MAJOR ACHIEVEMENTS OF RESEARCH

MD/IDP/03 - Broodstock development, captive breeding and seed production techniques for selected marine finfishes and ornamental fishes (2009-2012)

(AND)

FISHCMFRISIL201202400024 - Development and standardization of seed production technologies for selected high value finfishes and shellfishes (2012-2014)

Food Fishes

A wholesome technology of "Breeding, Seed production and Farming of high value marine food fishes" was developed and successfully transferred the technology to the end user. The details of major technologies involved in this endeavor are given below:

1. ***Broodstock development***

   It comprises of collection from wild, conditioning under captive environment and development into brood fishes by feeding with specialized feeds to cater to their physiological requirements.

2. ***Captive breeding and spawning***

   It involves tagging, sexing, assessment of reproductive stages, selection of parents and induction of spawning.

3. ***Mass culture of live feed, larviculture protocols and fingerling production***

   This include green water technique, mass production of appropriate live feed, nutritional enrichment protocols of live feed, weaning, grading, fingerling production and transportation of seed.

4. ***Farming or culturing***

   It involves the nursery rearing, development of suitable feed formulations, grow-out farming (pond culture or sea cage farming) and health management.

5. ***Transfer of technology***

   It comprises of field demonstrations of sustainable pond and sea cage farming, capacity building through hands-on training in hatchery management, nursery and farming techniques

Selection of species for seed production

The factors considered for selection of the species of food fishes were as follows:

- Availability of the species in Indian waters
- Demand in both national and international trade

- Adaptability to environmental variations
- Feasibility of breeding under captive conditions
- Feasibility of completion of larviculture within a reasonable time frame
- Suitability to farming (pond or sea cages)
- Growth rate and disease resistance
- High market value

Mandapam Regional Centre

Based on the above criteria, the species of food fishes identified and selected for Mandapam Regional Centre were:

1. Cobia (*Rachycentron canadum*)
2. Silver Pompano (*Trachinotus blochii*)

The Cobia possesses the special characteristics namely fast growth rate, adaptability to captive conditions, lower cost of production, good meat quality and high market demand, while the pompano is highly preferred delicacy in the domestic market. In addition, the pompano can easily adapt to low saline conditions and also has ornamental value during its juvenile stages for its bright, glossy and silvery appearance.

Wild-caught cobia does not support a major commercial fishery and generally considered as incidental catch. Hence, the seed production and farming of cobia is rapidly gaining momentum in many Asian countries. Under culture conditions, cobia can reach 4-8 kg body weight in one year and 8-16 kg in two years. The fecundity of the species is very high and it has protracted spawning season so that seed production throughout the year would be possible. The Silver Pompano is amenable to various methods of culture namely sea cage farming, pen culture, pond culture, etc. The vast low saline waters of our country could be effectively used for farming of pompano due to its adaptability to low saline waters, besides its potential for sea cage farming. It is also one of the highly priced fin fishes, mainly due to its good meat quality.

Initially, available information on captive breeding of cobia and pompano was collected and then the biology of the species in our waters was studied. Then, trials were made to develop broodstock in captivity and to standardize the hormonal protocols under our conditions. Once, the captive broodstock development was successfully completed, focus was given on evolving larviculture protocols. The major bottleneck of mass production of live feed was addressed to increase the larval survival and quality.

Thereafter, the protocols for nursery rearing and long distance transportation of seeds followed by farming methodologies were developed and standardized.

A brief narration of the technology developed is given below.

Broodstock Development of Cobia and Pompano

Envisaging the prospects of Cobia and Pompano farming in India, broodstock development was initiated at the Mandapam Regional Centre of Central Marine Fisheries Research Institute during the year 2007 and 2008, respectively. Initially, the sea cages were designed and fabricated by the team of scientists. The wild caught brood fishes of cobia (2 to 10 kg) and pompano (0.25 to 0.75 kg) were collected. Immediately after collection, the fishes were treated with 100 ppm formalin for 2 to 5 minutes and then conditioned for 2-3 weeks in 100 ton FRP tanks. After the quarantining, the fishes were released into the broodstock cages. Eventually, they were reared in cages of 6 meter diameter and 3.5 meter depth. The fishes were sexed by cannulation techniques and tagged with PIT tags.

As a refinement of the technology, to develop bio-secure broodstock on-shore, Recirculating Aquaculture System (RAS) was also adopted. The RAS incorporates systems for treatment and reuse of water with less than 10% of water volume replaced per day. Of late, the brood fishes were developed both from the wild collection and hatchery produced stock with the help of pedigree information. A high plane of nutrition was followed based on their physiological need in order to become good quality brood fishes. These fishes were fed with high plane of nutrition twice daily with sardines (*Sardinella* species), squids, portunid crabs and other species like *Pellona* and *Ilisha* @ 5 % of their body weight. They were supplemented with vitamins and minerals in addition to essential nutrients like rich protein and HUFA/PUFA. Subsequently a more cost effective indigenous RAS was designed and installed in the Centre. Broodstock development of *Lutjanus argentimaculatus* was initiated in the indigenous RAS system

Broodstock Development under captivity

Broodstock of cobia in sea cage

Broodstock of pompano in sea cage

Catching of brood fishes from cage

PIT Tagging equipment

PIT Tagging of cobia brood fish

Reading the tag in a brood fish

Reading the PIT tag for identification

Transferring of tagging information to computers

Broodstock of cobia in spawning tank

Brood fishes of cobia at RAS tank

Imported RAS facility

Imported RAS components (UV filter, Bead filter, Protein skimmer & Reactors)

Captive breeding and Induced Spawning

The brood fishes were sexed and tagged with Passive Integrated Transponder (PIT) tags in order to maintain the breeding history. The PIT tag is a device to permanently mark fishes internally with radio frequency tags. The assessment of their stage of reproduction from gonadal biopsies was carried out through direct cannulation technique. The females were cannulated every fortnightly interval to assess the stage of development in reproduction through the diameter of the intra-ovarian eggs. Females of cobia with intra-ovarian eggs of minimum 700 µ size were selected for breeding. The males were selected based on the pedigree information. The selected parents were brought from the sea cages to the breeding cum spawning tanks or tanks with RAS facility. The sex ratio was standardized as two males for one female in order to have maximum fertilization. The induction of spawning was carried out with exogenous hormones. The dosage for induction was standardized for both sexes in cobia and pompano.

Successful induction could be achieved with human chorionic gonadotropin at a dosage of 500 IU and 250 IU per kg body weight for females and males of cobia, respectively, whereas 350 IU per kg body weight for both the sexes of pompano. The spawning was obtained usually 36 to 48 hours after the hormone injection. Various experiments were conducted to ascertain the optimum temperature for spawning and it has been found that a temperature range of 28 to 30.5°C is ideal. The fertilized eggs would be floating and unfertilized eggs would sink to the bottom of the tank. The total number of eggs spawned was estimated and the fertilized eggs were stocked in separate incubation tanks. Usually the fertilization rate would be 80 to 90 per cent. The first successful breeding and spawning of cobia and pompano were achieved in India at Mandapam Regional Centre of CMFRI during the year 2010 and 2011, respectively. After the first

success, successive breeding and seed production are regularly being achieved (Annexure 1 and 2).

Volitional spawning of cobia in RCC tanks was achieved at the broodbank facilities of Mandapam Regional Centre of CMFRI -Two sets of cobia broodstock, each with one female and two males, which were maintained at the National Marine Fish Brood Bank facility at the Mandapam Regional Centre, spawned volitionally without any hormonal induction during the month of May 2013. The water quality parameters were maintained at highest standards with indigenously designed filtration systems. The broodstock were fed with good quality squid and crabs. A total of 2.5 million fertilized eggs were obtained and 85 % hatching was achieved in the volitional spawning.

First Successful spawning of cobia in RAS was achieved at Mandapam on 20th September 2013. The RAS facility inaugurated by the Director General, ICAR during May 2013 was effectively utilized for the maintenance of cobia brooders. In this system, the brooders could be conditioned and maintained in healthy condition. One female and two male brooders were kept in the system. The ova size was assessed by cannulation biopsies based on which, the brooders were induced with HCG. The total number of eggs spawned was 2.40 million and the fertilization percentage was 86.1. The temperature range was 27.5 – 29°C. The hatching started by late evening of 20th September 2013 and completed by early morning of 21st September 2013. A total of 1.80 million larvae hatched out with a hatching percentage of 86.7%. The larvae were stocked at different densities in the larviculture tanks.

