# SYNOPSIS OF BIOLOGICAL DATA ON THE GIANT MURREL, *Channa marulius* (Hamilton, 1822) THE STRIPED MURREL, *Channa striatus* (Bloch, 1793) and THE SPOTTED MURREL, *Channa punctatus* (Bloch, 1793)

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(INDIAN COUNCIL OF AGRICULTURAL RESEARCH)
BARRACKPORE 743 101 • WEST BENGAL • INDIA

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## *Foreword*

*The 'air breathing fishes' constitute a unique group of fishes belonging to diverse genera which have developed accessory respiratory organs to utilize atmospheric air for respiration, and enabling them to thrive in oxygen-depleted waters. They form about 13% of the marketable surplus of freshwater fishes in India and include the genera Channa, Clarias, Heteropneustes, Anabas, Osphronemus, Colisa, Notopterus, and Amphipnuous amongst which Channa spp. (murrels) constitute the most common and dominant group. Murrels are highly prized all over India for their keeping quality, flavour; and nutritive, recuperative and medicinal properties, especially in Peninsular India and in the States of Assam, Punjab, West Bengal & Madhya Pradesh. They can be held in a small quantity of water for long periods and are mostly sold alive. Murrels constitute the mainstay of the natural freshwater fisheries in Peninsular India where they are also stocked in village ponds, irrigation wells and shallow waters. The commonly encountered species are the giant murrel, Channa marulius; the striped murrel, Channa striatus; the spotted murrel, Channa punctatus; and the mud murrel, Channa orientalis, of which the former two attain large size and are economically more important.*

*Reclamation of vast swamps and other weed infested shallow water-logged areas, occupying over 0.64 m ha, for carp culture in India is cost prohibitive and beyond the present financial resources and priorities of the country. Because of their hardy nature and capacity to thrive in swamps and other derelict waters (where carps cannot be grown because of adverse conditions), murrels and other air-breathing fishes have attracted the attention of fishery scientists and planners as candidate species for culture in such water bodies without much investment. However, being major or minor predators, these fishes are not traditionally* *cultured in the country rather they are meticulously eliminated from carp culture ponds and no empirical knowledge of their culture methods is available with us. Information on their age and growth, food and feeding habits, recruitment, seed resources, etc., is also scanty.*

*Realising the potential for the culture of air breathing fishes the Indian Council of Agricultural Research (ICAR) initiated an All India Coordinated Research Project on Air Breathing Fish Culture in 1971 at the Central Inland Fisheries Research Institute. This work has yielded valuable information on air breathing species suitable for culture, their biological properties and seed resources. The present bulletin summarises the biological data on the three common species of murrels. It is believed that this publication would be of use to scientists and planners alike.*

*Arun G. Jhingran*
*Director*

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C O N T E N T S

PART-I CHANNA MARULIUS (HAMILTON, 1822)

Page No.

PART-II CHANNA STRIATUS (BLOCH, 1793)

PART- III <u>CHANNA PUNCTATUS</u> (BLOCH, 1793)

Page No.

Page No.

PART I CHANNA MARULIUS (HAMILTON, 1822)

1 IDENTITY

1.1 Taxonomy

1.1.1 Definition
(According to Berg, 1947)

Phylum Vertebrata
Subphylum Craniata
Superclass Gnathostoma
Series Pisces
Class Teleostomi
Subclass Actinopterygii
Order Channiformes (Ophicephaliformes)
Family Channidae (Ophicephalidae)
Genus Channa 1763
Species Channa marulius (Hamilton 1822)

Valid generic name

Over 15 species of fishes belonging to the genus Channa have been reported from Asia and Africa.

1.1.2 Description

Genus Channa Gronovius, 1763

1763 Channa Gronovius, Zoophyl.Gronovius animal., p. 135, t.9.fig.1 (type C.orientalis Schneider)

Synonyms:

1777 Channa Scopoli, Introd.Hist.Nat., p. 459 (type C. orientalis Schneider)

1793 Ophiocephalus Bloch, Nature. Aukland Fieche. 7. p. 137 (type O. punctatus Bl)

Head snake-like, depressed and covered with scales which are plate-like dorsally; long, spineless dorsal and anal fins; paired fins spineless; ventrals thoracic ( or absent) with rays, the outer not branched; branchiostegals 5, gills 4, pseudobranchiae absent; body elongated, anteriorly sub-cylindrical; eyes lateral; curved teeth on intermaxillaries, mandibles, vomer and palatines, canine teeth in lower jaw; gill openings wide, the membranes of the two sides connected beneath the isthmus; lateral line abruptly curved or interrupted; a suprabranchial cavity communicating with the pharyn serving as a simple accessory breathing organ (Day, 1878, 1889; Weber and de Beaufort, 1922 and Misra, 1959).

Species Channa marulius (Hamilton,1822) (Fig.1)

Length of head 4-5, depth 7 to 7.5, caudal 6 to

7½ in total length; eyes 5 to 7 in head; maxilla extends half a diameter of the eye behind the orbit; cephalic pits multiple. Teeth: Numerous villiform rows in jaws, vomer and palate and a posterior row of about 12 large conical teeth on the rami of the mandibles. Fins: ventral two thirds as long as the pectorals, but does not reach the origin of anal. Scales: about 10 rows between the orbit and angle of preopercle. Predorsal scales 17 to 20th. Lateral line descends by two rows after 15 to 20 row of scales, and passes straight posteriorly. Colour: Varies with age and environment: dorsally brownish or greyish green; 5 to 7 dark cloudy bands with bright white spots descend below the lateral line; pearly white spots on the posterior half of body and on dorsal, anal and caudal fins; abdomen pale orange; base of scales dark; a large black ocellus may be present on the upper half on the base of the caudal fin, prominent to varying degrees or may be absent in larger specimens. (Day, 1878, 1889; Weber and de Beaufort 1928; Misra, 1949a and Parameswaran, 1975).

## 1.2 Nomenclature

### 1.2.1 Valid scientific names

Channa marulius (Hamilton, 1822)

Gronovius proposed the genus Channa in 1763 which was followed by Scopoli (1777). Bloch in the year 1793 proposed the name Ophiocephalus to the genus which has been popularly used. However, Channa Gronovius being the name proposed earlier, according to the law of priority, is the valid one (Parameswaran, 1975).

The species was first described by Hamilton (1822) as Ophiocephalus marulius by which name it was known more popularly till recently.

Day (1878; 1889) has described two more allied species viz. Channa leucopunctatus (Sykes, 1841) and Channa pseudomarulius (Gunther, 1861). He had, however, doubted their validity and remarked that they may be varieties of C. marulius. Parameswaran (1975), after a detailed study of the morpho-meristic characters of the forms and rearing experiments, has established that both should be considered as synonyms of C. marulius, further review of the systematic position of the Indian fishes of the genus Channa and has given a key based on meristic characters for the identification of the various species (Annexure- 1). The origin, distribution and phylogeny of the genus Channa has been discussed by Chandy (1953).

1.2.2 Synonyms

Channa marulius (Hamilton, 1822)

Ophiocephalus marulius Hamilton, Fish. Ganges, pp. 65, 367, pl. 17, fig. 19, 1822; type locality: River Ganga, Cuvier (in C. & V.), Hist.Nat. Poissons 7, p. 432, 1831. Bleeker, Verh.Bat.Gen., 25, p.42, 1853. Gunther, Catal.Fish.Brit.Mus., 3, p. 478, 1861. Day, Fish. India, 1 & 2, p. 363-4, pl. 76, fig.4, 1876. Day, Fauna Brit. India, Fish., 2, p. 360, 1889, Shaw and Shebbeare, J.Asiat. Soc.Sci., 3, p. 122, pl. 4, fig.2, 1937.

Ophiocephalus grandinosus Cuvier (in C. & V.), Hist.Nat.Poissons, 7, p. 434, pl. 203. Bleeker, Verh.Bat. Gen., 25, p. 42, 1853, Gunther, Catal.Brit.Mus., 3, 478.

Ophiocephalus leucopunctatus Sykes, Trans.Zool.Soc. Lond., 2, p. 352, pl. 40, Fig.3, 1941; type locality; Coromondal and West Coast of India. Day, Fish.India, 1 & 2, pp. 363-4, pl. 77, fig.1, 1878. Day, Fauna Brit.India, 2,p.362.

Ophiocephalus pseudomarulius Gunther, Catal.Brit. Mus., 3, p.478, 1861. type-locality; India. Day, Fish.India, 1, pp. 374-5, 1878. Day, Fauna Brit.India, Fish., 2,362.

Ophiocephalus theophrasti Valenciennes, Jaco.Voy. Ind.Or., pl. 13, fig.1, 1835-44.

Ophiocephalus aurolineatus Day, Proc.Zool.Soc.Lond., p. 99, 1870, type locality Moulmein, Burma.

Channa marulius Misra, Rec.Indian Mus., 5(1-4), pp. 218-9, 1959. Menon, Checklist, p. 89, 1974.

D. 45-46, p. 17-18, V.6, A.28-37, C. 14-15,L1C.1.59-71, Ltr. 5½-6/16-15

1.2.3 Standard common names, vernacular names

See Table 1

## 1.3 General variability

### 1.3.1 Subspecific fragmentation (races, varities, hybrids).

Since there is some difference in the number of dorsal and anal fin rays of C. marulius in Sri Lanka, in comparison to those in India, Deraniyagla (1945) assigned it to the subspecies Channa marulius ara. However, Deraniyagla's (1945) view may not be tenable in view of the fact that in another species belonging to the same genus, viz. Channa striatus also such wide variations in the number of dorsal and anal fin rays occur in samples from different geographical regions (Parameswaran and Goorah, 1981).

No races, varieties and hybrids of C.marulius have been reported.

The characteristic ocellus in the caudal fin in the population of C. marulius in Karnataka State begins fading after the fish attains a size of 300 mm and completely disappears in specimens over 500 mm in length (Parameswaran, 1975).

### 1.3.2 Genetic data

(chromosome number, protein specificity)

No information on the chronosome number and protein specificity of C. marulius is available.

The composition of the flesh of C. marulius, has been investigated by Sharma and Simlot (1971).

## 2. DISTRIBUTION

### 2.1 Total area

The giant murrel is widely distributed in India, Pakistan, Bangladesh, Sri Lanka, Burma, China and Thailand. In India it inhabits freshwaters in West Bengal, Uttar Pradesh, Madhya Pradesh, Bihar, Punjab, Haryana, Orissa, Assam, Gujarat, Maharashtra, Andhra Pradesh, Tamil Nadu, Karnataka and Kerala (Day, 1878, 1889 and Parameswaran, 1975).

C. marulius occurs in slow and fast moving rivers, lakes, reservoirs, large tanks and ponds, swamps, bheels and jheels. It is found in mountainous stretches up to an altitude of 457 m MSL (Munro, 1955). The fish occurs in tide-ways but it never frequents salt water (Hamilton,1922). Because of the possession of accessory respiratory organ,it thrives in weed infested, silt laden, shallow, oxygen depleted and polluted waters (Parameswaran, 1975).

## 2.2 Differential distribution

### 2.2.1 Area occupied by eggs, larvae and other junior stages: annual variations in these patterns and seasonal variations for stages persisting over two or more seasons.

The breeding season of C. marulius depends on the monsoons and varies from one region to the other, extending generally from early February to November (Alikunhi, 1957, Parameswaran, 1975 and Parameswaran and Murugesan, 1976 b).

The fish lays its eggs in a cleared area in weed infested swamps and tanks, bays of reservoirs and current - free pockets of rivers in a somewhat cleared area nearer the margin, formed by the active movement of the breeders during courtship and spawning (Parameswaran and Murugesan, 1976 b). The weeds held the free floating eggs without dispersal. The fry move in shoals slightly away from the water margin, guarded by the parents (Parameswaran, 1975 and Parameswaran and Murugesan, 1976 b). The young ones disperse when they attain a size of 125 to 170 mm (Devaraj, 1973 b and Parameswaran, 1975). The fry and fingerlings are surface and column dwellers while the juveniles are column and shallow bottom dwellers.

Parameswaran and Murugesan (1976 b) have studied the distribution in time and space of the fry and fingerlings of the giant murrel and computed the seed index through months of the species in swamps in Karnataka.

# 3. BIONOMICS AND LIFE HISTORY

## 3.1 Reproduction

### 3.1.1 Sexuality (hermaphroditism, heterosexuality, intersexuality)

C. marulius is heterosexual. Externally the sexes can be distinguished in the species only during the breeding season when the vent appears pale in male and round, prominent and reddish in the female. In addition, the abdomen of the female will be slightly bulging, unlike that of the male (Parameswaran, 1975 and Parameswaran and Murugesan, 1976 a)

3.1.2 Maturity (age and size)

The giant murrel normally attains maturity in two years (Devaraj, 1973 b and Parameswaran 1975). The smallest mature male from swamps in Karnataka encountered by Parameswaran (1975) was 300 mm/235 g and female, 320 mm/252 g. Devaraj (1973 b) has reported that maturation in both sexes commences at a size of about 360 mm in swamps and reservoirs in Tamil Nadu and that all males and females over 560 mm and 660 mm in length respectively are mature; the mean length at maturity at 50% level was 460 mm in females and 550 mm in males. Chacko and Kuriyan (1947) have reported that the species attains maturity in Tamil Nadu when 300 to 350 mm long.

3.1.3 Mating (monogamous, polygamous, promiscuous)

Mating is preceded by an elaborate courtship, the male actively chasing the female. The species is reported to construct a cup-like nest in waters not more than 1.2 m deep, by weaving blades of aquatic weeds (Chacko and Kuriyan, 1947; Chacko, 1956 and Arumugam, 1966). According to Khan (1924) and Alikunhi (1951) the nests are mere clearings made among shallow, marginal weeds. Parameswaran (1975) and Parameswaran and Murugesan (1976 b) located several broods of eggs of the giant murrel in Karnataka, but did not come across constructed nests, as reported by earlier workers. They found that the eggs are laid in shallow margin of weed infested waters, where the vegetation is cleared in a small circular area, probably during active spawning movement of the breeders.

3.1.4 <u>Fertilization</u>

Fertilization is external. The surrounding weeds hold the eggs together without getting dispersed. The parents guard the eggs and probably aerate the water by their movements (Alikunhi, 1953 and Parameswaran, 1975).

3.1.5 Fecundity

The fecundity of 13 specimens of the giant murrel studied by Devaraj (1973 b) ranged from 2214 eggs in a fish 500 mm in length to 18 475 in another, 820 mm long.

The relation between fecundity (F) and fish length (L in mm)/weight (W in g) and ovary weight (OW in g) and ovary weight (OW) and fish length (L) obtained by Devaraj, (1973 b) were as follows :

$$\log F = -0.7700 + 1.6038 \log L \quad .... (1) \quad \text{(Fig. 2)}$$
$$\log F = 2.1665 + 0.4916 \log W \quad .... (2) \quad \text{(Fig. 3)}$$
$$\log F = 2.7900 + 0.7418 \log OW \quad .... (3)$$
$$\log OW = 5.0876 + 2.2644 \log L \quad .... (4)$$

The equations indicate that

(i) the fecundity of *C. marulius* increases at a rate much lower than that of the body weight in relation to length of the fish,

(ii) the ovary weight increases at a less rapid rate in relation to length of fish than the body weight and

(iii) the fecundity increases at a rate less than the increase in ovary weight.

According to Devaraj (1973 b) the fall in fecundity with increase in size of fish after it attains 4 years provides direct clue to the disharmony between the growth of the fish and the ovary that manifests added stress on the fish with increase in length.

The fecundity of 17 specimens of the giant murrel ranging from 320 mm/252 g to 994 mm/6 260 g in size was studied by Parameswaran (1975) and was found to range from 1 799 to 38 375. The number of ova $g^{-1}$ mature ovary varied from 257 to 351 with a mean ($\bar{X}$) of 302. The ovaries constituted 2.008 to 2.858% of the total weight in mature females. The number of ova $g^{-1}$ body ranged from 6.15 to 8.41.

The mature ovarian eggs are golden yellow in colour and measure 1.584 to 1.980 mm in diameter (Parameswaran, 1975 and Parameswaran and Murugesan, 1975 a).

The relation between fecundity (F) and total length of fish L (in mm)/weight of fish (W in g) worked out by Parameswaran (1975) is as given below:

$$\text{Log } F = -3.705093 + 2.76055 \text{ Log } L \quad .... \quad (5)$$
$$\text{Log } F = -1.039260 + 0.93998 \text{ Log } W \quad .... \quad (6)$$

Unlike Devaraj (1973), Parameswaran (1975) observed that the fecundity of C. marulius in swamps in Karnataka increases at a rate slightly less than the cube of the length of the fish and somewhat proportionately in relation to weight.

The variation in the fecundity of C. marulius in the two habitats appears to be due to difference in the prevailing ecological conditions.

3.1.6 Spawning

Spawning season

The spawning season of the giant murrel in different regions appears to be influenced by the pattern of rainfall (south-west and north-east monsoons and local rains). The breeding commences one or two months prior to the onset of the regular monsoon and extends beyond the monsoon season, with the peak coinciding with the period of maximum rainfall (Parameswaran, 1975).

Broods of C. marulius are encountered from early March (size 34 to 46 mm) to November (size 25 to 26 mm) in Malnad region of Karnataka, their number being maximum during July and August, suggesting that the breeding season of the species is from February to October with the peak in July (Parameswaran, 1975 and Parameswaran and Murugesan, 1976 b). This inference is supported by the studies on the maturity cycle, gonadosomatic index and $\bar{X}$ size of ova of the fish through months (Parameswaran, 1975). The percentage of males and females in different stages of maturity during various months in the reservoir and river and swamp in Bhavanisagar are depicted in Fig. 4 (Devaraj, 1973 b). The available information on the breeding season of the species in different regions is given below :

| Region/State/Country | Spawning season | Authority |
|---|---|---|
| Punjab | April to July | Khan (1924) |
| Sri Lanka | April to June | Deraniyagala(1929) |
| Rivers of south India | March to June and October to December | Chacko (1956) |
| India | April to June | Alikunhi (1957) |
| - do - | - do - | Hora and Pillay (1962) |

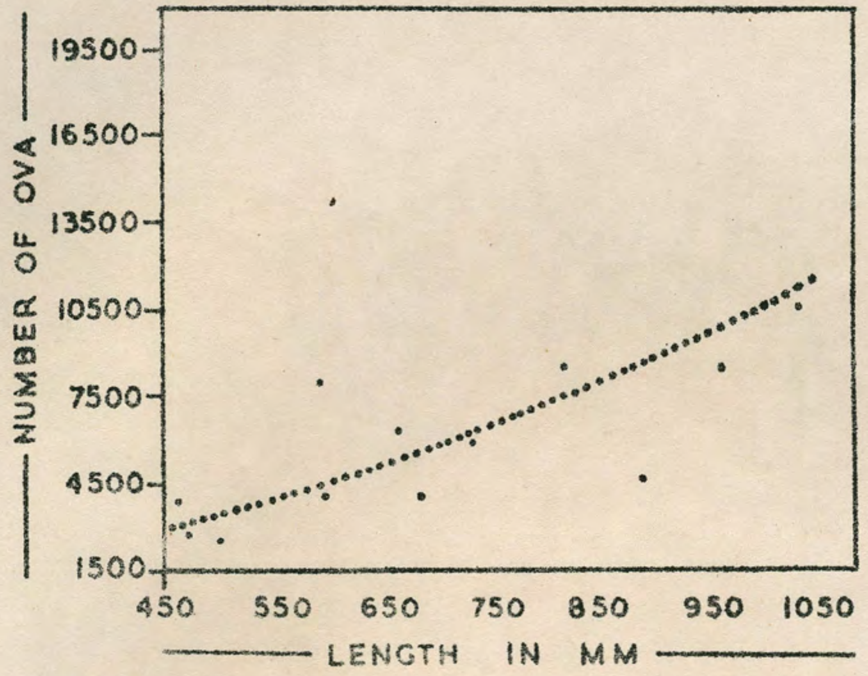


FIG. 2 - RELATION BETWEEN FECUNDITY AND TOTAL LENGTH OF <u>C. marulius</u> IN BHAVANISAGAR (from Devaraj, 1973 b)

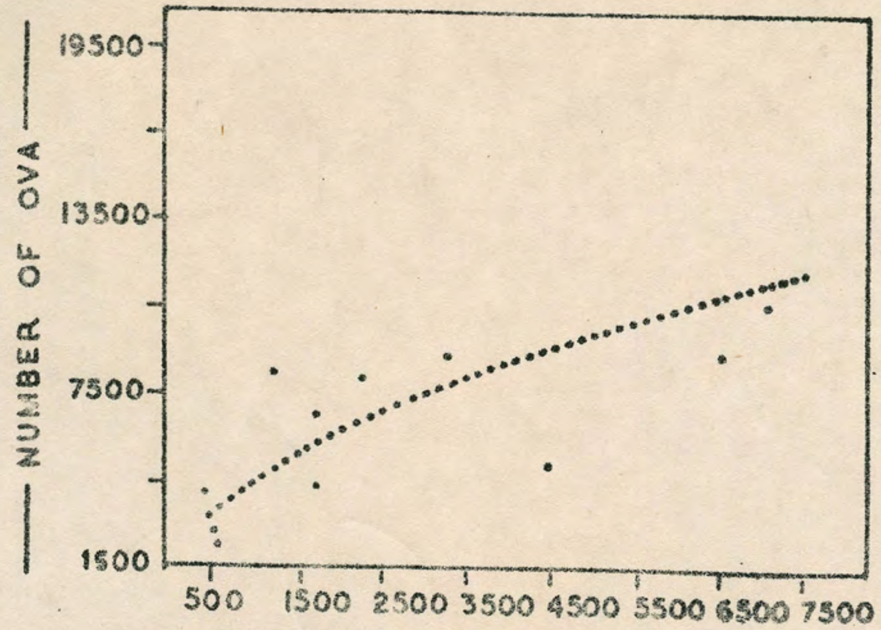


FIG. 3 - RELATION BETWEEN FECUNDITY AND BODY WEIGHT OF <u>C. marulius</u> IN BHAVANISAGAR (from Devaraj, 1973 b)

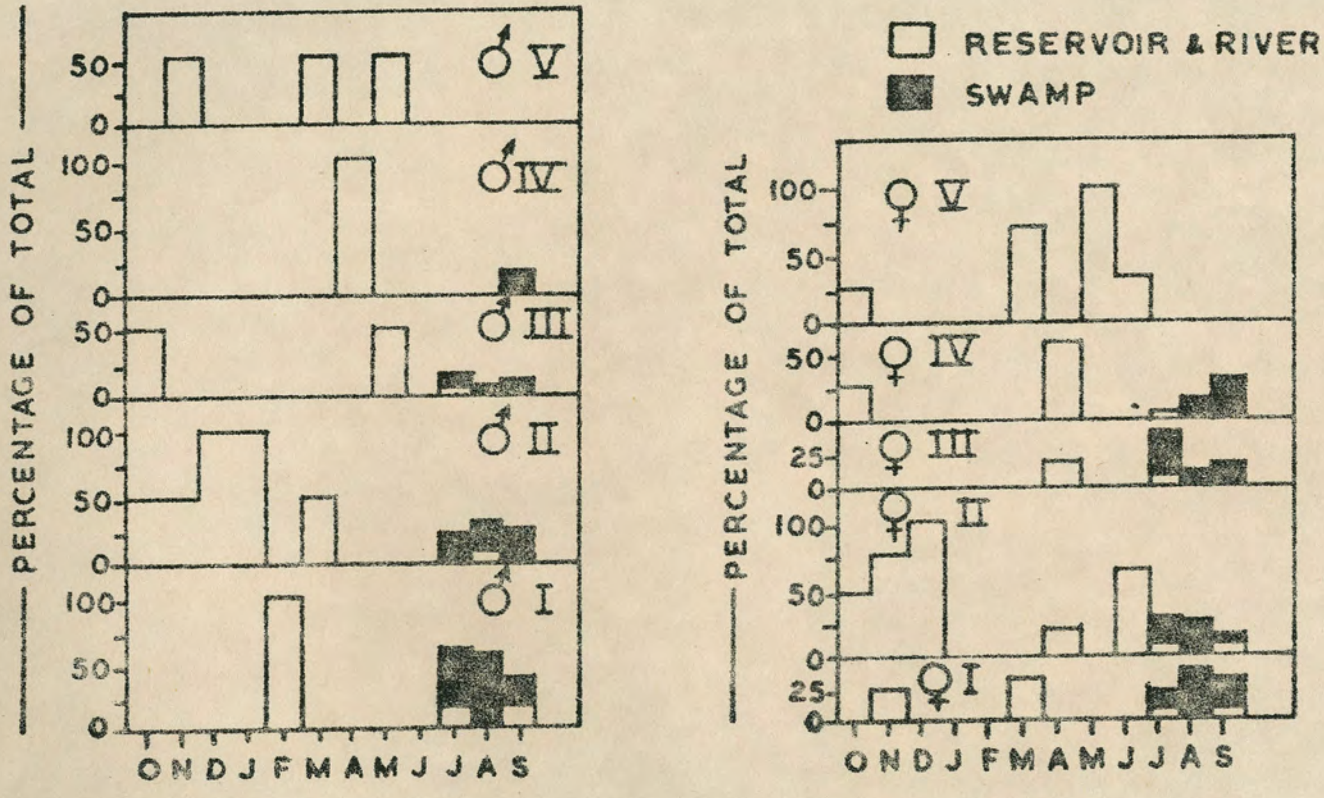


FIG. 4. PERCENTAGE OF DIFFERENT MATURITY STAGES IN C. marulius THROUGH MONTHS IN BHAVANISAGAR (from Devaraj, 1973 b)

| Region/State/Country | Spawning season | Authority |
|---|---|---|
| Uttar Pradesh | June to October | Qasim and Qayyum (1961) |
| Tamil Nadu | April to June | Arumugam (1966) |
| Tamil Nadu, rivers and reservoirs | May to July | Devaraj (1973 b) |
| Tamil Nadu, swamps | October to Decem- | Devaraj (1973 b) |
| Karnataka (Malnad region) | February to Octo-ber; Peak in July | Parameswaran (1975 and Parameswaran and Murugesan (1976b) |

Frequency of spawning

Ova diameter frequency polygons of mature ovary of the giant murrel from Uttar Pradesh (northern India) developed by Qasim and Qayyum (1961) showed distinct groups of ova (fig. 5), suggesting that the fish is a fractional spawner. Studies made in swamps in Malnad region of Karnataka on the progression of ova through successive stages of maturity and their depletion by Parameswaran (1975) suggested that C. marulius is an intermittant breeder in this area and spawns at least twice during the breeding season. Parameswaran and Murugesan (1976a) experimentally confirmed this in the allied species C.striatus and C. punctatus by successfully hypophysing the females twice within an interval of 2½ to 5 months. The ovaries of females from swamp and a reservoir in Coimbatore district in Tamil Nadu, however, had only one group of ova indicating that the fish in that area spawns only once a year (Fig. 6) Devaraj, (1973 b).

Induction of spawning,

Artificial fertilization

C. marulius was successfully induced to spawn at Bhadra Reservoir Project (Karnataka) by hypophysation (Parameswaran and Murugesan, 1976 a). Altogether 5 sets (consisting of 2 males and one female) were given carp pituitary injections. The hormones were administered in 2 instalments, an initial dose of 20 mg $kg^{-1}$ and after 6 to 8 hr. a final dose of 60 to 100 mg $kg^{-1}$ body weight. The female paired with a single male about 1 to 4 hr after the second injection. The spawning was preceded by active, excited movement of the paired breeders. The percentage of fertilization of eggs in the two instances was 23.3 and 34.7. However, the embryos began dying 12.15 and 19.30 hrs after fertilization and complete mortality occurred before hatching.

3.1.7 Spawning grounds

The giant murrel spawns in a variety of habitats such as rivers, lakes, reservoirs, swamps, jheels, bheels and large tanks. However, unlike the smaller species of murrels which normally spawn in small ponds C. marulius breeds only in larger water bodies (Parameswaran, 1975).

3.1.8 Eggs : Structure, size, hatching type, parasites and predators

The salient distinguishing characters of the developing eggs of C. marulius, C. striatus and C. punctatus have been reported by Khan (1924; 1926) and Mookherjee (1945) and described by Parameswaran (1975) and Parameswaran and Murugesan (1976 a and b). The eggs are free floating, spherical and nonadhesive and have an oil globule. They could be distinguished from those of C. striatus and C. punctatus vide characters given in Table 2. The fertilized eggs slightly swell up after being laid (Parameswaran, 1975).

Dead eggs of the giant murrel have been found to be infected with fungus (Parameswaran, 1975). Copepods attack and kill the tender fry (Parameswaran and Murugesan, (1976 a).

3.2 Larval history

3.2.1 Account of embryonic and juvenile life (prelarva, larva, postlarva and juvenile)

The embryonic development of C. marulius has been reported by Mookherjee (1945) and Khan (1924, 1926). The period of incubation of the eggs at a temperature range of 26.4 to 30.0°C varies from 52.20 to 65.30 hr.

Khan (1924, 1926) reported that the embryonic development of the giant murrel is fairly rapid and the outline of the embryo becomes defined within 12 hr. The tail end is swollen, transparent and grandular, while the head end is darker. Overnight the unpigmented, auditory vesicles and heart appear. Just before hatching the heart given off the aorta which passes dorsally to the posterior end to turn back into caudal vein which passes into the subintestinal vessel just near the attachment of the tail to the yolk-sae (fig. 6 a).

