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ON THE EARLY DEVELOPMENTAL STAGES OF A FEW FISHES FROM VELLAR ESTUARY*

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ABSTRACT

Among the many fishes found in Vellar Estuary, a few early developmental stages of *Polynemus sextarius, Sillago sihama, Gerres oblongus, G. setiferus, Therapon jarbua, Lates calcarifer* and *Siganus javus* were collected and identified during 1977-79. Postlarvae of *P. sextarius* ranged in total length from 2.5 to 6.5 mm ; those of *S. sihama* from 2.8 to 6.8 mm and juveniles from 8.3 to 150 mm ; those of *G. oblongus* from 2.9 to 17.0 mm ; of *G. setiferus* from 7.6 to 25.0 mm ; *T. jarbua* from 1.6 to 11.3 mm ; *L. calcarifer* from 2.1 to 4.9 mm ; and *S. javus* from 4.8 to 24.0 mm. The eggs of only two species, *G. oblongus* and *T. jarbua* could be collected and identified. The paper gives illustrations and brief descriptions of most of these stages, many of them for the first time. Salient features of taxonomic value are mentioned, along with comparison and contrast with similar stages of allied species described.

INTRODUCTION

VELLAR ESTUARY in the southeast coast of India (11°30'N; 79°46'E) harbours many euryhaline fishes, many of them supporting fisheries there. One or the other early developmental stage of a few of these fishes have been described so far (Rangarajan and Jacob, 1960 ; Vijayaraghavan, 1973 ; Venkataramanujam, 1975 a, b). In the course of studying the early developmental stages of some marine and estuarine fishes there during 1977-79 (Bensam, 1984 ; 1986 ; 1987), a few early developmental stages of seven estuarine species were collected, studied and identified, most of them for the first time.

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MATERIAL AND METHODS

Most of the early developmental stages were collected from the plankton off Parangipettai (formerly known as Porto Novo), about 2 km from the coast where the depth is about 12-15 m ; while some stages were obtained from fry net catches collected from Vellar Estuary and a few from trawl catches operated off the coast. The plankton net was 1.5 m long and 0.5 m in diameter, made of No. 20 bolting silk ; and was towed in surface waters for about 15 minutes, between 0600 and 0700 hours. In the laboratory, each type of egg was separated based on distinguishing features and transferred to a large container with filtered sea water, for further stages. The eggs as well as the larvae, postlarvae, etc. were studied under a microscope and illustrations were with the aid of a *camera lucida*. Live, identical postlarvae of some culturable fishes were reared in

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brackish water ponds for confirming the identification.

In the present work it was experienced that in most cases the same body of water which supports one developmental stage does not support one or more of the other stages. This has been the experience of other workers also such as Nellen and Hempel (1970) and Russell (1976). In India, in spite of the abundance of the postlarvae and juveniles of *Chanos chanos* (Tampi, 1968), the eggs and early larvae have been recorded very rarely. In the present work also in many cases all the developmental stages could not be collected during 1977-79.

The guidelines followed for identification are those as reviewed by Ahlstrom and Moser (1976 ; 1980 ; 1981), such as size and shape of eggs, extent of perivitelline space, nature of yolk, presence/absence and number of oil-globules, nature of muscle fibres in the larvae and postlarvae, shape of the body, number and disposition of myomeres, etc. Lebour (1921) has drawn attention to the fact that in the larvae and postlarvae, among all morphometric and meristic characters, the myomere count alone is reliable for identification. Russell (1976) has further drawn attention to the fact that the other adult morphometric and meristic characters are not reliable for identifying the larvae and postlarvae because these in the early developmental stages are different from the adult condition ; and these can be used to identify only the juveniles.

The terminologies for the developmental stages are the ones as given by Russell (1976). Length of the larvae, postlarvae, etc. given are total length, from tip of the snout or the lower jaw, whichever is longer, to the tip of the fin-fold or caudal fin. Accuracy of each measurement is standardised, to the first decimal place for the larvae, postlarvae and juveniles ; to the second place for the eggs ; and to the third place for oilglobules. As the figures of all the stages are given, detailed morphological descriptions are avoided. And, since the total length of each specimen figured is given in the legend, individual scale for each figure is not provided, as is done in recent publications such as by Russell (1976), Jones *et al.* (1978), Hardy Jr. (1978, a ; b), Johnson (1978), Fritzche (1978) and Martin and Drewry (1978).

Description and Discussion

Polynemus sextarius (Bloch and Schneider)

Four postlarvae and one juvenile have been collected during August-November, 1977. In the earliest stage of 2.5 mm (Fig. 1 a), the larval finfold is still present and pigmentation is sparse, as a few patches mostly in the viscera and operculum. There are 8 preanal and 15 postanal myomeres. In a 3.6 mm stage (Fig. 1 b), the body has undergone lateral expansion and a spine has appeared infront of opercular base. Above and behind anal fin base, a few pigment spots are present. A change in the disposition of myomeres is observed, to 6 preanal and 17 postanal. In a stage of 4.8 mm (Fig. 1 c) all the fins are under progressive development and pigmentation has increased. The preanal number of myomeres is 5 and the postanal is 18. The body has become elongated in a 6.5 mm postlarva (Fig. 1 d), particularly in the postanal region. In the only juvenile measuring 22.4 mm (Fig. 1 e) collected from trawl catches, the body has become polynemid-like. All the fins have developed : the anterior dorsal has one short and seven long spines ; the posterior dorsal has an anterior spine followed by twelve rays ; there are 28 caudal rays, most of them showing 7 to 10 segments ; the anal fin has 3 spines and 12 rays ; there are 9 rays in the upper pectoral and 6 free rays in the lower pectoral, which is diagnostic of the species ; and about 7 rays are present in the pelvic fin. Along the preopercular region a series of five spines is present. Pigmentation is sparse, in the form of a group of spots dorso-laterally below the dorsal fins and a few spots

