CMFRI
bulletin 44
Part Two

MARCH 1990

NATIONAL SYMPOSIUM ON RESEARCH AND DEVELOPMENT IN MARINE FISHERIES

MANDAPAM CAMP
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CENTRAL MARINE FISHERIES RESEARCH INSTITUTE
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P. B. No. 2704, E. R. G. Road, Cochin-682 031, India

Central Marine Fisheries Research Institute
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Bulletins are issued periodically by Central Marine Fisheries Research Institute to interpret current knowledge in the various fields of research on marine fisheries and allied subjects in India.

Published by
Dr. P. S. B. R. JAMES
Director
Central Marine Fisheries Research Institute
E. R. G. Road
Cochin-682 031, India

Limited Circulation

Paper 49

PRESENT STATUS ON INDUCED BREEDING OF MARINE FINFISHES IN INDIA

P. Nammalwar and G. Mohanraj
*Central Marine Fisheries Research Institute, Cochin**

ABSTRACT

The paper deals with the present status on induced breeding of marine finfishes in India. The role of induced breeding of marine finfishes in aquaculture research and development is emphesised. A review on the seasonal availability of marine finfish spawners such as milkfish and grey mullet from the coastal waters and estuaries in India wes made. The methods employed in the collection of live fish breeders from the wild, constraints encountered in broodstock management and induced breeding for mass propagation of grey mullet, milkfish, rabbit fish and other marine finfish larvae in hatcheries are given. The problems and prospects on induced breeding of marine finfishes in India are discussed.

INTRODUCTION

The success of large scale marine finfish culture is largely dependent upon the continuous and adequate supply of seed for stocking. Although fish seed may be collected from natural sources, its supply is seasonal and unreliable. A more reliable source is to induce the fish to breed in hatcheries (Jhingran, 1969). Some of the herbivorous and euryhaline fishes are traditionally cultured in various confinements. Fluctuation of natural recruitment and unreliability of the seed supply in quantity have necessitated research in developing suitable hatchery techniques. Further, with the increased emphasis given by the Government of India to aquaculture, there is a growing

*Present address: Madras Research Centre of Central Marine Fisheries Research Institute, 29, Commander-in-chief Road, Egmore, Madras-600 105.

demand for seed by the fish farmers. In India, although farming of herbivorous fishes such as grey mullets and milkfish has been practised for many centuries, the seed are exclusively collected from the natural habitat (Pillay, 1972; Tampi, 1973; Nammalwar, 1986).

Many of the major current problems in fish breeding relate to nutrition, reproduction and environmental control. The technique of hypophysation has triggered progress in the induced breeding of fishes. It has been of particular importance in the case of fishes that do not ordinarily breed under confinement. Breeding with pituitary hormones and Human Chorionic Gonadotropin and the current knowledge on fish hybridisation have been encouraging for further development (Chaudhuri, 1966; Radhakrishnan *et al*, 1976). Induced breeding of grey mullets and other fishes was initiated in 1961 in India. This paper reviews the present status of knowledge of research and development on induced breeding of marine finfishes and enlists the problems and prospects for further development in India.

ROLE OF INDUCED BREEDING IN AQUACULTURE

Fish seed collected from the natural waters is not pure and very often consists of a high percentage of uneconomic species. Induced breeding enables the farmer to obtain quality fish seed. Moreover, by genetic manipulation and selection of strains and breeding lines, improved varieties with desirable qualities can be produced.

In general, the techniques for induced breeding can be classified into (i) creating suitable conditions for inducing fishes to breed (ii) creating favourable environment in confined waters and (iii) using hypophysial extract and hormones. The use of a suitable method has to be carefully determined with reference to the species.

SPECIES SELECTION FOR INDUCED BREEDING

The milkfish *Chanos chanos*, grey mullets *Mugil cephalus*, *Liza macrolepis*, *Liza parsia*, *Liza waigiensis*, *Valamugil seheli* and *Liza tade* are the major herbivorous species which have been widely cultivated in coastal and brackish water ponds in India for a long time. The other species such as *Etroplus suratensis*, sand whiting, *Sillago sihama*, rabit fish *Siganus javus* and *Siganus canaliculatus* and groupers *Epinephelus tauvina* and *Epinephelus hexagonatus* and other perches *Lates calcarifer* are cultivated only from late sixties. These species do not breed in ponds or other confined waters and spawning occurs only in the sea. The seed are collected from the natural waters.

