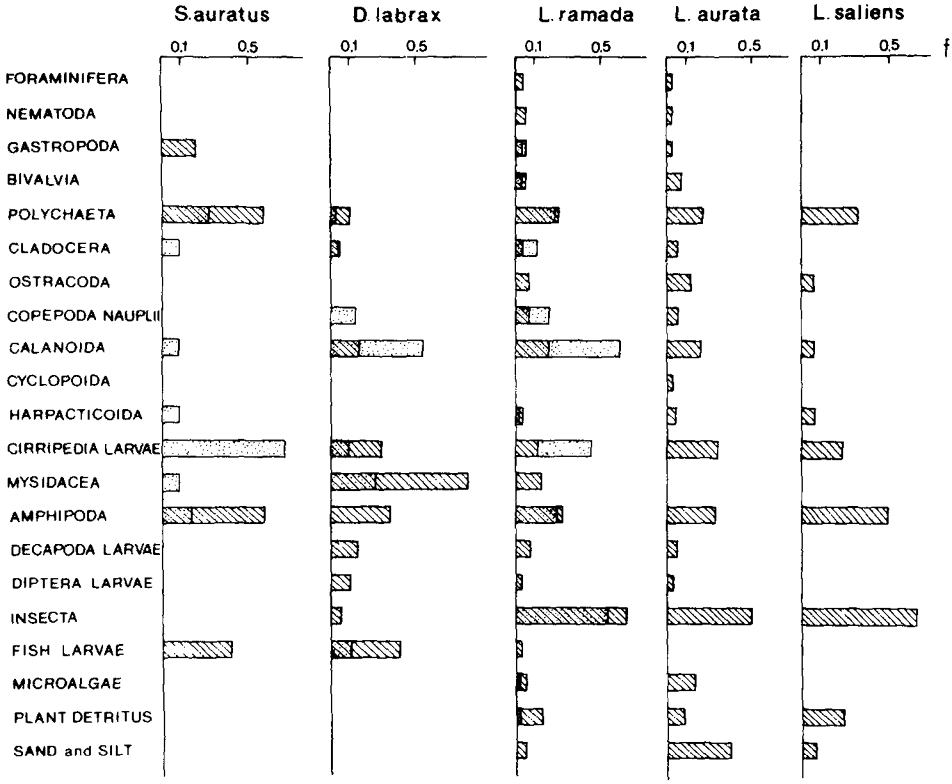
Finally, a calculation was made for each species of the emptiness coefficient considered as the ratio between the number of empty stomachs and the total number of examined stomachs.

RESULTS

The stomach contents of fish fry caught in 1977

In 1977 a small number of samples of fish fry were collected over a short period of time. The analysis of the stomach contents of the five species gave useful preliminary information (Fig. 2). The coefficients of emptiness were very low for all the species; out of a total of 230 individuals only eight were found with empty stomachs.

The frequency indices for juvenile *S. auratus, D. labrax* and *L. ramada*



No. of fish examined	S. auratus	D. labrax	L. ramada	L. aurata	L. saliens
S.L. < 30 mm	11	35	63	–	–
S.L. > 30 mm	5	17	45	42	12
S.L. min mm	21.5	20	19	30	36
S.L. max mm	78	66	79	85	49.5

Fig. 2. Frequency indices (f) of the different food items in the stomach contents of fish fry caught in 1977 (dotted area: SL < 30 mm; dashed area: SL > 30 mm).

were calculated in two different size groups, one of individuals with SL < 30 mm, the other of larger individuals; *L. aurata* and *L. saliens* were present only with individuals with SL > 30 mm (Fig. 2).

The fish fry of smaller size (SL < 30 mm) feed principally on micro- and mesoplankton organisms (Calanoida, nauplii of Copepoda and of Cirripedia, Cladocera) and to a lesser extent on benthic animals (Harpacticoida and Amphipoda); other animal forms such as planktonic larvae of Polychaeta and, in the case of gilthead and sea bass, Mysidacea are also present in their diet; adult insects have a high frequency only in the stomach contents of *L. ramada*.