Volitional spawning of cobia in RAS – The same brooders of cobia were maintained in healthy condition in the RAS by maintaining optimal water quality parameters. The first volitional spawning in the RAS was recorded on 29th October 2013. The total number of eggs spawned was 1.3 million and the fertilization percentage was 0.27 and total number of fertilized eggs was 3,600. Since the spawning happened unexpectedly, arrangements for facilitating maximum fertilization rate could not be made in the system which might be the reason for the low fertilization rate. The temperature maintained was 30.5°C, pH 8.2, DO 4.98 ml/litre and salinity at 36 ppt. The fertilized eggs were collected and stocked in the incubation tank for hatching.

The first successful off-season spawning of cobia through thermal regulation has been achieved in the RAS on 02nd December 2013. Breeding experiment was conducted in the RAS through thermal regulation by installing titanium water heaters. During this season the temperature in source seawater was 25.1 to 26.0°C and it was raised in the RAS to 29.7 to 30.3 °C, by titanium heaters. The cobia brooders were healthy and broodstock development was continued in the RAS by regulating the temperature. Intra-ovarian cannulation biopsy revealed the maturation of ova in the altered temperature. The female cobia was weighing 9.29 kg and males were 9.89 kg & 10.34 kg. Successful hormonal induction with hCG was carried out on 30th November 2013 and spawning was achieved on 2nd December 2013. The fertilized eggs were collected and stocked in the incubation tanks for hatching. It is felt that the present success is a major breakthrough which can pave way for the successful spawning and seed production of cobia all through the year.

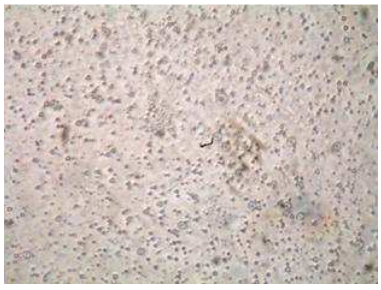
Captive Breeding and Spawning

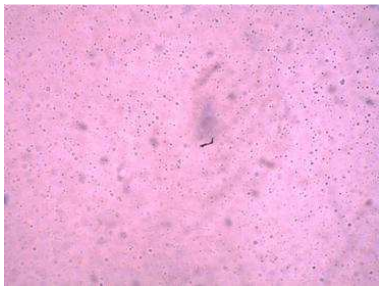
Catching of brooders from sea cage

Cannulation of cobia at sea cage for gonadal biopsy

Cannulation of cobia at brood bank for biopsy

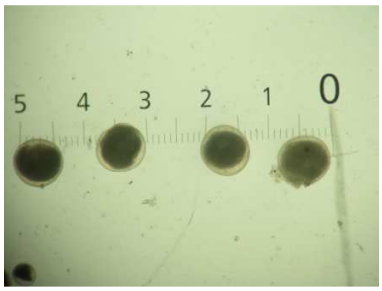
Cannulation of pompano for gonadal biopsy





Matured spermatozoa of Cobia

Matured spermatozoa of Pompano



Assessment of Egg maturation in Cobia

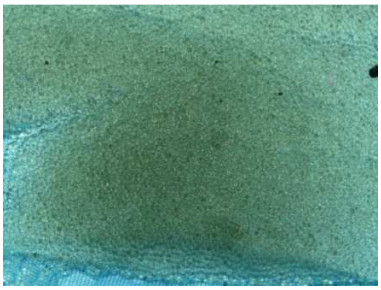
Assessment of Egg maturation in Pompano

Administration of hormones for Final oocyte maturation and spawning in Cobia

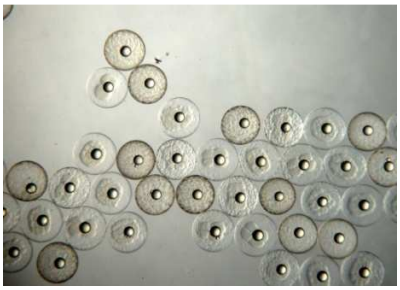
Administration of hormones for Final oocyte maturation and spawning in Pompano

Cobia spawners

Pompano spawner



Fertilized eggs of cobia collected from spawning tank



Zygotes of cobia under microscope

Embryonic development in Cobia **Embryonic development in Pompano**

Larviculture and fingerling production

The fertilization rate was determined by counting the floating as well as sunken eggs using sampling techniques. The fertilized eggs (zygotes) were transferred from spawning tanks to the hatching tanks. The developmental stages were observed and studied periodically for ascertaining the embryonic development. Various experiments were conducted to ascertain the optimum temperature for hatching and it has been found that a temperature range of 29°C to 30.5°C is ideal. The hatching would take place within 18 to 22 hours of fertilization. The newly hatched larvae were transferred to larviculture tanks for further rearing. The stocking density was standardized as five larvae per liter for better survival during the larviculture period. The protocols were developed and standardized for larviculture by appropriate management of live feeds in suitable quantities and also taking into consideration the nutritional requirements of the larvae.

The mouth opening was observed on third day post hatch (dph) and was measuring around 200 µ in size. The larvae were stocked in FRP tanks of 5 ton capacity for larviculture. The intensive larviculture tanks were provided with green water at a density of about $1x10^5$ cells per ml and rotifers enriched with DHA SELCO/Sparkle at a density of 8 to 10 nos. per ml from 3 to 9 dph. The critical stage for the larvae was 5 to 7 dph when they entirely resorted to exogenous feeding from yolk sac feeding. From 9 to 21 dph, the larvae were fed four times daily with enriched *Artemia* nauplii by maintaining a nauplii concentration of 3-5 nos. per ml. During this period, co-feeding with rotifers was also continued due to the presence of different size groups of larvae.

Larviculture and High density mass scale Live feed culture

Intensive culture of live feed (Rotifers)

Intensive culture of live feed (Rotifers)

Extensive mass culture of live feed (Micro-algae)

Green water culture

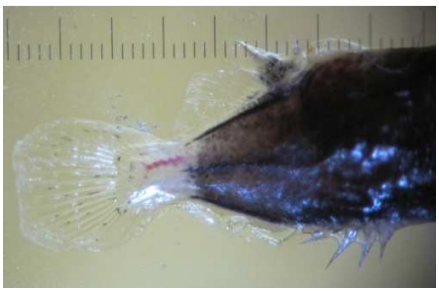
Green water addition to larviculture

Enriched *Artemia* nauplii for larviculture

Larvae of cobia

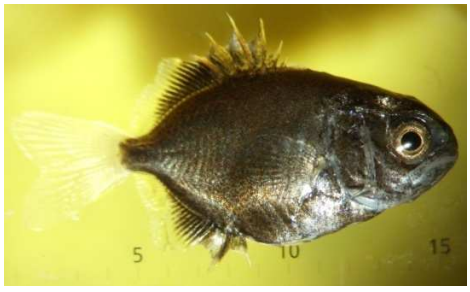
Cobia larva (3 DPH)

Larvae of Cobia (15 DPH)



Larva of Pompano (20 DPH)

Cobia Fingerling (30 DPH)



Pompano fingerling (30 DPH)

Fingerlings of cobia (35 DPH)

Pompano fingerlings (40 DPH)

Juveniles of Cobia (45 DPH)

Juveniles of Pompano (45 DPH)

Cobia fingerlings for stocking

Pompano fingerlings (45 DPH)

Cobia seed for transportation

Pompano seed transportation

Green water was also maintained in appropriate densities in the larval tanks. From 7 and 12 dph onwards, the larvae of cobia and pompano, respectively, were fed with *Artemia* nauplii. The larvae were weaned to larval inert feeds from 18 dph onwards. From 25 dph, grading of larvae was started. The shooters were fed exclusively with the artificial feed of the size 500-800 µ and 800-1200 µ. On 30 dph, three size groups of juveniles were noted in cobia with mean sizes of 10 cm (10%), 6 cm (25%) and 4 cm (65%). The

juveniles measuring 10 cm length were ready for stocking in nursery tanks or ponds. In pompano, size variation is minimal and hence, grading is not mandatory.

The period of larviculture was 30 to 35 DPH depending on the growth of larvae. Then, the nursery rearing was carried out up to 55 to 60 DPH. At this stage they can be called as fingerlings/seed ready for stocking in cages or ponds. Several batches of seeds were produced for farming by aqua farmers. The packing and transportation protocols for cobia and pompano for long distance transport were developed and seeds were distributed to aqua farmers in majority of maritime States of India (Annexure 3).

