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ELECTIVITY AND FOOD RATIONS OF THE FRY OF MILK FISH *CHANOS CHANOS* (FORSKAL) UNDER LABORATORY CONDITIONS

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ABSTRACT

The fry of milk fish *Chanos chanos* (Forskal), measuring 11-15 mm (13.5 mm mean length) obtained from the creeks and canals of Puthuvype area in the Vypeen Island have been used to study the electivity and food rations under laboratory conditions using rotifers, copepods, copepodites, copepod nauplii and *Artemia* nauplii as feed. The observations at 24 hour intervals lasted for 7 days in one set and 14 days in another set of experiments in different containers with 10‰ salinity. The survival rate was 100% during the period of observation.

The index of electivity varied between —0.7839 to +0.0575 for roitifers, —0.0034 to +0.4598 for copepod nauplii and —1.0 to +0.0509 for copepodites and copepods, showing first preference towards copepod nauplii and then to rotifers and copepodites and copepods. The quantitative relations between food concentration and rate of feeding have been discussed.

INTRODUCTION

FOOD AND FEEDING is an important factor in the early life history and the survival of fry depends on the availability of the right kind of food.

Three methods have been employed to study the feeding of larval fishes. In the first method, as followed by Lebour (1918, 1919 a, b), Sarojini (1954), Berner (1959) and Covill (1959), the fish larvae are collected from the natural waters and the food organisms present in their guts are studied. In the second method, as followed by Marshall *et al.* (1937), Yokota *et al.* (1961) and Blaxter (1965), the fish larvae and the plankton are collected from the natural waters and the gut contents are compared to the availability of plankters in the natural waters so as to determine the selective feeding. In the third method, as followed by Blaxter (1968), Rosenthal (1969) and Ghosh and Das (1972) the fish larvae are reared and provided with different food organisms and the gut contents are compared with the food organisms present in the tank or by counting the left over food organisms and thereby determining the food consumption and the type of food.

The rearing of the fry and fingerlings of milkfish *Chanos chanos* (Forskal), using zooplankters has been discussed by Alikunhi *et al.* (1976); Chaudhuri *el al.* (1978); Ranoemihardjo *et al.* (1975); Yamasaki and Canto (1978) and Yamasaki (1977). However, there is a lack of information on the electivity and food rations of milkfish fry following the principles of Parsons and Le Brasseur (1970) and Sushchenya (1970).

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Material and Methods

The milkfish fry, used in this experiment were collected from the creeks and canals of Puthuvype area in the Vypeen Island, in waters with 9‰ salinity. The body length ranged from 11 to 15 mm with a mean of 13.5 mm. The mean weight was 7.04 mg.

The milkfish fry were kept for 24 hours in zooplankton enriched water with 10‰ salinity, before distributing to different experimental containers. A combination of rotifers *Brachionus urceolaris* and copepods, copepodites and copepod nauplii of *Pseudodiaptomus annandalei* were made in different proportions and kept in quadruplicate in 1 litre beakers with 3 milkfish fry in each for preliminary screening and in duplicate in 3′ dia pools with 100 litre of 10‰ water with 100 milkfish fry in each for field studies. The rotifers and copepods were obtained from different mass culture tanks maintained under controlled conditions. The total food organisms varied between 35,000 to 89,000 per litre, with rotifers ranging from 5,000 to 60,000 per litre, copepod nauplii 3,500 to 59,000 per litre and copepods and copepodites 500 to 38,000 per litre in one litre containers and in the 3′ dia pools.

Artemia nauplii were fed in the proportion 200, 400, 800 and 1,000 in the 1 litre beakers and 200 per litre and 1,000 per litre in the 3' dia. pools. *Artemia nauplii* were not mixed with rotifers and copepods, copepodites and copepod nauplii. The *Artemia* nauplii were used to understand the growth rate between the fry fed with rotifer and copepod combination and *Artemia* nauplii. Counts were made for every 24 hours and fresh nauplii were introduced to make up the original number. Controls were kept and observed every 24 hours. The experiments were of 7 days duration in 1 litre beakers and 14 days in 3′ dia pools with 100 l water.

