ON THE FOOD OF *CHANOS CHANOS* (FORSKÅL)

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Introduction

During the last few years several observations have been reported, particularly from the East Asian countries, regarding the food of the milkfish and most of the existing information is reviewed in a paper by Schuster (1949). Abstracts of other publications on this subject are also available in the bibliography on *Chanos* culture prepared by him (1952 *b*). Excepting for Sunier (1922) in Java and Chacko (1945 and 1949) in India, observations by others seem to have been based mostly on fish reared in saltwater ponds for commercial purposes. The absence of the fish in appreciable numbers in commercial catches from the sea in any part of the coast where the fish is known to occur, unfortunately, is a barrier hindering our progress towards the elucidation of many important aspects in the life of the fish and leaves several problems inadequately solved. Thus, in understanding the food and feeding habits or for determining the age, maturity and spawning behaviour, we have necessarily to depend on the occasional specimens caught during fishing operations intended for other species. Recently, after consistent efforts, it has been possible to obtain a few adult fish around Mandapam through the co-operation of the local fishermen. The examination of the stomach contents of these fish revealed certain interesting features and these, together with previous data collected by the author, are presented here, mainly to supplement our existing information on the food of the fish from their natural habitat, as these may be of some importance to fish culturists of the Indo-Pacific region.

No definite conclusions are drawn beyond indicating some possibilities. Similarly, any reference to quantitative estimation is avoided because such estimations based on a very small number of specimens that could be examined, particularly among the juveniles and adults, have their own limitations.

The observations have been dealt with under three sub-headings based on the size and sexual maturity of the fish: food of (*i*) fry and fingerlings, which include all sizes from the 14 mm. fry to fish of about 100 mm. in total length, (*ii*) juveniles, embracing a rather wide range of size from 100 mm. to sexually immature ones, and (*iii*) adult fish, referring to those

which had attained sexual maturity as judged from the nature of the gonads. This simplified and very arbitrary grouping has been adopted here on account of the fact that the interest in this paper is centred mainly around the food of the adult fish, to which the discussion is limited, and the observations on the earlier sizes are given only to make the account complete.

The author's thanks are due to Dr. N. K. Panikkar for his encouragement in this field of investigation, to Dr. (Mrs.) F. Thivy for identifying most of the algal matter in the stomach contents of the fish, and to Dr. S. V. Job and Shri C. M. Menon for reading through the manuscript and giving several suggestions which have improved the format of the paper.

OBSERVATIONS

Food of fry and fingerlings.—The fry and fingerlings collected along the coastal areas from the tidal creeks and mud flats during the period March to June, which happens to be the principal season of their occurrence, were examined for their stomach contents. It was found that their stomachs contained mostly diatoms, bits of blue-green algæ, detritus and occasionally forms such as nematodes and remains of crustacean larvæ. *Chroococcus* sp. was by far the most common item in the stomach of the smaller fry, while greater amount of algal filaments were seen in the case of the fingerlings. Many of the diatoms and algæ were of the type commonly occurring at the bottom of these swampy areas where the water is often only a few inches deep. A list of the more important genera of diatoms and other major constituents found in the stomach is given below.

Chroococcus,	*Amphora*,
Pleurosigma,	*Phormidium*,
Diploneis,	Nematodes,
Planktoniella,	Appendages of crustacean larvæ,
Navicula,	Detritus.

Comparison with the observations of previous workers reveals general agreement with the present report. In ponds too, the fry and fingerlings are known to subsist on the same diet. Hiatt (1944) found diatoms, blue-green algæ, filamentous algæ, debris and animal forms such as nematodes and crustacean ova in the stomach of the fish of 55 to 115 mm. grown in ponds. Similar results were obtained by Schuster (1952 *a*) and others in the case of fry and fingerlings reared in brackishwater fish farms in Java. The elaborate preparation of *Chanos* nurseries (Rabanal, 1949; Rabanal, *et al.*, 1951) are obviously based on such extended observations.

Food of juveniles.—As pointed out in the introduction, a rather wide range of individuals below the maturing size are included in this category.

Here again fish culturists are unanimous in the general view that the food of the young fish consists of a greater proportion of algæ and less of diatoms; at any rate, the chief element here also is plant material. The observations of the present author also largely contribute towards this view, particularly with regard to those below 500 mm. in length (Table, Nos. 26 to 32). The different items encountered in the stomach of individuals collected from the sea on various occasions were found to be the same as those recorded previously by other workers and do not warrant repetition. In general it may be said that there is a dominant occurrence of blue-green and green algæ and a relatively smaller proportion of diatoms. A few fish obtained from the Gulf of Mannar (length varying from 250 to 300 mm.) showed in their stomach mainly *Microcoleus, Phormidium, Lyngbia,* a considerable quantity of digested algal material and occasionally a few copepods. Diatoms were almost absent. Hiatt (1944) observed in the stomach of fish (116 to 402 mm. in length) reared in ponds some larvæ and ova of copepods, polychætes and ostracods in addition to plant material. Schuster (1949) found that fish with a body length of 150 to 300 mm. mainly fed on blue-green algæ and diatoms and those above 350 mm. were said to consume in addition, soft green algal trichomes and parts of higher plants. Animal forms in restricted numbers were also included among other food.

