Observations on the Biology of *Harpodon nehereus* (Hamilton) *

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With 4 Text-figures

Received 22nd October, 1951

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I—Introduction

It is well-known that *Harpodon nehereus,* popularly known as "Bombay Duck" and locally called "Bombil" abounds in the waters around Bombay and the Salsette Islands. On the West coast of India this species is found up to Ratnagiri along the Konkan Coast and to the Gulf of Cambay along the Gujerat Coast. It forms one of the most important commercial fishes of Bombay and the magnitude of the Bombay duck fishery can be judged from the fact that 315,855 lbs. of fish were landed at Versova fishing village alone in the month of November 1949. The total catch of Bombay duck in India during 1949 has been estimated at about 7,250 tons i.e. about 2% of the total yield of marine fishes of India. The fishing season commences some time in September just after the South West monsoon and continues for a period of about 4 to 5 months. It is also available during the other months of the year in smaller numbers but is somewhat rare during May to August.

Fishing for Bombay duck is usually carried out by means of bag nets locally known as "Dols"; the details of the dol and its operation have been described by

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Setna (1932). The nets are generally operated at a distance of four to five miles from the shore during the season from October to January and at a distance of ten to twelve miles during the slack season from February to May. During the monsoon months the fishing activities are restricted to inshore waters, about one to two miles from the shore depending on the weather conditions.

Harpodon nehereus is a very soft fish of low standing quality. As the craft employed are almost exclusively the local sailing boats, the catches on some occasions get stale if the time taken to reach the shore is exceeded even by a few hours. The spoiled fish has to be discarded or converted into manure. Due to its highly perishable qualities, a large part of the catch particularly during the peak season, is sun-dried and only the rest is sold fresh. It is usually dried on specially constructed raised bamboo platforms and the dried fish finds special favour with some sections of the population. The city of Bombay gets its supply of fresh Bombay ducks from nearby villages like Worli, Danda, Versova, etc. in addition to the landings at Sassoon docks. This fish is also used as bait for sharks and rays in hook and line fishing.

Most of the work so far done on *H. nehereus* is more or less of a taxonomic nature. Short notes on the systematics of the species have been given by Kemp (1917) and Hardenberg (1934). A few references to the species have been made by Lloyd (1907), Hornell (1916) and Moses (1922), giving mostly information regarding its occurrence. The craft and gear employed in Bombay duck fishing have been described in detail by Setna (1932). Hora (1934) has discussed the occurrence and distribution of *H. nehereus* in the Arabian Sea and the Bay of Bengal, and has indicated the possible existence of a correlation between the presence of this fish in various localities and the salinity of the water and the ocean currents. Awati and Pinto (1937) have described the anatomy of this fish. But for these short accounts we do not have any detailed information on the biology of this common food fish of Bombay.

It has been noted from a series of plankton collections extending over a period of about five years, both in the inshore waters and to some extent in the off-shore fishing grounds, that the eggs as well as the larval forms of this species were totally absent although the adults are commonly found in this area. The question arises that if it does not come near the shore for spawning, what factors influence its appearance in Bombay waters. To study these and allied problems an investigation was undertaken at the Bombay sub-station of the Central Marine Fisheries Research Station since May 1948 and the present paper embodies the results thus obtained until April 1950, when the sub-station was closed.

II—Material and Methods

The observations for the present investigation commenced from May 1948 and extended for a period of 22 months, i.e. up to March 1950. In the beginning, i.e, from May 1948 to September 1949, the observations were made at Sassoon docks and thereafter at the Manori fishing village, a suburb about 22 miles north

of Bombay. Two sets of observations, quite independent of each other, were made for the purpose of this study. The first set refers to the length measurements in millimetres of some specimens selected at random at Sassoon docks and Manori. The landing place was visited once or twice every week as far as practicable and during each visit the total length of about 50 specimens selected at random were noted on the spot. These data were then arranged in a frequency table, *vide* Table I and I(*a*) and were also represented graphically, *vide* Text-fig. 1.

The second set of observations related to a small set of randomly selected sample of specimens collected during each visit to a landing place for study in the laboratory. The total length (from snout to the tip of the caudal fin) in millimetres and the weight in grammes were first recorded after which the fish were dissected and examined for sex, the conditions of gonads and the stomach contents. In order to find out the percentage of different food constituents, the various items of food were separated and the volume of each was noted by the displacement method. Bi-weekly records of specific gravity and surface temperature of sea water were also maintained during the period of this investigation. The hydrometer used was graduated to give values to the third decimal place and the thermometer to the first decimal place respectively. The data have been studied and show a correlation between the occurrence and spawning of *H. nehereus* and the specific gravity and surface temperature of the sea water.

