OBSERVATIONS ON THE ACCLIMATISATION, NESTING HABITS AND EARLY DEVELOPMENT OF *OSPHRONEMUS GORAMI* (LACÉPÈDE)

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Introduction

Osphronemus gorami (Lacépède), popularly known as Gourami is a native of Malay Archipelago. On account of its large size, bonelessness and delicate flavour and the ease with which it breeds, it is considered to be the best fresh-water fish for pisciculture (Sundara Raj, 1939). It has been recently introduced into Europe, Australia, Philippines, India and Ceylon. It is a herbivorous, non-predaceous and hardy fish capable of breeding in confined waters, and is therefore ideally suited for cultivation in ponds. In India it has recently been introduced into several parts of Madras Presidency, Bombay Presidency and Mysore State where it has acclimatised itself and is breeding well. There is every reason to think that if it is cultivated in different parts of India it would make the inland fisheries highly productive. It is well known that a study of the breeding habits and mode of development of food fishes is an essential prerequisite for organising fishery development. In this connection the contributions of Sundara Raj (1916), Gopala Aiyar (1935), Jones (1937 *a*, 1940), Job (1941), Hamid Khan (1943) and Kulkarni (1939) on the breeding and development of certain Indian fishes are very helpful in carrying out similar investigations on the food fishes of India. Considerable attention is being paid to the study of the bionomics and development of Gourami by several workers. Roxas and Umali (1937) in an article entitled "Fresh water fish-farming in Philippines" have made cursory observations on a few larval stages of this species. Kulkarni (1939) is the first to record the embryonic and larval development of Gourami but his description requires modification and elaboration. The following notes relate to the acclimatisation, nesting habits and early development of Gourami.

Acclimatisation

Eight dozen Gourami fingerlings ranging from 6 to 9 inches in length were purchased from the Madras Fisheries Department in February 1942 and

introduced into a breeding pond at the Markonahalli Fish Farm. There was considerable mortality of the fishes of this lot as they were affected with fin-rot when they were supplied. Some of them survived after they were given a course of saline bath. About a year after introduction there were 25 Gourami, 12 to 15 inches in length.

The Gourami breeding pond of the Fish Farm has a waterspread area of about 1,400 sq. yards. It slopes gradually from the margin to the centre where there is 8 feet depth of water. Before the fishes were let in, the pond was rendered fertile with manure and the introduction of aquatic vegetation, and is now rich in aquatic organisms. The fishes are also artificially fed with baked ragi flour mixed with groundnut oil-cake and rice bran. The breeding of Gourami was first noticed in the pond during August 1943.

It is stated in the Service Bulletin No. 3. (Pisciculture) of the Madras Fisheries Department (1939) that " It (Gourami) is not suitable for cold hill water at elevations above 1,000 feet. Breeding is satisfactory up to elevation of 1,000 feet with a water temperature of 80° F." The elevation of Markonahalli Fish Farm is 2,400 feet above sea-level and the temperature of water in fish ponds is 75 to 80° F. Here Gourami is not only thriving well but also breeding freely.

Nesting Habits

In an article recently published, Jones has given a history of the previous work on the nesting habit of Gourami. Carbonnier (quoted by Jones) describes a floating " bubble nest " made of air bubbles and the buccal secretion of the fish. Gilbert (1894) observed eggs of Gourami as having been plastered to the under-side of a rock and supplied with bubbles of air by the parent fish. A reading of the papers of these authors clearly indicates that it is not the nesting habit of the true Gourami (*O. gorami*) that they have described but of some other Anabantoid fishes which are known to construct floating nests of air bubbles. The Editor of the *Journal of Bombay Natural History Society* has rightly pointed out in commenting on Jone's paper that divergent views expressed by various authors is due to the mistake in the identity of the species. That Gourami builds a nest of aquatic plants for the reception of its eggs has been fully established by Sundara Raj (1916), Roxas and Umali (1937) and Kulkarni (1939).

The nest of Gourami is constructed out of aquatic plants and is more or less spherical or to be more precise slightly ovoid in shape. The size and form vary slightly from nest to nest. It is slightly thicker in front where there is the opening. The length and width of the nest are about 15 and 12 inches respectively. The size and shape of the nest conforms with those

described by Kulkarni from Bombay. The mouth is circular about 4″ in diameter and directed towards the deep portion of the pond. The cavity inside is not deep, being just a shallow depression. The eggs and larvæ are very well protected within the thick nest. In the pond at Markonahalli Fish Farm, the nests are anchored to the long stems and leaves of bulrush (*Typha augustata* B and Ch.) Fig. 1. The nests are constructed along the weedy