To study the electivity, the formula as proposed by Ivlev (1961) and discussed by Parsons and Le Brasseur (1970) has been used.

$$\text{Electivity index (E)} = \frac{ri - pi}{ri + pi}$$

where 'ri' is a relative count of different organisms consumed and 'pi' is a relative count of different organisms present in the surrounding water.

The relation between food ration (consumption) and food concentration has been studied by using the formula as proposed by Sushchenya (1972). At high food concentration R=Rmx. Rmx=the asymptotic relation between ration and food concentration as ration tends to its maximum.

Relation between rations value (R) and food concentration (K) has been calculated using the formula :

$$R = Rmx\,(1\text{-}10^{-pk})$$

where 'p' is estimated by least squares.

That is

$$p = \frac{1}{n} \sum_{I=1}^{n} \frac{\log Rmx - \log (Rmx\text{-}Ri)}{Ki}$$

Results

Electivity

The electivity index are presented in Table 1 for the experiments conducted in one litre containers and in Table 2 for experiments conducted in 3′ dia pools. The electivity index varied between —0.7839 to +0.0575 for rotifers (size 153 to 272 μ); —0.0051 to + 0.4598 for copepod nauplii (size 119 to 225 μ) and —1.0 to +0.0509 for copepods and copepodites (size 510 to 1190 μ). For rotifers,

TABLE 1

Expt. No.		Rotifers			Copepod nauplii			Copepods and copepodites		
		Relative concentration		Electivity Index Number	Relative concentration		Electivity Index Number	Relative concentration		Electivity Index Number
		% in Water	% Consumption		% in Water	% Consumption		% in Water	% Consumption	
I	A.	60.76	47.06	—0.1271	36.71	50.94	0.1623	2.53	2.00	—0.1169
	B.	66.67	21.05	—0.5201	27.27	73.69	0.4598	6.06	5.26	—0.0706
	C.	55.0	6.66	—0.7839	20.00	85.00	0.4285	25.00	8.34	—0.4997
	D.	40.0	8.00	—0.6666	30.00	78.00	0.4444	30.00	14.0	—0.3636
II	A.	76.71	76.92	0.0014	17.81	19.99	0.0577	5.48	3.08	—0.2804
	B.	85.11	88.41	0.0191	8.51	11.59	0.3049	6.38	0	—1.0
	C.	84.0	85.11	0.0066	14.0	14.89	0.0308	2.0	0	—1.0
	D.	77.77	81.35	0.0224	20.83	18.65	—0.0552	1.39	0	—1.0
III	A.	77.46	67.75	—0.0669	20.46	31.01	0.2090	2.08	1.24	—0.0669
	B.	80.32	77.49	—0.0052	17.46	20.77	0.0866	2.22	1.74	—0.1244
	C.	77.74	77.74	0	20.19	20.19	0	2.07	2.07	0
	D.	79.67	76.45	—0.0206	18.50	23.55	0.1201	1.83	0	—1.0
IV	A.	49.16	48.76	—0.0041	49.16	59.12	0.0096	1.68	1.12	—0.2
	B.	36.10	34.62	—0.0209	62.62	65.38	0.0220	1.28	0	—1.0
	C.	24.85	24.84	—0.0002	74.53	74.54	0.0001	0.62	0.62	0
	D.	37.81	37.81	—	59.70	59.70	0	2.49	2.49	0
V	A.	21.85	20.63	—0.0288	74.81	75.80	0.006	3.34	3.57	0.0333
	B.	22.2	25.00	0.0563	33.0	63.0	0.3125	44.8	12.00	—0.5774
	C.	32.5	33.5	0.0151	30.0	52.0	0.2682	37.5	14.5	—0.4423
	D.	36.8	38.2	0.0186	28.9	50.6	0.2729	34.3	11.26	—0.5076
VI	A.	65.15	68.97	0.0291	32.57	30.01	—0.0409	2.28	1.02	—0.3818
	B.	65.15	70.89	0.0422	32.57	28.72	—0.0628	2.28	0.39	—0.7078
	C.	65.15	66.51	0.0103	32.57	31.16	—0.0221	2.28	2.33	—0.0108
	D.	65.15	69.93	0.0353	32.57	29.95	—0.0419	2.28	0.12	—0.9
VII	A.	32.32	32.31	0.0058	64.63	64.08	—0.0043	3.65	3.21	0.0256
	B.	32.0	34.36	0.0356	63.23	61.22	—0.0160	4.77	4.42	—0.0350
	C.	31.86	31.86	0	66.23	66.23	0	1.91	1.91	0
	D.	33.68	33.68	0	65.26	65.26	0	1.06	1.06	0

