OBSERVATIONS ON THE NUTRITION OF *PANCHAX PANCHAX* (HAMILTON).[1]

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For evaluating the relative utility of the probable larvivorous fishes of India it is of paramount importance to study the various problems connected with their nutrition under natural conditions. A number of workers have by feeding experiments already successfully demonstrated the probable utility of some of the forms, but so far as we are aware very little field work has hitherto been done on the food of the indigenous small minnows. Sen's (1937) recent article on the food-factors of the so-called mosquito-destroying fishes of Bengal is, however, an exception. Though, as pointed out by one of us (Hora, 1937), Sen's technique is not up-to-date in several respects and his conclusions seem to be somewhat premature, all the same his is a pioneer contribution on the subject and deserves careful scrutiny.

A large number of observers have testified that usually no mosquito larvæ are found in pieces of water where *Panchax panchax* live. This coincidence has been explained on the assumption, strongly supported by laboratory experiments, that *Panchax* feed on mosquito larvæ and are thus very efficacious in the control of mosquitoes. Sen's studies on the natural food of *Panchax*, however, showed that

> 'Even in *Panchax* which is a carnivorous fish only about 10 per cent of the fish examined were found to feed on Anopheles larvæ in their habitat . . . . . The diet of *Panchax* is so varied that it seems to have no selective food-habit, and as such cannot be relied upon as a larvicidal fish. Whatever comes along in their way, whether of vegetable or animal origin, if it is not too big for them, is devoured by *Panchax* as in the case of the types of fish studied by Seal. The field observations seem to show that *Panchax* have greater attraction for small moving objects whatever they may be. The employment of fish which are not known to show a definite preference for Anopheline larvæ cannot therefore prove a success in controlling malaria in Lower Bengal.'

From the analysis of the stomach contents of *P. panchax* published by Sen his conclusions would appear to be justified, but he seems to have ignored the fact that no mosquito larvæ have usually been found in the pieces of water inhabited by this fish. We have recently confirmed this observation by surveying a large number of pools, ponds, tanks and drains in the Ballygunge, Tollygunge, Howrah and Pulta Waterworks areas. Though mosquito larvæ were

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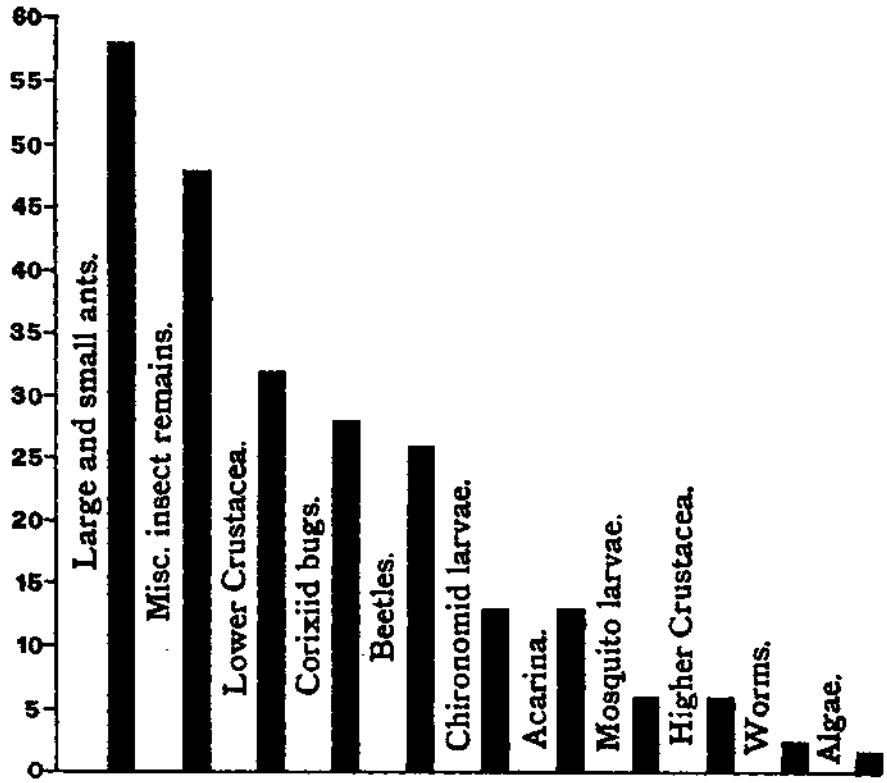
found in abundance in the puddles at the edges of the collections of water beyond the reach of the fish, the main water areas, which contained fish, were invariably free of mosquito larvæ. The contents of the whole of the alimentary canal of a large number of individuals from various localities were examined and it was found that in the case of only about 6 per cent of the specimens examined mosquito larvæ had been eaten and even then with the exception of one individual the number of larvæ did not exceed 3 in any one specimen ; this is certainly



TEXT-FIG. 1.—Graphic representation of percentages of *Panchax panchax* alimentary canals containing different kinds of organisms.