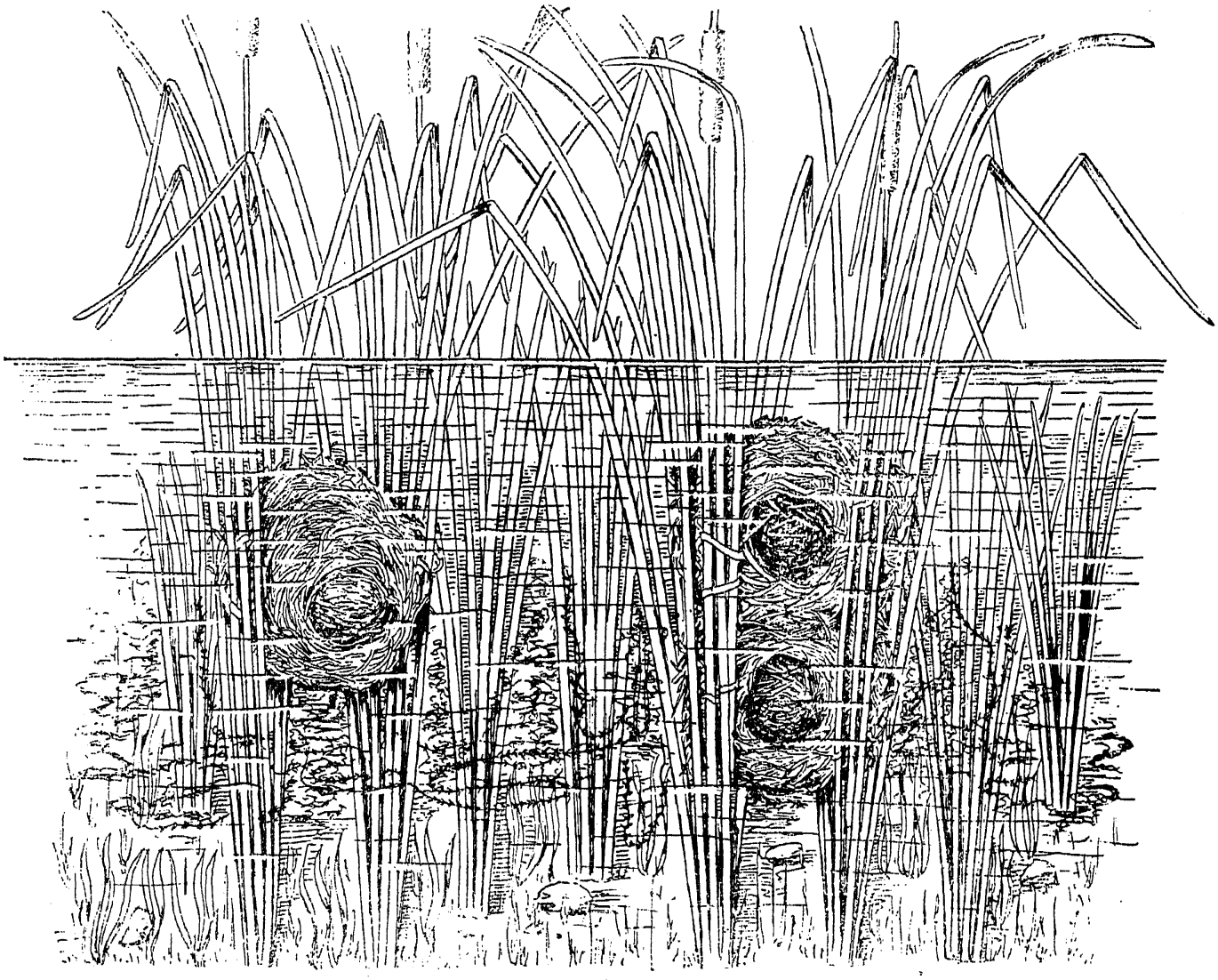

Fig. 1. Nests of *Osphronemus gorami* (Lacépède) (Diagrammatic)

margin of the pond about 6 to 10 inches below the surface of water and about one foot above ground level. During our study three double nests (Fig. 1) one above the other have been noticed; in these it was observed that the upper nest was a discarded one without any eggs or larvæ in it and in a more disintegrated condition than the lower, the latter apparently constituting the second brood of the same pair of fish.

The nests were mostly made up of cut pieces of bulrush which grow profusely at the margin of the pond. Bulrush is a long gregarious robust

grass-like weed attaining a height of about 8 to 10 feet. Pieces of bulrush are closely interwoven into a thick basket-like structure and to this groundwork are added aquatic grasses, twigs of other plants and sometimes even bits of rags that may be found at the margin of the pond. The fact that plants like Elodea, Chara, Nitella, Vallisneria and others though found in plenty were assiduously kept out of the nest is interesting; probably the fish selects only plants which yield fibrous material for constructing the nest. Further, the disintegrating softer tissue stimulates the growth of micro-organisms, particularly rotifers and infusorians within the nest, which are noticed abundantly among the fibrous tissue. They form excellent food for the developing larvæ till they leave the nest. Roxas and Umali (1937) have noticed nests being built among roots of water hyacinth in Philippines. The fishes nibble leaves and stems with their hard jaws and soak the cut pieces in water for sometime, probably to render them more pliable and then carry them in their mouths for nidification. The fish takes about 8 to 10 days to build the nest.

While examining the nests it was noticed that whenever a nest was approached, a fish would scuttle away into the deeper portion of the pond. With a view to examine whether the fish guarding the nest was a male or a female, two separate nests were carefully encircled with a drag net on two occasions and the fish caught. On both the occasions the fish was a male with the characteristic hump on the forehead. It may therefore be concluded that it is the male that guards the nest. In the case of another nest building Anabantoid, *Macropodus cupanus* (C and V), Jones states that the nest is always guarded by the male fish. On another occasion a male fish was noticed nibbling grass in shallow water cutting it with a series of jerks.