The authors are grateful to Dr. N. K. Panikkar, Chief Research Officer, Central Marine Fisheries Research Station, Mandapam Camp, for kindly going through the manuscript and making valuable suggestions. They are also indebted to Shri A. S. Gupte, Fishery Survey Assistant, Bombay, for collecting a random sample of *H. nehereus* during June 1951.

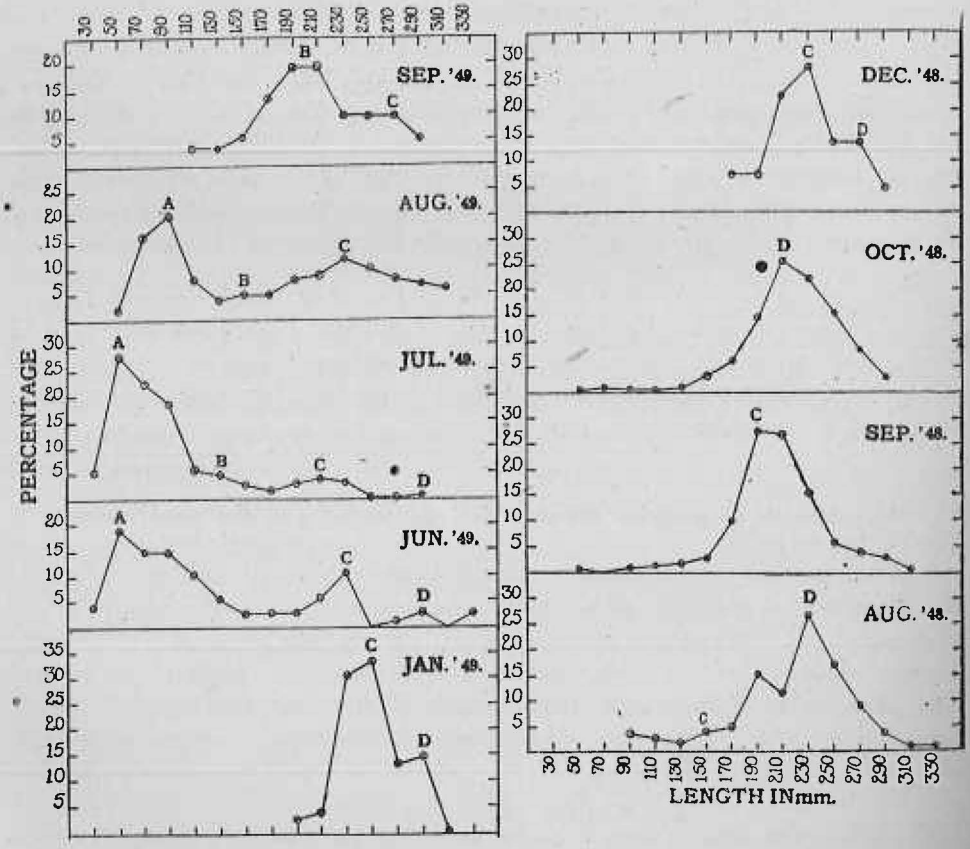
III—Length frequencies showing the age-groups and the growth-rate

When the length measurements of a large number of fishes selected at random are arranged in suitable groups, the resultant frequency chart presented graphically may show one or more modes, which are interpreted as average sizes corresponding to different year classes. This method of obtaining the average sizes of a fish at different age groups which is known as the length frequency method has certain limitations. While this method helps in fixing the average size corresponding to the first 2 or 3 year classes, it fails to indicate the average size for the later year classes. In addition to providing growth rate of fish in its earlier years, this method helps in fixing the age at first maturity of the fish, when information regarding the condition of gonads of the fish at different sizes is available.

Table I shows the frequency of the total length measurements taken at Sassoon docks from August 1948 to September 1949 and Table I(*a*) for those

taken at Manori fishing village from November 1949 to March 1950. The Table I also shows the frequency of length measurements of a sample of 1298 fish collected towards the end of June 1951 at Sassoon docks. As the number of observations during each month was not equal, the frequencies have been converted into percentages, as shown by figures in brackets below the frequency figures in Tables I and I(*a*). With these converted percentage frequencies, the graphs in the Text-fig. 1, has been drawn corresponding to Tables I and 1(*a*).

Owing to the scarcity of fish during the slack season, sufficient numbers were not available from February to May 1949 and hence representative samples could not be collected during these months. The absence of data in November 1948 was due to the great cyclone that passed over Bombay during that month and stopped the entire fishing activities for some time.



TEXT-FIG. 1. Length frequency of *Harpodon nehereus* at Sassoon docks.