In fry of a SL > 30 mm the diet tends to be clearly different: it consists almost exclusively of Amphipoda, Polychaeta and fish larvae in *S. auratus; D. labrax* feed on the same organisms, but preferential prey is represented by Mysidacea. In *L. ramada* the diet is characterized by a high frequency of adult insects; compared with smaller sized fry, there is an increase in frequency both of meiobenthic and macrobenthic animals and of benthic algae, mainly Diatoms, and macrophyte detritus, often associated with sand, while the frequency of the zooplankers decreases. The diet of *L. aurata* and *L. saliens* does not appear to differ substantially from that of *L. ramada*; the smaller variety of prey found in *L. saliens* can probably be attributed to the small number of the individuals examined.

The stomach contents of fish fry caught in 1978

Tables I—VI show, month by month, the average abundances of food items per stomach for each species; the range and average SL of the examined fishes are also shown. The coefficients of emptiness were very low (less than 5%) for *S. auratus*, *D. labrax*, *L. ramada* and *L. aurata*, while relatively high coefficients of emptiness were found in *L. saliens*. They are further characterized by a tendency to increase with fish size: 7.5% in individuals with SL < 30 mm, 21.1% in individuals with SL ranging from 30 to 50 mm, 25.0% in individuals with SL > 50 mm. The highest emptiness coefficients were found for all species during winter (December through March).

TABLE I

Average number of food items per stomach of juveniles of *Sparus auratus* caught in 1978

	Feb.	Mar.	Apr.	May	Jun.	Jul.
No. of fish examined	30	30	10	20	16	10
SL — $\bar{x}$ (mm)	17.4	17.5	19.3	31.5	43.7	79.2
SL — range (mm)	16—20	15—20	16—22	27—36	36—55	68—85
Rotatoria		0.1				
Gastropoda				0.1		
Bivalvia						0.2
Polychaeta larvae		++	+			
Polychaeta				+	+	+++
Cladocera			0.1			
Copepoda nauplii			0.3	0.1		
Unidentified Copepoda		0.1	0.1	0.1	0.1	
Calanoida	4.5	2.8	0.5	0.1	0.1	
Cyclopoida	0.3	0.1	0.1		0.1	
Harpacticoida	0.7	1.5		5.3	0.1	
Cirripedia larvae	2.8	8.3	3.7			
Mysidacea		0.1			0.1	
Amphipoda		2.5	0.4	4.5	8.9	9.1
Unidentified eggs		+		+	+	
Fish eggs						1.7
Fish larvae		0.4				
Microalgae		+		+		
Plant detritus			+	+	+	+++

TABLE II

Average number of food items per stomach of juveniles of *Dicentrarcus labrax* caught in 1978

	Feb.	Mar.	Apr.	May	Jun.	Jul.
No. of fish examined	10	6	10	17	20	10
SL — $\bar{x}$ (mm)	15.9	17.7	18.0	26.3	37.5	62.3
SL — range (mm)	14—18	15—19	17—19	23—31	28—43	52—80
Polychaeta larvae			+	+		
Copepoda nauplii			5.7	543.8		
Unidentified Copepoda			6.0		0.1	
Calanoida		0.7		23.9	0.8	
Cyclopoida			0.1			
Harpacticoida	0.1	0.3	0.7	6.2	0.1	0.1
Cirripedia larvae	0.2	3.2	0.2	9.5	0.2	
Mysidacea				0.1	4.4	34.5
Amphipoda				1.7	0.6	0.1
Decapoda larvae				0.4	24.5	
Diptera larvae						1.2
Unidentified eggs				+		0.1
Fish larvae				0.9	1.4	
Plant detritus				+		

Parasites (Trematoda Digenea not identified as species) were found in the stomach of many fry of all five species, particularly in samples collected from February to April.

The main characteristics of feeding habits and their variations according to size for each species are as follows.

