# ON THE WINTER BREEDING OF *HILSA ILISHA* (HAM.) IN THE GANGA RIVER SYSTEM

by

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## ABSTRACT

Winter breeding of *Hilsa ilisha* (Ham.) in the Gangetic System has for long been a controversial issue. While some authors doubted the possibility of winter breeding, others differed in their opinion as to the time of spawning. The present investigation has shown that the species breeds in the fresh water sector of lower Ganga around Bhagalpur from late February or early March to the last week of April. The spawning ground has also been broadly demarcated and it is shown that water temperature, current velocity and standing crop of plankton influence the spawning and that the resident 'Slender' variety (Ghosh *et al* 1968) is responsible for the post-winter spawning.

## INTRODUCTION

Conflicting opinions were expressed by different authors about the winter breeding of *Hilsa ilisha* (Ham.). On the basis of the availability of young *Hilsa* in the Pulta Water Works, Hora and Nair (1940) and Hora (1941) surmised that the fish breeds throughout the year in the river Hooghly with the main peak period between July-August and a small peak in May. On the other hand, Jones and Menon (1951) contended that the breeding in the Hooghly is very restricted, if not at a stand still, during the winter months of December and January. Their contention was based on the scantiness or non-availability of the prelarvae and postlarvae of the species in the routine plankton hauls. Studying the early growth pattern of *Hilsa ilisha* in the Hooghly, Sujansinghani (1957) inferred that the spawning of *Hilsa* cannot be demonstrated to cease by about January and hinted at the possibility of restricted spawning during January and February. Depending on the pattern of ova maturation, Pillay (1958) concluded that there are two spawning seasons of *Hilsa* in the Hooghly, one from the onset of the south-west monsoon to November and the other from January to February or March. From studies on the distribution and abundance of fish larvae in the Hooghly estuary, Ravish Chandra (1962) concluded that there is no winter spawning of this species and that the fish breeds during the monsoon months with one peak in August and another in October. If we accept the contention of Jones and Menon (1951) and Ravish Chandra (1962) that there is no winter breeding of *Hilsa* two questions immediately come to mind:

Proc. Indo-Pacific Fish. Coun., 13(II): 132-142.

1) From whence come the juveniles, recorded by Sujansinghani (*op. cit*) in the month of February and suggesting the possibility of winter spawning?

2) What happens to the matured ovarian ova recorded by Pillay (1958) pointing to the possible winter breeding?

Therefore, the possibility of winter breeding of *Hilsa ilisha* cannot be completely overruled. However, previous investigations were mainly localised in the estuarine belt of the Ganga System and its fresh water sector was largely ignored in spite of the possibility of *Hilsa* spawning in this sector (Southwell, 1914) and the availability of the fish throughout the year (Prasad, 1919). Motwani *et al* (1957) suggested that the breeding of *Hilsa* in the Ganga appears to commence with the beginning of the monsoon season in July and continues till December with the peak breeding from September to December. Studying the morphological and histological features of the gonads of *Hilsa* of the River Ganga at Benaras, Nair (1958) concluded that the oogenesis reached its peak in March and the ova undergo atresia and resorption. These observations appear to indicate that there is no winter spawning of *Hilsa* in the fresh water sector of the Ganga System too. However, the systematic larval survey conducted by the Central Inland Fisheries Research Institute during the years 1965 and 1966, revealed the presence of postlarvae of *Hilsa ilisha* in the collections during the month of March thereby indicating the possibility of winter spawning of this species in the system or at least extended spawning beyond the month of December. (Central Inland Fisheries Research Institute Report, June, 1966) and demonstrating the need for further investigation to find out whether there is extended breeding beyond December or whether the larvae were the result of a separate breeding cycle unconnected with the monsoon run. The present account provides information on the nature of winter breeding, its duration and the stock to which it pertains in the lower sector of the Ganga river, based on observations made during the winter and post winter seasons of 1968.