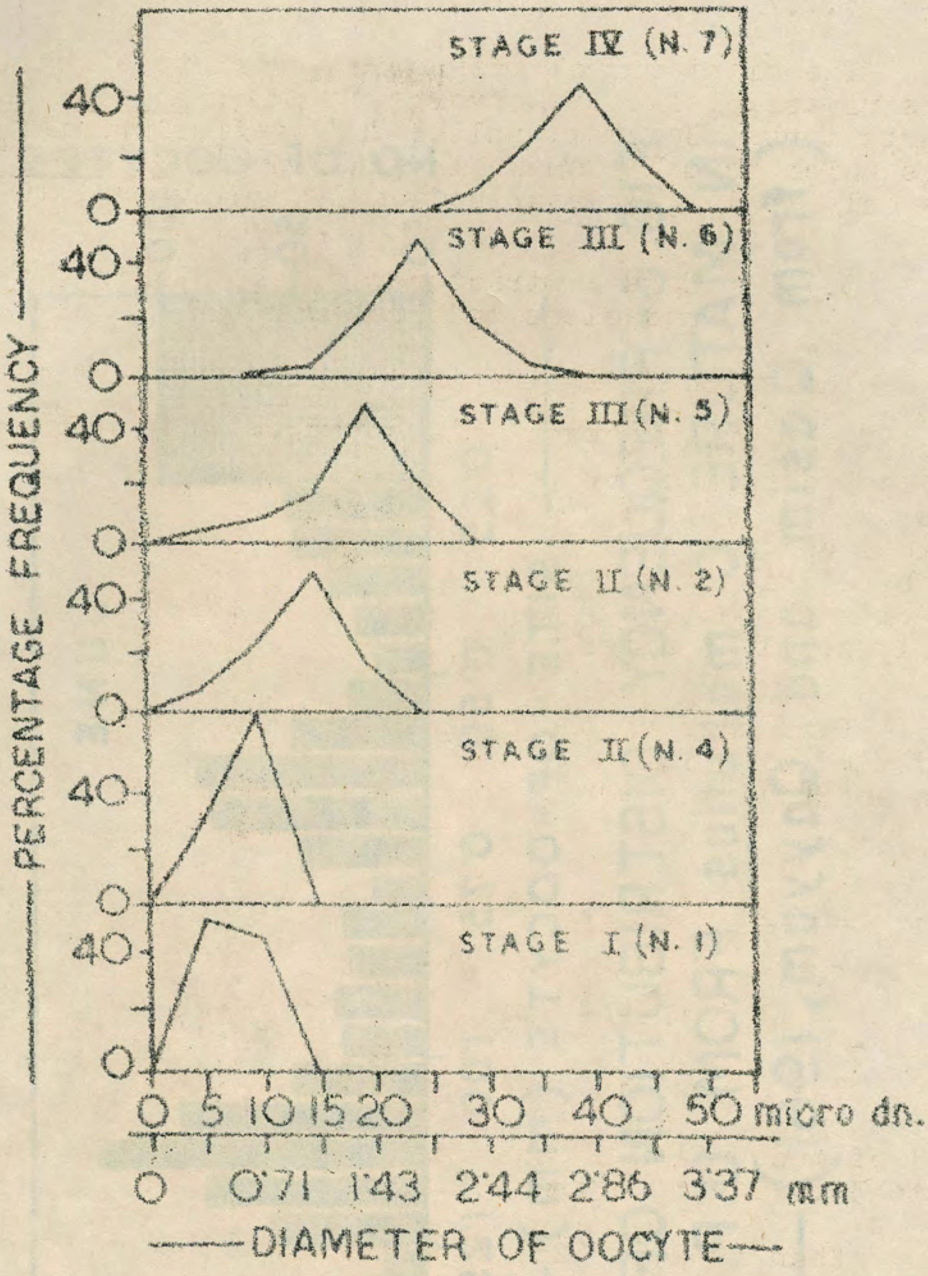


FIG. 5-FREQUENCY DISTRIBUTION OF OVA IN OVARIES IN STAGES I TO V OF MATURITY IN C. marulius FROM BHAVANI-SAGAR ( from Devaraj, 1973 b)

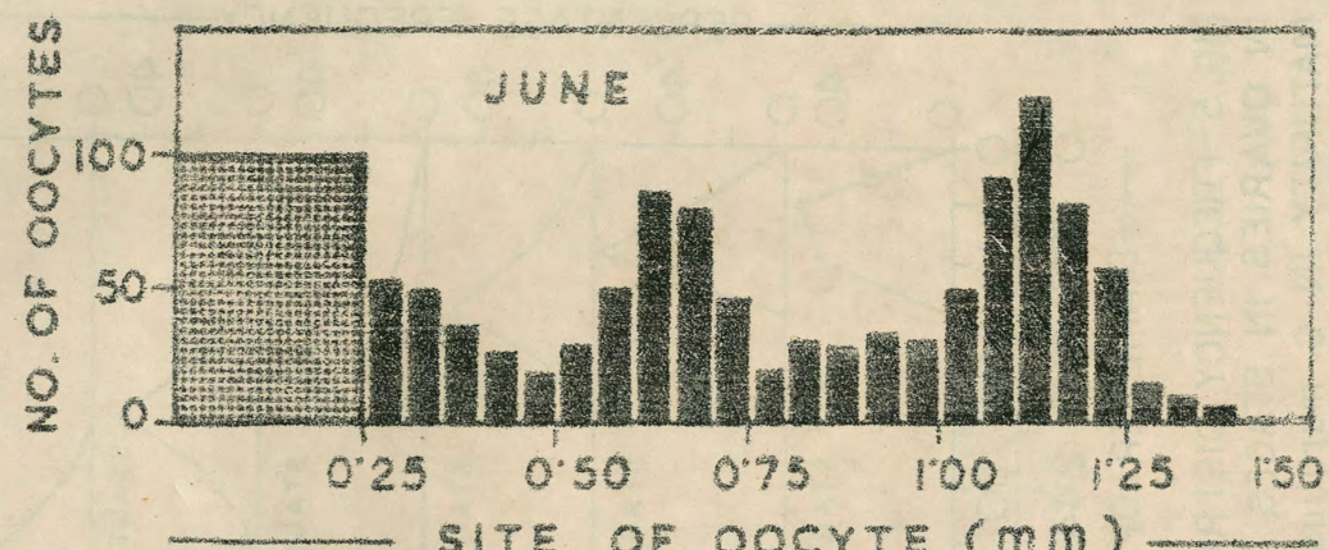


FIG. 6 - FREQUENCY DISTRIBUTION OF OVA IN MATURE C. *marulius* FROM U.P. (from Qasim and Qayyum, 1961)

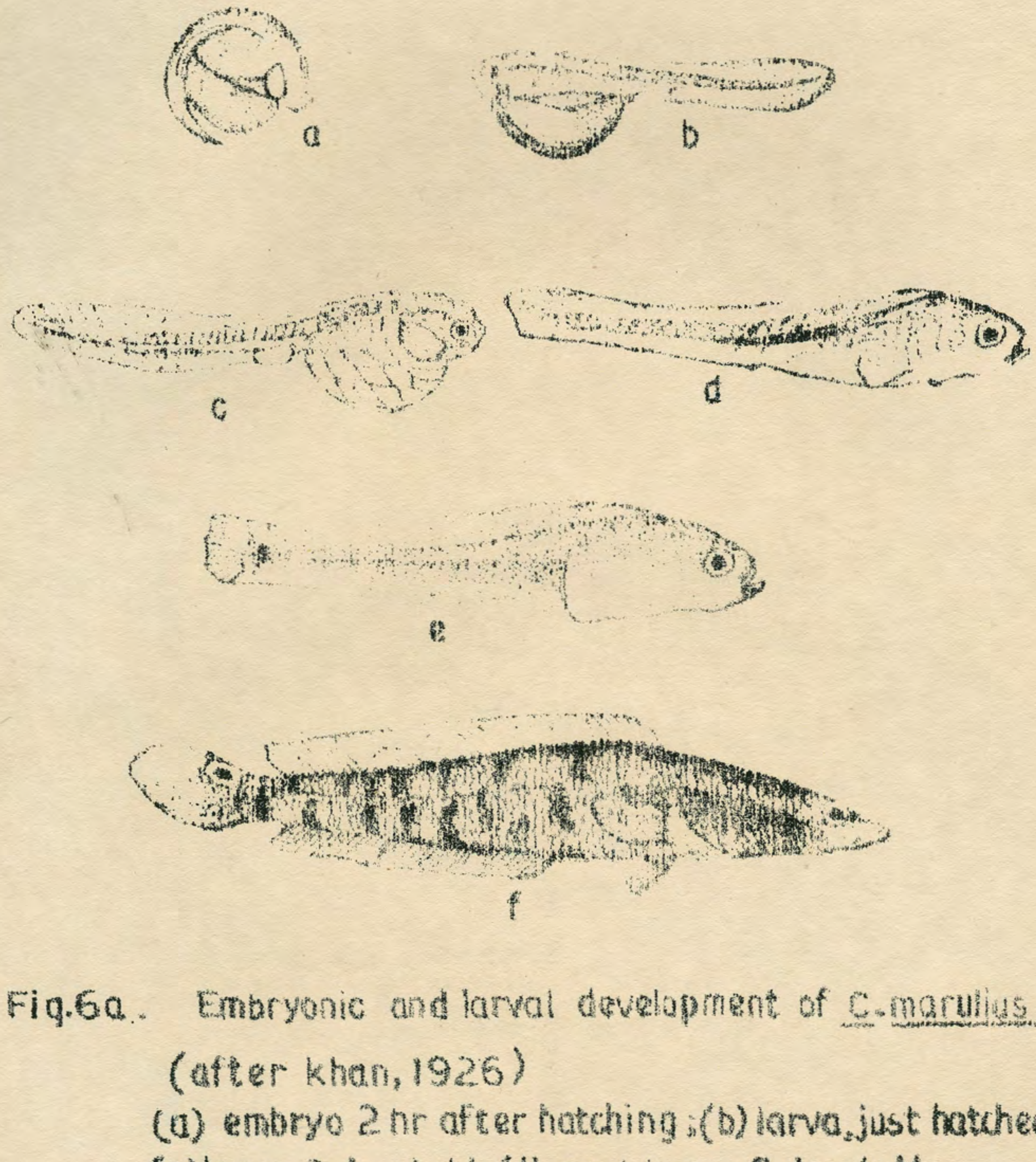


Fig.6a. Embryonic and larval development of C. marulius
(after khan, 1926)
(a) embryo 2 hr after hatching ;(b) larva, just hatched;
(c) larva, 2 days' old; (d) post-larva, 5 days' old;
(e) post-larva 12 days' old (f) fingerling, 98 days' old.

Brief accounts of the larval development of the species (Table 3) have been given by Khan (1924, 1926), Deraniyagala (1929) and Mookherjee (1945).

The length of the larvae of C. marulius, C. striatus and C. punctatus just after hatching and after yolk absorption are compared in Table 4 (Parameswaran, 1975 and Parameswaran and Murugesan, 1975 a). The distinguishing characters of the fry and juveniles of the three species are given in Table 5 (Parameswaran, 1975 and Parameswaran and Murugesan 1976 a).

## Feeding

Parameswaran (1975) reported that the percentage of empty guts in C. marulius increased with increase in size of fish while the gastrosomatic index and feeding intensity decreased, suggesting that the fry and juveniles are active feeders and that there is a slackening in feeding intensity with increase in size of fish.

Parameswaran (1975) has made a detailed study of the food and feeding habits of C.marulius in swamps and derelict tanks in Karnataka. He found that the post-larvae are exclusively planktophagaous, the bulk (97.5%), constituted by zooplankton which comprised in the order of dominance of cladocerans (52.3%, Ceriodaphnia sp., Bosmina sp., Diaphanosoma sp., Moina brachiata, Alonella sp. and Daphnia sp.), Copepods (32.6%, Cyclops sp., Diaptomus spp. and their nauplii), rotifers (11.5%; Keratella sp. Brachionus spp. Polyarthra sp., Lecane sp., Euchlanis sp., Monostyla sp., Trichocerca sp., Filinia sp. and Asplanchna sp.) and small quantities of protozoans (1.2%; Arcella sp., Difflugia sp. and ciliates). The phytoplankters encountered were desmids (1.2%; Pediastrum spp., Staurastrum sp., Cosmarium sp. and Eusstrum sp.), blue green algae (0.8% Microcystis aeruginosa) and diatoms (0.3%; Navicula spp., Pinnularia sp., Melosira sp. and Stauroneis sp.). The larger post-larvae (21 to 50 mm) subsist mainly on small aquatic insects (63.9%; Anisops sp. Plea spp. and other small hemipterans), zooplankton (28.9% mostly copepods), annelids (5.1%) and small shrimps (Macrobrachium spp., Caridina spp. and Streptocephalus sp.).

The small juveniles (51 to 100 mm) of the giant murrel feed on aquatic insects consisting of hemipterans (53.2%; Anisops spp., Corixa sp. and Gerris sp.), Coleopterans (6.4%, Gyrinus sp., Dytiseus sp. Cybister sp. and hydrophilids) and nymphs of dragonfly, damselfly and mayfly, shrimps (Macrobrachium spp. Caridina spp. and fairy shrimps) and annelids (2.9%). Aquatic insects (55.1%, coleopterans and Odonata nymphs) predominate the diet of larger juveniles (101 to 200 mm). The species develops piscivorous tendency at this stage, fishes (mainly carp minnows) constituting 23.1% of the feed, the rest being shrimps (21.4%).

Devaraj (1973 b) found that the postlarvae (30 to 49 mm) of C. marulius are predominantly planktophagous, Daphnia forming 70.8 to 81.3% of the total number of food consumed. Small insects such as nymphs of Caenis, Lestes and Tholmys and larvae of Chaoborus and other culicids formed the rest of the feed. In fingerlings (50 to 109 mm), Daphnia is completely replaced by Macrobrachium which accounts for 69.2 to 86.2% of the food. Among insects, larger nymphs of Ephemeroptera and Odonata (2.4 to 4.6%) formed the major part. Diptera was totally absent and Hemiptera insignificant. Unlike Parameswaran (1975), Devaraj (1973b) observed monthly variation in the diet constituents in the young fish which may be due to the fluctuations in their abundance in the habitats from where the samples were collected.

The difference in the diet of the early stages of the species observed by Devaraj (1973 b) and Parameswaran (1975) may be attributable to the variation in the availability of the different food organisms in the swamps studied.

Alikunhi (1957) has reported that the fry of the giant murrel feed on animaleules, water-fleas and insect larvae and fingerlings, on insect larvae and fish fry.

## Rate of development and survival

Studies made by Parameswaran and Murugesan (1976 a) have indicated that the hatching percentage is invariably low when murrel eggs are left in the induced breeding pool. The high mortality observed during embryonic and larval developmental stages was considerably reduced by transfering the eggs to basins and providing slow dripping of water in the container as suggested by Alikunhi (1953). By holding the eggs under oxygen packing till hatching and the hatchlings till yolk absorption, the hatching technique could be simplified and the mortality reduced to less than 5 to 10% (Parameswaran and Murugesan, 1975 a). In nature, probably the large area of the water sheet and the slow, sinuous movement of the parents guarding the eggs and larvae (Alikunhi, 1953) ensure better oxygenation of the ambient medium.

## TABLE- 1

Standard common names, vernacular names of C. marulius

| Country | Standard and common name | Vernacular name |
|---|---|---|
| Burma | giant murrel<br>large murrel<br>large snake-head | wga-van-daing, nga yan dyne |
| Sri Lanka | | gangara, ara, kalu maha, iruviral |
| Thailand | | plachon ugua hao |
| Bangla Desh | | kole maach |
| India | | haal (Assamese)<br>saal, ga jari (Bengali)<br>pula chapa, bhor, pu-muri (Hindi)<br>choaree veral, curavu, bral (Malayalam)<br>saal (Oriya)<br>kubrah, sawal, dowlah (Punjabi)<br>hoovina murl, madinji, aviru, avul, puveral (Tamil)<br>pool-a-malla, poola mattu, pula chapa, choaree verarl (Telugu) |
| Pakistan | | kurbah, sawal, dowlah |

## TABLE- 2

Characters of developing eggs of murrels (from Parameswaran 1975)

| Characters U x U | Species | | |
|---|---|---|---|
| | C. striatus | C. marulius | C.punctatus |
| 1. Size (range in diameter:mm) | | | |
| 1.1 Egg shell | 1.1484-1.4652 | 1.8414-2.1383 | 1.0296-1. |
| 1.2 Egg proper | 1.0098-1.2772 | 1.6038-1.8216 | 0.8118-0. |
| 1.3 Oil globule | 0.7920-1.0296 | 1.1880-1.5840 | 0.6336-0. |
| 2. Colouration | | | |
| 2.1 Fertilized eggs | Translucent and bright yellow | Translucent and bright golden yellow | Translucent and straw yellow |
| 2.2 Early embryo | Transparent and brownish yellow | Transparent and brownish yellow | Transparent and brownish yellow |
| 2.3 Advanced embryo | amber coloured | amber coloured | dark brown |

TABLE- 3 : Larval and post-larval development of C.marulius (after Khan, 1924, 1926)

| No.of days after hatching | Total length (mm) | Characters |
|---|---|---|
| Larva, Just hatched | 4.5 | Eyes colourless, dark pigment confined to lower portion of yolk in a semicircular band; larva lies on one side, moves tail now and then; when swimming, rotates or spins around (Fig. 6, b). |
| 1 | 45-50 | Black pigment cells appear on body; eyes become pigmented; invagination of vent appears. |
| 2 | 6.0 | Stellate pigment cells appear on body; mouth opens for respiratory movements. Pectoral fin buds formed; embryonic finfold shows striations (Fig. 6, c). |
| 3 | 7.0 | Pigment scattered uniformly on body; gut has appeared as a simple tube; caudal vessels drawn backwards. |
| 4 | 7.8 | Swim-bladder formed; yolk thin and tapering; pigment concentrated more on ventral side of the body. |
| Post-larva 5 | 7.8 | Yolk has disappeared; black pigment cells on ventral surface of body only, while dorsal is yellowish, spherical pigment cells in rows on anterior extremity of jaws; alimentary canal opens posteriorly; pectoral fin striated, with stellate pigments (Fig. 6, d). |
| 9-12 | 8.0-10.0 | Caudal fin rays have appeared, 11 rays jointed and articulated with basal cartilages; tip of the notochord turned upwards (Fig. 6, c). |
| 13-18 | 10.0-20.0 | Caudal fin separated ventrally; dorsal and anal fins separate; rudiments of ventral fins have appeared; fry come to water surface to gulp air. |
| 19-21 | 26.0 | A yellow band runs on the dorsal surface and a bluish band with black tinge, ventrally. |
| 98 | 70.0-90.0 | Caudal ocellus formed as reddish yellow mark with a black oval area in the middle (Fig. 6, f). |

TABLE- 4

Length of larva just after hatching and after yolk absorption in murrels (from Parameswaran, 1975)

| Species | Length of larva just hatched (mm) | | Length of larva just yolk absorbed (mm) | |
|---|---|---|---|---|
| | Range | Average | Range | Average |
| C. marulius | 3.8801-4.4748 | 4.2750 | 6.8904-7.1478 | 7.0488 |
| C. striatus | 2.8116-3.4056 | 3.2274 | 5.3064-6.1340 | 5.9598 |
| C. punctatus | 2.4948-2.7522 | 2.6928 | 4.6924-4.9104 | 4.8510 |

TABLE- 5

Distinguishing characters of fry and juveniles of murrels (from Parameswaran, 1975)

| Size (mm) | C. marulius | C. striatus | C. punctatus |
|---|---|---|---|
| 1 | 2 | 3 | 4 |
| 6-15 | Yolk not completely absorbed when 6 mm long. Colour dirty gray dorsally and laterally pale golden brown. A faint dark spot with pale reddish yellow rim begins developing on the dorsal half of caudal fin when 14-15 mm long. The head and body streamlined. Fin rays have begun forming. | Yolk completely absorbed when 6 mm ~~long.~~ General colouration dark brown. Specimens 8 to 10mm long develop a light, reddish golden hue. Nape pigmented dark with a central lighter (golden) area. Rin of eye golden. Abdomen pale white. Head longer compared to that of C. punctatus. Full compliment of rays formed in fry 14.7 mm long (dorsal fin rays; 34 to 44; anal rays; 23 to 26). | Yolk completely absorbed when 6 mm long. The fry with a brownish ground colouration develop brighter yellow colour. When 8 to 10 mm long, a diamond shaped yellow broadening at the nape and a bright yellow, lateral longitudinal band also develop. Eye rim iridescent silvery greenish. Full compliment of rays formed in fry 10.5 mm long (dorsal fin has 29 to 32 rays and anal 21 to 23). |

contd....

Table- 5 (continued)

| 1 | 2 | 3 | 4 |
|---|---|---|---|
| 16-30 | Dorsally dark greyish with a tinge of golden orange. A conspicuous orange yellow longitudinal lateral band. Characteristic ocellus (a faint dark spot on the upper half of the caudal fin with pink rim around) prominent. Ventrally yellow to pale. Full compliment of fin rays develop when 18.6 mm long (dorsal fin rays 34 to 44 and anal, 23 to 26). | General body colouration vermilion red. Anterior to origin of the dorsal fin pigmented with a central, diamond shaped, golden area at nape. Laterally bright reddish golden longitudinal band and a dark band bellow. Abdomen light (16 to 33 mm) to light golden yellow (15 to 30 mm). Eye rim golden orange. Head and body stumpy compared to that of *C. marulius*. | General body colouration dark with a tinge of yellow. The diamond shaped area on nape conspicuous. Eye rim greenish to dark. A lateral bright golden yellow longitudinal band. Three faint, alternating vertical, dark and yellow bands on either side of body. Head and body stumpy in comparison to that of *C. marulius* and *C. striatus*. |
| Over 31 | Dorsally dirty gray to brown. The orange yellow longitudinal lateral band conspicuous. Body bluish below lateral line. Five to seven alternating, iridesecent blue and yellow vertical bands on either side. Eye rim orange, caudal ocellus prominent. Fins brownish with a tinge of orange. Lateral longitudinal band turns yellow and pale when fingerlings grow over 100 mm. Head and body longer and thinner than the other two species. | The vermilion red body colouration and lateral bands fade and become bluish yellow. Eye rim golden red with blue periphery. Pectoral fin pale yellow. Caudal brownish with dark margin. The characteristic striations develop when 45 to 50 mm long. Above the lateral line 7 to 9 striations and 6 to 8 below. Eight dark blotches on anal fin and 12 on dorsal, with a posterior circular patch; the latter disappears when fingerlings attain 91 to 95 mm length. | Body dark brown dorsally and pale to yellow ventrally. Head stumpy compared to that of *C. marulius* and *C. striatus* with dark patches on both dorsally and ventrally. A dark lateral band on the head in the region of eye and dark blotch above pectoral fin. Above lateral line 7 to 9 stripes and 6 to 8 below, the space in between yellowish and to brownish. Numerous black dots on the dark stripes. Four to five vertical bands in caudal fin and 3 to 4 on pectoral. |

Pronounced cannibalism is generally observed in C. marulius and other murrels during the fry and juvenile stages (Parameswaran, 1975). This could, however, be minimised by ensuring abundant supply of feed (Parameswaran and Murugesan, 1976 b and Murugesan et al., 1978).

No information on the survival rate of giant murrel fry in natural habitats and prepared nurseries and concrete cisterns is available. However, it is generally presumed that the survival of the species is low because of cannibalism and predation (Parameswaran, 1975).

Parental care

Both parents guard the eggs and fry although at times only one parent is seen with the brood (Khan, 1926; Chacko, 1956; Alikunhi, 1957; Arumugam, 1966, Devaraj, 1973a and b, Parameswaran 1975 and Parameswaran and Murugesan, 1976 b). The brood, generally ranging from 1 500 to 4 000 in number, moves in shoals a little away from the water margin, guarded by the parents (Parameswaran, 1975 and Parameswaran and Murugesan, 1976 b), Chacko and Kuriyan (1947), however, have stated that a brood of C. marulius consists of about 500 fry in Tamil Nadu. The maximum number of fry per brood recorded was 13 690.

Parasites, predators

Fry and fingerlings of C. marulius held in nursery cisterns are often attacked by the protozoan parasite Ichthyoptherius sp. Fin rot and fungal attack on developing eggs is also common (Parameswaran, 1975). A new species of Ichthyophtherius sp. has been described in the fry stages of C. marulius (Ranganathan and Devaraj, 1966). Fingerlings of the giant murrel from swamps and ponds having an attack of Lernaea sp. and to a lesser extent Argulus sp. and fungus are often encountered (Parameswaran, 1975). Mortality of the giant murrel fry due to fungal attack has been reported by Khan (1922).

Cannibalism is pronounced in C. marulius, especially in the post-larval and juvenile stages, the larger and stronger ones preying upon the smaller and weaker ones. Shoot fry grow fast in stocks held in nurseries and prey on the less grown ones, reducing the survival in the early rearing phase (Parameswaran, 1975). Parameswaran (1975) found a fingerling of 92 mm size to have preyed upon another measuring 40 mm. Yolked larvae with heavy yolksae, being not able to move fast, are very suceptible to attack by copepods, especially Cyclops spp. To ward off attacked by copepods, Parameswaran and Murugesan (1976 a) have recommended that only seived, small plankton should be given in the early rearing phase of the murrel fry. The tender fry are attacked by a variety of aquatic insects such as Anisops spp. Nepa sp., Ranatra sp., Cybister sp. and nymphs of dragonfly damselfly and mayfly. Trash and predatory fishes also take a heavy toll of the fry (Parameswaran, 1975).

## 3.3 Adult history

### 3.3.1 Longivity

Ageing of C. marulius from Poongar swamp (Tamil Nadu) by probability analysis of length frequency (Cassie, 1954), was done by Devaraj (1973 b) who recognised up to 5+ age groups. Parameswaran (1975) made detailed studies on ageing of the species from swamps and tanks in Malnad region of Karnataka by probability analysis of length frequency and from examination of growth checks on scales and operculam and delineated up to 9+ age groups.

### 3.3.2 Hardiness

Subadults and adults of C. marulius are very hardy. Because of their accessory respiratory organ, facilitating utilization of atmospheric air directly for respiration and modified blood physiology, they are able to thrive in foul waters such as swamps and withstand poisonous gases like methane and hydrogen sulphide as well as extreme fluctuations in dissolved oxygen and carbon dioxide which are characteristic of such biotopes. These adaptations enable them to tide over summer when swamps shrink and partially dry up (Das, 1940 and Parameswaran, 1975). They migrate from one water body to another during monsoon, negotiating moist land. They die due to asphyxia if not allowed to breathe atmospheric air (facultative air breathers; Das, 1940).

### 3.3.3 Competitors

C. marulius in the fry stage is planktophagous like that of most of the other freshwater fishes and adult catla (Catla catla) causing interspecific competetion for food. Fingerlings of the giant murrel (feeding on aquatic insects, shrimps and trash fishes) offers competition for food to minor predaters such as C. striatus, C. punctatus, Notopterus notopterus, Anabas testudineus, Clarias batrachus, Heteropneustes fossilis and Ompok bimaculatus which have comparable feeding habits. Competitors to adult of the species include major predatory fishes like Wallago attu, Notopterus chitala, Mystus seenghala, Mystus aor, large sized C. striatus and other fishes which have similar food habits.

3.3.4 Predators

Large specimens of predetory fishes like W. attu, M. aor, M. seenghala, N. chitala, N. notopterus, C. marulius, C. striatus, fish eating birds and others prey on smaller C. marulius.

3.3.5 Parasites and diseases

Diseases most commonly come across in C. marulius are fungal finrot and dropsy. Eye disease caused by the bacterium Staphylococus aureus which results in the eye balls becoming milky white with the fishes making abnormal movements, gasping frequently and making erratic and jerking movements, wallowing water and projecting their snout above the water surface has been reported by Kumaraiah et al. (1981). This is the first record of eye disease caused by S. aureus in fishes.

Mild to serve infection with Argulus sp. and Lernaea sp. has been reported in the species (Parameswaran, 1975).

3.3.6 Greatest size

The maximum length attained by C.marulius as reported by various authors is as follows :-

| Authority | Size attained (mm) |
|---|---|
| Hamilton (1822) | 914 |
| Cuvier and Velenciennes (1931) | 914 |
| Day (1878, 1889) | 1 219 |
| Munro (1955) | 811 |
| Alikunhi (1957) | 1 219 |
| Misra (1959) | 1 219 |
| Devaraj (1973 b) | 979 |
| Parameswaran (1975) | 1 000 |
| Murugesan and Kumaraiah | 1 056 |

## 3.4 Nutrition and growth

### 3.4.1 Feeding (time, place, manner and season)

Being a predator, the giant murrel feeds in the surface, column and bottom of the water body. It is a sight feeder and the feeding intensity is more during day time. The fish caught in the early morning mostly have empty guts.

Parameswaran (1975) observed that the percentage of empty guts increases with increase in size of fish whereas, gastrosomatic index and feeding intensity decreases, suggesting that while fry and juveniles are active feeders there is a slackening in the feeding intensity with increase in size of fish. He found that the feeding activity is maximum during August to November and January to March. Thus there is a depression in the feeding intensity when the fish are mature and during the cold winter months.

### 3.4.2 Food (type, volume)

Parameswaran (1975) has made a detailed study of the food and feeding habits of adult giant murrel. The diet of the smaller adults consisted of fishes (50.0%), aquatic insects (19.6%), shrimps (19.0%), frogs and tadpoles (10.5%) and crabs (0.9%). Adults of the size 501 to 700 mm had fishes (59.2%) and tadpoles (21.2%) as the main feed. There was a decline in the aquatic insects (8.8%) and shrimps (4.4%) component while that of crabs (4.0%) increased. Small quantities of worms (1.6%) and gastropods (0.8%) were also eaten. In large adults (701 to 990 mm), fishes (46.2%) formed the principal feed followed by frogs and tadpoles (30.8%), large aquatic insects (15.4%, Belostoma sp., Nepa sp., Ranatra sp. and Dytiscus sp. and nymphs of Ephemeroptera, Anisoptera and Zygoptera) and crabs (7.7%). Major carps and minnows and a variety of other trash fishes were come across in the gut contents (Parameswaran, 1975).

The gut contents of 3 specimens of the giant murrel examined by Devaraj (1973 b) consisted of Barbus mahicola and Oxygaster malabaricus. Alikunhi (1957) has described the adult C. marulius as piscivorous.

Examination of the rectal contents of the species indicated that appendages and other hard parts of the insects and crabs, scales and bones of fishes, bones of frogs and shells of gastropods are only scantily digested (Parameswaran, 1975).

### 3.4.3 Relative and absolute growth pattern and rates

Among all the murrels, C. marulius is the fastest growing. Alikunhi (1957) has reported that under ideal conditions it attains a size of 750 mm in one year. Even in irrigation wells it grows to 460 mm in one year (Chacko and Kuriyan, 1947). In culture ponds the species grows to 34.4 mm/29.6 g $month^{-1}$ (Murugesan et.al., 1978) and in a derelict pond having abundant forage Murugesan (1978) reported growth of 528 mm/910 g in 7 months. Preliminary tagging experiments conducted by Murugesan and Kumaraiah (1979) indicated that the species grows by about 43 to 46.5 mm $month^{-1}$ in a sewage fed tank.

Age and growth of the giant murrel was studied by Devaraj (1973 b) by probability analysis of length frequency data (Fig. 7) and fitting von Bertalanffy's growth equation to length at ages thus obtained and he could recognise 4 age groups. The von Bertalanffy's growth equation for the species computed by him was found to be

$$l_t \text{ (mm)} = 1130 \left[ 1 - e^{-0.22565 (t + 0.7976)} \right] \quad \ldots\ldots (7)$$

The lengths at various ages, annual and monthly growth increments and relative growth of C. marulius obtained by Devaraj (1973) are given in Table 6.

Parameswaran (1975) studied the age and growth of giant murrel in swamps and tanks in Karnataka by probability analysis of length-frequency data, examination of growth checks on scales and opercular bones and by fitting von Bertalanffy's checks to lengths at ages obtained from the study of the growth checks on scales. He established the annual nature of these growth checks by measuring the width between the last ring and the periphery of the scale expressed as percentage of the radius of the scale and the percentage of scales with marginal rings by pooling the data through different months and showing that the scale margin from the last growth check was least during May to August and that scales with marginal rings were encountered during February and April to December, being maximum during June to September. He attributed the annulus formation to spawning stress from age 2 onwards and to physiological rhythm (Hartley, 1947) during the first year.

The relation between length of fish (L in mm) and radius of scales (S in mm X 29.5) was estimated (for back calculation of length of fish at various annuli on scales) as

$$\log \underline{L} = 0.42946 + 0.97821 \quad \underline{S} \quad ..... \quad (8)$$

The von Bertalanffy's growth equation obtained for C. marulius by Prameswaran (1975) was

$$l_t \text{ (mm)} = 1373.5[1 - e^{-0.1259(t + 0.6942)}] .... \quad (9)$$

Nine year classes were delineated by Parameswaran (1975). The lengths at ages obtained by various methods were as in Table 7. The weights at different ages of the species are given in Table 8 and annual and instantaneous rates of growth, in Table 9.

Devaraj (1973 b) computed the length ($\underline{L}$ in mm) weight ($\underline{W}$ in g) relationship of C. marulius separately for specimens below 80 mm and those above 80 mm (Fig. 8) as follows :-

Specimens $<$ 80 mm $\log \underline{W} = -1.8398 + 1.1752 \log \underline{L}$ .... (10)

Specimens $>$ 80 mm $\log \underline{W} = -6.1192 + 3.3260 \log \underline{L}$ .... (11)

The general and sex-wise length ($\underline{L}$ in mm) weight ($\underline{W}$ in g) equations derived for the species by Parameswaran (1975) were as under :-

General $\underline{W} = -0.000007612\ \underline{L}^{2.9621}$

or

$\log \underline{W} = -5.11857 + 2.9621 \log L$ ......(12)

Male $\underline{W} = 0.000006038\ L^{2.9977}$

or

$\log \underline{W} = -5.219172 + 2.9977 \log \underline{L}$ .... (13)

Female $\underline{W} = 0.000005375\ \underline{L}^{3.0204}$

or

$\log \underline{W} = -5.269622 + 3.0204 \log \underline{L}$ .... (14)

-Relative condition factor

Devaraj (1973 b) studied the relative condition factor (Kn; observed weight ÷ calculated weight) of the species through different length ranges and attributed the peaks and valleys to fluctuations in the feeding intensity, attainment of maturity and spawning. Fluctuations in Kn through various size ranges in C. marulius were observed by Parameswaran (1975) also but their relationship with maturity cycle or feeding was not apparent, probably due to the

## TABLE- 6

Length at various ages, percentage composition, annual and monthly growth increments and relative growth of C.*marulius* from Poonjar swamp (Devaraj, 1973)

| Age in years | Mean length attained by probability plot | Mean length attained by von Bertalanffy's growth equation | Growth increment between checks (mm) | Growth $month^{-1}$ (mm) | Relative growth |
|---|---|---|---|---|---|
| 0 | 106 | - | | | |
| | | | 280 | 23.3 | 42.4 |
| 1 | 386 | 380.1 | | | |
| | | | 147 | 12.3 | 22.3 |
| 2 | 533 | 528.2 | | | |
| | | | 120 | 10.0 | 18.2 |
| 3 | 653 | 651.8 | | | |
| | | | 133 | 9.4 | 17.1 |
| 4 | 766 | 746.3 | | | |

## TABLE- 7

Length at ages in C. *marulius* derived by various methods (from Parameswaran, 1975)

| Age in years | Length (in mm) derived by Probability analysis of length frequency date | Study of growth checks on scales | von Bertalanffy's growth equation |
|---|---|---|---|
| 1 | 273 | 276.2 | 263.3 |
| 2 | 400 | 393.6 | 394.8 |
| 3 | 505 | 513.0 | 510.8 |
| 4 | 615 | 619.5 | 613.0 |
| 5 | 715 | 716.9 | 702.2 |
| 6 | 719 | 793.4 | 791.8 |
| 7 | 890 | 878.0 | 851.9 |
| 8 | 948 | 932.0 | 913.7 |
| 9 | - | 970.0 | 986.8 |

TABLE- 8

Weight at ages in C. marulius derived by various methods (from Parameswaran, 1975)

| Age in years | Weight (in g) derived by | | |
|---|---|---|---|
| | Probability analysis of length frequency data | Study of growth check on scales | von Bertalanffy's growth equation |
| 1 | 127.9 | 129.6 | 112.5 |
| 2 | 388.4 | 370.1 | 373.5 |
| 3 | 774.3 | 811.2 | 801.0 |
| 4 | 1,389.0 | 1,149.0 | 1,374.8 |
| 5 | 2,169.0 | 2,185.0 | 2,055.9 |
| 6 | 2,914.0 | 2,952.0 | 2,825.8 |
| 7 | 4,114.0 | 3,985.0 | 3,644.2 |
| 8 | 5,001.0 | 4,755.0 | 4,484.3 |
| 9 | - | 5,355.0 | 5,322.2 |

TABLE- 9

Annual and instantaneous rates of growth in C. marulius (from Parameswaran, 1975)

| Growth period (years) | | Annual and instantaneous rates of growth derived from lengths at ages by | | | | | |
|---|---|---|---|---|---|---|---|
| | | Length frequency | | Scale method | | von Bertalanffy's | |
| From | To | Annual | Instantaneous | Annual | Instantaneous | Annual | Instantaneous |
| 1 | 2 | 2.0367 | 1.1103 | 1.8554 | 1.0492 | 2.3198 | 1.1999 |
| 2 | 3 | 0.0036 | 0.6901 | 1.1918 | 0.7045 | 1.448 | 0.7630 |
| 3 | 4 | 0.7939 | 0.5839 | 0.7493 | 0.5593 | 0.7164 | 0.5402 |
| 4 | 5 | 0.5616 | 0.4460 | 0.5398 | 0.4317 | 0.4954 | 0.4024 |
| 5 | 6 | 0.3435 | 0.2955 | 0.3510 | 0.3008 | 0.3745 | 0.3181 |
| 6 | 7 | 0.4238 | 0.3532 | 0.3499 | 0.3000 | 0.3896 | 0.2544 |
| 7 | 8 | 0.2054 | 0.1869 | 0.1932 | 0.1768 | 0.2305 | 0.2074 |
| 8 | 9 | Nil | Nil | 0.1262 | 0.1186 | 0.1869 | 0.1713 |

