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Bikash Chandra Mohapatra
ICAR-Central Institute of Freshwater Aquaculture, Kausalyaganga, Bhubaneswar, Odisha, India

Kedar Nath Mohanta
ICAR-Central Institute of Freshwater Aquaculture, Kausalyaganga, Bhubaneswar, Odisha, India

Dukhia Majhi
ICAR-Central Institute of Freshwater Aquaculture, Kausalyaganga, Bhubaneswar, Odisha, India

Correspondence
Bikash Chandra Mohapatra
ICAR-Central Institute of Freshwater Aquaculture, Kausalyaganga, Bhubaneswar, Odisha, India

Indian major carps seed production through induced breeding in FRP hatchery at Bisoi, Mayurbhanj district, Odisha, India

Bikash Chandra Mohapatra, Kedar Nath Mohanta and Dukhia Majhi

Abstract
For demonstration and carp seed production, one unit of fiberglass reinforced plastic (FRP) hatchery consisting of one spawning pool, one incubation pool, one egg/spawn collection tank and one overhead tank of capacity 2000 liter for spawn production capacity of 1.0-1.2 million per operation in four days was established and operated in farmer's field at N.B. Pokhria Village under Bisoi Block, Mayurbhanj District, Odisha from 4 July, 2016. Induced breedings of Indian major carps (catla, *Catla catla*; rohu, *Labeo rohita* & mrigal, *Cirrhinus mrigala*) were conducted in the established hatchery using synthetic hormone 'Ovatide' for 1, 3 and 6 times in the monsoons of 2016, 2017 and 2018 (till 31 July), respectively. Total 7.0 lakh (rohu), 20.0 lakh (rohu 10.0, mrigal 3.0, and catla 7.0) and 48.5 lakh (rohu 28.5, mrigal 5.0, and catla 15.0) lakh spawn was harvested in 2016, 2017 and 2018, respectively showing a positive trend as the farmer is getting experienced year after year. Under the temperature range of 27-34ºC, spawning was observed after a latency period of 342-400 minutes (5.7-6.7 hours); fertilization rate recorded was 91.7-97.5% and spawn production was 1.02-1.18 lakh/kg body wt. of female in IMC. Highest fertilization rate (97.5%) was recorded in mrigal followed by rohu (92%) and catla (91.7%). Effective spawning period was 62, 53.3 and 40 minutes for rohu, catla and mrigal respectively.

Keywords: FRP carp hatchery, carp seed production, induced breeding, tribal farmer, Mayurbhanj district

1. Introduction
Aquaculture sector is expected to play a significantly greater role in contributing to food security, poverty alleviation and economic development of the poor. However, the global population is increasing and, in order to maintain at least the current level of per-capita consumption of aquatic foods (19.7 kg in 2013, FAO, 2016) [1], the world will require an additional 23 million tonnes by 2020. This additional supply will have to come from aquaculture. A number of studies have pointed a positive scenario for the role of aquaculture in providing the much-needed animal protein to the world population. Recognized as a powerful income and employment generator, aquaculture stimulates growth of a number of subsidiary industries and is a source of cheap and nutritious food, besides being a foreign exchange earner. Aquaculture in India has evolved as a viable commercial farming practice from the level of traditionally backyard activity over last three decades with considerable diversification in terms of species and systems.

Quality fish seed is the prime factor for increase of aquaculture production. Fish seed from natural sources of spawning possess uncertainty in availability, quality, mixing of predatory and weed fish seeds. The induced breeding in hatcheries helped in mass production of quality carp seed under controlled condition and assured timely supply of stocking material for culture farms [2]. Induced breeding is based on the principles of manipulating hormonal or environmental factors for stimulation of reproduction in fishes [3]. In India the first attempt for induced breeding was done in 1938 and the species was mrigal, *Cirrhinus mrigala* [4]. In 1957, minor carps (*Esomus danricus* and *Pseudotropius atherinoide*) were induced bred [5]. Induced breedings were successfully carried out in Indian carps, such as, *Labeo rohita*, *Cirrhinus mrigala*, *Cirrhinus reba* and *Labeo bata* through hormone injections [5]. The need for the production of quality fish seed in hatcheries to stock ponds, tanks and natural water bodies has steadily been encouraged, as it is the only practicable means of producing enough quality fish seeds.