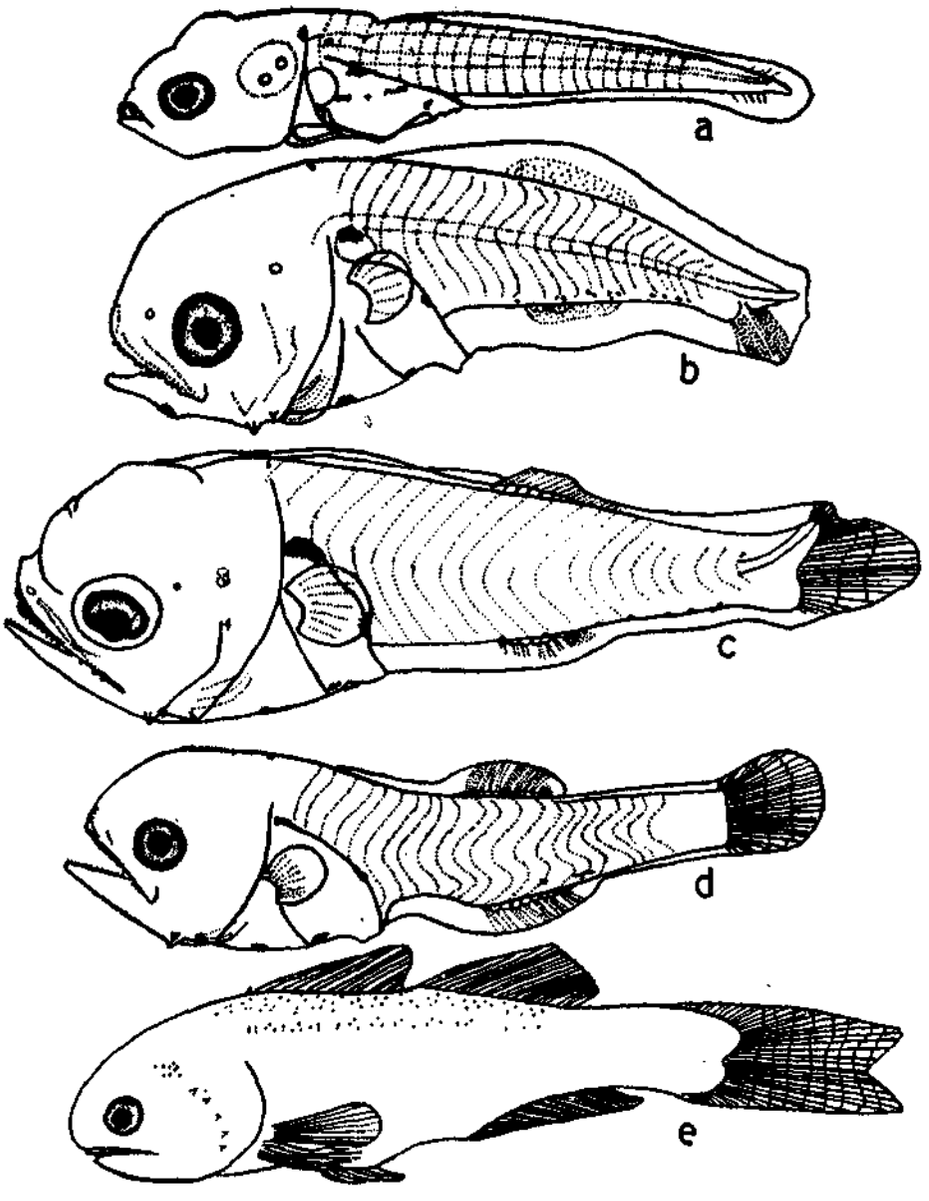

Fig. 1. Postlarvae and juvenile of *Polynemus sextarius* : (a) Postlarva of 2.5 mm total length ; (b) 3.6 mm ; (c) 4.8 mm ; (d) 6.5 mm and (e) Juvenile of 22.4 mm total length.

anterio-dorsal to the preopercular spines. There are 9 preanal and 14 postanal myomeres, the number and disposition corresponding to adult vertebral condition.

Identification of the postlarvae as those of *P. sextarius* is based upon the coincident occurrence of them along with the spawning stock at Parangipettai and is confirmed by the number of myomeres tallying with the adult vertebral number as well as from the differences the present postlarvae have shown from comparable stages of allied species described so far. The 6 mm postlarva of *Eleutheronema tetradactylum* (Sarojini and Malhotra, 1952) differs from the 6.5 mm stage of *P. sextarius* in having 9 preanal and 15 postanal myomeres and in having a row of chromatophores from anal region to caudal. The 2.5 mm larva of *Polynemus paradiseus* dealt with by Jones and Menon (1953) is without the mouth opening, whereas the 2.5 mm stage in the present work has already become a postlarva. Older stages from 3.5 to 5.6 mm of *P. paradiseus* (Jones and Menon, 1953) differ from the comparable 3.6 to 6.5 mm postlarvae of *P. sextarius* in that in the latter the mouth gape does not extend beyond the middle level of eyes. The present postlarvae differ from those of *E. tetradactylum* reported by Kowtal (1972) in that in the latter there is a total of 27 myomeres, as against only 23 in *P. sextarius*. In pigmentation also the postlarvae of these two species show differences, in the aggregation of pigments at five or six spots along the base of anal fin in *E. tetradactylum*, but not so in *P. sextarius*. The juvenile described in the present paper can be easily distinguished from comparable stages of other species of polynemids in having six free pectoral filaments, which is diagnostic.

Sillago sihama (Forsskal)

Among a large number of postlarvae collected during August-September 1977, in a 2.8 mm stage (Fig. 2 a) yolk is still present, a pigment spot is seen at the forehead, a few pigments in the viscera and a series along the ventral aspect of the postanal region. There are 7 preanal and 27 postanal myomeres. In 3.2, 3.5 and 3.6 mm stages (Fig. 2 b, c and d respectively), there is an increase in the ventral pigmentation, with two black bands at the anterior and posterior aspects of the viscera and containing two chromatophores in between. By 5.8 mm (Fig. 2 e), anal fin rays have developed and disposition of the myomeres has changed to 10 preanal and 24 postanal. The 6.8 mm postlarva (Fig. 2 f) is characterised by the development of the posterior dorsal fin and with 11 preanal and 23 postanal myomeres. There are about 21 dorsal rays, 18 anal rays and 18 caudal rays, most of the last being 3 to 4 segmented. Among the juveniles collected from fry net catches, an 8.3 mm specimen (Fig. 2 g) is the youngest, with disposition of myomeres changed to 12 preanal and 22 postanal. The anterior dorsal fin has developed with about 7 spines ; the posterior dorsal has about 21 rays ; pelvic fin has shifted from a level below the vent in the previous stage to a level below the pectoral fin in this stage ; and caudal fin shows the beginning of bifurcation. In a 11.3 mm juvenile (Fig. 2 h), a few pigments have appeared along the caudal peduncle and at the base of lower caudal lobe. There are 8 anterior dorsal spines, about 21 posterior dorsal rays ; 24 caudal rays ; and 23 anal rays. Further increase in pigmentation is recorded in a 19.0 mm juvenile (Fig. 2 i), as a group above and behind the eyes, two dorsolateral patches at the hind region of the head and one pigment in the middle of upper jaw. The anterior dorsal has 9 spines ; posterior dorsal 22 rays ; caudal 24 rays ; anal fin 24 rays ; and pelvic fin about 6 rays. The number of pectoral fin rays cannot be ascertained accurately in this stage as well as the previous ones, due to lack of ossification. The disposition of myomeres has changed to the adult condition of 14 preanal and 20 postanal in this stage. A few more juveniles in the size