Sparus auratus (Table I) — The juveniles caught from February to March have an average SL of less than 31.5 mm; in their diet both zooplankton (Polychaeta larvae, Cirripedia nauplii, Calanoida) and zoobenthos (Harpacticoida, Amphipoda) are of considerable importance. In the larger gilthead caught in June (average SL 43.7 mm) and especially in those caught in July (average SL 79.2 mm), the diet consists mainly of both benthic plants (macrophytes) and benthic animals (Amphipoda and Polychaeta).

Dicentrarchus labrax (Table II) — From February to May the juveniles have a SL of less than 31 mm and feed mainly on Copepoda and nauplii of Cirripedia. The stomach contents of larger sea bass fry caught in June (average SL 37.5 mm) and in July (average SL 62.3 mm) include larger prey, particularly larvae of Decapoda and Mysidacea; in the July samples the latter appear with an average of 34.5 individuals per stomach.

Liza ramada (Table III) — In the samples from February to May the SL is less than 28 mm and the diet is almost exclusively planktophagous, including Polychaeta larvae, Rotatoria, nauplii of Copepoda and of Cirrepedia, marine Calanoida and freshwater Cyclopoida. The importance of the above-mentioned zooplankters decreases in the feeding of young *L. ramada* caught in June

TABLE III

Average number of food items per stomach of juveniles of *Liza ramada* caught in 1978

	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Nov.
No. of fish examined	20	20	10	23	3	10	10	4
SL — $\bar{x}$ (mm)	19.8	19.1	18.7	22.7	38.0	53.0	86.1	17.8
SL — range (mm)	16—22	17—21	16—21	18—28	37—39	48—62	78—105	17—18
Rotatoria		17.5	0.1		0.3	4.0		
Nematoda					1.0	6.0		
Bivalvia larvae					6.7	2.0		
Polychaeta larvae		++						+++
Polychaeta			+	+	+	+	+	
Cladocera			0.7					
Copepoda nauplii		9.2	136.9	1139.8	3.7	2.0		
Calanoida	18.6	22.4	0.1	2.6				1.3
Cyclopoida			29.9	5.2				
Harpacticoida		0.1				14.0		0.3
Cirripedia larvae	3.0	33.5	35.7	25.7	4.7			1.3
Amphipoda					0.7			1.0
Diptera larvae			0.2	0.1				
Insecta		0.5		0.8	0.3	0.5		
Unidentified eggs		5.6	23.0	17.0	2.3	6.0		
Microalgae	++	+		+	++	+++	+++	
Sand and silt							+++	

TABLE IV

Average number of food items per stomach of juveniles of *Liza aurata* caught in 1978

	Feb.	Mar.	Apr.	May	Jun.	Oct.	Nov.
No. of fish examined	29	20	10	10	10	10	10
SL — $\bar{x}$ (mm)	25.1	26.0	26.5	29.7	55.6	22.6	26.0
SL — range (mm)	22—29	22—32	20—33	19—35	51—60	21—25	23—31
Nematoda					4.0	0.2	
Bivalvia larvae					2.0	0.5	
Polychaeta larvae		++	+++	+++		+++	+++
Polychaeta					+++		
Cladocera						7.6	0.3
Copepoda nauplii			255.0	450.0	4.0	1.0	
Calanoida	39.8	3.0	12.5	10.0		1.2	0.7
Cyclopoida			7.5				
Harpacticoida					2.0		0.1
Cirripedia larvae	1.4	38.7	82.5	90.0	8.0	20.3	1.3
Amphipoda		3.0	2.5	5.0	0.4	16.0	0.1
Decapoda larvae					2.1		
Diptera larvae		1.0			0.1		
Insecta		5.0			20.2	++	
Unidentified eggs		1.0			28.0	0.4	
Microalgae					+++	+	+
Sand and silt					++		

(average SL 28 mm) and July (average SL 53 mm), while Bivalvia larvae, Nematoda and Harpacticoida and especially benthic Diatoms become well represented. Microalgae are the preferential and practically the only food of the fish caught in August (average SL 86.1 mm). The small fry caught in November, at the beginning of inwards migration, have a carnivorous diet based on plankton and meiobenthos. Adult insects appear in the stomachs during different months, but their abundance is always much reduced.