Scarcity of carp spawn is a major problem for fish farmers in villages to stock their ponds [6, 7, 8, 9, 10, 11] and due to lack of technical knowledge and basic infrastructure facilities, such as hatchery system; induced breeding of carps was rarely adopted by farmers [12]. The contributions of several workers starting from hapa breeding to cemented eco-hatchery, and then to portable FRP hatchery have made easy in availability of fish seed for aqua-farming. For timely production of quality seed, "ICAR-AICRP on Plasticulture Engineering and Technology" Center at ICAR-CIFA, Bhubaneswar has designed and developed portable fiberglass reinforced plastic (FRP) carp hatchery [13, 14, 15, 16] and it has been installed and successfully operated in 26 states of India. The system is designed to create an environment for fish breeding in the farmers' field [2, 7, 8, 9, 10, 17, 18]. It is capable to bread 10-12 kg of female carps and equal quantity of males in one operation. In one run, 1.0-1.2 million spawn can be produced from the hatchery which is sufficient to stock pond area of about 30 hectares with stocking density @ 5000 fingerlings/ha [2]. There are several advantages of this hatchery *viz*., it is portable, easy to install and operate, requires less quantity of water during fish breeding and spawn production, needs less space for installation and the durable for about fifteen years [2, 14, 16]. In lean season, the hatchery can be used for ornamental fish rearing in which village women may take part in leisure time [2, 16]. One complete operation of the hatchery for 1.0 million spawn production requires 90m^3 water [19]. This hatchery can be a tool for biodiversity conservation through production of seed of endangered and threatened fish species [16].

The present work was carried out in the Farm of Shri Bhabendra Mohanta, a progressive tribal fish farmer from a remotely located village namely, N.B. Pokhria of Bisoi Block, Mayurbhanj District, Odisha during 2016-2018. Demonstration and production of seed was done through induced breedings of carps in FRP hatchery supplied and installed by ICAR-CIFA in his farm. The village habitants mostly depend on agriculture for their livelihood and aquaculture activities received less attention because of their dependency on outside agencies for quality carp seed supply and lack of knowledge on scientific aquaculture. Hence, steps were taken through Shri Bhabendra Mohanta, a model and award winning fish farmer of the region for organizing farmers' group for transmitting scientific fish farming and quality seed production techniques to them. Induced breeding of Indian major carps was initiated in 2016 in his farm for supplying quality fish seed to his farm and to the local farmers of the area.

2. Materials and Method

2.1 Study Area

As per Census 2011, Mayurbhanj District, Odisha has a total population of 22, 23,456; out of which 12, 58,459 are scheduled tribes (ST). Bisoi Block (Lat.22.262189 N and Lon. 86.17714 E) of Mayurbhanj District has 73,899 total population out of which 51,299 are ST. The farm of Shri Bhabendra Mohanta, a progressive fish farmer of N.B. Pokhria Village of Bisoi Block, Mayurbhanj District, Odisha, India was selected for installation and operation of fiberglass reinforced plastic (FRP) hatchery for quality carp seed production. The village is approximately 300km away from Bhubaneswar, the capital city of Odisha. Deviating from his traditional agriculture activities (mainly the upland rice cultivation), Shri Mohanta ventured into fish farming activity from 1998. He has nine ponds of various sizes with total farm area of 1.5 ha. He is using those ponds for composite carp culture, brood fish rearing and smaller ones for seed growing. He has achieved the fish production of 4.0 t/ha/yr for last 10 years.

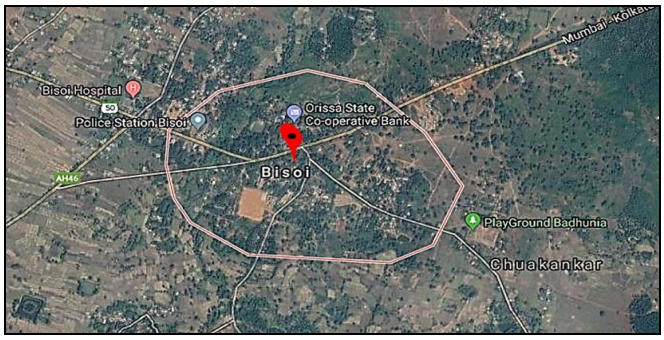

Fig 1: Geographical situation of Bisoi Block, Mayurbhanj District, Odisha, India

2.2 FRP Hatchery Unit

Portable fiberglass reinforced plastic (FRP) carp hatchery unit of production capacity 1.0-1.2 million spawn per operation in four days consisting of four parts *i.e.*, one spawning pool, one incubation pool, one egg/spawn collection tank and one overhead water storage tank of capacity 2000 liter with all accessories was supplied and installed at N.B. Pokhria Village of Bisoi Block, Mayurbhanj District, Odisha for operation and seed production.