MARINE FINFISH BREEDING

The major activities in marine finfish breeding are the collection and maintenance of broodstock, hatchery operations including spawning, incubation of eggs and hatching, larval food production, larval and nursery rearings and raising of hatchery bred fingerings to brood stock level.

SURVEY OF MILKFISH AND GREY MULLET SPAWNERS

Milkfish spawners have been collected from both the west and east coasts of India (Table-1). Based on the availability of milkfish spawners and fry and correlating the observations made by various workers from different localities during different periods, possible spawning grounds along the Indian coasts have been identified (Silas *et al.*, 1985). The occurrence of spawning population of milkfish and fry in the Gulf of Mannar and Palk Bay during January-April (primary spawning season) and October-November (secondary spawning season) indicates the existence of two spawning seasons of milkfish (Gandhi *et al.*, 1986.)

Table 1. *Availability of milkfish spawners in India*

Place	Period of availability	Authority
Calicut	March-April	Devanesan & Chidambaram (1953)
Appa Island (Near Keelakarai)	February-March & November-December	Silas *et al.*, (1985)
Pudumadam	February-March	Tampi (1958)
	November	Silas *et al.*, (1985)
Theedai (Mandapam)	October-November	Silas *et al.*, (1985)
Mandapam	October	Panikkar *et al.*, (1952)
	March-April	Devanesan & Chidambaram (1953)
	February-May	Tampi (1957)
Pamban	October	Tampi (1958)
	March-April	Devanesan & Chidambaram (1953)
Ariyankundu (Rameswaram Island)	January-April	Silas *et al.*, (1985)
Krusadai Island	March-April	Devanesan & Chidambaram (1953)
Sethubavachatram	March-April	Devanesan & Chidambaram (1953)
Pulicat Lake	March-May	Chacko (1951) & Chacko *et al.*, (1953)
	March-April	Devanesan & Chidambaram (1953)
Nellore	March-April	Chacko (1951)
Vizagapatnam	March-April	Devadesan & Chidambaram (1953)
Srikakulam	April-May	Chacko *et al.*, (1953)

Among the grey mullets, the spawners of the striped mullet *Mugil cephalus* are available from September onwards in Goa and Porto-Novo waters, whereas the peak period is from November to January in other areas. Other grey mullet species occur throughout the year with one or two peaks (Table-2)

COLLECTION OF MILKFISH AND GREY MULLET SPAWNERS AND MANAGEMENT

In India, breeders of milkfish, grey mullets and other cultivable marine finfishes are mainly caught from the wild during the spawning migration. The success of collection of spawners from the wild depends largely on the fishing method used. The milkfish spawners are caught by bottom set gill nets and drift nets at Theedai and Ariyankundu (Palk Bay) and by shore-seines at Pudumadam and Appa Island (Gulf of Mannar). The size of the spawners range from 1043-1340 mm and the weight from 7-15 kg. Details on the sex, stage of maturity, gonad weight, ova diameter and Gonado Somatic Index of the spawners have been tabulated by Gandhi *et al.*, (1986).

The grey mullet spawners are caught by the gill nets, seine nets, bag nets, stake nets, Chinese dip net and cast nets in India. Mature fish of *Liza macrolepis* were collected from the stake-net at Manoli Island and from bag net at Thonithurai. The spawners of *Valamugil seheli* were collected from the bag net at Pillaimadam and Thonithurai. Ripe fish of *Mugil cephalus*, *Liza parsia* and *Liza tade* were collected from the bag nets operated in the coastal waters at Kovalam, Adyar and Pulicat.

The grey mullet spawners were selected and transported through rectangular or circular tanks of 300 litre capacity with aeration. At a time, maximum five spawners were transported without mortality. The spawners were