TABLE 2

Expt. No.		Rotifers			Copepod nauplii			Copepods and copepodites		
		Relative concentration		Electivity Index Number	Relative concentration		Electivity Index Number	Relative concentration		Electivity Index Number
		% in Water	% Consumption		% in Water	% Consumption		% in Water	% Consumption	
I	A.	74.61	75.10	0.0033	17.63	16.72	—0.0265	7.76	8.18	0.0263
	B.	65.52	65.44	—0.0006	17.24	18.43	0.0334	17.24	16.13	—0.0333
II	A.	70.39	71.29	0.0064	27.39	26.89	—0.0109	2.22	1.91	—0.0751
	B.	38.09	33.19	—0.0696	59.25	66.26	0.0559	2.66	0.61	—0.6269
III	A.	65.47	65.87	0.0030	33.82	34.13	0.0046	0.71	0	0
	B.	28.12	27.36	0.0137	68.79	69.09	0.0022	3.09	3.55	0 0503
IV	A.	62.85	66.98	0.0518	33.89	29.41	—0.0708	3.26	3.61	0.0509
	B.	30.68	32.36	0.0219	67.91	66.15	0.0131	1.41	1.49	0.0311
V	A.	67.09	73.51	0.0457	29.42	24.57	—0.0898	3.49	1.92	—0.2902
	B.	63.31	63.03	—0.0022	31.45	34.13	0.0409	5.24	2.84	—0.2985
VI	A.	51.72	51.79	0.0007	44.83	46.43	0.0175	3.45	1.78	—0.3193
	B.	40.58	42.42	0.0222	57.97	57.58	—0.0034	1.45	0	—1.0
VII	A.	51.61	50.00	—0.0158	45.16	48.28	0.0334	3.23	1.72	—0.3051
	B.	41.67	44.44	0.0322	57.29	55.56	—0.0153	1.04	0	—1.0
VIII	A.	52.63	51.85	—0.0075	45.61	48.15	0.0271	1.76	0	—1.0
	B.	46.15	45.63	0.0052	51.28	51.81	0.0051	2.57	1.56	—0.2446
IX	A.	90.09	89.57	—0.0029	9.01	9.48	0.0254	0.90	0.95	0.0270
	B.	91.56	90.51	—0.0057	7.75	8.81	0.0640	0.59	0.68	0.0708
X	A.	17.39	19.25	0.0508	73.91	76.47	0.0170	8.60	4.28	—0.3405
	B.	17.39	19.51	0.0575	73.91	78.95	0.0272	8.70	2.42	—0.5619
XI	A.	55.06	51.77	—0.0307	29.56	32.63	0.0494	15.38	15.60	0.0071
	B.	46.51	44.61	—0.0208	41.86	46.81	0.0558	11.63	8.58	—0.1509
XII	A.	74.01	73.21	—0.0054	25.82	26.61	0.0151	0.17	0.18	0.0285
	B.	72.88	72.88	0	25.42	25.42	0	1.70	1.70	0
XIII	A.	49.50	48.15	—0.0138	49.51	50.83	0.0132	0.99	1.02	0.0149
	B.	46.51	47.62	0.0118	51.16	50.00	—0.0115	2.33	2.38	0.0106

though there is a slight shift of values from negative to positive during the course of experiment, there is not much shift observed in the values obtained from 3' dia pools. More positive values obtained for copepod nauplii indicate the preference for these organisms. Electrivity index values were more negative for copepodites and copepods.