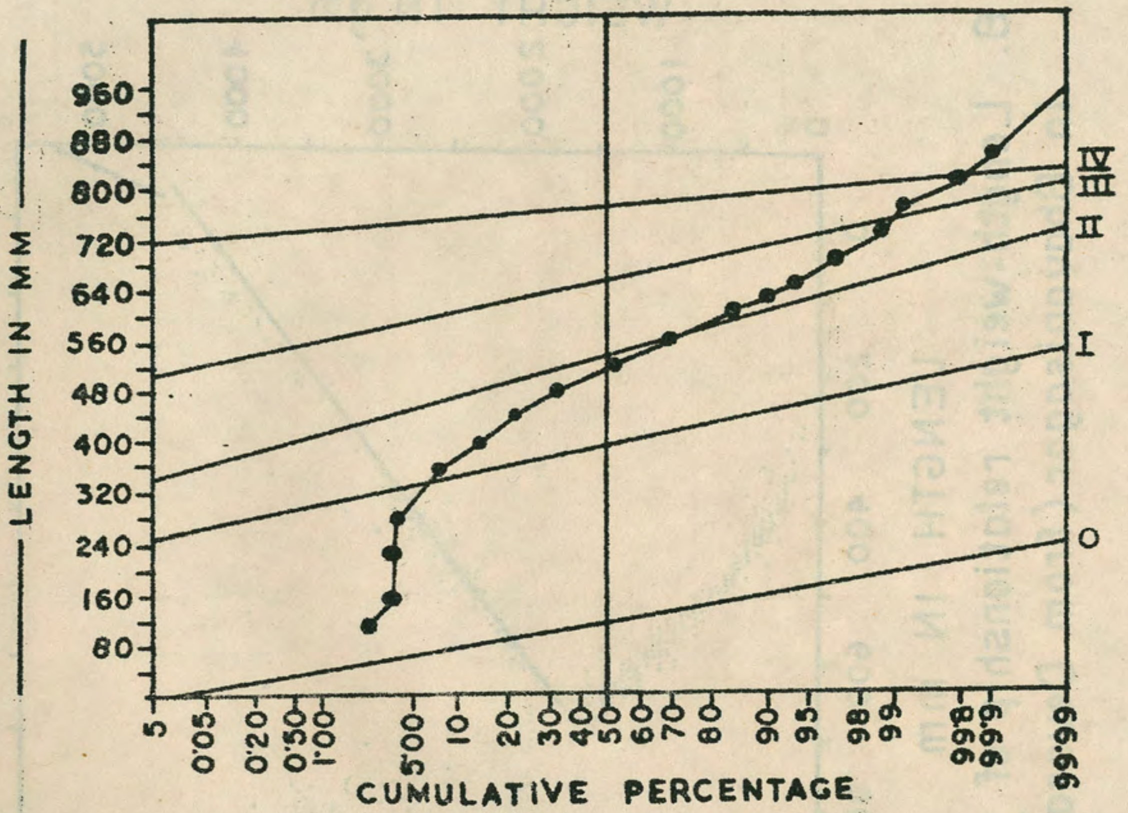


FIG. 7 – PROBABILITY ANALYSIS OF LENGTH FREQUENCY DATA OF *C. marulius* FROM POONJAR SWAMP IN BHAVANISAGAR ( from Devaraj, 1973 b )

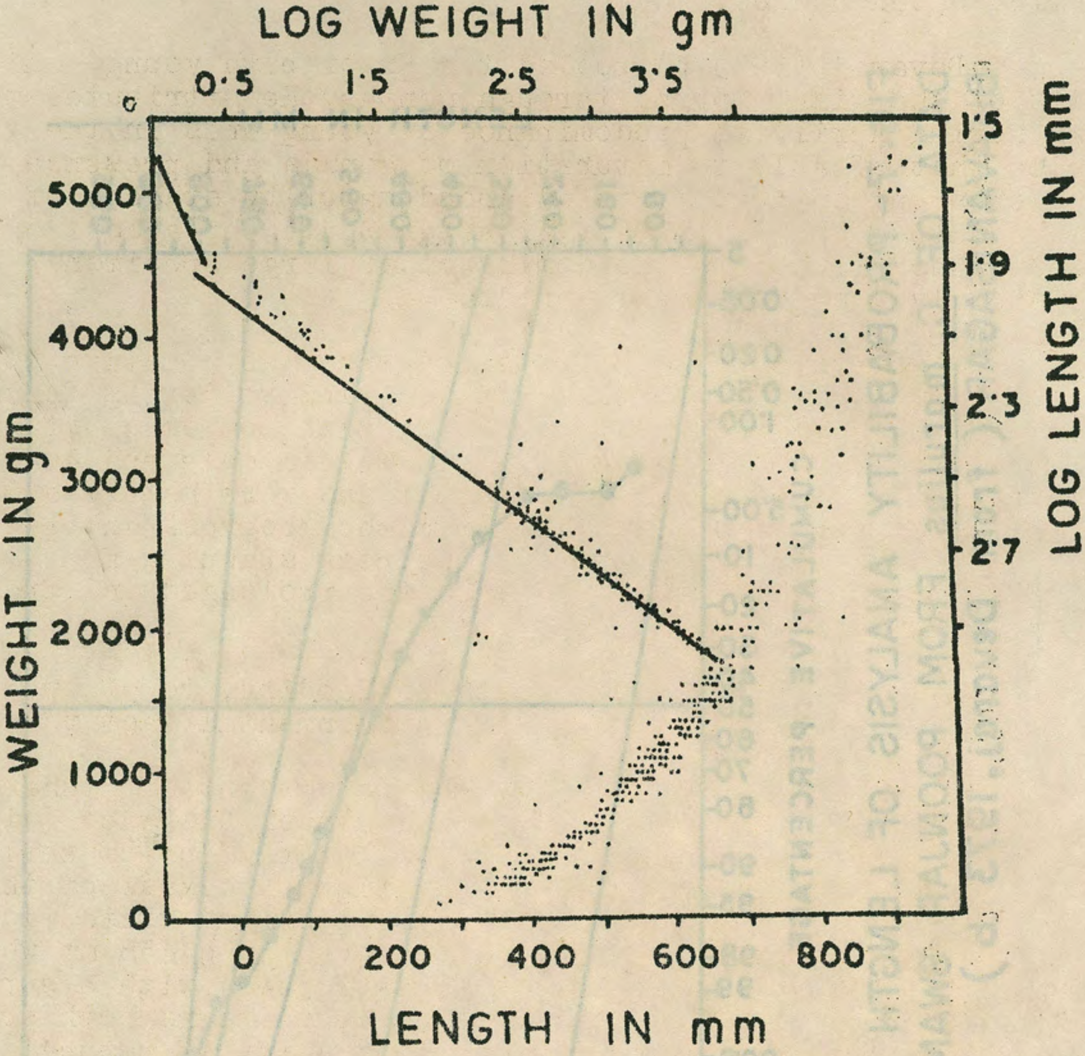


FIG. 8. Length-weight relationship of C. marulius in Bhavanisagar (from Devaraj, 1976 b).

fact that the samples were drawn from several swamps and derelict water bodies.

Devaraj (1973 b) pooled the Kn of both young and adults of the giant murrel through months. He attributed the peaks during April, to predominance of young ones in the samples that of July to maturation of gonads and presence of young ones and of August, to advanced maturity stages of the specimens. The decline of Kn after September according to the author is due to the dominance of large specimens from the river and to spent gonads.

Parameswaran (1975) reported that the relative condition of adult fish in both sexes was minimum during December. The value increased from February with commencement of maturation and reached the maximum in May in male and June in female when maximum number of specimens were mature and thereafter showed a slow decline with the progress in spawning. The gradual fall in Kn after the peak spawning months has been attributed by the author to the prolonged and fractional spawning.

3.4.4 Relation of growth to feeding, to other activities and to environmental factors

Experiments conducted by the Department of Fisheries of the erstwhile Madras Presidency in Kurnool District ( in the present Andhra Pradesh) indicated that rearing of early stages of *C. marulius* is extremely difficult because of their specialised food habits (Anon., 1929). In Bombay State, during 1938-1939, *C. marulius* fingerlings grew to *c* 438 mm when juveniles of *Megalops* sp. were given as forage, with a survival percentage of 14.2%. During subsequent years both survival and growth were very poor due to paucity of natural food (Anon., 1939, 1940). In Bangalore, under excellent forage conditions, the species attains a size of 445 mm in derelict tanks in 7 months (Murugesan *et al.*, 1978).

In swamps in Malnad Districts of Karnataka the growth rate of the species is low compared to those in Coimbatore in Tamil Nadu which may be attributable to the higher temperature of the ambient medium and the better food availability and other favourable ecological conditions in the latter. The higher rainfall ( $>$ 1000 mm $yr^{-1}$) and lower pH and temperature in Malnad make the water sheets less productive.

3.5 Behaviour

3.5.1 Migration and local movements

C. marulius is probably only a local migrant, moving about short distances for feeding and locating suitable breeding grounds. During the rainy season it negotiates short stretches of wet land for migrating into other nearby water bodies.

3.5.2 Schooling

Although the fry and fingerlings move in schools guarded by the parents, the adults have no schooling habits.

3.5.3 Reproductive habits

A fairly elaborate courtship precedes spawning, only one male pairing with the female and taking part in the spawning act. Some workers (see 3.1.3) have reported that the breeding pair construct a nest by weaving together blades of aquatic weeds while others have contradicated this and said that the spawning area is a mere clearing between weeds, formed in the process of active movement during courtship (see sections 3.1.6 and 3.1.7). Courtship and sex play precedes spawning when the fish are hypophysed also (Parameswaran and Murugesan, 1975 a). Presence of weeds is not essential for spawning and introduction of aquatic vegetation is not recommended in the induced breeding containers (Parameswaran and Murugesan, 1976 a). These authors have reported that the parental care observed in nature is absent when the fish are induced to spawn by administration of pituitary hormones.

4. POPULATION (STOCK)

4.1 Structure

4.1.1 Sex ratio

The sex ratio of C. marulius was studied in small samples from reservoir and river and fairly large samples from Poonjar swamp in Bhavanisagar by Devaraj (1973 b: Table 10) from which he concluded that females are preponderant in reservoir and swamps and males in river.

Parameswaran (1975) studied the ratio between males and females of 653 specimens of the giant murrel through different months of the year and found it to be 1:1.0535 i.e. equal to the hypothetical 1:1 ratio.

4.1.2 Age composition

Information on the age composition of C. marulius in different habitats is very scanty. Parameswaran (1975) studied the frequencies of year classes of the species in various length ranges by the examination of growth checks on scales and opercular bones of a representative samples drawn from swamps and derelict tanks through various months of the year (Table 11 and 12) which indicated that the percentage composition of age groups decreases with increase in age.

4.1.3 Size composition

The pooled quarterly length frequency distribution of C. marulius in Poongar swamp, Bhavanisagar reservoir and river as well as all the three habitats combined (Devraj, 1973) are given in Fig. 9.

## 4.2 Natality and recruitment

4.2.1 Natality

Information on the natality of the species is scarce. However, it should depend on the size of the female breeder and climatic conditions of the habitat which determines the frequency of spawning (see section 3.1.6). Parameswaran and Murugesan (1976 a) have reported that the number of eggs laid by a female when hypophysed is more than in natural spawning.

4.2.2 Recruitment

The spawning season and frequency of the giant murrel depends on the climatic conditions of the area, especially the pattern of rainfall. The recruitment is governed by the population of the brood stock, predators and trash fishes and the ecological conditions of the water bodies.

## 4.3 Mortality, morbidity

### 4.3.1 Rates of mortality

The instantaneous rate of mortality (natural + fishing) of the species (Table 14) in swamps and derelict tanks in Karnataka was maximum between the third and fourth year followed by that between second and third year. During fourth to seventh years the value was more or less steady while between seventh and nineth years it showed an increase (Parameswaran, 1975).

### 4.3.2 Factors or conditions affecting mortality

Large scale mortality of C. marulius occurs when water areas inhabitated by them partly of completely dry up during the summer months. Intensive fishing of murrels is done during these months.

## 4.4 Dynamics of population

No studies on the dynamics of the populations of C. marulius in various types of habitats have been undertaken so far.

## 4.5 Relation of population to community and ecosystem, biological production, etc.

Since C. marulius and other murrels are predatory fishes feeding in the tertiary level and the accent in India and other developing countries is on the efficient energy conversion, i.e., production of maximum fish flesh from the available food resources by cultivating fast growing fishes which feed on primary and secondary trophic levels, their culture has not been traditionally popular. The early attempts to culture murrels in the erstwhile Madras and Bombay States (Nicholson 1918 and Hora, 1945) were not successful and hence efforts in this direction were more or less given up. Attempts made for the culture of C.marulius using tilapia and trash fishes as forage were also not successful (Parameswaran, 1975). However, considerable progress has been achieved in recent years in the aquaculture of the highly prized murrels by refining the management methods (Murugesan et al., 1978 and Dehadrai et al., 1979).

TABLE- 10: Sex ratio of *C. marulius* in different habitats at Bhavanisagār (Dēvarāj, 1973 b)

| Habitat | No. of specimens examined | Sex ratio Male | : Female |
|---|---|---|---|
| River | 28 | 1 | : 0.65 |
| Reservoir | 42 | 1 | : 2.00 |
| Swamp | 743 | 1 | : 1.60 |

TABLE- 11: Frequencies of year classes of *C. marulius* in various length ranges determined by study of scales (from Parameswaran, 1975)

| Class interval (mm) | No. of specimens | Frequency of age groups 0+ | 1+ | 2+ | 3+ | 4+ | 5+ | 6+ | 7+ | 8+ | 9+ |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 161-190 | 10 | 10 | 2 | = | - | - | - | - | - | - | - |
| 191-220 | 30 | 30 | - | - | - | - | - | - | - | - | - |
| 221-250 | 42 | 39 | 3 | - | - | - | - | - | - | - | - |
| 251-280 | 47 | 37 | 10 | - | - | - | - | - | - | - | - |
| 281-310 | 50 | 16 | 34 | - | - | - | - | - | - | - | - |
| 311-340 | 60 | 2 | 40 | 18 | - | - | - | - | - | - | - |
| 341-370 | 37 | - | 16 | 21 | - | - | - | - | - | - | - |
| 371-400 | 30 | - | 4 | 26 | - | - | - | - | - | - | - |
| 401-430 | 32 | - | - | 31 | 1 | - | - | - | - | - | - |
| 431-460 | 24 | - | - | 18 | 6 | - | - | - | - | - | - |
| 461-490 | 22 | - | - | 7 | 15 | - | - | - | - | - | - |
| 491-520 | 16 | - | - | 5 | 11 | - | - | - | - | - | - |
| 521-550 | 10 | - | - | 2 | 8 | - | - | - | - | - | - |
| 551-580 | 11 | - | - | 2 | 9 | - | - | - | - | - | - |
| 581-610 | 9 | - | - | 2 | 6 | 1 | - | - | - | - | - |
| 611-640 | 8 | - | - | - | - | 8 | - | - | - | - | - |
| 641-670 | 8 | - | - | - | - | 7 | 1 | - | - | - | - |
| 671-700 | 4 | - | - | - | - | 2 | 2 | - | - | - | - |
| 701-730 | 4 | - | - | - | - | 2 | 2 | - | - | - | - |
| 731-760 | 10 | - | - | - | - | 1 | 8 | 1 | - | - | - |
| 761-790 | 4 | - | - | - | - | - | 2 | 2 | - | - | - |
| 791-820 | 5 | - | - | - | - | - | 1 | 4 | - | - | - |
| 821-850 | 4 | - | - | - | - | - | - | 3 | 1 | - | - |
| 851-880 | 3 | - | - | - | - | - | - | 1 | 2 | - | - |
| 881-910 | 5 | - | - | - | - | - | - | 1 | 4 | - | - |
| 911-940 | 1 | - | - | - | - | - | - | - | - | 1 | - |
| 941-970 | 7 | - | - | - | - | - | - | - | 2 | 5 | - |
| 971-1000 | 3 | - | - | - | - | - | - | - | - | - | 3 |
| Total | 496 | 134 | 102 | 132 | 56 | 21 | 16 | 12 | 9 | 6 | 3 |
| Percentage in total sample | | 27.95 | 23.18 | 26.36 | 10.68 | 3.64 | 2.73 | 1.82 | 1.59 | 1.36 | 0.64 |
| Standard deviation | | 9.41 | 8.86 | 9.25 | 6.48 | 3.93 | 3.42 | 2.82 | 2.62 | 2.42 | 1.73 |
| Mean length (mm) | | 242.3 | 316.1 | 432.7 | 526.7 | 646.0 | 733.8 | 803.6 | 885.1 | 949.0 | 998.0 |

TABLE- 12

Frequencies of year classes of C. marulius in various length ranges determined by study of opercular bones (from Parameswaran, 1975)

| Class interval (mm) | No. of specimens | 0+ | 1+ | 2+ | 3+ | 4+ | 5+ | 6+ | 7+ | 8+ | 9+ |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Frequency of age groups | | | | | | | | | |
| 161-190 | 9 | 9 | - | - | - | - | - | - | - | - | - |
| 191-220 | 30 | 30 | - | - | - | - | - | - | - | - | - |
| 221-250 | 41 | 38 | 3 | - | - | - | - | - | - | - | - |
| 251-280 | 47 | 30 | 17 | - | - | - | - | - | - | - | - |
| 281-310 | 46 | 14 | 32 | - | - | - | - | - | - | - | - |
| 311-340 | 59 | 2 | 39 | 18 | - | - | - | - | - | - | - |
| 341-370 | 31 | - | 12 | 19 | - | - | - | - | - | - | - |
| 371-400 | 30 | - | 4 | 26 | - | - | - | - | - | - | - |
| 401-430 | 24 | - | - | 22 | 2 | - | - | - | - | - | - |
| 431-460 | 23 | - | - | 17 | 6 | - | - | - | - | - | - |
| 461-490 | 18 | - | - | 3 | 15 | - | - | - | - | - | - |
| 491-520 | 15 | - | - | 5 | 10 | - | - | - | - | - | - |
| 521-550 | 8 | - | - | 1 | 7 | - | - | - | - | - | - |
| 551-580 | 8 | - | - | 1 | 7 | - | - | - | - | - | - |
| 581-610 | 6 | - | - | 1 | 3 | 2 | - | - | - | - | - |
| 611-640 | 4 | - | - | - | - | 4 | - | - | - | - | - |
| 641-670 | 8 | - | - | - | - | 7 | 1 | - | - | - | - |
| 671-700 | 3 | - | - | - | - | 1 | 2 | - | - | - | - |
| 701-730 | 2 | - | - | - | - | - | 2 | - | - | - | - |
| 731-760 | 5 | - | - | - | - | - | 5 | - | - | - | - |
| 761-790 | 4 | - | - | - | - | - | 1 | 3 | - | - | - |
| 791-820 | 4 | - | - | - | - | - | 1 | 3 | - | - | - |
| 851-880 | 3 | - | - | - | - | - | - | 1 | 2 | - | - |
| 881-910 | 4 | - | - | - | - | - | - | - | 4 | - | - |
| 911-940 | 1 | - | - | - | - | - | - | - | - | 1 | - |
| 941-970 | 6 | - | - | - | - | - | - | - | 2 | 4 | - |
| 971-1000 | 2 | - | - | - | - | - | - | - | - | - | 2 |
| Total | 443 | 123 | 108 | 113 | 50 | 14 | 12 | 9 | 8 | 5 | 2 |
| Percentage in total sample | | 27.77 | 24.15 | 25.31 | 11.29 | 3.32 | 2.71 | 2.03 | 1.81 | 1.13 | 0.45 |
| Standard deviation | | 9.45 | 9.01 | 9.07 | 6.89 | 3.68 | 3.42 | 2.97 | 2.80 | 2.22 | 1.41 |
| Mean length (mm) | | 239.9 | 310.5 | 398.1 | 523.9 | 641.2 | 736.3 | 805.3 | 886.1 | 950.1 | 997.0 |

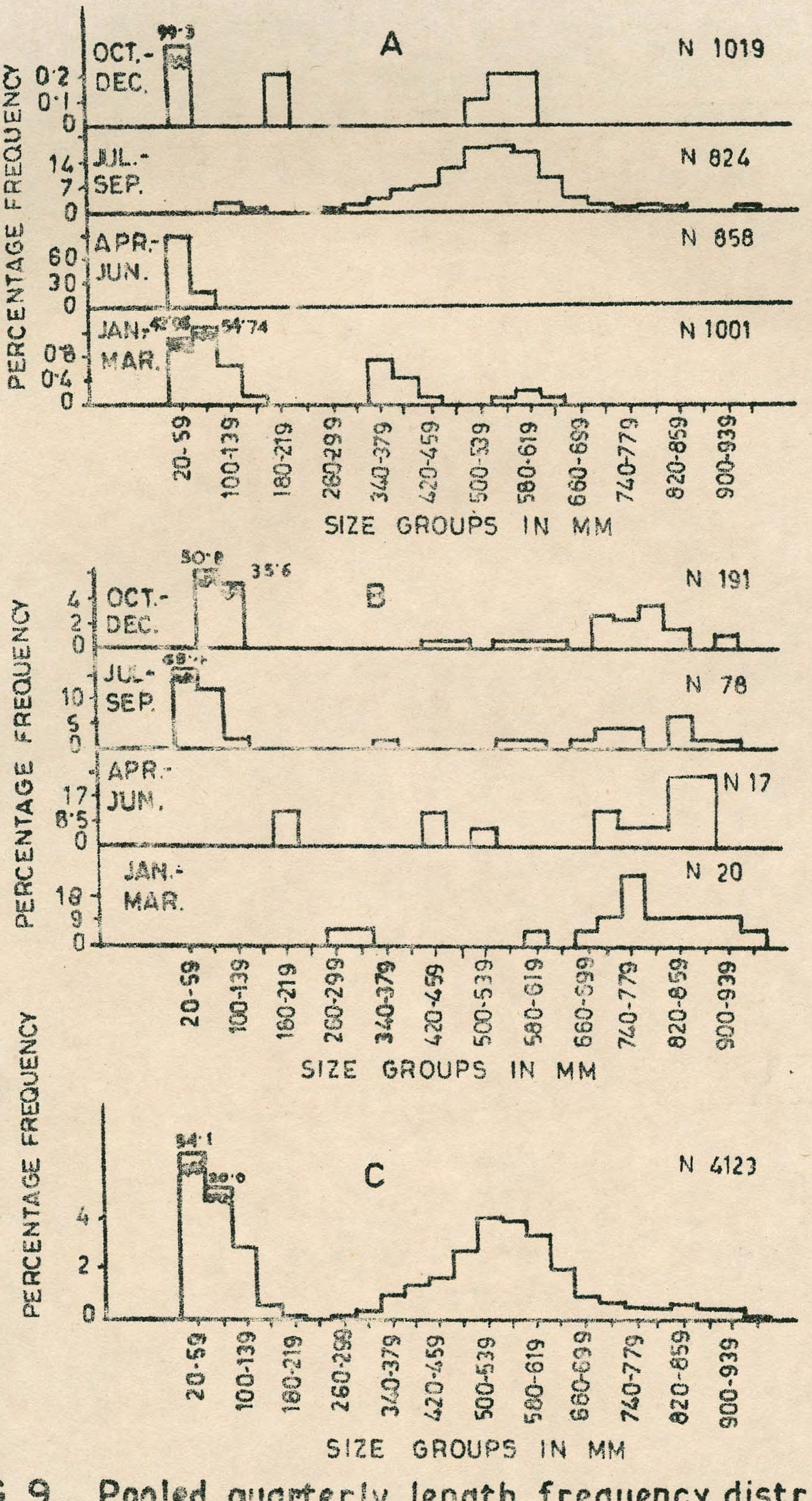


FIG. 9. Pooled quarterly length frequency distribution of *C. marulius* in Bhavanisagar (from Devaraj, 1973 b).

C. marulius is meticulously eradicated from carp nurseries and growout ponds because of their highly predatory nature.

## 5. EXPLOITATION

C. marulius and other murrels constitute the mainstay of the wild freshwater fisheries in India, especially in the peninsular region (Alikunhi, 1953). They are stocked in village ponds, irrigation wells and shallow waters (Chacko and Kuriyan, 1947; Alikunhi, 1948, 1953, 1957 and Anon., 1962). Air breathing fishes constitute about 13% of the marketable surplus of freshwater fishes in India (Anon, 1962) and the major part of it is murrels, especially C. marulius and C. striatus. Murrels are highly prized for their keeping quality, flavour and nutritive and medicinal properties, especially in the Punjab, Madhya Pradesh and Peninsular India (Hora, 1934; Alikunhi, 1953, 1957 and Anon, 1962) and invariably fetch a much higher price than most of the other freshwater fishes.

### 5.1 Fishing equipment

#### 5.1.1 Fishing gear

C. marulius is caught mainly by long lines and hook and line using fish and frogs as bait. The species is caught in fairly good numbers from reservoirs, rivers and swamps in gillnets and also by castnetting, especially when guarding the young. In swamps where the fish abounds, gears like dragnets, driftnets, and scoopnets cannot be operated because of the weed infestation and the looseness of the bottom. In ponds, tanks and reservoirs C. marulius is caught in dragnets, but it has the tendency to avoid getting caught by burying in mud. Longlines are operated generally in the night and picked up early in the morning. Rod and line is operated in the day time. During the breeding season the parent murrels guarding the young are usually caught by spearing and by shooting. A common method of collection of the species from shallow waters in Assam, North Bihar and peninsular India is by bailing out the water and picking the fish.

#### 5.1.2 Fishing boats

The coracle is the craft commonly used for fishing murrels and other fishes in Karnataka, Tamil Nadu and Andhra Pradesh. It is a circular, basin-shaped light craft made out of split bamboo strip frame and covered with cattle hide, having a diameter ranging from 1.8 to 2.5 m.

In the rest of India, fishing murrels in large freshwater bodies like lakes, rivers, bheels and jheels is incidental to fishing for carps and large catfishes.

## 5.2 Fishing areas

### 5.2.1 General geographic distribution

See section 2.1

### 5.2.2 Geographical ranges (latitudes, distances from coast, etc.)

Latitudes 8° N to 40°N

Longitudes 62°E to 130°E

### 5.2.3 Depth ranges

Because of the need of the fish to surface periodically for air breathing, it frequents the surface and the shallow areas and of the column of water bodies.

## 5.3 Fishing seasons

### 5.3.1 General pattern of fishing

Although the giant murrel is caught throughout the year, the fishing effort is maximum in swamps, tanks and low lying areas including paddy fields and canals from the month of September, when the water level in them begins to shrink, till the commencement of the monsoons by June-July in the succeeding year. During the extreme summer months (March to June) large quantities of murrels of all sizes are caught and brought to the markets after wayside selling.

### 5.3.2 Duration of the fishing seasons

See 5.3.1

### 5.3.3 Dates of beginning, peak and end of season

See 5.3.1

### 5.3.4 Variation in time or duration of fishing season

See 5.3.1

## 5.4 Fishing operations and results

### 5.4.1 Catches

Because of the rather dispersed nature of the major fishing grounds only a small percentages of the catches reach the markets.

No serious attempts have been made to estimate the annual catches of murrels in India nor it is easy. Out of 18 000 tonnes of marketable surplus of air breathing fishes caught from nature in India, murrels account for nearly 12 000 t (Jhingran, 1975). Since most of the murrels caught are disposed off at the landing site itself because of the high demand for them, the actual landings should be much higher (Parameswaran and Murugesan, MS.).

In Hebbal tank (area: 26 ha) Bangalore which was devoid of the giant murrel, stocked with 150 fingerlings of the species established and formed 5.7% of the catch in 3 years.

## 5.5 Fisheries management and regulation

*C. marulius* being a major predator, is unwelcome in capture fisheries and in carp aquaculture because of the detrimental effects it will have on the fishery of other species, especially that of carps. Hence application of fisheries management and regulation policies for the conservation of its fishery is redundent in the species. In fact, selective fishing of the giant murrel is encouraged in many reservoirs and large tanks.

## 5.6 Fish farming, transplanting and other intervention

### 5.6.1 Procurement of stocks

Although some sort of extensive culture of the giant murrel is prevalent in Tamil Nadu, Andhra Pradesh, Karnataka and Kerala, systematic culture of murrel has not yet become popular in India. Murrels have been successfully induced to breed by hypophysation (Parameswaran and Murugesan, 1976 a) and the supplemental feeding and nursery rearing techniques of murrels have been standardised to a great extent (Parameswaran and Murugesan 1975). However, the present limited demands for the seed are met from natural sources (Chacko, 1947; Chacko and Kuriyan, 1947 and Alikunhi, 1957).

The characters by which the eggs, fry and fingerlings of *C.marulius* can be distinguished from these of the other two common murrels have been described in Section 3.2.1.

The fry and fingerlings of the giant murrel move in shoals slightly away from the water margin, guarded by the parents. The fry can be collected by a quick haul with a velon netting hapa and fingerlings by operating a small meshed (7 mm mesh bar) cast net or with a large rectangular scooping net. The entire brood can be collected by allowing the escaped fry, if any, to congregate and by repeated hauling. The developing eggs can be collected by scooping with a clean mug (Parameswaran and Murugesan, 1976 b).

5.6.2 Conditioning

When long distance transport is involved either in open containers or under oxygen packing, the fry are conditioned by holding them in a hapa fixed in a pond or in a large container for about 4 to 6 hours to get rid of their gut contents so that the water medium is not polluted during transport by the excreta (Murugesan and Parameswaran, 1976).

5.6.3 Transport

The fry stages can be transported under oxygen packing while it is desirable to transport fingerlings in large containers provided with perforated lids. In the latter case water is to be changed every 4 to 6 hr. Sufficient open space above the water column will have to be provided to facilitate the habitual surfacing of the seed to breathe air (Murugesan and Parameswaran, 1976 b). Provision of aquatic plants such as Hydrilla, Ceratophyllum and Najas in the containers creates natural environment and checks the jumping tendency of the fingerlings.

Considerable mortality is observed when fry, after long transport under oxygen packing are directly released in rearing ponds, probably due to asphyxia, they being not able to negotiate the water column for breathing air, as a result of having become weak due to starvation, strain due to transportation and stay in somewhat polluted water for long periods and also sudden transplantation to a changed environment. Acclimatzing the fry to the new environment substantially reduces mortality (Murugesan and Parameswaran, 1975). It is desirable to transfer them to shallow basins, slowly replace the water with that from the pond where they are to be released, feed and later release them in the shallow area of the pond.

5.6.4 Holding of stock

No information on the optimum stocking density of C. marulius in nursery rearing phase, is available, However, Parameswaran and Murugesan (1976 b) have gathered considerable information on the supplemental feeding and nursery rearing of the alled species, C. striatus.

Survival is very low when the spawn is planted directly in the nurseries due to predation by various enemies like copepods, notonectids etc. A prenursery phase of rearing the spawn in containers such as gamlas and plastic pools or hapas made of monofilament cloth and feeding with small zooplankton, till the fry attain a size of 8.0 to 10.0 mm has been recommended by Parameswaran and Murugesan (1976 b) as at this stage they can ward off attack by copepods and small aquatic insects.

A density of 0.6 million $ha^{-1}$ was found to be the optimum stocking rate in cement nursery cisterns by Parameswaran and Murugesan (1976 b) when stocked with fry of size range 8.5 to 9.1 mm in case of C. striatus and fed with goat's blood (dried) or notonectids at the rate of 50% of the initial weight of fry, for a duration of 30 days rearing. Micronutrients such as yeast and vitamin-B complex improve the growth and survival of fry. In the absence of adequate feed, fry and fingerlings tend to become cannibalistic (Parameswaran and Murugesan, 1975).

The recommended stocking rate of C.marulius fingerlings in growout ponds with adequate natural forage is 5 000 to 6 000 $ha^{-1}$ and with additional supplemental feeding 20 000 to 40 000 $ha^{-1}$ (Dehadrai et al., 1981).

5.6.5 Pond management

Day (1878) has stated that murrels appear to be suitable for culture as some of them grow to very large size and are good for eating. However, attempts made in 1913 in the erstwhile province of Punjab 1917 in Madras Presidency (Nicholson, 1918) and in the years 1938 to 1940 in Bombay province (Anon., 1939, 1940) indicated that the rearing of fingerlings is very difficult and in the growout phase although a growth of 356 to 712 mm was achieved, the survival was extremely poor (7.1 to 14.2%) Anon, 1939, 1940 and Hora, 1945). These results led to the conclusion that murrels are not suitable for culture because they are voracious, predatory and cannibalistic (Hora, 1945).

Experiments conducted by the Madras Fisheries Department (Anon., 1929) in Kurnool District also indicated that rearing of early stages of murrels is rather difficult because of their specialized feeding habits.

Hora (1945) considered murrels to be unsuitable for culture in ponds and tanks and suggested that marshy areas unsuitable for carp culture could be used for fattening murrels on account of the abundant availability of natural food in them. Murrels are considered to be suitable for stocking in irrigation wells and small village ponds which are unsuitable for carp culture (Anon., 1962). According to Chacko (1947) and Chacko and Kuriyan (1947), limited culture of the giant murrel is practiced in irrigation wells in Tamil Nadu. About 100 fingerlings are stocked and fed occasionally with live minnows, frogs, dead birds, rats and kitchen waste of which about 10% survive and attain a size of 460 mm. Efforts have been made to popularise murrel culture in Andhra Pradesh, Tamil Nadu and parts of Karnataka by distribution of fry through Government agency, with some success.

Some of the problems encountered in the culture of murrels such as the heavy mortality during embryonic development of the eggs, the low survival in the fry and juvenile rearing phases due to cannibalism and lack of information on suitable supplemental feeds have been solved to a great extent (Parameswaran and Murugesan, 1975, 1976a, 1976b and Murugesan and Parameswaran, 1976).