Lower Crustacea were mostly Ostracods and higher Crustacea comprised small crabs and shrimps. Under miscellaneous insects are included all undeterminable remains of Arthropods.

a negligible quantity in a voracious fish like *Panchax*. The food of the fish was found to consist mainly of a variety of insects, such as ants, Corixiid bugs, water beetles and their larvæ, Chironomid larvæ, etc., small Crustaceans, such as Ostracods, Copepods, young crabs and shrimps, water mites, worms, etc. Small quantities of algæ were found in the stomach contents of two specimens collected from a large tank by the side of the Golf Club, Tollygunge.

Some variations were found in the nature of the food of specimens collected at different times of the day and also of those collected from different localities, but sufficient data are not yet available for discussing these points.

So far our results are more or less in agreement with those of Sen, but the question naturally arises, had there been mosquito larvæ in the habitats of *Panchax* would they have shown any preference for them ? We have attempted to answer this question in two ways, firstly by introducing this fish in pits in which mosquito larvæ were breeding and observing their food from day to day and secondly by providing the fish with a mixed menu in the laboratory and studying at intervals of 30 minutes the food consumed by the fish.

Field Experiments.

Two valve chambers at the Pulta Pumping Station, designated **A** and **B** in the following notes, were selected for the purpose of the first experiment. Both the chambers had collections of water about 2 feet deep and were overgrown with rank vegetation, both under water and along the *pucca* walls. Chamber **A**, which is situated near the old Engine Room, is a circular pit approximately 9½ feet in diameter and is about 7 feet deep. Chamber **B** is a rectangular pit approximately 12 feet by 9½ feet and about 10 feet deep ; it is situated near the new Engine Room. Before starting the experiment mosquito larvæ were found in fair quantities in both the chambers—in chamber **A** there were approximately 4 larvæ in a cupped handful of water all over the surface, while in chamber **B** their number was 5 in the same quantity of water.[1]

On the evening of the 29th June, 1937, at about 4-30 P.M. 18 specimens of *P. panchax* were introduced in chamber **A** and 19 in chamber **B**. By 6 A.M. next morning the density of mosquito larvæ was reduced to 3 per measure in chamber **A**. Three specimens were taken from this chamber and the contents of their alimentary canals were examined. From their stomachs 6 mosquito larvæ and 1 Chironomid larva were recovered, whereas from their intestines 17 mosquito larvæ and 2 adult mosquitoes were taken out in a semi-digested condition. The three specimens, one female and two males, ranged in total length from 46 to 49 mm.

In chamber **B**, at 6-30 A.M. on the 30th June, 1937, the density of mosquito larvæ population was 4 per measure and the contents of the alimentary canal of 3 specimens dissected were as follows : Eight mosquito larvæ in stomachs and 6 mosquito larvæ, 3 adult mosquitoes, 1 fly and 1 beetle, all in a semi-digested condition, in the intestines. The specimens ranged in total length from 35 mm. to 43 mm. and comprised 2 females and 1 male.

On the evening of the 30th June no appreciable decrease was noticed in the density of mosquito larvæ in chamber **A**, and 20 more specimens of the

[1] Not being trained malariologists we regret we did not know at the time any up-to-date method employed in determining the density of mosquito larvæ in a piece of water.

fish were introduced, thus bringing the total strength to 35. In chamber **B** the density of the larvæ decreased to 3 per measure and 35 more fish were introduced in this chamber, thus bringing the strength to 51.

On the evening of the 1st July, no mosquito larvæ were found in chamber **A**, while 2 larvæ per measure were found in certain parts of chamber **B**. Twenty-five more fish were introduced in the latter chamber. On the next day no larvæ were found in either of the chambers and subsequent observation on the 13th July did not reveal the presence of any mosquito larvæ in them. Unfortunately by the time the next observation could be made, water from chamber **B** had been pumped out and the walls and bottom thoroughly cleaned. On the 6th of August, mosquito larvæ were found in this chamber in small quantities and about a dozen fish were introduced. No mosquito larvæ were, however, found in chamber **A**, which had not been disturbed. Daily observations taken up to August 15 showed no mosquito larvæ in these chambers. The contents of the alimentary canal of fishes taken from these two chambers subsequent to the eradication of the mosquito larvæ were periodically examined and found to contain ants and several other types of insects, but no mosquito larvæ.

