there are two layers of Australasian impact ejecta at two different stratigraphic levels although they belong to the same impact event: the larger tektites are retained at the surface due to the mechanisms similar to those responsible for the ocean floor retention of manganese nodules, and the smaller microtektites sink to the appropriate stratigraphic levels beneath the sea floor corresponding to the 0.77 Ma age of the event. This, however, needs to be confirmed by the finding of microtektites at deeper levels in the sediment column in a sediment core from this location.

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Breeding and improved hatchery technology for the giant freshwater prawn, *Macrobrachium rosenbergii* in Karnataka

The giant freshwater prawn, *Macrobrachium rosenbergii* is popularly known as scampy. The species has been widely cultured in Asian countries such as Thailand, Taiwan, Malaysia, Indonasia, Bangladesh and India. It is also farmed in USA, particularly in South Carolina and Hawaii provinces. The first breakthrough was achieved by S. W. Ling[1] in successful breeding and larval rearing of the giant prawn, *M. rosenbergii* in controlled condition. Later mass production of larvae using greenwater system was developed by Fugimura and coworkers in Hawaii[2]. The prawn spends its entire life in freshwater rivers and tanks but migrates to brackishwater estuaries for breeding because the larvae do not survive in freshwater. The berried female prawn reaches estuaries before the eggs hatch out. This mystery was known only after the pioneering work of Ling.

The giant freshwater prawn is popularly cultured because of the beneficial factors like its fast growth compared to other freshwater prawn species, its hardy nature in withstanding adverse environmental conditions, its low protein requirement compared to penaeid shrimps, resistance to diseases, its consumer preference and demand in the export market. Further, it is a compatible species for polyculture with carps. Although it is commercially cultured in several Asian countries, its culture in India is unorganized. The seed required for culture is largely met from wild collection, although few hatcheries exist in the states of Andhra Pradesh, Kerala and Tamil Nadu.

However, there is no hatchery established so far for seed production in Karnataka. In view of the unavailability of seed, prawn farming in Karnataka has not picked up. The objectives of the present study were to breed the freshwater prawn, *M. rosenbergii* in the agro-climatic conditions of coastal Karnataka, to design a suitable hatchery with airlift recirculatory system for larval rearing.

Post-larvae of *M. rosenbergii* were procured from a private hatchery in Trichur, Kerala. They were cultured for seven months in 25 m^2 cement cisterns to raise brood stock. A formulated feed (35% protein) containing Nutripro-Aqua as a growth promoter was used. After seven months of rearing, the adult prawns were harvested and stocked in brood stock ponds in the ratio of 4 : 1 female and male.

Three cylindro conical fibreglass tanks each with a capacity of 150 l were fabricated locally (Figure 1). The circular tank had bottom sloping towards centre and looked like a funnel. It was fitted with a drain pipe at the bottom, with a control valve. The tank has three fibreglass legs to stand errect on the floor (Figure 2). The tank was thoroughly washed and filled with mixed seawater and freshwater having salinity of 12 ppt. Continuous aeration was provided by using an air blower.

Maintainance of water quality is the prime concern in the freshwater prawn hatchery operation. In order to maintain the water quality and reuse the water, an airlift recirculatory system connected to a biological filter was designed and fabricated. Three cylindroconical small fibreglass tanks each with a capacity of 50 l were fabricated locally. These tanks were used as biological filters. Each small (50 l) tank was connected to one of the three large (150 l) hatchery tanks. Biofilter tanks were filled with graded layers of sand, pebbles and dry oyster shells as substrate media for the growth of nitrification bacteria. The biofilter tank was connected to hatchery tank by means of an airlift pump and back flow was by siphoning action from hatchery tank to biofilter for water recirculation (Figure 3).

The berried females carrying grey coloured eggs were seggregated from broodstock ponds and transferred to laboratory broodstock tanks. The salinity in this tank was maintained at 8 ppt. The spent female prawn was removed from hatchery immediately after hatching. The larvae were fed on *Artemia* nauplii daily once and unused *Artemia* nauplii were removed once in two days. *Artemia* cysts were hatched in separate *Artemia* hatching tanks, each with a maximum capacity of 50 l. Daily about 2 g of *Artemia* cysts was kept in 5 l of water for hatching. The hatching was completed in 24 h in 12 ppt saline water. Continuous aeration and light was supplied to the *Artemia* hatching tank.

Mating was achieved between hard shelled blue clawed male and newly moulted, soft female prawn in cement cisterns. The fertilized eggs were carried by the female underneath in the brood pouch for 20 days. After day 12 of mating, eggs changed colour from bright orange to brown, during which time healthy and active females were seggregated and transferred to broodstock-holding tank having 8 ppt saline water. When the eggs were slate grey or black in colour the berried prawn was transferred from broodstock-holding tank to hatchery tank having 12 ppt water. The larvae were hatched usually the next day. Active and healthy 6000 larvae were maintained in the hatchery tank. They were not fed on the first day of hatching as they depended on yolk reserves. From the second day onwards they were fed with freshly hatched *Artemia* nauplii. *Artemia* nauplii was given as the sole food daily once @ 20 per larvae up to V stage. *Artemia* nauplii is the best live feed for prawn larvae, since it does not possess any anatomic defence mechanism so that it forms an easy prey for larvae. Further, it is rich in polyunsaturated fatty acids and protein content[3].

