Annexure 3

SOME OBSERVATIONS ON SIZE GROUPS IN THE FISHERY AND MIGRATION OF HILSA IN BANGLADESH WATERS DURING 1985-86

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1. INTRODUCTION

Although one of the aspects which received the attention of many workers on Hilsa shad *(Hilsa ilisha)* was the length composition in the fishery, practically all the efforts were directed on the fish that frequented Indian inland waters (Refer Raja, 1985 for compilation of information). There is little information on the length frequency distribution of hilsa in the Bangladesh environment. Also, length frequency distribution of the hilsa population in the marine environment has received no attention so far. In view of the anadromous behaviour of the fish, a programme to collect length frequency data from all the three environments is necessary in order to:

(i) identify the seasonal changes, modal progression and the occurrence of various size groups in the three environments,

(ii) estimate growth and population parameters,

(iii) detect migratory trends that may become evident from length frequency distribution and

(iv) determine the selectivity of the commercial nets that are being used for hilsa fishing.

2. MATERIAL AND METHODS

To include all the three major habitats — i.e. river, estuary and sea — Cox's Bazar and Chittagong (marine), Khepupara (estuarine) and Chandpur (riverine) were selected as suitable sampling stations for collecting data. Each place was taken as a functional unit and the one biologist assigned to each station was given the responsibility of collecting data. The four biologists were each assisted by a field assistant. The sampling was conducted during a one-year period, from March 1985 to April 1986.

Random samples of fish were taken on three consecutive days per fortnight at each station, two of these days being the sampling days for catch and effort data collection. The length frequency sample size was 50 fish per observation day from each station, but sometimes non-availability of hilsa or poor catches due to unfavourable weather conditions, festivals, etc. resulted in the measurement of less than 50 fish per day. The total weight of all the 50 fish measured was taken with the help of a spring balance. Since it has been repeatedly mentioned in the literature that there are slender and broad bodied hilsa in the fishery, a two-way table was devised to simultaneously record the length and the corresponding depth of the fish, in the field itself (Appendix 1).

In the case of Chittagong and Khepupara, samples for length frequency distribution were taken directly from hilsa fishing boats, but in Cox's Bazar and Chandpur the samples were taken from the landing centre. Further it was observed by the biologist in Cox's Bazar that smaller sizes of hilsa were being segregated away for inclusion among the other fishes and only the remainder were brought by the small conveyor boats to the landing place. However, it was later found that non-inclusion of these small-sized hilsa, which were very few in number, did not materially affect the distribution pattern of the size groups. At Chandpur, the mechanized carrier boats brought fish from marine and estuarine areas while the non-mechanized boats landed fish that were caught from the river, especially the Meghna. The length frequency samples in Chandpur were taken from the latter type of craft.

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In all cases the total length was measured with a measuring board. Length frequency by sex was not possible when the fish was commercially landed because of the cost of purchasing large numbers of fish for cutting and determining the sex.

3. OBSERVATIONS

3.1 Mesh-size ranges

Normally in the riverine and estuarine areas, fishermen use larger mesh nets during the pre-monsoon and monsoon period and small mesh gillnets in winter. In the marine sector, large mesh nets are used also during the winter months. In Chandpur and Khepupara, 10.5 to 12.8 cm mesh sizes are used from July to November, but during winter, gillnets of different mesh sizes, ranging from 6 to 12 cm, are employed. In Cox's Bazar and Chittagong 10.0 to 12.0 cm mesh sizes are more commonly used throughout the year (Figures 1a and 1 b).

3.2 Size ranges

The annual picture of length frequency distributions of hilsa caught during March 1985 to April 1986 from the four selected sampling places is shown in Fig. 2. The size ranges entering the commercial fishery in the three environments were almost the same, from 25 to 55 cm mid-length. However, more than 90% of the catch falls within the range of 30 cm to 50 cm. In Khepupara 23 cm fish have been recorded, but seldom fish above the 50 cm length group. In the other areas i.e. in riverine and marine, length groups of 52-54 cm and 54-56 cm were recorded, but no length group below the 27 cm group was observed in the commercial fishery.

Length frequency distribution showed modal lengths around 41 and 47 cm in the riverine station, around 37 cm in the estuarine station and 39 cm in the marine stations. It appears that practically all the size groups occur in all environments but not necessarily at the same time.

The juveniles landed by the set bagnet fishery in Khepupara, observed during December 1985 to March 1986 (Figs. 3 and 6), were 4.2 cm to 15.1 cm, from December 1985 to April 1986.

Earlier one of the authors had collected juveniles ranging from 2.1 cm to 9.3 cm during December 1983 to August 1984 at Chandpur. (Hossain, unpublished thesis, 1985). It was reported by the biologist based at Cox's Bazar that in the channel Moheskhali (close to Cox's Bazar) several hilsa of about 10-11 cm were observed in the set bagnets during February. Small-sized groups (20-30 cm) were not significantly reported during this investigation in the catches of any of the environments. The only occasion when they were found to form some significant portion of the catch, was in Khepupara in January.

3.3 Seasonal changes in size distribution

Length frequency distributions in Figures 4A, 4B. 4C, 4D, representing the picture at Chandpur, Khepupara (Mohipur), Chittagong and Cox's Bazar respectively, show modal sizes. Modal progressions were not very clearly established and this may be due to the use of gillnets with different mesh sizes in the fishery. A negative progression is seen in the monthly length frequency distributions of all the stations, due to emigration and fishing mortality of larger fish and immigration of smaller sizes into the fishery. This probably indicates a continuous movement of hilsa into and out of each area. Negative modal progression is more clear in riverine and estuarine areas than in the marine sector. The entry of a smaller-sized group indicates the appearance of another year's class/brood of hilsa.

Monthly mean sizes of hilsa in the fishery of the four stations are shown in Fig. 5. Chandpur has a wide range of mean lengths, ranging from 35 to 45 cm, the highest in July and the lowest in December. An almost similar picture is obtained at Khepupara where the range of mean sizes was 33 to 44 cm with the highest in July and the lowest in January. On the other hand, ranges of mean length in marine sector were not so wide, 39 to 44 cm. It is also significant to note that the estuarine fish were most of the time smaller in size than the marine and smaller than the riverine fish except in December.

This situation which is rather intriguing is also reflected in the annual picture (Figure 2). It is not clear why the mean lengths of fish at the estuarine station should be smaller than those at the marine stations. If the estuarine station is in the migratory route between **the** sea and the Meghna river, whether upstream or downstream, the mean size should be higher than that of the fish from the marine side.

However, it can be concluded that the general mean length of hilsa in Bangladesh is 40.5 to 45.5 cm from April to August, 38.3 to 42.5 cm during September to November and 33.3 to 43.1 cm from December to March. If we connect the last mentioned group in December to March with the one from April to August, then the group found between September and November belongs to a fresh batch of recruits. As is seen in the study reported by Islam et al. (1986), a major spawning occurs in October and subsidiary spawnings in March/June. If the December-March group is considered as recruits from previous October, they are 1½ years old, attaining about 46 cm by the end of the second year. The recruits of the subsidiary spawning manifest themselves in September-November when they can be back-calculated to an age of 1½ years. Thus it can be stated provisionallythat the limited evidence of a one year period appears to indicate that the fish grow to a length of about 30 cm in one year, 40 cm in 1½ years and 46 cm in 2 years. Observations contained in the paper by Van der Knaap *et* al (1986) appear to lend support to these presumptions.

