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THE PHYLLOSOMA LARVAE OF THE INDIAN OCEAN*

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ABSTRACT

Despite the fact that at least 18 species of palinurid lobsters and nearly 20 scyllarids are definitely known from the Indian Ocean region, the complete life histories of only very few of them are understood. Practical difficulties in this line of investigation are many, as in the case of most marine fishes and other Crustacea. Nevertheless, some earlier attempts have been made to correlate the various larval stages with adults of the species. Several hitherto undescribed phyllosomas have recently become available, based on which this account tries to give a brief review of the variety of the phyllosomas and their general distribution in the Indian Ocean.

INTRODUCTION

IN almost all the marine plankton studies we come across reference to the phyllosoma larvae and several workers in the recent past, particularly following Gurney (1936), have tried to establish the identity of some of these larvae. Quantitatively phyllosomas do not form a significant item in routine plankton collections from any region. Apart from their apparent scarcity, there seem to be problems which had led to the inadequate progress in our knowledge of this group of larvae. Among the many difficulties, the more important one concerns their identification. The larval life passes through a series of at least ten or twelve stages over some months and hardships are many in keeping the larvae alive through this period if one is to follow the transformations from the first to the final stage. In nature they get widely distributed during such extended phase of their growth and development until finally they get metamorphosed into the adult to lead a demersal life. Under such conditions it is difficult to get a dependable connected series of the same species. Further, a close resemblance amongst the early stages of many species or between related genera renders difficulties in absolute identifications. To cite one instance, when the newly hatched larvae of two species of *Panulirus*, viz. *homarus*(=*burgeri*) and *ornatus* are compared, their close similarity in many respects has been pointed out by Prasad and Tampi (1959). The same kind of almost closely related characteristics can be observed amongst most of the hitherto known larvae, especially of allied species. In more advanced larvae certain structural differences become apparent but even these may not help very much in separating individual species. Combinations of known identifying characteristics such as in the structure of antennae, third maxilliped or abdominal region, make it further difficult to distinguish definitely even some of the genera. Except perhaps in rare instances it is now possible, with a fair amount of certainty, to separate the palinurids from the scyllarid larvae. Specific identity of the lobster larvae, based on actual hatching from eggs and supported by subsequent rearing, is even now restricted to a relatively small number. These include *Ibacus ciliatus* (Harada, 1968), *Panulirus ornatus, P. burgeri, Thenus orientalis* and *Scyllarus sordidus* (Prasad and Thampi, 1959-66), *P. longipes* (Saisho

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and Nakahara, 1960), *Parribacus antarcticus* and *Scyllarus bicuspidatus* (Saisho,1962). In most other cases, the species identification has been largely based on circumstantial evidence, depending on the localities of occurrence of both the larvae and the adult at the same place. While this is an obvious limitation, until we are able to successfully adopt modern techniques of rearing the larvae through the various stages, we may necessarily have to rely tentative correlation based mainly on occurrence.

In the Indian Ocean region there are at least 18 species of palinurids under 9 distinct genera and another 20 species of scyllarids belonging to 5 genera. The general distribution of these adults in the Indian Ocean has been broadly indicated by Prasad and Tampi (1968). Doubtless, there seem to be other species in both groups occurring in these regions although at present we have hardly any reliable information.

Two principal sets of collections from the Indian Ocean region, *viz.*, DANA collections of 1928-1933 and the IIOE Standard Collections of 1952-65, constitute the basis of this report. The systematics of these material are still being worked out and will be published in due course. Pending such species identification, the discussions below will be confined mainly to an overall distribution pattern of the palinurid and scyllarid groups of larvae in the Indian Ocean. The paucity of phyllosoma larvae in most of the general plankton collections, as already indicated, makes quantitative generalisations rather difficult. Several isolated collections in the past have yielded limited number of larvae and these may only be indirectly referred to in this account.

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DANA AND IIOE PHYLLOSOMAS

Some general facts regarding these two major collections may be presented here as they are relevant to the discussions that follow. As regards the "DANA" collections, it may be said that the material has been obtained from along a definite route commencing from the coast of the Eastern Archipelago cutting across towards Ceylon and thence to the Madagascar via the Maldives-Seychelles, and finally from Mombasa to the Cape through the Mozambique channel and E. coast of S. Africa. The cruise had thus left off both the Bay of Bengal and Arabian Sea, eliminating the Burma-India-Arabian region. All the sampling stations come to lie in a definite path and so the area is somewhat restricted. Stramin nets (with 400-500 strands to 100 cm) have been used for horizontal hauls and vertical hauls with modified Nansen net have also been made from selected stations. From amongst the 169 stations in the Indian Ocean 75 stations have yielded phyllosoma larvae in varying numbers. Thus, a total of 1983 larvae, comprising an extraordinary variety, assorted species and stages have been obtained, making the DANA collections by far the biggest source of material for these studies. A preliminary account of these larvae has already been published by Prasad and Thampi (1965).