Larviculture experiments revealed that maintaining a larval density of 5 numbers/litre and live feed (rotifer) at a density of 35- 40 numbers/ml up to 18 days post hatch (dph), early grading starting from 10 dph onwards and continuing on a daily basis yielded better survival for cobia. Maximum survival rate obtained was 8.4%. A few tanks with better light intensity and extended duration of higher temperature yielded up to 10% survival in cobia. Larviculture experiments on silver pompano revealed that a larval density of 10 numbers/litre and live feed (rotifer) at a density of 35- 40 numbers/ml yielded better survival in pompano larviculture. Maximum survival rate obtained was 31 per cent.

Groupers (Visakhapatnam)

The broodstock of the grouper, *Epinephelus coioides* at Visakhapatnam was PIT tagged. A total of 32 adult groupers (2-9.5 Kg weight) were maintained in a cage by feeding at 5 % body weight with squid and trash fishes fortified with vitamins. A total of 16 numbers of tagged and female were stocked in a cage for sex reversal trial. Out of 16 fishes, 9 fishes of different size (3-9 kg) were implanted with 17- alpha methyl testosterone at the rate of 5 mg per kg body weight; 4 fishes with 5mg/kg body weight MT and 0.2mg/kg body weight Letrazole and remaining 3 fishes implanted with 5mg/kg body weight MT and 0.4mg/kg Letrazole for the sex reversal experiment. Gonadal maturity stages were being examined in every month by stripping and cannulation.

In addition, a total of five medium size fishes are being maintained in the hatchery for sex reversal studies. These groupers were orally fed with the male hormone 17 alpha methyl testosterone at the rate of 1 mg per kg body weight along with letrazole at the rate 0.05 mg per kg body weight on daily basis. The testosterone and letrazole were weighed

and filled in empty capsules. These capsules were fed to the groupers along with their diet. The hormone treated fish were examined once in a month by cannulation and stripping. Three spawning trials were carried out using hCG at different dosages. In the all the cases spawning yielded only unfertilized eggs.

Happa **attached in broodstock cage for spawning purpose**

Female broodstock of *Epinephelus coioides* cage

The maturity stages of female broodstock *Epinephelus tauvina* (Greasy grouper) were examined every month by intra ovarian biopsy (IOB) and individual gonad development history of fishes were maintained. Female fish with intra ovarian ova of diameter 450µ was used for induced spawning. Successful sex reversal (female grouper to male) was achieved with the hormonal and enzymatic manipulation. Twenty fishes were implanted with 17 α methyl testosterone and aromatase inhibitor enzymes. 60% of the implanted fishes were sex reversed after 4 months. Periodic implantation of hormone and aromatase inhibitor enzyme was being carried out once in two months to maintain the sex of male broodstock. These brooders were cannulated once in a month to assess the milt production. These males were used for induced spawning.

Induced spawning of grouper was carried out in happa (2m diameter and 3m depth) of mesh size 500 µ installed inside the brood stock cage. Six spawning induction trials were conducted during the reporting period. The females were administered with two doses of HCG @500IU/kg BW at 24 hrs interval and male was given single dose of HCG on 2nd day. The fishes spawned about 12-14 hrs after the last dose of injection. The details of spawning are as follows;

Date of induction	Hormone	No. of spawned eggs (lakhs)	Remarks
09/04/2012	hCG	1.50	Fertilization rate 45%
12/06/2012	hCG	5.00	Fertilization rate 80%

09/09/2012	hCG	6.00	Fertilization rate 87 %
18/11/2012	hCG	0.00	No response
12/12/2012	hCG	5.00	Unfertilized egg
17/12/2012	hCG	4.00	Unfertilized eggs

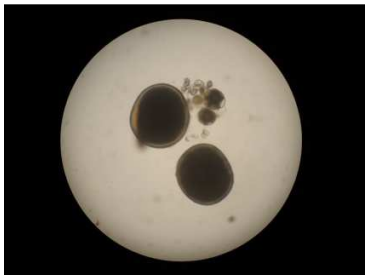
Breeding and seed production of Indian pompano *Trachinotus mookali*

Among the many high value marine tropical finfish that could be farmed in India, the Indian pompano *Trachinotus mookalee* is one of the ideal candidate species, mainly due to its good meat quality and high market demand. It is one of the fast growing carangid and is encountered rarely in the capture fisheries. The species is able to acclimatize and grow well even at a lower salinity of about 15 ppt and hence it is suitable for farming in the vast low saline pond waters of our country besides its huge potential for sea cage farming.

At Visakhapatnam Regional Centre of CMFRI, successful broodstock development induced spawning and larval rearing of Indian pompano was achieved for the first time in the world. Wild collected pompano of size ranging from 2 to 4 kg were stocked in sea cages. The fishes were fed twice a day with squids and sardines @ 5% of body weight supplemented with vitamin and mineral mixture. After one year of rearing in sea cages, the brooders attained a size range of 4 to 5.5 kg. The sexes were determined by intra-ovarian biopsy and males and females were segregated and stocked in separate cages. Intra-ovarian biopsy of females was done at regular interval to assess the size of the intra ovarian ova.

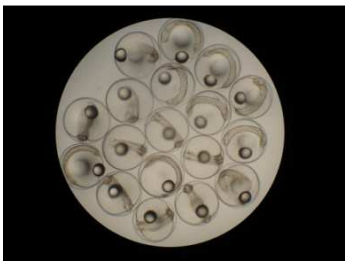
On 26.02.2014, two females with mature ova and two oozing males were selected for induced breeding. The females weighed 4.5 kg and 4.0 kg where as males were 5.0 kg and 4.5 kg in weight. Selected males and females were stocked in hapa of 3 m depth and 2 m diameter, which was fixed inside a 6 m diameter sea cage and induced for spawning with a single dose of hCG in the early morning of 26th February 2014. Spawning was observed after 36 hrs after injection. The floating eggs were collected with a scoop net of 500µ mesh and finally the hapa was lifted for collecting the remaining eggs. The total eggs spawned were estimated to be around 80,000.

Brooder of *Trachinotus mookalee*



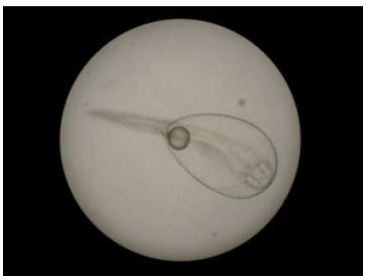
Cannulated ova of T.mookalee

Fertilized eggs of *T. mookalee*



Embryonic development in T. mookalee

The fertilized eggs were treated with 15 ppm iodophore solution for 10 min. to avoid contamination. The treated eggs were washed and stocked in glass aquarium for incubation. The size of the fertilized eggs was 950-1000µ. The eggs hatched out after 22-24 hrs of incubation at a temperature range of 28-30^{o} C. The hatching rate was estimated to be 80%. The newly hatched larvae measured from 2.1-2.2 mm in total length. The mouth opening was formed after 42-46 hrs post hatch. Green water was used for larval rearing. Artemia nauplii were also used in larval rearing tank from 9th day onwards. Weaning of larvae with inert diet was started from 15th day onwards. Metamorphosis of the larvae started from 17th day onwards and was completed by 22nd day. The size of the metamorphosed fry ranged from 16 to 17 mm. This is the first successful larval rearing of Indian pompano in the world. This success will go a long way in promoting mariculture in cages as well as in grow-out ponds in the country.



Fertilized eggs of *T. mookalee*

Larvae of *T.mookalee* (2 dph)

Larvae of *T.mookalee* (6 dph)

Metamorphosed fry of Indian pompano

Seabream (Vizhinjam)

Small and medium sized fishes of Goldlined seabream, *Rhabdosargus sarba* were collected from hooks and line and were maintained in cages at Vizhinjam for broodstock development. Fishes less than 1 kg or below 30cm in total length (TL) are all males. Fishes measuring above 30 cm TL, showed ovarian development.