Breeding

Roxas and Umali (1937) state that Gourami breeds throughout the year in Philippines. Kulkarni (1939) observes that the fish breeds in Bombay Presidency all the year round except during the monsoon from June to September. According to Sundara Raj (1939), Gourami generally breeds twice a year in Madras—in February and March and again in September to November. The fish in our fish farm breeds practically throughout the year. Nests with eggs or larvæ have been noticed during August and October of 1943 and January, February, April, May, June and July of 1944. Active breeding has been noticed during summer months, April and May, when quite a large number of nests were constructed.

We have not been successful in observing the actual process of spawning in spite of several efforts made in that direction. Several nests have been

noticed containing freshly-laid eggs. The eggs are deposited in the depressions in the nests and covered over with twigs and leaves with which the nest is constructed. The eggs are not adhesive and if they are not thus covered they float to the surface of water. The covering on the eggs not only keeps them within the nest but also protects them from being devoured by other fishes. The mouth of the nest is just wide enough to admit the head of the fish inside. Probably the male contrives to transfer the eggs into the nest by its mouth and covers them. Otherwise it is difficult to explain how the floating eggs can be deposited and covered within the nest. Further attempts will be made to observe the mode of spawning and of deposition of the eggs in the nests. From one nest 1,450 just hatched larvæ were collected on 20th May 1943. Kulkarni (1939) has collected from the tank at Bandra two to three thousand larvæ from each nest.

Development

1. *Embryonic Development*

A study of the early development of Gourami was conducted during May 1944. The eggs were carefully taken out of a nest and brought to the laboratory attached to the Fish Farm and developed in glass trays. The embryonic and larval stages were examined under the microscope. The different stages of development have been fixed in 5% formaldehyde. The pre-larval stages can be seen distinctly after the eggs are stained in Delafield hæmotoxylin and differentiated in acid alcohol.

The egg.—The eggs were collected at 10 A.M. on 13-5-44. They are not quite spherical but slightly oval in shape—2·7 mm. in diameter, the long axis being about 0·2 mm. longer. The size of the egg noticed by us is more or less in agreement with what has been stated by Kulkarni (1939) but Roxas and Umali (1937) record the diameter of the egg of Gourami as 1 mm. They are yellowish in colour and are semi-transparent. On account of the presence of clear fluid, which we are inclined to believe is fluid yolk (*f.yk.*) together with a few oil globules (*o.g.*) occupying about one-third of the egg at the abapical pole, the egg is actually inverted in the natural condition. The fluid yolk and the oil globules give buoyancy to the eggs. About two-thirds of the egg on the apical side constitutes a solid mass of yolk (*yk*). The vitelline membrane (*e.m.*) is thin and non-adhesive. By the time the eggs were collected from the nests the preliminary cell division was complete and a layer of blastoderm (*bl.*) had formed on the yolk mass of the apical pole (Fig. 3). The nest from which the eggs were taken was noticed to be empty on the previous evening and therefore it is presumed that this particular batch of eggs was laid during the early morning of the 13th May.