Ration

There is a relation between rations value and food concentration (Fig. 1). As the food concentration increased, there was a progressive drop of consumption resulting in an asymptotic relation between ration and food concentration (Fig. 1). The maximum ration of 18,000 prey/fish/day was obtained for rotifers

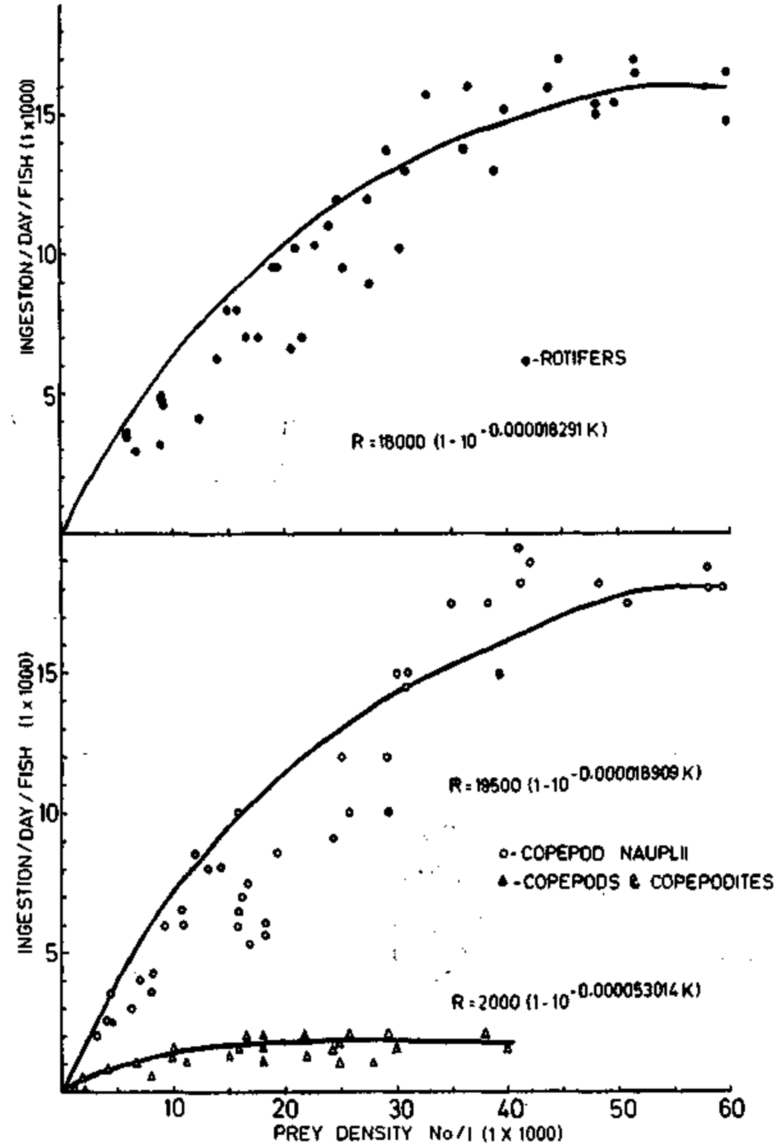

Fig. 1. Relation between rations value and food concentration.

when the prey concentration was around 40,000 per litre, the ration tend to decrease above this prey density.