Rhabdosargus sarba

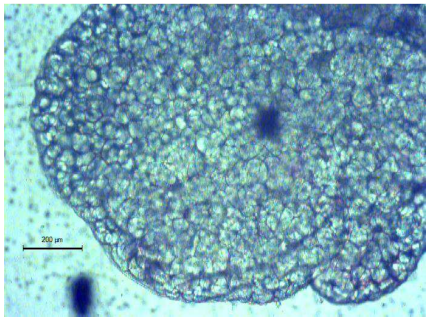
Broodstock development of goldlined seabream

Snappers (Karwar)

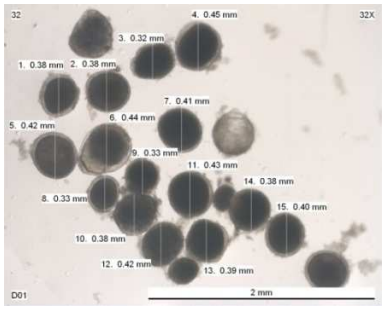
Collection and maintenance of snappers (*Lutjanus argentimaculatus*, *L. russelli*, and *L. Johni*) from wild for broodstock development was carried out at Karwar. The fishes with a weight of more than 1 kg were PIT tagged and maintained in separate cage and fed with crabs and squids. Fishes weighing more than 1 kg were cannulated and it was recorded that a total of 10 nos. of fishes were males and 9 nos. were females. The red snapper *L. argentimaculatus* weighing 1.5 to 2.5 kg were collected from the wild and were stocked in a sea cage in Kochi. On Cannulation, it was found that the gonads of most of the fishes were in maturing stage

Broodstock cage launched at Kochi

Broodstock of Malabar red snapper



Honey comb stage of ovary in Snapper



Cannulated eggs of *L. argentimaculatus*

Indian Halibut (Chennai)

The broodstock development of the Indian halibut, *Psettodes erumei*, was initiated at Kovalam, Chennai. Reproductive biology of the species was studied and the sexes were found to be separate. Observations on adult fishes sampled from the fish landings at Kovalam indicated size range of 225-545 mm (females) with fecundity ranging from 19740 to 300699. The GSI was found to range from 2.27% (in fish of 427 mm TL) to 8.22 (in fish of 225 mm TL). Depending on the ovarian maturation stage, the number of eggs per gram ranged from 1420 to 3850. The fishes bred twice in captive conditions, one spawning yielded fertilized eggs with development progressing for 16 hours, the next spawning did not synchronise with male response and thus the eggs were not fertilized

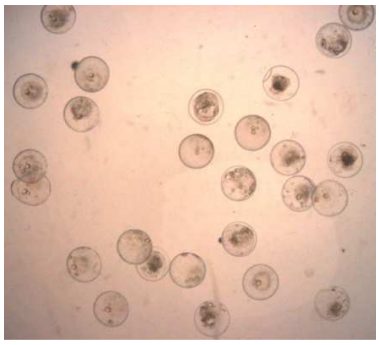
Halibuts in holding tank

Adult female with ripe gonads

Testes

Ovaries

Fertilized eggs of *P. erumei*



Embryonic development of eggs of *P.erumei*

Broodstock development and breeding of Shellfishes

Breeders of sand lobster *Thenus unimaculatus* were developed in the Kovalam Field lab facility responded and twelve numbers spawnings were obtained. More than 60 brooders of *Petrarctus rugosus* were developed and several spawnings were obtained. A pair of the deep sea scyllarid lobster *Scyllarides tridacnophaga* spawned in capivity in August 2013. Three egg bearing females of the portunid crab *Portunus pelagicus* released zoeae and a new crab rearing facility was set up for rearing the larvae with rotifer and microalgal culture. Larval development progressed till the second zoeal stage. Wild spawners are being used for further broodstock development and spawning trials

Ornamental Fish

Broodstocks of the following species of marine ornamental fishes were maintained experiments on scaling up of seed production were carried out.

Pomacentrus caeruleus – blue damsel

Dascyllus aruanus – humbug damsel

D. trimaculatus – three spot damsel

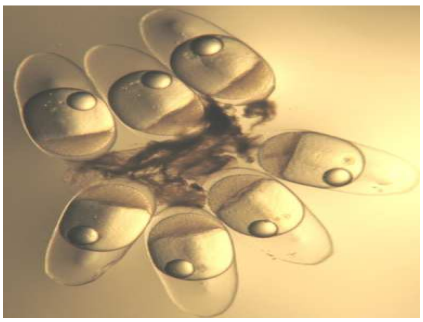
Neopomacentrus nemurus – yellow tail damsel

Amphiprion sebae - sebae clown fish

Chromis viridis -Green damsel fish

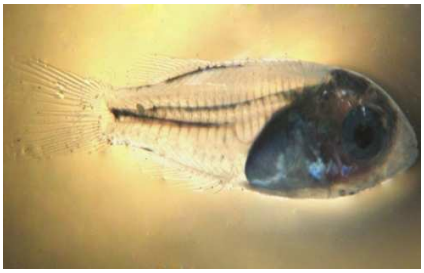
Amphiprion percula – Percula clown fish

Seed production of the Sapphire devil damselfish *Chrysiptera cyanea* was standardised during the period at Mandapam.



Fertilized eggs of Sapphire devil

Newly hatched larva



Larvae about to metamorphosis

Juveniles of Sapphire devil

Broodstock development of tomato clown, *A. frenatus* and Moon Wrasse- *Thalassoma lunare* and Cleaner wrasse, *Labroides dimidiatus* were carried out. Broodstock development and spawning was achieved for moon beam angel *Centropyge falvipectoralis.* Different size groups of midnight angel *Centropyge falvipectoralis* were reared for broodstock development. The fishes showed spawning behaviour on the day of full moon after rearing for about 4 months. The larvae were very thin and the size ranged from 1.1 to 1.5mm and had small yolk sac.

Moon beam angel *Centropyge falvipectoralis*

Newly hatched larva of *Centropyge falvipectoralis*

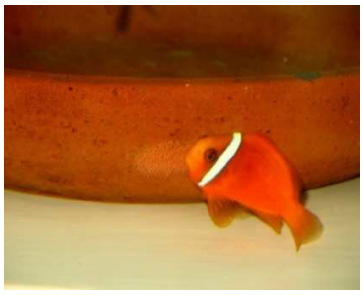
Broodstock development and captive breeding of Redhead *Pseudochromis dilectus* (Family *Pseudochromidae)* was achieved. Spawning took place during early morning and it lasted for one to two hours, during which the female gradually produces a ball-shaped egg mass. The diameter of the spherical egg ball varied between 25 to 35 mm and consisted of 400 to 500 spherical eggs. Size of egg: 1743 to 1919 micron during incubation and all the eggs were interconnected by fine threads. The newly hatched larvae were photo positive and have a total length of 5.1 to 5.3mm with very small yolk sac. Apart from a few green pigment cells, the body is completely transparent and contrasts sharply with the well pigmented eyes. The mouth gape of newly hatched larvae measured to 150 to 160 micron. First feeding started at 10 to 12 hrs after post hatch. The larvae are very active swimmers and utilize the entire water column although an assemblage of larvae is found near the light in water column.

Different experiments were carried out for larval rearing of dotty backs, out of this, the feeding the larvae with micro algae Chlorella and Nannochloropsis in 1:1 proportion at 1 laks cells/ml from 0 to 14th day, Provided rotifer at concentration of 30-50 Nos/ml from 3rd to 5th day and from 5th day to10th day (Enriched Rotifer 20 to 25 nos/ml + copepod nauplii1 to 5 nos /ml) and From 11th to 14th day (rotifer 5 to 10 Nos/ml+ nauplii1 to 5 nos /ml+ newly hatched artemia nauplii 10 to15 Nos/ml) has given 30-40% survivability.

Broodstock development and successful breeding of four species of clown fish viz. *Amphiprion ephippium* , *A.frenatus*, *A.clarkii* and *A.peridarion* was achieved for the first time in India. Broodstock development and successful breeding of clown fish viz. *Amphiprion ephippium* was achieved at Mandapam for the first time in India. The broodstock of *A. ephippium* were maintained in the aquarium glass tanks and fed twice with chopped squid and shrimp meat, and once with artificial fish feeds. PVC pipes/ earthen pots were provided in the tanks to serve as substratum for laying of eggs. They tanks were also provided with a sea anemone. After incubation of 8-9 days hatching of the eggs occurred. The total length of the newly hatched larvae was around 5 mm and the mouth gape was 200µ. Larviculture was carried out mainly with rotifers and followed by larval inert diets. The metamorphosis was completed during 14-16 days. The juveniles start epibenthic life from 21days onwards.