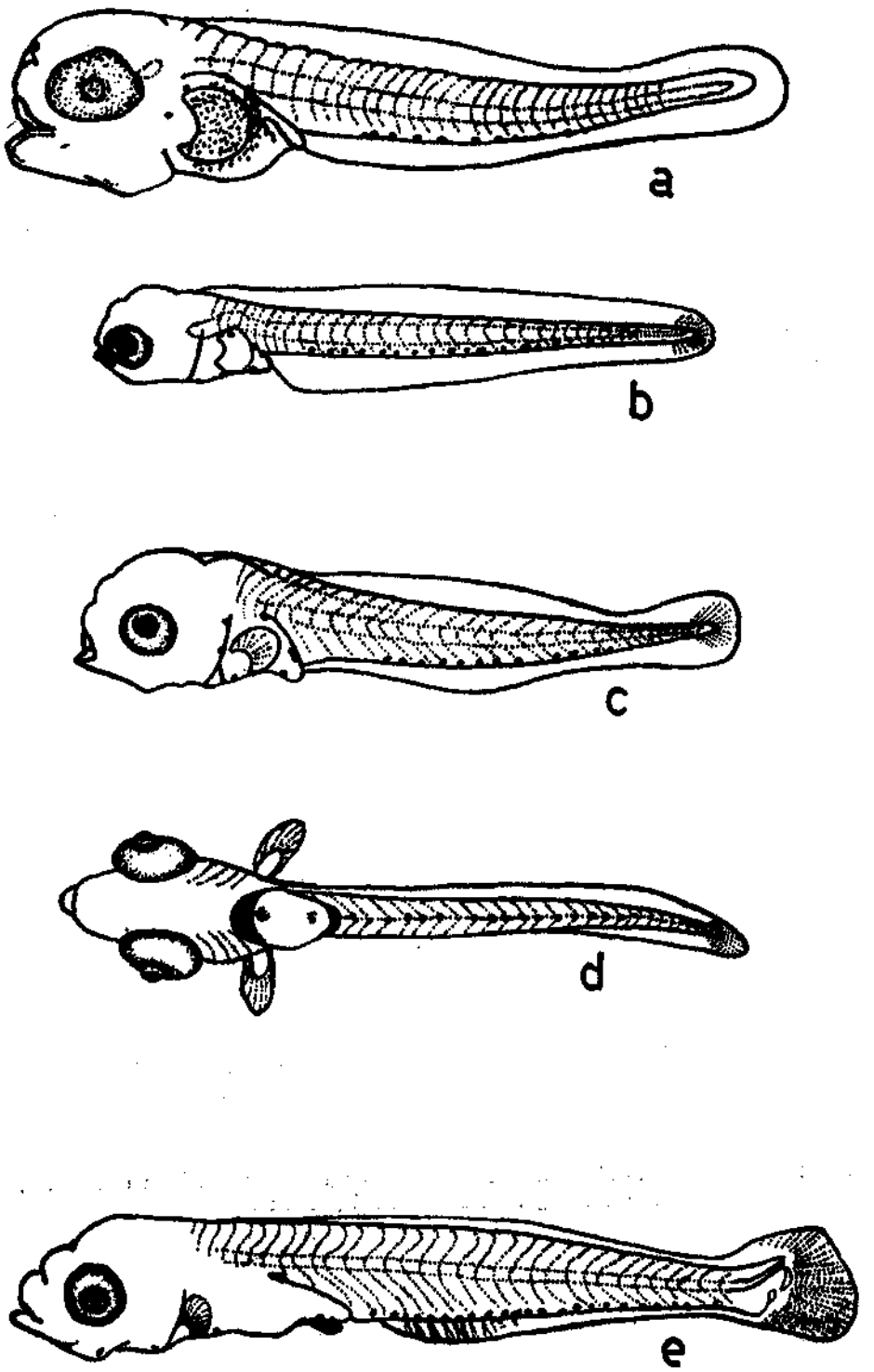

Fig. 2. Postlarvae of *Sillago sihama* : (a) 2.8 mm total length ; (b) 3.2 mm ; (c) 3.5 mm; (d) 3.6 mm and (e) 5.8 mm.