2.3 Brood Stock

Matured brood stocks of three Indian major carps, *viz.*, rohu (*Labeo rohita),* catla (*Catla catla*) and mrigal (*Cirrhinus mrigala*) free from diseases and any kind of abnormalities, were selected for the breeding programmes from the brood stock ponds of the farm. The hatchery owner raised these brood fishes in his farm and selection of the fishes for breeding operations were done based on their maturity and weight.

2.4 Inducing Agent

'Ovatide', an indigenous, cost-effective hormonal formulation developed by Mumbai-based pharmaceutical company, M/s Hemmo Pharma was used for the breeding programmes. Ovatide has been successfully tested for ovulation of several fishes, including *Labeo rohita*, *Labeo calbasu*, *Cirrhinus mrigala*, *Catla catla* and *Clarias batrachus* in India [8, 9, 20]. The Ovatide is easy to store at room temperature, simple to use and less expensive [21].

2.5 Breeding Programme

The present carp breeding experiments were conducted in the FRP hatchery installed at N.B. Pokhria Village of Bisoi Block, Mayurbhanj District, Odisha during June-August months of 2016, 2017 and 2018. Normal hatchery operation practices were followed for production of carp seed[2,14]. Three different carp species *viz.*, rohu (*L. rohita),* catla (*C. catla*) and mrigal (*C. mrigala*) were tried with induced breeding for production and supply of seed to aqua-farmers of the area. Brooders were selected from brood stock pond and their sexes were identified based on morphological characters like swollen abdomen, pinkish vent and smooth pectoral fin in female; and rough pectoral fin in male. Brooders were then carefully transferred to the FRP hatchery avoiding much

handling and conditioned for one hour in the spawning pool prior to administration of inducing agent, Ovatide. Male and female brooders were injected @ 0.2 ml/kg and 0.5 ml/kg body weight, respectively, intra-peritoneally in a single dose. CIFE in 1998[22] reported the Ovatide dose of 0.20-0.45 ml/kg for female and 0.1-0.2 ml/kg for male carps. The injected fishes were released in the spawning pool for egg laying. After spawning, the brood fishes were removed from the breeding/spawning pool with the help of a scoop net. Water circulation was maintained as per recommendation[2,19]. The fertilized eggs were kept in the incubation pool for the next three days and the pool was disinfected by sprinkling 5.0 ppm potassium permanganate solution at an interval of two hours.
Percent fertilization per female [23] was calculated with the following formula:

$$\text{Fertilization} = \frac{\text{No. of fertilized eggs}}{\text{Total No. of egg counted}} \times 100$$

Latency period for egg release, effective spawning period and spawn production per kg body weight of different female species were determined [24].

2.6 Water quality parameters
The water quality parameters (physico-chemical) of the pond (inlet water to hatchery unit) were analyzed as per standard laboratory procedures [25] bringing water samples to ICAR-CIFA.