Consider now the graph of August 1948 (Text-fig. 1). Two modes are seen, viz. (C) at 150 mm. and (D) at 230 mm. The group represented by (C) relates to

the one that was spawned in 1947 and (D) to the group that was spawned in 1946. The group that was spawned in 1948, i.e. the young first year class, is not represented here. The only possible explanation as to the absence of the first year group almost throughout the year except during the monsoons may be as follows. The strong current and the upswelling of the sea resulting from the monsoons probably bring the young first year group in the inshore waters from the distance breeding grounds. At other times when the sea is normal, the group no longer comes to the inshore waters and is not therefore represented in the commercial catch.

The group represented by the modes (C) and (D) goes on increasing in size every month till in January 1949, the mode (C) comes to the position 230 mm. and (D) to the position 290 mm.

No representative data are available from February to May 1949. In the graph of June 1949, we see the modes (C) and (D) representing the 1947 and 1946 groups at 230 mm. and 290 mm., i.e. at the same positions as in January 1949. Besides, we see a new group represented by mode (A) at 50 mm. This is the group that was spawned in 1949. The group that had spawned in 1948 is not sufficiently represented in the commercial catch so as to be characterised by a mode (B) in this graph, though ample indication of the existence of this group is seen from the graph. The existence of this group was clearly seen in a sample collected from Sassoon docks in June 1951, a reference to which will be made separately.

In July and August 1949 we see the mode (A) in the same position. The mode (C) also remains in the same position, the slight retrograde movement in July being probably due to sampling error. The mode (D) goes out of picture. The emergence of mode (B) representing the 1948 group may be noted.

The graphs of August 1948 and August 1949 appear to be almost similar, excepting for the prominence of the first year group in the 1949 graph.

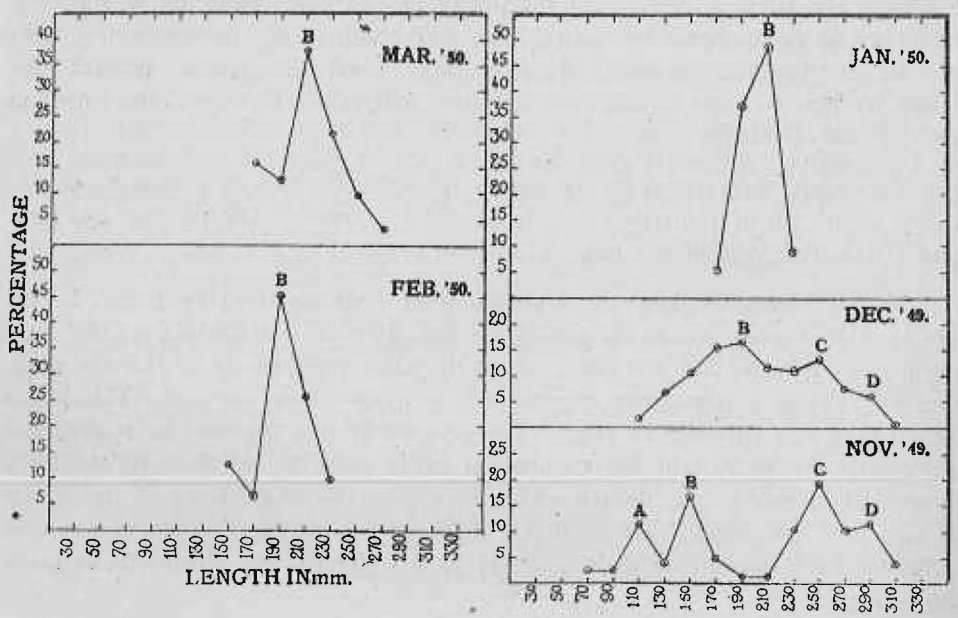
In the September 1949 graph, the 1949 group goes out of the picture. This is expected in view of the reasons stated above. The mode (B) representing the 1948 year class and the mode (C) representing 1947 year class increase to 190 mm. and 250 mm. from 150 mm. and 230 mm. respectively.

After September 1949, no data are available for Sassoon docks.

The graphs representing November 1949 to March 1950 relate to the landings at Manori fishing village (Text-fig. 2).

In the November 1949 graph, we see 4 modes (A), (B), (C) and (D) representing 1949, 1948, 1947 and 1946 groups at 110 mm., 150 mm., 250 mm. and 290 mm. respectively. The modes (C) and (D) are in the same position as we saw in the graph of September 1949 relating to Sassoon docks data. The position of mode (B) is at 150 mm. though in September 1949 it was at 190 mm.

But this should not be taken too rigidly, since the data related to two different places. The position of mode (A) has come to 110 mm. from 50 mm. in September 1949.



TEXT-FIG. 2. Length frequency of *Harpodon nehereus* at Manori.

