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Macrobrachium lar (Monkey River prawn): A potential Candidate Species of fresh water Prawn for aquaculture in Andaman Islands

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Abstract

The scampi aquaculture sector in India, dominated by the *Macrobrachium rosenbergii,* has been nearly 50% declines in production from its peak, necessitating the exploration of alternative candidate species. *Macrobrachium lar* (Monkey river prawn), a large-sizeed, fast growing, and native to the Andaman and Nicobar Islands (ANI) has emerged as a promising candidate. It is a amphidromus species with adult dwelling in freshwater but require marine water 30-34 ppt for larval development. *M lar* male reach up to 100g in 4 months with observed survival rate up to 70%. The primary constraint to commercialization remains the complete hatchery technology. Its life cycle involves an extensive larval phase of 13 zoeal stage over 77 days to reach first post-larvae (decapodite), which is significantly longer than *M rosenbergii*, resulting in very low survival rates in current practices. Research has successfully documented complete larval development using a green water technique and standardized optimal parameters temperature, salinity, dissolved oxygen and total ammonical nitrogen. Further research is crucial to optimize larval feeding, improve survivability, and standardize the Indian scampi sector and provide a hardier, native option against potential disease outbreaks, ensuring the future sustainability.

Introduction

Scampi or freshwater prawns, are widely consumed across the globe, much like marine shrimps. Among various genera, *Macrobrachium sp.* particularly *M rosenbergii* is of significant commercial importance due to its high demand and suitability for aquaculture. Freshwater prawn farming is predominantly practiced in tropical and subtropical regions, with southeast Asian countries like China, India, Bangladesh, Indonesia, Malaysia, Thailand, and Vietnam, etc (FAO, 2020; Valenti et al., 2010). *M rosenbergii* is the most cultured freshwater prawn species globally. In addition to this, species like *M nipponesis*, *M orientalis*, *M malcomsoni* are also farmed depending on the availability of seed from hatcheries and natural waterbody resources. Among the top ten cultured species worldwide *M nipponesis*, *M orientalis* stand out with current annual production of 2.6 and 2 thousand tons, respectively (FAO, 2023). Many potential candidate species that have no complete breeding technology, only they are produced from capture or capture based culture fisheries. The *Macrobrachium lar* (Monkey River Prawn), is a freshwater prawn, native to Indo-west Pacific regions islands, is showing its importance in culture practice due to its faster growth rates and larger size (New *et al.,* 2009). Earlier the major constraint found in the culture of this species was procurement for the grow-out culture due to difficulty in the larval rearing practice. The scampi industry in India is primarily dominated by *M rosenbergii*, commonly known as giant fresh water prawn. However, according to the production data from the Marine Products Export Development Authority (MPEDA, 2023), the total scampi production in 2021-22 was 21,317 tons which is nearly 50% lower than peak production 42800 tons in 2005. To revitalize and expand this sector the culture of alternative freshwater prawn species is essential. Among these, *Macrobrachium lar* has emerged as a potential candidate due to its potential for commercialization in India's scampi aquaculture industry. *M lar* is native species of Andaman and Nicobar fresh water bodies. There are about 200 ha of fresh water aquaculture pond in ANI mainly culture long duration fish species like IMC, Pangas and Rupchanda. *M rosenbergi* is being captures form large fresh water bodies for consumption and commercial culture is not currently practices in Island water bodies.

Morphological difference of *Macrobrachium lar*

Macrobrachoium lar, commonly known as monkey river prawn, shares many similarities with *M rosenbergii*. It has a sigmoid shaped rostrum with 7-9 numbers of dorsal teeth compared to the 8-13 numbers of dorsal teeth found in *M rosenbergii* (Ghazi and Hassan, 2021). Matured male of *M lar* are easily distinguished by their large, long, and robust pereopods with cutting edge incisors. Specifically in the second pereopod, the merus is longer than the carpus which is the reverse in *M rosenbergii*. Other phenotypical characteristics are smaller in females than males with shorter thoracic legs and more slender heads, and it carries fertilized eggs on pleopods (New *et al.,* 2009). The sexual dimorphism of *M lar* is similar to the *M rosenbergii*. *M. lar* population, three male morphotypes can be distinguished by claw colour and their relative size ranges within the population. The adult males of *M lar* having three distinct morphometry like Black claw (BC) are relatively large size and long stout chelate legs, orange or brownish claw (OC) males having medium-sized claws and small males (SM) possess short delicate claws, with very less growth compared to other two (Valenti *et al.,* 2010).