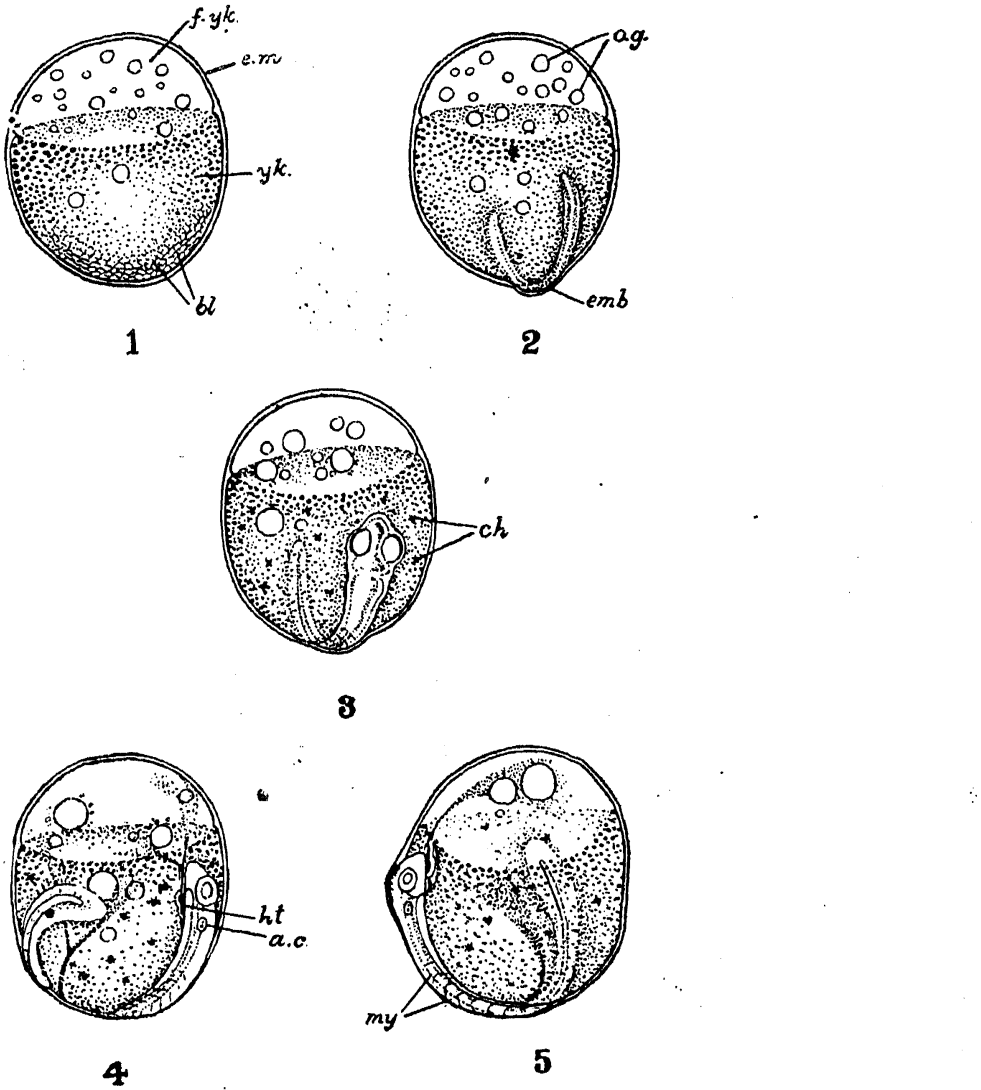

FIG. 3. *Osphronemus goramy* (Lacépède), Embryonic stages, approximately **1.** 4 hours, **2.** 6 hours, **3.** 13 hours, **4.** 27 hours, **5.** 34 hours after fertilization of the egg. × ca. 8½.

a.c., auditory capsule ; *bl.*, blastoderm ; *ch.*, chromatophores ; *e.m.*, egg membrane ; *emb.*, embryo ; *f.yk.*, fluid yolk ; *ht.*, heart ; *my.*, myotomes ; *o.g.*, oil globules ; *yk.*, yolk.

By 12 noon the layer of blastoderm extends to the region of the fluid yolk at the abapical pole and faint indications of the formation of the embryo noticed. By 2 P.M. the blastoderm completely envelopes the yolk and the differentiation of the embryo begins. In the head could be seen broad divisions of the brain and the formations of the optic vescicles. The caudal end is narrow. Two hours later 7 to 8 somites appear along the body. The fluid yolk becomes opaque on account of the extension of blastoderm over it. The embryo is still adpressed to the yolk mass. By 7 P.M. the number of myotomes increases to about 15. A few stellate cells appear on the yolk.

By 8 A.M. next morning the embryo has grown considerably in size. The tail has developed a thin fin-fold and has become free from the yolk surface and lashes from side to side. The head is wider and thicker and

the eyes are proportionately large, but there is no pigment in them. A little behind each eye could be seen the auditory capsule. The notochord and the nerve cord are seen distinctly. The divisions of the brain are well marked. About 20 to 25 myotomes can be counted (*my.*). The heart is just beginning to form beneath the head between the yolk and the outer layer of blastoderm. Gradually circulation is established. The outline of blood vessels is not yet clear. By 4 P.M. there is active blood circulation and the different parts of the heart—sinus venousus, ventricle, auricle and the conus—can be distinguished. The colourless blood flows forwards from the heart and coursing below the notochord proceeds to the end of the tail. Immediately below this is another vassel which conveys the blood forwards. About the middle of the body the vessel turns downwards conveying the blood to the yolk mass. The blood collected from the yolk goes back to the heart by a thick vessel. About this period some of the larvæ are seen hatching. It is seen that except for the tail the rest of the body is not free from yolk surface. The powerful lashing movement of the tail causes the rupture of the vitelline membrane and the larva comes out of the membrane. By about 6 P.M. all the larvæ have hatched out. Hatchlings are seen darting out of