Experiments conducted during the last decade, although preliminary in nature, have clearly indicated the potent prospects of murrel culture. In a pond (area: 0.0285 ha) stocked with fingerlings of C. marulius (61 to 67 mm long) at the rate of 10 000 $ha^{-1}$ and fed with live trash fish for the initial two and a half months and thereafter with dried marine trash fish (soaked and chopped) yielded a production of 22.8 kg in 8 months (c production 3 200 $kg^{-1}yr^{-1}$ ; Murugesan and Kumaraiah, 1980).

A swampy pond (area: 0.1 ha) at Bangalore was experimentally stocked with fingerlings of C. marulius, C. punctatus, C. orientalis and H. fossilis at the rate of 3 000, 150, 100 and 200 respectively by Murugesan et al. (1978). The murrels trained to accept supplemental feed by providing fresh trash fishes collected extraneously for 15 days in the beginning were later fed with dried marine trash fish (soaked and chopped) and silkworm pupae. The feeding was adjusted according to demand.

The growth of C. marulius was remarkable during the first three months, rather slow during fourth and fifth months and again picked up in the sixth month. The supplemental feeding was inadequate from the fourth month for want of enough feed. On termination of the experiment after 7 months, a catch of 235.75 kg was obtained (c production 4 041 kg $ha^{-1}yr^{-1}$) of which 98.3% was constituted by the giant murrel.

Polyculture of common carp (Cyprinus carpio), Labeo fimbriatus, mrigal (Cirrhinus mrigala) and the giant murrel in a running water pond at Bhavanisagar at a stocking density of 24 000 $ha^{-1}$ yielded c production of 5 400 kg $ha^{-1}yr^{-1}$ (Barrackpore, 1981). In another experiment, a pond stocked with catla (Catla catla), silver carp (Hypophthalmichthys molitrix), mrigal, common carp and grass carp (Ctenopharyngodon idella) in the ratio 1:3:6:3:4:3 (stocking density:10,000 $ha^{-1}$) and a gross/net production of 5 790/5 276 kg $ha^{-1}yr^{-1}$ was obtained (Barrackpore, 1981). Supplemental feeding was done at the rate of 2% body weight of the standing crop in this experiment. In both experiments the giant murrel was stocked primarily for keeping the trash fish population under water check.

Concrete cisterns stocked with giant murrel at the rate of 150 fingerlings $m^{-2}$ and fed with trash fishes, with occasional change of water gave a gross production of 16.3 to 22.2 $kg^{-2}$m 6 $months^{-1}$ (Murugesan and Kumaraiah,1976).

Fingerlings of C. marulius held in plastic pools (stocking density 200$m^2$) having a water depth of 0.25 m. fed with fresh trash fish initially and thereafter cheap dried marine trash fish (cooked) with occasional change of water gave an yield of 8.4 kg $m^{-2}$ in 3 months with a survival of 93.7%.The cost of production in terms of inputs alone worked out to Rs.4.50 $kg^{-1}$ (Murugesan and Kumariah, 1978).

Culture experiments were conducted (Murugesan and Kumaraiah, 1978) in cages fabricated with bamboo and nylon netting material under stocking densities varying from 50 to 200 fingerlings $m^{-2}$ $yr^{-1}$ cage made with nylon twine of Code No. 210/6/2 with a mesh size of 10 mm was found to vary durable. The optimum stocking rate was found to be 100 fingerlings $m^{-2}$.

Devaraj (1973) stocked 148 fingerlings (length range 50 to 79 mm; x 65 mm) in a cement cistern of area 14.9 $m^2$ and fed them with 100 to 150 g fresh liver of Wallago attu and Mystus aor daily, supplemented by 5 g dried caddis fly twice a week and occasionally aquatic bugs and beetles. In 3 months the size attained by the stock was 105 to 155 mm : $\bar{x}$:128 mm; monthly increase in length; 20 mm) and the survival, 19.3%. On termination of the experiment after 8 months it was found that only 2 fish (185 and 190 mm length) had survived (1.3%). The $\bar{x}$ monthly growth was 15.6 mm.

In another study, Devraj (1973) stocked 48 adult C. marulius (362 to 565 mm long) in a farm pond of area 224.5 $m^2$, made semi-weedy by planting the emergent weed Polygonum indicum and the submerged weed (Hydrilla verticicellata in August 1964. 320 fingerlings of Tilapia mossambica ($\bar{x}$ length 90 mm; weight 7 g) and $\bar{}$ 750 specimens of the minnows (Nuria sp; (65 to 100 mm long and 2.5 g in weight). When first assessment was done after 13 months, 23 C.marulius surviving had grown to a size of 120 mm/11 g to 655 mm/1 650 g (total weight 16.312 kg). The original parent stock introduced grew 8 mm $month^{-1}$ and the brood 12 mm $month^{-1}$. The experiment was continued with the original stock and levels of forage and was finally terminated after a total observation period of 2 years, 6 months and 22 days and 23 fish were recovered, belonging to three age groups having a size range of 90 to 99 mm (3 months old brood), 370-389 mm (1 year and 3 months old) and 610 to 629 mm (the parent stock), the former two showing a monthly growth of 33 mm and 27 mm $month^{-1}$.

Observations on the culture of murrels in irrigation wells in Tamil Nadu gave varying results, depending on the availability of feed (Devaraj, 1973). The monthly growth rate of the species ranged from 6 to 29 mm with a mean of 15 mm ( n = 4). The survival of the stocks in two of the wells was found to be 14 and 34%.

Murrel growers have reported (Devraj, 1973) that in irrigation wells in Tamil Nadu adult fishes feed on domestic food items such as biscuits and trash fish and frogs and get so tamed that they take food from hands stretched in water. In the culture experiments conducted at Lalbagh, Bangalore, the fish was reported to take trash fish from hand dipped in water (Murugesan et al., 1978).

The foregoing account indicates that so far only very few experiments have been conducted on the culture of C. marulius. There is need to carry out a large number of replicated experiments on the culture of the species in ponds and derelict tanks under different stocking densities, alone and in combination with other predatory fishes and large carps under varying management regimes.

Being a feeder in the tertiary trophic level, the giant murrel will not be able to utilize conventional fish feeds which are mostly agricultural byproducts. However cheaply available marine trash fish which is not fit for human consumption can be efficiently converted into high quality, prised fish by culturing the giant murrel. The fish is ideally suited for extensive culture in derelict swampy waters where carps cannot be reared. By adopting proper management measures, they can be grown together with fishes belonging to the low energy system such as the carps. In large tanks and ponds where control of trash fish is a problem, introduction of a few murrels may be welcome to keep them under check and to increase the overall production.

CHANNA STRIATUS (BLOCK, 1793)

IDENTITY

1.1 Taxonomy

1.1.1 Definition
(After Berg, 1947)
Phylum vertebrate
Subphylum Craniata
Superclass Gnathostoma
Series Pisces
Class Teleostomi
Subclass Actonopterygii
Order Channiformes (Ophicephaliformes)
Family Channidae (Ophicephalidae)
Genus Channa 1763
Species Channa striatus (Bloch, 1793 (Fig. 10)

Of the fishes belonging to the genus Channa reported from Asia and Africa, C. striatus is the most common one and has the widest distribution.

1.1.2 Description

Genus Channa Gronovins 1763

(See 1.1.2 of C. marulius)

Generic characters

(See 1.1.2 of C. marulius)

Species Channa striatus (Bloch) 1793

Specific characters

Body cylindrical anteriorly and compressed posteriorly; head depressed, upper profile convex, interorbital space flat, head 3.3 to 4, caudal fin 6 and depth 6 to 8 in total length ; eyes 6 to 7 in head; lower jaw longer; cleft of month oblique; maxilla reach below the hind end of the eye or one diameter behind; cephalic pits multiple. Teeth: In intermaxillaries 5 to 6 rows which are pointed and curved backwards, tapering posteriorly; post symphysial ones longer and canine-like; mandibular in several rows near the symphysis and one row laterally; laterally 5 equidistant canines; slender and curved ones on vomer and palatines in several rows, those in the posterior row longer. Fins:Dorsal begins behind base of pectoral and extends beyond anal; anal origin below 17th dorsal ray; pectorals do not reach the origin of anal. Scales; 9 rows between eye and angle of preopercle; predorsal scales 17 to 20 (in the present study; 19 to 22); lateral line curves down at 16th to 20th scales. Colour: Olive green, dark greyish to black above, dirty green to white below; cheeks and ventral surface of head streaked and spotted black; a dark band, running from corner of mouth to suboperculum, absent in old specimens; vertical (oblique) bands of grey or black from sides to the abdomen; spots and bands posteriorly on the dorsal fin; ventrals and anals greyish with whitish spots and lines on the latter. The species attains a maximum length of 914 mm (Day, 1878; Weber and de Beaufort, 1922; Smith, 1946; Misra, 1959 and Parameswaran and Goorah, 1981).

## 1.2 Nomenclature

### 1.2.1 Valid scientific names

*Channa striatus* (Bloch, 1793)

(See 1.2.1 of *C. marulius*, para 1 & 4)

### 1.2.2 Synonyms

*Ophiccephalus striatus* Bloch, Naturg, Ausland Fissche, 2p.141 pl 3. 1793; type locality; ~~Malabar.~~ Cuvier (in C & V.) Hist.Nat.Poiss., 7, p.417, 1831. Jerdon, Madras J.Lit.&Sci. 15.p. 146. 1848, Bleaker, Verh.Bat.Gen., 23, p.13. 1850. Gunther, J.Asiat.Soc.Sci., 18, p. 1074, 1850, Bleeker Verh.Bat.Gen., 25p 41. 1853. Gunther, Catal. Brit.Mus., 3 p. 474, 1861. Day, Fish.Malabar, p.148, 1865. Kner, Novara Fische p;243, 1867. Bleeker, Atl.Ichth., 9, t.399, fig.1, 1877. Day, Fish India, 1. p.363, 366, 1876. Day Fauna.Brit. India.,Fish., p. 363, 1889. Jordon and Evermann, Bull.U.S. Fish.Comm., 13, p.535, 1905. Weber and de Beaufort, Fish.Indo-Australian Archipelago, 4, p.314. 317-9, 1922. Shaw and Shebbeare, J.Asiat.Soc.Sci., 3,p.124, pl. 4.Fig.4, 1937. Smith, Fish.Siam, p. 1945. Menon, Rec.Indian.Mus., 52,p.22, 1954.

*Ophicephalus wrahl* Lacepede, Hist.Nat.Poiss., 3,p.551, 1802, type locality; Tranquebar, Hamilton, Fish.Ganges, pp40-367, pl 31, Fig. 17, 1882.

Ophicephalus chena Hamilton, Fish.Ganges.p.62, 1822, type locality; Goalpara, Assam.

Ophicephalus planiceps Valenciennes (in C. & V.).Hist.Nat. Poiss.,7, p. 425, 1831; type localityl Java,Bleeker, Nat.Geneesk Arch.Ned.India.2(3):p. 519, 1845.

Ophicephalus cyanospilus Bleeker, Verh.Bat.Gen., 25.p. 41, 1853, Bleeker, Atl.Ichth., 9, t.397,Fig.1, 1877.

Ophiocephalus sowarah Bleeker, Nat.Geneesk.Ned.India, 2(3): p.519, 1845.

Ophiocephalus vagus Peters, Monatsber Akad.,Berlin (1968) p.260, 1869.

Channa striatus Misra, Rec.Indian Mus., 59(1-4), p.220, 1959, Menon, Check list, 1974, Parameswaran and Goorah, Rev.Agric.Sucr.Maurice,pp.117-24.Fig.1,1982 D.37-45, p. 15-17, V.6, A.21-27,C.13, Ll 50-57, Ltr. 4½-7/9-7 or 5½-8/13-9

1.2.3 Standard common names, vernacular names (See Table 14)

## 1.3 General variability

### 1.3.1 Subspecific fragmentation (races,varieties, hybrids)

Wide variation in the number of dorsal and anal fin rays, lateral line scales and other meristic characters have been recorded in samples, of C. striatus from different geographical regions (Parameswaran and Goorah, 1981). However, no races, varieties and hybrids of the species have been reported.

### 1.3.2 Genetic data

(chromosome number, protein specificity)

No information is available on the chromosome number and protein specificity of the striped murrel.

Sharma and Simlot (1971) have studied the composition of the flesh of C. striatus. The differential blood cell counts of the species have been reported by Khan et al. (1969). The distribution of lipids in the muscles of the fish has been investigated by Alexander (1970). Khwaja and

Jafari (1968) have investigated the seasonal variation in calcium and phosphorus content in juvenile striped murrel.

## 2 DISTRIBUTION

### 2.1 Total area

*C. striatus* has the widest distribution among the murrels. The species naturally occurs in India, Bangla Desh, Sri Lanka, Pakistan, Burma, China, Malayasia, Thailand, Korea, Vietnam, Kampuchea and Phillippines (Day, 1878). It has been transplanted in Mauritius, Hawaii and San Francisco (Parameswaran, 1975 and Parameswaran and Goorah, 1981).

The common murrel occurs in slow and fast moving rivers, lakes, reservoirs, tanks, ponds, swamps, *bheels*, *jheels*, canals, ditches and paddy fields. It is capable of thriving in weed infested, silt-laden, shallow, oxygen depleted and polluted waters on account of the possession of the accessory air respiratory organ (Das, 1940 and Parameswaran, 1975).

The fry of the striped murrel (49 to 97 mm long) withstands salinity upto 5 ppt on direct transfer without mortality and upto 12 ppt if the salinity increase is made in stages (Murugesan, *et al*., 1979).

#### 2.2.1 Areas occupied by eggs, larvae and other junior stages, annual variations in these patterns and seasonal variations for stages persisting over two or more seasons

Alikunhi (1953, 1957) and Rahimullah (1946) have reported that *C. striatus* breeds throughout the year, with peaks in months immediately preceding and during monsoons.

The common murrel has been reported to construct a nest with its tail in the vegetation near the edge of tanks and biting off the ends of weeds which grow in them (Puckle, 1868). According to Arumugam (1966) nests of the species are found in shallow waters, among the bushes and crevices, at a depth of 44 cm. Parameswaran (1975) and Parameswaran and Murugesan (1976b) who surveyed a large number of swamps and ponds in Karnataka State did not come across any constructed nests of the striped murrel. According to them, the species generally lays its eggs in shallow margins of weed-infested waters where the weeds are cleared in a small circular area, probably during active spawning movement of the breeders. The weeds help to hold the floating eggs together without dispersal. The fish has been found to breed in weed-free waters and even puddles (Alikunhi, 1957; Parameswaran, 1975 and Parameswaran and Murugesan, 1976 b).

Both parents guard the eggs and larvae (Willey, 1908, 1909, 1910; Raj, 1916; Alikunhi, 1953; 1957; Jones 1946 a. and b; Battacharya, 1948; Mookerjee et al., 1948 and Qayyum and Qasim 1964). The fry move in shoals near the water margin. Alikunhi (1953) has made detailed observations on the brood care of the common murrel. The parantal care and gregareous tendency cease and the young ones disperse when they attain a size of 57 mm. The fry and fingerlings frequent the surface and column, while the juveniles are column and shallow bottom dwellers.

The distribution in time and space of the fry of the striped murrel and the seed index through months in swamps and derelict tanks in Malnad region of Karnataka have been studied by Parameswaran and Murugesan (1976 b).

## 3 BIONOMICS AND LIFE HISTORY

### 3.1 Reproduction

#### 3.1.1 Sexuality (hermaproditism, heterosexuality, intersexuality)

The common murrel is heterosexual. However, synchronous hermaphroditism has been reported in a single specimen (Swarup and Srivastava, 1976). The sexes can be distinguished during the breeding season, vide characters listed in Table 15.

#### 3.1.2 Maturity (age and size)

Raj (1916), Bhattacharya (1946) and Mookerjee et al. (1948) have reported that the striped murrel attains maturity when 2 years old. According to Parameswaran (1975) the species matures in the first year itself in Karnataka at a minimum size of 173 mm/36 g in male and 179 mm/39 g in female. Alikunhi (1953, 1957) has also reported that the fish attains maturity in the first year, but at a larger size of 234 mm, in Tamil Nadu.

#### 3.1.3 Mating (monogamous, polygamous, promiscuous)

An elaborate courtship, the male actively chasing the female, precedes spawning. The parents have been reported to construct a nest, but this has been contradicted (Section

2.2.1). Only one male pairs with the female (Parameswaran and Murugesan, 1976a).

3.1.4 Fertilization

Fertilization is external. The eggs are generally laid in a clear area, in between aquatic vegetation. The parents guard the eggs and probably aerate the water by their movements (Alikunhi, 1953 and Parameswaran, 1975).

3.1.5 Fecundity

According to Raj (1916), the fecundity of the common murrel varies from a few hundreds to a few thousands, depending on the size of the fish. The fecundity of 5 specimens in the size range 234 mm/113 g to 448 mm/794.5 g studied by Alikunhi (1953) ranged from 2 997 to 20 070. The author reported that the $\bar{x}$ diameter of the ovum varies from 1.01 to 1.17 mm.

The relation between fecundity (F) and total length (L in mm)/weight (W in g) of fish computed from the data of Alikunhi (1953) are as follows :-

$$\underline{F} = 0.0011765\ \underline{L}^{2.650623} \quad \ldots\ldots \quad (1)$$

$$\underline{F} = 54.984685\ \underline{W}^{0.870145} \quad \ldots\ldots \quad (2)$$

The fecundity of 47 specimens of C. striatus in the size range 206 mm/80 g to 405 mm/830 g studied by Parameswaran (1975) varied from 2 794 to 28 046. The ovaries constituted 3.651% of the body weight with a mean of 4.796%. Fully mature ova measured 1.069 to 1.266 mm in diameter ($\bar{x}$ size). They are golden yellow in colour in the fresh condition.

The fecundity (F) - total length (L in mm)/weight (W in g) relationship of C. striatus obtained by Parameswaran (1975) were as follows :

$$\underline{F} = 0.00005225\ \underline{L}^{3.3203} \quad \ldots\ldots \quad (3)$$

$$\underline{F} = 13.58\ \underline{W}^{1.17625} \quad \ldots\ldots \quad (4)$$

### 3.1.6 Spawning

#### Spawning season

Parameswaran (1975) reported the occurrence of spawning and partially spent pecimens of the striped murrel during February to October in Malnad region of Karnataka. The peak spawning, as evidenced by the occurrence of large number of spawning and partially spent fishes and maximum number of broods, was during June and July in this region, coinciding with the peak rainfall (Parameswaran 1975 and Parameswaran and Murugesan 1976 b). Broods of the species were obtained during early March to November.

Alikunhi (1953, 1957) and Rahimullah (1946) reported that the striped murrel breeds throughout the year, with peak in the months immediately preceding and during monsoon. According to Thomas (1870), Day (1889), Willey (1910), Raj (1916), Khan (1924). Bhattacharya (1946), Mookerjee et al. (1948) and Qasim and Qayyum (1961), breeding in C.striatus takes place during the monsoon and post-monsoon months, the intensity of spawning depending on the climate conditions, with a single peak in northern India during April to August and two peaks one during June to July and the other, November to January in peninsular India (corresponding to southwest and north-east monsoon seasons), with limited breeding in other months also. In South Canara (Karnataka), it is reported to breed twice a year, in June and December (Thomas 1870). Intensive spawning of this fish takes place in southern Kerala during May and June (Jones, 1946 a). In Malnad region of Karnataka the species breeds throughout the year, excepting in the cold winter months November to January. Ova diameter frequency polygons of mature ovary of C.striatus developed by Qasim and Qayyum (1961) Fig. 11 and Parameswaran (1975) indicated two graphs of ova, suggesting that the fish spawns at least twice in the season.

According to Qasim and Qayyum (1961), the moderate climate and abundant rainfall in peninsular India provide favourable conditions for breeding of murrels throughout the year. In contrast, in north such conditions are prevalent only for a limited period viz. during the monsoon and post-monsoon months, which accounts for the restricted breeding season.

Parameswaran and Murugesan (1976 a) successfully induced the striped murrel to spawn at Bhadra Reservoir Project (Karnataka) by hypophysation, using carp pituitary glands. An initial dose of gland varying from 2 to 20 mg $kg^{-1}$ weight of fish was administered to the female and nil to 20 mg to the males. After 4 to 6 hr a higher dose ranging from 5 to 380 mg $kg^{-1}$ was given to the females and 5 to 250 mg to the males.

The female paired with a single male 1 to 4 hr after the second injection. The spawning was preceded by active, excited movement of the paired breeders, which commenced in about 13 to 17 hr after the second injection. Out of the 15 sets hypophysed by Parameswaran and Murugesan (1976 a) 9 spawned. The fertilization of eggs ranged from nil to 100%. The doses administered to the females in experiments where successful spawning occurred, varied from 20 + 60 to 10 + 380 mg $kg^{-1}$. Artificial fecundation was attempted in 4 experiments where the females (dose range 20 + 60 to 1 + 208 mg $kg^{-1}$) were found to be oozing eggs freely. In one instance, an uninjected female held in the pool along with the injected breeders also spawned (Parameswaran and Murugesan 1976 a).

3.1.7 Spawning grounds

The common murrel spawns in a variety of habitats such as rivers, lakes, reservoirs, swamps, _jheels_, _bheels_, tanks, ponds, paddy fields and even puddles (Parameswaran, 1975).

3.1.8 Eggs : Structure, size, hatching, type, parasites and predaters

The salient characters of the developing eggs of _C. marulius_, _C. striatus_ and _C. punctatus_ have been reported by Parameswaran (1975) and Parameswaran and Murugesan (1976 a and b). The eggs are free floating, spherical and non-adhesive and have an oil globule. They could be distinguished from those of _C. marulius_ and _C. punctatus_ _vide_ characters given in Table 5.

## 3.2 Larval history

3.2.1 Account of embryonic and juvenile life (prolarva, postlarva and juvenile)

The embryonic and larval development of _C. striatus_ has been studied by Mookerjee (1945 a, b), Mookerjee _et al_ (1948) and Alikunhi (1953).

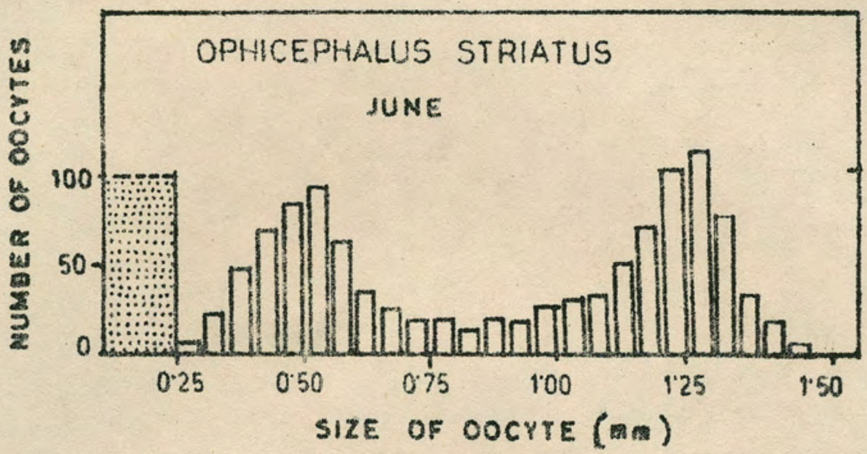


FIG. 11. Ova diameter frequency polygon of mature ovary of C. striatus (from Qasim and Qayyum, 1961).

The $\bar{x}$ size of the developing eggs is 1.53 mm. The eggs are pale yellow or amber coloured in the early stages of embryonic differentiation. With the formation of the chromatophores (in the advanced embryos), they appears brownish to the naked eye. The eggs have a single large oil globule and a narrow pervitelline space. The advanced embryo with the tail coiled over the head ruptures the eggs membrane, hatches out with the tail foremost, and wriggles about with the head still inside the egg, using the projecting tail portion as a paddle. The lashing movements of the tail help to cast off the half ruptured egg membrane covering the head portion (Alikunhi, 1953). The period of incubation at a temperature range of 21.3 to 26.9°C is 46.00 to 56.30 hr (Parameswaran and Murugesan, 1976 a).

The hatchling, according to Alikunhi (1953), measures 4.33 mm in length and according to Parameswaran and Murugesan (1976 a; induced bred), 2.81 to 3.41 mm ($\bar{x}$ 3.23 mm). It is considerably pigmented and has a conspicuous oblong yolk-sac from which the head hardly projects out. The larvae floats upside down at the water surface, at a slight angle. The eyes are not fully pigmented and the pectoral fin buds and mouth have not appeared. The yolksac is fully absorbed on the third day when the post-larvae measure 5.73 mm (Alikunhi 1953), According to Parameswaran and Murugesan (1976 a), however, it takes 84.00 to 92.30 hrs for the larvae for complete yolk absorption at a temperature range of 21.3 to 26.9°C, when they measure 5.31 to 6.53 mm ($\bar{x}$ 5.96 mm) in length. At this stage the post-larva has a well formed mouth and has commenced feeding. The pectoral fins are flaplike. The mouth and the tip of the notochord are directed upwards by the 5th and 7th day respectively. The caudal fin has indications of 7 to 8 rudimentary rays. The body is reddish and eyes golden red and glistening. The characteristic yellow and dark lateral bands along both sides of the body are well indicated. A distinct bright yellow spot has appeared in the dorsum of the head, posteric-1 medially, over a spindle shaped median patch of dark brown pigment extending upto the level of the eyes. The dorsal and anal fins are clearly indicated by the 9th day, almost separate from the caudal fin. Rudimentary rays are present in the dorsal and anal fins. Ventral fin buds are also formed. Pigmentation has become pronounced. Within the next two days all the fins are fully formed, excepting the ventrals which take two more days to get fully differentiated. Scales appear on the body by the 13th to 16th day.

( Also see 3.2.1 of <u>C</u>. <u>marulius</u>, para 4 & 5)

Feeding

It has been reported by Parameswaran (1975) that the percentage of empty guts in C. striatus increased with increase in size of fish while the gastrosomatic index and intensity of feeding steadily decreased, indicating that there is a slackening in feeding intensity with increase in size of fish.

Parameswaran (1975) reported that the smaller post-larvae (5 to 15 mm) subsisted on plankton, of which zooplankton constituted the bulk (97.4%), consisting of cladocerans (63.6%), rotifers (27.9%) and protozoans (5.4%); the rest being phytoplankters. Larger post-larvae (16 to 30 mm) consumed in addition to the above (cladocerans 41.30%), rotifers 6.2%, copepods 27.9% and phytoplankters 0.7%), aquatic insects (mainly Anisops spp. and other small hemipterans) and small shrimps. The aquatic insects (42.4%) and shrimps (4.7%) component increased in the stomach contents of the juveniles of the size range 31 to 50 mm with corresponding decrease in plankton (52.9%). The diet of still larger juveniles (50 to 100 mm) comprised mainly of aquatic insects (82.5%); Anisops spp. Croxia sp. and Gerris sp.). Other items in the stomach contents were zooplankton (13.7%) mostly copepods) and shrimps (3.9%). The adolescents (101 to 150 mm) were also found to be mainly entamophagous (insects; 77.3%), feeding on the same groups of aquatic insects and insect larvae, with a preference for larger ones. Shrimps constituted a larger component of their feed (15.9%), compared to the previous stage. Annelids formed 6.8% of the diet. Plankton was absent in the stomach contents of the fish at this stage.

Mookerjee et al. (1948) reported that the larvae of C. striatus feed almost exclusively on planktonic algae and protozoans while early fry subsist on planktonic crustacea. Alikunhi (1953), however, found that the early fry are zooplankton feeders, feeding on copepod nauplii, colonial rotifers and other zooplankters.

- Rates of development and survival

Hatching percentage is very low when murrel eggs are left in the induced breeding pool. The high mortality observed during embryonic and larval developmental stages can be considerably reduced by transferring the developing eggs to shallow basins and arranging slow dripping of water in the containers (Alikunhi, 1953, and Parameswaran and Murugesan, 1976 a). The hatching technique has been further simplified and the mortality reduced to less than 5 to 10%, by holding the eggs under oxygen packing till hatching and the hatchlings till yolk absorption (Parameswaran and Murugesan, 1976 a). In nature, probably the large area of the water sheet and the slow, sinnous movement of the parents guarding the eggs and larvae may ensure better oxygenation of the ambient medium (Alikunhi, 1953 and Parameswaran, 1975).

The parental care exhibited by the species ensures a better survival of fry in nature.

Pronounced canniblism is observed in C. striatus(and other murrels) during the fry and juvenile stages, the larger and healthier ones preying upon the smaller and weaker ones (Parameswaran 1975). This could be minimized in captive stocks by ensuring abundant supply of preferred feed (Parameswaran and Murugesan, 1976 b).

Experiments on the transport of developing eggs and young of C. striatus were conducted by Murugesan and Parameswaran,(1975) under various densities and for different time durations in 8 l water and a column of oxygen in air-tight polythene bags kept inside empty kerosene oil tin containers (18 l capacity), with the objective of studying the physico-chemical changes taking place in the water medium and for standardizing the transportation techniques of murrel seed.

The lethal levels of dissolved oxygen, free carbon dioxide and ammoniacal nitrogen for seed of different sizes and the capacity of fry of various sizes to withstand starvation, determined by Murugesan and Parameswaran (1975) are given in Table 16. These authors observed that when various factors individually or collectively reached lethal levels in the experimental units, the fry slowly changed from light brown to dark colour. They showed signs of distress,congregating and gasping near the water surface and later went passively down, moved erratically and died.

Murugesan and Parameswaran (1977) reported that in spite of the density of packing being high in experiments with eggs and spawn, the percentage of survival was high compared to the larger fry, apparently due to the low oxygen demand and metabolic excretion by the eggs and spawn in comparision to those of fry. The percentage of survival in experiments with post-larvae, just after complete yolk absorption, was low. Since the values of various chemical parameters at conclusion of the experiments were well below lethal levels, the mortality in attributable to starvation rather than adverse physico-chemical conditions.

Assuming that a survival of over 75% is satisfactory in the transport of spawn and fry, the packing density worked out by Murugesan and Parameswaran (1977) for various sizes of seed and durations of time are given in Table 17.

An important point to be borne in mind while transporting the seed of murrels and those of other air breathing fishes is their habitual surfacing to breathe air. Sufficient open space above the water column is to be ensured for this purpose. When eggs are to be transported, it is desirable to remove the dead ones, if any, before packing, since they develop fungal moulds which spread to live ones and cause further mortality.

Considerable mortality was observed by Murugesan and Parameswaran (1977) when fry, after transportation, were directly released in rearing ponds, which they attributed to asphyxia, the fry being unable to negotiate the water column for breathing air, as a result of having become weak due to starvation, strain experienced during transport and stay in somewhat polluted water for long periods, as also sudden transplantation to a changed environment. It is desirable to acclimate the fry to the new environment by transferring them to shallow basins and slowly replacing the water with that from the pond, before stocking.

Practically no information on the survival rate of the young of C. striatus in various types of natural habitats is available. The survival of the species is generally presumed to be low because of cannibalism (Parameswaran, 1975).

Parameswaran and Murugesan (1975) conducted experiments on evolving supplemental feeds for C. striatus fry. Six items of animal origin viz. goats blood, egg yolk, fishmeal, shrimps, notonectids and defatted silkworm pupae and five items of plant origin, namely peanut cake, rice-bran, wheat flour, bloated rice and cooked potato (sun dried and powdered) were screened. Feeds of plant origin generally gave poor results both in terms of survival of fry and growth, their ranking being lower than all the feeds of animal origin, excepting silkworm pupae. Feeds which gave promising results were goat's blood, notonectids, egg yolk, fishmeal and shrimps, in that order. Addi-

TABLE- 13 : Instantaneous rate of mortality in C.marulius (from Parameswaran, 1975)

| Growth period (years) From | To | Instantaneous rate of mortality |
|---|---|---|
| 2 | 3 | 0.8575 |
| 3 | 4 | 0.9809 |
| 4 | 5 | 0.2722 |
| 5 | 6 | 0.2876 |
| 6 | 7 | 0.2878 |
| 7 | 8 | 0.4053 |
| 8 | 9 | 0.6933 |

TABLE- 14: Standard common names, vernacular names of C. striatus

| Country | Standard common names | Vernacular names |
|---|---|---|
| Burma | Common murrel, striped murrel, snake fish | nya yan |
| Bangla Desh | Striped snake | shol, holi, chena |
| Cambodia | head, murrel | tray ras |
| Indonesia | | gabus, kutak, bajong, deluk, gapuran, betul, rutiang, rajong, tjing-kong, bako, palompong, tubian, tumba, rua, behan harusn, uran, arosan, bale salo, tola, kajee |
| India | | koochina marl, kuchu meenu, pooli kuchi, owlu meean (Kannada), morrul murl, soura, dheri-murul (Hindi), virahal, veralu, carappu veralu (Tamil), Wrhal, veral, kannan, chothiyan (Malayalam), sowarh, korra meenu, budda-matta, mettasavudalu(Telugu) shol, chana, holi (Bengali) sola (Oriya), haal shawl, gojil (young) (Assamese), sowl, dhoalu, crrodh (Punjabi), shor, dakhu (Marathi) |
| Malayasia | | gabus |
| North Bornoo | | aruan sakak |
| Pakistan | | sowl |
| Philippines | | sulbus, bukule, haruan, haluan, lawag, dalag, bundaki |
| Sri Lanka | | lulla, hal path naka, viral lulla |
| Thailand | | pla chon, pla chora. |

TABLE- 15

Sexual dimorphism in C. striatus during breeding season

| Male | Female |
|---|---|
| 1. No bulging of abdomen | 1. Slight bulging of abdomen |
| 2. Vent pale | 2. Vent round and reddish |
| 3. Anal papilla-like structure prominant; its tip pointed | 3. Anal papilla-like structure broad, slightly reddish and blunt with a reddish dot |

TABLE- 16

Results of laboratory experiment on lethal levels and capacity of seed to withstand starvation in C. striatus (from Murugesan and Parameswaran, 1977)

| Size of seed (mm) | Lethal levels | | | Duration to withstand starvation (hrs) |
|---|---|---|---|---|
| | dissolved oxygen (ppm) | Carbon dioxide (ppm) | ammonical nitrogen (ppm) | |
| 5.9 | 0.56 | 146.4 | 18.4 | 57 |
| 9.0 | 0.44 | 180.6 | 32.0 | 86 |
| 16.3 | 0.40 | 290.4 | 52.6 | 98 |

tion of micronutrients, yeast and vitamin-B complex at the rate of 1 mg $fry^{-1}day^{-1}$, especially the former, to the first two feeds improved the survival and growth of fry significantly. Feeding with zooplankton, however, gave the best results.