## SURVEY PROCEDURE

Concurrent with the examination of the *Hilsa* landings as to the state of maturity of the fish and the sub-populations to which they belong, regular tow net collections with 1/2 m. organdie ring net were made in the main river at Bhagalpur at weekly intervals from January onwards. The sampling was undertaken for a period of half an hour in the shallow reaches of the river in the surface and sub-surface layers, where the total water depth ranged between 0.65 m. to 1.30 m. Each collection was separately preserved and analysed to find out the bathymetric preference of the *Hilsa* larvae. Occasional sampling was carried out beyond this water depth to find out the magnitude of distribution of *Hilsa* larvae in such water zones. Based on the reported time of spawning towards the afternoon and evening hours (Jones and Menon, 1951) and early hours of the morning (Karamchandani, 1961) collections were made both in the morning and evening hours, preserved in 5% formalin and the *Hilsa* larvae identified (Jones and Menon, *op.cit.*). Turbidity, water pH, water and air temperature and current velocity and plankton concentration were also recorded to find out their possible relation with the spawning of the fish.

## RESULTS

Though the investigation was initiated in January 1968, the *Hilsa* larvae were first recorded in the samples collected on 5 March 1968 and thereafter continued to appear in the collections till 24 April 1968. The magnitude of their availability during this period, with their size ranges are presented in Table I.

According to Jones and Menon (1951) the early larvae of 4.5 to 5.0 mm in length would be about 4-5 days old. Using the availability of this group as the index of spawning it may be inferred that the breeding of *Hilsa* started towards the beginning of March and continued till late in April with the maximum peak towards the middle of March and another minor peak towards the middle of April. However, the growth studies of *Hilsa* larvae by Karamchandani (*op.cit.*), suggest that spawning might have started a little earlier than the beginning of March.

The distribution of larvae in different water zones covered by this investigation and their bathymetric preference is given in Table II which reflects a preference of the larvae for the marginal waters in the regions where the total depth from surface to bottom does not exceed approximately 1.30 m. Some collections made beyond this depth, to about 2.00 meters, revealed that though few larvae are available in the surface layers, practically no larvae occur in the deeper layers. Possibly the high current in such zones affects their distribution of the larvae. Hubbs (1943) suggested that larvae be divided into prolarvae or postlarvae on the basis of presence or absence of yolk. The *Hilsa* larvae recorded from this area were found to bear yolk till they are 7 mm in length and may, therefore, be considered as prolarvae and those beyond this length may be grouped as postlarvae. The distribution of prolarvae and postlarvae is shown in Table III which indicates that the prolarvae prefer surface waters whereas postlarvae have no particular preference and are distributed throughout.

## RELATION WITH ENVIRONMENTAL FACTORS

The present investigation demonstrates that in the lower stretches of the Ganga River, the fish breed during the post winter months of March and April, a period separated from the monsoon spawning in this stretch which commences about July and continues till October (Annual Report, Central Inland Fisheries Research Institute, 1965-1966). The winter generally ends here by the beginning of February and its effect does not last for more than a fortnight thereafter. Therefore, this breeding cannot be construed to be winter spawning and the authors consider it as post-winter or early summer spawning of the species since there is no well demarcated spring season here (Jones, 1957) and the summer condition sets in soon after the end of winter. However, the same may not hold true for all places and times of spawning may differ. It is, therefore, worthwhile to consider some of the environmental factors which may be responsible for such spawning.

While the air temperature, water pH and turbidity do not appear to have any bearing on the commencement and continuance of the spawning, water temperature, current velocity and planktonic condition appear to have some influence (Table IV). The water temperature was recorded by dipping the bulb of

a centrigrade thermometer well below the water in the river itself at the collection site while the surface current velocity was recorded by float method (Welch, 1948) with a cork and a spindle. It will be seen that lowering of water temperature after an initial rise with a low water flow prompted the spawning activity while the low water flow without initial rise of the water temperature or high water flow with a rise of water temperature had no effect. Though the current velocity could not be recorded on some occasions due to excessive windy condition, yet, from the general pattern, it may be inferred that the current velocity maintained at uniform level throughout the period after the commencement of the spawning. The water temperature, however, varied and comparison with Table I will indicate that the larval concentrations were higher on the dates recording lower water temperatures compared to the preceding dates indicating thereby that spawning magnitude fluctuated with the fluctuations in the water temperature. During the entire period of larval availability the river was rich in plankton with the zooplankters predominating. With the decrease in the zooplankton the larval availability also decreased till it became almost negligible when the zooplankton formed only 60% of the standing crop of net plankton on 23 April 1968.