Fire clown brooder

Brooders of Pink skunk clownfish



Male *A. frenatus* guarding eggs

Brooders of A.*clarkii* guarding the eggs

Forty numbers (Average TL = 50.25mm) of hatchery produced *A. frenatus* were stocked in 500-liter Perspex tanks in Kochi and the impact of temperature was studied. It showed no significant somatic growth difference in both male and female in different temperatures.. However, the gonadosomatic index (GSI) varied between 1.46 to 2.52 in the females and 0.51 to 1.02 in males at different temperatures. It was noted that that the GSI was highest at 29°C. Newly hatched larvae were reared in 6 hrs light:18 hrs dark, 12 hrs light:12 hrs dark, 18 hrs light: 6 hrs dark and 24 hrs light: 0hrs dark up to 15 days of post hatch (DPH). It was seen that 24hrs light: 0hrs dark yielded the best survival rate of 80-85% of *A. frenatus*. Juveniles of ***A. frenatus, A. nigripes*** and ***A.*** *ocellaris* reared in sea cages showed better growth and colouration when compared with the same grown in indoor tanks.

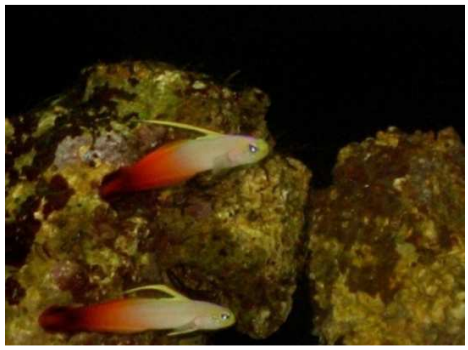
Cages employed for grow out of ornamental fishes

***A. ocellaris* reared in cages**

***A. ocellaris* reared in hatchery**

Broodstock development of five species of ornamental fishes *viz. Nemetelotris magnifica, N.decora, Ptereleotris evides, Pholidichthys leucotaenia* and *Pterapogon kauderni* are progressing

Brooders of *Ptereleotris evid*es



Pair of *Nemateleotris magnifica*

The technologies for scaling up hatchery production of the following species were carried out.

- *Amphiprion percula*
- *Amphiprion sebae*
- *Chrysiptera cyanea*
- *Pomacentrus caeruleus*
- *Dascyllus aruanus*

Amphiprion percula

Amphiprion sebae

Chrysiptera cyanea

Pomacentrus caeruleus

Dascyllus aruanus

Juveniles of *Amphiprion ephippium*

Hatchery produced juveniles of *A. frenatus*

Hatchery produced juveniles of *A. clarkia*

Mass seed production of *A. percula*, *Chrysiptera cyanea*, *Dascyllus aruanus and Pomacentrus caeruleus* was carried at the Mandapam Regional Centre. The amount realised through sales of the same was deposited under the ICAR Mega Seed project and inhouse project. A total of Rs.2,10,000/- and Rs.36,900/- were generated and remitted to the ICAR account under the mega seed and in-house projects respectively

Studies on larviculture of Damselfishes

The most widely traded pomacentride in the international market in the recent past include the humbug damsel (*Dascyllus aruanus)*, the three spot damsel (*Dascyllus trimaculatus*) and the blue damsel *Pomacentrus caeruleus*. Methodologies for breeding and seed production of these three species of damselfishes were developed and several trials of

seed production were carried out. Experiments were conducted to study the impact of greenwater and live feeds during the initial phase of larviculture.

The most critical aspect of larviculture of pomacentride other than clownfishes is the underdeveloped state of larvae at hatching and the consequent problems of starter feed. The three species of damselfishes studied were with altritial type of larvae and the mouth gape of newly hatched larva ranged from 150 – 200 µ. Trials on feeding with the available strain of the rotifer *Brachionus rotundiformis* as starter feed were not successful. The co-culturing of the selected two species of copepods *viz. P.serricaudatus* and *E.acutifrons* in greenwater along with larvae yielded positive results. The small size of the first naupliar stages of the copepods employed and the availability of different sizes of nauplii during the initial phase of larviculture had initiated and sustained the first exogenous feeding of the larvae. The initial stages of nauplii noted in the larviculture system measured from 60 – 80 µ, which is suited for the first feeding of the larvae. The high EPA, DHA and ARA content of copepods also would have facilitated the larval survival and growth.

The maintenance of copepods in multiplicative phase in the larviculture system is the crucial factor for the survival of the larvae. An optimum cell count of green water was found to be suited for the purpose. The cell count range of 1×10^4 - 6×10^4 cells ml^{-1} would have been too low for the multiplication of the copepods. The cell count range of 1×10^6 - 6×10^6 appears to be too high as it would have affected the filter feeding of the copepods. Hence the cell count range 1×10^5 - 6×10^5 cells ml^{-1} appears to be optimum for multiplication as was indicated by the maximum number of egg bearing copepods and nauplii. The naupliar count alone cannot be taken as an indicator of multiplication due to the fact that most of the newly hatched nauplii will be fed by the larvae. The better survival of the larvae can be directly attributed to the availability of freshly hatched nauplii which was indicated by the abundance of egg bearing copepods and nauplii in the larviculture system. It is felt that survival rates could be further enhanced if the copepods in the larviculture system could be kept at optimum production level.

The larviculture systems experimented with copepods and rotifers as live feeds were not successful. The rotifers multiplied rapidly by parthenogenesis and filled the system .The copepods being sexually reproducing could not keep pace with the rotifer multiplication and were rapidly eliminated from the system. The larvae of the species experimented were unable to accept rotifers as starter feed which resulted in total mortality

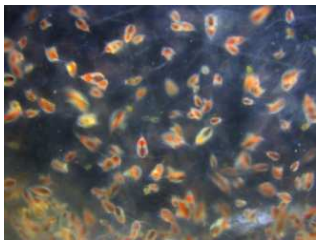
of the larvae. It is also noted that the critical phase of larviculture was over by 15 – 20 dph. After 15-20 dph, the mouth gape had reached around 450µ and can be fed with freshly hatched Artemia nauplii. The absence of any mortality from this stage onwards indicated that once the starter feed problem is solved; the larviculture of these species could be accomplished easily with conventional live feeds.

Studies on copepods as live feed for larviculture

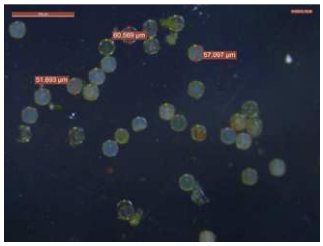
Two species of harpacticoid copepods *viz, Longipedia weberi* and *Microsetella norvegica* were isolated and their biology was studied. The adult of *L. weberi* measured. The length range of adults of *L. weberi* was 550 to 945 microns and the early nauplii measured about 75 microns. The frequentity ranged from 15 to 18 nos of eggs per batch. The nauplii became adult within 7 to 9 days and released first batch of young ones by 12 / 13th day. The length range of *M. norvegica* adults was 277 to 540 microns and the early nauplii measured around 57 microns

Protocol for mass culture of *Acrocalanus gibber* developed at Vizhinjam

Mass production of Calanoid copepod *Temora turbinata* was standardised. For adults an intensity of 1000/l and for naupliar stages 2000-2500/l. The culture was mainly fed with a combination of *Isochrysis galbana* and *Nannochloropsis* sp. Protocols for feeding, rearing, isolation, cleaning, and maintaining culture without any contamination were also developed. Continuous culture of another promising species of copepod *Pseudodiaptomus serricaudatus* was maintained. Mass culture of *P. serricaudatus* was initiated in tanks of 1000l capacity. For adults an intensity of 600-800/l could be obtained. The culture was mainly fed with a combination of *Isochrysisgalbana* and *Nannochloropsis* sp. Protocols for feeding, rearing, isolation, cleaning, and maintaining culture without any contamination were also standardised. Larviculture trials were conducted using copepod (*Temora turbinata*) naupliar stages as feed for larvae of *Amphiprion frenatus* against the traditional practice of rotifer and artemia –naupleii combination. A 30 day trials give 24.5% better survival, better growth and brighter colouration in copepod fed larvae.



***Temora turbinata* (live)**



Eggs of *Temora turbinata*

Nauplii (5 days old) of *T.turbinata*

Juvenile of *A.frenatus* fed with copepod on 30th day

MD/IDP/04 - Innovations on sea cage farming and development of sustainable Capture Based Aquaculture (CBA) systems (2009-2012)

AND

FISHCMFRISIL201202400024 – Innovations in cage farming and coastal mariculture (2012-2014)

The seed transported from the hatchery were first acclimatized to the local water conditions of the ponds or sea cages. Then they were stocked in ponds or sea cages after ensuring their successful adaptability to the local environment. Cage farming of cobia was experimented for the first time in India at Mandapam Regional Centre of CMFRI from the hatchery produced fingerlings. The fingerlings were stocked in grow-out cages after nursery rearing. The fish were fed with trash fish *ad libitum* twice a day initially and later once a day. The grow-out fishes of cobia could reach an average weight of 2 to 3 kg in 6 months and 4 to 8 kg in one year of culture period. The results show that cobia is a lucrative species for sea cage farming in India.