In rearing experiments where spawn of C. striatus just after yolk absorption (5.5 mm in length) was stocked in manured nursery cisterns, Parameswaran and Murugesan (1975) observed that the survival was poor in both control (no supplemental feeding; survival: 1.76 to 24.55%) and where goat's blood was given as supplemental feed (survival: 2.[illegible]9 to 26.36%), which they attributed to predation by various enemies like copepods, notonectids, etc. They found that a prenursery phase, i.e., rearing the spawn in containers such as gamlas (earthern vats) and plastic pools or hapas of monofilament cloth fixed in ponds and feeding with small zooplankton for 4 to 5 days, till the fry attain a size of 8.0 to 10.0 mm, will be advantageous. At this size they are able to ward off attack by copepods and small aquatic insects and utilize supplemental feed. Hence Parameswaran and Murugesan (1975) used only fry over 8.5 mm in length in the rest of the experiments. Stocking densities ranging from 0.2 to 1.5 million $ha^{-1}$ and supplemental feeding with a variety feeds (alone or in combination) were attempted. Best results in terms of both survival and growth were obtained with goat's blood and notonectids as supplemental feed. The results with shrimps and fishmeal were not very promising while those with silkworm pupae were rather disappointing. Goat's blood was found to be marginally superior to notonectids as well as a mixture of the two feeds. The quantity of feed given was 2, 4 and 6 times the initial weight of the stock respectively till the 10th, 20th and 30th day in the case of spawn and for fry 50% of their initial weight. Micronutrients, yeast and vitamin-B complex at the rate of 1 mg $fry^{-1}day^{-1}$, especially the former, substantially improved the survival as well as growth of fry. Survival varying from 10.5 to 87.7% was obtained in these experiments. Generally, survival and growth were inversely proportional to the stocking density.

These investigations indicated that a density of 0.6 million $ha^{-1}$ is probably optimum in nursery phase when stocked with fry in the size range 8.5 to 9.1 mm and fed with goat's blood or notonectids at the rate of 50% of the initial weight of fry for a rearing period of 30 days.

- Parental care

The striped murrel has been reported to construct a nest with its tail among the vegetation near the edge of tanks and biting off the ends of the weeds which grow in them (Puckle, 1868). This has, however, been contradicted by Alikunhi (1953, 1957), Parameswaran (1975) and Parameswaran and Murugesan (1976 b).

Both the parents have been observed to guard the eggs and larvae (Willey, 1908, 1909, 1910), Raj (1916), Alikunhi (1953, 1957), Jones (1946 a, b), Bhattacharya (1946) and Mookerjee et al (1948). Detailed observations on the brood care of the species have been reported by Alikunhi (1953).

A brood of eggs of C. striatus ranges from 2 000 to 2 500 in number according to Rahimulla (1946). Parameswaran (1975) and Parameswaran and Murugesan (1976 b) have reported that the number of fry per brood varies from 538 to 5 290. They found that the number of fry per brood declines in the later months as compared to the earlier months of the breeding season, suggesting that there is a reduction in the number of eggs laid with every repeated spawning. The parental care and schooling tendency cease when the fry attain the size of 57 mm.

- Parasites and predators

The protozoan parasite Ichthyoptherius sp. often attacks the fry and fingerlings kept in nursery cisterns. Fungal attack on developing eggs and fin rot in fry and fingerlings is also common. Infestation of the fry by the copepod parasite Lernaea elegans has been reported by Iyengar and Venkatesh (1956). Fingerlings collected from ponds and swamps have often been found to be attacked Lernaea sp. and Argulus sp. (Parameswaran, 1975).

Yolked larvae with heavy yelksac being not able to move fast, are very suceptible to attack by the copepod Cyclops spp; The fry are attacked by a variety of insects such as Anisops spp., Nepa sp., Ranatra sp., Cybister sp. and nymphs of dragonfly, damselfly and mayfly. Trash and predatory fishes also take a toll of the fry (Parameswaran, 1975).

Cannibalism is pronounced in the post-larval and juvenile stages, the larger and stronger ones preying upon the smaller and weaker ones. Shoot fry grow fast in stocks held in nurseries and prey on the less grown ones, reducing the survival in the nursery phase (Parameswaran, 1975).

## 3.3. Adult history

### 3.3.1 Longivity

Bhatt (1970) attempted ageing of the common murrel from Aligarh (rivers, channels and ponds) in Uttar Pradesh and recognized up to 5 + age groups. Parameswaran (1975) studied the ageing of the species from swamps and derelict tanks in Karnataka and delineated upto 6 + age groups by probability analysis of the length frequency (Cassie, 1954) and from the examination of growth checks on scales and opercular bones.

### 3.3.2 Hardiness

C. striatus in the subadult and adult stages is reported to be very hardy. Their accessory respiratory organ (facilitating utilization of atmospheric air directly for respiration) and modified blood physiology enable murrels to thrive in ~~foul waters and withstand~~ poisonous gases like methane and hydrogen sulphide as well as extreme fluctuations in dissolved oxygen and carbon dioxide, which are characteristic of swamps and other derelict waters. These adeptations enable them to tide over summer when the shallow quarters they inhabit dry up partially (Das, 1940 and Parameswaran, 1975). Murrels migrate from one water body to another during the rainy season, negotiating moist land. They can stay alive for considerable time outside water without dying (Dehadrai, 1962). Being facultative air breathers, they die due to asphyxia if not allowed to breathe atmospheric air (Das, 1940).

However, the fry and fingerlings of the common murrel, in spite of their capacity to breathe atmospheric air, are rather delicate and do not withstand handling unlike those of major carps and are prone to injury and infection (Parameswaran, 1975).

### 3.3.3 Competetors

In the fry stage, the striped murrel is planktophagous like that of most other freshwater fishes and adult stages of fishes such as catla (Catla catla) and several species of minor carps and minnows and Clupeoids, causing interspecific competetion for food. Fingerlings of the striped murrel which feed on aquatic insects, shrimps and trash fishes compete for food with other predatory fishes such as C. marulius (fingerlings and subadults), C. punctatus

N. notopterus, A. testudineus, C. batrachus, H. fossilis and O. bimaculatus which have similar feeding habits. Major predatory fishes such as W. attu, N. chitala, M. seenghala M. aor and C. marulius compete with the adult C. striatus for food.

3.3.4 Predators

Fishes like W. attu, M. aor, M. seenghala and N. chitala and fish eating birds prey on the common murrel.

3.3.5 Parasites and ~~diseases~~

The commonly encountered diseases in the striped murrel are fungal fin-rot and dropsy. Mild to severe infections of Argulus sp. and Lernaea sp. have also been reported in this species (Parameswaran, 1975).

3.3.6 Greatest size

The maximum length attained by the striped murrel according to various authors is as follows :-

| Authority | Size (mm) reported |
|---|---|
| Alikunhi (1957) | 610 |
| Bhatt (1970) | 540 |
| Parameswaran (1975) | 470 |
| Day (1878) | 914 |
| Parameswaran and Goorah (1981) | 535 |
| Weber and de Beaufort (1922) | 900 |
| Smith (1932) | 900 |

3.4 Nutrition and growth

3.4.1 Feeding (time, place, manner and season)

Being a predator, the common murrel feeds in the bottom, column and surface of shallow water bodies and the feeding intensity is more during day time. C. striatus caught in the early morning have mostly empty guts. The fish generally accepts only feeds of animal origin.

Parameswaran (1975) has reported that in the striped murrel the percentage of empty guts increases with increase in size of fish whereas gastrosomatic index and feeding intensity decreases, suggesting that while fry and juveniles are active feeders, the feeding intensity slackens with increase in size of fish. There is a depression in the intensity of feeding during the months in which the fish are maturing or mature (March to August) and in the cold winter months (December and January). The feeding activity is maximum during the maturing and recovering months (Parameswaran, 1975).

3.4.2 Food (type, volume)

According to Parameswaran (1975) in swamps and tanks in Karnataka C. striatus in the size range 151 to 250 mm had aquatic insects as the dominant feed (41.3%), followed by shrimps (26.8%). The species at this stage develops piscivorous tendency, with minnows and trash fishes forming 25.5% of the diet. Other items encountered in small quantities were frogs and tadpoles, annelid worms and gastropods. The adult fish in the size range 251 to 400 mm fed mainly on fishes (36.8%), shrimps (30.5%) and aquatic insects (23.3%), with frogs and tadpoles, gastropods and annelids making up the rest of the feed. Larger adults (401 to 484) were predominantly piscivorous fish, comprising 66.7% of the diet. Shrimps and aquatic insects in somewhat equal proportions constituted the rest of the feed. Fishes which formed the forage of the common murrel were carp minnows, other weed fishes and smaller sized murrels.

3.4.3 Relative and absolute growth patterns and rates

In ponds in Tamil Nadu, fingerlings of C.striatus grow to a size of 241.5 mm in 215 days and under good forage conditions, 317.5 mm in 8 months (Alikunhi, 1953). The species attains a size of 480 mm in one year under favourable conditions. Murugesan (1978) has reported a growth of 41.5mm $month^{-1}$ in the species in a swampy pond. Under supplemental feeding, in culture ponds it grows to 258 mm/150 g in 7 months.

The validity of annulations of the scales in providing basis for age determination in C. striatus has been established by Bhatt (1959). He studied the age and growth of the species from the growth checks on the scales (Fig.12) and by fitting von Bertalanffy's growth equation (von Bertalanffy, 1957) to lengths at ages thus obtained and recognized 5 age groups. The von Bertalanffy's growth equation computed for the common murrel by Bhatt (1970) is :

$$l_t \text{ (cm)} = 56.5 \left[1-e^{-0.420 (t + 0.981)}\right] \ldots\ldots (5)$$

The length at various ages obtained by Bhatt(1970) by the various methods are given in Table 18 and Fig. 13.

The age and growth of the striped murrel from swamps and tanks in Karnataka was studied by Parameswaran (1975) by probability analysis of length frequency data (Cassie, 1954), examination of growth checks on scales and opercular bones and by fitting von Bertalanffy's growth equation to lengths at ages obtained from study of growth checks on scales. The annual nature of the growth checks was established by him by measuring the width between the last ring and the periphery of the scale, expressed as percentage of the radius of the scale and the percentage of scales with marginal rings, by pooling the data through months and showing that the scale margin from the last growth checks was least and scales with marginal rings are maximum during June to October, suggesting that the rings are laid during this period.

Bhatt (1970) and Parameswaran (1975) estimated the relation between length of fish (L in mm) and radius of scale (S; S in mm 29.5 in the latter case respectively for back calculation of length of fish at various annuli on scales as

$$\text{Log } \underline{L} \text{ (cm)} = 0.875 \log \underline{S} \quad \ldots\ldots \quad (6)$$

$$\text{Log } \underline{L} \text{ (mm)} = 0.3071 + 0.9934 \log \underline{S} \ \ldots \ (7)$$

Parameswaran (1975) obtained the von Bertalanffy's growth equation of the species as follows :

$$l_t \text{ (mm)} = 753.41 \left[1 - e^{-0.1311\,(t\,+\,0.9489)}\right] \ \ldots .(8)$$

Six year classes were delineated by Parameswaran (1975). The lengths at ages obtained by the various methods were as in Table 19.

The length (L in mm) - weight (W in g) relationship of *C. striatus* computed by Bhatt (1970) was :

$$\underline{W} = 0.00697\ \underline{L}^{\,3.05} \quad \ldots \quad \ldots \quad \ldots \quad (9) \text{ (Fig.14)}$$

The general and sex-wise length (L in mm) - weight (W in g) relationship equations obtained for the species by Parameswaran (1975) were as follows :-

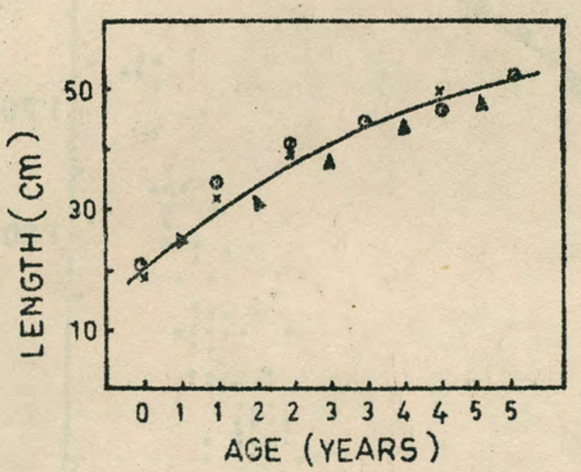


FIG. 13. Growth curve of C. striatus. Mean length of various year classes determined by scale readings ——×—— ; calculated length from the fitted von Bertalanffy equation ——o—— ; back calculated length ——▲—— (from Bhatt, 1970).

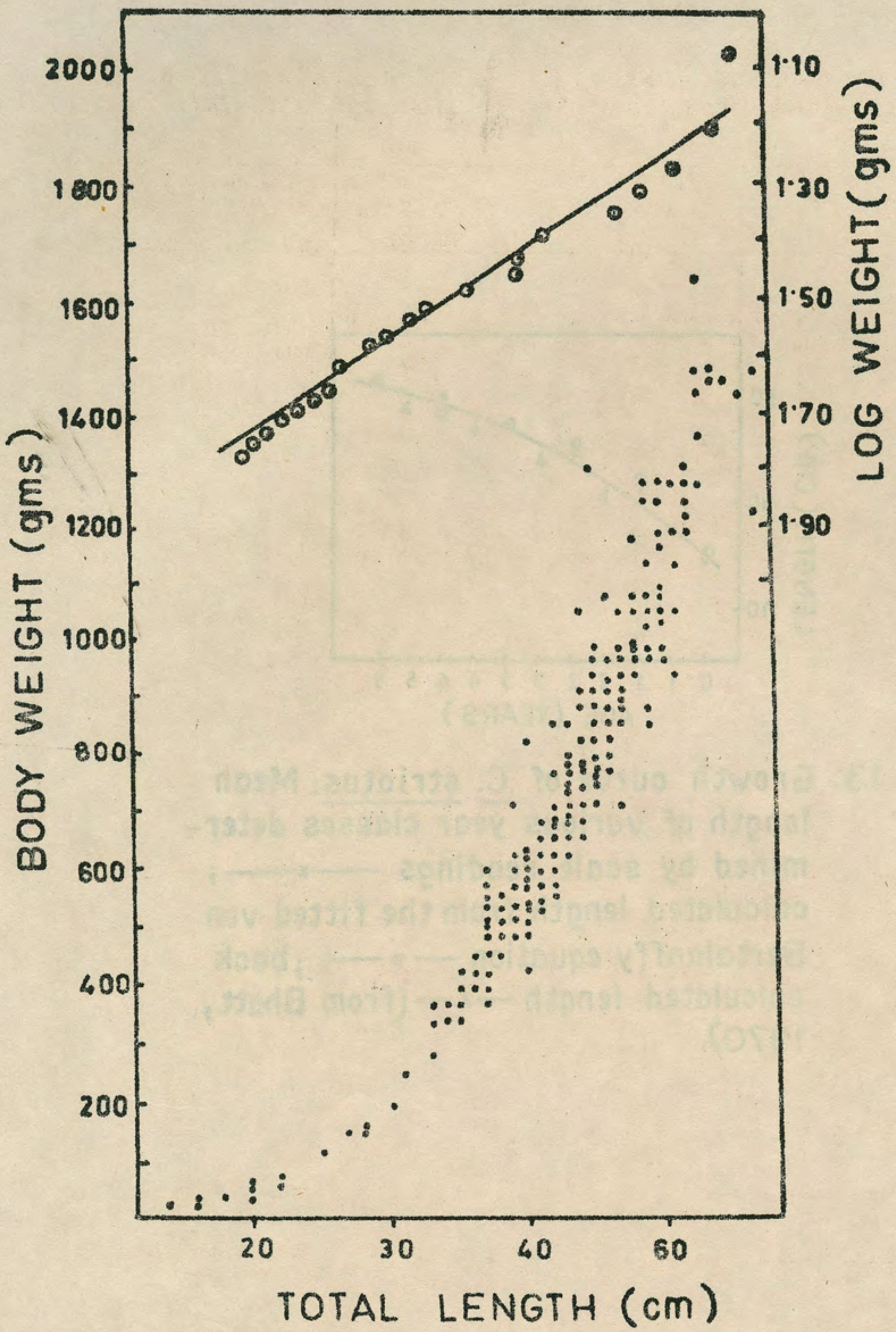


FIG. 14. Length-weight relationship of C. striatus. Each point in the lower part of the figure refers to the observed value. Each point in the upper part of the figure gives the log transformation of mean values (from Bhatt, 1970).

TABLE- 17

Optimum densities of packing for different durations in C. striatus (from Murugesan and Parameswaran, 1977)

| Size of seed (length in mm) | Duration (hrs) | Optimum density of packing (no.of seed/l water) |
|---|---|---|
| 1.1 | 24 | 2,000 |
| | 48 | 1,500 |
| | 72 | 1,000 |
| 3.2 | 24 | 1,500 |
| | 48 | 1,000 |
| | 72 | 750 |
| 5.9 | 24 | 1,000 |
| | 48 | Not suitable |
| | 72 | - do - |
| 9.0 | 24 | 600 |
| | 36 | 500 |
| | 48 | 300 |
| | 72 | 125 |
| 12.2 | 24 | 500 |
| | 36 | 400 |
| | 48 | 300 |
| 16.3 | 24 | 400 |
| | 36 | 300 |
| | 48 | 200 |
| 23.5 | 24 | 300 |
| | 36 | 200 |
| | 48 | 125 |
| 32.1 | 24 | 250 |
| | 36 | 150 |
| | 48 | 100 |
| 35.3 | 24 | 150 |
| | 36 | 125 |
| | 48 | 75 |

TABLE- 18

Mean size of the first five zones on the scales and the back-calculated lengths of fish at various ages (from Bhatt, 1970) in *C. striatus*

| Age years | Mean size (cm) | S.D. | Back-calculated body length | Observed length |
|---|---|---|---|---|
| I | 0.494 | 0.037 | 25.20 | 20.0 (0+) |
| II | 0.653 | 0.048 | 31.99 | 35.1 (1+) |
| III | 0.813 | 0.065 | 38.75 | 41.1 (2+) |
| IV | 0.953 | 0.049 | 44.53 | 45.1 (3+) |
| V | 0.072 | 0.020 | 49.36 | 48.1 (4+) |
| VI | - | - | - | 53.1 (5+) |

TABLE- 19

Lengths at ages in *C. striatus* derived by various methods (from Parameswaran, 1975)

| Age in years | Length (in mm) derived by | | |
|---|---|---|---|
| | Probability analysis of length frequency data | Study of growth checks on scales | von Bertalanffy's growth equation |
| 1 | 153 | 169.2 | 169.6 |
| 2 | 239 | 240.0 | 241.4 |
| 3 | 310 | 304.1 | 304.0 |
| 4 | 365 | 359.4 | 359.3 |
| 5 | 411 | 408.5 | 407.9 |
| 6 | 445 | 444.9 | 450.5 |

General : $\underline{W} = 0.000009322\ \underline{L}^{2.9854}$ ..... (10)

Male : $\underline{W} = 0.000009296\ \underline{L}^{2.9843}$ ..... (11)

Female : $\underline{W} = 0.000007943\ \underline{L}^{3.0179}$ ..... (12)

The weights at different ages of the fish are given in Table 20 and annual and instantaneous growth rates, in Table 21.

Although relative condition (Kn) in male and female striped murrel showed fluctuations through different sizes, this could not be correlated with maturity cycle (Parameswaran, 1975) as has been done in several other species of fishes.

Parameswaran (1975) observed that the relative condition in the common murrel from swamps and tanks in Malnad region of Karnataka which was minimum in December increased steadily and reached the maximum during May to July in both sexes, coinciding with the period of peak maturity. The slow fall in Kn thereafter has been attributed by him to the prolonged and fractional spawning.

3.4.4 Relation of growth to feeding, to other activities and to environmental factors

See section 3.4.3

## 3.5 Behaviour

3.5.1 Migration and local movements

*C. striatus* is probably only a local migrant moving about short distances in larger water bodies, for feeding and locating suitable breeding grounds. It negotiates short stretches of moist land during the rainy season for migrating into other nearby water bodies. This way the species migrates from one pond to another in fish farms.

3.5.2 Schooling

Although the fry and early fingerlings of the common murrel move in shoals, guarded by the parents, the adults do not have schooling habit.

3.5.3 Reproductive habits

Spawning in the striped murrel is preceded by a fairly elaborate courtship, only one male pairing with the female and taking part in the spawning act. The breeding pair is reported to construct a nest by some workers while this has been contradicted by others (see section 3.1.3, 3.1.6 and 3.1.7).

Spawning is preceded by courtship when the fish is hypophysed also (Parameswaran and Murugesan, 1976 a). Unlike in nature, however, parental care is not observed when the fish are hypophysed.

# 4. POPULATION (STOCK)

## 4.1 Structure

### 4.1.1 Sex ratio

The sex ratio of C. striatus in swamps in Malnad region of Karnataka through months was studied by Parameswaran (1975). He examined a total of 1 009 specimens and the ratio between male and female was found to be 1:1.055, i.e. equal to the hypothetical 1:1 ratio (Chi square: 0.7225; probability: 0.396).

### 4.1.2 Age composition

Very scanty information is available on the age composition of the common murrel in different habitats. Bhatt (1969, 1970) studied the frequencies of year classes of the species in various length ranges of a sample drawn from river channels and ponds in Aligarh, by the examination of growth checks on scales (Table 22).

Parameswaran (1975) studied the age composition of a representative sample of the common murrel from swamps and tanks in Malnad region of Karnataka by the examination of the growth checks on scales (Table 23) and opercular bones (Table 24).

### 4.1.3 Size composition

Parameswaran (1975) has dissected the length frequency data of the striped murrel by the probability plot method (Cassie, 1954), for deliniating the age groups.

## 4.2 Size and density

No information is available

TABLE - 20

Weights at ages in C. striatus derived by various methods (from Parameswaran, 1975)

| Age in years | Weight (in g) derived by | | |
|---|---|---|---|
| | Probability analysis of length frequency data | Study of growth on scales | von Bertalanffy's growth equation |
| 1 | 31.0 | 41.9 | 42.2 |
| 2 | 116.7 | 119.6 | 121.0 |
| 3 | 255.5 | 241.1 | 240.9 |
| 4 | 414.0 | 397.2 | 396.8 |
| 5 | 592.6 | 582.1 | 579.5 |
| 6 | 751.6 | 751.1 | 779.6 |

TABLE- 21

Annual and instantaneous rates of growth in C. striatus (from Parameswaran, 1975)

| Growth period (years) | | Annual and instantaneous rates of growth derived from lengths at ages by | | | | | |
|---|---|---|---|---|---|---|---|
| | | Length frequency method | | Scale mathod | | von Bertanlanffy's equation | |
| From | To | Annual | Instantaneous | Annual | Instantaneous | Annual | Instantaneous |
| 1 | 2 | 2.7621 | 1.3247 | 1.8394 | 1.0431 | 1.8689 | 1.0539 |
| 2 | 3 | 1.1894 | 0.7835 | 1.0261 | 0.7067 | 0.9904 | 0.6883 |
| 3 | 4 | 0.6204 | 0.4829 | 0.6474 | 0.4692 | 0.6470 | 0.4990 |
| 4 | 5 | 0.4314 | 0.3585 | 0.4655 | 0.3822 | 0.4603 | 0.3787 |
| 5 | 6 | 0.2680 | 0.2379 | 0.2903 | 0.2549 | 0.3452 | 0.2966 |

## TABLE- 22

Length frequencies of various year-classes in *C. striatus* determined by the scale reading together with the number of fish with doubtful scales (from Bhatt, 1970)

| Length groups (cm) | Total No.of fish examined | 0+ | 1+ | 2+ | 3+ | 4+ | 5+ | Doubtful |
|---|---|---|---|---|---|---|---|---|
| 14 | 2 | 2 | - | - | - | - | - | - |
| 16 | 2 | 2 | | | | | | |
| 18 | 1 | 1 | | | | | | |
| 20 | 4 | 4 | | | | | | |
| 22 | 5 | 5 | | | | | | |
| 24 | 1 | 1 | | | | | | |
| 26 | 1 | 1 | | | | | | |
| 28 | 2 | 1 | 1 | | | | | |
| 30 | 3 | | 3 | | | | | |
| 32 | 3 | | 3 | | | | | |
| 34 | 7 | | 4 | 2 | | | | 1 |
| 36 | 22 | | 6 | 14 | 1 | | | 1 |
| 38 | 49 | | 4 | 31 | 12 | | | 2 |
| 40 | 39 | | | 23 | 13 | 3 | | - |
| 42 | 58 | | | 29 | 25 | 4 | | - |
| 44 | 58 | | | 13 | 34 | 7 | 1 | 3 |
| 46 | 35 | | | 3 | 27 | 5 | - | - |
| 48 | 29 | | | | 20 | 6 | - | 3 |
| 50 | 20 | | | | 6 | 10 | - | 4 |
| 52 | 13 | | | | 3 | 5 | 4 | 1 |
| 54 | 3 | | | | 1 | 1 | 1 | - |
| 56 | 4 | | | | | 1 | 1 | 2 |
| Total | 361 | 17 | 21 | 115 | 142 | 42 | 7 | 17 |
| Mean length | | 20.9 | 35.1 | 41.1 | 45.1 | 48.1 | 53.1 | |

## 4.3 Natality and recruitment

Very little information is available on the natality of the common murrel. The natality will depend on the size of the female breeder and the climatic conditions of the habitat which determines the frequency of spawning (see section 3.1.6). Parameswaran and Murugesan (1976 a and b) have reported that the number of fry in the species decreases with every repeated spawning and that the number of eggs laid by a female when hypophysed is more than in natural spawning.

### 4.3.3 Recruitment

The spawning frequency of the striped murrel depends on the prevailing climatic conditions of the area, especially the pattern of rainfall. The recruitment is influenced by a variety of factors such as the populations of the broodstock predators and trash fishes and the ecological conditions of the habitat.

## 4.4 Mortality, morbidity

### 4.4.1 Rates of mortality

The instantaneous rate of mortality (natural + fishing) of the common murrel in swamps and derelict tanks was less during in first and second year, more or less same during the second and third and, third and fourth year; thereafter it showed an increase (Table 24 A).

### 4.4.2 Factors or conditions affecting mortality

Extensive areas of shallow waters inhabited by <u>C. striatus</u> partly or completely dry up during the summer months March to June, when intensive fishing of the species is done.

### 4.4.3 Factors or conditions affecting morbidity

No information is available

## 4.5 Dynamics of population

So far no studies on the dynamics of the populations of the striped murrel have been undertaken in different habitats.

4.6 <u>Relation of population to community and ecosystem, biological production, etc.</u>

In India and most other developing countries, the accent is on production of maximum fish flesh from available food resources by culturing fishes such as carps and tilapia, which feed on primary and secondary trophic levels and are thus efficient in energy conversion. Murrels, although they fetch a high price, are not cultured traditionally, because of their predatory habit and hence no cultural practices had been developed. Since the early attempts to culture murrels in the erstwhile Madras and Bombay States (Nicholson, 1931 and Hora, 1945) were not successful, efforts in this direction were given up. Rearing of their seed was also found to be extremely difficult. Attempts made for the culture of the striped murrel using tilapia and trash fishes as forage were also not successful. In recent years, however, success has been achieved in the aquaculture of the highly prized murrels by improving the management methods (Murugesan <u>et al</u>., 1978 and Dehadrai <u>et al</u>., 1979).

Because of their predatory nature and tendency to migrate from one pond to another, the striped murrel is generally eradicated from fish farms.

5. EXPLOITATION

Air breathing fishes form about 13% of the marketable surplus of freshwater fishes in India (Anon., 1962) and the striped murrel constitutes the major part of it. In peninsular India, murrels form the mainstay of freshwater capture fisheries (Alikunhi, 1953) They are stocked in village ponds, irrigation wells and shallow waters in Southern India (Chacko and Kuriyan, 1947, Alikunhi, 1953 and 1957, Anon., 1962). Murrels are esteemed for their keeping quality, flavour and nutritive and recuperative properties in the Punjab, Madhya Pradesh and the peninsular states in India and the whole of South and South-east Asia (Hora 1934, Hora and Pillay, 1962; Alikunhi, 1957 and Parameswaran, 1975). They invariably fetch a much higher price than most other freshwater fishes.

5.1 <u>Fishing equipment</u>

5.1.1 Fishing gear

The striped murrel is caught from swamps, tanks and small reservoirs mainly by operating long lines and rod and line, using fish and frogs as bait. Longlines are operated

TABLE- 23: Lengths at ages in <u>C.striatus</u> derived by various methods (from Parameswaran, 1975)

| Age in years | Length (in mm) derived by | | |
|---|---|---|---|
| | Probability analysis of length frequen y data | Study of growth checks of scales | von Bertalanffy's growth equation |
| 1 | 153 | 169.2 | 169.6 |
| 2 | 239 | 240.0 | 241.4 |
| 3 | 310 | 304.1 | 304.0 |
| 4 | 365 | 359.4 | 359.3 |
| 5 | 411 | 408.5 | 407.9 |
| 6 | 445 | 444.9 | 450.5 |

TABLE- 24: Frequencies of year classes of <u>C. striatus</u> determined by study of opercular bones (from Parameswaran, 1975)

| Class Interval (mm) | No. of speci-mens | Frequencies of age groups | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | 0+ | 1+ | 2+ | 3+ | 4+ | 5+ | 6+ |
| 141-160 | 3 | 2 | 1 | - | - | - | - | - |
| 161-180 | 15 | 3 | 12 | - | - | - | - | - |
| 181-200 | 29 | 1 | 27 | 1 | - | - | - | - |
| 201-220 | 42 | - | 35 | 7 | - | - | - | - |
| 221-240 | 52 | - | 18 | 34 | - | - | - | - |
| 241-260 | 70 | - | 19 | 49 | 2 | - | - | - |
| 261-280 | 79 | - | 2 | 17 | 7 | - | - | - |
| 281-300 | 88 | - | - | 55 | 33 | - | - | - |
| 301-320 | 62 | - | - | 25 | 36 | 1 | - | - |
| 321-340 | 33 | - | - | 5 | 21 | 7 | - | - |
| 341-360 | 30 | - | - | - | 19 | 11 | - | - |
| 361-380 | 16 | - | - | - | 2 | 13 | 1 | - |
| 381-400 | - | - | - | - | - | - | - | - |
| 401-420 | 6 | - | - | - | - | 1 | 5 | 1 |
| 421-440 | 1 | - | - | - | - | - | - | 1 |
| 441-460 | 3 | - | - | - | - | - | 3 | - |
| 461-480 | 2 | - | - | - | - | - | 1 | 1 |
| Total | 538 | 6 | 114 | 191 | 120 | 33 | 10 | 2 |
| Percentage in total sample | | 1.12 | 21.19 | 45.73 | 22.31 | 7.44 | 1.85 | 0.37 |
| Standard deviation | | 2.44 | 9.48 | 11.55 | 9.44 | 6.08 | 3.13 | 1.42 |
| Mean length (mm) | | 169.3 | 211.8 | 269.5 | 340.9 | 369.1 | 420.1 | 451.5 |

TABLE- 24 A

Instantaneous rate of mortality in *C. striatus* (from Parameswaran 1975)

| Growth period (years) | | Instantaneous rate of mortality |
|---|---|---|
| From | To | |
| 2 | 3 | 0.7755 |
| 3 | 4 | 0.7610 |
| 4 | 5 | 0.9986 |
| 5 | 6 | 1.4350 |

generally at night and picked up early in the morning. Rod and line is operated in the day time. Because of the weed infestation, looseness of the bottom and shallowness, gears like dragnets, driftnets and scoopnets cannot be operated in swamps. The species is obtained in fairly large numbers from reservoirs, rivers and swamps in gillnets and also by castnetting, especially when guarding the young. C.striatus is caught in dragnet from ponds, tanks and reservoirs but it has a tendency to avoid getting caught by burying in mud. Murrels guarding the young are also caught by spearing and shooting. A common method of collection of the species from shallow waters in north Bihar, Assam, West Bengal and peninsular India is by bailing out water in them and hand picking.

5.1.2 Fishing boats

See 5.1.2 of C. marulius

5.2 Fishing areas

5.2.1 General geographic distribution

See section 2.1

5.2.2 Geographical ranges (latitudes, longitude, distances, coast, etc.

Latitude 50° N to 10° N
Longitude 60° E to 130° E

5.2.3 Depth ranges

Being a facultative air-breather, needing to surface frequently for taking air, C. striatus generally frequents the surface and shallow areas of water bodies.

5.3 Fishing seasons

5.3.1 General pattern of fishing

The common murrel is caught throughout the year. However, the fishing effort is more in swamps, tanks and canals and low lying water areas including paddy fields, from the month of September when the South-east monsoon ceases and the water levels start shrinking, till the commencement of the monsoons in the succeeding year. The fishing effort is generally intense during the extreme summer months in shallow water bodies when the water level in them becomes very low and large number of the species of all sizes are caught and brought to the markets, after wayside selling.

