Indian J. Fish., 37 (3): 229-235 (1990)

A SYNOPSIS OF THE EARLY DEVELOPMENTAL STAGES OF FISHES OF THE GENUS *SARDINELLA* VALENCIENNES FROM INDIAN WATERS WITH KEYS FOR THEIR IDENTIFICATION

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ABSTRACT

In the present synopsis, a brief resume of relevant literature published on the early stages of *Sardinella* species is given, along with keys prepared for identification of the eggs, larvae and posflarvae, to the extent available. Some of the subtle characters to distinguish the eggs, larvae and postlarave of the species described are brought out for their easy separation in plankton studies.

INTRODUCTION

Fishes of the Genus *Sardinella* play a vital role in the marine fisheries of countries throughout South Asia. The distributional range of one or the other species extends from East African coasts to the Red Sea in the north-west, to New Guinea in the south-east and to so far as Taiwan and Okinawa (Japan) in the north-east. In India, although the annual production from this Genus is about 3,00,000 tonnes (18% of total annual marine fish production), workers on ichthyoplankton of this Genus have been voicing concern at the difficulties in identifying the early development stages of the various species. This is chiefly due to the fact that most of the species have overlapping breeding seasons, breeding grounds and overlapping sets of developmental characters (Bensam, 1981,1988). This is accentuated by the fact that some work on this group was carried out in the twenties and thirties by Delsman (1926 a, b, 1933) and that the recent work remains scattered. Hence, it is thought desirable to bring together all the relevant information concicely in the form of a synopsis as well as to provide keys for the eggs, larvae and postlarvae, to the extent possible.

DEFINITIONS AND TERMINOLOGIES

For describing the eggs in the present paper, the terminology proposed by Ahlstrom and Counts (1955), viz, "early egg", "middle egg" and " late egg" (Bensam, 1990), is adopted. The terms "larva" and "postlarva" are used as defined by Russell (1976). Within the postlarval phase for the present paper, three principal stages have been reckoned, as is done by Moser and Ahlstrom (1970), Ahlstrom *et al.* (1976) and Moser *et al.* (1977), viz, "Preflexion", "Flexion" and "Postflexion" Postlarvae (Bensam, 1990).

For the sake of uniformity of comparison and contrast, the various developmental stages mentioned in the present paper are grouped under the above terminologies. In the preflexion postlarval stages of Clupeiformes, the pectoral fin alone is formed and the larval finfold is prominent. During the flexion stage, the dorsal, caudal and anal fins develop progressively; and it is only in the postflexion stage that the pelvic fin is formed. Since the diagnostic characters of Clupeiform eggs, larvae, postlarvae, etc are very well known (Delsman, 1926 a, b, 1933; Devanesan, 1943; Nair, 1960; Bensam, 1970, 1973, 1984,

1986, to mention only a few) these are not recounted in the present paper.

RESUME OF LITERATURE

In the present brief resume, the relevant publications describing the early stages are arranged species-wise and the classification of the speices followed is as given by Whitehead (1973).

(i) *S. albella* (Valenciennes):- Delsman (1933): planktonic eggs, larvae from Indonesia; Chacko and Mathew (1956) : planktonic eggs, larvae; Bensam (1984,1986) : postflexion postlarvae.

(ii) *S. brachysoma* Bleeker :- Rare in India; Delsman (1926 a) : planktonic eggs, larvae from Indoesia.

(iii) *S. (Amblygaster) clupeoides* (Bleeker):- Bensam (1984,1986) : planktonic eggs, larvae, flexion and postflexion postlarvae.

(iv) *S. dayi* Regan :- Bensam (1973) : flexion and postflexion postlarvae, juveniles.

(v) *S. fimbriata* (Valenciennes) :- Delsman (1926 a; Bapat, 1955) : planktonic eggs, larvae from Indonesia and India; Bensam (1984, 1986) : postflexion postlarvae.

(vi) *S. gibbosa* (Bleeker) :- Bensam (1970) : planktonic eggs, larvae, juveniles.

(vii) *S. jussieu* (Valenciennes) :- Limited distribution in India (Whitehead, 1973); early developmental stages not yet documented.

(viii) *S. (Amblygaster) leiogaster*^Valenciennes :- Delsman (1926 a): planktonic eggs, larvae, flexion postlarve, from Indonesia.

(ix) *S. longiceps* Valenciennes:- Devanesan (1943) : intraovarian ova, planktonic eggs; Nair (1960) : planktonic eggs, larve, preflexion postlarvae; UNDP/FAO (1976) : planktonic eggs, larvae, postlarvae; Lazarus (1976, 1985) : planktonic egg, flexion and postflexion postlarvae.

