J. mar. biol. Ass. India, 1990, 32 (1 & 2) : 236-247

A RESUME OF THE STUDIES ON EARLY DEVELOPMENTAL STAGES OF MARINE OSTEICHTHYES IN INDIA WITH SUGGESTIONS FOR FUTURE RESEARCH*

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ABSTRACT

With more than seventy years history of research on identification of the early developmental stages of marine bony fishes in India, it is time now to assess the present status and to look forward for future lines of work. The number of species whose one or more developmental stages have been documented so far is less than 300, forming about 23% of the total species reported from the country. The maximum output of important publications is in the fifties, followed by the sixties. In spite of these advances, only in a few cases that absolutely all the stages have been documented. Of the two methods of identification, the 'hatching method' has not progressed well so far, chiefly because oozing stages of most marine Osteichthyes are difficult to collect. Until ship-board and shore-based facilities are developed and/or perfected much more than as at present, in a country like India for the time being, there is no alternative, but to depend upon the 'series method' of identification. For this method to be effective, all the developmental stages of the concerned species should be documented. To achieve this, much more extensive and intensive collections are needed. Also, in order to make effective comparison and contrast of the developmental stages of allied species and genera, it is essential to define and standardise the important phases of development as well as to employ drawing skills, so that an uniformity of approach can be achieved. Besides, new characters, subtle features and differences in developmental sequences have to be found out and documented.

INTRODUCTION

AN ABSOLUTE knowledge on the identity of eggs, larvae, postlarvae and juveniles of marine osteichthyes is an essential prerequisite for determining their distribution and abundance, undertaking spawning surveys, monitoring the dynamics of exploitable stocks and yields, identifying new stocks, clarifying taxonomic problems and for collecting seeds for culture (Ahlstrom, 1954, 1966, 1968; Ahlstrom and Moser, 1976, 1981). Realising this fact, considerable work has been carried out on identification of the early developmental stages in various parts of the world, from the second half of the last century. In the recent past, three international symposia were conducted, one in 1973 (Blaxter, 1974), the second in 1979 (Lasker and Sherman, 1981) and the third in 1983 (Kendall and Marliave, 1985). Also, compilation and documentation on the various developmental stages have been done, the notable publications being those of Uchida *et al.* (1958) and Mito (1966) in Japan, Russell (1976) in Britain and Jones *et al.* (1978), Hardy Jr. (1978 a, b), Johnson (1978) Fritzche (1978), Martin and Drewry (1978) all from Mid-Atlantic Bight, Ozawa (1986) from Western North Pacific and Mataresc *et al.* (1989) from Northeast Pacific.

In India, according to Talwar and Kacker (1984) there are about 1,400 marine fishes of which 100 belong to elasmobranchs and the

* Presented at the 'Symposium on Tropical Marine Living Resources' held by the Marine Biological Association of India at Cochin from January 12-16, 1988.

rest to Osteichthyes. Perhaps the first publication on the eggs and larvae of marine Osteichthyes from India is that of Bhattacharya (1916). Thereafter, there has been a steady increase in research on this subject, especially by many maritime Universities. With the establishment of Central Marine and Inland Fisheries Research Institutes by the Government of India in the late forties, further impetus was given to this subject on a national basis. Realising the importance of this subject in the marine fisheries of the country, Jones (1951) has brought together all available literature on this subject till then, followed by an annotated bibliography by Jones and Bensam (1968) comprising both Osteichthyes and Chondriichthyes and including fresh water species. With a past history of 73 years of progressive research in the subject and in the present context of modern techniques and new methods of studies introduced such as scanning electron microscopy, electrophoresis, etc. it is felt essential to make an objective appraisal of the research work carried out in the country so far, to assess the present status and to formulate suggestions for future course of action which will accelerate investigations on understanding the most crucial phase forming the basis of population dynamics.

The author is indebted to Dr. P. S. B. R. James, Dr. S. Jones, Dr. S. Z. Qasim and Dr. R. Natarajan for the help rendered and encouragement given in this work on fish eggs and larvae. Thanks are due to Dr. P. V. Rao for going through the present paper and offering comments.