3. Results and Discussion
3.1 Carp Breeding Operation
One unit of fiberglass reinforced plastic (FRP) hatchery for spawn production capacity of 1.0-1.2 million per operation in four days was established in farmer's field at N.B. Pokhria Village under Bisoi Block, Mayurbhanj District on 4 July, 2016. Native carps including *Labeo rohita*, *Catla catla* and *Cirrhinus mrigala* with single injection of Ovatide were successfully induced to spawn in FRP carp hatchery during monsoons of 2016, 2017 and 2018. Results of the breeding trials are summarized in Table 1. Induced breedings were conducted for five times for *L. rohita*, three times for *C. catla*, and two times for *C. mrigala*. Total 7.0 lakh (rohu), 20.0 lakh (rohu 10.0, mrigal 3.0, and catla 7.0) and 48.5 lakh (rohu 28.5, mrigal 5.0, and catla 15.0) spawn was harvested in 2016, 2017 and 2018, respectively. Under the temperature range of 27-34ºC, spawning was observed after a latency period of 342-400 minutes (5.7-6.7 hours); fertilization rate was 91.7-97.5% and spawn production was 1.02-1.18 lakh/kg body wt. of female in IMC. Highest fertilization rate of 97.5% was recorded in mrigal followed by rohu (92%) and catla (91.7%). Effective average spawning period was 62, 53.3 and 40 minutes for rohu, catla and mrigal respectively.
Pandey *et al.* (2002) [26] also found similar fertilization rate of 95-100% and 90-98% hatching success in *L. rohita* at a water temperature of 28-31 ºC using hormone Ovatide. Dhawan and Kaur (2004) [27] used Ovatide and Ovaprim for induced breeding of Indian carps. They found that Ovaprim was more effective than Ovatide in breeding induction in *C. catla*; however, in *L. rohita* and *C. mrigala*, Ovatide resulted in high fecundity and fertilization rate. Khan *et al.* (2006) [28] stated that Ovatide was better than Ovaprim-C in induced spawning, fecundity, hatching and fertilization of *L. rohita*. Effective spawning period of catla was calculated to be 53.3 minutes, rohu 62 minutes and mrigala 40 minutes.
Just like the present study, the FRP carp hatchery was established and operated at Amarpur Village under Potaspur Block, West Bengal [9]. In the monsoon of 2016, induced breeding of Indian major carps (*L. rohita* & *C. catla*) and Indian minor carp (*L. bata*) was conducted for 4 times in the established hatchery. Induced breeding of these fishes was done successfully using synthetic hormone "Ovatide". Under the optimum temperature range of 29-32 ºC, spawning was observed after a latency period of 5-6 hours. The fertilization rate was recorded 88-96% and the hatching success was 89-94%. Highest fertilization rate (96%) was recorded in catla followed by rohu (93%) and bata (89-91%). Time needed for completion of egg hatching was almost similar among the experimented fishes, *i.e. C. catla* (940 minutes), *L. rohita* (920 minutes) and *L. bata* (895-945 minutes). Spawn production was 0.91 lakh/kg female body weight for catla, 0.94 lakh/kg for rohu and 0.775 lakh/kg (average) for bata. In another similar field study Mohapatra *et al.* (2016) [8] had conducted induced breedings of IMC in portable fiberglass reinforced plastic (FRP) carp hatchery at Puranapradhan Village of Balianta Block, Khordha District, Odisha, India. During breeding season of 2015 the hatchery was used for induce breeding of Indian major carps *i.e.* rohu and mrigal for 19 times (*viz.*, rohu 11 times, and mrigal 8 times). Total 198 lakh spawn was produced (*i.e.* rohu 125 lakh and mrigal 73 lakh). Spawning fecundity was found to be 1.3-1.82 and 1.25-1.58 lakh egg/kg female body weight of rohu and mrigal, respectively. Percentage of fertilized eggs during spawning was calculated to be 90-100% for both species. Spawn production per kg female body weight was found to be 1.23-1.55 lakh/kg for rohu and 1.09-1.4 lakh/kg for mrigal and percentage of spawn survival from fertilized egg ranged 90-97.17% in rohu and 87.3- 94.74% in mrigal. Similarly the FRP carp hatchery was installed and operated at Subarnapur Village of Gop Block, Puri District, Odisha, India during monsoon months of 2014 [29]. Ten trials of induced breeding of three IMC, *L. rohita* (4 times), *C. catla* (4 times) and *C. mrigala* (2 times) were conducted during monsoon season of 2014. A total of 92.0 lakh spawn (carp seed) was produced (rohu 42 lakh, catla 30 lakh and mrigal 20 lakh). Spawning fecundity of rohu, mrigala and catla was found to be 1.43-1.72; 1.41-1.54 and 1.15-1.23 lakh egg/kg female body weight respectively. Percentage of fertilized eggs during spawning was found to be 90-95%. Spawn production per kg female body weight (lakh) was found 1.07-1.36 lakh/kg female body weight of rohu, 1.17-1.36 lakh/kg female body weight of mrigal and 0.9-0.95 lakh/kg female body weight of catla. Further to compare the findings of present study, the study of Chakrabarti *et al.* (2016) [7] may be cited here. One unit of FRP carp hatchery was installed and operated at Bali Island, Sunderban, West Bengal, India during 2014-15. In the experiment, spawning fecundity of rohu was found to be 0.88-1.0 lakh, catla 0.95 lakh and bata 1.1-1.3 lakh egg/kg bodyweight of female fish. Time for completion of egg hatching was found more or less similar in rohu 920-970 minutes, catla 965 minutes and bata 940-990 minutes. Percentage of spawn survival from egg release was calculated to be 85.5-92.5 in rohu, 84.5 in catla and 86.5-90 in bata. Spawn production per kg female body weight (lakh) was found similar for all the experimented fishes *i.e.* rohu 0.74-0.88 lakh, bata 0.86-1.2 lakh and catla 0.66 lakh.
Response of *C. catla*, *L. rohita* and *L. bata* to Ovatide was found to be good in present study considering the breeding success in terms of fertilization rate and spawn production.

So, it is clear that, successful spawning and hatching can be achieved by inducing these species with Ovatide in fiberglass reinforced plastic (FRP) carp hatchery system. Ovatide is the cheaper hormone and 70% more economical as compared to Ovaprim [30]. The Ovatide suppresses the Ovaprim use giving an equal result of seed production in hatcheries. FRP make small-scale carp hatchery enables the farmers to operate it with less labor and manage it effectively. Land and other infrastructure facilities required are also low as it is small in size.