3.4 Migration

For convenience of discussion, the observed size group of the fishery may be classified into four major groups viz. small size less than 30 cm, medium size 30 cm to 39 cm, large size 40 cm to 49 cm and extra large size, above 50 cm. In order to study the movement of these groups through the passage of time, the values of catch rates (catch/boat/day) for each of these groups for each month are shown in Fig. 7.

In the riverine area the large size group of fish are abundant roughly between May and October. After October this group declined to a minimum by December. The catch rates for Chandpur area revealed two peaks, one in May and another in August, but the Gonado-Somatic index (GSI) value was found to peak in October (Islam et al., 1986). The medium-sized group was available all through the year. From November to March, medium-sized groups showed dominance over the large-sized group. Fishermen during this time also fished with smaller-meshed nets, because of the predominance of smaller sized hilsa. The catch rate and GSI value were found to be higher during March. The catch rate of this medium sized fish in winter indicates a lesser degree of migration into the river. This migration is also supposed to be for breeding.

In Khepupara, it was observed that fishermen fish for hilsa only 10 months in a year, from June to the beginning of April. The abundance of high-priced varieties such as prawn and other species in the canal and river as well as in the nearby estuarine belt, also diverts the fishermen's interest away from the hilsa fishery during this two-month period. All fishermen during this period were engaged in catching prawns with set bagnets.

In Khepupara estuaries, the large-sized group outnumbered the medium-sized fish only between June and August. In all the other months, it is the medium-sized fish which were dominant.

The large-sized group at a slightly advanced stage of maturity was also found in the estuary in July. The medium-sized group also showed greater abundance from September to March with peaks in September and January. The mean GSI value also showed a rising trend in January, February and March. (Islam *et* al., 1986). This medium-sized group may also be moving into the estuaries for spawning in 'winter'.

In the marine sector, Cox's Bazar showed that the large-sized group was always slightly more conspicuous than the medium-sized fish between August and March. The large-sized fish were distinctly more abundant from April to June. In Chittagong also the picture was roughly the same, with the catch rate of medium and large-sized group being similar from July to March; from April to June, as in Cox's Bazar, the larger-sized group clearly dominated. The medium-size group had a minor peak in winter with a corresponding minor peak for catch in the same month. So large-sized fish was greater during the pre-monsoon and monsoon periods both in

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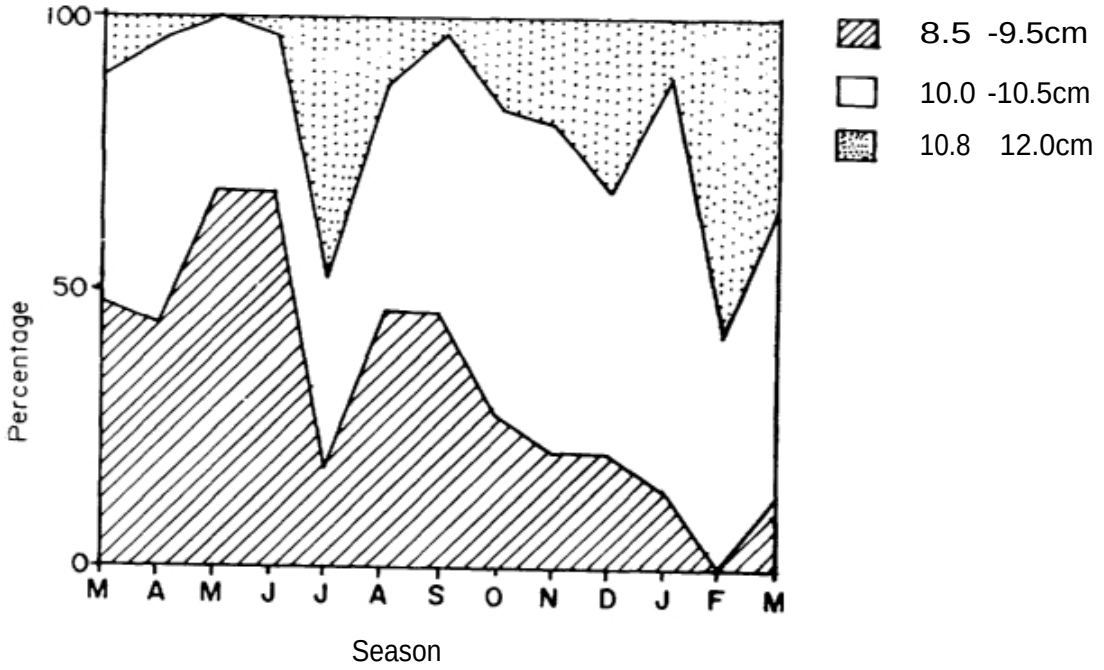

Fig. 1a Seasonal changes in the proportions (%) of different mesh sized giliflets in the hilsa fishery at Cox's Bazar, 1985/1986.

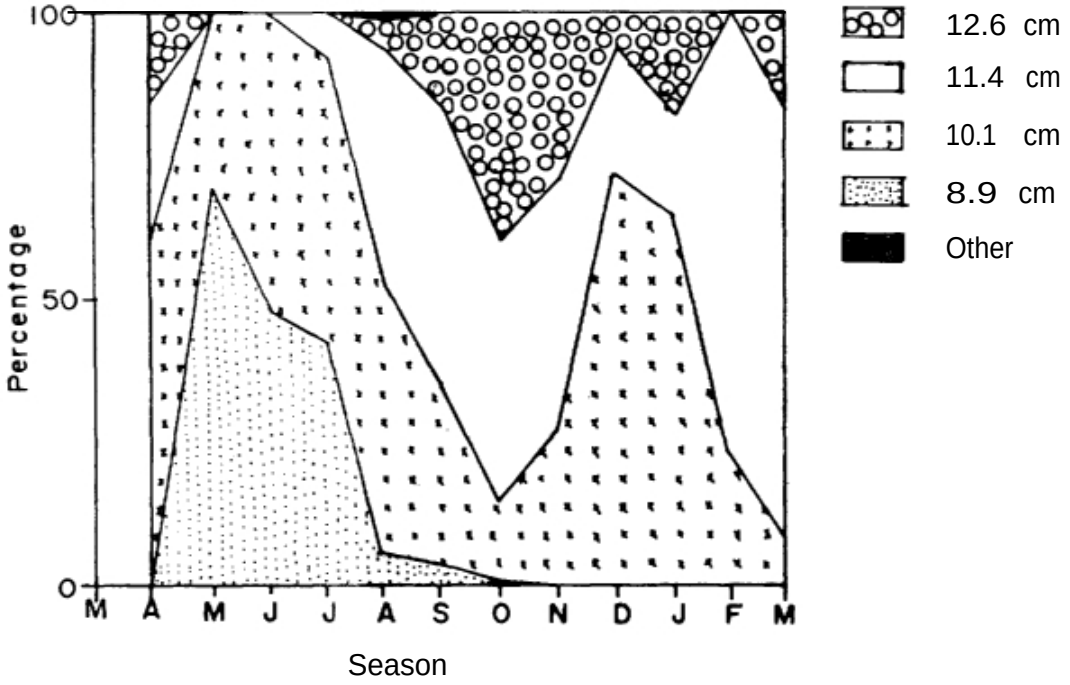

Fig. 1b Seasonal changes in the proportions (%) of different sized glilnets operated in the hilsa fishery at Chittagong, 1985/86.