The phyllosomas available to the author from the IIOE standard net collections are numerically far inferior to those from the DANA collections. The IIOE samples have been collected by a number of different research vessels at various stations scattered over the entire Indian Ocean region through a period covering nearly 32

months from 1962-65. The earliest record of phyllosoma in these collections is in May 1962 by "Pioneer" while no larvae is available since the cruise of "Meteor.' in January 14, 1965. The IIOE Station List (IOBC, 1969) has indicated the methodology of collection. The IIOE Standard collections, according to their explanation are those vertical hauls with an Indian Ocean Standard net from 200 m depth or from as close to the sea bottom as possible. A total of only 74 phyllosoma larvae have been obtained from all over the region. It is seen that only a fraction of each sample has been sorted out although the larger forms seem to have been retained. In this process, there is a chance that some of the smaller ones of less than about 3 mm particularly belonging to the earlier stages, could have escaped sorting. Such sub-sampling and any loss of individuals can affect quantitative expressions especially as more than one species may be present in each collection. The approximate depth and the column of water through which the vertical haul was made is indicated by the length of wire out, although the wire angle in some cases has not been available. The actual depth at which any particular larva has been trapped cannot be determined in these cases. Another point is that there seems to be some likelihood of the influence of the pattern of cruises of the different participating research vessels which had apparently their own programme and limitations while making these standard type collections. In such cases it is possible that certain area would not have been adequately sampled while other regions might have received relatively greater attention. However, the IIOE zooplankton stations in general may be said to have given a fairly wide and uniform coverage of the entire region including the Central Indian Ocean.

From the point of view of any quantitative study or for a critical examination of the distribution of these larvae over space and time, both these principal collections seem to have limited value. Despite such drawbacks, certain general and tentative conclusions seem to be justified at this stage after having examined the larvae obtained from the Indian Ocean.

DISTRIBUTION OF PHYLLOSOMAS IN THE INDIAN OCEAN

Examining as a whole all the available material and data from this region, only some very generalised inferences on the distribution of lobster larvae seem justified. As regards the spatial distribution of the larvae is concerned the DANA material has revealed their comparatively greater concentration near the coastal areas, islands and Archipelagoes while the deeper regions of the Arabian Sea, Bay of Bengal and Central Indian Ocean are almost devoid of these larvae. There is thus a predominence along the E. African Coast, from South Africa to Mombasa but their population dwindles as we proceed north along the Somali Coast and beyond. From Madagascar to the South Indian and Ceylon region, via the Seychelles-Maldives chain of islands, their density is high and this more or less continues towards the Malayan and Indonesian Archipelago. The West coast of Australia also shows some moderate distribution of the larvae. As far as the coastal waters of India and Pakistan both in the Arabian Sea and Bay of Bengal, we have only stray records of phyllosomas based on routine plankton collections. But generally their occurrence in such regions seems to be rare and there seems to be a natural paucity of these larvae in the northern boundaries of the Indian Ocean. Thus, the fact that the IIOE stations also have not brought out any larvae from these regions seems to be significant, despite the fact that the participating vessels such as 'Kistna,' 'Varuna' and 'Zulfiquar', had made collections from these regions during both the monsoons. Except for these few records along the South Arabian Coast, the whole of the Central Arabian Sea above about 10°S is a region poor in phyllosoma. The

same observation may be made about the Bay of Bengal which also shows a sparse population of these larvae only along the Burma-Malayan Coast, but for which the rest of the region is devoid of many records. Perhaps the pattern of distribution of adult lobsters may be one of the major influencing factors in this respect. Both in numbers and in species the E. African coast dominates with about 10 palinurids and 5 scyllarids. The occurrence of larvae along the coast of Aden Protectorate can be explained in view of the well known crawfish fishery of this region (George, 1963). Along the African and South Indian waters, there seems to exist a vast population of lobsters which are known to constitute a fishery of some magnitude. It is so in the Maldives-Seychells Seas also. Similarly on the eastern half of the Indian Ocean where a moderate concentration of the larvae is observed from the Indo-Malayan Archipelago and down south along the west coast of Australia, limited numbers of palinurids and scyllarids have been known to occur.