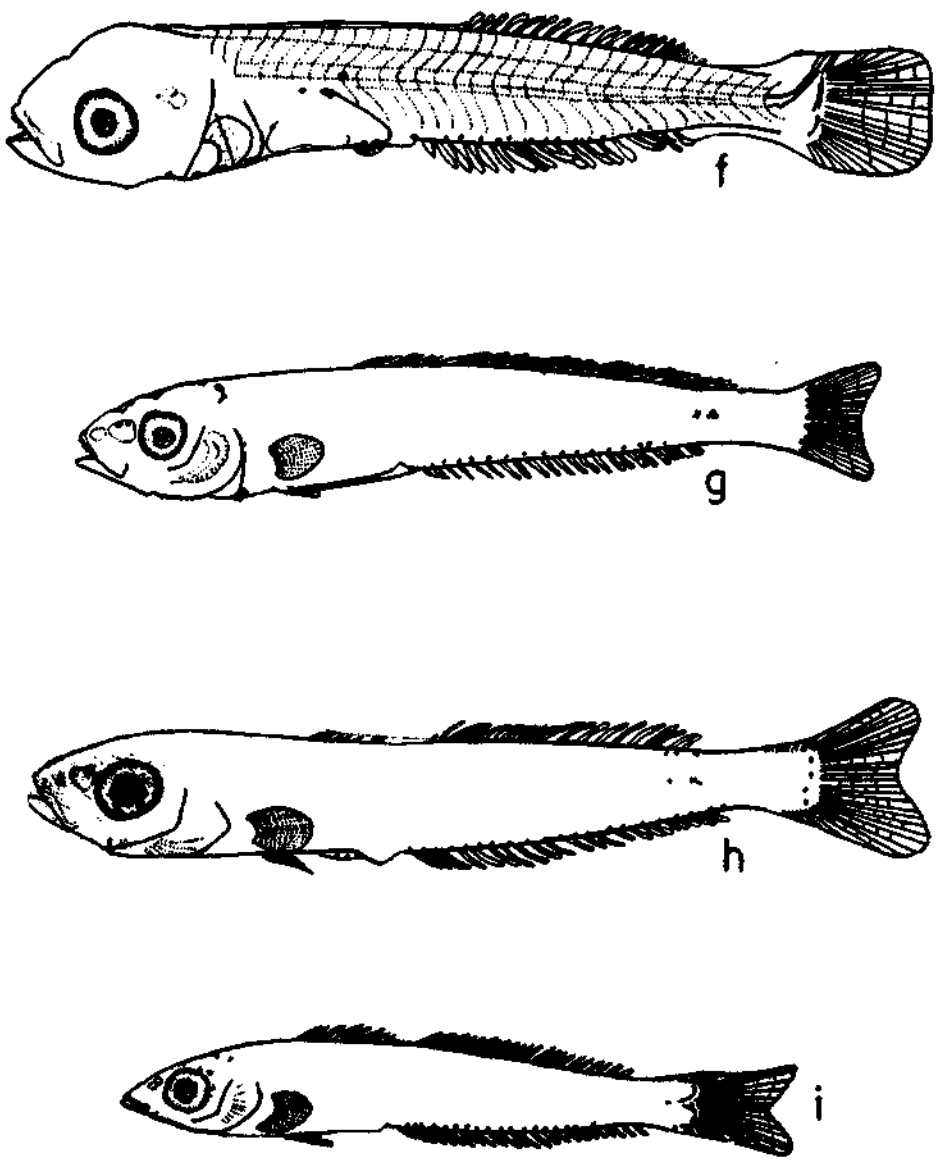

Fig. 2 (*Contd.*). Postlarva and juveniles of *Sillago sihama:* (f) Postlarva of 6.8 mm total length ; (g) juvenile of 8.3 mm total length ; (h) 11.3 mm and (i) 19.0 mm.

range of 50-150 mm total length have conformed to the adult morphometric and meristic characters, except that there is a gradual increase in the proportion of preanal length. Thus, in a 50 mm juvenile, the preanal length is 40% of total ; in a 56 mm stage it is 44% of the total ; and in a 150 mm juvenile it is 48% of the total.

Identification of the present postlarvae and juveniles is confirmed by rearing identical stages in culture ponds. McKay (1980) has reported that at Parangipettai, but for *Sillago sihama* no other species of the genus is recorded by him. The above author also has observed 34 vertebrae in *S. sihama*, 14 preanal and 20 postanal. Ueno *et al* (1958) have described the early development of a species assigned to *S. sihama*. But, Tomiyama and Abe (1958) have shown that this species is actually *S. parvisquamis* Gill and not *S. sihama* (Forsskal). In the 2.6 mm postlarva of another species, *S. japonica* described by Mito (1963), there are about 36 myomeres, as against only 34 in *S. sihama*.

Gerres oblungus Cuvier

Two eggs collected in October 1977 and identified as of this species have diameters of 0.63 and 0.73 mm in formalin (Fig. 3 a, b). Yolk is vacuolated, leaving a small perivitelline space. One pigmented oilglobule is present, with a diameter of 0.21 mm. Among the postlarvae collected during the same month, 2.9 mm stage (Fig. 3 c) is the youngest, with 7 preanal and about 18 postanal myomeres. In a 6.0 mm stage (Fig. 3 d), the body has become deeper, with 7 preanal and 17 postanal myomeres ; and the caudal fin has about 18 rays. The dorsal fin is indicated by 8.5 mm (Fig. 3 e), with 5 spines and 11 rays and the anal fin is with 9 rays. There is also an increase in pigmentation, particularly in the postoptic region. Among two juveniles collected during October 1977, in a 13.1 mm stage (Fig. 3 f) the body has assumed a more gerreid character, with 9 spines in anterior dorsal fin, about 10 rays in the posterior dorsal, about 36 rays in the bifurcated caudal fin and 3 spines and about 9 rays in the anal fin. There is also a progressive increase in pigmentation, particularly on the head and viscera. In a 17.0 mm juvenile (Fig. 3 g), there is some increase in pigmentation, at the hind end of the posterior dorsal fin, at the middle region of the posterior dorsal fin base, the base of the upper caudal margin and the caudal peduncular region. No significant change has been observed in the spines and ray counts of the fins over the previous stage. The number and disposition of the myomeres in both the juvenile stages are 7 preanal and 17 postanal, corresponding with the adult vertebral condition.

Identification of the present eggs as those of *G. oblongus* is based upon the size of the nature ova examined, ranging from 0.4 to 0.5 mm which is close to the sizes of the free eggs. As figured earlier by Rass (1972), the vacuolated condition of the yolk and pigmentation of the oilglobule are characteristic of the eggs of Gerreidae. Number and disposition of the myomeres in the postlarvae and juveniles tallying with adult vertebral condition as well as rearing of the postlarvae identical with the present ones have confirmed the identification. The only other species of *Gerres* found in mature and spawning conditions at Parangipettai during September-November 1977 is *G. setiferus*. But, the postlarvae of this species may be distinguished from the present ones in the difference in pigmentation as well as in the number of spines in the anterior dorsal fin, *vide infra*.

Gerres setiferus (Hamilton)

Three postlarvae and a single juvenile are collected during October 1977. In the youngest postlarva of 7.6 mm (Fig. 4 a), all the fins are under progressive development. There are 3