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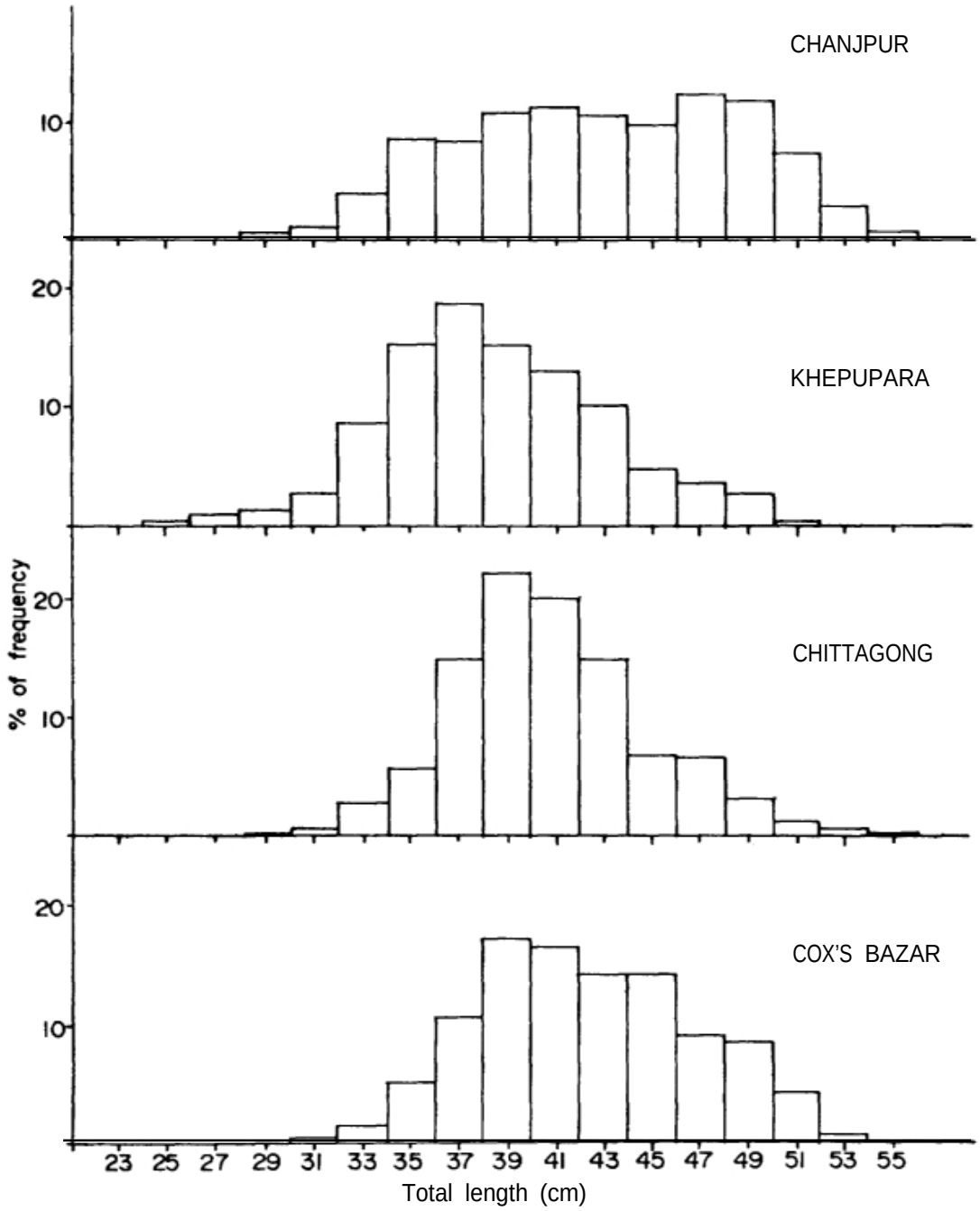

Fig. 2 Size composition of the catch of *Hilsa ilisha,* between March 1985 and April 1986, at the four sampling stations.

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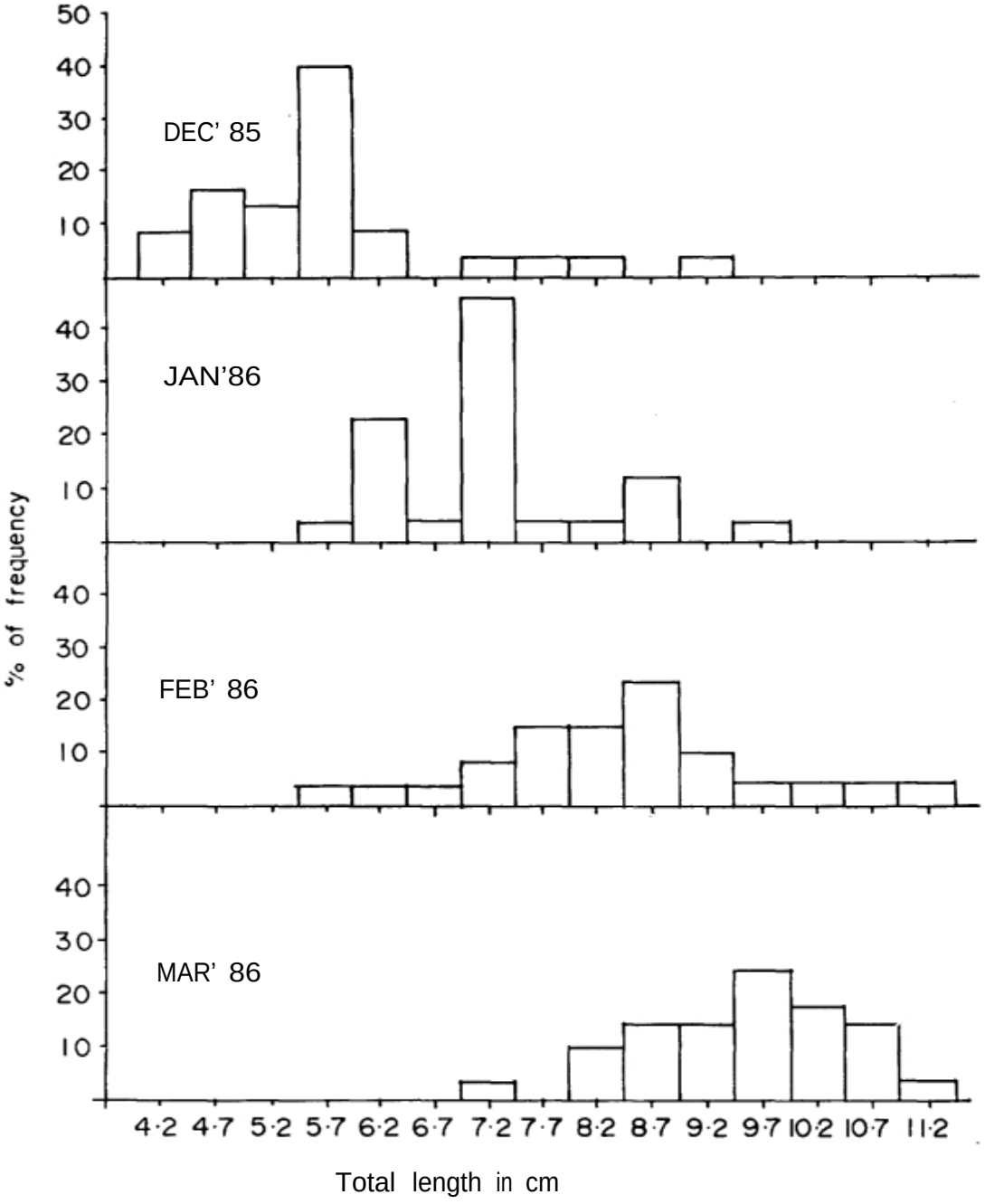

Fig. 3 Length frequency distribution of juvenile *Hilsa ilisha* in Khepupara.