The above experiment was repeated with two other chambers near the new Engine Room with similar results. In one chamber (about 8 feet in diameter and 6½ feet deep) the water was very foul smelling and turbid and the bottom was overgrown with long grass. The number of mosquito larvæ in it was very great—something like 200–300 in a pint of water taken from the surface. About 16 fish eradicated all the larvæ in 4 days, the smell disappeared and the water became clean. The fish were later found to be feeding on ants and other types of insects.

The examination of the stomach contents of a number of *Panchax* from a pit containing a profuse growth of algæ showed that the fish sometimes ingest small quantities of algæ with their animal diet. A number of fish when kept with algæ alone preferred to starve rather than to feed on algal matter. It is really amazing how this small fish can manage to devour small crickets, crabs and big black or red ants, which would apparently seem to be too big for the size of the mouth of the fish.

The above observations indicate that *P. panchax* shows a definite preference for mosquito larvæ provided they are available. Only in their absence or when they are scarce they begin to feed on other types of animal matter, mostly ants. Normally algæ do not form any part of their regular diet.

Laboratory Experiment.

For the purpose of a laboratory experiment, water from small pools, in which mosquito larvæ were found, was bailed out into a bucket, thus ensuring the presence of the mosquito larvæ and the associated fauna and flora. A number of specimens of *P. panchax* were starved for 4 hours and it was then

found by dissecting six of them that they had practically no food in any part of the alimentary canal. These starved specimens were then introduced into the water collected as above. After intervals of 30 minutes, 2 specimens were taken out and the contents of their alimentary canals examined. The results of the experiment are tabulated below.

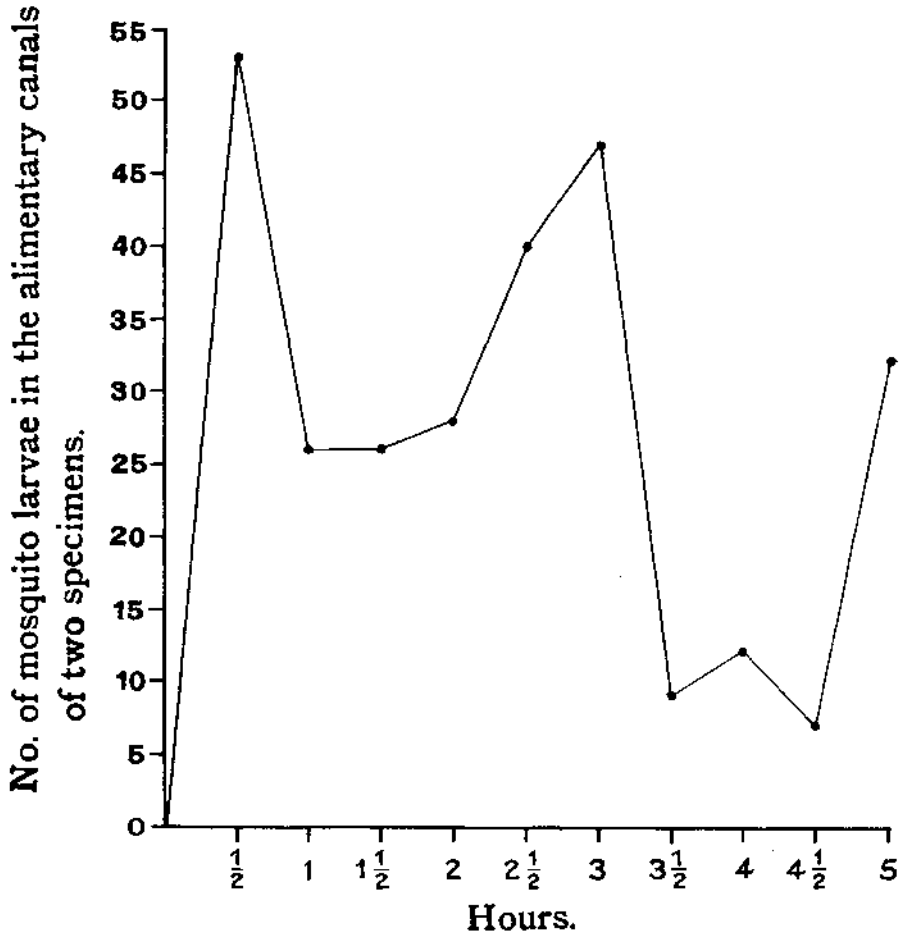
DETERMINABLE CONTENTS OF THE ALIMENTARY CANAL OF *P. panchax* (HAM.).