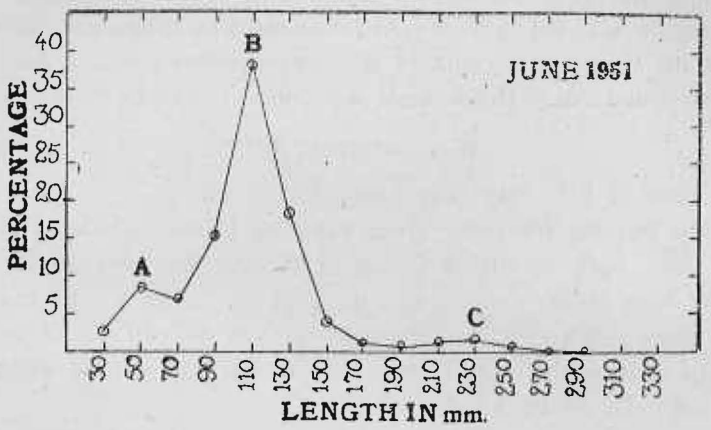
In December 1949, the mode (A) does not appear in the graph as expected. The mode (B) goes over to 190 mm., while the modes (C) and (D) remain at 250 mm. and 290 mm. respectively.

Only the mode (B) is seen more or less at 210 mm. during the months of January to March 1950. The other modes do not show themselves during these months.

To verify the above observations, a sample of 1298 specimens of *H. nehereus* were collected from Sassoon docks towards the end of June 1951. The graph representing the data is drawn separately in (Text-fig. 3). Three modes are seen clearly at 50 mm., 110 mm. and 230 mm. corresponding to the modes A, B, and C respectively.

Thus from the length frequency method, we can recognise four year classes, viz. the first year group having the average size 50 mm., the second year 150 mm., the third year 230 mm. and the fourth year 290 mm. The growth rates during first, second and third year are thus approximately 100 mm., 80 mm. and 60 mm. respectively.

The growth from month to month may be seen by watching the movements of the modes of different year classes. It is evident from the graphs that the



TEXT-FIG. 3. Length frequency of *Harpodin nehereus* at Sasson Docks in June, 1951.

growth takes place mainly between July to December and that there is no indication of growth during the rest of the year.

IV—Size and age at first maturity

During the course of this study 721 specimens of *Harpodon nehereus* varying between 40-320 mm. were examined for their gonadic conditions. Of these, 232 measuring 120-320 mm. in length were found to have either mature or ripe ovaries. Only 5.6 per cent of the 232 specimens were distributed within the size range 120-200 mm., the remaining falling within the size range 200-320 mm. Thus for all practical purposes it may be said that the first maturity takes place when the length of the fish is above 200 mm.

Now from what has been discussed in the preceding chapter we know that the size 230 mm. correspond to the third year class. Thus it may be inferred that first maturity in *H. nehereus* takes place by the end of the second year of at the beginning of the third year class.

V—Length-weight relationship

In the course of this investigation, the individual weight and length of 496 specimens of *H. nehereus* were measured to find out their relationship.

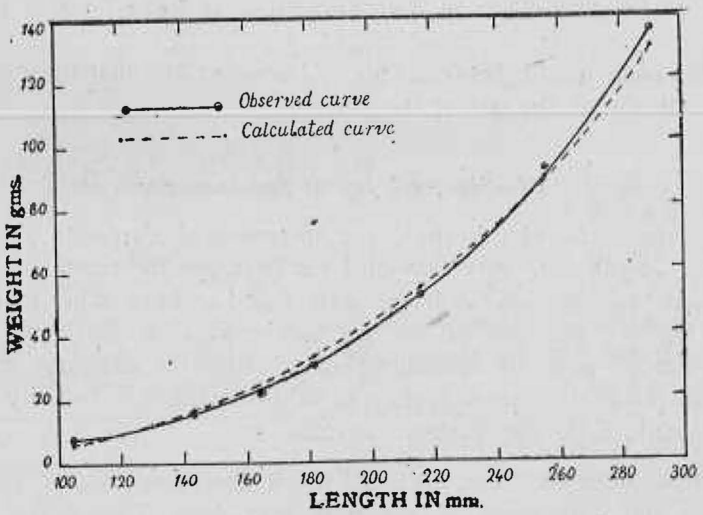
The length of 496 specimens recorded for the purpose varied from 80 mm. to 320 mm. The whole range was divided for convenience into six groups of 40 mm. interval; thus the six classes were 80-120 mm., 120-160 mm., 160-200 mm., 200-240 mm., 240-280 mm. and 280-320 mm.

In the first class, viz. 80-180 mm. there were four observations, in the second 35, in the third 122, in the fourth 134, in the fifth 172 and in the sixth 29. The average length and weight of all the observations in each class were calculated. A general equation of the type $W = AL^k$ was fitted to these data, where W and L represent the weight and length of the fish respectively and A and k are the consts. to be found out. The formula was found out to be

$$W = .00001032\ L^{2.889}$$

where the value of k is very near three.