Pond farming of pompano was experimented for the first time India at Andhra Pradesh from the hatchery produced fingerlings. Pompano fingerlings were transported to low saline ponds at Anthervedi, East Godavari District, Andhra Pradesh to conduct demonstration of farming in earthen ponds. After proper acclimatization to the local environment, the fingerlings were released into ponds for grow-out culture. They were fed with floating pellet feed formulated specially by the Mandapam Centre of CMFRI and

manufactured by a private feed mill operator in Andhra Pradesh. The feeding, farm and health management procedures were also developed and standardized according to the availability of resources in the farming area. The common diseases of cobia and pompano recorded were Vibriosis and Gill parasitism, respectively. They were addressed with suitable preventive and control measures to have successful farming. The details of farming demonstrations and harvesting are given in Annexure 4.

Grow-out Farming/ Culture

Sea cage farm at Mandapam

Sea cages with security cabin

Cobia sampling in demonstration

Cobia fingerlings in demonstration

Cobia fingerlings in demonstration cage

Cobia seed distribution for demonstration

Preparation of low value fishes for feeding

Feeding at sea cages with low value fishes

Cobia grow-out sampling

Harvested cobia being weighed

Fish farmer with harvested cobia

Harvested cobia from sea cage farming

Harvested cobia from sea cage farming

Transportation of harvested cobia

Disease monitoring of pompano farming at Andhra Pradesh by the team member

Disease monitoring of pompano farming at Andhra Pradesh by the team member

Participatory farming of pompano in Tamil Nadu

Participatory farming of cobia in Tamil Nadu

Feed manufacturing by collaboration with a private feed manufacturing entrepreneur at Andhra Pradesh

Pompano nursery and grow-out in Andhra Pradesh

Pompano harvest function at Andhra Pradesh

Harvested Pompano from pond culture

Participatory demonstration of Pompano farming in Andhra Pradesh

Pond cultured pompano from Andhra Pradesh

Creating awareness on cage farming

Cage farmed pompano in Tamil Nadu

Cage farmed pompano

Harvested Pompano from sea cages

Pond harvested Pompano ready for marketing

Cage harvested pompano in Tamil Nadu

Kochi

The farming and harvest of *M. cephalus and E. suratensis* in 2 HDPE 6 m cages were carried out. Fourteen numbers of *M. cephalus* weighing above 1 kg is being maintained in a private hatchery towards broodstock development and seed production of the species. In a square 4 m x 4 m x 4 m dismantling and reassembling type GI cage, 25 numbers of *M. cephalus* is being reared in open backwater at Pooyappilly for developing the broodstock of the species. Seed survey were carried out in an around Chellanam and seeds of *Siganus canaliculatus* available from February to September. About 1000 seeds (20 to 40 mm) collected and stocked in cages & fed with pellet feed @10% of their body weight.

A total of 10,000 numbers of *M. cephalus* fry (size: 1.5 to 2.0 cm) were collected with the help of fishermen at Puthuveypu area, Vypeen Island for nursery rearing trials. They were stocked in 2m x2m x1.5 m velon happas in a private earthen pond located 2 km away from the collection site. Each happa was stocked with 2000 numbers. Feeding was done thrice a day with dry mix of wheat bran and wheat flour mixed at 1:1 ratio. During nursery phase some mortality was observed due to sudden influx of rain water. After two months, about 7500 numbers were distributed in 2 m x 2 m x 1.5 m HDPE happas with 10mm mesh size at the rate of 1500 numbers per happa. After 150 days, 5500 numbers of the seed were transported and stocked in cage during January 2012. They reached a size of 10-15 cm during the nursery phase

A 6 m diameter HDPE cage was installed at Chittattukara Panchayat, Ernakulam district during for farming trials. The volume of the net bag is calculated to be 127 m3. The cage is moored at a depth of 5.5 m using anchors as well as bamboo poles. The salinity of the site is between 15-18 ppt. A total of 5500 numbers of juveniles measuring 10-15 cm size were stocked in the cage Godrej low protein floating pellet (22% Protein) is being

given ad libitum, thrice a day in a netlon floating feeding ring (2 m dia) installed inside the cage. Two hundred numbers of silver pompano brought from Mandapam RC of CMFRI and 150 numbers of Pearlspot produced at CMFRI hatchery, Cochin are also stocked in the cag**e.**

Two indigenously fabricated high-density polyethylene (HDPE) floating cage measuring 6 m diameter was used for cage culture . Pearlspot *Etroplus suratensis* fry (4-5 g) collected from the flood filled earthen ponds were directly stocked into the cages. About 15,000 numbers of Pearlspot juveniles were stocked in one cage. The other cage was stocked with 2000 numbers of 40-50 g size seabass *Lates calcarifer*. Wet feed dough balls using commercial low protein pellet feed was recommended for Pearlspot feeding. While, seabass was given 35% protein pellet feed. About 2000 numbers of pearl spot *Etroplus suratensis* (5-10 cm) were stocked as an additional stock along with *M. cephalus* after two months of stocking. During harvest *i.e.,* after four months of stocking, about 225 kg was harvested from the cage.

Calicut

The harvest of Pearl Spot from low cost cages carried out at Madhav Fish farm of Mr. P.K. Venugopal, an innovative fish farmer. The fish was harvested after 8 months after introducing in the cages. Total ten numbers of cages each costing Rs. 2,500/- was introduced with 150 numbers of Pearl Spot. Total 250 Kg was harvested. The culture of 1200 nos. of Silver Pompano (*Trachinotus blochii*) and 1500 nos. of Pearl Spot *(Etroplussuratensis)* were of initiated in beach ponds at Beach Farm. Integrated farming of Pearl Spot *(Etroplus suratensis)*, Silver Pompano (*Trachinotus blochii*) and White Prawn (*P. indicus*) was initiated in a pond at Atholi near Calicut with farmer's participation.

Sea cage farming of Mullets

Nursery rearing of Mullets in seacage

Harvest of Mulltes in Kerala

Harvested Pearl Spot in Calicut

Karwar

Survey on selection of site suitable for marine cage farming was carried out at three states viz., Karnataka, Goa and Maharashtra states. Other than Karwar, three places were selected for cage culture operations at Uttar Kannada District, viz., Kumta (Vanahalli Bay) and Amdalli (Kodar Bay). Polem Bay and Canacona Bay are selected at Goa state whereas, in Maharashtra state Ratnagiri outer harbour I and II are selected for cage farming of marine finfish and shellfish. Two thousand numbers of Cobia fingerlings were stocked in two 6m diameter cages with a density of 4 nos/ m3 and 14 nos/m3 and were fed with fresh oil sardines @ 5% biomass. Cobia attained an average weight of 3.5 kg and 10.5 kg which were stocked with densities of 4 nos/ m3 and 14 nos/m3 after 360 days of culture.

Five species of marine finfishes *viz*., Asian seabass, Cobia, Pampano, Snappers and Sea breams were cultured at Karwar in 6m diameter cages with varying stocking densities. Asian seabass, *Lates calcarifer*, seeds were brought from RGCA, reared in a private hatchery for one month till they reached 15g size and stocked at a density of 14 nos/m^3 in 6m marine cages and were cultured for an year. Two thousand numbers each of Cobia, *Rachycentron canadum* and Pampano, *Trachinotus blochi* seeds were transported from Mandapam Regional Centre, stocked in two different 6m diameter cages with a density of 14 nos/m^3. Average weight attained for Asian seabass during 360 days of culture was 1.8 kg. Cobia attained an average weight of 8 kg during this period. Average weight of Pompano was 500 g at 360 days of culture.

Two 6 m diameter HDPE cages introduced in the Karwar Bay with 2500 and 6200 numbers of seabass seed were harvested and yielded 2 and 4 tonnes of fish respectively. The crop duration was only for 4.5 months. The FCR obtained was 1:3. The maximum

weight obtained was 1150 g with a production of 25 kg m-3. The feeding protocol developed at Karwar for seabass includes demand feeding, domestication of the stock to take the feed in a better way right from nursery rearing to farm, frequent net changing for better water exchange, development of better disease management protocols and twice a day monitoring of the stock.