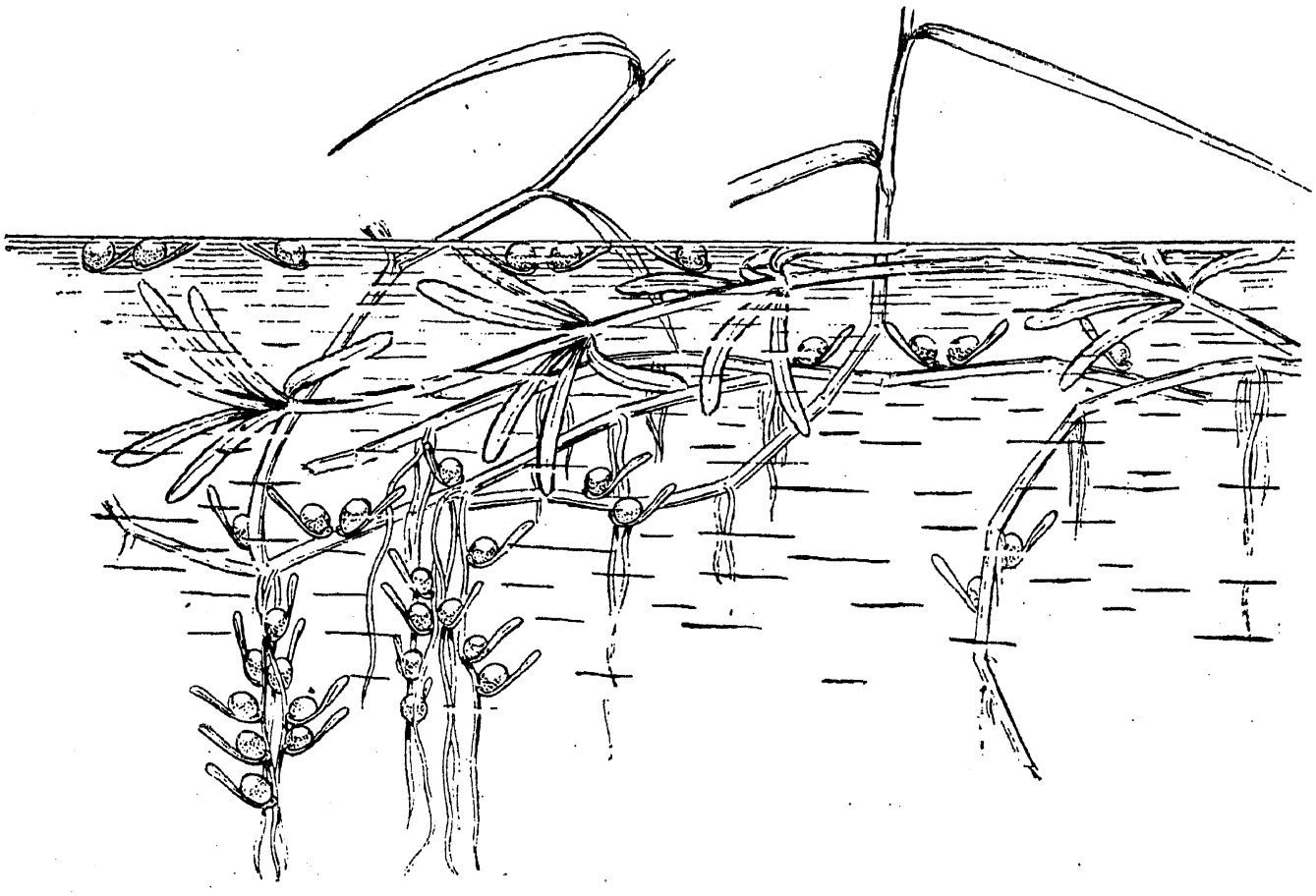

FIG. 2. The hatchlings of *Osphronemus gorami* (Lacépède) are shown attached to the aquatic plants and a few floating at the surface of water in a glass trough.

the egg membrane with a vigorous movement and float upside down at the surface of water on account of the presence of the fluid yolk and the oil globules at the abapical pole of the yolk sac and some of them attach themselves in groups to the roots and leaves of aquatic plants kept in the glass trough by the dorsal aspect of their heads as in Fig. 2. A few are attached to the sides of the trough. It is thus seen that the larvæ hatch out in about a day and a half. The period of the embryonic development of Gourami from the time of deposition of the eggs up to the hatching of larvæ varies in the same pond during different parts of the year. It is short during summer and prolonged during winter. The larvæ hatched out in two and half to three days during August, in 5 to 6 days during January and February and in about a day and a half during May.

2. *Larval Development*

Newly hatched larva.—The newly hatched larva is in a remarkably poorly developed state. The larva is transparent and measures 6 mm. in length and is closely pressed to the yolk mass except in the tail region. The mouth, gills, alimentary canal and the fins have not yet appeared. There is a thin median fin-fold extending along the dorsal and ventral aspects of the tail region. The notochord is straight and unsegmented. There is no pigment in the eye. The blood is colourless. About 25 myotomes are seen along the body. An interesting feature about the newly hatched larva is the presence of highly enlarged cells on the dorsal aspect of the head which exude a mucus secretion by which it attaches itself to the vegetation or any other object in water. An examination of the microscopic sections of the larva shows that these cells arise from the ectoderm and are much larger than the cells covering other parts of the body. It is also noticed that by the 8th day after hatching when the larva is actively moving about the secretory cells disintegrate giving place to normal ectodermal cells. The secretory cells on the head can be regarded as generalised adhesive or cement gland (Fig. 4, *c.gl.*). The cement glands described by Jones in *Macropodus cupanus* appear to be more or less similar to those found in Gourami. In Teleosteans like *Hyperopisus bebe, Sarcodacus odæ* and *Etroplus maculatus* the secretory cells are localised giving rise to well-developed cement organs (Jones, 1937). A detailed account of the cement gland in Gourami will be published shortly. Though Kulkarni (1939) has noticed larvæ resting on the weeds at the bottom of the observation tank, he denies the presence of any cement glands in Gourami. During the first day of development there is a marked development in the vascularisation of the yolk mass and rapid absorption of yolk is noticed.