(x) *S. melanura* (Cuvier) :- Limited distribution in Indian waters; Early developmental stages not yet documented.

(xi) *S. sindensis* (Day):- Rare in India (Whitehead, 1973).

(xii) *S. (Amblygaster) sirm* (Walbaum) : - John (1951) : planktonic eggs, larvae; Bensam (1984,1986): preflexion postlarvae; Lazarus (1987): intraovarian ova, planktonic eggs, larvae, preflexion, flexion and postflexion postlarvae. Bensam (1989) opined that for a firm separation of the eggs and larvae of this species from those of *S. leiogaster*, the characteristic features of the ripe ova of *S. leiogaster* also are needed, in view of the similarities between the free eggs of *S. sirm* (Lazarus, 1987) and *S. leiogaster* (Delsman, 1926 a).

KEY FOR EGGS AND LARVAE

(1) Eggs and early larvae with an oilgloblue ..... (6), (7)

(2) Eggs and early larvae without oilglobule ..... (3),(4),(5)

(3) Late egg with a total diameter of 2.12 mm; yolk with a diameter of about 1 mm (Fig. I. A. Newly hatched larva 6.5 mm Ion ..... *S.(A)sirm*

(4) Late egg with a total diameter not exceeding 1.6 mm and yolk of about 1 mm (Fig I B). Newly hatched larvae 3.2 mm long ..... *S. (A) leiogaster*

(5) Late egg with a total diameter not

exceeding 0.95 mm and yolk of about 0.5 mm (Fig I C). Newly hatched larva 2.7 mm long; pigment spots appear along the gut by 4.5 mm. . . . . *S. (A) clupeoides*

(6) Eggs with a single egg capsule- (8), (9)

(7) Egg with two capsules, the outer one being thin and the inner one thick. Total egg diameter about 1.2 mm; inner capsule somewhat globular, the longer axis of 0.98 mm and the shorter one of 0.94 mm; yolk diameter about 0.6 mm and oilglobule diameter about 0.075 mm (Fig. I D). Newly hatched larve about 1.8 mm; pigments absent during larval phase. . . . . S. *brachysome*

(8) Yolk diameter more than 0.7 mm; total diameter of late eggs more than 1 mm
. . . . . (12), (13), (14)

(9) Yolk diameter less than 0.7 mm-
. . . . . (10), (11)

(10) Total egg diameter about 1.07 mm; yolk diameter about 0.57 mm; oilglobule diameter only about 0.077 mm (Fig IE). Newly hatched larva about 2.2 mm; pigments absent during larval phase. . . . . *S. albella*

(11) Total egg diameter not more than 0.8 mm; yolk diameter about 0.58 mm; oilglobule diameter about 0.12 mm (Fig. I F). Embryos in late eggs with dorsal pigments. Newly hatched larva about 1.3 mm in formalin and with dorsal pigments
. . . . . *S. gibbosa*

(12) Yolk diameter about 0.80 - 0.87 mm; total egg diameter about 1.41 mm; oilglobule diameter about 0.102 - 0.115 mm (Fig. 1 G); embryonic pigmentation absent. Newly hatched larva about 2.5 mm; devoid of dorsal pigments during larval phase
. . . . . *S. fimbriata*

(13) Yolk diameter ranges from 0.98 to 1.23 mm; total egg diameter about 1.4-1.5 mm; Oilglobule diameter about 0.14 mm (Fig. IH). Dorsal pigments present during larval phase
. . . . . *S. longiceps*

KEY FOR POSTLARVAE

(1) Total myomere number 45 or more
. . . . . (9), (10), (11), (12)

(2) Total myomere number 42-43 only
. . . . . (3), (4), (5), (6), (7), (8)

(3) 10.2 mm postflexion postlarva with dorsal fin, club-shaped cadual fin and 38 preanal myomeres; 13.1 mm stage has 35 preanal myomeres
. . . . . *S. {A.) clupeoides*

(4) 10.4 mm postflexion stage has forked caudal fin and 31 preanal and 12 postanal myomeres; 13.4 and 14.1 mm stages have 21 preanal and 22 postanal myomeres
. . . . . *S.(A.)sirm*

(5) Preflexion stages with prominent finfold and without indication of pelvic and unpaired fins
. . . . . (6),(7)

(6) In the 5 mm preflexion stage the preanal proportion of the body is 80% of total length. Greatest depth of body 6.45 of total length; ventral pigmentation present
. . . . . *S. (A.) leiogaster*

(7) In the 4.04 mm preflexion stage, the preanal proportion of the body is only 75% of total length. Greatest depth of body only 6.17 of total length; ventral pigmentation absent
. . . . . *S.brachysoma*