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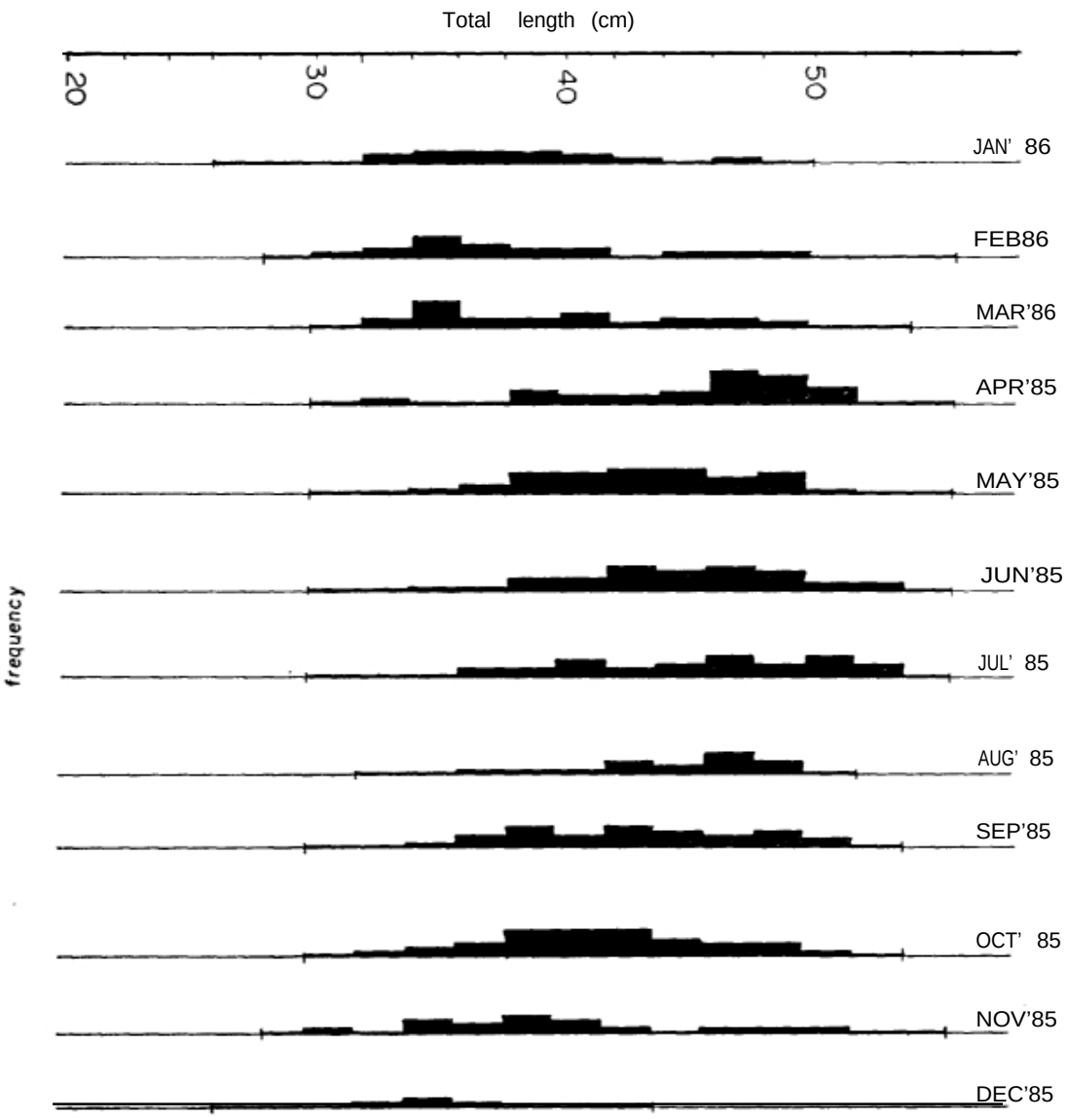

Fig. 4a Length frequency distribution at Chandpur, 1985-86 with 2 cm group intervals.

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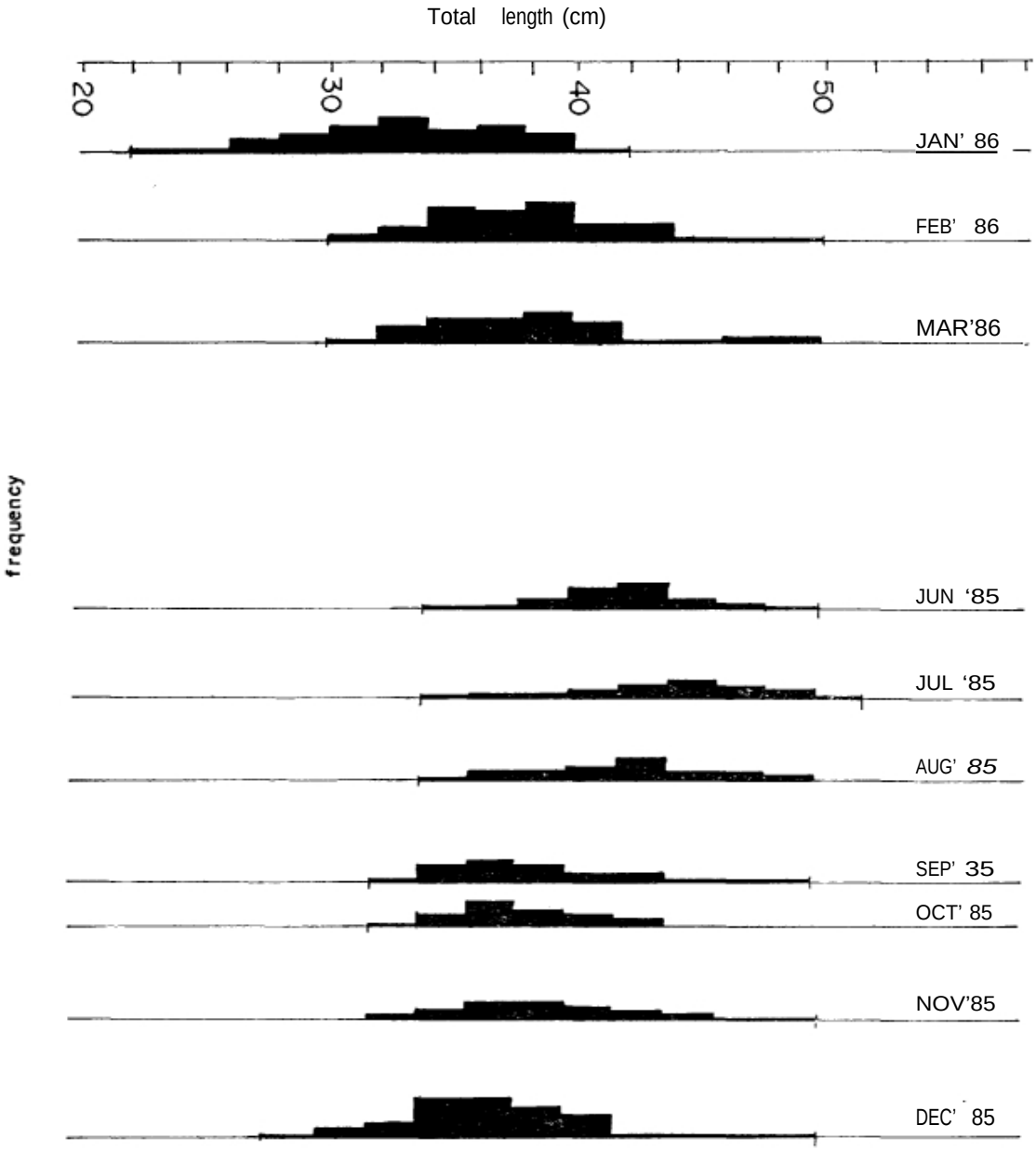