Table 2. *Availability of grey mullet spawners in India*

Place	Species	Period of availability	Authority
Goa coast	*Mugil cephalus*	September-February	Das (1978)
Kayamkulam Lake, Kerala	*Mugil cephalus*	October-January	John (1955)
	Liza macrolepis	November-January	
	Mugil tade	September-March	
	Mugil speigleri	December- March	
	Mugil troschelli	September-December	
	Mugil ophuyseni	November-February	
	Mugil engeli	October-December	
	Mugil cunnesius	September-December	
Mandapam	*Liza macrolepis*	June-February	Luther (1963)
	Mugil troschelli	May-February	Luther (1968)
	Mugil waigiensis	May-February	
	Mugil sehell	May-February	
	Liza parsia	June-August	
	Mugil cunnesius	July-August	
Porto-Novo	*Mugil cephalus*	September-April	Sulochanamma *et al.*, (1981)
	Osteomugil speigleri	December-April	Sathyashree *et al.*, (1981)
Adayar estuary, Madras	*Mugil cephalus*	November-January	Mohanraj *et al.*, (MS-1987)
	Liza macrolepis	January-April	
	Liza parsia	December-March	
	Liza tade	November-January	
	Liza cunnesius	December-January	
Kovalam estuary, Madras	*Mugil cephalus*	October-January	Mohanraj *et al.*, (MS-1987)
	Liza macrolepis	December-June	
	Liza parsia	December-March	
	Liza tade	November-January	
	Liza oligolepis	January April	
Ennore estuary, Madras	*Mugil oeur* (cephalus)	October-May	Jacob & Krishnamurthy (1948)
	Mugil dussumieri (parsia)	October-May	
	Mugil buchanani	October-May	
	Mugil oligolepis	October-May	
Pulicat Lake	*Mugil cephalus*	September-February	Ramaswamy (1975)
		November onwards for few months	Luther (1968)
	Liza macrolepis	Throughout the year *Two peaks* January-July & February-April	Rangaswamy (1980)
	Liza parsia	Throught the year *Two peaks* July-Septem. & March	Rangaswamy (1980)
Mahanadi estuary, Orissa	*Mugil cephalus*	September-December	Shetty *et al.*, (1965)
Chilka lake, Orissa	*Mugil cephalus*	September-December	Jhingran & Natarajan (1969)
		October-January	Luther (1968)
Hooghly-Matlah estuary	*Liza parsia*	October-February	Luther (1968)
Bengal waters	*Liza parsia*	December-March	Sarojini (1957)
	Liza cunnesius	May-July	Sarojini (1958)

maintained in 12' diameter polycraft pools provided with running water system and aeration. The fish chosen for the experiments were held individually in 3' diameter circular tanks. Handling of the fish caused the shedding of body scales making the fish more vulnerable to bacterial and fungal attacks, leading to mortality. This problem was overcome by guiding the fish into a polythene bag filled with water whenever the fish was handled. Loss of slime from the body and scale shedding resulted by rubbing against the hapa whenever the fish were maintained in the hapas. Circular tanks were found suitable than the rectangular tanks. Nylon net screen covers to the tanks prevented fish from jumping out of water.

INDUCED BREEDING OF MARINE FINFISHES

In India much emphasis has been given to induced breeding of the grey mullets, milkfish and rabbit fish. Fish can be induced to spawn either by hormonal treatment or by environmental manipulation. Major carp pituitary hormone, mullet pituitary glands and human chorionic gonadotropin were effectively used in the induced breeding experiments of grey mullets and other marine fishes. Females with eggs at the tertiary yolk globule stage with 0.6 mm diameter and above were used for breeding experiments of milkfish and mullets.

Grey mullets

The grey mullets do not breed in saline or brackishwater ponds or lakes and estuaries although they attain maturity there. They migrate to the sea for breeding during monsoon months. The available information shows that the gonads reach full maturity at 30 ppt and above (Nash and Shehadeh, 1980). Mullet eggs and larvae were collected by Jacob and Krishnamurthy (1948) from Ennore, by Chacko (1950) from Gulf of Mannar and Jones and Sujansingani (1954) from Chilka lake. The development of *Mugil corsula* was studied by Pakrasi and Alikunhi (1952). Studies on embryonic and larval development as a result of stripping on *M. cephalus* were made by Nair (1957). Kuthalingam (1966) was successful in rearing the larvae of *M. cephalus* to early juveniles. Pati (1970) has studied the early development of *Liza troschelli* from the Chilka lake by the artificial fertilization of eggs stripped from spawning females. Embryonic and larval development of *L. macrolepis* were studied from the developing eggs collected from Chilka lake by Natarajan and Patnaik (1972). Though, success has been achieved on an experimental scale in India, so far it has not been possible to rear the induced-bred hatchlings on mass scale. Experiments on induced breeding of grey mullets (Table-3) were initiated during 1961 in Chilka lake and success was achieved in breeding *M. cephalus* by injection of fish pituitary hormones (Anon, 1962). At Azhicode, Kerala, ovulation was induced in *M. cephalus* but the eggs could not be fertilized (Alikunhi *et al.*, 1971; Sebastian and Nair, 1973). The success on the induced breeding of *M. cephalus* in Chilka lake has been reported by Mohanty (1971) but the larvae were reared only for 7 days. The production of hatchlings and rearing of larvae for about 10 days were reported by Chaudhuri *et al.*, (1977). Successful spawning and larval rearing of *M. cephalus* for 10 days were achieved at Narakkal, Cochin in 1987 (Krishnan and George-personal communication).