(8) 6.6 mm preflexion stage with dorsal, caudal and anal fins, has 34 preanal and 9 postanal myomeres; 8.4 and 11.0 mm stages with 32 preanal and 11 postanal myomeres, reaching 29+14 in 19 mm juvenile
. . . . . *S.albella*

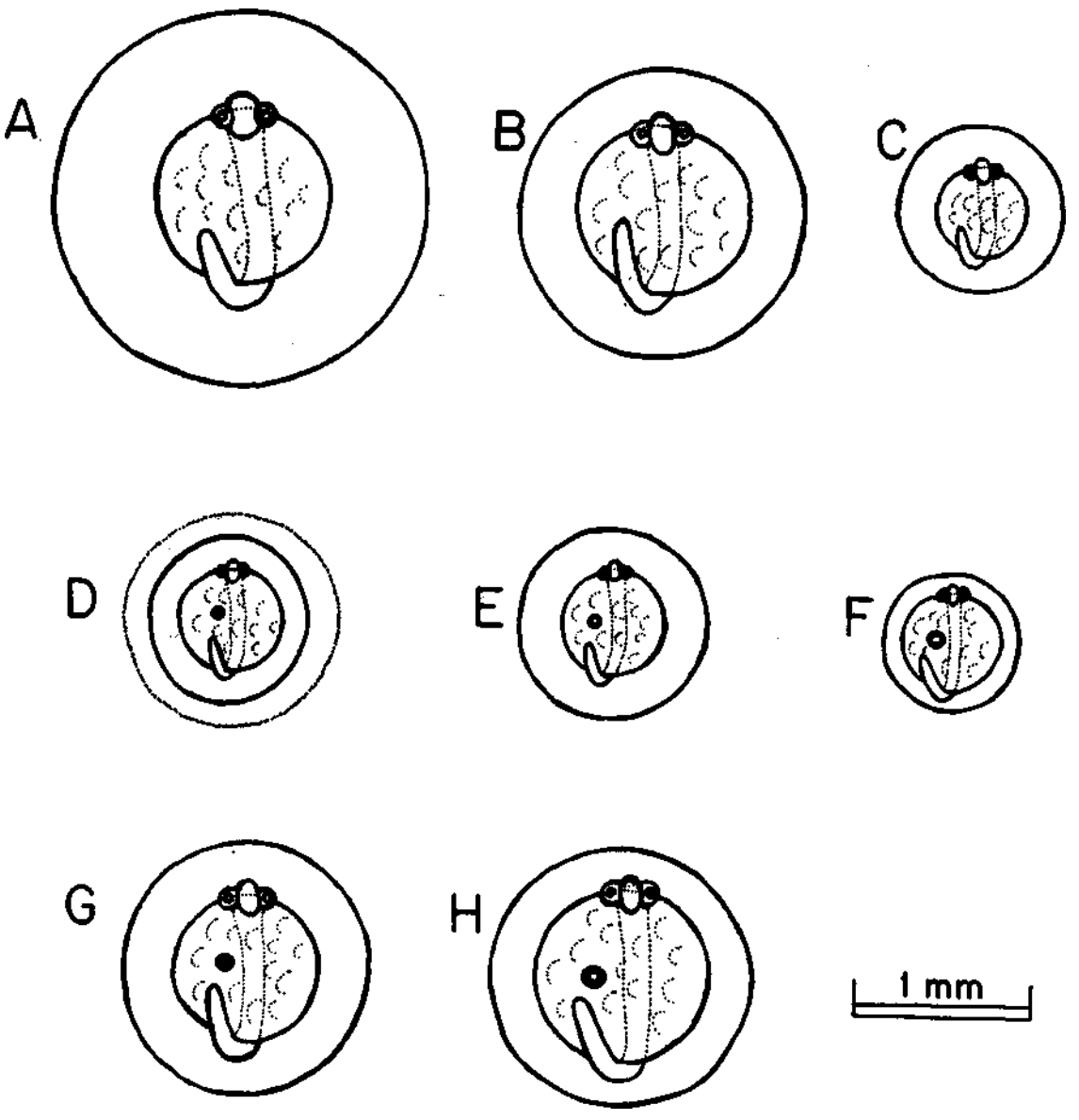

Fig. 1. Semidiagrammatic sketches of the " late" eggs of eight species of *Sardinella.* A. S. *sirm.* B. *S. leiogaster.* C. *S.clupeoides.* D. S. *brachysoma.* E. S. *albella.* F. S. *gibbosa.* G. S. *fimbriata* and H. S. *longiceps* (A, after John, 1951; B,D,E and G, after Delsman,1926; A, B, Cafter Bensam, 1984, 1986; F, after Bensam, 1970; H, after Nair, 1960).