3.2 Physico-chemical properties of inlet water to hatchery.
Physico-chemical parameters of the inlet water to hatchery from pond during different breeding operations were analyzed. The range of water temperatures, pH, dissolved oxygen, total alkalinity, total hardness and transparency were analyzed and recorded and presented in Table 2.

Table 1: IMC breeding in FRP carp hatchery at Bisoi, Mayurbhanj District, Odisha during 2016-2018

Parameters	Indian Major Carps Breeding												
	Rohu						Mrigal			Catla			
Year	2016	2017	2018	2018	2018	2016-18	2017	2018	2016-18	2017	2018	2018	2016-18
Trials	I	II	III	IV	V	Total (T) /Ave (A)	I	II	Total (T) /Ave (A)				Total (T) /Ave (A)
Number of male breeders	6	7	8	5	6	32 (T)	3	4	7 (T)	6	5	5	16 (T)
Number of female breeders	5	7	6	5	5	28 (T)	2	4	6 (T)	5	4	4	13 (T)
Total weight of male breeder (kg)	6.0	9.2	8.8	7.0	8.0	39 (T)	4.0	4.5	8.5 (T)	8.0	7.6	6.5	22.1 (T)
Total weight of female breeder (kg)	8.0	9.8	8.5	7.6	8.3	42.2 (T)	2.8	4.0	6.8 (T)	7.5	7.0	7.0	21.5 (T)
Time of first egg released after hormone injection (in minute) (latency period) (A)	320	360	340	330	360	342 (A)	360	340	350 (A)	420	400	380	400 (A)
Completion time of egg release from time of injection (in minute) (B)	360	420	430	400	410	404 (A)	390	390	390 (A)	480	440	440	453 (A)
Effective spawning period (B-A) (minute)	40	60	90	70	50	62 (A)	30	50	40 (A)	60	40	60	53.3 (A)
Egg released (lakh approx.)	8.0	10.5	11.0	9.0	12.0	50.5 (T)	3.5	5.0	8.5 (T)	8.0	7.5	9.0	24.5 (T)
Fertilization rate of egg (%)	90	95	95	95	85	92 (A)	95	100	97.5 (A)	90	95	90	91.7 (A)
Time of first hatchling observed from spawning (in minute)	720	660	680	700	650	682 (A)	660	720	690 (A)	720	760	700	727 (A)
Spawn recovered (lakh)	7.0	10.0	10.0	8.5	10.0	45.5 (T)	3.0	5.0	8.0 (T)	7.0	7.0	8.0	22.0 (T)
Spawn production (lakh/kg body weight of female)	0.875	1.02	1.18	1.12	1.2	1.08 (A)	1.07	1.25	1.18 (A)	0.93	1.0	1.14	1.02 (A)

Table 2: Physico-chemical properties of hatchery inlet water

Water quality parameter	Value
Temperature (ºC)	27-34
Dissolved oxygen (mg/l)	3.0-5.5
pH	7.2-8.25
Total alkalinity (mg/l)	54.0-80.0
Total hardness (mg/l)	46.0-94.0
Water transparency (cm)	5.5-12.4

The water quality required for hatchery operation for IMC seed production is 24-29 ^{0}C temperature, 6.5-8.5 pH, 5.0-6.0 mg/l dissolved oxygen and less than 150 mg/l total alkalinity [31]. The water parameters recorded during the present breeding programmes were found within the range for hatchery operation of IMC.

4. Conclusion
The FRP carp hatchery has been widely adopted across the country for quality seed production. In the present case, the farmer located at N.B. Pokhria, Bisoi Block, Mayurbhanj District, Odisha is able to produce 75.5 lakh spawn during 2016-18 with average fertilization rate of 91.7-97.5%. By observing the success of Shri Bhabendra Mohanta for carp seed production, many progressive fish farmers of five adjacent blocks (Kusumi, Mananda, Jashipur, Rairangpur and Bangiriposi) of Mayurbhanj District are also interested to set up the portable carp hatchery as the availability of quality seed is still a major problem for the development of aquaculture in the region. These farmers are regularly visiting to the fish farm of Shri Mohanta to learn about the carp breeding and seed production technology. With the present level of technical support and training made available by ICAR-CIFA, the technology has performed well and would be able to improve further in future. The conditions like availability of brood-stock, suitable climatic conditions would enable the farmers to reach to the potential level of performance of the technology.

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