From the formula for every given value of L, the calculated value of W was found out. Such calculated values of W and the corresponding observed values of W were plotted as shown in Text-fig. 4. It is seen from the two curves that there is a very close agreement between the two sets of values. The weight-length relationship thus shows the normal pattern, the weight varying almost as the cube of the length.



TET-FIG. 4. Length weight relationship of *Harpodon nehereus*.

VI—Spawning habits

A considerable number of fish depending on the total catch of the day were examined and the gonad conditions noted during the period, May 1948 to March 1950. In the case of a female the appropriate stage of development of the ovary was noted. In the case of the male it was rather difficult to determine the exact stage of development of the testis and hence the condition was noted as immature or mature from the general appearance of the testis and by the examination of temporary mounts.

A table showing the distribution of mature and immature fishes in different months is given below:

Months.	No. of obs.	Percent of fish Mature	Immature	Months.	No. of obs.	Percent of fish Mature	Immature
May 48	7	42.8	57.2	May 49	—	—	—
Jun. 48	9	55.6	44.4	Jun. 49	13	15.4	84.6
Jul. 48	38	73.7	26.3	Jul. 49	51	15.7	84.3
Aug. 48	59	45.8	54.2	Aug. 49	42	14.3	85.7
Sept. 48	60	18.4	81.6	Sept. 49	46	6.5	93.5
Oct. 48	16	43.7	56.3	Oct. 49	25	8.0	92.0
Nov. 48	—	—	—	Nov. 49	39	66.6	33.3
Dec. 48	22	86.3	13.6	Dec. 49	120	30.8	69.2
Jan. 49	24	29.2	70.8	Jan. 50	45	—	100.0
Feb. 49	14	71.4	28.6	Feb. 50	31	32.3	67.7
Mar. 49	20	60.0	40.0	Mar. 50	32	6.2	93.8
Apr. 49	8	75.0	25.0				

A casual glance at the table will show the presence of mature specimens in almost every month which tends to show that this species is probably a continuous breeder. Besides, it seems to have two peak spawning seasons, the first falling somewhere during April-July and the second during November-December, i.e. one approximately before the S.W. monsoons and the other after. This observation needs confirmation with more material.

The absence of eggs and larval forms of this fish in inshore waters and as well as on some of the actual fishing grounds indicates that the spawning takes place somewhere beyond this region. This view is further supported by the fact that about a dozen specimens were taken in a trawl net about 50-60 miles N.W. of Bombay lightship in November 1948. On examination they were found to be all females, possessing ripe or ripening ovaries. It is probable that an intensive study of the plankton and of fish taken from deeper waters may throw more light on the spawning habits.

VII—Temperature and specific gravity of sea water and the occurrence and spawning of *H. nehereus*

The surface temperature and the specific gravity of sea water were recorded twice a week during the period of this investigation. The minimum and maximum values recorded in each month are shown in the following table:

Month	Temperature °C Min.	Max.	Specific gavity Min.	Max.
May 48	32.0	35.0	1.025	1.026
June 48	32.0	35.0	1.026	1.027
July 48	34.0	35.0	1.020	1.026
August 48	34.0	35.0	1.020	1.027

Month	Temperature °C		Specific gavity	
	Min.	Max.	Min.	Max.
September 48	27.0	34.0	1.020	1.029
October 48	28.0	29.0	1.026	1.028
November 48	27.0	28.0	1.026	1.028
December 48	26.0	29.0	1.026	1.028
January 49	25.0	28.0	1.027	1.029
February 49	18.0	28.0	1.027	1.030
March 49	25.0	29.0	1.027	1.031
April 49	28.0	30.0	1.028	1.030
May 49	29.0	32.0	1.025	1.028
June 49	30.0	31.0	1.025	1.029
July 49	27.0	31.0	1.026	1.032
August 49	28.0	29.0	1.024	1.030
September 49	28.0	29.0	1.018	1.024
October 49	28.0	30.0	1.024	1.027
November 49	27.0	29.0	1.027	1.030
December 49	26.0	28.0	1.027	1.030
January 50	27.0	—	1.028	1.032
February 50	29.0	—	1.030	1.030
March 50	—	—	1.030	—

It is seen from the above table that the temperature remains comparatively low in the period between September to February and then it begins to rise. Until in May-June it is very high and thereafter it gradually falls down again. It has been mentioned already in the introduction that the fishing season for Bombay ducks commences sometime in September and continues to be brisk for a period of about 4-5 months. The fish is also available during the other months in smaller numbers and is somewhat rare from May to July. It thus appears that the intensive fishing coincides more or less with the low temperature period, and there is practically little or no fishing in the inshore waters, during the summer months.

It may also be seen from the table that the specific gravity was comparatively higher during the two peak spawning periods referred to previously than in the other months.

VIII—Food and feeding habits.