The ration maximum (Rmx) reached 19,500 for copepod nauplii when the prey concentration was around 42,000 per litre. However, the ration reduced to about 18,000 copepod nauplii/fish/day above this prey density. The ration values for copepods and copepodites were low compared to rotifers and copeod nauplii and also showed high negative electivity index. Even at 40,000 per litre prey density, the ration maximum (Rmx) was only around 2,000 copepod and copepodites/fish/day. The Rmx reached at about 23,000 per litre prey density and then onwards the curve is almost parallel to the axis.

Growth rate

Data on the body length and weight of milkfish fry has been summarised in Table 3. During the experiment, the maximum mean growth rate of 0.8928 mm/day has been achieved for the fry fed with 61092.2 prey density rotifer and copepod combination. There is an increase of growth rate with the increase of prey density as it is shown in experiment A (conducted in one litre beakers) and B (conducted in 3' dia. pools). The maximum increase in weight was 7.4143 mg per day for the fry in the container with 61,092.2 prey density of rotifers and copepod combination. However, not much change in the growth rate (0.8214 mm/day or 6.6571 mg/day) was observed in the fry fed with 72353.8 prey density of the above combination.

In the experiments fed with *Artemia* nauplii the growth rate was less compared to fry fed with rotifer and copepod combination. The maximum growth rate of 0.7743 mm/day (weight 7.1429 mg per day) was achieved for the fry in the container with 1,000 per litre *Artemia* nauplii. This is next to the growth rate of 0.8928 mm per day (weight 7.4143 mg per day) for the fry fed with 61.092.2 per litre of rotifer and copepod combination.

Discussion

Schuster (1960) observed that the 13 to 18 mm larvae of milkfish feed on epiphytic planktonic organisms, the principal share of food organisms being diatoms. Chacko (1949) investigated the young stages of estuarine fishes in the waters of Madras and opined that *Chanos chanos* are almost entirely plankton feeders. Utilization of zooplankters as feed for *Chanos* fry has already been evidenced by Alikunhi *et al.* (1975), Chaudhuri *et al.* (1978) and Yamasaki and Canto Jr. (1978).

During the present investigation an attempt has been made to understand the selection and utilization of zooplankters, such as rotifers and copepods, as food by the milkfish fry. The electivity index shows that the fry prefers copepod nauplii to rotifers or in par with it. This may be related to the prey size of rotifers (153 to 272 μ) and copepod nauplii (119 to 225 μ). This may also be related to the observation by Detwyler and Houde (1970) that for both clupeid and engraulid larvae the limiting factor for food size is the gape of the jaw, not the length of the gut. The copepods and copepodites being larger in size, the *Chanos* fry showed more negative index values. The motility of the food organism must also be considered, wherein copepod nauplii are less motile than copepodites and adult copepods. Liao *et al.* (1971) opined that the quality, size, density and mobility of the food are the important factors for developing larval rearing techniques.

An attempt has also been made to understand the food ration of *Chanos* fry. Parsons and Le Brasseur (1970) opined that the quantity grazed by a predator, indicate that the quantity of food consumed is concentration dependent and can be best explained by a relationship