Results of observations on the food of fish larger than 300 mm. have been rather surprising. It may be seen from the table that in the case of specimens Nos. 1–3, 5–11 and 33, the stomach contained only a small quantity of white mass of mucoid substance. The alimentary canal which was almost collapsed in many of these specimens was apparently empty but for the white pasty mass in which no identifiable food material could be found. Very rarely, however, diatoms such as *Cyclotella, Cymbella,* and the dinoflagellate *Gymnodinium* were recognised in this white, semi-fluid matrix, although the significance of these in rare numbers cannot be adequately understood. The condition here appears to be similar to that described earlier by Sunier (1922, p. 215). In general the alimentary canal of these fish gave the impression that the fish had been starving for some days prior to their capture.

Juvenile fish in ponds are known to subsist on much the same type of food as the younger ones. The table (specimens 20 to 25) also gives the results of examination of a few fish reared in the brackishwater farms at

TABLE

Stomach contents of Chanos chanos[1]

No.	Date	Locality	T.L.[2] (mm.)	S.L.[3] (mm.)	Sex	Stomach contents
1	Aug. 15, 1950	Pamban, Gulf of Mannar	500	380	Sex indistinguishable	White semi-solid mass throughout the alimentary canal, with a few cells of *Cymbella, Cyclotella* and *Gymnodinium*
2	Dec. 7, 1950	Mandapam	550	435	Do.	Only mucoid material
3	,,		380	300		
4	Oct. 16, 1951	Pamban	1240	1000	Female	Neither plant nor animal matter except a *Rhizosolenia* frustule in a mass of white substance
5	Nov. 1, 1951	Pamban	500	..	Female	Trichomes of *Lyngbia* alone present in an otherwise empty alimentary canal
6	Dec. 19, 1951	Pamban	690	..	Female	No recognisable matter; only a small amount of white semi-solid substance
7	,,		670	..	Female	
8	Nov. 30, 1953	Mandapam	720	580	Female	Apparently empty and a little quantity of white unidentifiable mass present only in the intestinal region
9	Dec. 8, 1953	Mandapam	830	650	Female	
10	Jan. 8, 1954	Thonithurai	750	..	Male (?)	
11	Jan. 9, 1954	Thonithurai	690	575	Female	

12	Feb. 8, 1954	Pudumatom	1203	970	Female	The entire alimentary canal was gorged with lamellibranchs, gastropods, algal bits and detritus
13	Feb. 24, 1954	,,	1260	1000	Female	
14	March 5, 1954	,,	1140	880	Male	
15	,,	,,	1080	850	Male	
16	,,	,,	1105	870	Female	
17	March 7, 1954	,,	1250	1003	Female	
18	,,	,,	1210	990	Female	
19	March 20, 1954	,,	625	465	Sex not known	Apparently empty stomach and devoid of identifiable material
20	March 23, 1954	Narakkal fish farms	630	474	Female	Alimentary canal in all the specimens were filled with black loose mud from the bottom of the ponds which contained several species of diatoms, lamellibranch larvae, a few copepods and appendages of some crustacean larve
21	,,	,,	448	340	Sex not determined	
22	,,	,,	415	312		
23	,,	,,	382	290		
24	,,	,,	373	282		
25	,,	,,	613	465	Female	
26	Dec. 30, 1955	Mandapam	347	263	Sex indistinguishable	Filled with algal filaments, mainly of *Microcoleus* and *Phormidium*
27	,,	,,	330	255		
28	,,	,,	335	257		
29	,,	,,	342	263		
30	Jan. 1, 1956	,,	337	260		
31	,,	,,	375	295		
32	Jan. 3, 1956	,,	500	373	Female	
33	Jan. 15, 1956	Mandapam	990	814	Female	Empty alimentary canal and contained only white material as in Nos. 1–11

[1] Only those above 300 mm. in total length are given in the table.
[2] Total length: Length from the tip of the snout to the end of the dorsal lobe of the caudal fin.
[3] Standard length: From the tip of the snout to the end of the hypurals.