In connection with the study of the feeding habits of this fish, 806 specimens were examined, of which 217 were found to contain either digested food or no food. The various food constituents from the stomachs of the remaining were separated and the volume of each item was noted by the displacement method.

Table II shows the percentage of different food items taken month by month. For purpose of convenience the food items have been classified into

seven chief categories, viz.: 1. Prawns, 2. *Harpodon nehereus*, 3. *Bregmaceros macclellandi*, 4. *Coilia dussumieri*, 5. *Polynemus heptadactylus*. 6. Other fish food, and 7. Miscellaneous food.

Prawns appear to be the most favourite food of *H. nehereus* because more than 50% of the food consisted of prawns during the major part of the year. This is further seen from the very high average percentage of 57.34% of prawns, indicating a definite preference. The different species of prawns taken according to their order of abundance were: 1. *Acetes indicus*, 2. *Leander tenuipes*, 3. *Leander spp.*, 4. *Metapenaeus brevicornis*, 5. *Metapenaeus sp.*, and 6. *Penaeus indicus*.

Next item in order of preference is *Harpodon nehereus* itself indicating its cannibalistic food habits. If we examine the percentage distribution of this food item in different months it is found that a very high percentage is taken in two periods, viz. July-August and December-January and these two periods happen to be after the two peak spawning seasons. It has also been observed that it generally takes only small-sized Bombay ducks which occur in plenty just after the intensive spawning. This peculiar habit of cannibalism particularly in two periods further supports the presence of two spawning peaks.

The third and fourth important items of food are *Coilia dussumieri* and *Bregmaceros macclellandi*, respectively. Their presence is somewhat irregular and it appears that they are taken only when they are easily available.

It is interesting to note that *Polynemus heptadactylus* is taken in appreciable percentages only from October to January, when the number of specimens without any food in the stomachs is generally high. It is very likely that *H. nehereus* has no special liking for this fish but it feeds on it due to the probable food shortage. It has been observed by Bapat[1] that *P. heptadactylus* is found in Bombay waters almost all the year round though it is taken by *H. nehereus* only during a short period.

Other fish food consisted of the following species of fishes according to their order of abundance. 1. *Otolithus argenteus*, 2. *Trichiurus sp.*, 3. *Engraulis commersonianus*, 4. *Clupea sp.*, 5. *Trypauchen vagina*, 6. *Pellona sp.*, *Caranx armatus*, 8. *Sciaena sp.*, 9. *Gobius sp.* and 10. *Chirocentrus dorab*. The percentages of miscellaneous food shown in column 9 were comparatively very low and it comprised of Squilla, crustacea remains, Sepia (young), Gammarus, etc.

Hora (1934) has observed that the food of *H. nehereus* consists of prawns mainly *Acetes indicus*, and of fish comprising *Bregmaceros macclellandi*, *Harpodon nehereus*, *Engraulis sp.* and *Trichiurus sp.* The present observations confirm these findings. The fish is often found moving with large sized specimens of *Coilia dussumieri*, *Trichiurus savala*, *Polynemus heptadactylus* etc. with part of

[1] Unpublished work, 1948. A thesis on "The Food of Fishes" submitted to the Bombay University.

the prey hanging from the mouth. The peculiar type of dentition and the mechanism of the jaws facilitate in catching hold of the food. In over-fed specimens the walls of the stomach expand to about 8-10 times their normal size and the stomach in the distended state is very transparent.

The column three of Table II shows that (a) in May 1948 and in April-May 1949, no specimens without food were observed, (b) from May onwards in both the years the percentage of specimens without food showed a tendency to increase till it is highest in November, (c) a fairly high percentage of fishes without food is seen from November to January of both the years, and (d) then from January onwards the percentage of specimens without food goes on slowly diminishing till it is practically nil in April-May.

The result is interesting and is borne out by data for about two years. In this connection it may be recalled here that the chief fishing season for this fish in Bombay is from September to January and thereafter the catches are poor. The abundance of *H. nehereus* in the inshore waters during this period probably causes depletion of the available food supply and consequently a certain percentage of them may have to go without food. It has been observed that the scarcity of fish begins from February onwards, when the percentage of fish with empty stomachs also diminishes. It seems, therefore, that the food shortage in the inshore waters after February may be one of the causes influencing the movement of this fish away from the shores.

The food resources are likely to be sufficient for the smaller population that is left over after the movements of the shoals in February. Hence the percentage of specimens without food begins to decline during these months.

It may also be added that the number of specimens without food seems to have no bearing on spawning, as the records maintained show that most of the specimens without food had immature gonads.

We have seen that rise in temperature may be one of the factors that influence the mass movements of this fish. Now there is also an indication that limited resources of food particularly taken by the species, may be another factor responsible for its disappearance from the inshore waters.