Fig. 4b Length frequency distribution at Mohipur (Khepupara) 1985-86 with 2 cm group intervals.

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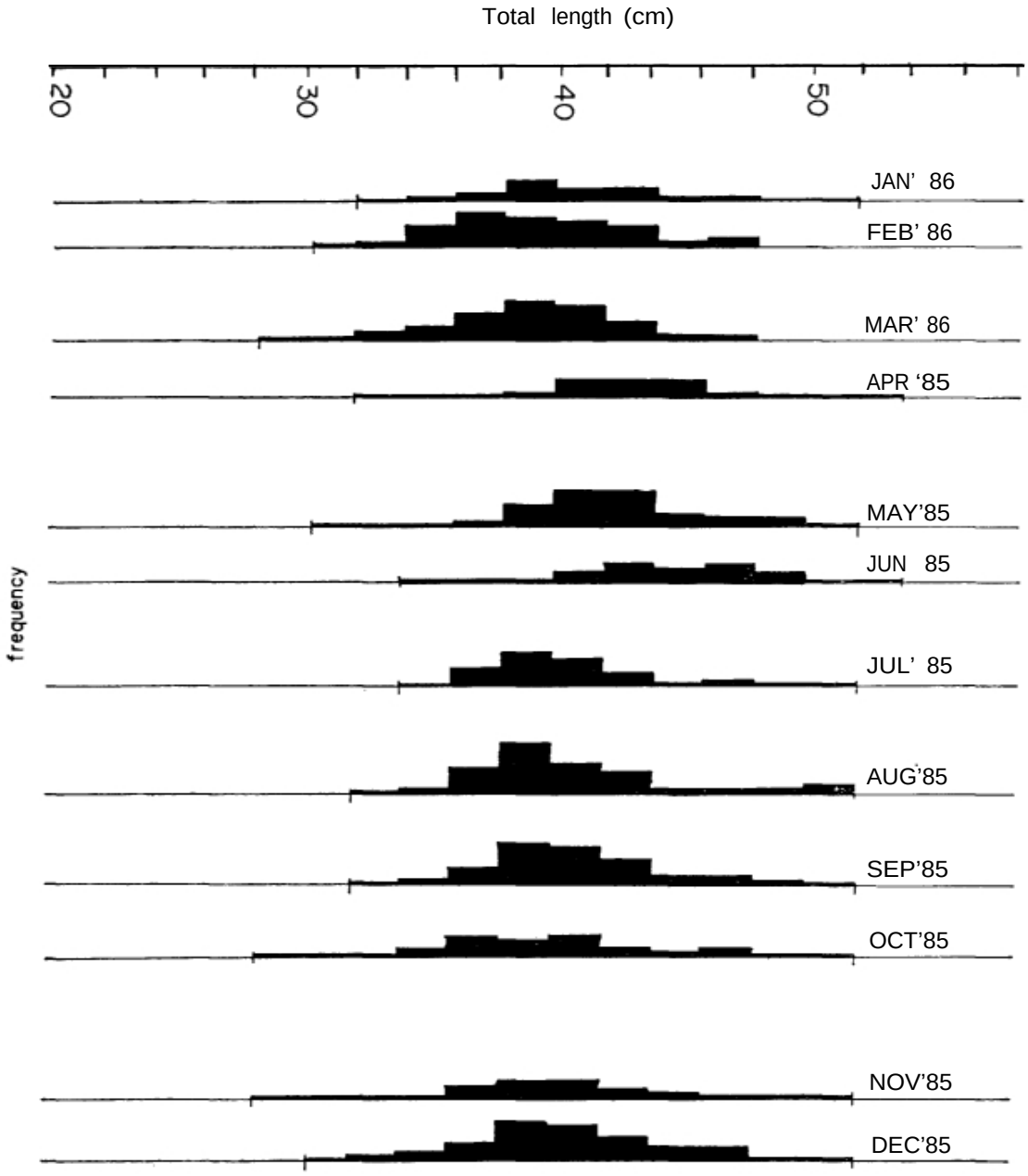

Fig. 4c Length frequency distribution at Chittagong, 1985-86 with 2 cm group intervals.

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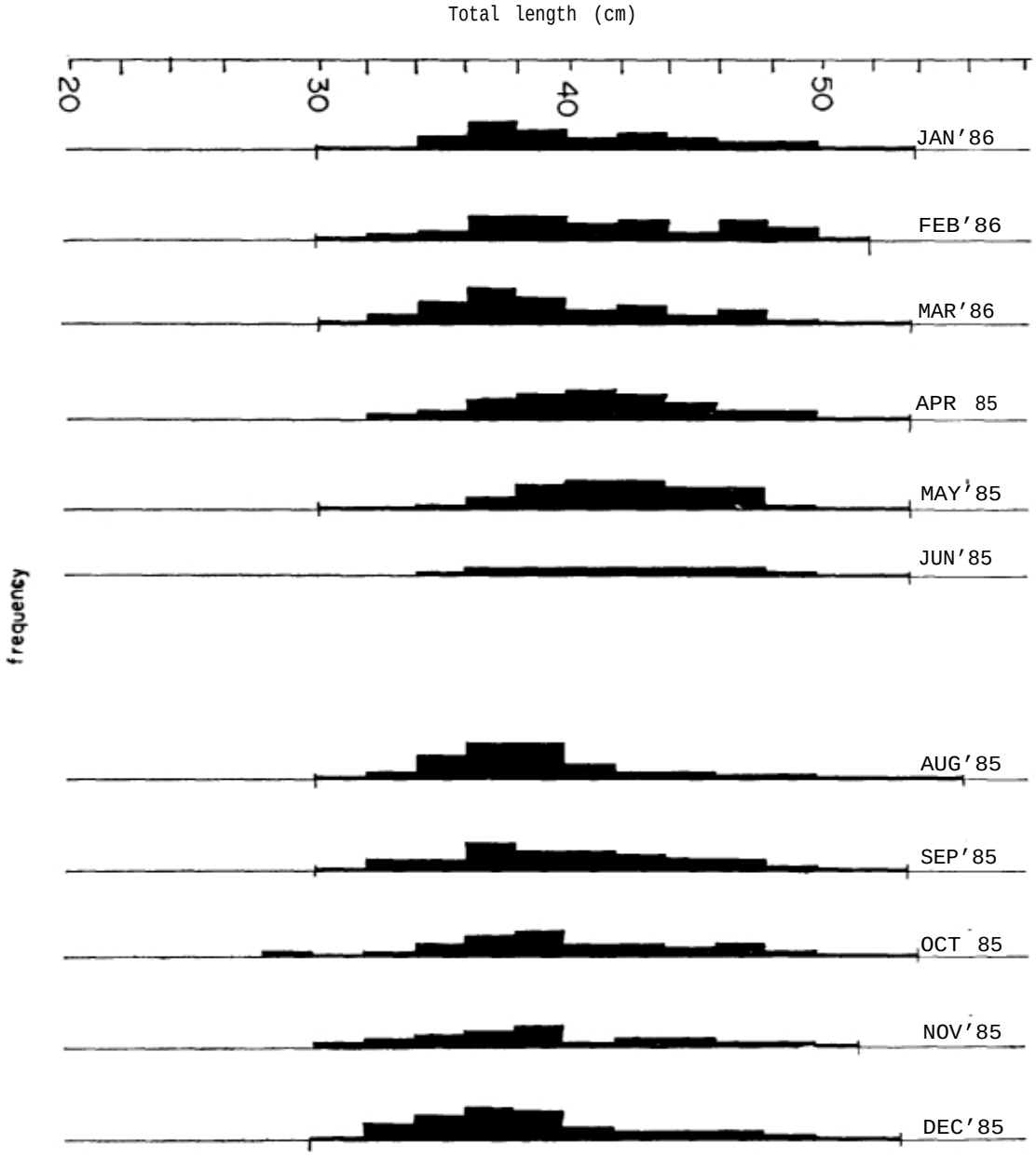