A Resume of Work Done

While attempting to make an objective appraisal, it is found that a good proportion of the publications deals only with the occurrence, distribution, size groups and/or abundance of one or the other developmental stage of certain species. Since the publications with improper identification and uncertainties are of limited value for follow-up identification, they are not taken into account for the purpose of the present paper. But, only the papers which give adequate descriptions and/or figures of the developmental stages dealt with are considered for the present purpose and are listed in Table 1. As the number of papers even after this screening is too many, in the present paper only those issued from India subsequent to the Bibliography by Jones and Bensam (1968) are cited under 'References'. For the papers referred in the present account published prior to it, the above publication may be consulted.

Present Status

From Table 1 it may be observed that since 1916 there has been a steady increase in research output on the early development of marine Osteichthyes, although most of the publications till the end of the thirties are on estuarine species. Also, it may be seen that in the initial period many identifications are based on those made elsewhere, more so from Indonesia (formerly Java) by Delsman (1922-1938). And, although more recently original contributions have been made, still quite a few identifications made are based on those done elsehwere on species distributed in other countries also. An analysis of the quantum of publications shows that the mainstay so far is from the fifties through the seventies, with peak during fifties (30%), followed by sixties (24%) and seventies (22%). Species-wise coverage also is maximum during the fifties (30%) followed by sixties (20%) and seventies (19%).

As may be seen from Table 2, there are about 290 species, whose one or the other developmental stage has been identified so far. Among the more common species treated by Fischer and Bianchi (1984) in the Indian Region, this proportion becomes 34%. Although this is impressive enough, a more in-

TABLE 1. *Decade-wise break up of the publications on the early developmental stages of marine Osteichthyes from Indian waters giving adequate descriptions and figures of the species dealt with*