Narakkal (Kerala). In all these cases their alimentary canal contained mostly mud and decaying organic matter from the bottom of the pond and along with these were also found a variety of diatoms (not identified), *Phormidium* and *Microcoleus* filaments and a few lamellibranch larvæ.

Food of adult fish.—The following list gives the important constituents in the stomach contents of adult fish caught at Pudumatom (Long. 79° 09'; Lat. 9°16') (see also Table, specimens 12 to 18).

Plant material:	Animal forms:
Hypnea,	Spats of *Pteria*
Gracilaria,	(Lamellibranch),
Polysiphonia,	Small Gastropods,
Nitzschia,	Copepods,
Pleurosigma	Crustacean larvæ and eggs,
Grammatophora,	Spionid larvæ (Polychæte)
Diploneis,	Nematodes.
Higher plant material in partly digested state.	

A variety of lower plants which form the food of *Chanos* has been recorded by all previous workers. But in those few fish examined by the author the diatoms and such smaller forms constituted only a relatively lesser proportion compared to *Hypnea* and *Gracilaria* which were predominant among the algal forms while *Phormidium* and *Microcoleus* were almost absent in these. Undigested remains of higher plants were seen in most cases and a large amount of digested organic matter was also present.

The animal forms given in the list are of great interest, particularly the spats of the lamellibranch *Pteria*, large numbers of which were found in the stomach of all fish examined in 1954. Both in number and in bulk these lamellibranchs constituted by far the most dominant item comprising a single group. The stomach and intestines were fully gorged with this material unlike what was observed in the case of the immature ones described in the preceding section. Most of the animals within the muscular gizzard were entire while those in the lower regions of the alimentary canal had their shells crumpled and the animals were almost digested. The gastropods with their relatively harder shells seem to have passed through the stomach unaltered in form but only their empty shells were recovered from the small intestines. Besides lamellibranchs and gastropods, small numbers of cope-

pods, larval spionids, nematodes and a few crustacean appendages and eggs were also observed in certain instances.

Before discussing these observations, it may be relevant to make a passing reference to certain abnormal features observed in some *Chanos* reared in our continuous sea-water circulating aquaria. These fish, about 180 mm. in total length at the beginning, although gradually got accustomed to a routine diet consisting of bits of clams, polychætes or prawns, showed during the course of about four months (when they attained nearly 240 mm. in length) certain changes in appearance. An increase in the size of the head in relation to their lean body was apparent. Compared to the normal specimens of about the same size an enlargement of the eyes, formation of translucent raised occipital region, a slight growth of the upper lip over the lower, and a falcate curving of the tips of the caudal fin lobes were noticed. A somewhat similar change was also seen to take place in the case of fry reared under similar conditions of diet. In all these instances no plant material was supplied except perhaps the diatoms and detritus that went in with the unfiltered sea-water. It should also be mentioned that no such change was noticed in the case of another similar group of fry grown in a fresh-water tank and fed mainly with wheat flour. These observations are, however, without any controlled experiments and hence reasons for these peculiar growths cannot be explained. Artificial foods like dehydrated egg, powdered milk, alfalfa meal, etc. (Carbine, 1947) and soyabean meal and rice bran (Chen, 1950) have been widely used with satisfactory results in studying the growth of *Chanos* and no one has so far reported any abnormalities among fish reared under these conditions.

Discussion

The importance of a precise understanding of the food requirements of the fish at various stages in its growth for its successful culture need hardly be emphasised. Based on the observations by workers in the East Asian countries the assumption is made that *Chanos* is a selective feeder, and unless its specific diet is available it will not thrive (Le Mare, 1950). In *Chanos* culture there is often the difficulty of maintaining a satisfactory yield every year and the experience is that after a number of harvests the yield drops, probably owing to the inadequate food in the ponds.

There is always good agreement in the observations of workers in India and elsewhere as regards the food of the fry and fingerlings. Disagreement sometimes arises with regard to the food of juveniles and adults from the sea, although such observations have been only few. Summing

up the various observations on *Chanos* reared in salt-water ponds in Indonesia and Philippines, it may be said that the fish in these surroundings feed mainly on filaments of blue-green algæ and only soft or half-decayed parts of green algæ. Other plant materials are also consumed only when these are broken up into smaller bits and softened by decay. Some fish ponds in the Philippines are thus supplied with *Gracilaria* as a supplementary item of food for the growing fish (Abagon *et al.*, 1951).