Figure 1: *Macrobrachium lar*

Biology of *Macrobrachium lar*

Habitat of Monkey River Prawn

The first report of the species was described by J. C. fabricus in India in 1798. This is amphidromous and one of the largest prawn species of western Indo-Pacific high islands exhibit specific habitat preference in natural conditions (Cai and Ng, 2002). This species can be found from East Africa to the Marquesas Islands in the Indo-west Pacific area. The species is also native to Andaman & Nicobar Island of India as reported by many workers (Sarangi, *et. al.,* 2001). This species shows a upward feeding migration in freshwater streams from which it originates from the plane areas. It is found in freshwater streams, pools, and water falls that are connected to sea, because at the juvenile stage, it returns to the fresh water after completing the larval development in marine water (35 ppt). In addition to preferring clean water, *M lar* inhibits well oxygenated pools beneath riffles and waterfalls. It is also found in wetland and swamps with taro and other aquatic plants. *M. lar* prefers clear water and individuals are usually found or occur in well oxygenated pools below riffles or waterfalls and individuals shelter in piles of rocks, brush, burrows and fallen trees, and among tree roots (Gereva, 2014).

Life Cycle

The life cycle of *M lar* consists of four distinctive stages: egg, larvae, juvenile and adults. Brooders are usually found in upper section of streams, where mating and egg laying activity takes place. Egg hatching occurs in coastal sea waters, that reaches to sea water by waves and water current within 24-36 hours to survive of larvae. The post larvae start migrating from sea water to fresh water system, after completing larval development stages (Cai and Ng, 2002). The juvenile becomes a benthic feeder found in lower reaches of fresh water stream and grows at stenothermal water range of 18-32^{o}C**.** The completer life cycle of *M lar* comprises of an extended marine larval

phase, a short duration of brackish water phase, and a long freshwater phase. The marine larval phase is very extensive period which is longer than any other known *Macrobrachium sp*).

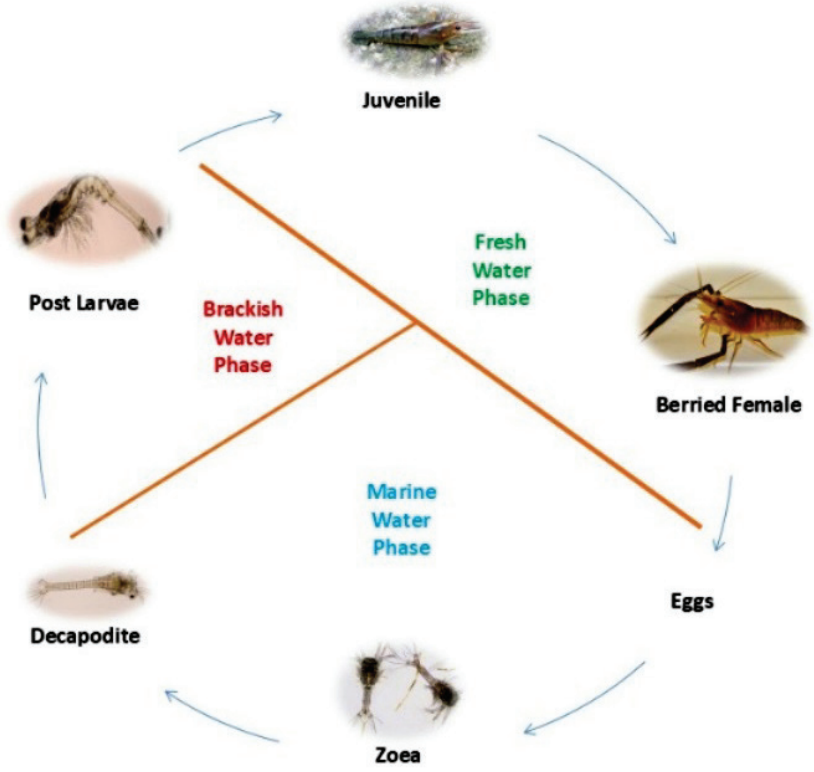

Figure 2: Life Cycle of *Macrobrachium lar* in different habitat

Food & feeding habit

The feeding habits of *Macrobrachium lar* were studied in inland water bodies of Andaman Islands by Sethi et al., 2013. Their finding revealed that the species is omnivorous, feeding on both plant and animal matter, with a strong preference for animal protein, particularly among larger individuals. Common foods include detritus, nuts and insects. *M lar* is nocturnal, actively feeding at night, while in the day, it typically hides under bushes, stones, rocks and logs. Feeding intensity observed was higher in monsoon season. Adult individuals are predominantly predators rather than scavenger. When held in tanks, they readily consume pelleted feeds, as well as animal flesh such as molluscs, bivalves, fish, crustaceans, and even coconut flesh during the day.