IX—Summary

The present investigation was carried out at Bombay from May 1948 to March 1950 and during this period about 2,000 specimens of *H. nehereus* taken at random from landings at the Sassoon docks and Manori were measured. The analysis of the length measurements approximately shows that the modal size of the first year class is at 50 mm., of the second year class at 150 mm., of the third year class at 230 mm., and of the fourth year class at 290 mm. respectively. Thus the growth rate during the first year seems to be on an average 100 mm., in the second year 80 mm., and 60 mm. during the third year.

Examination of the gonads of a number of fishes of different sizes in each month indicates that they become mature for the first time by the end of the second year or at the beginning of the third year of their life when they attain a size of about 230 mm. in length.

From individual weight and length measurements of 496 specimens of *H. nehereus*, it is found that the weight of the fish varies almost as the cube of the length.

From the regular occurrence of mature fishes it can be inferred that *H. nehereus* is a continuous breeder, having two peak breeding seasons, viz. May-July and November-December. These two peak seasons appear to synchronize with the high specific gravity of the sea water.

The feeding habits of *H. nehereus* have been studied in detail. Prawns form the main food, the other important items being *Harpodon nehereus* itself, *Bregmaceros macclellandi*, *Coilia dussumieri* and *Polynemus heptadactylus*. The scarcity of the usual food taken by this fish seems to be one of the probable causes responsible for their disappearance from the local waters.

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TABLE I—SHOWING THE LENGTH FREQUENCY OF *HARPODON NEHEREUS* AT SASSOON DOCKS.

Frequency in mm.	Aug. 48	Sep. 48	Oct. 48	Dec. 48	Jan. 49	Jun. 49	Jul. 49	Aug. 49	Sep. 49	Jun. 51
0- 20	—	—	—	—	—	—	—	—	—	—
20- 40	—	—	—	—	—	3 (4.0%)	23 (5.6%)	—	—	35 (2.7%)
40- 60	—	2 (0.4%)	1 (0.4%)	—	—	14 (18.9%)	113 (27.7%)	2 (2.0%)	—	114 (8.8%)
60- 80	—	—	2 (0.7%)	—	—	11 (14.9%)	91 (22.3%)	17 (16.7%)	—	91 (7.0%)
80-100	5 (3.4%)	4 (0.8%)	1 (0.4%)	—	—	11 (14.9%)	76 (18.6%)	21 (20.6%)	—	199 (15.3%)
100-120	4 (2.7%)	6 (1.2%)	1 (0.4%)	—	—	8 (10.8%)	24 (5.9%)	8 (7.8%)	2 (3.8%)	501 (38.6%)
120-140	2 (1.4%)	8 (1.7%)	2 (0.7%)	—	—	4 (5.4%)	20 (4.9%)	4 (3.9%)	2 (3.8%)	241 (18.6%)
140-160	6 (4.1%)	13 (2.7%)	9 (3.3%)	—	—	2 (2.7%)	11 (2.7%)	5 (4.9%)	3 (5.8%)	51 (3.9%)
160-180	7 (4.8%)	46 (9.6%)	17 (6.2%)	6 (7.4%)	—	2 (2.7%)	6 (1.5%)	5 (4.9%)	7 (13.5%)	15 (1.2%)
180-200	23 (15.6%)	132 (27.6%)	38 (14.1%)	6 (7.4%)	2 (2.7%)	2 (2.7%)	11 (2.7%)	8 (7.8%)	10 (19.2%)	9 (0.8%)
200-220	17 (11.6%)	129 (26.9%)	69 (25.6%)	20 (22.7%)	3 (4.0%)	4 (5.4%)	15 (3.7%)	9 (8.8%)	10 (19.2%)	16 (1.2%)
220-240	39 (26.5%)	74 (15.4%)	59 (21.8%)	23 (28.4%)	23 (30.66%)	8 (10.8%)	13 (3.2%)	12 (11.8%)	5 (9.6%)	18 (1.4%)
240-260	25 (17.0%)	28 (5.8%)	42 (15.6%)	11 (13.6%)	25 (33.3%)	—	1 (0.2%)	5 (4.9%)	5 (9.6%)	6 (0.5%)
260-280	12 (8.2%)	20 (4.2%)	22 (8.2%)	11 (13.6%)	10 (13.3%)	1 (1.4%)	1 (0.2%)	3 (2.9%)	5 (9.6%)	1 (0.1%)
280-300	5 (3.4%)	15 (3.1%)	7 (2.6%)	4 (4.9%)	4 (14.7%)	2 (2.7%)	3 (0.7%)	2 (2.0%)	3 (5.8%)	1 (0.1%)
300-320	1 (0.7%)	2 (0.4%)	—	—	1 (0.3%)	—	—	1 (1.0%)	—	—
320-340	1 (0.7%)	—	—	—	—	2 (2.7%)	—	—	—	—
TOTAL	147	479	270	81	75	74	408	102	52	1,298

N.B. Figures given in brackets are percentages.