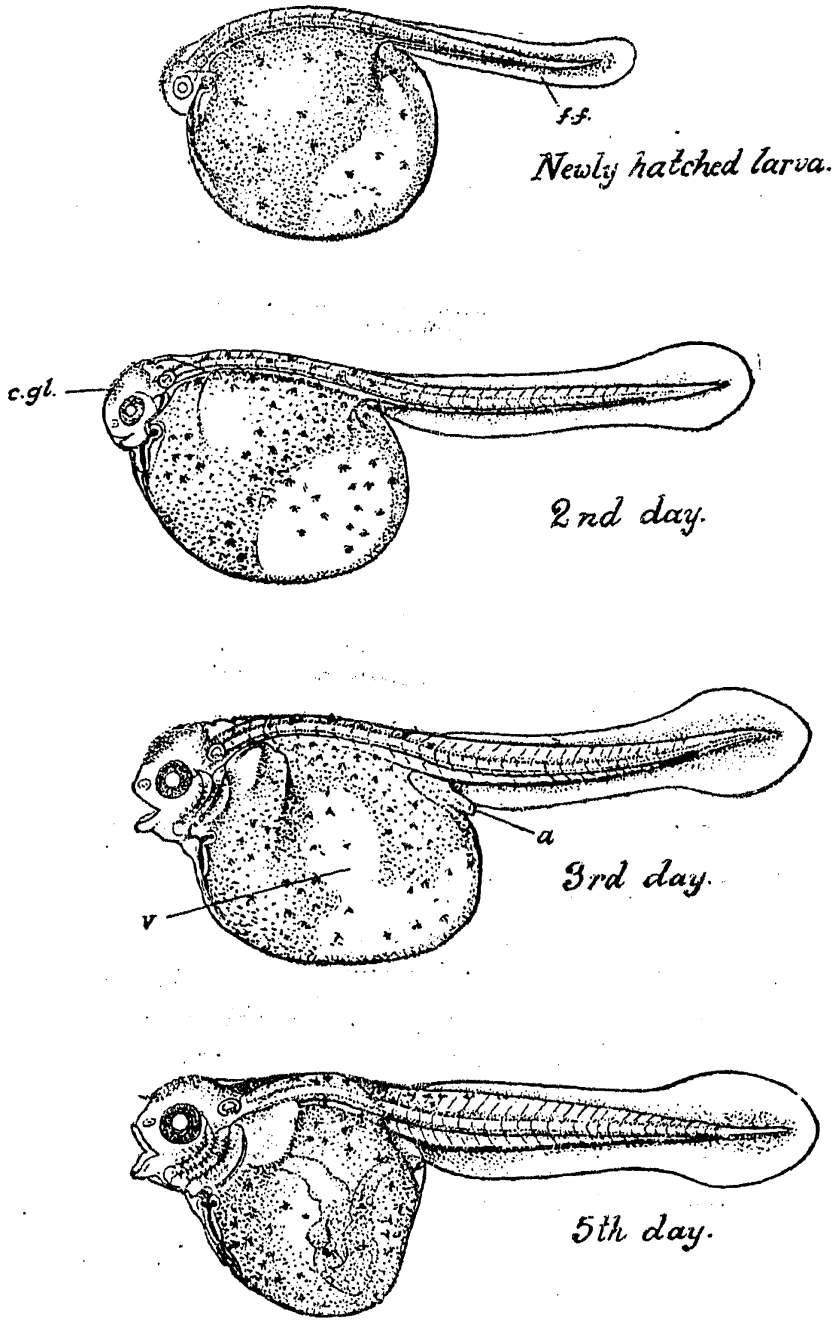

FIG. 4. *Osphronemus gorami* (Lacépède), larval stages. × ca. 8.
c.gl., cement gland ; *f.f.*, fin-fold ; *v.*, vacuity.

2nd Day Larva.—The larva grows to about 8 to 9 mm. in length. The head becomes slightly lifted up from the yolk mass. Nasal capsules make their appearance. There is a gradual pigmentation of the eyes. The auditory capsules are drawn slightly nearer the eyes. The chondrocranium is forming. The mouth is just appearing as a slit but it is not yet functioning as it is covered up by membrane. The cells of the cement gland are prominently seen. The notochord is straight and unsegmented. Rudiments of the pectoral fins arise as small buds behind and below the auditory capsules. The circulation of blood is becoming complicated. There are

vessels given out to the head and between myotomes. The number of chromatophores increase on the yolk sac and a few appear on the body.

3rd Day Larva.—The larvæ though attached are more active. The head and the body have become thick. The eyes are large with black pigment. The mouth has appeared but the jaw bones are not yet developed. The gill arches and rudimentary gill filaments are formed. The larva has commenced to breathe. The blood has become red and can be seen flowing into the gill filaments. The heart is functioning at a rapid rate of about 180 beats a minute. The pectoral fins have grown longer and vibrate rapidly. The anus appears as an invagination at the angle between the yolk sac and the body. The alimentary canal is not yet seen. Considerable yolk has been absorbed by now and in its place a clear vacuity appears which gradually increases in size.