Period	Author(s) of Publication(s) and name(s) of the species
1910-'19	Bhattacharya (1916) *Gobius ostericola, Petroscirtes bhattacharyae, Hemirhamphus limbatus.*
1920-'29	Panikkar (1920) *Etroplus suratensis, E. maculatus* ; Nayudu (1922) *Cypselurus.*
1930-'39	Aiyar (1935) *Acentrogobius neilli* ; Devanesan (1937) *Hemirhamphus georgii* ; Jones (1937) *Acentrogobius viridipunctatus, Boleophthalmus boddaerti* ; Job and Jones (1938) *Tylosurus strongylurus, Hemirhamphus gaimardi* ; Nair (1939) *Hilsa ilisha.*
1940-'49	Nair (1940) *Engraulis telera* ; Devanesan and John (1940) *Rastrelliger kanagurta* ; Devanesan and Chidambaram (1941) *Dorosoma chacunda, Caranx crumenophthalmus* : Devanesan (1943) *Sardinella longiceps* : Devanesan and Chacko (1944) *Dussumieria hasseltii* ; Nair : (1946) *Uroconger lepturus* ; (1947) *Muraenesox cinereus, Muraena macrura* ; (1948) *Congrellus anago.*
1950-'59	Kulkarni (1950) *Hilsa ilisha* ; Jones and Menon : (1950 a, 1951 c) *Setipinna phasa* : (1950 b, 1951 a) *Hilsa ilisha* ; (1951 b) *Brachiurus pan, Cynoglossus lingua, C. Cynoglossus* : (1952) *Coilia dussumieri* ; (1953) *Tylosurus strongylurus, Polynemus paradiseus, Ichthyocampus carce, Paragobiopsis ostericola, Callionymus fluviatilis* : Sarojini and Malhotra (1952) *Eleutheronema tetradactylum* · Jones and Pantulu : (1952) *Muraenesox talabon* ; *Pisoodonophis hijala* : (1958) *Zenarchopterus buffoni, Bregmoceros macclelandi, Callionymus melanopterus, Arnoglossus tapeinosoma, Samaris macrolepis, Solea ovata, Heteromycterias oculus, Triacanthus brevirostris, Parapegasus natans* ; John (1951) *Sardinella sirm, Opisthopterus tardoore, Anchoviella tri, Plotossus anguillaris, Centriscus acutatus, Leiognathus lineolatus, L. insidiator, L. ruconius, Pseudosciaena aneus, Psettodes erumei, Arnoglossus macrolophus, Paraplagusia bilineata* ; Bapat and Prasad (1952) *Caranx kalla* ; Nair : (1952 a) *Kowala coval* ; (1952 b) *Elops saurus, Trichiurus haumela, Therapon jarbua, Lactarius lactarius, Scatophagus argus, Gerres lucidus* ; Bapat (1955) *Sardinella fimbriata, Caranx leptolepis* ; Seshappa and Bhimachar (1955) *Cynoglossus semifasciatus* ; Chacko and Mathew : (1955) *Caranx crumenophthalmus, C. djedaba, C. kalla* ; (1956) *Sardinella albella* ; Vijayaraghavan (1957) *Engraulis grayi, Decapterus russelli, Saurida tumbil, Hemirhamphus far, Cynoglossus bilineatus* ; Kuthalingam : (1957) *Cynoglossus lingua* ; (1959 a) *Megalaspis cordyla, Caranx mate* ; (1959 b) *Saurida tumbil* ; (1959 c) *Triacanthus brevirostris* ; Nair (1957) *Ambassis gymnocephalus* ; Padmanabhan (1957) *Antennarius marmoratus* ; Sarojini (1958) *Mugil corsula, M. parsia, M. tade, M. cunnesius* ; Jones : (1958) *Xiphias gladius* ; (1959 a, b) *Istiophorus gladius.*
1960-'69	Nair (1960) *Sardinella longiceps* ; Jones : (1960 a) *Gempylus serpens* ; (1960 b) *Katsuwonus pelamis, Neothunnus macropterus* ; (1960 c) *Euthynnus affinis* ; (1961, 1963) *Auxis thazard, A. thynnoides, Sarda orientalis* ; (1962) *Scomberomorus guttatus, S. commerson, S. lineolatus* ; Balakrishnan : (1961) *Cynoglossus semifasciatus* ; (1963) *Bothus ocellatus Laeops guntheri, Solea ovata* ; Kuthalingam : (1960) *Solea elongata* ; (1961 a) *polynemus indicus* ; (1961 b) *Dussumieria acuta* ; Nair (1961) *Stigmatogobius javanicus* ; Nair and Mohamed (1961) *Muraenesox talabanoides, M. talabon, Uroconger lepturus* ; Padmanabhan : (1961) *Solenostomus cyanopterus* ; (1963) *Cypselurus comatus* ; Mahadevan and Chacko (1962) *Dussumieria hasseltii* ; Jones and Kumaran (1964) *Myripristis murdjan, Holocentrus* ; Jones (1967) *Pegasus volitans, Dactyloptena orientalis, D. macracanthus* ; Masurekar (1967) *Tylosurus crocodilus* ; Peter (1967) *Rastrelliger* ; Bensam (1968) *Opisthopterus tardoore* ; Sudarsan : (1968 a) *Syngnathoides biaculeatus* ; (1968 b) *Hemirhamphus quoi* ; Devi (1969) *Pseudorhombus elevatus.*
1970-'79	Kowtal (1970) *Nematalosa nasus* ; Rao (1971) *Omobranchus japonicus, Cruanthus smithi* ; Rao (1970) *Syngnathus cyanopsilus* ; James (1971) *Micrognathus brevirostris* ; Bensam : (1970) *Sardinella jussieu* ; (1971 a) *Kowala coval* ; (1971 b) *Anodontostoma chacunda* ; Silas and George (1971) *Vinciguerria nimbata* ; Balakrishnan and Rao (1971) *Rastrelliger kanagurta* ; *Kowtal* (1972) *Eleutheronema tetramactylum* ; Natarajan and Patnaik (1973) *Liza macrolepis* ; Rao (1973) *Hilsa kelee* ; Bensam (1973) *Sardinella dayi* ; Vijayaraghavan : (1973) *Hirundichthys coromandelensis* ; (1974) *Cypselurus*

TABLE 1 (*Continued*)