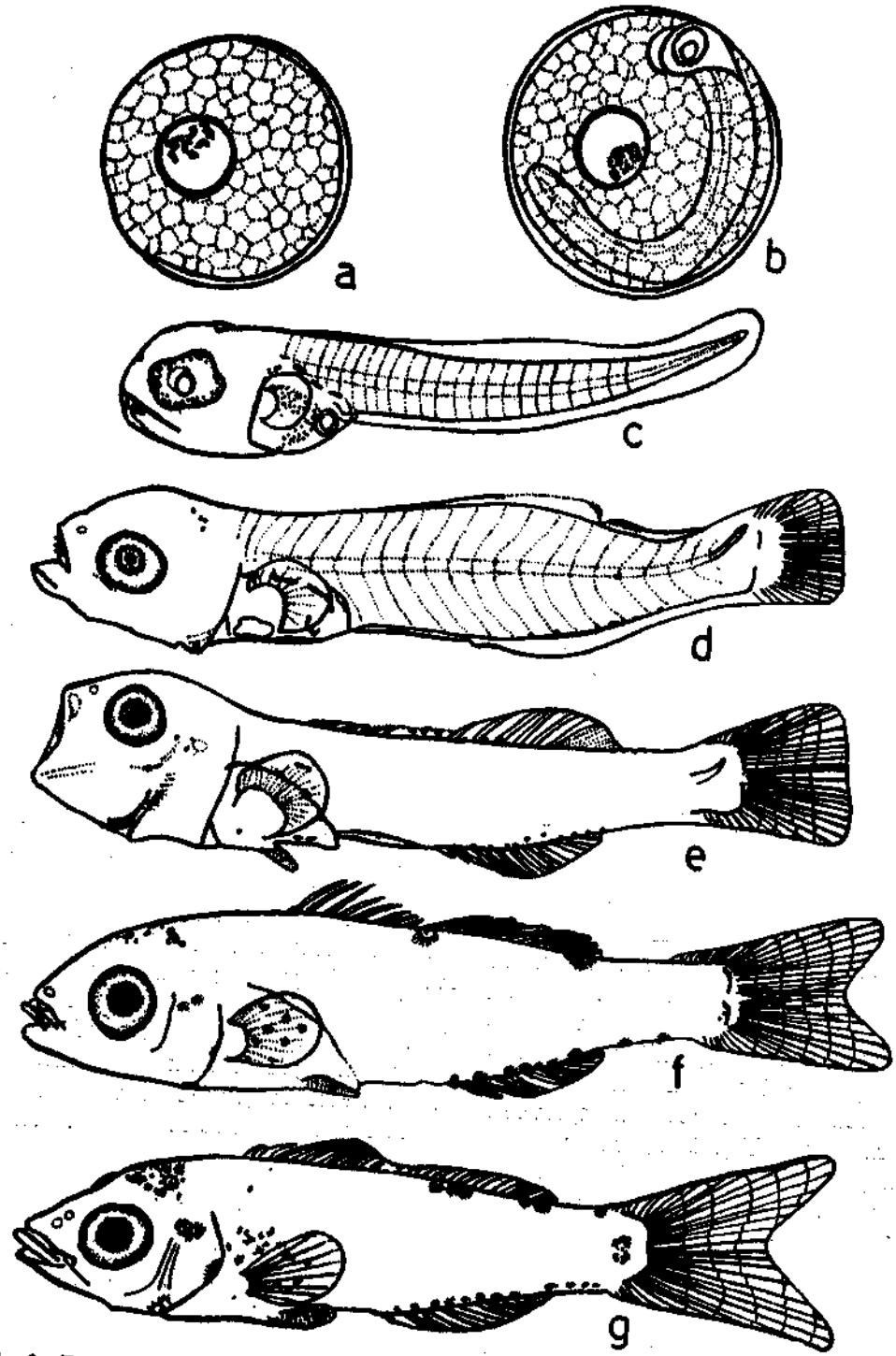

Fig. 3. Eggs, postlarvae and juveniles of *Gerres oblongus* : (a) and (b) Eggs in two stages of development ; (c) Postlarva of 2.9 mm total length ; (d) 6.0 mm ; (e) 8.5 mm ; (f) Juvenile of 13.1 mm total length and (g) 17.0 mm.

anterior dorsal spines, 8 posterior dorsal rays and about 14 caudal rays. Pigmentation is characteristic, with a characteristic posterior mid lateral row, a post-pectoral ventral series and another series along the base of the dorsal fins. There are 10 preanal and 14 postanal and 17 postanal. The significant change observed in a 10.5 mm postlarva (Fig. 4 c) is an increase in the number of anterior dorsal spines to 10. There are about 10 rays in the posterior dorsal, 24 in the caudal, 3 spines followed by about 10 rays in the anal, 10 in

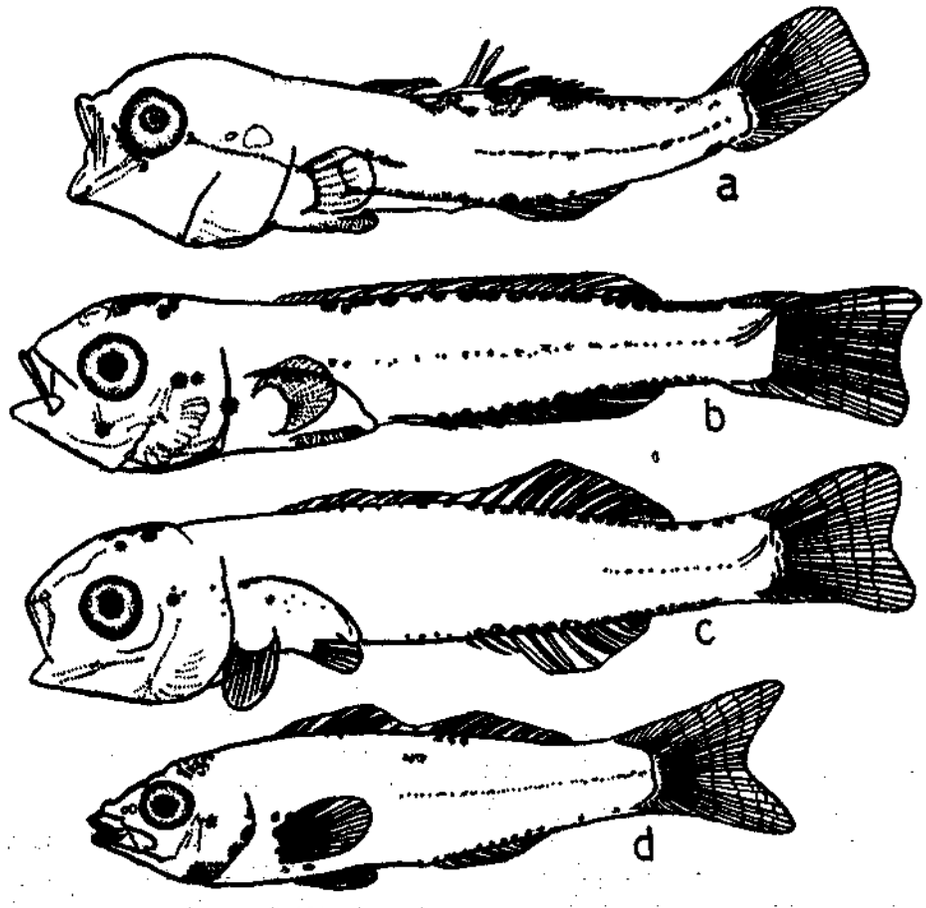

Fig. 4. Postlarvae and juvenile of *Gerres setiferus*: (a) Postlarva of 7.6 mm total length; (b) 9.5 mm; (c) 10.5 mm and (d) Juvenile of 25.0 mm total length.

myomeres. A stage of 9.5 mm (Fig. 4 b) shows 9 spines in the anterior dorsal fin, about 9 posterior dorsal rays, 24 caudal rays and 3 spines, followed by 7 rays in the anal fin. The mid-lateral pigmentation has become more prominent and continuous from the visceral region to the caudal peduncle. The disposition of myomeres has changed to 7 preanal the pectoral and 5 in the pelvic fins. The disposition of the myomeres continued to be the same as in the previous stage. The single juvenile stage collected from fry net catches has measured 25.0 mm (Fig. 4 d). There are 10 anterior dorsal spines, 12 posterior dorsal rays, 36 caudal rays, 3 anal spines followed by 9 rays, about 8 pectoral rays and 1 pelvic spine

followed by about 7 rays. Pigmentation pattern has remained almost the same as in the previous postlarva, with a characteristic mid-lateral series. Disposition of the myomeres has changed to 9 preanal and 15 postanal, corresponding to the adult condition.