TABLE 3

Expt. No.	Group diet	Food density/ 1/day	Initial length mm		Final length mm		Mean growth		Mean initial weight	Mean final weight (mg)	Weight fish gained (mg)	
			Range	Mean	Range	Mean	7 days	Per day			7 days	per day
A 1	Rotifers copepod nauplii copepods— & copepodite ..	72,353.8	12-15	13.25	18-20	19.0	5.75	0.8214	8.4	55.0	46.6	6.6571
2	Do. ..	61,092.2	12-15	13.25	19-20	19.5	6.25	0.8928	8.4	60.3	51.9	7.4143
3	Do. ..	38,957.14	11-13	12.00	16-18	17.0	5.0	0.7143	6.2	41.0	34.8	4.9714
4	Do. ..	46,192.8	12-15	13.25	18-20	19.0	5.75	0.8214	8.5	55.4	46.9	6.7
5	Artemia nauplii ..	200	11-14	12.50	16-18	17.33	4.83	0.69	6.4	39.9	33.5	4.7857
6	Do. ..	400	11-14	12.85	17-18	17.33	5.08	0.7257	6.4	39.9	36.5	5.2143
7	Do. ..	800	12-15	13.25	17-20	18.60	5.35	0.7643	8.3	56.1	47.8	6.8285
8	Do. ..	1,000	11-14	12.25	17-18	17.67	5.42	0.7743	6.5	56.5	50.0	7.1429
											14 days	
B 1	Rotifers copepod nauplii copepods— & copepodites ..	37,706.2	11-13	12.00	19.26	22.06	10.06	0.7738	6.25	79.4	73.15	5.6269
2	Do. ..	21,442.3	11-14	12.25	17-26	20.466	8.216	0.632	6.50	67.4	60.9	4.6846
3	Artemia nauplii ..	200	11-13	12.00	16-19	17.733	5.733	0.441	6.25	40.3	34.05	2.6192
4	Do. ..	1,000	11-13	12.50	19-28	21.466	8.966	0.6896	6.50	73.1	66.6	5.1231

similar to that proposed by Ivlev (1945) for planktivorous fish. In considering this problem for fishes Ivlev (1955) found that as food concentration increased, the increased ration was less than expected, suggesting a progressive drop in grazing efficiency, this was confirmed during the present investigation. The maximum ration was 18,000 rotifers per day per fry; 19,500 copepod nauplii per day per fry and 2,000 copepods and copepodites per day per fry, when the prey density was at or above 40,000 per litre.

Ghosh and Das (1972) observed that mullet fry (*Mugil parsia* Hamilton) of 12-20 mm size groups conssumed upto 17,500 rotifers within 24 hours. Theilacker and McMaster (1971) observed that best growth rates for larval anchovy *Engraulis mordax* were obtained in the high food density experiments, when 10-20 rotifers per ml were fed. It is observed that a high food denisty should be maintained for the fish larvae feeding on rotifers. During the present investigation the maximum ration of 18,000 rotifers per day per fish and 19,500 copepod nauplii per day per fish are comparable to the values obtained by Ghosh and Das (1972) for *Mugil parsia* (12 to 20 mm size). The increased ration may also be related to the high prey density provided in the experimental containers compared to the prey density available in the natural environment. The maximum ration of only 2,000 copepodites and copepods may be related to the large size and motility of the food organism, which results in negative electivity.

The growth rate indicates that there is no significant difference between the fry fed with rotifer and copepods and *Artemia* nauplii. Maximum growth rate of 0.8928 mm per day was obtained for fiy fed with rotifer and copepod combination and 0.7743 mm per day obtained for the fry fed with *Artemia* nauplii. However, the prey concentration of *Artemia* was considerably lower than that of the rotifer and copepod combination.

Yamasaki and Canto Jr. (1978) observed that no significant difference of growth of *Chanos* fry was found between fishes fed with *Tisbe* and *Artemia*. Further they opined that harpacticoid copepod *Tisbe* sp., shows potential as a substitute to the more expensive *Artemia* or to *Brachionus* which is used as food for finfish and crustaceans secondary to *Artemia*.

Raleanal *et al.* (1952) stocked 12.9 mm (5 mg) fry in fish pond nurseries and obtained 52.4 mm (1.42 gms) in 8 weeks. Alikunhi *et al.* (1975) stocked 11 to 14 mm *Chanos* fry in manured pools for the production of rotifers and obtained 67 to 98% survival rate. Schuster (1952) obtained 122 mm (30 gms) growth from 13 mm (0.01 gm) fry within 8 weeks in brackishwater ponds of Java. The maximum growth rate observed (Schuster, 1960) in nursery ponds was 1.9464 mm per day for *Chanos* fry, whereas in the present investigation it was 0.8928 mm per day for the fiy fed with rotifer and copepod combination at 61092.2 per litre prey density. The stage of fish larvae and the ecosystem existing in the culture tank also should be considered for evaluating the growth rate.

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