## SOURCE OF THE SPAWNING POPULATION

Jones (1957) observed that the rise in the river temperature is mainly responsible for the upstream migration of winter *Hilsa* towards the close of the season. Working on the American Shad, Talbot (1953) concluded that low water flows and high water temperature influenced the time of passage of the American Shad into the rivers.

Jones (*op.cit.*) further contended that such migrations are associated with breeding. With the closing of the connection with River Bhagirathi after December (Jones, *op.cit.*), the only course of such migration to the River Ganga is through the River Padma and should be reflected in the landings at Lalgola. The comparative monthly *Hilsa* landings at Lalgola and Bhagalpur for the months prior to and beginning of the spawning are presented in Table V.

This shows that there had been no ingress of *Hilsa* from outside the area and hence the spawning was due to a resident population. The figures also exhibit that such a population congregated in Bhagalpur region during January and spread out in subsequent months - probably in search of suitable spawning grounds.

Ghosh *et al* (1968) established the existence of three sub-populations of *Hilsa ilisha* in the Gangetic System. Applying the discriminant scores suggested by Ghosh *et al* (*op.cit.*) to the fish catches, it was observed that the "slender" variety predominated in the catches at Bhagalpur during the months prior to and at the commencement of spawning (Table VI).

A very high percentage of this variety consisted of specimens in advanced stages of maturity while the other varieties consisted of either immature fish or fish in resting stages and, therefore, it may be concluded that the "slender" variety breeds in this region during the post-winter months and that they tend to congregate at this region from the downstream areas.

## POSSIBLE BREEDING GROUND

Jones and Menon (*op. cit.*) cautioned that the availability of gravid specimens and young fish at a place should not be taken as the criterion to fix the breeding grounds especially for a migratory fish. Even the procurement of laid eggs may not be a sound criterion for locating the spawning ground since the eggs would drift to distant places with the flow of waters in the river.

Though there was no migration from outside the system, the population, which is responsible for post-winter breeding, was observed to have wide distribution and movements within the system. Therefore, to locate the possible breeding grounds, the availability of mature specimens, spent individuals and presence of larvae were taken as the criteria. During this season *Hilsa* fisheries operated at Colgong, about 31 km. downstream of Bhagalpur, at Bhagalpur proper and at Sultanganj about 27 km. upstream of Bhagalpur in this stretch. Catches from all these centres are brought to Bhagalpur fish assembly centre. An examination of the catches indicates that the landing from Sultanganj had a very high proportion of gravid and spent specimens while those from Colgong were in different stages of maturity. Collections from Bhagalpur had gravid specimens and few spents. The fishery at Sultanganj was of a greater magnitude than other two places and therefore, it may be inferred that the breeding ground lies between Sultanganj and Bhagalpur.

## CONCLUSION

The winter breeding of *Hilsa* in the Gangetic System, including its estuarine component has hitherto been a controversial issue. The present investigation has demonstrated spawning by a resident population in the freshwater sector of the lower Ganga after the winter season when the water warms up. Such a phenomenon may also exist in those environments where there is a resident population of *Hilsa* or the species form a sizeable fishery during the winter. During the course of tagging operation undertaken by the senior author in February 1959, at Chinsurah, on the river Hooghly, a large number of freely oozing gravid males and females were found in the catches of 'Sangla Jal' in that area, suggesting the possibility of winter breeding. Perhaps, due to the selection of the sampling stations and the oscillation of the water flow due to tidal actions, the larvae had a limited distribution and so were not recorded in the samples collected by Ravish Chandra and hence further investigations are needed. This is all the more necessary because Pillay (1957) concluded that the *Hilsa* stock observed in the Hooghly estuary during monsoon months of 1955 was distinctly different from the stock found near the mouth of the same estuary during the winter season. If we accept the contention of Prasad *et al* (1940) that the fish do not migrate deep into the sea and remain in the inshore waters, the possibility that the winter stock, recorded by Pillay, would be breeding in the Hooghly cannot be ignored and deserves special attention to properly understand the character of *Hilsa* fishery and its impact on the potential production in the Gangetic system since the fish are likely to be distri uted in the freshwater sector also during the monsoon months as revealed by the similarity of the stocks at Lalgola and the Hooghly during pre-1955 years.