Fig. 4d Length frequency distribution at Cox's Bazar, 1985-86 with 2 cm group intervals.

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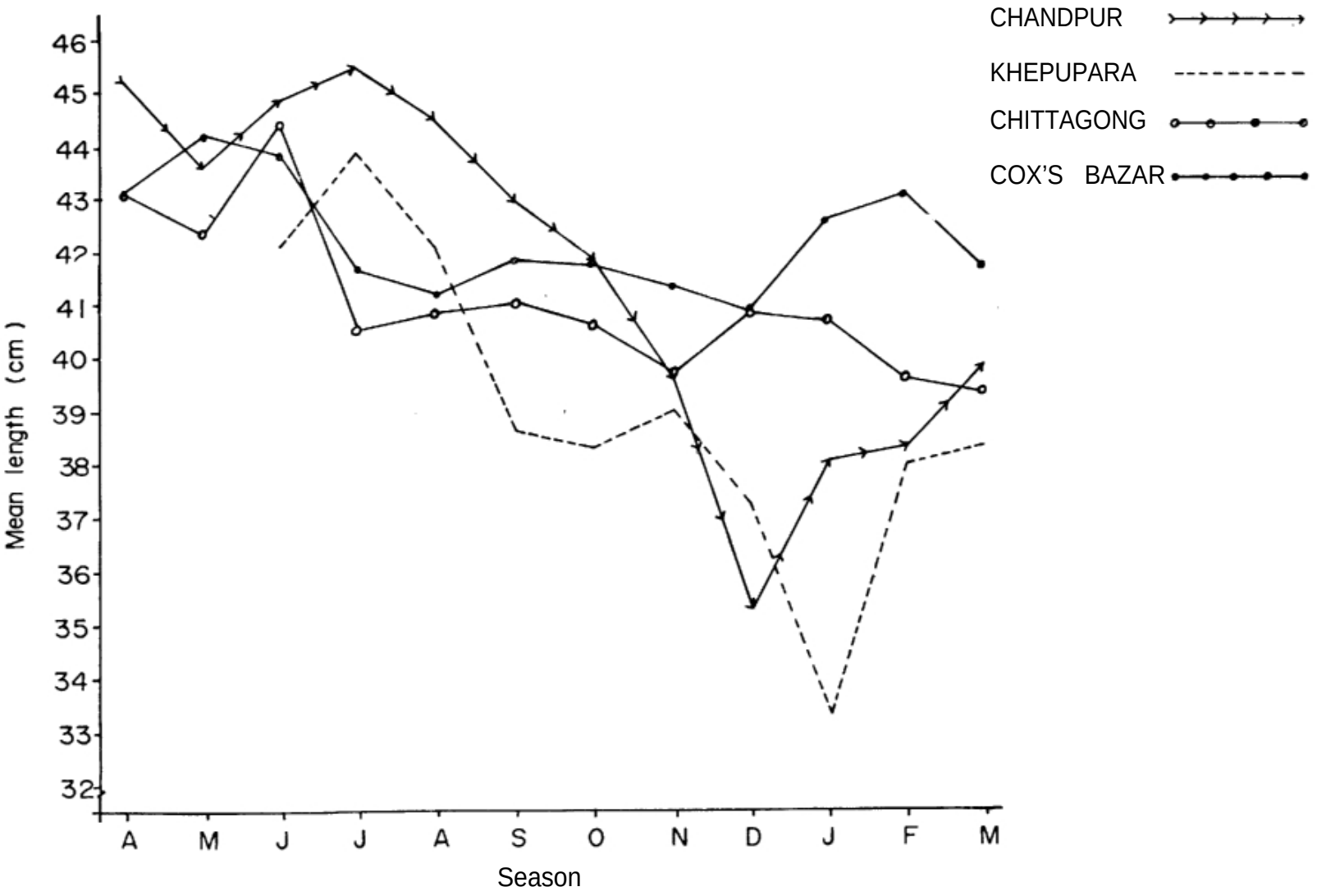

Fig. 5 Seasonal variations in the mean length of Hilsa ilisha at the four sampling stations iuring