Induced breeding experiments conducted on *Liza troschelli* resulted in ovulation and spawning but the fertilized eggs did not develop (Anon, 1992; Chaudhuri, 1966). At Azhikode, successful spawning and larval rearing of *L. macrolepis* for 10 days and upto fingerling stage was reported by Sebastian and Nair (1975) and Alikunhi *et. al*, (1971). Induced breeding and larval rearing of *L. macrolepis* for about 4 days at Chilka lake was reported by Kowtal and Gupta (1983). James *et al.*, (1983) have studied in detail the embryonic and larval development of

Table 3. *Induced breeding experiments conducted on grey mullets in India*

S.No.	Place	Name of Species	Environmental conditions of water	Hormones used and quantity	Observation	Workers and year
1	2	3	4	5	6	7
1.	Chilka lake, Orissa	*Mugil cephalus*	Temp 22.5-23.5°C	MPG 8-16 mg/kg	Hatchlings did not survive	Anon (1962), Chaudhuri (1966)
		Liza troschelli	,,	,,	Eggs did not develop	,,
2.	Azhicode, Kerala	*M. cephalus*	—	—	—	Alikunhi *et al.*, (1971)
		L. macrolepis	Temp. 26.0–29°C Sal. 29.0-31.0 ppt	MPG, 1-5 glands/fish	Larvae reared upto fingerling stage	,,
3.	Chilka lake, Orissa	*M. cephalus*	Temp; 19.5-24.°C Sal. 5.3.29.9 ppt D.O. 8.2.11.5ppm	MPG 6-10 glands/fish or 10-18 mg PO and 2.5-3.7 mg S.H./kg	Larvae reared for 7 days	Mohanty (1971)
4.	Azhicode, Kerala	*M. cephalus*	—	MPH	Ovulation achieved but eggs could not be fertilized	Sebastian and Nair (1973)
5.	Azhicode, Kerala	*L. macrolepis*	Temp. 27-30.5°C Sal. 29-31 ppt	MPG 3-9 glands/fish	Majority of the larvae were reared for 10 days	Sebastian and Nair (1975)
6.	Pulicat lake, Madras	*L. macrolepis*	Temp.24.7-31.4°C Sal. 28-40.5 ppt D.O.2.8-8.8 ppm	MPG 4-20mg/kg	Yielded ripe eggs on stripping	Radhakrishnan *et al.* (1976)
		M. cephalus	,,	MPG 20 mg/kg	No spawning	,,
		L. parsia	,,	MPG 5-25 mg/kg	Fertilized eggs perished after 10–30 h.	,,
7.	Chilka lake, Orissa	*M. cephalus*	Temp.16-28.5°C Sal. 4.1-26 ppt D.O. 3.6-8.6 ml/l	MPG 2-6 gland/fish or MPG 6-13 gland and Synahorin 17-45 R. U.	100-14000 hatchlings obtained majority survived for 10 days	Chaudhuri *et al.*, (1977)

1	2	3	4	5	6	7
		L. macrolepis	—	MPG 8-16 mg/kg	Fertilized eggs did not develop	,,
8.	Chilka lake, Orissa	*L. macrolepis*	Temp.15.5-23°C Sal. 13-29.6 ppt D.O.7.19 ppm	MPG 2-6/ fish	Larvae reared for 4 days	Kowtal and Gupta (1983)
9.	Mandapam, Tamil Nadu	*L. macrolepis*	Temp. 27-33.2°C Sal.31.6-32.5 ppt	CPG 600-1200 mg/kg or HCG110000-340000 I.U/kg or CPG 1200mg and HCG 12000-15000 I.U/kg	Larvae reared for 7 days. Attained the size of 2.47 mm	James *et al.*, (1983)
10.	Narakkal, Kerala	*L. macrolepis* *L. parsia*	—	—	1.2 lakh hybrid larvae were obtained. 40% survived for more than 3 months	Krishnan and George (1986)
11.	Madras	*L. macrolepis*	—	—	Larvae reared upto 22 days	Krishnamurthy *et al.* (1986)
12.	Narakkal, Kerala	*M. cephalus*	Sal. 24-31 ppt	CPG 70mg & MPG 15mg& HCG 30000 I.U/kg	Larvae survived for 10 days	Krishnan and George 1987 (Personal Communication)
		L. parsia	—	CPG 200-476 mg/kg	majority of larvae died by 5th day. 2000 juveniles survived beyond 40 days	,,
13.	Kovalam, Madras	*M. cephalus*	Sal. 28-30 ppt.	HCG 1500	No spawning	Nammalwar *et al.* (1987)
		L. parsia	,,	I.U/kg	,,	
		L. tade	,,	CPG 250-500 mg/kg HCG 1000 I.U/kg	,,	