5.3.2 Duration of fishing seasons

See 5.3.1

5.3.3 Dates of beginning, peak and end of seasons

See 5.3.1

5.3.4 Variation in time or duration of fishing seasons

See 5.3.1

## 5.4 Fishing operations and results

### 5.4.1 Catches

Because of the dispersed nature of the major fishing grounds (swamps, tanks, jheels, bheels, paddy fields and low-lying areas) and the high demand for the common murrel around the fishing grounds, only a small percentage of the catches reach the regulated markets. Neither attempts have been made to estimate the annual catches of murrels in India nor it is easy.

It has been estimated that out of the 18 000 t of marketable surplus of air breathing fishes caught from nature in India, murrels account for nearly 12 000 t (Jhingran,1975) and the major part of it is constituted by C. striatus. Since a sizable part of the murrels caught are disposed off at the landing sites because of the high demand for them, the actual landings should be much higher (Parameswaran and Murugesan, MS.).

## 5.5 Fisheries Management and regulation

Being a predator, the common murrel is not welcome in cultivated waters and no management effort is made to increase its population in natural waters also. On the other hand, attempts are made to control its population even in large water bodies. It is eleminated from aquaculture ponds to prevent predation on the cultivated carps.

## 5.6 Fish farming, transplanting and other intervention

### 5.6.1 Procurement of stocks

Culture of murrels has not yet become popular. However, some sort of extensive culture of the species is prevalent in Tamil Nadu. Andhra Pradesh, Karnataka and Kerala. Although the hypophysation techniques of the common murrel and the supplemental feeding and nursery rearing of the fry have been standardized to a great extent, their large scale application is not being done as the present limited demand for the stocking material can be met from natural sources (Parameswaran, 1975).

The characters by which the fry and fingerlings of the striped murrel can be recognized from those of other common murrels have been described in section 3.21. The fry moving in shoals can be collected by a quick haul, using a /suitable meshed hapa or a piece of fry net.

### 5.6.2 Conditioning

See 5.6.2 of C. marulius

### 5.6.3 Transport

See 5.6.3 of C. marulius

### 5.6.4 Holding of stock

Parameswaran and Murugesan (1976 b) reported that survival is very low when spawn of the spotted murrel is planted directly in the nurseries due to predation by various enemies such as copepods, notonectids, etc. They recommended a prenursery phase of rearing the spawn in plastic pools or hapas made of monofilament cloth and feeding with small zooplankton till the fry attain a size of 8.0 to 10.0 mm. At this stage they can ward off attack by copepods and small aquatic insects.

A density of 0.6 million $ha^{-1}$ is the optimum in cement nursery cisterns when fry of the size range 8.5 to 9.1 mm are stocked and fed with goat's blood (dried) or notonectids, for a duration of 30 day's rearing. Micronutrients yeast and vitamin-B complex improve the growth and survival of fry. The fry and fingerlings tend to become cannibalistic in the absence of adequate feed (Parameswaran and Murugesan, 1975). Hence it is not desirable to hold fingerlings of C. striatus in crowded conditions in ponds.

5.6.5 Pond management

Attempts made in 1913 in the erstwhile province of Punjab and from 1917 in Madras province (Nicholson, 1918) and during the years 1938 to 1940 in Bombay province (Anon., 1934 a; 1940) indicated that rearing of fingerlings of murrels is very difficult. However, some success was achieved in evolving supplemental feeds for the fry and fingerlings, consisting of a mixture of goat's liver, silkworm pupae and wheat flour, Hora (1945) concluded from these experiments that murrels are not suitable for culture in ponds and tanks because of their voracious, predatory and cannibalistic nature and suggested that marshy areas unsuitable for culture of carps could be used for fattening murrels on account of the abundant availability of natural food in them. Murrels are considered suitable for stocking irrigation wells and small village ponds which are unsuitable for carp culture (Anon., 1962).

Alikunhi (1953) observed that in ponds in Tamil Nadu, under favourable condition, C. striatus attains a $\bar{x}$ size of about 320 mm year$^{-1}$, with a survival of 22%, Efforts have been made to popularise murrel culture in Andhra Pradesh Tamil Nadu, Karnataka and Kerala by distributing fry through Government agency, with some success (Anon., 1962).

Because of the predatory nature (the accent in India being in the culture of non-predatory fishes belonging to the low energy system) and initial setback in the culture very little sustained effort was put in for developing the technology for the culture of murrels till recently. With a view to developing the knowhow for culturing murrels and air breathing catfishes for putting to productive use the extensive swamps and other derelict water areas in the states of Bihar, West Bengal, Assam, Orissa and Karnataka, which are lying fallow and are unsuitable for culture of carps without extensive reclamation, a Coordinated Research Project on the Culture of Air breathing Fishes in Swamps was taken up in the year 1971, with three Centres, one each in Karnataka, Bihar and Assam. Centres in West Bengal and Andhra Pradesh were added in 1977 and 1978 respectively. The concerted research effort of these Centres have provided valuable baseline information on the derelict water resources in the country, the present status of the fishery of the air breathing fishes, the ecology of swamps and other derelict waters and the biology of the economically important air breathing fishes. The natural seed resources of the various air breathing fishes in different regions were delineated in time and space. The different species were successfully induced to breed by hormones administration. The major problem of heavy mortality observed during embryonic development of the eggs, the low survival in the fry and juveniles rearing phases due to cannibalism and the lack of information on suitable supplemental feeds have been solved to a great extent (Parameswaran and Murugesan, 1975, 1976 a 1976 b and Murugesan and Parameswaran, 1976).

Murugesan and Kumaraiah (1980) conducted two sets of experiments in ponds (area; 0.0285 ha) each consisting of a control and two replicates with stocking densities of 20 000 and 50 000 $ha^{-1}$. Trash fishes were released in the ponds two months prior to stocking of murrels. Fertilization was done with raw cowmanure at the rate of 1 000 kg $ha^{-1}$ and lime @ 100 kg $ha^{-1}$ at monthly intervals. The water level was topped up in the ponds every 15 days. The trash fishes attained maturity in the ponds and multiplied faster than in the control ponds. Production ranging from 713.1 to 894.8 kg of murrels and 114.0 to 431.7 kg of trash fishes were obtained in the fertilized ponds against 128.7 to 145.6 kg murrels and 30.5 to 50.0 kg trash fishes from the control ponds (Table 25 and 26), (Murugesan and Kumaraiah, 1980).

Murugesan (1978) stocked a swampy pond of 0.0285 ha at Bhadravathi with trash fishes at a density of 10 000 $ha^{-1}$. After 2 months _C_. _striatus_ fry ($\bar{x}$ length: 48 mm; age: 30 days) were transplanted at the rate of 50 000 $ha^{-1}$∠to facilitate production of food organisms for trash fishes so that the latter would form sustained forage for the murrel stock. The experiment was concluded after 8.5 months observation. The maximum size attained by _C_. _striatus_ was 401 mm/ 670 g. The growth per day ranged from 1.3 to 3.0 mm during the first 3 months and 0.3 to 0.9 mm for the rest of the period of observation. From a derelict pond of 0.15 ha area stocked with _C_. _striatus_, _H_. _fossilis_ and _C_. _batrachus_ at the rate of 42 000 fry $ha^{-1}$ (Murugesan and Kumaraiah, 1978), a net production of 120 kg fish $year^{-1}$ was obtained. The layout of the experiment and harvesting particulars are given in Table 27.

Growth of fingerlings of _C_. _striatus_ in aquaria:

To assess the response of the common murrel to fresh silkworm pupae as feed, (Murugesan and Kumariah,1976) conducted experiments with fingerlings (54.3 to 107.1 mm) in aquaria (size 60 x 30 x 30 cm) having 25 l. water, feeding the stock with fresh trash fish or fresh silkworm pupae. The details of experiment are presented in Table 28.

∠ The swamp was manured with raw cowdung at the rate of 1000 kg $ha^{-1}$ $month^{-1}$

Air breathing fishes are well suited for culture in paddy fields. Iyengar (1953) successfully demonstrated the culture of *C. striatus* in rice fields with a production of 112 kg $ha^{-1}$ in addition to the 10% increase in the rice yield.

In Malayasia, Lee Chain Lui (1972) obtained a yield of 1 300 kg $ha^{-1}$ $year^{-1}$ when schooling fry were stocked at the rate of 7 500 $ha^{-1}$. The food conversion coefficient was 12.2.

The experiments briefly reviewed about on the culture of *C. striatus* in swamps and ponds although preliminary in nature, clearly indicate that this species can be profitably cultured in such water bodies. However, more replicated experiments need be conducted for standardization of the culture techniques and determine the precise economics.

## TABLE - 25

Layout of the experiments on the culture of *C. striatus* in swampy pond

| Pond | Area (ha) | Rate of stocking of trash fishes (No/ha$^{-1}$) | Fertilization with | | Initial size (X) | | Rate of stocking (No/ha$^{-1}$) |
|---|---|---|---|---|---|---|---|
| | | | cowdung kg ha$^{-1}$ month$^{-1}$ | lime kg ha$^{-1}$ month$^{-1}$ | length (mm) | Weight (g) | |
| 1 | 0.0420 | 50 000 | Nil | Nil | 44.0 | 0.800 | 50 000 |
| 2 | - do - | 20 000 | Nil | Nil | 43.0 | 1.034 | 20 000 |
| 3 | 0.0285 | 50 000 | 1 000 | 100 | 44.0 | 0.800 | 50 000 |
| 4 | 0.0285 | 50 000 | 1 000 | 100 | 44.0 | 0.800 | 50 000 |
| 5 | 0.0285 | 20 000 | 1 000 | 100 | 48.0 | 1.034 | 20 000 |
| 6 | 0.0285 | 20 000 | 1 000 | 100 | 48.0 | 1.034 | 20 000 |

## TABLE - 26

Survival percentage and production of *C. striatus* from swampy ponds

| Pond | Survival of *C. striatus* (%) | *C.* production kg of | | Total production *C.* (kg ha$^{-1}$ year$^{-1}$) |
|---|---|---|---|---|
| | | trash fishes | murrels | |
| 1 | 1.3 | 30.5 | 128.7 | 159.2 |
| 2 | 5.7 | 50.0 | 145.6 | 195.6 |
| 3 | 5.2 | 114.0 | 713.1 | 827.1 |
| 4 | 11.7 | 431.7 | 894.8 | 1 326.5 |
| 5 | 41.0 | 291.3 | 797.9 | 1 088.7 |
| 6 | 11.9 | 301.9 | 772.2 | 1 074.1 |

## TABLE- 27

Stocking density, growth and production of air breathing fishes in a derelict pond (area: 0.15 ha)

| Species | Actual number stocked | Density of stocking No.ha$^{-1}$ | Initial size ($\bar{x}$) length (mm) | Initial size ($\bar{x}$) weight (g) | Total weight (kg) | Feed | Culture period (months) | Final size range length (mm) | Final size range weight (g) | Growth % | Total fish harvested |
|---|---|---|---|---|---|---|---|---|---|---|---|
| *C. striatus* | 5 000 | | 47.2 | 0.925 | 4.625 | Trash fish | | 195-221 | 85-750 | 5.86 | 65.915 |
| *H. fossilis* | 1 000 | 42 000 | 63.8 | 3.733 | 3.733 | GNC & RB | 12 | 115-275 | 10-150 | 32.00 | 32.910 |
| *C. batrachus* | 300 | | 64.9 | 2.465 | 6.738 | -do- | | 145-300 | 35-245 | 11.66 | 21.090 |
| | | | | | | | | | | | 119.975 |
| | | | | | | | | | | | Approx. 120 kg |

GNC = ground nut cake; RB = rice bran

IDENTITY

1.1. Taxonomy

1.1.1 Definition

Phylum Vertebrate
Subphylum Craniata
Superclass Gnathostoma
Series Pisces
Class Teleostomi
Subclass Actinopterygii
Order Channiformes (Ophicephaliformes)
Family Channidae (Ophicephalidae)
Genus Channa 1763
Species Channa punctatus (Bloch, 1793)
(Fig. 15)

Over 15 species of fishes belonging to the genus Channa have been reported from Asia and Africa. One among them is C. punctatus which is fairly well distributed in Asia. It does not attain a large size.

1.1.2 Description

Genus Channa Gronovius, 1763

See 1.1.2 of C. marulius

Species Channa punctatus (Bloch, 1793)

Head 3.3 to 3.7, caudal fin 5.3 to 6.3, depth 5.5 to 7 in total length; eyes 7 to 8.5 in head; lower jaw larger; maxilla reach below or behind the hind border of eye; cephalic pits simple. Teeth : Lower jaw with a posterior row of 4 to 5 conical teeth; upper jaw, vomers and palatines with widely separated conical teeth. Fins : Pectorals reach the origin of anal; ventrals three-fourths as long as the pectoral; dorsals three-fourth as high as the body and little higher than the anal. Scales : Five rows of scales between eye and angle of preopercle; predorsal scales 12. Lateral line with a slight bend over the fourth anal ray. Colour : Generally grayiahttocdark grey dorsally, becoming yellow or pale on the abdomen; a dark stripe laterally on the head; several short cross bands from the dorsum of the body downward; fins spotted; the caudal and vertical ones have a light edge and a dark basal band; ventrals pale grey; scattered black spots all over the body.

1.2 Nomenclature

Valid scientific name

1.2.1 Channa punctatus (Bloch, 1793)

See 1.2.1 of C. marulius.

1.2.2 Synonyms

Channa punctatus (Bloch, 1793).

Ophiocephalus punctatus Bloch, Naturg. Ausland. Fische., p. 139, pl. 358, 1793; type locality; Coromandel coast. Jerdon, Madras J. Lit. & Sci., 15, p. 145, 1848. Bleeker, Verh. Bat. Gen., 25, p. 42, 1853. Gunther, Catal. Fish. Brit. Mus., 3, p. 469, 1861. Day, Fish. Malabar, p. 151, 1865, Day, Fish. India, 1 & 2, p. 367-8, pl. 78, fig. 1, 1876. Day, Fauna Brit. India, Fish., 2, p. 364-5, 1889. Regan, Rec. Indian Mus., 1, p. 158, 1949. Shaw and Shebbeare, J. Asiat. Soc. Sci., 3, p. 123, fig. 125, pl. 4, fig. 1, 1937. Hora, Rec. Indian Mus., 47, p. 235, 1949.

Ophiocephalus karrouvei Lacepede, Hist. Nat. Poiss., 3, p. 552, 1802; type locality : Tranquebar.

Ophicephalus lata Hamilton, Fish. Ganges, pp. 63, 367, pl. 34, fig. 18, 1822; type locality : R. Ganges.

Ophicephalus affinis Gunther, Catal. Fish. Brit. Mus., 3 p. 470, 1861; type locality : Mauritius ( ? ).

Channa punctatus Menon, Rec. Indian Mus., 52, p. 235, 1954. Misra, Rec. Indian Mus; 57(1-4), p. 219, 1959.

D. 29-32, p. 17, W. 6, A. 21-23, C. 12, L.l. 34-40, L.tr. $\frac{4}{9}$

1.2.3 Standard common names, vernacular names
(see table 29)

1.3 General variability

1.3.1 Subspecific fragmentation (races, varieties, hybrids)

No races, varieties and hybrids of the spotted murrel have been reported.

1.3.2 Genetic data

(Chromosome number, protein specificity)

Information on chromosome number and protein specificity of C. punctatus is not available.

Khan et al. (1969) have reported the differential blood cell counts of the spotted murrel. Formation of blood cells in the species has been studied by Sabris and Rangnekar (1962) and the chemical composition of the flesh, by Siddiqui and Siddiqui (1969, a, b). Shastri (1972) investigated the aminotriphosphadase activity in the species and Belsare (1962 a, 1962 b, 1963a and 1966) the development of endrocrine Glands and Belsare et al. (1960), the effect of thiourea and thyroxine on the larvae. Effect of copper acetate and asphalt on gonadial activity and preoptic nucleus of the common pond murrel have been studied by Khosla and Chandrasekhar (1972) while the lethal temperature has been investigated by Das (1945).

2. Distribution

2.1 Total area

C. punctatus has natural distribution in India, Pakistan, Bangla Desh, Burma, Sri Lanka, Malaysia, Thailand, Tahiti and Polynesia. In India it is found in freshwaters of the Punjab, Haryana, Uttar Pradesh, Bihar, Maharastra, Gujarat, Orissa, West Bengal, Assam, Andhra Pradesh, Karnataka, Tamil Nadu and Kerala (Parameswaran, 1975).

The species is found in lotic and lentic freshwaters such as rivers, lakes, reservoirs, tanks, ponds, swamps, canals and paddy fields. ossession of accessory respiratory organ enables it to thrive in weed infested, shallow and oxygen depleted waters (Das, 1940 and Parameswaran, 1975).

The spotted murrel fry (21.3 mm size) can withstand a salinity of 5 ppt on direct transfer and up to 8 ppt on gradual acclimation, without any mortality (Murugesan et al. 1979).

2.2.1 Areas occupied by eggs, larvae, and other junior stages : annual variations in these patterns and seasonal variations for stages persisting over two or more seasons.

C. punctatus has been reported to construct a cup-like nest in between aquatic vegetation (Willey, 1908 and Raj, 1916). However, Parameswaran (1975) and Parameswaran and Murugesan (1976 b), who surveyed a large number of derelict tanks and ponds in Karnataka State during the breeding season of murrels did not come across any constructed nests. According to these authors, the spotted murrel lays its eggs in a clear area in shallow weed infested margins of water bodies, formed in the process of active spawning movement of the breeders. The surrounding weeds help to hold the floating eggs together without getting dispersed by wind action. The fish also spawns in weed free waters and even puddles (Alikunhi, 1957; Parameswaran, 1975 and Parameswaran and Murugesan, 1976 b).

Both parents of th common pond murrel look after the eggs and fry, (Willey, 1908; Raj, 1976; Alikunhi, 1957 and Qayyum and Qasim, 1962). Qayyum and Qasim (1962) have given detailed account of the brood care of the species. The schooling tendency and brood care cease when the young ones attain a size of 35 to 37 mm (Qayyum and Qasim, 1962; Parameswaran, 1975 and Parameswaran and Murugesan, 1976 b). Like these of other murrels, the fry and fingerlings are surface and column dwellers while the juveniles are column and shallow bottom dwellers.

Parameswaran and Murugesan (1976 b) have studied the distribution in time and space and the seed index through months of C. punctatus in derelict tanks in the Malnad region of Karnataka.

# 3. BIONOMICS AND LIFE HISTORY

## 3.1 Reproduction

### 3.1.1 Sexuality, hermaphroditism, hetereosexuality, Intersexuality.

The spotted murrel is heterosexual although a freak hermaphrodite has been reported (Dutt and Reddy, 1977). The sexes can be distinguished in the species during the breeding season vide characters given in Table 30.

### 3.1.2 Maturity (age and size) :

C. punctatus attains maturity in the first year, at a size of 103 to 105 mm in the Malnad region of Karnataka (Parameswaran, 1975) and 110 mm in Uttar Pradesh (Qayyum and Qasim, 1962).

### 3.1.3 Mating (Monogamous, polygamous, promiscuous)

Mating is preceded by an elaborate courtship, the female activity chased by the males. Only a single male pairs with the female. It hits the female near the vent region frequently and at times nibbles its snout (Parameswaran and Murugesan, 1976 a).

### 3.1.4 Fertilization

Fertilization is external, the male fertilizing the eggs with its milt when the eggs are extruded by the female.

### 3.1.5 Fecundity

Day (1878) reported 4 700 ova in a specimen of the spotted murrel. Qasim and Qayyum (1961, 1962) found that the fecundity of the species of size 120 to 300 mm from ponds in Uttar Pradesh ranged from 2 360 to 29 690. Parameswaran (1975) reported that the fecundity of the species in the size range 122 mm/23 g to 297 mm/205 g varied from 2 477 to 25 483. According to him the number of eggs $g^{-1}$ weight of the fish ranged from 778 to 1 172 ($\bar{x}$ : 1 124).

Qasim and Qayyum (1963) obtained the following relationships between fecundity (F) and length (L in mm), weight (W in g) and gonad weight (GW in g) of *C. punctatus* :

$$F = 5.969\ L^{2.5516} \quad \ldots\ldots\ldots\ldots\ (1)$$

$$F = 257.6\ W^{0.8469} \quad \ldots\ldots\ldots\ldots\ (2)$$

$$F = 1823\ GW^{0.9612} \quad \ldots\ldots\ldots\ldots\ (3)$$

(Fig 16)

The fecundity (F) - length (L in mm)/weight (W in g) relationships of the species computed by Parameswaran (1975) were as follows :-

$$F = 0.0004901\ L\ 3.38183 \quad \ldots\ldots\ldots\ldots\ (4)$$

$$F = 83.75\ W^{1.07501} \quad \ldots\ldots\ldots\ldots\ (5)$$

The mature group of eggs of the spotted murrel vary from 0.75 to 1.15 mm in diameter (Qasim and Qayyum, 1961 and Parameswaran, 1975).

3.1.6 Spawning season

In Malnad region of Karnataka, Parameswaran (1975) and Parameswaran and Murugesan (1976 b) observed that the spotted murrel breeds from early May to late August, with the peak in June and July. It spawns during June to August in Bengal (Mookerjee, 1946) and from June to October in Central India (Qasim and Qayyum, 1961; 1963 and Qayyum and Qasim, 1964). In Telengana (Andhra Pradesh) the fish breeds throughout the year (Hosaini and Rahimulla, 1946), while in Tamil Nadu it has two breeding seasons, during January - February and July-August (Raj, 1916). According to Jones (1946 a), the fish spawns only during August and September in Tamil Nadu. In Sri Lanka its spawning season is during April and May (Willey, 1908).

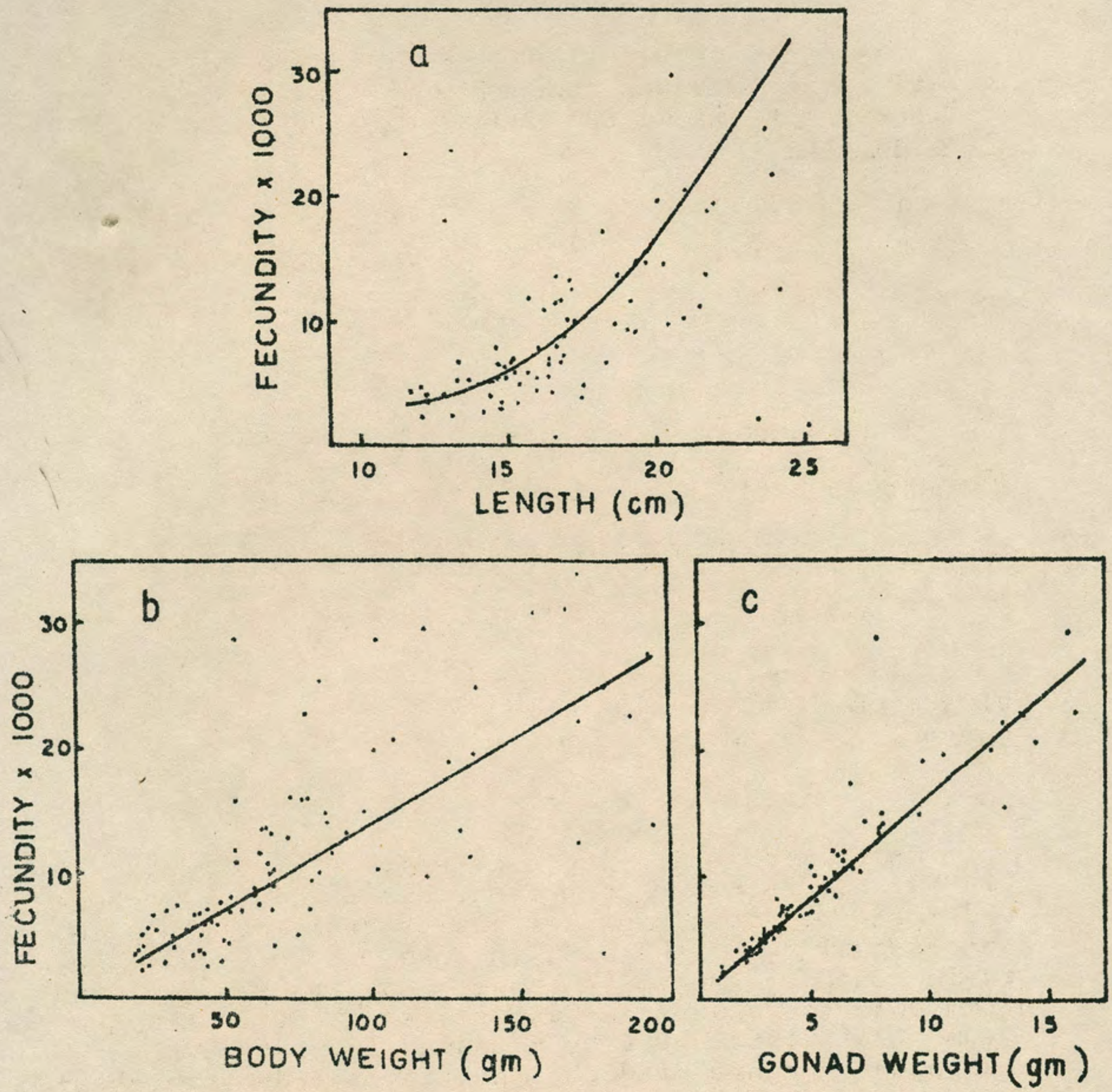


FIG. 16. Fecundity fish length (a) fish weight (b) gonad weight (c) relationship of C. punctatus (from Qasim and Qayyum, 1963)

Belsare (1962 c, 1966) has studied the development of the gonads and seasonal changes in the ovaries of the spotted murrel. Ova diameter frequency polygone of C. punctatus developed by Qasim and Qayyum (1961) and Parameswaran (1975) indicated that there are distinct groups of ova in the mature ovary, suggesting that the species may breed more than once in the spawning season. Parameswaran and Murugesan (1976 a) confirmed this by successfully hypophysing the female of the allied species C. striatus twice during the same breeding season in within 75 to 142 days.

Induced spawning

Banerje (1974) and Parameswaran and Murugesan (1976 a) induced the spotted murrel to spawn by hypophysation, using carp pituitary glands. Successful spawning was reported by Banerji (1974) with a single dose of 16 to 34 mg $kg^{-1}$ *to the male. The author observed that males with subdued ripeness required higher gonadotrophic stimulation for spawning. Parameswaran and Murugesan (1976 a) administered the hormones in two instalments, an initial dose of 5 to 10 mg and final dose of 10 to 160 mg $kg^{-1}$ female. The males received the hormones in one or two doses, amounting to 5 to 100 mg pituitary gland $kg^{-1}$ body weight of the fish. The interval between the two injection was 4 to 5 hr.

Banerje (1974) reported that spawning took place in C. punctatus 6 to 25 hr after hormone injection. Parameswaran and Murugesan (1976 a) who conducted breeding experiments in B.R. Project (Karnataka) and Tanjavur (Tamil Nadu) found that the female in the case of all successful spawnings, paired with a single male, 1 to 4 hr after the second injection. Spawning was preceded by active, excited movement of the paired breeders, which commenced about 9 to 14 hr after the second injection. The male was found to hit the female near the vent region frequently and at times nibble its snout. This activity continued till the spawning was completed, which took about 15 to 45 min. The unpaired males remained passive in a corner of the breeding container.

* body weight to the female and 29 - 53 mg $kg^{-1}$

Of the 8 sets of the spotted murrel hypophysed by Banerji (1974), successful spawning took place in 4, and ovulation (without fertilization) in another two sets. The water temperature in the breeding containers ranged from 26 to 29°C.

Of the 22 sets of the spotted murrel hypophysed by Parameswaran and Murugesan (1976 a), 17 spawned, The fertilization of eggs varied from 27.9 to 100%.

3.1.7 Spawning grounds

The spotted murrel spawns in all types of freshwater habitats such as rivers, lakes, reservoirs, swamps, bheels. Jheels, tanks, ponds, paddy fields and even puddles (Parameswaran, 1975).

3.1.8 Eggs : structure, size, type parasites

The embryonic and larval development of *C. punctatus* has been studied by Banerji (1974). The fertilized eggs are spherical, monadhesive, buoyant and straw yellow in else colour. They have an oil globule which may disintegrate into 5 to 6 smaller oil globules of unequal size. The diameter of the egg shell is 1.207 mm, while the egg proper measure 0.901 mm. The eggs swell up after being laid.

Also please see 3.1.8 of *C. marulius*, para 1.

3.2 Larval history (Fig. 17)

3.2.1 Account of embryonic and juvenile life (prolava, post larva and juvenile)

The cleavage of the fertilized egg is meroblastic. The sequence of embryonic development is given in Table 31.

The period of incubation at a temperature range of 26.5 to 28.0°C is 24 to 45 hr.

The larval and post-larval developmental sequence is listed in Table 32 and illustrated in Fig. 18. Areal respiration commences when the fry are 7.2 mm in length. The ventral fins are differentiated on the 23rd day when the fry measure 14 mm and scales appear on the body on the 26th day, when they are 18 mm long.

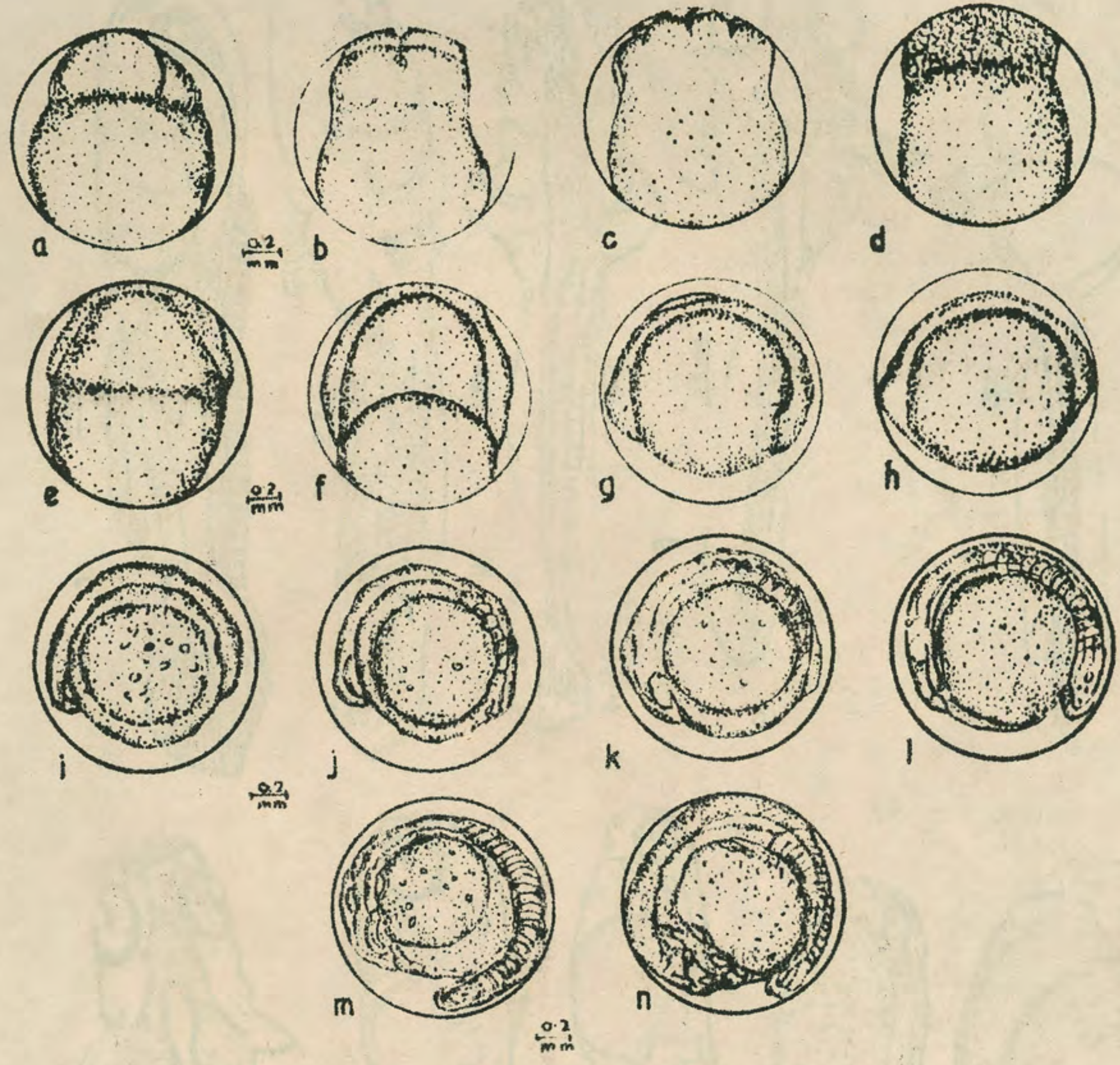


Fig.17. Embryonic development of C. punctatus.
(a) 2 celled stage. (b) 4 celled stage.
(c) 8 celled stage. (d) morula stage. (e) 3 hours old.
(f) 4 hours old. (g) 5 hours old. (h) 8 hours old.
(i) 10 hours old. (j) 14 hours old. (k) 16 hours old.
(l) 18 hours old. (m) 20 hours old. (n) 22 hours old.
(from Banerji, 1974).