Two specimens were examined each time. In all 20 specimens were dissected.	Mosquito larvæ and pupæ.	Chironomid larvæ.	Water-mites.	Corixiid bugs.	May-fly nymphs.
Half hour	53	5	2	2	1
One hour	26	3	7	..	..
One and a half hours	26	2	2	4	..
Two hours	28	2	..	..	..
Two and a half hours ..	40	1	..	3	..
Three hours.. ..	47	..	..	..	..
Three and a half hours	9	1	..	2	..
Four hours	12	..	..	..	..
Four and a half hours	7	2	1	1	..
Five hours	32	..	2	1	..
Total number of animals of each kind in the food of 20 specimens of *P. panchax*.	280	16	14	13	1

The above results clearly indicate that when a variety of other animal food is available in the habitat of *P. panchax* along with mosquito larvæ they prefer to feed on mosquito larvæ. A certain amount of indiscriminate feeding indicated in the above experiment was more marked in the first half of the period of the experiment, presumably because the fish, under the stress of hunger, were more liable to feed on anything that came in their way, but became more selective when their appetite was once satisfied.

The above results also show to a certain extent the intensity of digestion in *P. panchax*. It was observed that in the first half an hour the fish fed voraciously on mosquito larvæ and that their stomachs were probably filled to their maximum capacity. Towards the end of the period the food was just about to leave the stomach, as in one of the two specimens two Chironomid larvæ, one may-fly nymph, two water-mites and three mosquito larvæ had already passed into the intestine. In the next half an hour, however, a fair quantity of the food had passed into the intestine, leaving still an appreciable amount in the stomach. This condition lasted for an hour or so. At the close of the second hour feeding was started again and went on for one hour. During this period the food previously taken passed through the alimentary canal where it was seen in the form of a pulp. At the commencement of the

fourth hour feeding had slowed down again for an hour and a half after which vigorous feeding was resumed again.



TEXT-FIG. 2.—Graphic representation of quantity of the recognizable remains of mosquito larvæ in the alimentary canals of two specimens of *Panchax panchax* (Ham.) at intervals of half an hour after the commencement of the feeding experiment. The other types of food consumed were in negligible quantities and have, therefore, been ignored.

This experiment shows that the intensity of digestion is considerably greater in *Panchax* than in *Gambusia*, as determined by Sokolov and Chvaliova (1936) in the rice-fields of Turkestan. Further, it is evident that *Panchax* is a more voracious feeder than *Gambusia*, as two specimens of the former swallowed within half an hour 53 mosquito larvæ, besides 5 Chironomid larvæ, 2 water-mites, 2 Corixiid bugs and 1 may-fly nymph.

We fully realize that the experimental data we have presented here are of a very preliminary nature, but the object before us has been to show how for a proper appreciation of the great utility of the indigenous species it is absolutely

necessary not only to carry on extensive field work but also to undertake an intensive study of their ecology and bionomics. With regard to *P. panchax* we hope to have established beyond doubt that this top-minnow is more efficacious in destroying mosquito larvæ under home conditions than its near cousins of Tropical America belonging to the genera *Gambusia* and *Lebistes*.

Panchax are small, surface-feeding fishes, and are exceptionally hardy, as they have been found to tolerate very foul waters and to live in damp situations out of water for considerable periods. It is stated by Chatterjee (1934) that they breed freely throughout the year in confined waters ; they are difficult to catch and are not valued as food. Lastly they are out and out carnivorous fishes. Thus they satisfy all the requirements laid down by expert malariologists as necessary for a really useful larvicidal form, and we have no doubt that further work on the physiology of its nutrition and breeding habits will reveal several more points in its favour as the most suitable larvivorous species for Indian conditions.

Summary.

Sen's results regarding the food of *Panchax panchax* under natural conditions are confirmed from a study of the contents of the alimentary canal of a large number of specimens of *P. panchax* collected from several localities in the Ballygunge, Tollygunge, Howrah and Pulta Waterworks areas. It is, however, pointed out that practically no mosquito larvæ were found in the pieces of water inhabited by the fish. From experiments carried out in the field by introducing the fish in mosquito-breeding places, it is concluded that *Panchax* prefer to feed on mosquito larvæ, and only when their supply is exhausted they begin to feed on other animals, mostly insects and especially ants. These results are also confirmed by laboratory experiments, in which the fish were given a mixed diet of mosquito larvæ and other types of animals, such as Chironomid larvæ, Corixiid bugs, may-fly nymphs, water-mites, beetles, etc. Under these circumstances the fish showed a definite preference for mosquito larvæ. It is also observed that, when kept with algæ, the fish preferred to starve rather than to feed on vegetable matter. The voracity of feeding and the intensity of digestion of the fish are also studied.

It is thus definitely shown that *Panchax* is a very effective larvicidal fish and its use, under Indian conditions, is strongly recommended.

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