Breeding Biology

Macrobrachium lar is native to the freshwater streams and water bodies of Andaman and Nicobar Island. Male range size from 86 to 112 mm (32–40 gm), while females ranges 66 to 106 mm (14–20 gm). Males are found in December-February and September-November while females are more common in February-October in the Andaman freshwater habitats. The overall average ratio of male to female was around 1:2.84 which indicates the predominance of female population over the male ones. It breeds twice a year, with June and November seeing the greatest number of ovigerous females. The estimated mean fecundity of berried females ranges from 4500 to 5500 number of sizes 6 to 15 cm long. The highest average fecundity of *M. lar* is 11,000 numbers eggs, where fecundity of 20000 eggs reported from large females (Sethi *et al.,* 2014). *M. lar* has diadromous pattern

of migration, as the larval development must take place in seawater before individuals return to freshwater habitats as post larvae. The larvae are carried by stream currents to the ocean, where they undergo several pelagic stages over 3 month before re-entering estuaries, following which they return to freshwater streams. Field observations and experiments have shown that as adults *M. lar* do not undertake extensive migrations in streams (Nandlal, 2010).

Culture of *Macrobrachium lar*

M lar commercial culture till now has not been adopted by farmers, only artisanal cultures like polyculture with other species and scientific research trials for breeding and culture tried in some parts of the Asian countries. monkey river prawn (*M. lar*) is commonly culture in Fiji and called as peoples prawn due to its high demand for delicacy. The commercial culture of this species generally done up to size of 180 mm (medium size). In small pacific Island countries like Vanuatu, the monoculture practice of M lar is predominantly done in small earthen freshwater farm ponds. The integrating faming of taro and *M lar* is a traditional culture practise in swamp areas of this country. Juveniles of *M lar* captured from creeks and freshwater bodies by scoop net and stocked in water logged swamps which are planted for taro farming. During the rain period the taro fields get inundated with water and the juveniles also enter to the field from adjacent natural waterbodies. The prawns fed on household waste, grated coconut leftover and cow dunk which are applied to the taro field for manuring. The prawns also fed with artificial feed when the culture period id year-round. The harvesting of prawn was done after six months when the taro was harvested the swamp water drained completely for capturing the prawns. Partial harvesting is also conducted when farmers block off sections of the taro swamp and drain the water from each section separately. *M. lar* grew to a size of 20 gm in 4 months, with a survival of 70% in integrated farming system with taro (Nandlal, 2010).

Larval rearing and culture

The complete larval cycle has been standardized using a novel green water technique (Lal *et.al.,* 2014), where it has been documented that 13 zoeal stages are there before metamorphosis to young ones in this species. More research has to be done on the survivability aspect of the larval rearing of this species. It took around 77 days to reach zoea I to first decapodid and the larval survival rate was also very poor. The benthic habit of larvae was quite common in the case of these larvae, unlike the *M. rossenbergii* larvae where the active larvae were found to be swimming on the upper water surface.

In the early research stages of *M. rossenbregii*, the survival rate was found to be 16-17% while now a days 60-80% survival rate is being achieved in experimental and commercial RAS. As far as culture is concerned, biofloc along with green water technique has been used in the studies resulting in complete larval development. But further research is needed in that aspect to provide live feed along with clear water system.

Larvae metamorphosised into decapodite stage through 13 zoea stages, with an intermoult duration of 3 days (Zoea I to IV), 8 days and 12 days (zoea IX to XI). the irregular larval development occurs between 21 to 63 days for zoeae XII and XIII. The time taken for last individuals to reach decapodite was 34 days (Lal *et al.,* 2012). In contrast to *M. rosenbergii* , where the healthy larvae without aeration stay close to water surface, the M lar larvae showed more benthic dwelling activity in the presence of aeration. Cannibalism was not observed during the larval rearing study by Valenti *et al.,* (2010) although it cannot be conclusively ruled out, whereas Nandlal (2010) reported that *M. lar* larvae have cannibalism. The complete feeding in mass larval rearing was not standardised, whereas the different experiment conducted for larval rearing of M lar with artemia nauplii as live food could not succeed to reach decapodite stage. The mass larval rearing found survival rates are 40–50% in flow-through hatchery systems, 60–80% in Thai backyard hatcheries, and 60–80% in experimental and commercial recirculation systems, with development durations of 29–35 days (Valenti *et al.,* 2010). It can thus be expected that there will be room for improvement in *M. lar* larviculture performance as a result of further research.