4th and 5th Day Larva.—This period is marked by the larvæ setting themselves right in position. The larvæ which were floating or attached to aquatic plants hitherto in an inverted condition gradually assume correct position and move about freely. This is aided, as could be seen from the specimens, by the upward extension of the yolk sac with the vacuity as a pouch-like structure, one on either side of the body (Fig. 5, *l.p.*). In a microscopic section of the trunk region of the larva at this stage, the pouches can be seen distinctly. In the head the chondrorcranium, the jaw bones and the opercular bones are formed. The opercular opening is distinctly seen and the larvæ respire rapidly. The anterior portion of the alimentary canal is not clearly seen as it is covered by the yolk. The intestine, the wall of which consists of large cells, forms a loop and opens by the anus; the liver forms as sac-like evagination from the gut and is green in colour. A small pre-anal fin-fold is seen. By the end of the 5th day a slight upward bend of the hinder end of the notochord is observed. The heart is pushed up and the yolk circulation has become feeble. The post-cardinals have formed.

6th and 7th Day Larva.—Except for the thin mass of yolk along the margin of the yolk sac the yolk has been fully absorbed. The yolk sac is reduced in size and pushed upwards. It would be necessary to make it clear that the yolk sac is no longer a separate unit. It is already stated that the blastoderm covers the yolk sac completely with the result the yolk sac has to be regarded as having been taken inside the body. The notochord becomes segmented and the upward extension of the hinder end is more pronounced giving the caudal region a heterocercal condition. The rudiments of the caudal rays are formed. The neural and hæmal arches can

also be seen. The jugular veins and the hepatic portal vein are formed during this period. The larvæ begin to feed on the micro-organisms. They were fed in the laboratory with finely crushed boiled fowl's egg which they devoured with avidity.

8th and 9th Day Larva.—With the increasing development of musculature and bones, especially in the head, the larva is becoming thick and opaque. The larva is gradually assuming fish form by further diminution of the yolk sac region. The chromatophores become numerous and prominent all over the body. The air bladder is seen developing as an evagination from the dorsal aspect of the anterior part of the gut (Fig. 5, *a.b.*). The

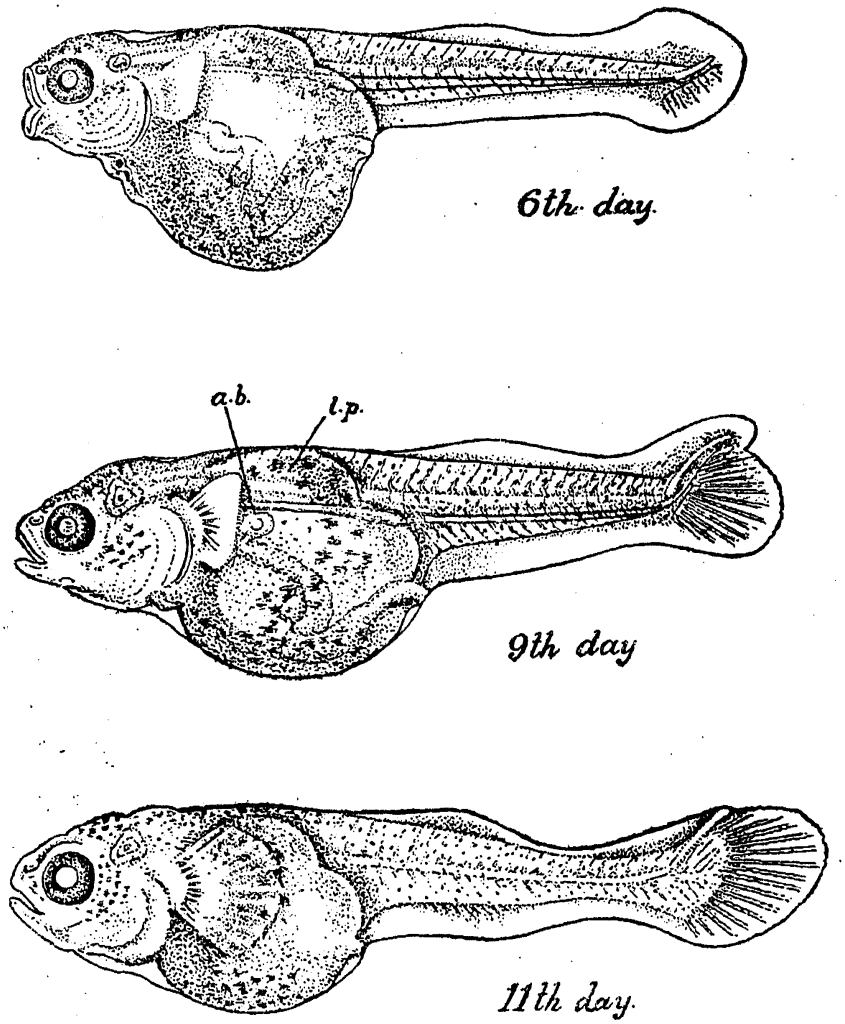

FIG. 5. *Osphronemus gorami* (Lacépède), larval stages. × ca. 8.
a.b., air bladder ; *l.p.*, lateral pouch of the yolk sac region.

median fin-fold is gradually diminishing in size. The caudal fin is well defined assuming a homocercal condition and the caudal rays are formed.

