Advancing Nutrition-Sensitive Aquaculture through Propagation of Small Indigenous Fish Species

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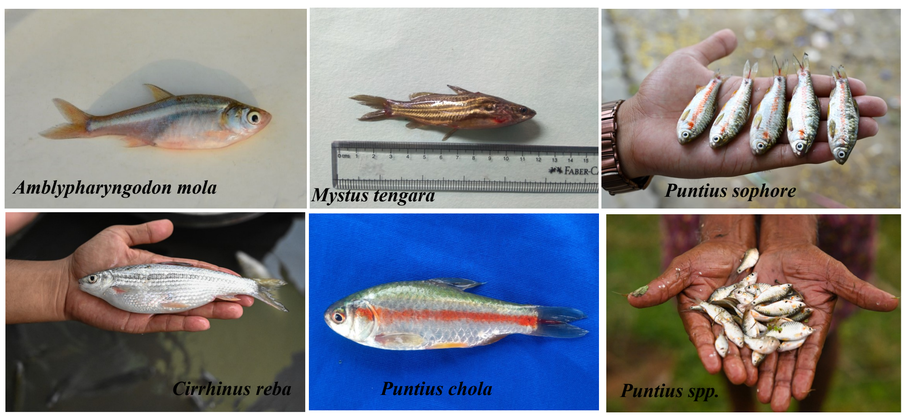
Introduction

- **Small indigenous fish species (SIS)**, which originate from freshwater environments, are known for their diminutive size, typically reaching a maximum length of approximately 25 cm.
- SIS are regarded as natural 'superfood' and are highly prized for their abundant protein, fatty acid, vitamin, and mineral content. These vital nutrients include vitamin A, B12 and C, iron, calcium, zinc, iodine and selenium.
- Once abundant, SIS diversity and abundance in Asia are now declining rapidly due to habitat degradation, unsustainable aquaculture practices, pollution, and climate change, making them scarce and expensive.
- In recent years, efforts have been made to integrate SIS into conventional carp polyculture as a form of **nutrition-sensitive aquaculture** to enhance micronutrient intake among farming households, especially women and children.
- The promising SIS for nutrition-sensitive aquaculture are mola (*Amblypharyngodon mola*), pool barb (*Puntius sophore*), swamp barb (*Puntius chola*), tengara catfish (*Mytus tengara*) and reba carp (*Cirrhinus reba*).
- **WorldFish** has been a trailblazer in championing and advancing nutrition-sensitive **carp-SIS polyculture** across various South Asian nations, including Bangladesh, India, and Nepal, for several decades.
- Research indicates that integrating mola and other SIS into carp polyculture systems has resulted in substantial mola yields in grow-out ponds without necessitating additional inputs or management, and without compromising carp yields
- However, these initiatives have relied on collecting SIS parent fish (broodstock) from natural sources to stock in farmers' ponds, where they reproduce naturally. This method is not sustainable in long run.
- A lack of commercial hatchery reproduction techniques for SIS seed is a key bottleneck that limits the potential for widespread adoption of carp–SIS polyculture.
- To address this bottleneck, WorldFish is implementing a project in India named Taking nutrition-sensitive carp-SIS polyculture technology to scale (2021-2024), with funding from Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ).
- A key goal of the project is to develop easily scalable techniques for the mass production of some important SIS seeds by standardizing a method of hatchery-based breeding.
- The overall objective is to accelerate ongoing efforts to promote and scale nutrition-sensitive aquaculture.

Methodology



❑ **Broodstock management**

- Broodstock were collected from diverse sources to ensure genetic diversity and reared in broodstock ponds for two months at partner hatcheries located in Assam and Odisha.
- Brooders were fed to satiation with 40-42% crude protein floating extruded feed twice daily.

❑ **Induce breeding arrangement**

- Brooders were conditioned under continuous showering in separate conditioning tanks for 3-5 hours before induced breeding to acclimatize them and stimulate readiness for spawning.
- Breeding arrangement was made in cement tanks and customized FRP, featuring a double hapa arrangement (10 mm inner hapa and 250-micron outer hapa).
- To facilitate egg-laying, artificial grass substratum was thoughtfully provided at the bottom of the inner hapa.

❑ **Hormone administration and environmental manipulation**

- Fish were exposed to constant showering of oxygen-rich water from an overhead tank equipped with an aeration tower. Rainwater and pond water are also added to manipulate water environment.
- Synthetic gonadotropin-releasing hormone analogue (S-GnRHa with dopamine antagonist) was diluted 15 times in 0.65 % sterile NaCl solution and administered using an insulin diabetic syringe of 1 ml capacity with 40 graduations.
- The diluted inducing agent was administered through the peritoneal cavity at the dose of 0.5 ml and 0.25 ml per kg of body weight of females and males respectively. The male-female sex ratio was maintained at 1:1/2:1

❑ **Breeding performance**

- Several parameters and breeding performances were recorded such as ovulation rate, fertilization rate and hatching rate, latency and incubation period.