Among various species of *Gerres*, it is only in *G. setiferus* that there are 10 anterior dorsal spines, while in the others there are only 9. In the 7.6 and 9.5 mm postlarvae the dorsal spines are lesser in number, thus resembling the postlarvae of other species of *Gerres*. But, these younger stages have a characteristic mid-lateral row of pigments which is absent in the postlarvae of an allied species, *G. oblongus*, *vide supra*. This identification is confirmed by rearing identical stages of postlarvae in ponds. Nair (1952) has described a juvenile of *G. lucidus* (=*G. setifierus*) ; but this specimen has only 9 anterior dorsal spines, instead of 10. Similarities between the above specimen and the juveniles described in the previous section indicate that the one described by Nair (1952) may belong to *G. oblongus*.

Therapon jarbua (Forsskal)

Eggs identified as those of *T. jarbua* are collected during February-March 1978. These are (Fig. 5 a, b) pelagic, have diameters from 0.72 to 0.75 mm, with a narrow perivitelline space and a clear yolk of glistening appearance. There is an oilglobule of 0.44-0.45 mm diameter, with a glistening appearance and heavy pigmentation consisting of melanophores and light greenish xanthophores. Embryos also show black and greenish pigmentation ; so also the newly hatched larva measuring 1.6 mm (Fig. 5 c, d), thus obliterating the boundaries of the myomeres. In a 12 hours old larva of 2.2 mm (Fig. 5 e), about 12 preanal myomeres are discernible. By 64 hrs old (Fig. 5 f), the postlarval phase has set in. Among postlarvae collected from plankton, in a 4.0 mm stage (Fig. 5 g), the fins are under progressive development, with the caudal fin showing about 12 rays ; and there are 10 preanal and 15 postanal myomeres. Pigmentation is in the form of a mid-lateral series and some dorsal and ventral chromatophores. In a specimen of 5.0 mm (Fig. 5 h) collected from fry net catches, further development of fin elements can be seen, with about 10 dorsal, 18 caudal and 6 anal rays, most of the caudal rays being 3 to 5 segmented. Pigmentation has become more pronounced than in the previous stage and four preopercular spines are visible. A much longer specimen of 11.3 mm (Fig. 5 i) shows the disappearance of many postlarval features and appearance of juvenile characters. The anterior dorsal fin has appeared in this stage, with 11 spines, followed by one spine of the posterior dorsal fin and about 9 rays. Caudal fin has about 34 rays, most of which are 5 to 8 segmented ; anal fin has 3 spines and about 7 rays ; pelvic has 1 spine and a few rays ; and pectoral has about 14 rays. Pigmentation is chiefly in the form of three longitudinal series, one at the mid-lateral aspect, another at the base of the dorsal fin base and the third along the ventral aspect of the postanal region. Number of preanal myomeres has decreased to 9 and that of postanal increased to 16, corresponding to the adult condition and different from the previous two postlarval stages.

Size range of the planktonic eggs described is closest to that of the mature eggs of this species reported by Prabhu (1956), *viz.* 0.35 to 0.45 mm, which when becoming ripe and getting waterhardened can attain about 0.7 to 0.8 mm. Presence of an oilglobule and high pigmentation of the eggs and oilglobule are characteristic of the eggs of perches. Presence of the spawning stock of *T. jarbua* in the local catches as well as the number of myomeres tallying with adult vertebral number have pointed out to the identity of the material. This is confirmed by rearing identical stages of the postlarvae in culture ponds.

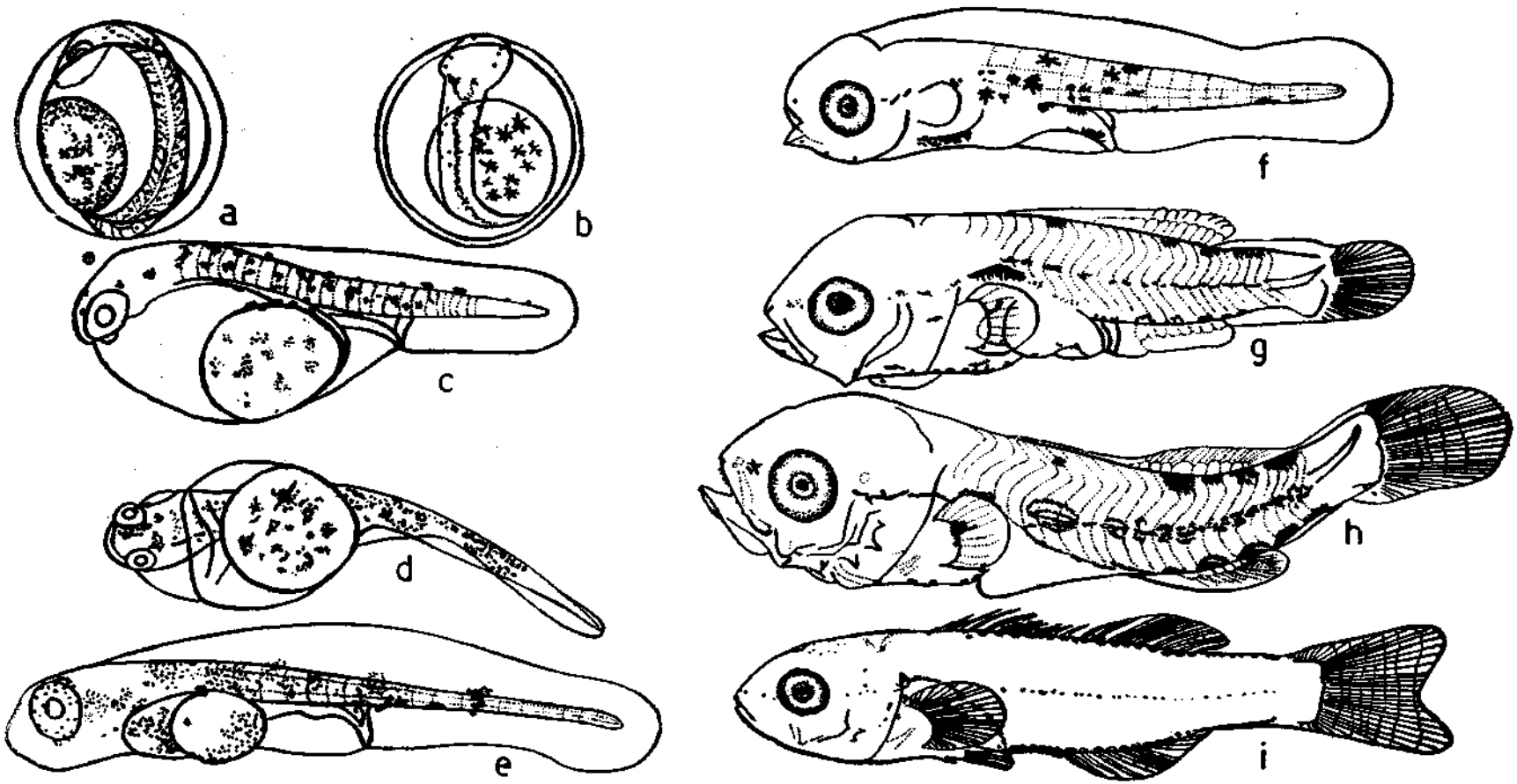

Fig. 5. Eggs (from live material), larvae and postlarvae of *Therapon jarbua:* (a) and (b) Eggs in two stages of development ; (c) Lateral view of a newly hatched larva ; (d) Ventral view of the same ; (e) Larva of 12 hours old (2.2 mm total length) ; (f) Postlarvae of 64 hrs old (2.2 mm) ; (g) Postlarva of 4.0 mm ; (h) 5.0 mm and (i) 11.3 mm.