The possibility of presence of other spawning areas in the upstream exists, because, during the course of *Hilsa* investigations in Allahabad region of the same system, the senior author recorded the frequent collection of juvenile *Hilsa* in the commercial catches in the summer months of 1963. From Sujansinghani's (*op. cit.*), studies these juveniles appeared to be 2-3 months old indicating spawning in the area towards the closure of winter. Hence, it may be said that, like the Fraser River Sockeye (Ricker, 1950), in the Ganga System also, there are up-river and down-river spawnings of *Hilsa ilisha* during the post-winter months. Whether the spawnings at different stretches are due to different populations of *Hilsa*, or due to a dispersal of the same population, is not known. The failure of the monsoon runs in the Ganga during the recent past, observed by Ghosh (1967) points to the fact that the potential *Hilsa* fishery in the Gangetic System might be determined to a large extent by the success of the post-winter breeding to replenish the stock. The "slender" variety has been observed to have a wide distribution over the system. If this sub-population is also responsible for the upriver post-winter spawning, it may be inferred that a part of this stock congregates in the upstream areas for spawning purposes and a proper understanding of such stock is required since the cumulative results of spawning success and survival will determine the strength of the population in succeeding years and consequent fluctuation in the fishery. If some other sub-population is breeding in that region, the correct appraisal of the sub-population responsible for such spawning is also essential because, the *Hilsa* fishery, as a whole, in any particular year, is determined by the strength of individual sub-populations available in the system.

## ACKNOWLEDGEMENT

The authors express their gratitude to Dr. V.G. Jhingran and Shri H.P.C. Shetty for the opportunity accorded for this investigation and for going through the manuscript and suggesting improvements.

## REFERENCES

Government of India (1966). Report for the Quarter Ending 30th June 1966. Central Inland Fisheries Research Institute, Barrackpore, West Bengal. P. 24.

----------. Annual Report 1965-66, Central Inland Fisheries Research Institute, Barrackpore, West Bengal. P. 47.

Ghosh, A.N. (1967). Observations on the *Hilsa* Fishery of the River Jamuna During the Years 1955-62 at Allahabad. Jour. Zool. Soc. India 17(1 & 2): 135-149.

Ghosh, A.N., P.K. Bhattacharya and K.V. Rao (1968). On the Identification of the Sub-populations of *Hilsa ilisha* (Ham.) in the Gangetic System with a Note on their Distribution. Proc. Nat. Inst. Sci. 34, B(1).

Hora, S.L. (1941). Life History and Wanderings of *Hilsa* in Bengal Waters. Jour. Roy. Asiat. Soc. Bengal, Sci. 6(2): 93-112.

Hora, S.L. and K.K. Nair (1940). Further Observations on the Bionomics and Fishery of the Indian Shad, *Hilsa ilisha* (Ham.), in Bengal Waters. Rec. Indian Mus. 1940 a, 42: 35-50.

Hubbs, C.L. (1943). Terminology of Early Stages of Fishes. Copeia, 1943(4): 260.

Jones, S. and P.M.G. Menon (1951). Observation on the Life History of Indian Shad, *Hilsa ilisha* (Ham.). Proc. Ind. Acad. Sci. 30(3): 101-125.

Jones, S. (1957). On the Late Winter and Early Spring Migration of Indian Shad, *Hilsa ilisha* (Ham.) in Gangetic Delta. Ind. Jour. Fish. 4(2): 304-314.