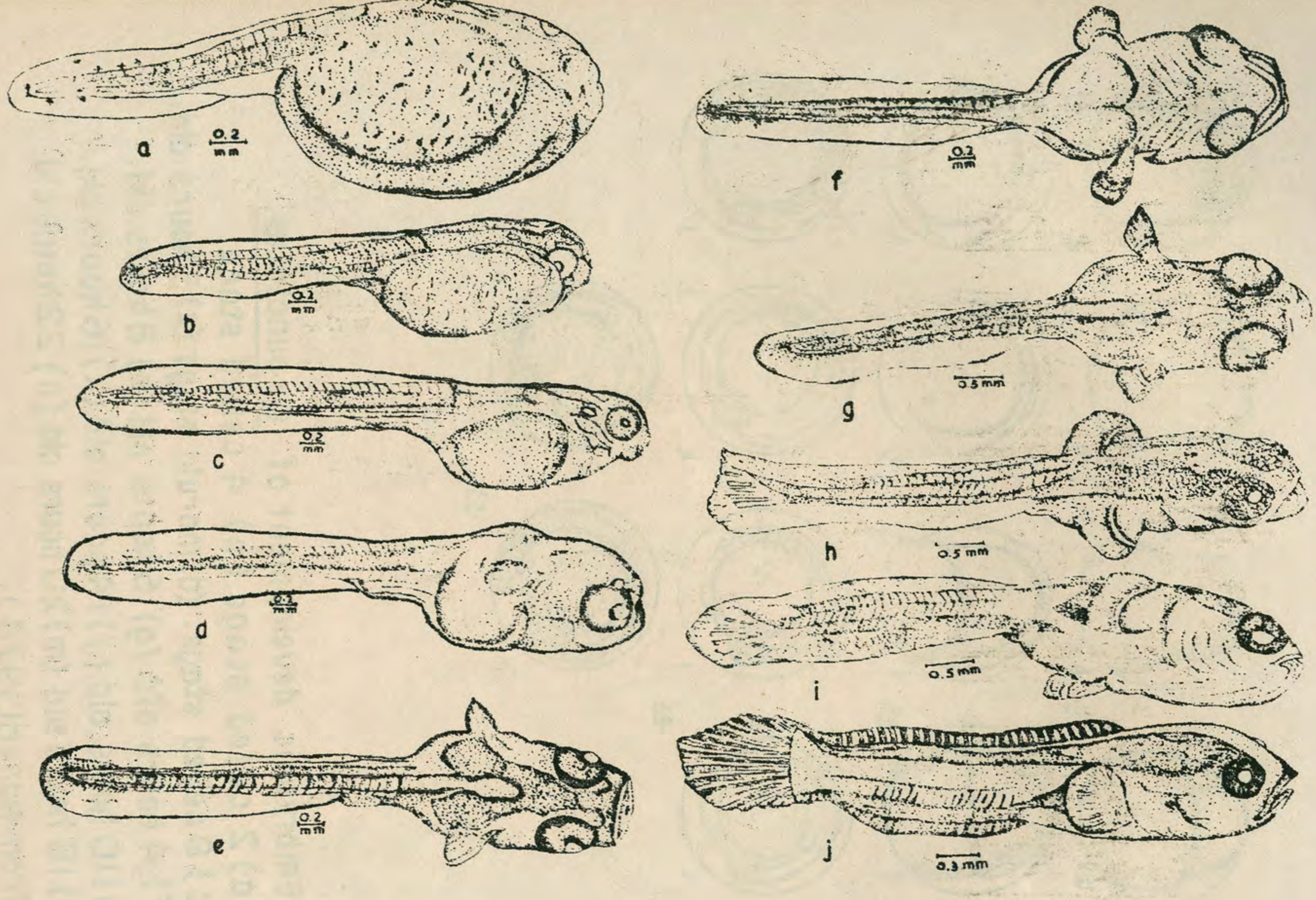


Fig.18 Larval and post-larval development of C. punctatus (from Banerji, 1974)
Larva (a) just hatched, (b) 8hr old, (c) 24 hr old, (d) 36 hr old,
(e) two days old; post-larva (f) 3 days old, (g) 6 days old,

TABLE- 28

Feeding experiments with fingerlings of C. striatus (No.of fingerlings in each aquaria 5; Duration of experiment:10 days)

| Feed | Quantity of food given (g $day^{-1}$) | Initial size ($\bar{x}$) length (mm) | Initial size ($\bar{x}$) weight (g) | Final size ($\bar{x}$) length (mm) | Final size ($\bar{x}$) weight (g) |
|---|---|---|---|---|---|
| FTF | 1.250 | 54.3 | 1.385 | 65.8 | 2.375 |
| FSWP | 1.250 | 54.3 | 1.385 | 62.4 | 1.860 |
| FTF | 1.500 | 72.4 | 3.000 | 81.6 | 3.805 |
| FSWP | 1.500 | 72.4 | 3.000 | 75.9 | 3.410 |
| FTF | 2.000 | 107.1 | 9.440 | 115.7 | 11.645 |
| FSWP | 2.000 | 107.1 | 9.440 | 101.2 | 8.120 |

FTF = Fresh Trash Fish  L = length
FSWP = Fresh silk worm pupae wt = weight

TABLE- 29

Standard common names, vernacular names of C. punctatus

| Country | Standard common names | Vernacular names |
|---|---|---|
| Sri Lanka | Common pond murrel, spotted murrel, Green snake head | mada ara, made kanaya, mada kariya, madaya, korruvaI |
| Burma | | nga panau |
| Pakistan | | dulooga, daula |
| India | | korava, kuchi, belikorava(Kannada) phool dhok (Hindi) korava, patti (Tamil) kavichal, arracan (Malayalam) mittu, mattagidasa, kodhadhalu, curru meenu, mutta (Telugu) taki, lata (Bengali) gorrisa, gurrie, cattus gorai (Oriya and Assamese) dulooga, daula (Punjabi) |

TABLE- 30 : Sexual dimorphism in *C. punctatus* during breeding season (from Parameswaran, 1975)

| Male | Female |
|---|---|
| 1. No bulging of abdomen | 1. Conspicuously bulging abdomen |
| 2. Numerous minute black dots on the dark vertical bands; once developed, they persist throughout the year | 2. Diffused, dark blotches on the vertical bands; a few minute black dots may or may not be present; once developed, they persist through the year |
| 3. Vent oblong and pale with brown to dark periphary; a pinkish dot may be present at the centre | 3. Vent round, slightly protruding and reddish |

TABLE- 31 : Embryonic development of *C. punctatus* (after Banerji, 1974)

| Time after fertilization (hr) | Developmental features (water temperature,26.5/ 28.0°C) |
|---|---|
| 0-45 | 4 to 16 celled stages |
| 2-45 | Blastula stage |
| 4-00 | Germinal ring formed |
| 5-30 | Embryonic shield formed. More than half the yolk invaded, anterio-posterior differentiation evident |
| 9-00 | Yolk invasion complete but for the yolk plug |
| 10-00 | Cephalic region broader with distinct forebrain |
| 11-30 | Two myotomes and optic cup formed |
| 14-00 | Six myotomes formed; notochord laid |
| 16-10 | Nine myotomes present; fore-, mid- and hind-brain indicated; cephalic region broadened |
| 17-00 | 13 to 15 myotomes laid; lens formed in the rudimentary eyes tip of the tail free; Kupffer's vesicle visible, embryonic in-fold formed. |
| 20-00 | 22 myotomes present; lens fully formed in the eye olfactory vesicle indicated; heart formed and blood circulation commenced. Heart beats at the rate of 144 to 150 $min^{-1}$; a few melanophores appear over the yolksac |
| 22-00 | The embryo encircles the whole of yolk and fills the entire egg capsule; olfactory pits and the concretions on, the auditory vesicles formed; blood colourless Kupffer's vesicle has diappeared; Heart beats at the rate of 180 $min^{-1}$; a few melanophores have appeared all over the body). |
| 24-00 | Embryos begin hatching out |

TABLE- 32: Larval and post-larval development of *C. punctatus* (after Banerji, 1974)

| Days after hatching | Length (mm) | Characters |
|---|---|---|
| Larva just hatched | 2.7 | Maximum depth 1.1 mm; heavy ovoid yolk sac, moves with ventral side up; clings to submerged roots etc. dark brown colour |
| 1 | 4.3 | 32 myotomes; buccal invagination, pectoral fin buds and swim bladder formed; eyes pigmented |
| 2 | 4.6 | Pectoral fins paddle-shaped; mouth formed with well developed lower jaw, and two teeth in each jaw; vent and gill rudiments formed- yolksae vestegial; a thick band of melanophores run from the post-orbital region to base of pectoral distribution of melanophores on the dorso-lateral region leaves clear roundish patch between orbitals and another avoid patch on dorsum; has commenced feeding |
| Post larva 3 | 5.0 | The pectoral fins vascularized; opercul are membranous; yolk is fully absorbed; abdomen heart- shaped when viewed from ventral side; the pigment-free patch on the nape is lanceolate |
| 6 | 5.2 | Yellow pigments on the dorsal and lateral sides appear as bands |
| 8 | 5.3 | The colour pattern is in the form of alternating lemon yellow and dark bands; an yellow band on the dorsal side with a diamond shaped broadening at the nape; yellow band laterally, between two dark lines; lemon yellow patch on the tail, ventrally rudiments of rays in the caudal fin |
| 15 | 6.3 | Dorsal contour of the head convex; dark and yellow bands prominent, Caudal fin dark along margin with bright yellow blotch in the middle; silver and greenish pigments appear on the orbit rim and post-orbital region; basal thickenings appear on the dorsal and ventral fin folds, eight caudal rays, the middle ones with articulation |
| 20 | 7.2 | Fry assumes adult characters except for colouration, 14, 19, 25 and 17 rays in the caudal, anal, dorsal and pectoral fins respectively; anal and dorsal fins are continuous with the caudal by narrow flanges; ventral fin not yet appeared; fry have characteristic irridescent lemon yellow and dull longitudinal black bands |

- Feeding

Mookerjee ~~et al.~~ (1946) reported that the fry of the spotted murrel in the size range 4.0 to 5.5mm feed exclusively on unicellular and multicelluar algae while those of 5.5 to 15 mm size feed on algae (70.9%) and zooplankton (29.1%; mainly protozoans). According to these authors 15 to 79 mm long fry subsist essentially on the same diet with preference for protozoans and crustaceans while insects (mayfly, dragonfly and chironomid and mosquito larvae) form a minor component.

According to Alikunhi (1957), young ones of C. punctatus feed almost exclusively on planktonic crustacea and insects. The gut contents of 62 post-larvae (7 to 34 mm) of C. punctatus analyzed by Qayyum and Qasim (1962 to 1964) indicated that their food consists of zooplankton, mainly copepods, crustacean larvae, rotifers and daphinids. These authors found that aquatic insects (belonging to Diptera, Hemiptera, Odonata, Ephameroptera and Coleoptera) constituted the main food of the larger specimens (35 to 99 mm), Corixa, Notonecta and their nymphs forming the bulk. In addition, small quantities of fish were also encountered. The gut contents of smaller fish consisted of copepods, daphnids and rotifers.

Parameswaran (1975) observed that post-larvae of the spotted murrel in the size range 5 to 15 mm feed almost exclusively on zooplankton (97.3%), mainly cladocerans and rotifers the yest of the diet constituted by phytoplankton. The stomach contents of the larger post-larvae (16 to 30 mm) was also predominantly constituted by zooplankton (75.5%; copepods, cladocerans and rotifers, in that order) and small aquatic insects (22.7%; mainly Anisops sp.). Juveniles (31 to 50 mm) showed an increasing preference for aquatic insects (51.0%; mainly, Anisops sp.), followed by zooplankton (46.1%, mainly copepods) and small shrimps (2.9%). In adolescents (51 to 100 mm), the antamophagous habit becomes more pronounced, 62.3% of the stomach contents constituted by aquatic insects and their larvae (mainly Anisops sp.) and occasionally gyrinids, hydrophilids and nymphs of dragonfly, damelfly and mayfly. In addition, zooplankton (18.9%; mostly copepods), shrimps (14.3%) and annilid worms (4.5) were also recorded.

The food habits of the fry, juvenile and adolescent stages of C. punctatus indicate that in these stages it is mainly a column and surface feeder.

Rates of development and survival

The low fecundity of the spotted murrel is compensated by the parental care of the eggs and fry, ensuring lesser predation and higher survival (Parameswaran, 1975).

High mortality is observed in embryonic and larval developmental stages of C. punctatus (obtained by hypophysation or from natural collections) when reared in laboratory and in the field. The mortality can be considerably reduced by transferring the developing eggs/larvae to shallow basins and by arranging slow dripping of water in the containers as suggested by Alikunhi (1963). The hatching technique has been further simplied and the mortality reduced to less than 5 to 10% by holding the eggs under oxygen packing till hatching and the hatchings till yolk absorption (Parameswaran and Murugesan, 1976a).

Not being a normally cultivated fish, practically no information is available on the survival rate of the spawn fry and fingerlings of C. punctatus in various types of habitats. However, the survival of the species is generally considered to be low because of cannibalism and the specialized feeding habits in the early stages (Parameswaran, 1975).

- Parental care

See 2.2.1

- Parasites and predators

Fungal infection of developing eggs and fin rot on the fry and fingerlings are occasionally encountered. Infection by Lernaea sp. and Argulus sp. have also been reported from swamps and tanks (Parameswaran, 1975).

Yolked larvae are very sectible to attack by Cyclops spp. The fry are attacked, especially in the absence of the parents guarding them, by aquatic insects and trash fishes. Cannibalism also is observed in the species during the post-larval and juvenile stages.

3.3. Adult history

3.3.1 Longivity

Ageing of the common pond murrel from ponds in Uttar Pradesh was done by Qasim and Bhatt (1964) by the study of the growth checks on opercular bones and scales and they recognized up to 6+ age groups. Parameswaran (1975) studied the age of the species from swamps in Karnataka by probability analysis of length data and by examination of the growth checks on the opercular bones and scales and encountered specimens up to six years in age.

### 3.3.2 Hardiness

The possession of accessory respiratory organ and modified blood physiology enable the spotted murrel to thrive in oxygen depleted and mildly polluted waters. These adoptation also enable the species to survive in shallow swamps which partially dry up during the summer months. They can stay alive for considerable time on moist land. During the monsoons, they migrate from one pond to other, negotiating moist land. Since the aquatic respiratory faculty is poorly develops in the species, the fish dies due to asphyxia, if not allowed to breathe air (Das, 1940).

However, in spite of their capacity to breathe atmospheric air, the fry and fingerlings of the common pond murrel are somewhat delicate and cannot withstand handling and are prone to injury and infection, unlike those of carps (Parameswaran, 1975).

### 3.3.3 Competitors

The fry stages of the spotted murrel being zooplanktophagous like those of other fishes and adult stages of fishes like catla (<u>Catla catla</u>) and several species of minor carps, minnows and clupecids with similar feeding habits, competes with them for food. The adolescents and adults being minor predators, subsisting on aquatic insects, shrimps and trash fishes, other minor predators like <u>N. notopterus</u>, <u>A. testudineus</u> and <u>O. bimaculatus</u> compete for food with the species.

### 3.3.4 Predators

Larger murrels like <u>C. marulius</u> and <u>C. striatus</u> and other predators like <u>W. attu</u>, <u>M. aor</u>, <u>M. seenghala</u> and <u>N. chitala</u> and fish eating birds prey on the spotted murrel.

3.3.5 Parasite and diseases

Specimens of the spotted murrel having fungal fin-rot and dropsy are occasionally come across. Varying degrees of infection with the crustacean parasites Argulus sp. and Lernaea sp. have also been encountered, although rarely (Parameswaran, 1975). Hassan and Qasim (1962) have described a new species of Trypanosoma (T. punctatus) from C. punctatus. A specimen of the species suffering from toxic hapatitis and primary testicular neoplasia and as a result, extreme, emaciation has been described by Murugesan and Kumaraiah (1982).

3.3.6 Greatest size

Table 33 gives the maximum size attained by the species according to various authors.

Table 33 - Maximum size attained by C. punctatus

| Authority | Maximum size (mm) |
|---|---|
| Day (1878, 1889) | 305 |
| Alikunhi (1957) | 305 |
| Qasim and Qayyum (1961) | 297 |
| Hora and Pillay (1962) | 300 |
| Parameswaran (1975) | 330 |
| Murugesan and Kumaraiah (1978) | 285 |

3.4 Nutrition and growth

3.4.1 Feeding (time, place, manner and season)

The spotted murrel being a predator, feeds on the surface, column and shallow bottom of the water body. The fish caught in the early morning have mostly empty stomachs, indicating that the species is a sight feeder and that the feeding activity is mostly during day time.

Qayyum and Qasim (1964) examined the gut contents of 1 047 C. punctatus in the size range 100 to 297 mm from ponds of which only 895 were found to contain food. Fig 19, shows the percentage occurence of the various feeds through months in the gut contents. Throughout the year, fishes constituted the major constituent of the gut contents, followed by insects, miscellaneous organisms and crustaceans. The fishes commonly encountered were Puntius stigma, Esomus danricus, Trichogaster chuna, Amblypharyngodon mola, Mystus tengara and Ompok pabda, while the insects included Corixa, Notonecta, Gerris, draganfly nymphs, Dytiscus and chironomid larvae, Gastropod shells were consistantly encountered in small quantities.

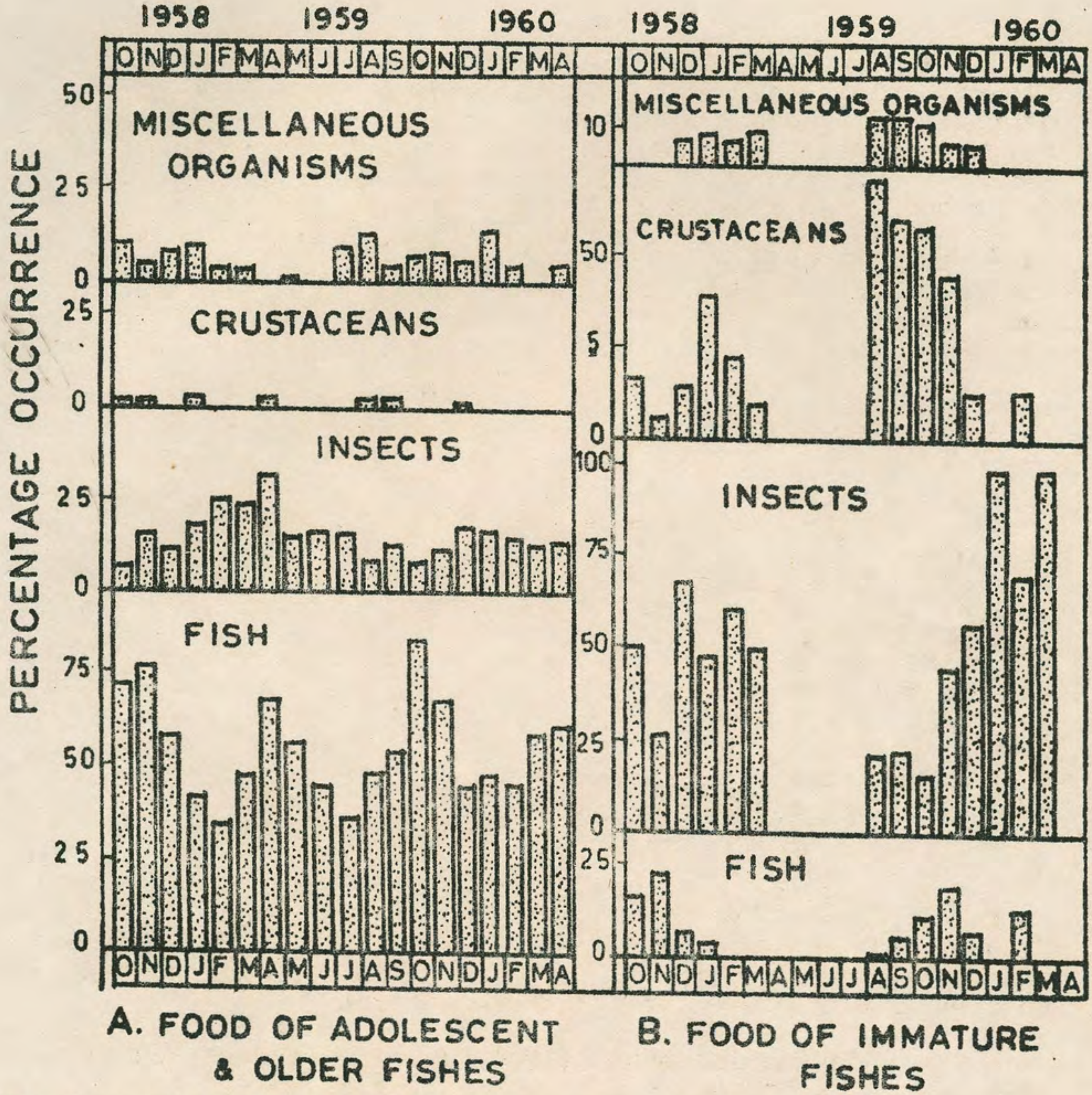


FIG. 19. Histograms showing the percentage occurrence of principal items of food of C. punctatus in different months (from Qayyum and Qasim, 1964).

Parameswaran (1975) found that aquatic insects (Anisops spp. Corixa sp. and Gerris sp., gyrinids, Dytiscus sp. Cybister sp. hydrophilids and nymphs of dragonfly, damselfly and mayfly formed the major component of the food (66.9%) of the spotted murrel in the size range 101 to 200 mm. Shrimps were the next constituent (19.6%), followed by fishes (carp minnows and other trash fishes). Other (minor) items in the guts included annelid worms, tadpoles and gastropods. In the diet of the larger adults (201 to 300 mm), the proportion of aquatic insects (51.1%) and shrimps (9.2%) decreased with an increase in that of fishes (33.6%) and gastropods (Amnicola sp., Viviparus sp., Lymnaea sp., Gyralus sp. and Melanoides sp.).

Alikunhi (1957) has reported that the common pond murrel feeds on small fishes, aquatic insects, microcrustacea, shrimps and occasionally, molluscs.

Menon and Chacko (1958) observed that C. punctatus feeds on filamentous algae, molluscs such as Indoplanorbis sp. and Melanoides sp. and worms like Nais and remarked that it is a bottom browser, which is in conflict with the observations of other workers.

Reddy (1980) who studied the gut contents of 2 028 spotted murrel in the size range 65 to 291 mm from commercial catches in Andhra Pradesh found that the species subsisted mainly on trash fishes (index of preponderance: 73.3 to 96.8), followed by acquatic insects (index of preponderance: 0.3 to 24.9) and small quantities of Crustacea, vegetation, frogs and molluscs.

From the data on the percentage composition of empty guts, gastrosomatic index and percentage of fullness of the adult fish through months, Parameswaran (1975) found that the feeding activity of C. punctatus is high during February to April and August to October and that it slackens during May to July (mature months) and November to January (winter months).

### 3.4.2 Relative and absolute growth patterns and rates

Compared to C. marulius and C. striatus, the growth rate of C. punctatus is slow. The maximum size recorded in C. punctatus is 285 mm/230 g, 261 mm/210 g and 257/180 g in tanks, reservoirs and rivers respectively

(Murugesan and Kumaraiah, 1978 a). However, the spocies attained a size ranging from 185 to 225 mm in length weighing 65-120 g in 7 months in a derelict pond (Murugesan and Kumaraiah, 1978 b) under supplementary feeding.

Qayyum and Qasim (1964) studied the age and growth of the common pond murrel from ponds in Uttar Pradesh, from length frequency data and reported that 1, 2 and 3 year old fish measure 153 to 198, 282 to 232 and 238 to 260 mm.

Qasim and Bhatt (1966) observed alternate opaque and transparent zone in the scale and opercular bones of the spotted murrel and established that the number of narrow transparent zones indicate the age of the fish. These author estimated the lengths at various ages from the growth checks on the scales and opercular bones (figs. 20 and 21) and by fitting von Bertalanffy's (1949, 1957) growth equation to the lengths at ages thus obtained and delineated up to 6+ age groups.

The von Bertalanffy's growth equations derived by Qasim and Bhat (1966) for the two sexes of the spotted murrel are

$$\text{Males} : l_t \text{ (cm)} = 32.35107 \left[1-e^{-0.2817(t+1.9286)}\right] \quad (6)$$

$$\text{Females} : l_t \text{(cm)} = 21.27663\left[1-e^{-0.4504(t + 1.2244)}\right] \quad (7)$$

The lengths at ages in C. punctatus obtained by various methods are given in Table 34 (Qasim and Bhatt, 1966).

Parameswaran (1975) investigated the age and growth of the species from derelict waters in the Malnad region of Karnataka by probability analysis of length frequency data, study of the growth checks on the scales and opecular bones and by fitting von Bertalanffy's growth equation to the lengths at ages obtained from the study of the growth checks on scales. Opercular bones and scales with marginal ring were maximum during July to September, indicating that the rings are laid annually during this period due to breeding stress. For back calculation of length of fish at various annuli on scales, the relation between length of fish (L in mm) and radias of scale (S in mm X 29.5) computed by Parameswaran (1975) is

TABLE- 34

Mean lengths of C. punctatus at different ages obtained from various methods (from Qasim and Bhatt, 1976)

| Age in years | Sex | 0+ | 1 | 1+ | 2 | 2+ | 3 | 3+ | 4 | 4+ | 5 | 5+ | 6 | 6+ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lengths determined from | m | 10.68 | - | 14.77 | - | 17.43 | - | 20.57 | - | 22.41 | - | 24.09 | - | 26.02 |
| Opercular bones (cm) | f | 9.09 | - | 13.71 | - | 16.31 | - | 18.14 | - | 19.09 | - | 20.02 | - | 21.44 |
| Lengths determined from | m | 10.58 | - | 13.66 | - | 17,37 | - | 20.69 | - | 22.84 | - | 25.09 | - | 26.32 |
| Scales (cm) | f | 9.56 | - | 13.57 | - | 16.18 | - | 18.49 | - | 20.36 | - | 20.68 | - | 21.29 |
| Lengths determined from | | | | | | | | | | | | | | |
| Size frequency | - | | | | | | | | | | | | | |
| Distribution (cm) | computed | 10.25 | - | 17.32 | - | 21.65 | - | 24.95 | - | - | - | - | - | - |
| Lengths determined from | m | - | 10.74 | - | 16.22 | - | 17.90 | - | 20.63 | - | 22.59 | - | - | - |
| Back calculations (cm) | f | - | 10.53 | - | 14.82 | - | 15.38 | - | 17.21 | - | 19.21 | - | - | - |
| Lengths determined from | m | 10.42 | - | 14.43 | - | 17,70 | - | 20.38 | - | 22.56 | - | 24.35 | - | 25.81 |
| von Bertalanffy equation (cm) | f | 9.02 | - | 13.46 | - | 16.29 | - | 18.10 | - | 19.25 | - | 19.99 | - | 20.45 |

$$\text{Log } L = 0.3071 + 0.9934 \log \underline{S} \ \ldots\ldots \ (8)$$

The von Bertalanffy's growth equation derived for the species by Parameswaran (1975) is as follows:-

$$l_t(\text{mm}) = 345.7 [1 - e^{-0.1953\,(t + 1.0220)}] \ \ldots\ldots \ (9)$$

The lengths at ages obtained by the various methods by Parameswaran (1975) are given in Table 35.

The length (cm) - weight (g) equations for the two sexes derived by Qasim and Bhatt (1964) were

Males : $\text{Log } \underline{W} = -\ 2.13787 + 3.117 \text{ Log } \underline{L}$ ...... (10)
Females : $\text{Log } \underline{W} = -\ 2.31876 + 3.559 \text{ Log } \underline{L}$ ...... (11)
(Fig.22)

The general and sex-wise length (mm) - weight (g) relationships obtained by Parameswaran (1975) for the spotted murrel were as follows :-

General : $\log \underline{W} = -\ 4.8494 + 2,9348 \log \underline{L}$ ........ (12)
Male : $\log \underline{W} = -\ 5.1610 + 3.0703 \log \underline{L}$ ........ (13)
Female : $\log \underline{W} = -\ 4.4901 + 2.7920 \log \underline{L}$ ........ (14)

The mean weight attained at different ages and the annual and instantaneous growth rate of C. punctatus are given in Table 36 and 37.

Parameswaran (1975) has reported that although relative condition (Kn) of male and female spotted murrel showed fluctuations through various sizes, no correlation between these fluctuations and maturity cycle was avident. The Kn which was minimum in both sexes in December, increased and became maximum during June in Males and July in females.Thereafter the values steadily declined.

3.4.3 .Relation of growth to feeding, to other activities, and to other environmental factors

See Section 3.4.3

## 3.5 Behaviour

### 3.5.1 Migration and local movements

C. punctatus often negotiates short stretches of moist land during the rainy season and migrates to other nearby water bodies. In large water bodies the species moves about short distances for feeding and locating suitable breeding grounds.

3.5.2 Schooling

Unlike the early stages, the adolescents and adults of spotted murrel have no schooling habit.

3.5.3 Reproductive habits

The female C. punctatus pairs with a single male and courtship preceeds spawning. The spawners have been reported to construct a nest by some workers while others have contradicted it. Spawning is preceded by coutship when the fish is induced to breed by hypophysation also (Parameswaran and Murugesan, 1976 a). However, no parental care of the eggs and larvae is observed when the fish are induced to breed, unlike in natural spawning.

4. POPULATION (STOCK)

4.1 Structure

4.1.1 Sex ratio

Qayyum and Qasim (1964) examined the sex of 1 410 specimens of the spotted murrel and found the ratio between male and female to be 1:0.8264, i.e., males are preponderent in the populations. The largest male encountered by them measured 297 mm and female 243 mm. Fish larger then 243 mm were all males. According to Qayyum and Qasim (1964), either the males grow fast or they have a longer life. Qasim and Bhatt (1966), however, found the sex ratio between male and female to be 1:1.126.

By examining 540 specimens spread over all the months of the year, Parameswaran (1975) found the ratio between male and female to be 1:1.0225 (Chi square: 0.0667; probability 0.796), indicating that it confirms to the theoretical 1:1 ratio.

4.1.2 Age composition

Information on the age composition of the spotted murrel in different habitats is meagre. Qasim and Bhatt (1966) have reported the frequencies of year classes in ponds

TABLE- 35

Lengths at ages in C. punctatus derived by various methods (from Parameswaran, 1975 )

| Age in years | Length (in mm) derived by | | |
|---|---|---|---|
| | Probability analysis of length frequency data | Study of growth checks on scales | von Vertalanffy's growth equation |
| 1 | 115 | 113.4 | 112.6 |
| 2 | 153 | 153.8 | 154.1 |
| 3 | 192 | 189.5 | 188.1 |
| 4 | 231 | 261.3 | 216.0 |
| 5 | 265 | - | 239.1 |
| 6 | 302 | - | 257.9 |

TABLE - 36

Weights at ages in C. punctatus derived by various methods (from Parameswaran, 1975)

| Age in years | Weight (in g) derived by | | |
|---|---|---|---|
| | Probability analysis of length frequency data | Study on growth checks on scales | von Vertalanffy's growth equation |
| 1 | 15.8 | 15.2 | 14.85 |
| 2 | 36.5 | 37.0 | 37.28 |
| 3 | 71.1 | 68.21 | 66.93 |
| 4 | 122.3 | 100.9 | 100.44 |
| 5 | 182.9 | - | 135.35 |
| 6 | 268.5 | - | 169.0 |

TABLE - 37

Annual and instantaneous rates of growth in *C. punctatus* (from Parameswaran, 1975)

| Growth period (years) | | Annual and instantaneous rates of growth derived from lengths at ages by | | | | | |
|---|---|---|---|---|---|---|---|
| | | Length frequency method | | Scale method | | von Bertalanffy's equation | |
| From | To | Annual | Instantaneous | Annual | Instantaneous | Annual | Instantaneous |
| 1 | 2 | 1.3122 | 0.8382 | 1.449 | 0.8941 | 1.5104 | 0.9205 |
| 2 | 3 | 0.9463 | 0.6661 | 0.8472 | 0.6136 | 0.7953 | 0.5852 |
| 3 | 4 | 0.7211 | 0.5427 | - | - | 0.5007 | 0.4059 |
| 4 | 5 | 0.4955 | 0.4027 | - | - | 0.3474 | 0.2982 |
| 5 | 6 | 0.4680 | 0.3839 | - | - | 0.2488 | 0.2222 |

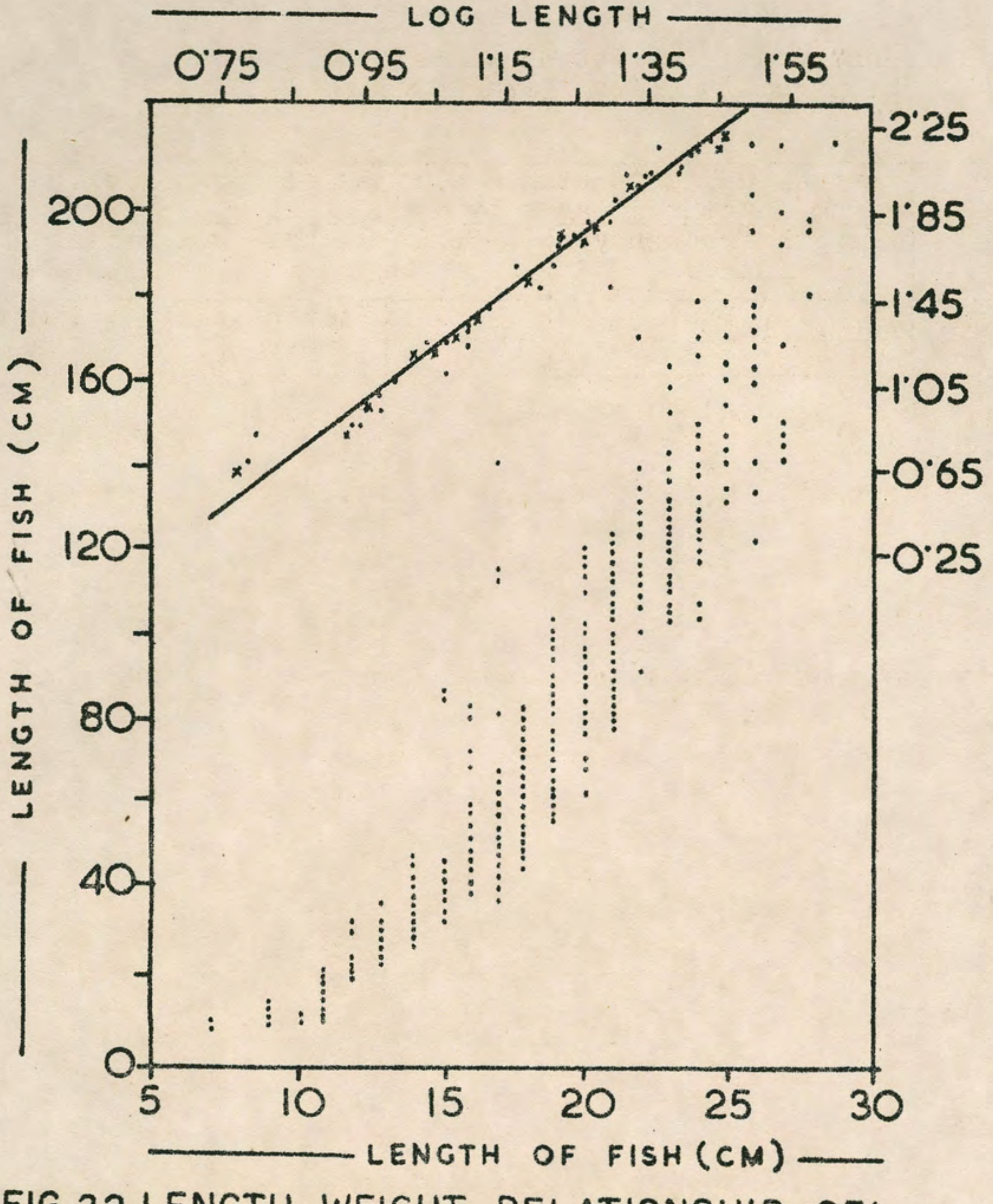


FIG. 22. LENGTH WEIGHT RELATIONSHIP OF *C. punctatus*. EACH POINT IN THE LOWER PART OF THE FIGURE REFERS TO THE OBSERVED VALUE: O, male; .., female. EACH POINT IN THE UPPER PART OF THE FIGURE GIVES THE LOG TRANSFORMATION OF MEAN VALUES: x, male; •, female (from Qasim and Bhatt, 1966)

in Aligarh (Uttar Pradesh) based on the study of growth checks on scales and opercular bones (Table 38 and 39) while Parameswaran (1975) has studied the age structure of the species from swamps and derelict tanks in Malnad region of Karnataka, employing the same methods (Tables 40 and 41).