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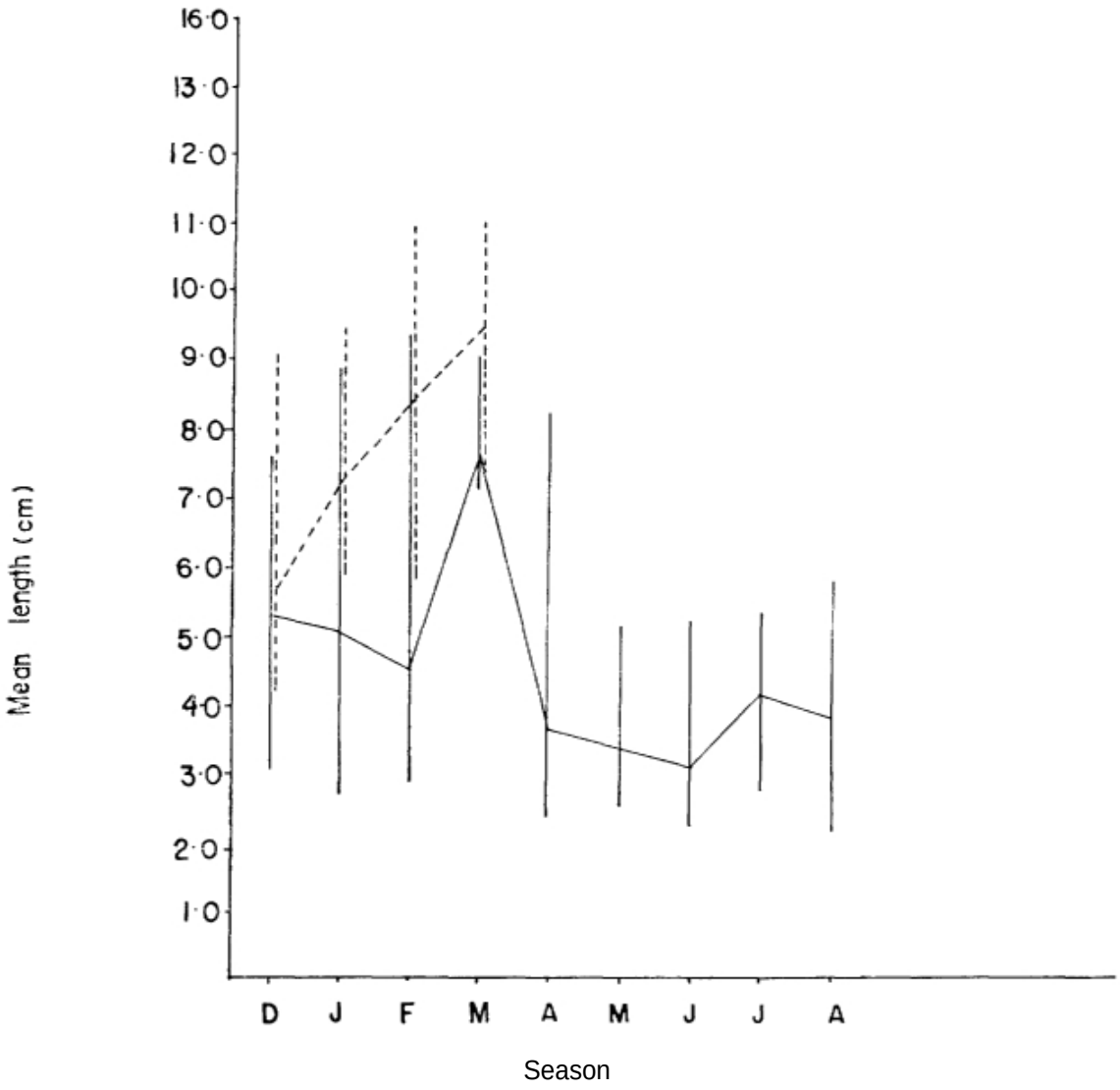

Fig. 6 Mean total length (continuous horizontal line) and length range (vertical line continuous) of juvenile hilsa caught by beach seine at Chandpur and set bagnet at Khepupara (broken line).
(data from the thesis by M. Hossain)

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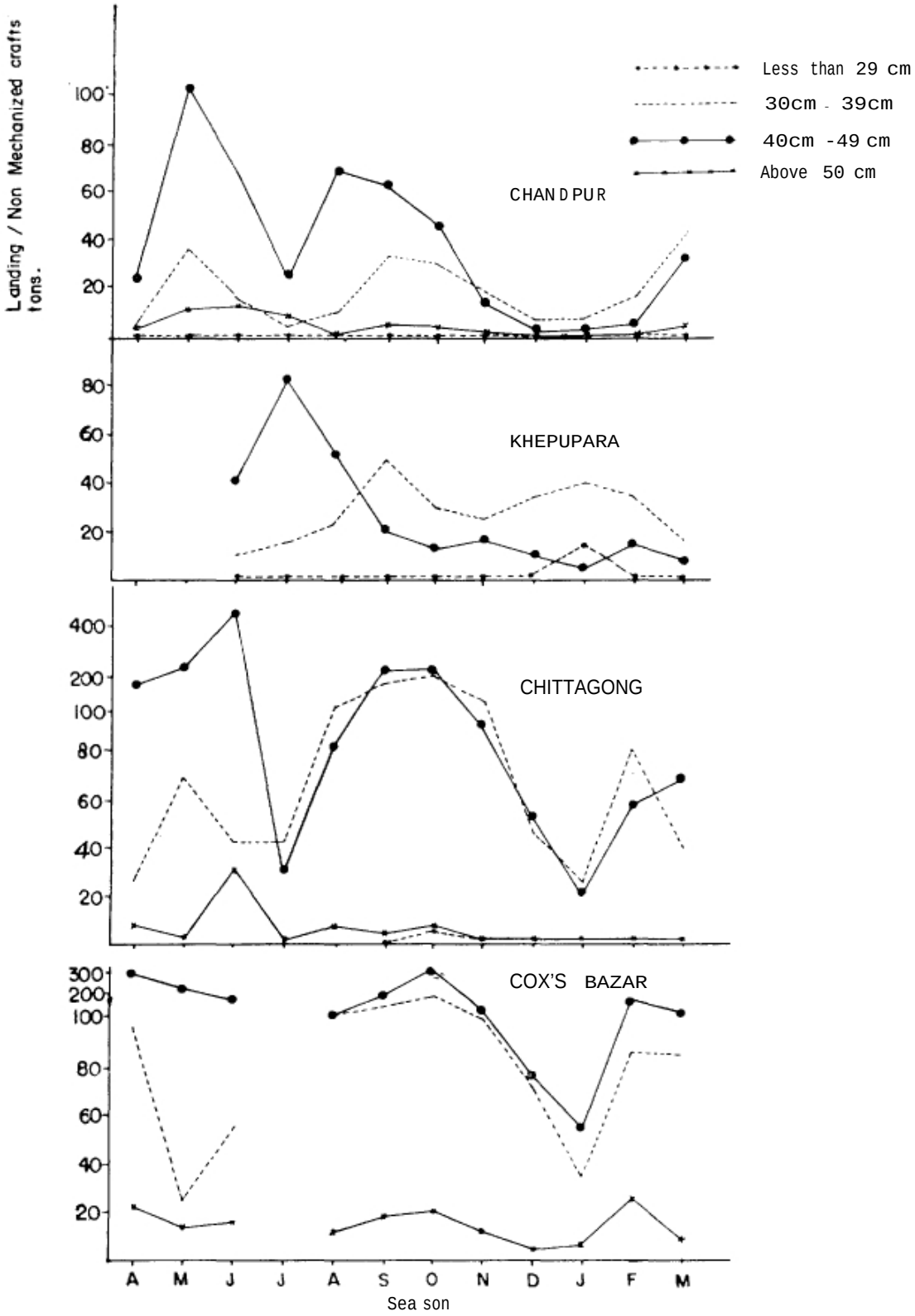

Fig. 7 Abundance of different size groups by month.

Annexure 3 Appendix I

LENGTH/DEPTH DISTRIBUTION OF HILSA

Landing centre :
Biologist:
Date of observation :

No./Name of boat:
Length of boat/HP of engine:
Name, length and depth of gear:
Total catch in the observed boat (kg) :
Sample weight (kg) :

Depth TL (cm)	2.0	2.5	3.0	3.5	4.0	4.5	5.0	5.5	6.0	6.5	7.0	Total
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28												
29												
30												
Total												

Annexure 3 Appendix 1 (contd.)