Karamchandani, S.J. (1961). On the Location of Spawning Grounds of Indian Shad, *Hilsa ilisha* (Ham.) in Freshwater Regions of Narbada River. Current Sci. 30(10): 373-375.

Motwani, M.P., V.G. Jhingran and S.J. Karamchandani (1957). On the Breeding of Indian Shad, *Hilsa ilisha* (Ham.) in the Freshwaters. Sci. and Cult. 23: 47-48.

*Nair, P.V. (1958). Seasonal Changes in the Gonads of *Hilsa ilisha* (Ham.) Philip. J. Sci. 87(3): 255-276.

Pillay, S.R. and H. Rosa, Jr. (1963). Synopsis of Biological Data on *Hilsa ilisha* (Ham.) 1822. FAO Fisheries Biology Synopsis No. 25.

Pillay, T.V.R. (1957). On the Abundance of *Hilsa*, *Hilsa ilisha* (Ham.) in the Hooghly and Padma Rivers during 1955. Ind. Jour. Fish. 4(1): 150-159.

---------- (1958). Biology of *Hilsa ilisha* (Ham.) of River Hooghly. Ind. Jour. Fish. 5(2): 201-257.

*Prasad, B. (1919). Annual Report of Department of Fisheries Bengal, Bihar and Orissa, for the Year Ending 31st March 1919.

Prasad, B., S.L. Hora and K.K. Nair (1940). Observation on the Seaward Migration of the So-called Indian Shad, *Hilsa ilisha* (Ham.). Rec. Ind. Mus. 42(4): 529-552.

Ravish Chandra (1962). Preliminary Account of the Distribution and Abundance of Fish Larvae in the Hooghly Estuary. Ind. Jour. Fish. 9, Sec. A(1): 48-70.

Southwell, T. (1914). Report on *Hilsa* Hatching Operation Conducted at Monghyr, Bihar During August, September and October, 1912. Bull. Dept. Fish. Bengal, Bihar, Orissa. 1914, No. 4.

* Not consulted in original.

Ricker, W.E. (1950). Cycle Dominance Among the Fraser Sockeye. Ecology. 31: 1-28.

Sujansinghani, K.H. (1957). Growth of Indian Shad, *Hilsa ilisha* (Ham.) in the Tidal Stretch of the Hooghly. Ind. Jour. Fish. 4(2): 315-335.

*Talbot, G.B. (1953). The Passage of Shad at the Bonneville Fishways. U.S. Special Scientific Rep. Fish. 94: 1-30.

Welch, Paul S. (1948). Limnological Methods. McGraw Hill, Pub. New York.

*Not consulted in original.

Table I

Availability of *Hilsa* larvae and their size ranges on the days of sampling.

| Sl. No. | Date of collection | Total No. of fish larvae | Total No. of *Hilsa* larvae | Size ranges of *Hilsa* larvae |
|---|---|---|---|---|
| 1. | 5.3.1968 | 26 | 21 | 4.5 mm. to 7.0 mm. |
| 2. | 12.3.1968 | 108 | 55 | 5.5 mm. to 7.5 mm. |
| 3. | 19.3.1968 | 635 | 399 | 5.0 mm. to 15.0 mm. |
| 4. | 26.3.1968 | 67 | 60 | 4.0 mm. to 13.0 mm. |
| 5. | 2.4.1968 | 146 | 106 | 4.5 mm. to 8.0 mm. |
| 6. | 9.4.1968 | 42 | 30 | 5.0 mm. to 13.0 mm. |
| 7. | 16.4.1968 | 117 | 87 | 5.0 mm. to 7.0 mm. |
| 8. | 23.4.1968 | 4 | 2 | 6.0 mm. to 7.5 mm. |

Table II

Bathymetric preference of *Hilsa* larvae.

| Sl. No | Date of collection | Total No. of *Hilsa* larvae at | | |
|---|---|---|---|---|
| | | *0.65m. total water column | 1.30 m. total water column | |
| | | | Surface | Sub surface |
| 1. | 5.3.1968 | 8 | 1 | 12 |
| 2. | 12.3.1968 | 22 | 14 | 19 |
| 3. | 19.3.1968 | 39 | 180 | 180 |
| 4. | 26.3.1968 | 11 | 30 | 19 |
| 5. | 2.4.1968 | 63 | 26 | 17 |
| 6. | 9.4.1968 | 2 | 20 | 8 |
| 7. | 16.4.1968 | 21 | 47 | 18 |
| 8. | 23.4.1968 | 2 | - | - |

* The diameter of the ring net almost covered the entire water zone from surface to bottom.