Chennai

One participatory cage farming with fishermen society on lobster farming was carried out for a period of 50 days. The cage was operated by the fisherrmen society of the Kovalam village, Chennai. Indigenous Sintex milk cans/sealed/PUF filled tested buoys are used. Solar flicker lamps (6 Vx2 cell powered) flickering zonly in the night are used as night navigation signals on the cage. Survey of the coastal stretch from Pulicat to Mahabalipuram was done to identify seed collection sites. Seed collection sites were identified and seed of different fishes and lobsters such as milk fish *Chanos chanos*, grey mullet *Mugil cephalus*, and silver biddy *Gerres filamentosus*, sand lobster *Thenus orientalis* and spiny lobster *Panulirus homarus* were collected and brought to the laboratory at Kovalam. Trials on nursery rearing for the seed were conducted successfully at Kovalam.

Transfer of Farming Technology to stakeholders

CMFRI has developed the technology for breeding, seed production and farming in cages and ponds for selected marine fin fishes to meet the need of fisher-folk for carrying out small scale mariculture. This is a better alternate livelihood option to sustain the marine capture fisheries. Initially on farm trials were carried out for both cobia and pompano in cages and ponds. Based on the trials, it was concluded that the cobia was more successful in sea cages and the pompano was successful in ponds with low saline waters although both the species can be reared in either conditions.

The information about the technology has spread to different parts of the country. The awareness about the technology was created among the aqua farmers/entrepreneurs and the officials of Central and State Government through mass media (TV, videos, magazines, Journals, newstories, newspaper, internet *etc*.), group contacts (meetings, lectures, demonstrations, workshop, seminar and trainings) and individual contacts (farmer to farmer approach). Several hands-on training programmes were also conducted on

hatchery and farming techniques in order to develop technical man power and to disseminate the technology.

The field demonstrations conducted at different places of the maritime States have aroused interest amidst the aqua farmers/entrepreneurs. Further, the participatory demonstrations conducted at different locations with aqua farmers created confidence among the farmers on the performance of the technology. Farmers' feedback and perception about the technology were also collected and evaluated. Field day and harvest programmes were organized periodically to project the technology among the group of interested aqua farmers/entrepreneurs. The components of transfer of technology in the process of adoption of the technology are given in Table 1 and 2.

''Seeing is believing'', by seeing the performance of cobia and pompano farming, the attitude has completely changed and many are now venturing into cobia and pompano farming in different coastal states of our country. The process of transfer of technology on cobia and pompano farming is depicted in the Figures 1 and 2. At present the awareness and knowledge about the farming of cobia and pompano is very high. Hence, the demand for cobia and pompano seeds is very high from the maritime States of the country. In order to meet the demand of seeds, participatory demonstrations of the hatchery technology are also being initiated at Tuticorin in Tamil Nadu, Bhimavaram, Palakol and Visakhapattinam in Andhra Pradesh and Karwar in Karnataka.

Experiments on Technology Demonstration of farming of cobia and silver pompano

(i) Sea cage farming demonstration of cobia through participatory mode with Cobia Aquaculture Fishermen Welfare Society, Rameshwaram, Tamil Nadu

Nine sea cages made up of GI pipes were fabricated by the private fishermen society, the Cobia Aquaculture Fishermen Welfare Society and installed in Gulf of Mannar with the technical guidance from CMFRI. The circular cages of 6 m diameter and 3 m depth were fabricated and installed. About 6000 nos. of cobia fingerlings of 12 cm length and an average weight of 20 grams were stocked. The fishes were fed *ad libitum* twice daily with low value fish. The water temperature in the cage sites are being recorded at regular intervals. The cost of cages, feed and labour are fully borne by the society. The hatchery produced seeds and technical inputs are provided by the institute. The farming demonstration is in progress.

(ii) Demonstration of cage farming of cobia through participatory mode with M/s. Vitality Aquaculture Pvt. Ltd., Thoothukudi, Tamil Nadu

A total of four numbers of sea cages made up of GI pipes were fabricated by the private entrepreneur and installed in Gulf of Mannar with the technical guidance from CMFRI. The circular cages of 6 m diameter and 3 m depth were fabricated and installed. About 2000 nos. of cobia fingerlings of 12 cm length and an average weight of 20 grams were stocked. The fishes were fed *ad libitum* once in a day with low value fish. The water temperature in the cage sites are being recorded at regular intervals. The cost of cages, feed and labour are fully borne by the entrepreneur. The hatchery produced seeds and technical inputs are provided by the institute. The farming demonstration is in progress.

(iii) Demonstration of cobia farming in sea cages through participatory mode with a fishermen group of the adjoining village (Maraikayarpatinam) of CMFRI

Two numbers of sea cages made up of GI pipes were fabricated by the private entrepreneur and installed in Gulf of Mannar with the technical guidance from CMFRI. The circular cages of 6 m diameter and 3 m depth were fabricated and installed. About 400 nos. of cobia fingerlings of 15 cm length and an average weight of 25 grams and 2000 nos. of fingerlings of 10 cm length with an average weight of 18 grams were stocked. The fishes were fed *ad libitum* once in a day with low value fish. The water temperature, salinity and pH in the cage sites are being recorded at regular intervals. The cost of cages, feed and labour are fully borne by the fishermen themselves. The hatchery produced seeds and technical inputs are provided by the institute. The farming demonstration is in progress.

(iv) Demonstration of pond farming of silver pompano through participatory mode with private entrepreneurs in Chidambaram, Tamil Nadu

About 1000 nos. of pompano fingerlings of 6.5 cm length and an average weight of 8.7 g were stocked in a one acre pond. The growth of pompano in six months culture period was observed to be an average length of 20.5 cm and a weight of 135.0 g. Another batch of about 1400 nos. of pompano fingerlings of 5.0 cm length and an average weight of 7.2 g were stocked. The growth of pompano in three months period

of culture was observed to be an average length of 14.2 cm and a weight of 50.3 g. The demonstration is in progress.

(v) Demonstration of silver pompano farming at Pedda Kammavaripalem, Nagayalanka , Krishna District, Andhra Pradesh

About 3,500 nos. of pompano fingerlings of 6.5 cm length and an average weight of 8.7 g were stocked in a one acre pond. In the same pond *Litopenaeus vannamei* seeds were stocked to study the co existence of silver pompano and *L. vannamei*. The growth of pompano in eight months culture period was observed to be an average length of 21.8 cm and a weight of 150.0 g. This slow growth was due to zero salinity prevailed for a period of 3 months in the water source and pond. Whereas *L. vannamei* reaced an average size of 120 grams and were harvested. Another batch of about 3,500 nos. of pompano fingerlings of 5.0 cm length and an average weight of 7.2g were stocked in the HDPE cages by the farmer in the Krishna river and being reared by feeding with low value fishes and the farming is in progress.

Transfer of Technology

Initial happa rearing of pompano fingerlings

Pond farming of pompano at Pedda Kammavaripalem, A.P.

Feeding zones created for dispensing the floating pellet feed to pompano

Cage farming of pompano in Nagayalanka, Krishna District, Andhra Pradesh

Paddle wheel aerators installed in the pond at Pedda Kammavaripalem, A.P.

Sampling of pompano in the pond located at Pedda kammavaripalem, Nagayalaka, Krishna District, Andhra Pradesh

Co - culture of pompano and *L. vannamei*

Harvested *L. vannamei* from the pompano pond

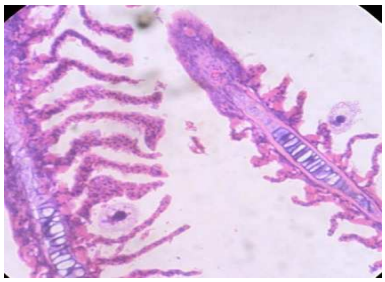
Pompano farming demonstration at Elanthirimedu Village, South Pichavaram, Chidambaram, Tamil Nadu

Sampling of pompano in cultured at South Pichavaram, Chidambaram, Tamil Nadu

Disease Management Studies as a part of innovations in cage farming revealed that the dinoflagellate *Amyloodinium ocellatum* is one of the most important pathogenic ectoprarasite affecting the cultured marine and brackish water fish, causing *Amyloodiniosis*. A total of thirty silver pompano, *Trachinotus blochii* with an average length and weight of 20 cm and 900 g respectively, were maintained for broodstock development and breeding purpose at Mandapam Regional centre of CMFRI. Suddenly all the animals showed difficulties in breathing, loss of appetite, rubbing its body on the sides of the tank/ objects in the tank and also an erratic swimming behavior and finally caused acute mortality.