Lates calcarifer (Bloch)

Two postlarvae have been collected from the plankton during September-October 1977. In the younger specimen of 2.1 mm (Fig. 6 a), the larval finfold is almost nonexistent. There are 8 preanal and 15 postanal myomeres, the total corresponding to the adult vertebral number. Pigmentation is mostly confined to the ventral aspect of the body. In an older stage of 4.9 mm (Fig. 6 b), the body has become very broad and pigmentation has increased much more, with branching chromatophores along the dorsal and ventral aspects and a mid-lateral series in the middle region. The fins are under progressive development and the caudal shows many rays of which the middle ones are prominent and 3 segmented. The disposition of myomeres has changed to 10 preanal and 13 postanal, corresponding to the adult vertebral condition.

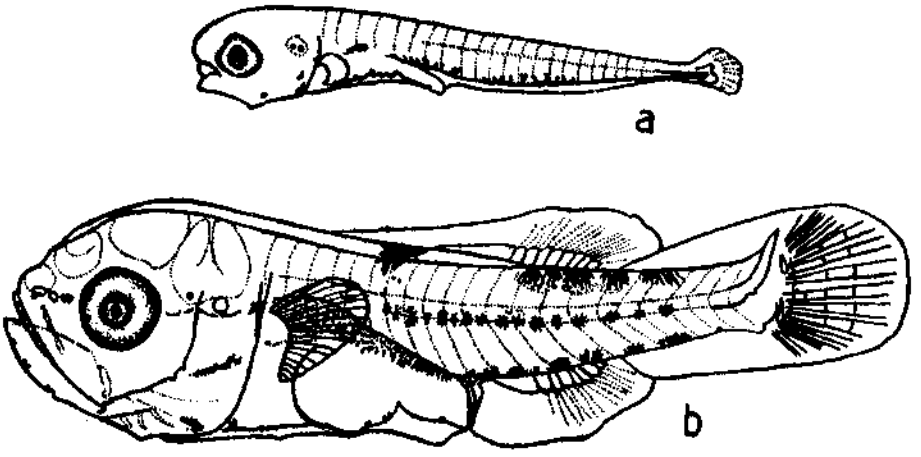

Fig. 6. Postlarvae of *Lates calcarifer* : (a) 2.1 mm total length and (b) 4.9 mm.

Identification of the present postlarvae as those of *L. calcarifer* is based on the coincident occurrence of the spawning stock and the postlarvae at Parangipettai and is strengthened by the number as well as disposition of the myomeres. Rearing of specimens identical with the stages described in brackishwater ponds has given rise to juveniles of this species, thus confirming the identification. The 4.2 mm postlarva of this fish described by Mukhopadhyay and Verghese (1979) has many similarities with the present 4.9 mm stage.

Siganus javus Linnaeus

Among four postlarvae collected from plankton during December 1977, in the earliest stage of 4.8 mm (Fig. 7 a) the dorsal and anal fins are indicated, but rays are not yet formed. There are 5 preanal and 18 postanal myomeres ; and pigments are present along the ventral aspect of the body. In a 5.6 mm stage (Fig. 7b), the disposition of myomeres has changed to 7 preanal and 16 postanal, a few dorsal and anal fin buds can be seen and a few caudal rays have been formed. By 9.7 mm (Fig. 7 c), excepting the pelvic, all other fins have developed, with about 9 dorsal spines and 13 rays, 26 caudal rays, most of which are 5-6 segmented, 2 anal spines and 10 rays. Disposition of myomeres has changed to 10 preanal and 13 postanal. In a larger stage of 10.8 mm (Fig. 7 d), the snout shows an anterior projection, marking the beginning of the snout in the later stages. The appearance of a group of pigments at the hinder aspect of the head and a few spots above the