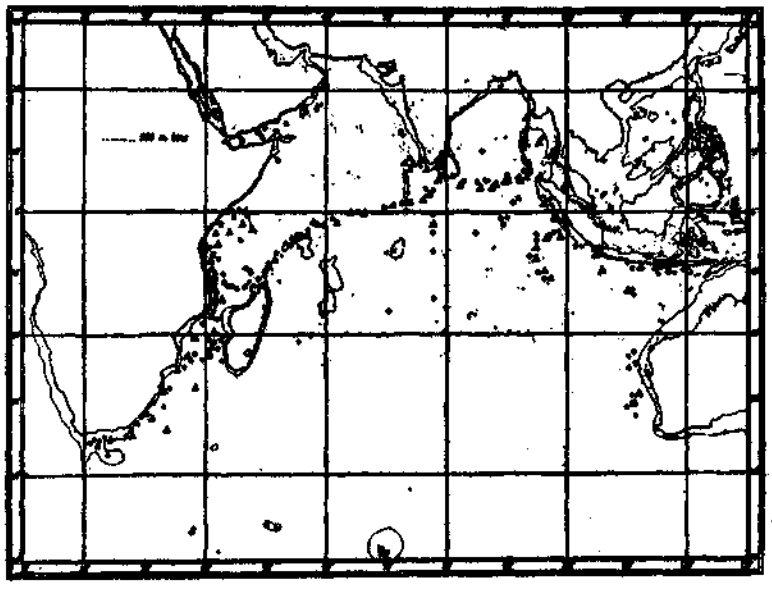

Fig. 1 Map showing distribution of phyllosoma larvae in the Indian Ocean. (Compiled from the major collections and reports of Gurney 1936, DANA 1930, IIOE 1962-65, Prasad and Tampi 1957-66, Saisho 1966). Palinurids are represented by solid circles and scyllarids by triangles.

During the IIOE apparently some participating agencies have been making non-standard hauls also of which the collections of 'Kagoshima-maru' are of special interest. A large number of larvae have been captured in a series of horizontal hauls with a 160 cm larval net, between 7° N and 10° S and between 75°-90° E. Based on these, Saisho (1966) has given some facts relating to their distribution with reference to oceanographical conditions. According to him, the average density of these larvae per sq. km varies from 3200 in 5° N to 0° and in 20° -25° S. He also remarks that the occurrence of the larvae in some of the off-shore stations would indicate that waters of almost all areas were being mixed up to same degree with coastal waters. The absence of the larvae beyond about 17°S, according to him, would indicate that there is no active mixing between Indian Equatorial and Central waters. In this connection the record of two larvae from the Central Indian

Ocean, one of the 'Anton Bruun' and another by 'Umitaka-maru' is also worth mentioning. Both are palinurids, the former one being an early stage and measuring only 3.7 mm, while the latter with a length of 15.5 mm represents a comparatively later stage of another species. These seem to be some of the stray individuals which have been carried to such distant regions along with the surface currents.

Apart from the habitation of the adult lobsters, certain hydrographical factors of these regions also should be exerting some influence in the distribution of these phyllosomas. In general it may be observed that the areas of poor phyllosoma catch coincide with regions of low zooplankton biomass and especially the decapod larvae. Prasad (1969) has briefly discussed the pattern of water circulation in relation to zooplankton biomass. The IIOE Plankton Atlas (Vol. II, Fas. 1, 1970) also generally records a relatively greater concentration of decapod larvae in the coastal areas in the Indian Ocean, especially in the shelf regions. Similarly, the Central Indian Ocean below the Equator and between 50° and 110° E and the central areas of the Bay of Bengal and Arabian Sea are regions of poor decapod larval populations. One is inclined to accept that major factors like depth, influence of heavy drainage from the major rivers such as the Indus in the Arabian Sea and the Ganga in the Bay of Bengal, as also the pattern of water currents in these regions, have some effect on the distribution or dispersal of these larvae which have a protracted planktonic life. While no distinction between seasonal occurrence or between day or night collections are apparent, it may be pointed out that the data available hitherto do not permit any more critical discussion on these aspects relating to distribution.

The available data also do not reveal any significant facts bearing on their distribution in relation to depth or their movements in the water column according to the time or in relation to the stages of development. However, the 'Dana' collections have indicated that compared to the very surface layers, there seems to be a tendency for the larvae to concentrate between 50 and 100 m and also some accumulation at about the 300 m level (Prasad and Tampi, 1966). A small number have been met within regions having a depth of 3500 m. The IIOE standard net collection material is not helpful in supplementing these facts.

Without going into the complex systematics, one point that may be mentioned here is the enormous variety of larvae seen in the DANA collections, while the IIOE material which consists of only about 74 larvae is limited to less than a dozen each of palinurids and scyllarids. The accompanying Map indicates the distribution of these two predominant groups of larvae. It may be seen that both palinurids and scyllarids are equally present along the E. African-Mozambique region and towards the southern coast of India. The larvae collected along the W. Australian and Saudi Arabian coast are predominantly palinurids, with an isolated scyllarid in the Red Sea. More extensive data through intensive collections alone would give us a proper understanding of the distribution of these larvae.

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