Period	Author(s) of publication(s) and name(s) of the species
	spilopterus ; Balakrishnan and Devi (1974) *Solea heinii, Cynoglossus punticeps, C. brevis* ; Silas (1974) *Rastrelliger kanagurta* ; Venkataramanujam (1975) *Saurida gracialis, Parastromateus niger, Carangoides malabaricus* ; Chaudhuri, Bhowmick *et. al.* (1978) *Mugil cephalus* ; Natarajan and Bensam (1978) *Rastrelliger kanagurta* ; Kowtal (1979) *Pseudosciaena coibor* ; Mukhopadhyay and Verghese (1979) *Lates calcarifer* ; Ramanathan and Natarajan (1979) *Pseudorhombus arsius, Bothus myriaster, Brachypleura novae-zealandiae, Synaptura albomaculata, S. commersoniana Cynoglossus macrolepidotus.*
1980-'89	Balasubrahmanyan (1981) *Gempylus* ; Devi (1981) *Psettina brevirictis, P. iijimae* ; Pillai *et al.* (1982) *Johnius carutta, Pervager tomentosus* ; George (1983) *Scomberomorus commerson* ; Lazarus (1985) *Sardinella longiceps* ; Bensam : (1984, 1986, 1987 a) *Sardinella clupeoides, S. sirm, S. albella, S. fimbriata, Ilisha melastoma, I. megaloptera, Thryssa dussumieri, Chanos chanos* ; (1987 b) *Hilsa kelee* ; (1987 c) *Valamugil seheli* ; (1988 a) *Polynemus sextarius, Sillago sihama, Gerres oblongus, G. setiferus, Upeneus (Pennon) bensasi, Lates calcarifer, Siganus javus* ; (1988 b) *Liza tade, L. subviridis* ; Lazarus (1987) *Sardinella sirm.*

TABLE 2. *List of Families of marine Osteichthyes and the number of species, one or more of the early developmental stages of which are described and the number of common species*

No. of species dealt with for eggs, larvae, post-larvae, etc.	Alphabetical list of Families and the number of common species in each Family, in parenthesis
1	Acanthuridae (9), Albulidae (1), Ambassidae (3), Antennariidae (11), Centropomidae (2), Chanidae (1), Coryphaenidae (2), Elopidae (1), Ephippidae (1), Gempylidae (7), Holocentridae (8), Kurtidae (1), Lactariidae (1), Megalopidae (1), Moringuidae (1), Pegasidae (3), Psettodidae (1), Scatophagidae (1), Sillaginidae (5), Solenostomidae (1), Symbranchidae (1), Triacanthidae (3), Tripauchenidae (1), Xiphiidae (1).
2	Anguillidae (2), Belonidae (6), Bregmocerotidae (2), Congridae (2), Dactylopteriidae (2), Fistularidae (2), Muraenidae (5), Ophichthyidae (5), Platycephalidae (8), Plotossidae (3), Scorpaenidae (8), Siganidae (8), Sphyraenidae (5).
3	Callionimidae (6), Cichlidae (3), Muraenesocidae (4), Pomacentridae (18), Tetrodonidaet (10), Trichiuridae (7).
4	Apogonidae (10), Blennidae (17), Lethrinidae (15), Pleuronectidae (4), Tetraponidae (4).
5	Gerreidae (8), Mullidae (15), Syngnathidae (12).
6	Cynoglossidae (8), Polynemidae (7), Soleidae (6).
7	Synodontidae (11).
9	Ariidae (15), Exocoetidae (15), Hemirhamphidae (6), Leiognathidae (17).
10	Bothidae (10), Mugilidae (13).
12	Gobiidae (49), Sciaenidae (28).
19	Carangidae (49), Engraulidae (15).
21	Scombridae (21).
23	Clupeidae (23)

depth analysis shows that only in the cases of a much lesser number of 100 only that all the vital developmental stages, *viz.*, eggs, larvae, postlarvae and juveniles are known adequately, mostly belonging to Clupeidae, Scombridae Mugilidae, Gobiidae, forming about 8% of the marine Osteichthyes occurring in India (Talwar and Kacker, 1984). These considerations indicate that there is urgent need to fill up the lacunae in our knowledge on the early developmental stages of the vast majority of the species as well as to document those species not yet covered.