4.1.3 Size composition

The quarterly size composition of the samples of the spotted murrel from ponds in Aligarh in Uttar Pradesh is given in Fig. 23 (Qayyum and Qasim, 1969). Parameswaran (1975) has analysed the length frequency data of the samples collected by him by probability plot method to delineate **the various age groups.**

4.2 Size and density *

4.3 <u>Natality and recruitment</u>

4.3.1 Natality

Since the number of spawning seasons and frequency of spawning during the same breeding season of the spotted murrel varies in different regions, the natality of the species will depend on the existing climatic conditions of the region and the size of the female breeder (see Section 3.1.6). It has been reported (Parameswaran and Murugesan, 1976 a and b) that in nature the number of young produced decreases with every repeated spawning and that the number of eggs laid by a female when hypophysed is more than in natural spawning.

4.3.2 Natality rates *

4.3.3 Recruitment

No information on the recruitment pattern of the spotted murrel is available. However, the general rule that the recruitment is influenced by the population of the brood stock, predators and trash fishes and the ecological conditions of the habitat should apply to the species also.

4.4 <u>Mortality, morbidity</u>

4.4.1 Rates of mortality*

4.4.2 Factors or conditions affecting mortality

Intensive fishing of the spotted murrel takes place when large areas of shallow water bodies inhabited by the spotted murrel completely or partially dry up during the summer months March to June.

4.4.3 Factors or conditions affecting morbidity*

4.5 Dynamics of population*

4.6 Relation of population to community and eco-system, biological production, etc.

Murrels in general, being predatory fishes, are not generally cultured in ponds, alone or in combination with other fishes such as the carps which are the commonly cultivated fishes in India and other countries in Asia. On the other hand, murrels are eradicated from nurseries and grow-out ponds. Attempts made for the culture of the larger murrels C. marulius and C. striatus have met with some success. However, because of the small size of the fish and a slow growth rate, no serious efforts have been made for the culture of C. punctatus in pomds.

5. EXPLOITATION

Large quantities of the spotted murrel are landed from ponds, tanks, swamps, canals and paddy fields, especially during the summer months. In terms of weight, they rank third among the marketable surplus of various species of murrels. Like other murrels, C. punctatus also fetches a higher price than most other freshwater fishes.

5.1 Fishing equipment

5.1.1 Fishing gear

The spotted murrel is commonly caught from swamps, tanks, ponds and reservoirs by operating long lines and rod and line, using fish and worms as bait. Because of its tendency to bury in mud, seines are not efficient in the collection of the species. The parents guarding the young are often caught in castnets. In West Bengal, Assam, North Bihar, Orissa and Peninsular India the species is caught in large numbers from shallow water bodies, by draining.

TABLE- 38

Frequencies of year classes of *C. punctatus* in various length ranges from ponds in Aligarh (Uttar Pradesh) based on growth checks on scales (from Qasim and Bhatt, 1966)

| Length groups (cm) | Total No. of fish examined | Male age-groups frequencies | | | | | | | Doubtful | Total No. of fish examined. | Female age-group frequencies | | | | | | | Doubtful |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 0+ | 1+ | 2+ | 3+ | 4+ | 5+ | 6+ | | | 0+ | 1+ | 2+ | 3+ | 4+ | 5+ | 6+ | |
| 5.0 | 1 | 1 | - | - | - | - | - | - | - | 1 | 1 | - | - | - | - | - | - | - |
| 6.0 | 2 | 2 | - | - | - | - | - | - | - | 1 | 1 | - | - | - | - | - | - | - |
| 7.0 | - | - | - | - | - | - | - | - | - | 3 | 3 | - | - | - | - | - | - | - |
| 8.0 | 2 | 2 | - | - | - | - | - | - | - | 8 | 6 | - | - | - | - | - | - | 2 |
| 9.0 | 2 | 2 | - | - | - | - | - | - | - | 5 | 5 | - | - | - | - | - | - | - |
| 10.0 | 4 | 3 | 1 | - | - | - | - | - | - | 3 | 3 | - | - | - | - | - | - | - |
| 11.0 | 11 | 5 | 4 | - | - | - | - | - | 2 | 5 | 2 | 1 | - | - | - | - | - | 2 |
| 12.0 | 5 | 3 | 2 | - | - | - | - | - | - | 2 | - | 2 | - | - | - | - | - | - |
| 13.0 | 11 | 3 | 5 | 2 | - | - | - | - | 1 | 12 | 1 | 4 | 3 | - | - | - | - | 4 |
| 14.0 | 15 | 2 | 8 | 3 | - | - | - | - | 2 | 7 | - | 3 | 2 | - | - | - | - | 2 |
| 15.0 | 5 | - | 2 | 3 | - | - | - | - | - | 20 | - | 2 | 5 | 6 | - | - | - | 7 |
| 16.0 | 14 | - | 2 | 8 | 2 | - | - | - | 2 | 23 | - | - | 9 | 8 | 3 | - | - | 3 |
| 17.0 | 12 | - | - | 7 | 3 | 1 | - | - | 1 | 50 | - | - | 8 | 18 | 15 | - | - | 9 |
| 18.0 | 14 | - | - | 9 | 5 | - | - | - | - | 73 | - | - | 5 | 33 | 25 | 5 | - | 5 |
| 19.0 | 24 | - | - | 2 | 18 | 2 | - | - | 2 | 51 | - | - | - | 19 | 16 | 8 | 1 | 7 |
| 20.0 | 26 | - | - | - | 16 | 6 | 1 | - | 3 | 34 | - | - | - | 5 | 11 | 9 | 2 | 7 |
| 21.0 | 28 | - | - | - | 15 | 8 | 2 | - | 3 | 18 | - | - | - | 5 | 5 | 6 | 2 | - |
| 22.0 | 28 | - | - | - | 9 | 12 | 1 | - | 6 | 8 | - | - | - | 1 | 2 | 4 | - | 1 |
| 23.0 | 31 | - | - | - | 4 | 16 | 8 | - | 3 | 1 | - | - | - | - | 1 | - | - | - |
| 24.0 | 22 | - | - | - | 1 | 11 | 5 | 1 | 4 | 1 | - | - | - | - | - | - | 1 | - |
| 25.0 | 10 | - | - | - | 1 | 3 | 3 | 1 | 2 | - | - | - | - | - | - | - | - | - |
| 26.0 | 13 | - | - | - | - | 1 | 8 | 3 | 1 | - | - | - | - | - | - | - | - | - |
| 27.0 | 8 | - | - | - | - | - | 5 | 1 | 2 | - | - | - | - | - | - | - | - | - |
| 28.0 | 3 | - | - | - | - | - | 1 | - | 2 | - | - | - | - | - | - | - | - | - |
| 29.0 | 2 | - | - | - | - | - | - | 1 | 1 | - | - | - | - | - | - | - | - | - |
| Total | 293 | 23 | 24 | 34 | 74 | 60 | 34 | 7 | 37 | 326 | 22 | 12 | 32 | 95 | 78 | 32 | 6 | 49 |
| Mean length | | 10.58 | 13.66 | 17.37 | 20.69 | 22.84 | 25.09 | 26.32 | | | 9.56 | 13.57 | 16.18 | 18.49 | 20.36 | 20.68 | 21.29 | |

TABLE- 39

Frequencies of year classes of <u>C. punctatus</u> in various length ranges from ponds in Aligarh (Uttar Pradesh) based growth checks on opercular bones (from Qasim and Bhatt, 1966)

| Length groups (cm) | Total No. of fish examined | Male age-group frequencies 0+ | 1+ | 2+ | 3+ | 4+ | 5+ | 6+ | Unreadable | Total No. of fish examined | Female age-group frequencies 0+ | 1+ | 2+ | 3+ | 4+ | 5+ | 6+ | Un-rea abl |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 5.0 | 1 | 1 | - | - | - | - | - | - | - | 1 | 1 | - | - | - | - | - | - | - |
| 6.0 | 2 | 2 | - | - | - | - | - | - | - | 1 | 1 | - | - | - | - | - | - | - |
| 7.0 | - | - | - | - | - | - | - | - | - | 3 | 3 | - | - | - | - | - | - | - |
| 8.0 | 2 | 2 | - | - | - | - | - | - | - | 8 | 8 | - | - | - | - | - | - | - |
| 9.0 | 2 | 2 | - | - | - | - | - | - | - | 5 | 5 | - | - | - | - | - | - | - |
| 10.0 | 4 | 4 | - | - | - | - | - | - | - | 3 | 3 | - | - | - | - | - | - | - |
| 11.0 | 11 | 9 | 2 | - | - | - | - | - | - | 5 | 4 | 1 | - | - | - | - | - | - |
| 12.0 | 5 | 5 | - | - | - | - | - | - | - | 2 | - | 2 | - | - | - | - | - | - |
| 13.0 | 11 | 2 | 9 | - | - | - | - | - | - | 12 | 1 | 9 | 2 | - | - | - | - | - |
| 14.0 | 15 | - | 13 | 2 | - | - | - | - | - | 7 | - | 6 | 1 | - | - | - | - | - |
| 15.0 | 5 | - | 2 | 2 | - | - | - | - | 1 | 20 | - | 6 | 13 | - | - | - | - | 1 |
| 16.0 | 14 | - | 3 | 7 | 3 | - | - | - | 1 | 23 | - | - | 18 | 3 | 1 | - | - | 1 |
| 17.0 | 12 | - | 3 | 2 | 4 | 2 | - | - | 1 | 50 | - | - | 9 | 28 | 9 | - | - | 4 |
| 18.0 | 14 | - | - | 7 | 5 | 1 | - | - | 1 | 73 | - | - | - | 36 | 22 | 8 | 2 | 5 |
| 19.0 | 24 | - | - | 5 | 14 | 2 | - | - | 3 | 51 | - | - | - | 8 | 28 | 11 | 1 | 3 |
| 20.0 | 26 | - | - | 2 | 10 | 9 | 2 | - | 3 | 34 | - | - | - | 2 | 14 | 13 | 2 | 3 |
| 21.0 | 28 | - | - | 1 | 11 | 7 | 4 | - | 5 | 18 | - | - | - | 2 | 3 | 10 | 2 | 1 |
| 22.0 | 28 | - | - | - | 13 | 9 | 1 | 1 | 4 | 8 | - | - | - | 2 | 2 | 4 | - | - |
| 23.0 | 31 | - | - | - | 3 | 14 | 8 | 1 | 5 | 1 | - | - | - | - | 1 | - | - | - |
| 24.0 | 22 | - | - | - | - | 7 | 10 | 3 | 2 | 1 | - | - | - | - | - | - | 1 | - |
| 25.0 | 10 | - | - | - | - | 4 | 3 | 1 | 2 | - | - | - | - | - | - | - | - | - |
| 26.0 | 13 | - | - | - | - | 1 | 6 | 6 | - | - | - | - | - | - | - | - | - | - |
| 27.0 | 8 | - | - | - | - | 1 | - | 6 | 1 | - | - | - | - | - | - | - | - | - |
| 28.0 | 3 | - | - | - | - | - | - | 1 | 2 | - | - | - | - | - | - | - | - | - |
| 29.0 | 2 | - | - | - | - | - | - | - | 2 | - | - | - | - | - | - | - | - | - |
| Total | 293 | 27 | 32 | 28 | 63 | 57 | 34 | 19 | 33 | 326 | 26 | 24 | 43 | 81 | 80 | 46 | 8 | 18 |
| Mean length | | 10.68 | 14.71 | 17.43 | 20.57 | 22.41 | 24.09 | 26.02 | | | 9.09 | 13.71 | 16.31 | 18.14 | 19.09 | 20.02 | 21.44 | |

TABLE - 40

Frequencies of year classes of C. punctatus in various length ranges determined by study of scales (from Parameswaran, 1975)

| Class/interval (mm) | No. of specimens | Frequencies of age groups | | | | |
|---|---|---|---|---|---|---|
| | | 0+ | 1+ | 2+ | 3+ | 4+ |
| 121-130 | 6 | 1 | 5 | 0 | – | – |
| 131-140 | 8 | – | 5 | 3 | – | – |
| 141-150 | 12 | – | 8 | 4 | – | – |
| 151-160 | 14 | – | 5 | 9 | – | – |
| 161-170 | 17 | – | 1 | 14 | 2 | – |
| 171-180 | 16 | – | – | 10 | 6 | – |
| 181-190 | 13 | – | – | 5 | 8 | – |
| 191-200 | 16 | – | – | 3 | 13 | – |
| 201-210 | 5 | – | – | – | 5 | – |
| 211-220 | 3 | – | – | – | 1 | 2 |
| 221-230 | 1 | – | – | – | – | 1 |
| Total | 111 | 1 | 24 | 48 | 35 | 3 |
| Percentage in total sample | | 0.90 | 21.62 | 43.24 | 31.53 | 2.70 |
| Standard deviation | | 0.11 | 4.34 | 5.22 | 4.90 | 1.71 |
| Mean length (mm) | | 124.0 | 142.4 | 168.0 | 196.8 | 221.7 |

TABLE- 41

Frequencies of year classes of C. punctatus in various length ranges determined by study of opercular bones (from Parameswaran, 1975)

| Class interval (mm) | No. of specimens | Frequencies of age groups | | | | |
|---|---|---|---|---|---|---|
| | | 0+ | 1+ | 2+ | 3+ | 4+ |
| 121-130 | 6 | 1 | 5 | - | - | - |
| 131-140 | 8 | - | 6 | 2 | - | - |
| 141-150 | 12 | - | 8 | 4 | - | - |
| 151-160 | 15 | - | 5 | 10 | - | - |
| 161-170 | 20 | - | 2 | 15 | 3 | - |
| 171-180 | 13 | - | - | 7 | 6 | - |
| 181-190 | 8 | - | - | 4 | 4 | - |
| 191-200 | 9 | - | - | 2 | 7 | - |
| 201-210 | 3 | - | - | - | 3 | - |
| 211-220 | 5 | - | - | - | 2 | 3 |
| 221-230 | 1 | - | - | - | - | 1 |
| Total | 100 | 1 | 26 | 44 | 25 | 4 |
| Percentage in the sample | | 1.0 | 26.0 | 44.0 | 25.0 | 4.0 |
| Standard deviation | | 1.12 | 4.39 | 4.96 | 4.33 | 1.96 |
| Mean length (mm) | | 124.0 | 143.5 | 165.7 | 194.7 | 220.8 |

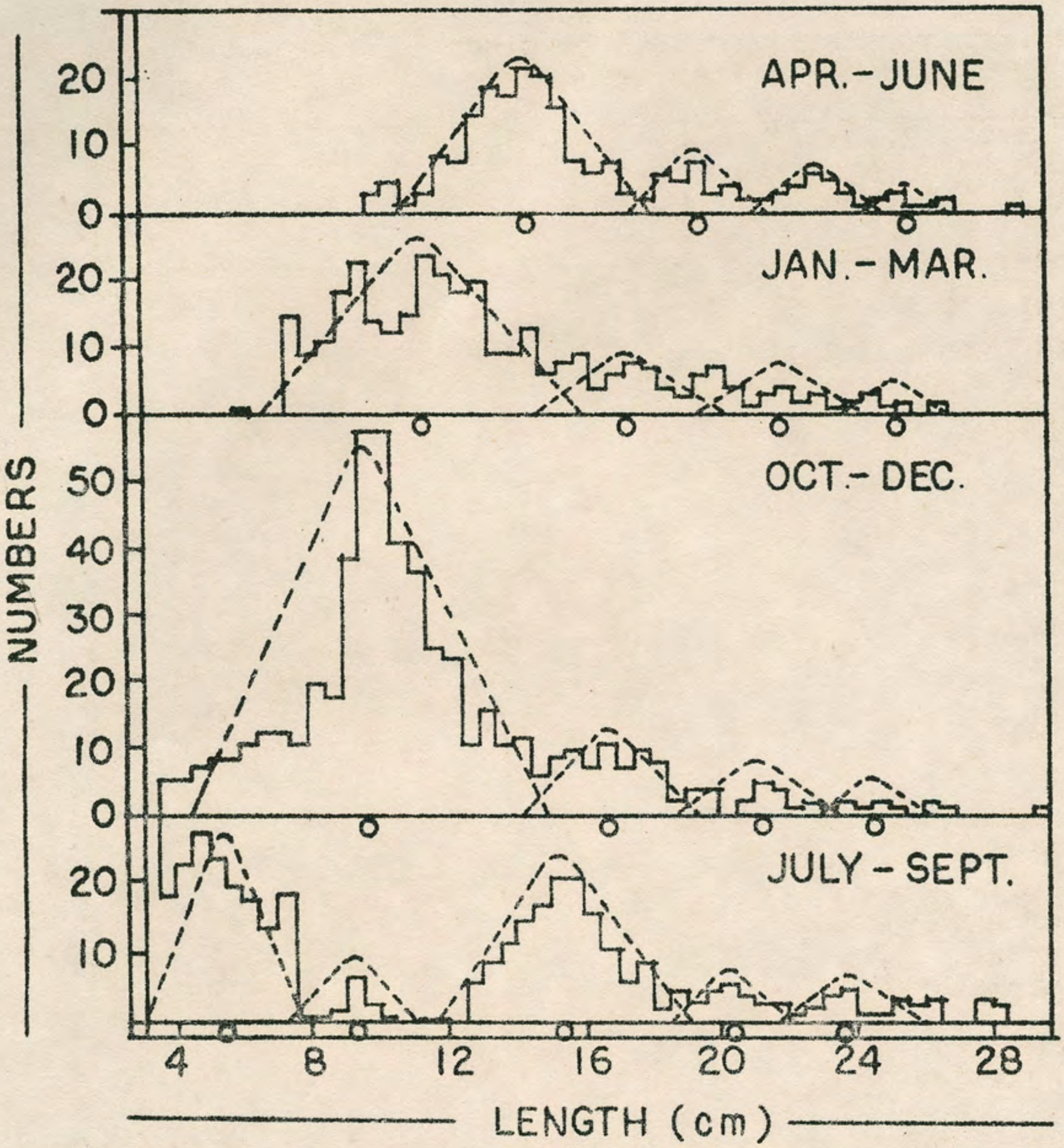


**FIG. 23 - Quarterly size composition of the spotted murrel from ponds in Aligarh, Uttar Pradesh (from Qayyum and Qasim, 1964)**

5.1.2 Fishing boats

See 5.1.2 of C. marulius

## 5.2 Fishing areas

5.2.1 General geographic distribution

See Section 2.1

5.2.2. Geographical ranges (latitudes, longitudes, distances, coast, etc.)

Latitudes 62°N to 110°N

Longitudes 36°E to 2°E

5.2.3 Depth ranges

C. punctatus generally inhabits the surface, column and shallow bottom of water bodies since it has to frequently come up to the surface for breathing air.

## 5.3 Fishing season

5.3.1 General pattern of fishing

Although the spotted murrel is caught throughout the year, the fishing effort in swamps, tanks, canals and shallow water areas including paddy fields is maximum during the peak summer months March to May/June, when the water level in them shrinks. Large quantities of murrels are caught during this period and marketed.

5.3.2 Duration of fishing season

See 5.3.1

5.3.3 Dates of beginning, peak and end of season

See 5.3.1

5.3.4 Variation in the time duration of fishing seasons

See 5.3.1

## 5.4 Fishing operations and results

### 5.4.1 Catches

The murrel fishing grounds (swamps, tanks, bheels and jheels, canals, etc.) are rather dispersed and are often in remote areas. Because of this and the generally high demand for murrels around the fishing areas, only a small percentage of the catches finally reach the markets. No serious attempts have been made to gather the annual catch statistics of murrels in India. However, it is estimated that out of the 18 000 t of the marketable surplus of air breathing fishes caught from natural waters in India, about 12 000 t is constituted by murrels (Jhingran, 1975). Species-wise information is not available.

## 5.5 Fisheries management and regulation

Being harmful to the major carp fishery, murrels in general are considered unwelcome in fishery waters. In capture fisheries other than swamps, efforts are often made to control their population. With a view to preventing predation on carps, murrels are eleminated from aquaculture ponds.

## 5.6 Fish farming, transportation and other intervention

### 5.6.1 Procurement of stocks

Some sort of extensive culture of murrels is practiced in Tamil Nadu, Andhra Pradesh, Karnataka and Kerala. However, no systematic culture is done. Even for extensive culture, the species preferred are the fast growing *C.marulius* and *C. striatus* and not *C. punctatus* which is relatively slow growing. The present limited demand for the seed of this species is met from natural collections. The fish has been successfully induced bred by hypophysation (Banerji 1974 and Parameswaran and Murugesan, 1976 b).

The characters distinguishing the fry and fingerlings of the spotted murrel from the other two common species have been described in Section 3.2.1. The fry moving in schools near the water margin can be collected with the help of a suitable meshed *hapa* or a piece of fry net.

### 5.6.2 Conditioning

See 5.6.2 of *C. marulius*

5.6.3 Transport

While the fry can be conveniently transported under oxygen packing, it is desirable to transport the fingerlings in large containers having perforated lids, with water change every 4 to 6 hr.

5.6.4 Holding of stock

The fry and fingerlings accept only feeds of animal origin. Dried goat's blood, notonectids, prawns, etc. are accepted by the young. Since in the absence of adequate feed the fry and fingerlings tend to become cannibalistic, abundant supply of supplemental feed need to be ensured for high survival.

5.6.5 Pond management

Compared to the giant murrel (C. marulius) and the striped murrel (C. striatus), the growth rate of the spotted murrel is low and hence it has not been generally favoured for culture.

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ANNEXURE-1

Key to the identification of various species of murrels

| | | |
|---|---|---|
| 1 a | Predorsal scales 13 or less; scales between eye and preopercle 5 | 2 |
| 1 b | Predorsal scales more than 13; scales between eye and angle of preopercle 9 or 10 | 4 |
| 2 a | Predorsal scales 12 | 3 |
| 2 b | Predorsal scales 13; dorsal fin rays 35 to 40; anal rays 23 or 28; lateral line scales 47 to 50; body dorsally purplish black, becoming lighter on sides and beneath; many scales on the body with a round black mark | C. stewartii |
| 3 a | Dorsal fin rays 29 to 32; lateral line scales 37 to 40; lateral line bends at 14th or 15th scale; pectoral fin with 17 rays, not striped; dark blotches and spots on body | C. punctatus |
| 3 b | Dorsal fin rays 32 to 37; lateral line scales 40 to 45; lateral line bends after 11th to 14th scale; pectoral fin with 14 to 15 rays, vertically striped; body bluish below; no distinct blotches or spots | C. orientalis |
| 4 a | Lateral line scales 57 or less (50 to 57); predorsal scales between eye and angle of preopercle 9 to 10; dorsal fin rays 37 to 45; anal rays 2 to 27; lateral line bends at 15th to 20th scale; oblique, gray or dark bends on sides | C. striatus |
| 4 b | Lateral line scales between 59 to 71 | 5 |
| 4 c | Lateral line scales 95 or more; predorsal scales 22; scales between eye and angle of preopercle 16 or 17; dorsal fin rays 43 to 46; anal rays 27 to 30; first ray of the ventral fin mildly spinous and unarticulated; head, back and side with numerous brownish spots | C.micropeltes |

ANNEXURE-1 (continued)

| | | |
|---|---|---|
| 5 a | Predorsal scales 15 or 16; scales between eye and angle of preopercle 9; dorsal fin rays 47 to 52; anal rays 34 to 36; first ray of the ventral fins mildly spinous and unarticulated; lateral line scales 60 to 65; body dark violet dorsally becoming dull white, spot with purple beneath; back and sides with large black blotches; pectoral fin reddish with numerous black spots | C. barca |
| 5 b | Predorsal scales 17 to 20; scales between eye and angle of preopercle 10; dorsal fin rays 45 to 56; anal rays 28 to 37; lateral line scales 59 to 71; lateral line bends at 17th to 20th scale; 5 to 6 cloudy bands descend below lateral line; posterior two-thirds body and dorsal, anal and caudal fins with numerous pearly white spots; a black ocellus may be present on upper half of caudal base | C. marulius |

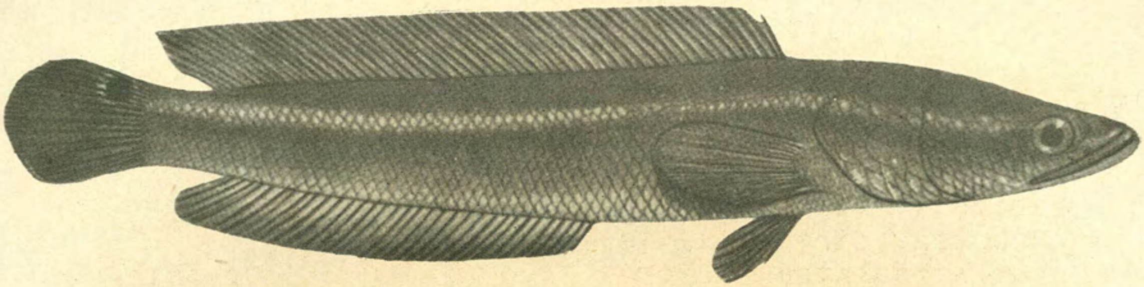

Fig. 1. Lateral view of *Channa marulius* (After Day, 1878)

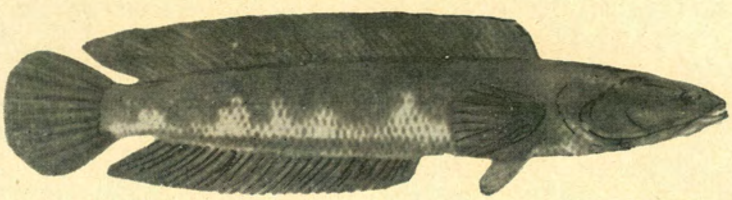

Fig. 10. Lateral view of *Channa Striatus*

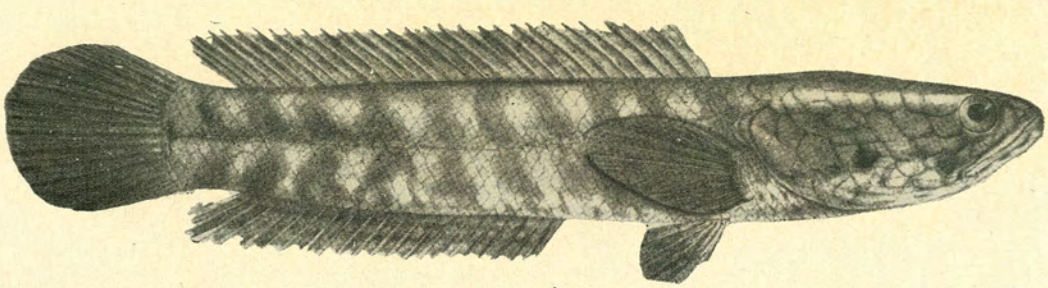

Fig. 15. Lateral view of *Channa Punctatus* (After Day, 1878)


**Fig.12 : Scale of C. striatus**

A.1 + year old (32.4 cm)
B.2 + year old (43.5 cm)
C.5 + year old (56.8 cm)[from Bhatt,1970].

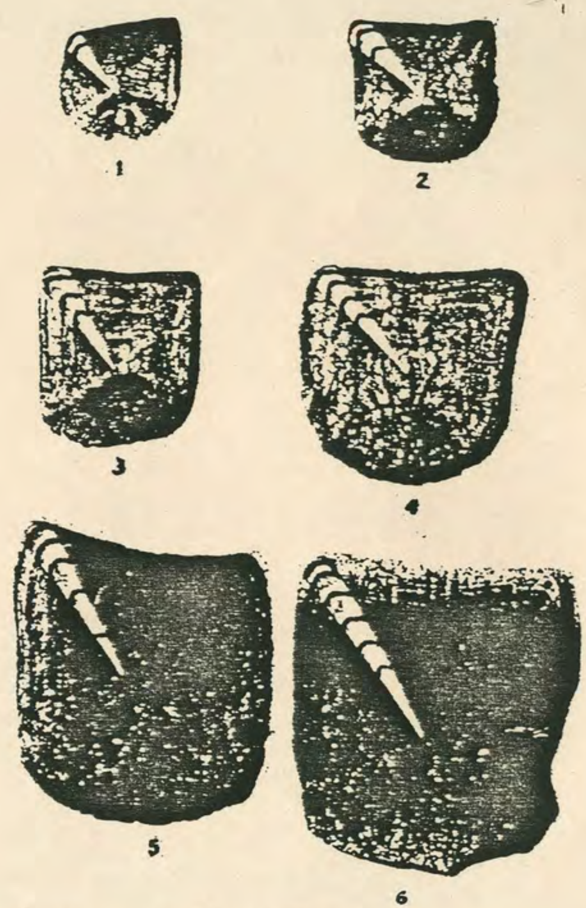


**Fig.20 : Scales of C. punctatus showing various year classes (from Qasim and Bhatt.1966)**

1.Male, 15.2 cm in length and 1 + year old.
2.Female, 16.2 cm in length and 2 + year old.
3.Male, 19.3 cm in length and 3 + year old
4.Female, 18.5 cm in length and 4 + year old
5. Female, 20.3 cm in length and 5 + year old.
6. Male, 26.5 cm in length and 6 + year old.

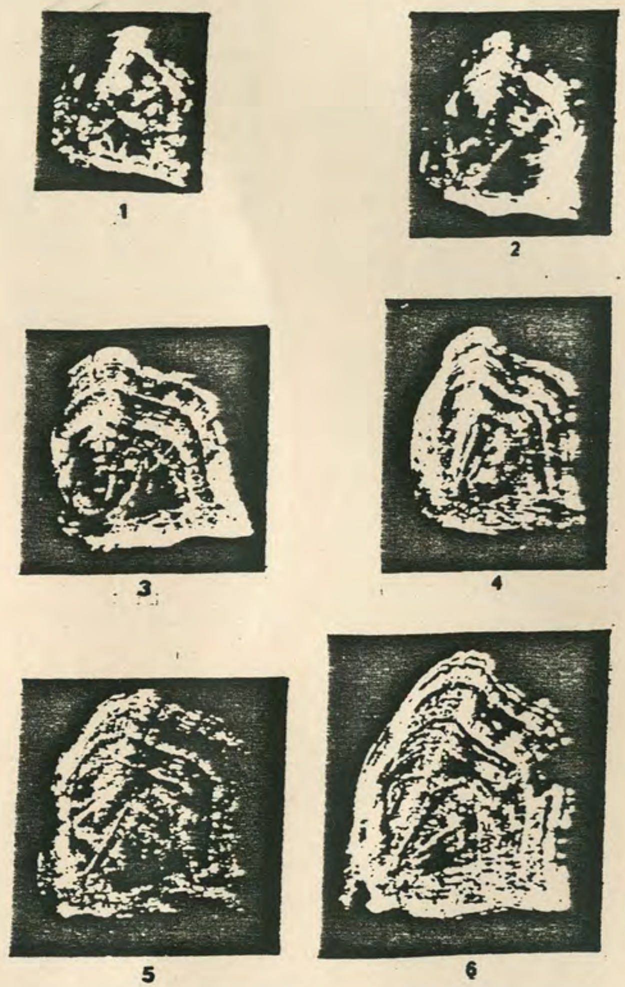


**Fig.21 : Opercular bones of C. punctatus showing various year classes (from Qasim and Bhatt. 1966)**

1.Male, 13.5 cm in length and belonging to 1 + year-class.
2.Male, 16.2 cm in length and belonging to 2 + year-class.
3.Male, 18.7 cm in length and belonging to 3 + year-class.
4.Female, 18.5 cm in length and belonging to 4 + year -class.
5.Male, 23.5 cm in length and belonging to 5 + year-class.
6.Male, 27.4 cm in length and belonging to 6 + year-class.