10th to 15th Day Larva.—The larvæ are gradually growing in bulk. The yolk sac region now presents the normal contour of the body. The

heart has become thick and occupies the normal position in the thorax. By this period practically the full compliment of the circulatory system of the adult fish has developed. The dorsal and the ventral fins are now distinct from the caudal and have developed rays. It is noticed that the larvæ leave the nest between 15th and 18th day after hatching.

1 *Month Old Larva.*—The whole body is covered with very large number of chromatophores. Nine broad vertical stripes are noticed. The head has become considerably big with large eyes. The scales and the ventral fins have not yet developed.

On 12th May 1944 a shoal of young Gourami was noticed in the pond. A few of them were netted and found to measure 18 mm. in length. The scales and ventral fins were developed but the long ray of the ventral fin was still lacking. The spinous rays of the dorsal and anal fins were present. There was a big dark blotch on the soft rays of the dorsal fin. The young fish had the exact shape and form of the adult. These are probably the offspring of breeding during the end of January or the beginning of February.

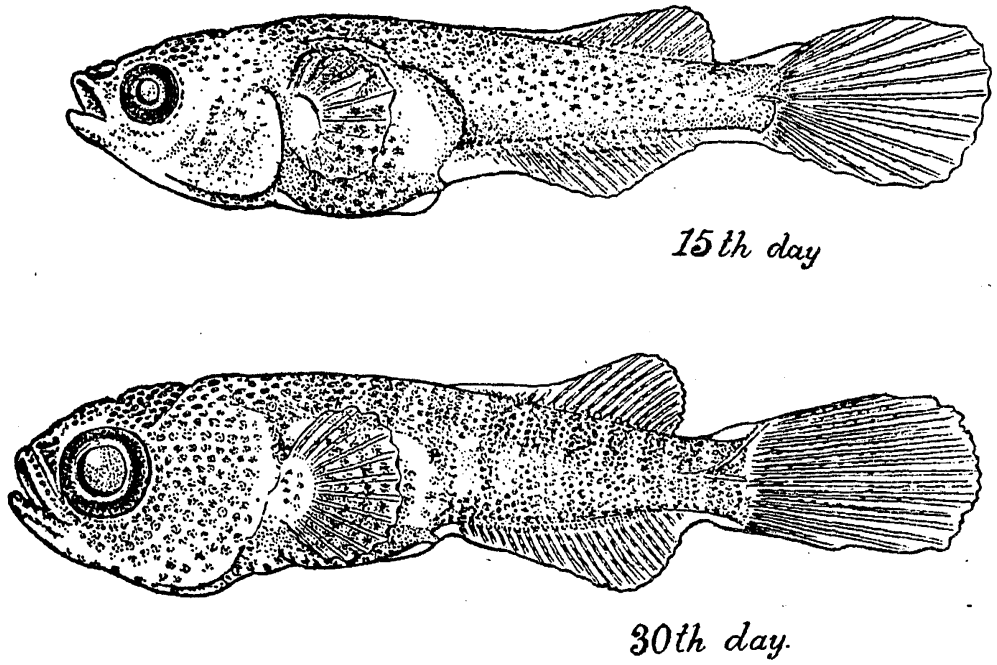

FIG. 6. *Osphronemus gorami* (Lacépède), larval stages. × ca. 8.

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Summary

Experiments on the acclimatisation of Gourami at the departmental fish farm at Markonahalli (2,400 feet above sea-level) in Mysore State have proved successful. The fish are thriving well and are breeding freely.

Gourami builds a nest of aquatic plants for the reception of its eggs. The nest is more or less ovoid in shape with a shallow depression. It is built among the vegetation along the margin of the pond and is attached to the long blades and stems of bulrush, a little above the ground level and a few inches below the water surface. It takes about ten days for the fish to construct the nest. Generally it is the male fish that guards the nest after spawning.

Gourami appears to breed practically throughout the year. The eggs are buoyant due to the presence of fluid yolk and oil globules in them. They are deposited in the nest and covered over with leaves and twigs. The embryonic development is rapid and the egg hatches in about 36 hours. The newly-hatched larva is highly immature without the mouth, gills and fins. The larvæ either float upside down or are attached to the aquatic plants by means of cement glands present on the dorsal aspect of the head. At the time of hatching the blood circulation has started and the yolk is being absorbed. Rudiments of pectoral fins appear on the second day after hatching. The mouth, anus and gills appear on the third day when the larva commences to breathe. By the fourth or the fifth day the larva sets itself right and the alimentary canal is seen in the vacuity caused by the absorption of the yolk. The larvæ commence feeding on the micro-organisms from the fifth day. By the eighth day the larva becomes opaque with the increasing development of muscles and bones. Gradually the dorsal, caudal and anal fins become differentiated. Within a period of fifteen days the full compliment of the circulatory system of the adult fish is developed. During the third week the larvæ leave the nest. The ventral fins do not appear even in a month old larva. Young Gourami of about four months old, measuring 18 mm. in length, have the form and shape of the adult and have developed scales, ventral fins and spiny rays of the dorsal and anal fins.

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