Among the two methods of identifying marine fish eggs and larvae, the one beginning with ovarian eggs and milt of known adults and rearing upto juveniles, known as the 'hatching method' is the perfect one. In India this method has been possible only in the cases of a few estuarine and inshore marine fishes such as mullets (Natarajan and Patnaik, 1973; Chaudhuri *et al.*, 1978). But, this method cannot be followed in the vast majority of inshore and offshore fishes of India, chiefly due to the fact that marine fishes in oozing condition have been difficult to collect for stripping and artificial fertilization. It may be noted in this connection that even in temperate countries this difficulty has been experienced, even in the cases of species supporting major fisheries such as the Pacific sardine (Miller, 1952). In India also, although the oilsardine *Sardinella longiceps* and the mackerel *Rastrelliger kanagurta* are supporting the two largest fisheries, their oozing specimens, particularly females, could not be collected in enough numbers. Thus, for a country like India, with the existing facilities, the hatching method of identification has not yet been realised in the cases of most marine Osteichthyes.

In view of the above reason, workers in India have relied largely upon the second method of constructing a series of stages from juveniles, postlarvae, larvae, eggs, called the 'series method'. For this method to be successful, the whole series of stages should be available, in order to follow the vital changes in developmental characters. But, a perusal of publications from India shows that only in some cases the whole series are available and that in most cases collections are not adequate to document all the important stages. Hence, much of the recent works done in India were based on the eggs collected from plankton and the larval as well as postlarval stages hatching out of the eggs and those collected from the plankton. For identification, the circumstantial evidence of coincident occurrence of the spawning stock along with the eggs and larvae and certain diagnostic characters are relied upon. This can be valid only in the cases of species with well marked diagnostic features, spawning seasons and/or breeding grounds. But, in the cases of species which do not have such well marked characters and spawning conditions, this method can only be of limited value.

Suggestions for Future Research

Since the hatching method is the perfect one for identification, it is essential to develop this on a sound basis. In the past, due to lack of technical facilities for the collection of breeders, induced spawning, hatching, feeding the early stages, etc. both on board vessels as well as inshore laboratories, this method could not progress well. But, recent advances in India and abroad with regard to ship board facilities for collection of spawners, rearing early stages, controlling hydrological conditions and feeding the larvae have initiated possibilities for making the hatching method much more practicable at present than so far. That this method should be developed adequately becomes all the more important from the fact that for solving some of the taxonomic problems such as overlapping egg diameters and numbers as well as disposition of myomeres as in Clupeids and Mugilids, the hatching method alone can provide a solution.

Besides, as pointed out by Ahlostrom and Moser (1981) in order to make valid identification based on various characters, the specimen studied should be in the best possible condition displaying all vital characters. Although it is very much desirable to study live eggs for their various characteristics, in cases where it is not possible, great caution has to be exercised while documenting the various features. As the problem of poor preservation has been experienced particularly with regard to early larval stages, one method to overcome poor preservation may be to narcotise the collections before preserving in formalin. As drawn attention to by Ahlstrom and Moser (1981), there is need for some research on ship-board handling and preservation techniques for marine fish eggs and larvae.

One factor that has been causing some difficulty for effective comparison of the developmental stages is the ambiguity prevailing in the definition and standardisation of the stages. For instance, the egg of a species soon after its fertilization may present a set of characters such as diameter, pigmentation, etc. different from a fully developed egg ready for hatching. Also, the egg of one species at a particular developmental stage may show some characters different from a comparable stage of another species under the same genus. Although in many other countries specific definitions and standardizations of early developmental stages have been followed by most authors, a perusal of literature shows that in India most authors have not been following them. This system is particularly important in a country like India with multispecies fisheries having overlapping spawning seasons and spawning grounds. Hence, in order to bring out the differences in the characters of the developmental stages of allied species and to enable future identification by other workers in the Indian context, it is essential to standardise and define vital developmental stages. Ahlstrom and Counts (1955) while describing the eggs of the Pacific hake *Merluccius productus* have divided the embryonic period into (1) the early egg, from fertilisation to closure of blastophore, (2) the middle egg, from the closure of blastophore to the time when the tail begins to separate and curves laterally from the embryonic axis and (3) the late egg, from the time the tail is curved away from the embryonic axis to the time of hatching. Such a standardisation and definition of the eggs shall facilitate the above requirement, as also pointed out by Matarese and Sandknop (1984) and Kendall *et al.* (1984). Regarding larval stages, extending from the newly hatched condition to the disappearance of the yolk, as per the definition of Russell (1976), the newly hatched larva may be standardised as the earliest stage, as is being done at pesent. Thereafter, the every 6-hours or 12-hours old larvae may be standardised as the other stages for comparison and contrast.