Length/Depth distribution of hilsa

Landing centre:
Biologist:
Date of observation:

No/Name of boat:
Length of boat/
HP of engine:

Name, length and depth of gear:
Total catch in the observed boat (kg)
Sample weight (kg):

DEPTI(m)	6.0	6.5	7.0	6.5	8.0	8.5	9.0	9.5	10.0	10 .5	11.0	11 .5	12 .0	12 .5	3.0	13.5	1.0	14 .5	15.0	Total
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Chittagong and Cox's Bazar, and the appearance of a small peak of the medium-size group in February was also witnessed in both places. However, during winter there was a relative decline in the strength of the large-sized group in Chittagong, which resulted in medium-size groups becoming dominant during this period.

It may be that the large-size group of fish, which shows a peak in April at Cox's Bazar (the same happens in Chittagong around June), moves into the estuarine and riverine areas. In Khepupara and Chandpur, peak catches of the large-size group of fishes were observed in July and August respectively, which probably remained in these environments until spawning. From October there was a sharp fall of the large-sized group of hilsa in all the stations. The general decline could also be due to the fish moving into upstream areas beyond the sampling station. As regards the winter spawning on the other hand, the medium-sized group was abundant from July in the marine sector and migrated towards the estuarine and riverine areas where it was believed to spawn in winter.

The small-size group 20-29 cm had not made a significant contribution to the hilsa catches in any of the environment strata, probably because they were concentrated in an eco-system not covered by the fishery. Small quantities of this group were captured from Khepupara during January and off Chittagong in October. There were a few records of this size from the fresh water from November to February. They probably become available to the fishery only when they attain 30 cm size.

Similarly, the extra-large size group above 50 cm was also relatively low. It appeared in the fishery throughout the year in the Cox's Bazar and Chittagong landings, and from March to November in Chandpur, but almost nil in Khepupara at any time of the year.

Restricting the discussion only to the two important groups, the large and the medium, it appears that in the marine stations from July to next March, the catch rates (by weight) are similar. Considering the fact that the medium-sized fish would be certainly more numerous for a unit weight, it is obvious that they are the backbone of the fishery from July through March. It is then that most of the annual landings take place. It is only from April to June that the larger fish dominate the landings and contribute to heavy catches, especially at Cox's Bazar. There is also no doubt that the medium-sized fish outnumber the larger fish at Khepupara right from September to March and from November to March in Chandpur. There, it is the medium-sized fish which are the mainstay in the fishery for about eight months in the year, starting in July in the marine sector but shifting to September in the estuaries and November in the rivers. This group during the period goes into the next category; the large one, 40-49 cm now, becomes dominant from April onwards in all the sectors, till the first batch of medium-sized fish appear in the fishery, first in the marine sector.

In the Sunderbans, the commercial fishery is supported by the medium-sized 30-38 cm group (Sarkar, 1957). In the river Jamuna, it is seen from the tabulated statement of Ghosh (1967) showing the distribution of dominant size groups, that the small-cum-medium sized fish in the size range of 23 to 38 cm was more frequently represented than the other size groups, while the success of the fishery depends upon additional contributions from the larger fish in the 38 to 50 cm group. This is very similar to the situation obtained in the previous study also. In Chilka lake, it is the small and medium-sized fish in the size range of 24 to 40 cm which support the fishery (Thingson and Natarajan, 1969; Ramakrishnaiah, 1972). Although the reasons are rather outdated, the only information available indicates that the larger fish were dominant in the central and southern parts of the Burmese coast and the medium-sized fish in the northern Arakan coast. Interestingly, the small-sized fish in the 20-29 cm group were seen in the northern coast in January, November and September (FAO, 1970 and 1971).

The upstream migration of winter spawners and the downstream migration of summer spawners as spent fish are likely to intermingle at various positions in one or the other environment. Such intermingling may also be caused by use of different mesh sizes in the fishery. More intensive and extensive investigations in Bangladesh, Burma and India would help to obtain a clearer picture of movement and distribution of *Hilsa ilisha* in the Upper Bay of Bengal.

3.5 Mesh selectivity

A wide range of mesh sizes are used in the hilsa gillnet; more than one mesh size may be used in any one locality or area during a particular season. As a result, the selectivity effect of all the mesh sizes on the length frequency distribution becomes complex and quite often tends to produce confusing results. Further, the combination of mesh sizes used in any area changes seasonally. Based on years of fishing experience, fishermen determine the mesh sizes to be used during a particular time, in a particular area. The combination may influence the size composition of catch, in which the observed composition may not be representative of the actual population in that area. In another paper in this series (Huq et *al.,* 1986) this aspect has been dealt with in some detail. Suffice to say that the results of the analysis of gilling of hilsa show a wide range of length size being caught by each mesh size and considerable overlapping of size distribution of two nets of different mesh sizes.

Entangling and gilling collectively produced a wider range of distribution than that which could be expected if the fish were only gilled in a particular size of mesh. As a result, modal progressions are evident to some extent and these may have to be used for estimating the growth parameter. When length frequency of different mesh sizes is combined for an area and season, the modal progression tends to get destroyed and the data fail to reveal useful information. It is therefore necessary to separate the length frequencies according to mesh sizes, in which case, as Van der Knaap et *al.* (1986) showed, it would be possible to obtain growth and population parameters from the length frequency data.

4. SUMMARY

1. Length frequency data collected from March 1985 to April 1986 from the four selected sampling places show that the general size range of hilsa in Bangladesh is 21 to 56 cm total length. More than 90 per cent of the catch falls within the range of 30 to 50 cm. Modal length is around 41 and 47 cm in riverine stations, 37 cm in the estuary and 39 cm in the marine area. Smaller sizes were observed in Khepupara. Juveniles from the set bagnet fishery of Khepupara and the shore seine fishery of Chandpur exhibited a length range of 2.1 to 15.1 cm from December 1985 to April 1986.

2. The length frequency diagram shows negative progression of modal sizes and is clearer in riverine and estuarine stations than in the marine station.

3. Chandpur and Khepupara have wide mean length size ranges of 33-34 cm to 44-45 cm. In Cox's Bazar and Chittagong the range is shorter, 39 to 44 cm. The general mean length size in Bangladesh is 40.5 to 45.5 cm from April to August, 38.3 to 42.5 cm during September to November and 33.3 to 43.1 cm from December to March.

4. Hilsa have been classified into four size groups, small (less than 30 cm), medium (30 to 39 cm), large (40 to 49 cm) and extra large (above 50 cm).

Catches of large-size groups in rivers improve mainly during the south-west monsoon; these are probably for spawning migration. Medium size groups, again based on CPUE, are dominant in winter; they also probably migrate for winter breeding. This is roughly the picture in both Chandpur and Khepupara. In marine areas, the large-size group distinctly dominates over the medium size one for about four months from April-July. Thereafter, from the next month there is not much difference in the catch rates between the two groups. But the medium-sized fish are numerically more than the large-sized fish. The small-sized group (20-29 cm) has not appeared significantly in the observation. Small quantities of this group were obtained from Khepupara during January and off Chittagong in October. This size group is mentioned in riverine records during November to February. The large-size group was poorly represented in marine and freshwater areas and was almost absent in the catches in Khepupara.

5. A wide range of mesh sizes is used in the hilsa gillnet fishery during different seasons and

at different stations. So the selectivity effect of all mesh sizes makes analysis and length frequency data very complex.

6. The results are discussed vis-a-vis the information in some earlier reports, and certain postulations made.

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