Grossly the operculum showed focal area of erosion. Gill showed excessive mucus secretion and pale discolouration. Microscopic examination of the fresh gill filaments showed the presence of the adult parasite feeding stage (Trophont). Histopathologically, the gill showed erosion and necrosis of primary and secondary lamellar filament. The causative organism A. *ocellatum* was identified based on the clinical signs, gross and microscopic lesions. Fresh water dip and 5 per cent Povidone Iodine dip treatment was effective to control the condition in affected fish.

***A. ocellatum* infestation in ompano broodstock gill lamellae**



Histological sections showing the damege caused to gill lamellae and presence of trophonts

Trial on Integrated Multi Trophic Aquaculture (IMTA) in a participatory mode

One trial on Integrated Multi Trophic Aquaculture (IMTA) by integrating the seaweed *Kappaphycus alvarezii* with cobia is being initiated at Munaikadu (Palk bay) in a participatory mode with fishermen group. Three GI square cages of 4.5×4.5 m outer dimension and 3.5×3.5 m inner dimension were launched on 31st March 2014. Hatchery produced 400 cobia fingerlings (133 nos. in each cage) of average length and weight of 20.3 cm and 49.2 grams respectively were stocked in three cages on 1st April 2014. The stocking density was between 5-6 numbers per cubic meter. The fishes are being fed with trash fish twice a day.

Launching of cages for IMTA trial

Launching of cages near the seaweed farm

Dr.G.Gopakumar & scientists handing over cobia seed to fishermen group at Munaikadu, Tamil Nadu

Stocking of Cobia seed inside the cages for IMTA

Transfer of Technology – Field and Participatory Demonstrations

The team leader distributing the Pompano seed to a farmer at Vedhalai for participatory demonstration

Dr. M.V. Gupta distributiong the seed to a farmer from Tuticorin

The team leader at a function on popularising the Cobia farming at Rajulalanka, A.P.

The team leader along with members distributing the Cobia seed to farmer in Rajulalanka, A.P.

The harvest function of pond-farmed Pompano at Antervedi, Andhra Pradesh

The harvest function of pond-farmed Pompano at Antervedi, Andhra Pradesh

Training of scientist from fisheries intitutes on finfish seed production technology

Training on Pompano seed production to private hatchery technicians

Hands-on training on live feed culture to hatchery technicians

Training session in progress

Inauguration of a training programme by the ADG Dr. Madan Mohan

Inauguration of national workshop on cobia seed prouction technology

CIFE sholars for training on marine fin fish seed production with the team of scientists

Inauguration of a training programme on marine fin fish seed production technology

MoUs signed by Mandapam Regional Centre of CMFRI for Transfer of Technology

Sl.No	Name of the Firm		Technology transferred
1	Mr. Ramana Reddivari, Bangalore, Karnataka	:	Pond farming of Pompano
2	M/s Vishnupriya Aqua Feeds, Bhimavaram, Andhra Pradesh	:	Hatchery and Farming of Pompano
3	Mr. Simon Varghese, Alappuzha, Kerala	:	Seed production of mullets
4	M/s Vitality Aquaculture, Tuticorin, TN	:	Hatchery and farming of cobia and pompano
5	Mr. Raghu Sekar, Nagaylanka, Andhra Pradesh	:	Farming of pompano
6	Mr. Srinivasa Raju, Palakollu, Andhra	:	Hatchery and farming of

	Pradesh	pompano
7	M/s Indo-aquatics Ltd., Nellore, Andhra Pradesh	

Patents developed/ applied

A patent application has been filed for "GROWOUT PELLET FEED FOR SILVER POMPANO, *Trachinotus Blochii* (LACÉPÈDE) AND A PROCESS THEREFORE TO INCORPORATE FATTY ACIDS" under application no.2965/CHE/2013 dated 03/07/2013 in the name of Indian Council of Agricultural Research and submitted to the Intellectual Property Rights (IPR) office, Chennai.

Major Infrastructure developed /renovated during the period

The following are the infrastructure facilities developed during the period and a detailed report follows.

Karwar

- Nursery rearing facility
- Sea cage farm

Chennai

- Shellfish hatchery facility at Kovalam

Mandapam

- Research and Administrative Block
- International Trainee`s Hostel
- Wet and Dry Laboratories
- Hatcheries for finfish and shellfishes
- Recirculation Aquaculture System
- National Marine Finfish Brood bank
- Centralized Instrumentation Facility
- Sea Cage farm
- Mariculture Complex
- Library
- Marine Reef Aquarium
- Marine Museum
- Conference hall
- Guest house
- R.O plant
- Residential quarters

At the Mandapam Regional Centre of CMFRI, India's first marine brood fish bank facility, a state of art Recirculating Aquaculture System (RAS) laboratory and a Mariculture complex were commissioned by the Hon'ble Secretary, DARE & Director General of ICAR, Dr. S. Ayyappan on 12th May 2013. A new Research & Administrative Block and an International Trainees' Hostel were also inaugurated by the Hon'ble Director General. The function was graced by Dr. B. Meenakumari, Deputy Director General (Fy.), ICAR, Dr. Madan Mohan, Assistant Director General (Fy.), ICAR, Shri. K. Nanthakumar, IAS, District Collector, Ramanathapuram and Commandant H.H. More, Commanding Officer, Indian Coast Guard, Mandapam Station.

A national marine finfish brood bank where the brooders of high value finfishes can be developed for breeding and seed production was designed and built. The concept of broodstock bank was evolved, designed and the same was constructed at the Mandapam Regional Centre. The broodstock tanks with continuous bio-filtration system can be used to maintain broodstocks of high value marine finfishes like cobia, silver pompano, groupers, snappers, breams, *etc.*, in healthy condition. Maintenance of marine finfish broodstock in land based system is generally expensive, time consuming and labour intensive which prohibits the private sector / entrepreneurs to venture in mariculture. Understanding this bottleneck, the CMFRI has established a National Marine Fish Brood Bank at Mandapam aimed to hold broodstocks of commercially important marine finfishes and to supply quality eggs / newly hatched larvae to the private hatcheries for fingerling production. This facility is the first of its kind in India and was commissioned by the Hon'ble Director General.

Commissioning of National Marine finfish brood bank

DG viewing the brood bank facility

A recirculation aquaculture system with components such as drum filter, fluidized-bed bioreactor, protein skimmer, UV sterilizer and egg collection facility, is inevitable for healthy maintenance of the marine finfish broodstocks and year-round breeding. The system will serve to develop the broodstocks into spawners. The photo-thermal conditioning for accelerating maturation can also be incorporated into the system. The safety of the spawners and year-round controlled spawning are ensured in this sytem. The RAS facility, which was installed at Mandapam by importing sophisticated equipment from M/s. Aquatic Ecosystems, USA, is the first of its kind in the fisheries scenario of India. This facility was commissioned by the Hon'ble Director General.

Unveiling of plaque by District Collector at RAS

Hon'ble DG viewing the RAS facility

Massive infrastructure for broodstock development is needed for developing the broodstocks of larger species such as yellowfin tuna. The large scale fingerling rearing also requires extensive facilities. To meet these requirements, a mariculture complex consisting of high volume concrete tanks (4 nos each of 1250 tonne capacity) was designed and established on the Palk Bay side of the Mandapam Regional Centre of CMFRI. This facility would support standardising the technologies for broodstock development, grow-out culture and on-farm trials. This complex was dedicated to the nation by the Hon'ble Director General.

Unveiling of plaque by ADG at mariculture complex

Viewing the mariculture complex by Hon'ble DG

Hon’ble Director General inaugurated a small-scale marine ornamental fish production unit run by all women self help group established within the premises of the Mandapam Regional Centre of CMFRI.

Inaugurating the all women small-scale hatchery unit by DDG

Hon'ble DG observing the hatchery run by all women

Hon’ble Director General delivered the inaugural address and honoured the fish farmer and entrepreneurs.

Inaugural address by Hon'ble DG

Handing over the fingerlings to the farmer by Hon'ble DG

Honouring entrepreneur by Hon'ble DG

Honouring farmer by Hon'ble DG

Honouring farmer by Hon'ble DG

Honouring farmer by Hon'ble DG

Handing over the MOU with entrepreneur by Hon'ble DG

Handing over the MOU with entrepreneur by Hon'ble DG

DG with the staff of MRC of CMFRI

Press meet

Other Infrastructure Facilities at Mandapam

Ornamental Hatchery

Shrimp hatchery

Sea cage farm

Fish Farm