TABLE I (a): SHOWING THE LENGTH FREQUENCY OF *HARPODON NEHEREUS* AT MANORI.

Frequency in mm.	Nov. 49	Dec. 49	Jan. 50	Feb. 50	Mar. 50
0- 20	—	—	—	—	—
20- 40	—	—	—	—	—
40- 60	—	—	—	—	—
60- 80	2 (2.6%)	—	—	—	—
80-100	2 (2.6%)	—	—	—	—
100-120	9 (11.5%)	3 (1.7%)	—	—	—
120-140	3 (3.8%)	12 (6.8%)	—	—	—
140-160	13 (16.7%)	18 (10.2%)	—	4 (12.9%)	—
160-180	4 (5.1%)	17 (15.3%)	2 (5.7%)	2 (6.5%)	5 (15.6%)
180-200	1 (1.3%)	29 (16.5%)	13 (37.1%)	14 (45.2%)	4 (12.5%)
200-220	1 (1.3%)	20 (11.4%)	17 (48.6%)	8 (25.8%)	12 (37.5%)
220-240	8 (10.2%)	19 (10.8%)	3 (8.6%)	3 (9.7%)	7 (21.9%)
240-260	15 (19.2%)	23 (13.1%)	—	—	3 (9.4%)
260-280	8 (10.2%)	13 (7.4%)	—	—	1 (3.1%)
280-300	9 (11.5%)	11 (6.2%)	—	—	—
300-320	3 (3.8%)	1 (0.6%)	—	—	—
320-340	—	—	—	—	—
TOTAL	78	156	35	31	32

N.B. Figures given in brackets are percentages.

											1,298
										52	
									102		
								408			
							(2.7%)				
						74					
					75						
				81							
			270								
		479									
	(0.7%)										
TOTAL	147										

N.B. Figures given in brackets are percentages.

TABLE II—SHOWING THE PERCENTAGE OF *H. NEHEREUS* WITHOUT FOOD AND THE PERCENTAGE OF DIFFERENT FOOD ITEMS TAKEN BY IT.

Month	Total No. examined.	Percentage without food.	Number with food.	Stomach contents						
				Prawns.	*Harpodon nehereus.*	*Bregmaceros macclellandi.*	*Coilia dussumieri.*	*Polynemus heptadactylus.*	Fish food.	Miscellaneous food.
May 48	7	—	7	83.57	10.72	—	—	—	5.71	—
Jun. 48	9	11.1	7	65.71	8.57	—	—	—	22.86	2.86
Jul. 48	38	7.9	29	51.48	18.14	3.45	17.17	—	8.72	1.03
Aug. 48	59	25.4	44	67.76	24.41	1.36	4.92	—	0.80	0.80
Sep. 48	60	26.7	46	57.02	14.74	—	5.58	1.13	21.44	0.09
Oct. 48	18	16.7	14	32.35	5.14	27.71	5.86	13.57	5.50	9.86
Nov. 48	20	40.0	11	57.27	6.36	8.18	9.09	4.55	11.82	2.73
Dec. 48	22	18.2	16	29.45	—	25.52	6.25	8.75	11.28	18.75
Jan. 49	24	33.3	16	50.37	29.12	0.94	9.56	—	9.99	—
Feb. 49	15	6.7	14	34.50	22.50	—	—	—	43.00	—
Mar. 49	20	25.0	15	52.33	23.00	11.33	—	—	—	13.33
Apr. 49	8	—	8	46.25	—	13.75	2.50	—	25.00	12.50
May 49	—	—	—	—	—	—	—	—	—	—
Jun. 49	18	16.7	13	58.85	0.77	—	17.31	—	17.68	5.38
Jul. 49	68	26.5	50	70.22	17.32	2.00	—	—	10.46	—
Aug. 49	48	20.8	40	66.20	2.20	2.50	12.72	—	14.62	1.75
Sep. 49	52	21.15	41	75.27	2.44	2.44	6.78	—	10.63	2.44
Oct. 49	25	16.0	19	78.95	7.89	5.26	—	—	5.26	2.64
Nov. 49	39	38.5	24	62.71	—	—	—	11.46	19.58	6.25
Dec. 49	158	24.7	112	52.99	3.65	8.12	1.92	18.35	13.70	1.34
Jan. 50	35	42.9	20	33.60	10.40	0.10	1.50	13.00	41.50	—
Feb. 50	31	35.4	20	20.25	22.25	5.00	27.50	—	25.00	—
Mar. 50	32	25.0	23	69.73	4.09	1.65	16.13	—	7.96	0.43
Average percentage				57.34	10.27	4.74	6.12	5.13	13.95	2.47