Liza aurata (Table IV) — The average SL from February to May increases from 25.1 to 29.7 mm; during this period the juveniles feed mainly on zooplankton (Polychaeta larvae, Cirripedia nauplii, marine and freshwater Copepoda), but also on Amphipoda and, occasionally, on adult insects. In June the average SL is 55.6 mm and food has a completely different composition, consisting mainly of Polychaeta, meiozoobenthos and Diatoms; the presence of adult insects which appear with an average of 20 individuals per stomach is also very important. In the stomach contents of small fry caught in October and November, at the beginning of inwards migration, the most abundant groups are Polychaeta larvae, Cirripedia nauplii, neritic Cladocera and Amphipoda.

TABLE V

Average number of food items per stomach of SL < 30 mm juveniles of *Liza saliens* caught in 1978

	Feb.	Mar.	May	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
No. of fish examined	10	20	6	5	10	9	10	10	10
SL — $\bar{x}$ (mm)	24.7	27.3	29.2	15.2	20.1	12.1	26.8	26.6	22.4
SL — range (mm)	18—30	24—30	28—30	14—17	14—26	11—15	23—30	20—30	17—30
Rotatoria					1.0	1.1			
Nematoda		0.2				1.1	1.0	0.5	
Gastropoda larvae						2.2	1.0		
Bivalvia larvae						0.6	2.0		
Polychaeta larvae	+	++	+++			++	+++	+++	+
Polychaeta		+							
Cladocera							0.5		
Copepoda nauplii		1.0	41.7	256.0	18.0		1.0		
Calanoida	12.0	3.0	0.2		1.0	4.4		9.0	5.0
Cyclopoida	0.5	2.5	1.5				1.5	0.5	2.5
Harpacticoida	0.2	1.5		280.0		2.2	4.0	2.5	26.5
Cirripedia larvae	132.0	29.7	16.0	4.0	34.0	6.7	64.0	11.5	0.5
Amphipoda		0.4	0.3				2.0	1.0	0.1
Decapoda larvae					4.5				
Insecta		1.0			1.5		+		
Unidentified eggs		3.9			76.0	0.6	1.0		4.0

TABLE VI

Average number of food items per stomach of SL > 30 mm juveniles of *Liza saliens* caught in 1978

	30 mm < SL < 50 mm							SL > 50 mm				
	Feb.	Mar.	Apr.	May	Jun.	Oct.	Dec.	Feb.	Mar.	Apr.	Jul.	Aug.
No. of fish examined	20	20	10	20	6	10	10	10	20	10	4	10
SL — $\bar{x}$ (mm)	38.5	37.8	41.9	39.1	49.7	35.2	34.3	52.5	62.9	57.5	65.3	90.6
SL — range (mm)	31—50	31—50	33—48	34—44	45—62	31—42	31—38	51—63	51—75	51—68	60—74	75—103
Rotatoria					0.5	2.0					8.8	
Nematoda			1.0	1.2		3.0			0.2	6.1	3.8	2.0
Bivalvia larvae						2.0					3.8	14.0
Polychaeta larvae			+++	+		+			+	+		
Polychaeta		+	+++	+++	+	+				+++		+++
Ostracoda					0.3						1.3	
Copepoda nauplii			735.0	585.0	0.7					104.2	30.0	
Calanoida		0.2	3.0			1.0	1.5	0.1			1.3	
Cyclopoida		0.1					1.5					
Harpacticoida	0.1		2.0		0.2	1.0	25.5	0.7		0.3	7.5	
Cirripedia larvae	0.1	12.5	74.0	45.5	1.5	39.0	1.0	434.0	43.8	76.7		148.0
Amphipoda		0.2	+	0.5	+	10.5	+		+			0.3
Diptera larvae			2.0									
Insecta		2.5			+	0.1			+			
Unidentified eggs		4.2	2.0			3.0	5.0			1.0		228.0
Fish larvae												0.1
Microalgae	++	+	+++	++	+	+			+	+++	+++	+
Plant detritus				++	+						+++	
Sand and silt					++	+			+	+		+++