In the case of postlarval phase of development, from the time of disappearance of the yolk until most juvenile features develop (Russell, 1976), three principal stages are reckoned by Moser and Ahlstrom (1970), Ahlstrom *et al.* (1976) and Moser *et al.* (1977). These stages are associated with the development of the caudal fin and its suppoting elements, before, during and after the upward flexing of the posterior tip of the notochord ; and are termed as (1) Preflexion, (2) Flexion and (3) Postflexion stages respectively. For the sake of uniformity of comparison and contrast, it is desirable to describe the postlarval development of marine Osteichthyes in relation to the above three vital conditions. Regarding the juvenile development of marine bony fishes, Russell (1976) pointed out that the postlarval sequence of development has no sharply demarcated termination because some adult characters may appear before some postlarval characters are lost. Also, it may be said that the juvenile phase of development also does not have a sharply demarcated ending at an early size. As such, it is desirable that after the Postflexion stage the vital stages may be determined depending upon major

TABLE 3. *Proposed pro forma giving standard stages in the early development of marine Osteichthyes in relation to which descriptions may be made*

Developmental phase	Standard stages
Egg	(1) Early Egg (2) Middle Egg (3) Late Egg
Larva	(1) Newly hatched Larva (2) 6 hours old Larva (3) 12 hours old Larva (4) 18 hours old Larva (5) 24 hours old Larva, etc.
Postlarva	(1) Preflexion Postlarva (2) Flexion Postlarva (3) Postflexion Postlarvae, based on length groups of 1 to 5 mm intervals until juvenile characters become dominant.
Juvenile	Variable between species and/or genera ; May be determined depending upon major changes in morphometrics, meristics and/or pigmentation, at different lengths.

developmental sequences of each genus and/or family. For example, in clupeoid fishes, the changes in morphometric proportions such as preanal length in relation to standard length, pigmentation, meristics and the like may be taken into account. A pro forma containing such stages is proposed in Table 3. for adoption in future investigations.

It has been the experience of many workers that with regard to the larvae and postlarvae of fishes like clupeids, the specimens become partly or fully curved soon after preservation due to higher proportion of length in relation to width of the body. Earlier workers on ichthyoplankton have sketched such specimens as they are. But, this has made it difficult for proper measurements and comparison of various characters. In this connection it is proposed that when it is absolutely essential to sketch such specimens, drawing skills may be employed to present the sketches in an uncurved manner, without compromising the basic characters and measurements. In such cases, if found necessary, the figures showing the natural

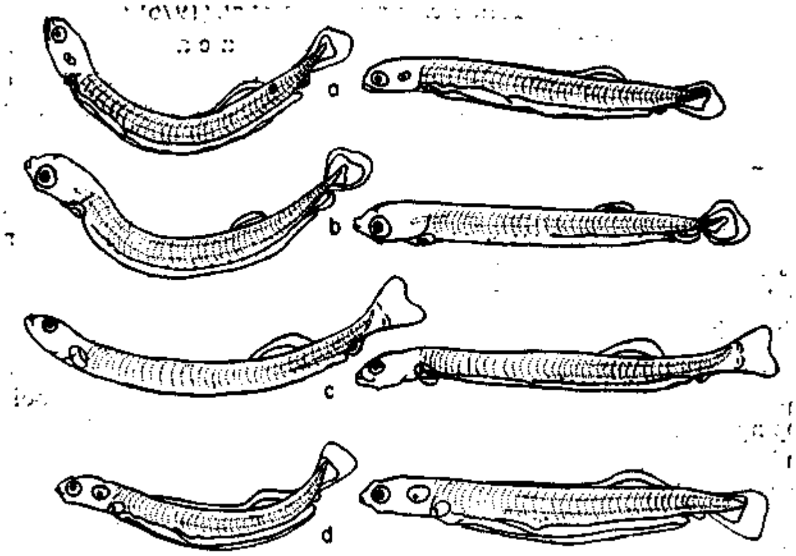

Fig. 1. Partly curved postlarvae of four species of *Sardinella* as well as the sketches redrawn in an uncurved manner : a. *S. jussieu* of 5.36 mm (curved one after Bensam, 1970) ; b. *S. longiceps* of 7.64 mm (curved one after Lazarus, 1985) ; c. *S. fimbriata* of 11.4 mm and d. *S. albella* of 6.64 mm (uncurved ones after Bensam, 1984, 1986 are redrawn from curved specimens).