Aeration tower installed in overhead water reservoir tank for constant showering of oxygen-rich water

Results

- Spawning occurs after an average latency period of 6 to 8 hours (at 28-29.5°C) following hormone administration.
- Hatching occurs 12–14 hours after fertilization at a water temperature of 28.5°C–30°C.
- Eggs typically attached to the bottom part and wall of the 250-micron outer hapa.
- Hatchlings are typically harvested 60–72 hours after hatching, just before the yolk sac is fully absorbed.
- After three days, hatchlings can be stocked in the nursery pond or directly sold from the breeding tank.

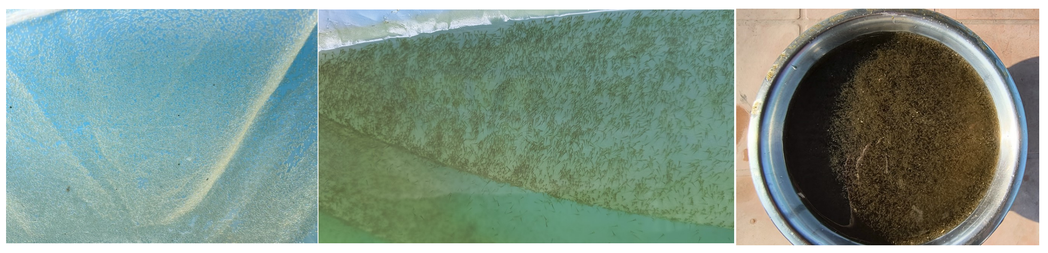
TABLE 1. Various breeding parameters of different SIS under the project.

Parameters	*Amblypharyngodon mola*	*Puntius sophore*	*Mystus Tengra*	*Cirrhinus reba*
Avg. weight of female (g)	6.90 ± 0.4	20.06 ± 2.09	25.90 ± 3.50	102.80 ± 9.10
Avg. length of female (cm)	8.81 ± 0.38	10.91 ± 0.45	11.90 ± 2.10	21.10 ± 3.20
Avg. weight of male (g)	2.85 ± 0.22	7.56 ± 0.58	7.20 ± 1.03	56.60 ± 5.08
Avg. length of male (cm)	4.84 ± 0.17	7.58 ± 0.68	8.00 ± 4.09	17.70 ± 2.20
Female responded (%)	80.70 ± 4.99	78.86 ± 3.73	94.43 ± 4.30	96.10 ± 3.90
Fertilization rate (%)	81.20 ± 2.39	81.38 ± 3.64	79.93 ± 3.80	84.83 ± 3.20
Hatching rate (%)	85.05 ± 4.66	89.88 ± 2.74	86.38 ± 4.20	88.17 ± 4.39
Survival rate (%)	88.40 ± 2.89	88.00 ± 2.94	80.02 ± 2.78	89.66 ± 3.92
Spawning fecundity (n)	4217.69 ± 511.61	1144.93 ± 136.93	7783 ± 583	47366 ± 783.20
Latency period (28-29.5°C) (h)	6-8	6-8	6 - 8	6- 8
Incubation period (h)	12-14	12-14	12 - 13	16 -18

Hormone administration to the peritoneal cavity of various brooders

Induced breeding and hapa arrangement for breeding of various SIS

Eggs, hatchling and fry of *Amblypharyngodon mola*

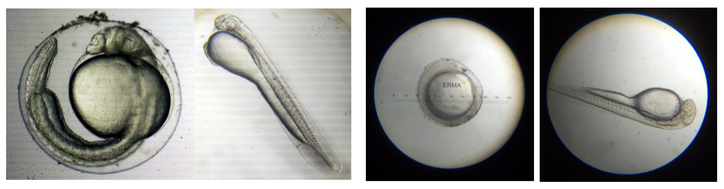


Eggs and hatchlings of *Puntius sophore*

Hatchlings of *Puntius chola*

Eggs and fry of *Cirrhinus reba*

Eggs of *Mystus tengara*



Developmental stages of *Amblypharyngodon mola* and *Puntius sophore*

Conclusion

- Mass seed production of various nutrient-dense SIS mola, barb, tengra and reba can be achieved through induced breeding using GnRH-based synthetic hormone (eg: Wova-FH) at a dose of 0.5 mL and 0.25 mL per kg body weight of female and male fish, respectively, combined with environmental manipulation using oxygen-rich water.
- The simple breeding protocol can be adopted by small-scale hatchery operators.
- Availability of SIS seed on a largescale will facilitate large-scale adoption of carp-mola polyculture to increase farm incomes and consumption of micronutrient-dense fish in regions of India where undernutrition is prevalent.
- Especially helpful in the case of Odisha and Assam, where governments have recognized and prioritized nutrition-sensitive approaches and included carp-SIS polyculture in their institutional policies by launching new programs.

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