Liza saliens (Tables V and VI) — There is a considerable size dispersion in the fry of the spring samples; the smaller ones (SL < 30 mm) feed on zooplankton (Cirripedia nauplii, neritic Copepoda, Polychaeta larvae), small Amphipoda and adult insects; those with a SL > 30 mm feed preferentially on benthic elements (Nematoda, Polychaeta and algae), but also on insects and zooplankton, particularly nauplii of Copepoda and of Cirripedia. In the July—August samples the preferential food of the smaller-sized fry are nauplii of Copepoda and of Cirripedia, copepodites of Harpacticoida, Decapoda larvae and adult insects. The stomachs of the fry over 50 mm in SL contain silt and sand, Diatoms and filamentous algae, Nematoda and Polychaeta, Bivalvia larvae, and again, nauplii of Copepoda and of Cirripedia. The juveniles caught from September to December, with a SL range from 11 to 42 mm, are carnivorous, feeding mainly on planktonic organisms (Cirripedia nauplii, marine Calanoida and Cyclopoida, Polychaeta larvae and Gastropoda veligers). In some samples, however, there is also a high abundance of Nematoda, Amphipoda and benthic Harpacticoida.

A comparison between dietary composition of the different fry species and prey organism distribution was made for the main zooplankton groups. No calculation, however, was made of prey preferential indices as the samplings of fish fry and zooplankton were not effected on the same dates. Table VII shows the species of planktonic Copepoda and Cladocera found in the stomach contents and those present in the zooplankton samples collected in 1978 (Colombo et al., 1979b). The diet of the fish fry contains a few freshwater and marine species which do not appear among the plankton in the embayment; the species most frequently found are however the dominant ones (*Acartia clausi, Paracalanus parvus, Euterpina acutifrons*) in the zooplankton. On the contrary, fish fry show a selective feeding behaviour towards different meroplankton groups; larvae of Cirripedia and of Polychaeta are rather abundant in their diet, while other groups, such as Bivalvia and Gastropoda larvae, which make up an important component of the embayment zooplankton, are generally fairly scarce. Moreover, the data of Table VII show an interesting connection between distribution of grey mullet species in relation to salinity (Rossi, 1980) and composition of stomach contents. Freshwater zooplankton are more frequent in the stomach contents of *L. ramada*, which is the species best adapted to low salinities.

DISCUSSION

The results of the research on the feeding habits of fish fry caught during 1978 confirm substantially the indications of the previous year's preliminary research. It would appear advantageous to integrate, in the study of the dietary composition, methods of analysis based on frequency indices (which are commonly used in the study of natural feeding of fish) and methods based on an estimate of abundance of every single food item.

The feeding habits of the fish fry of the five species show no great difference

TABLE VII

Frequency (f) of planktonic Cladocera and Copepoda occurring in the samples of stomach contents of fish fry in 1978[1]

No. of samples			*S. auratus* 11	*D. labrax* 8	*L. ramada* 12	*L. aurata* 9	*L.saliens* 14
CLADOCERA							
d	*Daphnia* sp.				*		
d	*Bosmina* sp.				*		
d	*Chydorus sphaericus*	z			*		
m	*Podon polyphemoides*	z	*		*	**	*
COPEPODA							
d	*Eudiaptomus* sp.				*		
d	*Eucyclops* sp.				**		
d	*Cyclops* sp.			*			
d	*Acanthocyclops* sp.	z	*		**		*
d	*Diacyclops bicuspidatus*		*				
d	Unidentified Cyclopidae	z	**			*	*
m	*Calanus tenuicornis*				**	*	
m	*Paracalanus parvus*	z	*	*	*	*	***
m	*Pseudocalanus elongatus*		*				
m	*Temora longicornis*	z	***			*	**
m	*Centropages* sp.	z		*	*		
m	*Acartia clausi*	z	***	***	***	***	***
m	*Oithona nana*	z					*
m	*Oithona* sp.	z					*
m	*Oncaea* sp.	z					***
m	*Corycaeus* sp.						*
m	*Euterpina acutifrons*	z					***
m	*Microsetella* sp.	z					*