MPG—Mullet Pituitary Gland; CPG—Carp Pituitary Gland;
HCG—Human Chorionic Gonadotropin; SH —Synthetic Hormone

induced bred *L. macrolepis* for 7 days. Krishnamurthy *et al.*, (1986) have reported the success in breeding *L. macrolepis* and the larvae were reared upto 22 days at Madras. An attempt was made towards interspecific hybridisation with eggs of *L. parsia* and milt of *L. macrolepis* and all the fertilized eggs perished within 30 hrs (Radhakrishnan *et al.*, 1976). Hybridisation by crossing the females of *L. macrolepis* with the males of *L. parsia* was achieved by Krishnan and George (1986). The larvae were reared upto the fry stage for about three months.

Induced breeding experiments under laboratory conditions on grey mullets *M. cephalus*, *L. parsia* and *L. tade* were conducted by giving effective dose of HCG (Human Chorionic Gonadotropin) ranging from 250-1500 I. U/kg and crap pituitary hormone (200-500 mg/kg) at Kovalam laboratory. The live ovarian biopsy of the fish revealed that the ova diameter has increased after hormonal treatment. Induced breeding experiments under field conditions on grey mullets *L. parsia* and *L. tade* were conducted by administering HCG ranging between 500 and 1500 I.U/kg and the fish were maintained in the net cages at Muttukadu farm. There was increase in the ova diameter after the hormonal treatment (Nammalwar *et al.*, MS-1987).

Milk fish

Success in breeding the fish has not been reported in India. During the period 1978-80, live milkfish breeders were collected from the gill nets of 17 mm mesh size operated at Ariyankundu (Palk Bay). The fish were conditioned in 15' diameter pen at the collection site and then transported to the fishfarm at Mandapam. For the first time, one ripe female was transported from Ariyankundu to Mandapam during 1978. The fish survived for 2 hr. in the holding pond. Subsequent to that, six spawners were collected and maintained in the broodstock pond at Mandapam for undertaking breeding experiments. It was not possible to keep the fish alive for more than two days since all the fish had received injuries during capture. With a view to overcome the problem posed with the wild spawners collection, 200 milkfish of 5-6 year age group are being raised as broodstock at Mandapam to achieve the goal of induced breeding of milkfish.

Rabbit fish

The spawners of the rabbit fish *Siganus* spp. are caught mainly by the traps from November to February. The traps are placed in the reef areas of Keelakarai, Appa Island and Valai Island (Gulf of Mannar). The size and weight of *Siganus canaliculatus* breeders ranged from 154-235 mm and 75-190 g. Success in breeding the rabbit fish *S. canaliculatus* was achived in 1984 at Mandapam by the administration of HCG at the rate of 28000 I.U/kg. The larvae were reared for four days (Mohanraj, MS-1987).

PROBLEMS AND PROSPECTS

The availability of live mature breeders of marine finfishes from the wild populations are lacking. Further, in the absence of pond grown fish broodstocks, concentrated efforts for mass seed production by induced breeding have to be made at the peak of the natural spawning season. Continuous maintenance of fish broodstocks in captivity, techniques to control and regulate gonadal maturation and development, environmental influence on breeding, inadequate supply of suitable live food organisms at different stages of larval development are some of the problems to be solved.

In India, eventhough some remarkable success has been achieved in developing techniques towards induced breeding of marine finfishes and in obtaining seed in some of the important cultivated fishes, our persent knowledge on reproductive physiology, breeding requirements and spawning behaviour with regard to milkfish, grey mullets and other important marine finfish species is meagre. Therefore, intensive research in this line has to be done to determine the exact breeding requirements of these fish species and develop suitable techniques for their artificial propagation.

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