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THE INDIAN SHAD, *HILSA ILISHA* (HAMILTON) IN THE SEA

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THE Indian shad, *Hilsa ilisha* (Ham.), has long been considered as a fluvial anadromous fish with feeding grounds in the sea and spawning grounds along considerable stretches of the lower and middle reaches of big as well as small rivers of India. However, Prashad¹ and Hora² cast doubt on the true anadromous habit of this valuable clupeid and considered it as a fluvial fish that does not go down beyond the estuary; since then, although various workers have observed either juveniles or adults in inshore waters,³⁻⁹ there has been some reluctance to consider the anadromous habit of hilsa. It is stated that even if hilsa does enter the sea, it is confined to inshore waters or to the "foreshore";^{4,8,9} it is however most unlikely that this medium-sized active fish resorts to an intertidal habitat during its extra-fluvial phase. A review of the literature shows that the fluvial anadromous stocks of hilsa do enter the sea, but that the available data on the movements in the sea are inadequate to determine the extent of their seaward migration because there are just no observations, negative or positive, beyond the continental shelf.

The recent record by Pillay¹⁰ of maturing, mature and spent hilsa in the sea, 9 to 12 miles off Veraval (in Saurashtra, Gujarat State) on the north-west coast of India adds a new dimension to the known behaviour of this fish; Pillay offers evidence that this particular stock of hilsa probably spawns in the sea. All previous records of mature and spent hilsa are from rivers.

Nikolsky¹¹ has observed that the reasons why anadromous fishes have not migrated completely to the sea where there are more favourable feeding conditions, but have retained their spawning grounds in freshwater, are

1. if they transferred their spawning grounds also to the sea, they would have to protect their spawn, as otherwise the latter would all be eaten, and

2. since migratory fishes mostly have a considerable hunting area and perform considerable feeding migrations, the adults would starve and die if they were to remain on the spawning ground to protect their spawn through a protracted incubation period. By retaining spawning grounds in the river, the eggs can develop through at least part of the juvenile stage in the river, where they are subject to far less danger than in the sea.

If the Saurashtra stock of hilsa does breed in the sea, how has it solved the problem of spawning in a *milieu* new to the species? Specifically, what is the type of eggs (demersal, semibuoyant or pelagic) and how have the problems of protection of eggs and larvae and of osmoregulation been solved? The eggs of hilsa spawning in rivers are demersal;^{6,12} they rest lightly on the bottom in still water and drift when there is a current;^{12,13} the eggs and larvae are not guarded or protected by the parents. Further, how does the fecundity of the Saurashtra hilsa compare with that of the stocks spawning in rivers? In this connection, it should be noted that in the same region, there is a fluvial anadromous stock spawning in the Narbada River.¹²⁻¹⁵ One may expect that if the Saurashtra stock of hilsa does breed in the sea, the fecundity should be at a higher level than that of normal stocks spawning in rivers (where mortality of eggs and larvae would be much less) if the former stock in its new *milieu* is not to decline. A comparison of the fecundity of mature hilsa from Saurashtra coast and from Narbada River should prove valuable.

The investigations to date on *Hilsa ilisha* thus indicate the possible existence of three ecotypes of this species:

1. Fluvial anadromous stocks that feed and grow in coastal waters and spawn in middle or lower reaches of rivers above

the level of tidal influence. Such would be the hilsa of the Hooghly, Godavari and Narbada.

2. Fluvial hilsa (physiologically but not geographically land-locked stocks) that inhabit the middle reaches of rivers and are potamodromous. Such are probably the hilsa as occur at Delhi, Agra, Allahabad and Buxar in the rivers Jamuna and Ganga.¹⁶⁻¹⁹ According to Jhingran,¹⁸ adult hilsa occur at Buxar throughout the year and Pillay, Rao and Mathur¹⁹ suggest that hilsa of the upper Ganga do not go even to the lower reaches of the Ganga-Brahmaputra system.
- 3 Marine hilsa as have been observed by Pillay¹⁰ off Veraval on the Saurashtra coast. It is not yet established whether these are 'purely' marine or whether the juveniles observed in the nearby Kodinar area²⁰ are the progeny of the adult mature hilsa that apparently spawn at sea. Pillay¹⁰ states that adult hilsa do not occur in the small rivers in the neighbourhood.

The first of the above three types is the normal condition in this species, and there is extensive literature pertaining to this type.²¹ Relevant references since 1952 are given at the end of this paper. However, there are still lacunæ in our knowledge of the movements of the anadromous stocks. At what stage in their life do fluvial anadromous hilsa descend to the sea? There are two views with regard to the period of life when they undertake the downward migration for the first time. According to Raj,²² based on observations in South Indian rivers, they spend the first two years in estuaries and the third year at sea before returning to the river for spawning, while Prashad, Hora and Nair²³ and Jones and Menon⁶ believe that in the Hooghly, they descend into the sea during the first year of their life. There is no doubt that juveniles occur in the rivers^{2,6,20,24,25} and can grow in confined water.^{2,26} Juveniles are also reported as having been observed in the sea.^{6,7,9} A biometric analysis of these juvenile fish caught in the sea should prove rewarding. Most of the work on adult hilsa is on specimens collected in rivers and estuaries. Practically no investigations have been carried out on adult hilsa caught in the sea. The records of hilsa in the sea^{4,5,7,8} presumably refer to adult hilsa. Pillay⁹ specifically refers to catches of large hilsa in winter at Junput on Contai coast in West Bengal.

One major reason for our limited knowledge of the behaviour of hilsa is that studies to date

have been based on commercial catches, which are neither satisfactory nor adequate, because commercial gear is selective by its very nature and/or seasonal in its application. The problem of the extent of migration of the hilsa can be solved by employing, at frequent and regular intervals throughout the year, suitable least-selective types of gear at various points in the rivers, in the estuaries and in the sea, and by large-scale tagging. It is recognised that these are expensive studies, but probably not much more expensive than a number of discrete observations, restricted in scope or in area of investigation. Such studies are moreover justified by the fact that they would help to determine any regulation of fishing seasons, size groups and quantities that may have to be introduced.

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