*$f < 0.15$; **$0.15 < f < 0.25$; ***$f > 0.25$

[1] z marks the species that appear in the zooplankton samples (d : freshwater, m: marine species)

in the smaller sized stages (SL < 30 mm); they have a carnivorous diet, based mainly on zooplankton and to a lesser extent on benthic or phytal organisms such as Harpacticoida and Amphipoda. As size increases, food preferences clearly differentiate. Sea bass feed on macroplankton; gilthead on macrobenthos and macrophytes; grey mullets turn to a mixed diet which still includes zooplankton but tends to be based on both plant (microalgae) and animal elements of the bottom communities.

The degree of stomach fullness was on the average rather high, probably owing to the great supply of food in the embayment. The emptiness coefficient was decidedly low in the fry of all the species in the two years of research, with the exception of *L. saliens* in 1978.

It has been possible to make a comparison between composition of stomach contents and composition of prey organism communities for zooplankton only. A study on taxonomy and distribution of phytoplankton and phytobenthos in the embayment has not yet been carried out. As regards benthic crustaceans, the results of research effected in 1976 can be considered

(Colombo et al., 1979b). The species of Amphipoda most frequently found in the stomach of the different fry species are *Gammarus aequicauda*, *Gammarus insensibilis*, *Corophium insidiosum* and *Melita palmata*, which are the most abundant species in the embayment (V. Malaroda, personal communication, 1979). The species of benthic Harpacticoida which appear most frequently in the diet of fish fry are *Canuella perplexa*, *Ameira parvula* and *Harpacticus* aff. *flexus*: the two former are the most abundant in the Harpacticoida taxocoenosis of meiobenthos (Ceccherelli and Cevidalli, 1981).

For grey mullets, it is possible to compare the results of this research with those of research on the juvenile stages of the same or congeneric species in other coastal and estuarine environments. Considerable differences emerge, for instance, in comparison to results of the research by Albertini-Berhaut (1973) on the feeding habits of young *L. ramada*, *L. aurata* and *L. saliens* in the Gulf of Marseilles. Benthic crustaceans, Harpacticoida in particular, prevail in the diet of these fry up to SL of 50 mm, while the food of juveniles of larger size consists mainly of benthic Diatoms. According to Albertini-Berhaut (1974) the transition phase from a carnivorous to an herbivorous diet begins at a SL of 20 mm. In the Scardovari embayment the transition to an herbivorous diet occurs after a SL of 30 mm has been reached; furthermore, only a few young grey mullets with a SL of more than 50 mm show an exclusively herbivorous diet, as they feed mostly on zoobenthos and even zooplankton in addition to benthic algae associated with sand and silt.

Several authors (Suzuki, 1965; Odum, 1970; Zismann et al., 1975; Chan and Chua, 1979) emphasized the importance of zooplankton in the natural feeding of young grey mullets up to a SL of 20—30 mm. In fact, in the Scardovari embayment, zooplankton organisms are the preferential prey for the smaller sized fry; however, zooplankton remain a not negligible prey of larger sized fry which are turning to a diet based on benthic elements.

Another important component of the diet of young grey mullets is adult insects; they probably represent a source of allochthonous food, from surrounding terrestrial environment, and were found in the stomachs of fry belonging to all the examined size classes. Albertini-Berhaut (1973) also reported the presence of adult insects, mostly as an accidental prey, in the stomach contents of *L. ramada*, *L. aurata* and *L. saliens* in the Gulf of Marseilles.

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