appearance also may be given along side the redrawn ones. Redrawings of the figures of some curved specimens presented as such by a few previous workers are given in Fig. 1, for comparison in this regard. Besides, in India usually the developmental stages of a species are drawn each to its respective magnification. For instance, a postlarva of 5 mm when magnified to 10 times for its figure becomes 50 mm and another stage of 20 mm becomes 200 mm for its figure. Such a presentation of the figures of two or more developmental stages of the same species may not facilitate easy comparison, contrast and comprehension. On the other hand, when the stages are magnified to the same final proportions for the figures, easier comprehension is possible. The reduction or enlargement can be accomplished after making the first Camera lucida drawing, with the aid of photostat facilities as exemplified in a case presented in Fig. 2.

A perusal of literature shows that in many instances except for some prominent diagnostic features, certain subtle characters are not given due attention for a tangible separation of the developmental stages of allied species. Such subtle characters have been observed in recent studies (Bensam, 1984, 1986) on certain clupeids with overlapping number and disposition of myomeres. One such character is the difference in the pace of development observed in the postlarvae of *Sardinella clupeoides* and *S. sirm*. Between the 10.2mm stage of *S. clupeoides* and the 10.4 mm stage of *S. sirm* (Fig. 3a, b), the former shows markedly lesser developmental sequence in its narrow body ; truncated caudal fin and lesser developed dorsal and anal fins when compared to the broad body, forked caudal fin and more advanced dorsal and anal fins in the latter species. Although there is a difference of 0.2 mm in the total length between the two specimens, it is rather insignificant to account for all these differences. In this connection it is suggested that for segregating comparable and/or similar sized developmental stages of closely allied species and/or genera, a tabulation of the characters of the developmental stages on the model proposed in Table 4 may be undertaken. By devising such a mechanism it may be possible to solve some of the identification poblems.

TABLE 4. *Tabulation proposed for documenting various characters of early developmental stages of allied species and/or genera*

Character/Name of species	Species 'X'	Species 'Y'
A. Egg		
e.g. Middle Egg		
1. Total diameter (mm) and nature		
2. Yolk diameter (mm) and nature		
3. Oilglobule diameter (mm) and number		
4. Pigmentation		
B. Larva		
e.g. Newly hatched Larva		
1. Total length (mm)		
2. Notochord length (mm)		
3. Head length (mm)		
4. Body depth at important portions such as		
(i) hind end of head		
(ii) pectoral region		
(iii) anal region		
(iv) caudal peduncle etc. (mm)		
5. Preanal length (mm)		
6. Postanal length (mm)		
7. No. of preanal myomeres		
8. No. of postanal myomeres		
9. Pigmentation		
10. Indication of rays, if any		
C. Postlarvae		
e.g. Postflexion postlarva		
Besides (i) through (9) above,		
11. Standard length (mm)		
12. Predorsal length (mm)		
13. Postdorsal length (mm)		
14. Eye diameter (mm)		
15. Meristics		
D. Juveniles		
All morphometric and meristic characters applicable in ichthyotaxonomy		

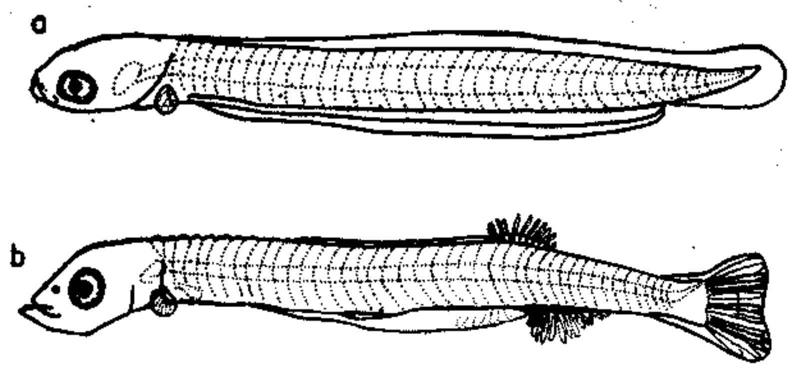

Fig. 2. Two postlarvae of *Hilsa kelee* : a. 5.68 mm and b. 7.92 mm to almost the same length in the figures for easier comprehension and comparison (Bensam, 1987).