According to the studies of salinity tolerance, the newly emerged larvae of *M lar* thrive and developed best in completely freshwater or slightly brackish water,

progressing to the full-strength sea water by the middle of their growth. After hatching larvae need gradually rising salinity to reach 30 to 34 ppt, which must be maintained until they transform in to the decapodite**.** The larvae can withstand low salinity upto 10 ppt**.** A distinct preference for salinities trending towards that of full-strength seawater is apparent as the larvae moulted through zoeal stages III to V, with full marine conditions being optimal for survival and growth beyond this developmental stage. Mean survival rates between the 10 ppt and 20 ppt treatments for zoea-I were largely similar, as in the case of the 20 ppt and 30 ppt treatments for zoea III and V larvae which were the only treatments containing surviving larvae at the end of the tolerance test.

Table.1: Optimized larval rearing parameters of *Macrobrachium Lar*

Parameters	Recommended range
Temperature	28±0.5 ºC
pH	7.8±
Salinity	10 ppt (gradually increased to 30ppt)
Dissolved Oxygen	> 6.5 ppm
Ammonia	<0.1 ppm
Live feed	Artemia

Table.2: Larval development stages of *Macrobrachium lar*

Larval stages	Days of Observation	Morphological characters
Zoea I	0	Sessile eyes
Zoea II	2	Stalked aye, Antennae developed
Zoea III	4	First pair pleura in adnominal segment
ZoeaIV	7	Pleura on 2nd and 3rd abdominal segment
Zoea V	10	Pleura on 4th abdominal segment
Zoea VI	15	Uropod biramus
Zoea VII	21	Pleura on 5th abdominal segment
Zoea VIII	29	First pair pleopod buds
Zoea IX	37	2nd pair pleopods
Zoea X	46	3rd and 4th pair pleopod
Zoea XI	56	5th par pleopod
Zoea XII	66	All pleopods biramus
Zoea XIII	77	Rostrum 7 to 9 number teeth
Post Larvae (PL)	77-100	First decapodite with all 19 pair appendages

Advantages of Macrobrachium lar

- Because of its size and relatively fast growth rates, this species appears to have good potential for aquaculture.
- This will serve as foundation for enhancing culture characteristics, like other successfully established species including Nile tilapia, Common carp, and the whit leg shrimp *(Litopenaeus vannamei).*
- The juveniles of *M. lar* grow faster and can reach 20-40g/120 days or 0.25g/day.
- Males often grows to a larger size (100 gm within 4 month) than females, and females typically grow steadily.

Constrains of *Macrobrachium lar*

- The availability of seed stock for grow-out is severely limited to wild collection only due to the non-availability of completer hatchery technology.
- The difficult larval rearing of metamorphosis till decapodite with low survivability may increase with proper larval feeding methods.
- Salt water budgeting is crucial for successful breeding and larval rearing.

Conclusion

Many researches have to be done to standardize the growth, stocking density, and feeding of *M. lar*, as only a few studies have been done so far. However, as an indigenous species to the Andaman and Nicobar water body, there is a lot of potential to develop this as an candidate prawn species, because the *Macrobrachium rosenbergii* is not intensively culture in this areas. The large size body as well as the higher growth rate, has tremendous prospects for improvement. The future Indian scampi aquaculture needs an alternative approach for its development which can be done by adopting *M. lar* as alternative species along with other species in monoculture, and polyculture purposes. The paradigm shifts in shrimp farming due to the outbreak of WSSV from *Penaeus monodon* to *Penaeus vannamei* has been changed the aquaculture industry of India. Due to high disease resistance and being hardier than *P. monodon*, the Pacific white shrimp dominated the market after the great downfall of shrimp industry as the production of black tiger shrimp was heavily hampered by the deadly WSSV infection. Though the same hasn't been encountered in scampi industry yet, preparedness should be there for an alternate species so that the industry does not face such a huge downfall. Moreover, the monkey river prawn is native to our country. The potential of this species to dominate scampi farming can be researched out and used at farmer level to become the alternative species in the prawn farming sector.

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