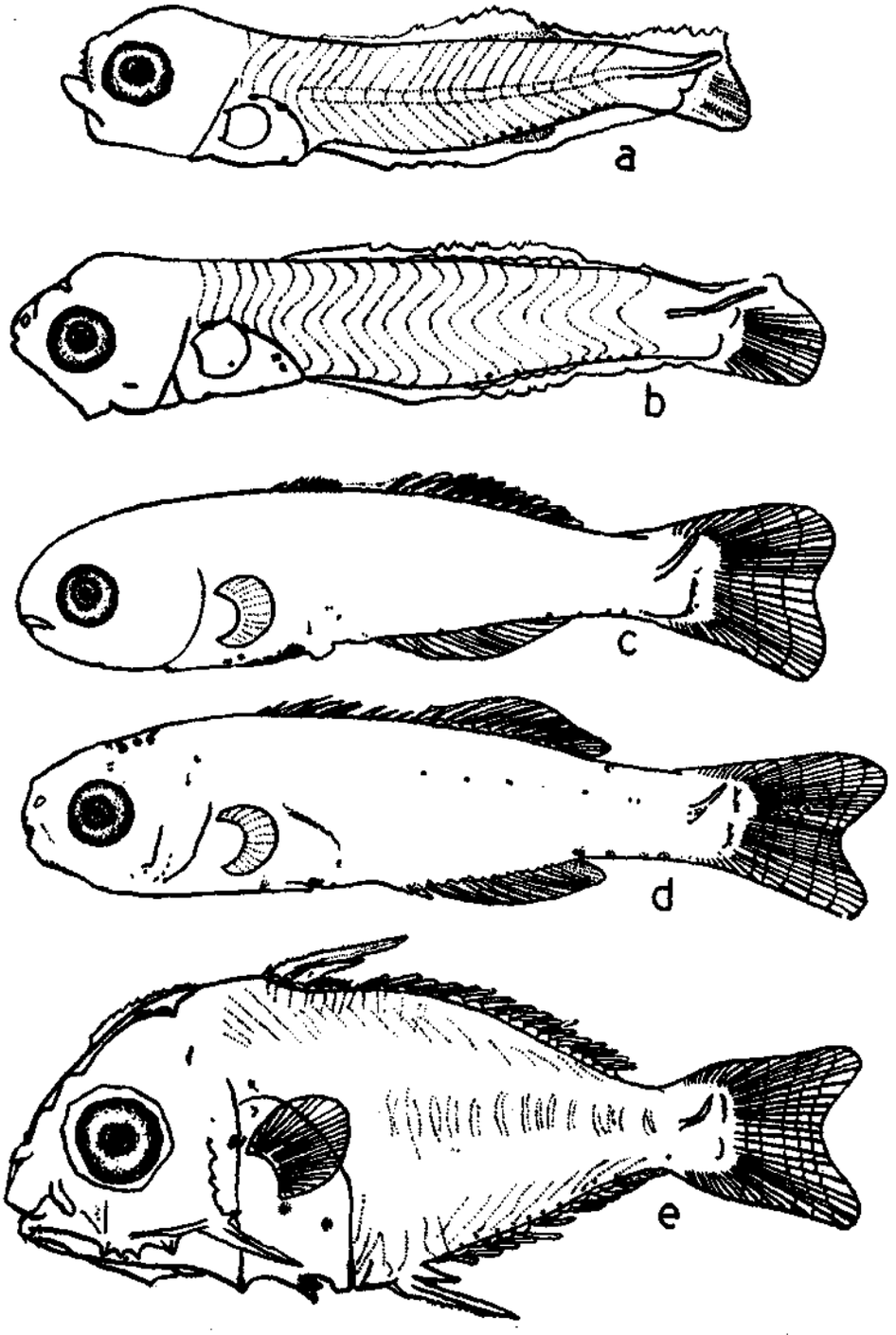

Fig. 7. Postlarvae and juvenile of *Siganus javas* : (a) Postlarva of 4.8 mm total length ; (b) 5.6 mm ; (c) 9.7 mm ; (d) 10.8 mm and (e) Juvenile of 9.5 mm total length.

mid-lateral aspect in the postanal part of the body is another change. Among the fins, the caudal rays have increased to about 30 and anal rays to about 12. Preanal myomeres have increased to 11 and postanals decreased to 12. Apart from the postlarvae, a few juveniles have been collected. The youngest one measures 9.5 mm (Fig. 7 e) ; from its shape it appears that the major morphological change undergone after the previous stage is a dorso-ventral expansion of the body, already indicated in the previous stage itself in the head region. It appears that between the previous postlarva and the present juvenile, there is a metamorphosis. This is further strengthened by the fact that the spines of the dorsal and anal fins in this stage are not the same ones as in the previous postlarva and the latter can be seen in a state of atrophy or resorption by the side of the newly developing spines, *vide infra*. There are 7 spines in the anterior dorsal, 19 rays in the posterior dorsal, 30 rays in the caudal, 3 spines and 15 rays in the anal, about 15 rays in the pectoral and indications of a few rays in the pelvic. The disposition of myomeres has changed to 8 preanal and 15 postanal. In a specimen of 15.0 mm, the head (Fig. 7 f) has become somewhat triangular and the mouth has been shifted to occupy a level opposite to the eye, in contrast to a level below the lower margin of the eye in the previous juvenile stage, obviously accompanied by a metamorphosis. The newly developing dorsal fin spines can be seen along with remnants of the postlarval spines (Fig. 7 g). In the anal fin also such a condition can be seen (Fig. 7 h). Further development of the new set of juvenile dorsal spines is under progress in a stage of 20 mm (Fig. 7 i) in which the dorsal fin rays in the hind region also are in the process of getting

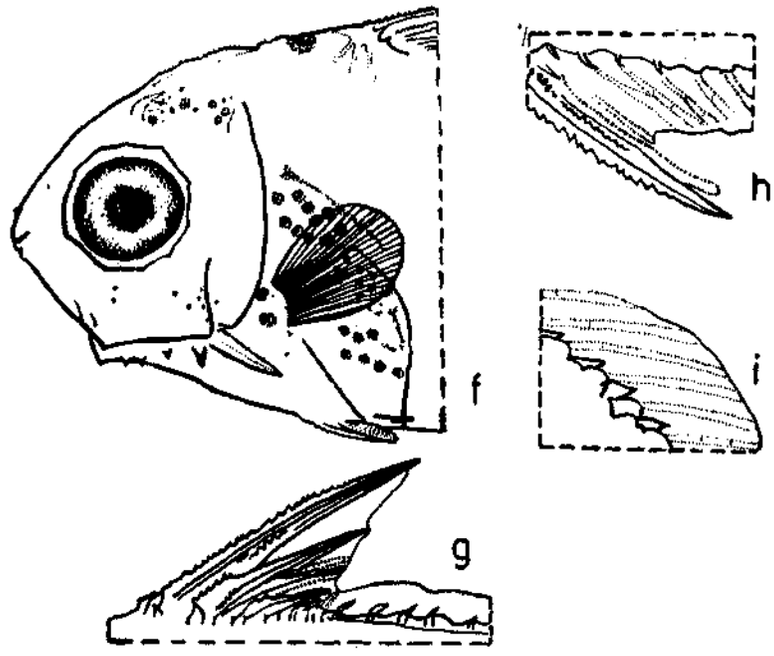

Fig. 7 (Contd.). Juveniles of *Siganus javus :* (f) Head region of a juvenile of 15 mm total length (g) Spinuous part of the dorsal fin in the same specimen ; (h) Anterior region of the anal fin in the same and (i) Hind region of dorsal fin in a juvenile of 20 mm.

atrophied or resorbed. The disposition of myomeres gets stabilised to 9 preanal and 14 postanal in the 24 mm juvenile stage, corresponding to the adult condition.

Identification of the present specimens as those of *S. javus* is based on the coincident occurrence of the material and the spawning stock of the species at Parangipettai. For confirming their identification, identical stages occurring in the plankton have been reared in culture ponds. Senta, Ueno and Fujita (1958) have described the early development of the Japanese species *S. fuscescens*. One significant difference between the postlarvae of these two species is in the development of the dorsal fins. In most bony fishes, the posterior dorsal fin is the first to develop, followed by the development of the anterior dorsal, as also observed in the development of *S. javus* in the present account. But, in the development of *S. fuscescens*, it is the anterior dorsal fin which develops first, in 3.84 mm stage, followed by the development of the posterior dorsal only by 8.3 mm. Another fact observed in the early development of *S javus* is the atrophy of the postlarval set of dorsal and anal fin spines and rays and its replacement by a juvenile set during metamorphosis, extending upto about 24 mm length. It is not known whether such a replacement takes place in the development of other siganids and/or other fishes.

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