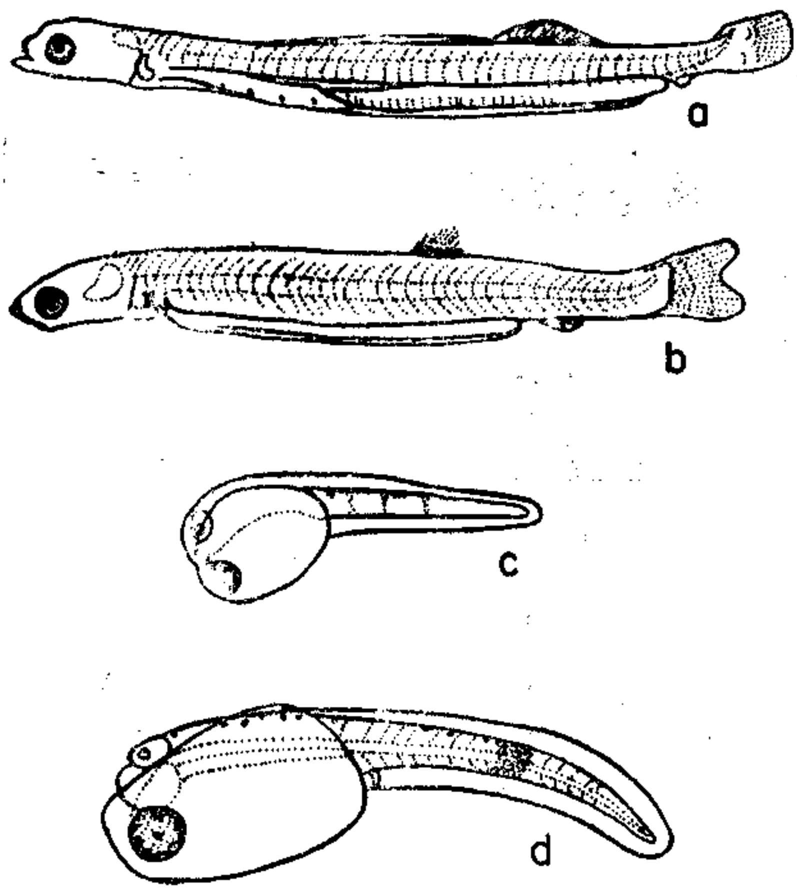

Fig. 3. Postlarvae of two species of *Sardinella* : a. *S. clupeoides* of 10.2 mm and b. *S. sirm* of 10.4 mm, showing differences in developmental sequences ; c, d, newly hatched larvae of two species of *Liza* ; c. *L. tade* and d. *L. subviridis* of 1.3 mm each, showing difference in pigmentation (Bensam, 1984, 1986, 1988 b).

Similarly, much more intensive studies are required on the variability of characters of developing stages, such as position of the oil globule and pigmentation between allied species, to bring out the differences. It is observed in recent studies (Bensam, 1984, 1988 b) among the larvae of the grey mullets *Liza tade* and *L. subviridis* which have the same number of myomeres that although the oil globule in the larvae of both the species is situated at the front aspect of the yolksac, the principal difference between the two is the presence of four narrow vertical streaks of brownish green pigments in *L. tade* (Fig. 3, c) but only a single prominent postanal band of yellowish pigments in *L. subviridis* (Fig. 3 d).

In addition to such character differences, it is also essential to look for new characters to identify the early developmental stages of species with overlapping sets of characters. Osteological and anatomical features of the early stages of one species may be different from those of an allied species. Hence, such characters may be found out and linked up with more noticeable external features. The advent of scanning electron microscopy has opened up the possibilities for solving such intricate identification problems. By this method Sumida *et al.* (1980) have found out the differences between the chorion structure of the eggs of flatfishes. Similarly, electrophoretic techniques may also be employed for discovering new distinguishing characters.

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