(9) 2.2 mm preflexion stage with prominent finfold and without indication of unpaired fins, has 36 preanal and 9 postanal myomeres; 4.26 - *7.77* mm flexion stages with developing unpaired fins, have 33 preanal and 12 postanal myomeres; 9.92 -17.3 mm postflexion stages have 30 preanal and 15 postanal myomeres; pelvic fin appears between 9.92 and 13.45 mm stages. . . . . *S. gibbosa*

(10) 3.73 mm preflexion stage with prominent finfold and without indication of unpaired fins, has 40 preanal myomeres and preanal proportion is 78.35% of total length; 11.4 and 12.3 mm postflexion stages with developing fins, except the pelvic, has 39 preanal and 7 postanal myomeres and pelvic fin develops later than 12.3 mm; 21.5 mm postflexion stage has 33 preanal and 13 postanal myomeres and preanal proportion is 68% of total length

. . . . . *S.fimbrhta*

(11) 4.03 mm preflexion stage with finfold, without indication of unpaired fins, has 40 preanal myomeres and preanal proportion is 82.4% of total length; 6.05 - 9.37 mm flexion stages with indications of unpaired fins and with preanal proportion 83 - 85% of total length; 13.8 and 20.4 mm postflexion stages with progressive development of fins, have 30 - 39 preanal myomeres and preanal proportion 73 - 79% of total length; pelvic fin appears later than 13.8 mm

. . . . . *S.longiceps*

(12) 18.7 and 20.25 mm postflexion stages have 34 + 12 and 32 +14 preanal and postanal myomeres respectively; pelvic fin develops earlier than 18.7 mm

. . . . . *S.dayi*

REMARKS

It may be seen from the above that among the 12 species of *Sardinella* reported to be present in Indian waters (Whitehead, 1973), one or the other stages of the eggs, larvae and postlarvae of only the two species of rare occurrence in India, viz., *S. melanura* and *S. sindensis* are not yet documented. Among postlarvae, apart from those of the above two species, those of *S. bryachysoma* and *S. clupeoides* are also not yet reported from Indian waters. One handicap for identification of the planktonic eggs is the nonavailability of spawning females, for comparison and contrast of the ripe intraovarian ova with the planktonic eggs. Even in the case of species supporting major fisheries, such as S. *longiceps*, availability of spawners is rather rare, the ones reported being that by Devanesan (1943) and Lazarus (1976, 1985). But, in the latter case of identifying the planktonic egg of *S. longiceps*, the one important character namely the size of the oilglobule does not appear to have received enough attention because the oilglobule in the planktonic egg figured by him (the measurement not given in the text) has a diameter of 0.23 mm, which is much higher than the known diameter range of the oilglobule in this species namely 0.11 to 0.14 mm. Since the diameter range of oilglobule in sardines is a firm character, the possibility of an oilglobule measuring 0.2 mm in *S. longiceps* is unlikely. From this it appears that the planktonic egg reported by Lazarus (1985) as of *S. longiceps* may not belong to this species.

Delsman (1926a) while commenting upon certain unidentified eggs "... a and f ..." opined that these might belong to one or the other of *Sardinella clupeoides, S. sirm* or *S. longiceps.* Of these, the egg *"i"* cannot belong to *S. longiceps* and *S. clupeoides*, since these do not have an egg as large as 2 mm overall diameters (Nair, 1960; UNDP/FAO, 1976; Bensam, 1984,1986). Thus according to the reasoning of Delsman (1926 a), the egg *"i"*

may belong to *S. sirm* only. This is corroborated by the work of John (1951). With regard to the egg "e" with 4-6 oilglobules described by Delsman (1926 a), it may be pointed out that in the eggs of *Sardinella*, an oilglobule may be either absent or usually only one may be present. Hence as pointed out earlier (Bensam, 1984), it appears that the possibility of the egg "e" described by Delsman (1926 a) as belonging to a species of *Sardinella* is rather doubtful.

As also may be seen from the present account, all the vital larval and postlarval stages of all species of *Sardinella* available in Indian waters have not yet been documented. • It is high time that much more intensive and extensive collections are carried out and characteristic features of the various developmental stages of comparable sizes and phases are brought out cogently, in order to facilitate identification and separation without much difficulty. This is particularly important for all the three phases, viz., preflexion, flexion and postflexion ones. Since the early developmental stages of various species of *Sardinella* have overlapping sets of characters, only such an integrated approach shall facilitate unambiguous identification of the developmental stages of various species.

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