Chacko (1945) after examining the stomach contents of over 300 fish concluded that the fish is a plankton feeder. Besides several diatoms and also *Trichodesmium* a variety of organisms such as appendicularians, copepods, fish eggs, fish larvæ, larval bivalves, larval gastropods, *Lucifer*, Mysids and species of *Spiratella* are listed by him. The information given by him (1945 and 1949) based on a wide range in size (from 4 to 43 inches in length) and the large number examined would have been of greater significance if the data had been critically analysed according to size in view of the possible changes in food habits of the fish accompanying the variation in its intestinal growth as suggested by Hiatt (1944). It may be incidentally mentioned that the blue-green algæ *Trichodesmium* was never seen at any time in the stomach of the fish examined by the present author. Among the few other workers who had recorded animal forms in the stomach of *Chanos* the observations of Sunier (1922) are significant. He had suggested the possibility that the stomach contents of fish caught in different biological environments can be of different composition and gave some instances where gammarids and a few salps were found in the stomach.

The lamellibranchs and gastropods observed at present in the stomach of *Chanos* are sedentary forms and their number in the stomach is too large to be ignored as casual or accidental inclusions. In all the adults caught from the same locality, although on different days, the constituents in the stomach contents were much the same. The thick-walled muscular gizzard in all of them was fully distended with such material while the intestines throughout contained the broken shells and other remains. The spats of the lamellibranch *Pteria* are known to occur in immense numbers along the coast of the Gulf of Mannar and cluster in millions on seaweeds and zoophytes. The author himself had come across large quantities of their shells washed ashore at certain places along with algal masses. The presence of these and similar material in the stomach of the fish denotes that the fish had resorted to browsing among the algæ growing near the bottom along the coastal regions where they were caught in the shore seines. From the morphology of the digestive system *Chanos* has been considered a coastal

species. Similarly it is believed from the small gape of the mouth and the absence of teeth that the fish is unable to bite off strong plant material or break up larger animal tissue. Still it appears that the fish is able to injest several medium-sized organisms as observed here and crush them in the highly muscular gizzard before they are passed down to the intestines. The presence of large quantities of loose mud from the bottom of the ponds along with other organisms in the case of fish reared in the Narakkal fish farms lends additional evidence to the fact that the fish feed near the bottom. Observations with fish kept in the aquarium tanks also support this view.

The long alimentary canal of the fish has been associated with a typically herbivorous habit. While the fact remains so, the present observations lead to suspect that the adult fish is not as much predominantly vegetarian as has been considered by many fish culturists. At least in their later stages of growth the fish appear to be capable of consuming and digesting a variety of animal matter along with plant material that are available in the surroundings.

Although Hiatt (1944) had observed that milkfish do not show any seasonal variation in the food consumed, possibility of any change in the feeding habits of the fish in their normal environments during spawning time was considered because all the adult fish caught in 1954 had nearly mature gonads. Out of the seven fish obtained where the stomach was full of lamellibranchs and other material, five were females and two were males (Table, specimens 12 to 18). The two females caught in February had their ovaries suggesting either a spent or a regenerating condition (Nos. 12 and 13). Three of the females obtained subsequently in March (16, 17 and 18) had enlarged yellowish ovaries almost filling the coelomic cavity and the eggs were nearly mature. The males also had their testes fully developed (Tampi, 1957). The occurrence of freshly spent fish in February and again in October may be explained by the fact that the fry appear along this coast usually during March to June and sometimes again in November (Panikkar *et al.*, 1952), and it may be likely that the fish would have approached the coastal areas for purposes of spawning. However, it is difficult to attribute a satisfactory explanation for the apparently empty alimentary canal seen in the case of those few fish caught along the coast.

The selective feeding nature of the fish as reported by previous workers is, to a great extent, a handicap in practical culture of the species. The problems involved in the management of fish farms and the role of algæ in *Chanos* culture are dealt with by Villadolid and Villaluz (1950) and also in

several other papers published from the Eastern countries. *Chanos* is often not reared in ponds to any large size because of the uneconomic nature of such growth from the commercial point of view and thus the fish are never known to breed in captivity. As Sunier (1922) had remarked, everywhere the largest fish seen in ponds are much smaller than the mature ones recorded from the sea. In all these cases, the gonads are mostly in the very early stage of development. If the fish are proved to feed indiscriminately on both plant and animal matter alike it may, perhaps, be possible to rear the fish to a much larger size in a shorter period than is known at present. Similarly by being able to rear the fish to a size at which the gonads start developing actively, it may obviate a serious obstacle in the progress of further experimental studies in inducing artificial spawning of the fish.

SUMMARY

Our existing knowledge of the food and feeding habits of the milkfish is reviewed in the light of some recent observations made by the author. The stomach contents reveal that the adult fish in the sea resort to a browsing mode of feeding and consume several animal forms besides algal matter. It appears that the fish, at least in its later stages, is not as much a selective feeder as is often considered. The practical implications of these observations in *Chanos* culture in marine fish farms are also indicated.

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