Table III

Distribution pattern of prolarvae and post larvae at different water zones

| | 0.65 m. total water column | 1.30 m. total water column | |
|---|---|---|---|
| | | Surface | Sub Surface |
| 1. Prolarvae | 43 | 219 | 195 |
| 2. Postlarvae | 81 | 85 | 60 |

Table IV

Environmental condition prior to and with the commencement of larval availability

| Sl. No. | Date of collection | Air Temp. in C | Water Temp. in C | Water pH | Turbidity in ppm. | Current velocity in Km./Hr. | PLANKTON | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Condition | % Composition Zoo | Phyto |
| 1. | 13.2.1968 | 26.5 | 19.5 | 8.2 | 112 | 1.8 | Rich | 95 | 5 |
| 2. | 20.2.1968 | 22.5 | 19.5 | 8.5 | Less than 107 | 1.2 | Rich | 95 | 5 |
| 3. | 27.2.1968 | 33.5 | 25.5 | 8.2 | do | 1.5 | Rich | 95 | 5 |
| 4. | 5.3.1968 | 27.5 | 23.5 | 8.2 | do | 1.2 | Rich | 95 | 5 |
| 5. | 12.3.1968 | 33.8 | 26.5 | 8.2 | Extremely windy conditions | | Rich | 95 | 5 |
| 6. | 19.3.1968 | 22.5 | 24.0 | 8.5 | do | | Rich | 95 | 5 |
| 7. | 26.3.1968 | 33.5 | 28.5 | 8.5 | do | | Rich | 95 | 5 |
| 8. | 2.4.1968 | 24.0 | 22.0 | 8.5 | 110 | 1.2 | Rich | 90 | 10 |
| 9. | 9.4.1968 | 35.0 | 28.0 | 8.2 | Less than 107 | 1.2 | Rich | 80 | 20 |
| 10. | 16.4.1968 | 32.5 | 27.0 | 8.8 | do | 1.2 | Rich | 75 | 25 |
| 11. | 23.4.1968 | 35.5 | 29.5 | 8.8 | do | 1.2 | Rich | 60 | 40 |

*_Hilsa_ larvae appeared for the first time.

**_Hilsa_ larvae practically disappeared.

Table V

Monthly Pattern of *Hilsa* landings at Lalgola on River Padma and Bhagalpur on River Ganga (in m. tons)

| Months | Lalgola | Bhagalpur |
|---|---|---|
| Dec. '67 | 0.24 | 0.71 |
| Jan. '68 | 0.21 | 1.52 |
| Feb. '68 | 0.15 | 0.36 |
| March '68 | 0.19 | 0.89 |

Table VI

Percental distribution of individual sub-populations of *Hilsa ilisha* at Lalgola and Bhagalpur from Dec. '67-March '68

| Sub-Population | Dec. '67 | | Jan. '68 | | Feb. '68 | | March '68 | |
|---|---|---|---|---|---|---|---|---|
| | Lal-gola | Bhagal-pur | Lal-gola | Bhagal-pur | Lal-gola | Bhagal-pur | Lal-gola | Bhagal-pur |
| "Slender" | 24.71 | 73.82 | 18.72 | 71.95 | 7.84 | 57.29 | 8.69 | 75.79 |
| "Broad" | 22.35 | 15.88 | 26.74 | 19.75 | 23.49 | 26.06 | 23.92 | 14.26 |
| "Broader" | 52.94 | 10.30 | 54.54 | 8.30 | 68.67 | 16.65 | 67.39 | 9.95 |