From V stage onwards, egg custard

Figure 1. Hatchery tanks connected to biofilter tanks with airlift recirculatory system (top view).

Figure 2. Cylindro conical fibre glass hatchery and biofilter tanks (side view).

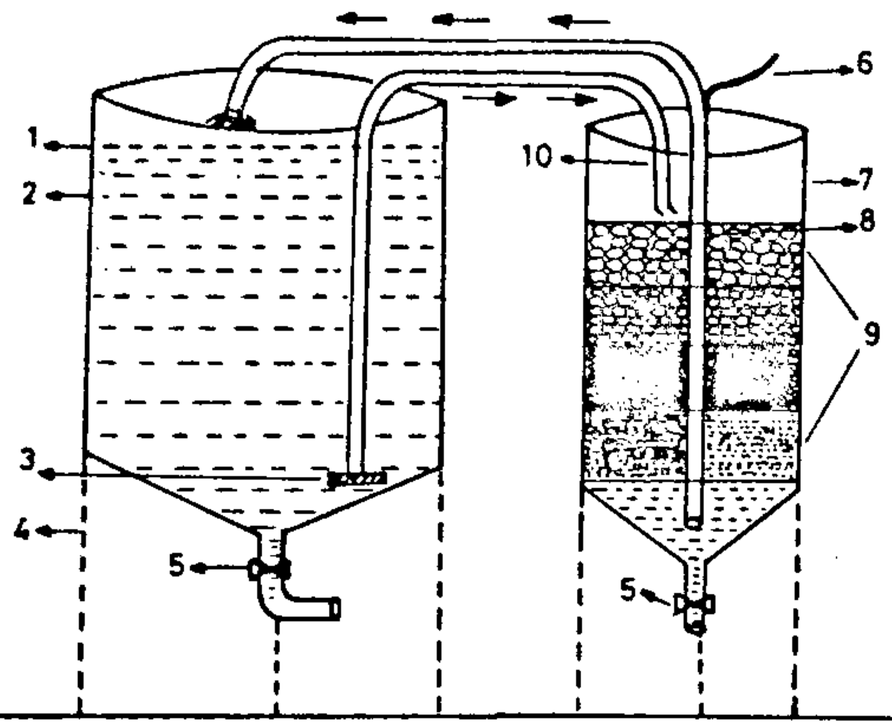

Figure 3. Diagrammatic sketch of airlift recirculatory system between hatchery tank and biofilter. 1, Water level; 2, Hatchery tank; 3, Filter bag; 4, Legs for the tank; 5, Control valve; 6, Airline; 7, Biofilter tank; 8, Airlift flow; 9, Graded layers of shells, granite, chips, gravel and sand; 10, Water flowback by siphon.

diet was formulated (using chicken eggs, shrimp meat, milk powder, vitamin and mineral mix; cooked and frozen) and given daily twice (after passing through standard set of sieves measuring 200, 400 600 and 800 micron size) and *Artemia* nauplii was continued once daily. Larvae passed eleven substages and metamorphosis to post larvae (PL) started from day 30 onwards. 95% of the larvae developed into PL on day 35. Total number of PL separated was 3100, giving a survival rate of 51.67%. Cost of production was worked out to Rs 210 per thousand PL. The cost involved was accounted mainly for *Artemia* cysts, formulated diet and labour charges.

Water quality and feeding are very important in the larval rearing of *M. rosenbergii*[4]. In the stagnant or replacement systems, ammonia (NH_3) and nitrite (NO_2) often create problems, when their levels exceeded 0.1 mg/l and lead to poor survival of larvae[5]. The designed and fabricated airlift recirculatory system was found suitable for the larval rearing. Water was exchanged frequently between biological filter and larval rearing tank (1 l/min). *Nitrosomonas* and *Nitrobactor* bacteria developed within three days on substrate material in the biofilter tank. The toxic ammonia was reduced to nitrite by *Nitrosomonas* and then to nitrate (non toxic) by *Nitrobacter* in the biological filter[6]. The average values of ammonia and nitrite recorded were 0.005 and 0.01 mg/l respectively. The recorded levels of ammonia and nitrite were ten times less than the level recorded in stagnant system. The other water-quality parameters recorded were temperature 29.0–30.5°C, pH 7.9–8.5, dissolved oxygen 7–7.5 mg/l and carbon dioxide 0–0.4 mg/l.

The designed and fabricated cylindro-conical fibre glass tank was found ideal for the prawn hatchery (Figure 2). A synchronized metamorphosis of larvae to PL and good survival (51.6%) was achieved in the system. The possible reasons for successful larval rearing are attributed to shape of the tank and recirculation through biofilter. This was a circular tank with centrally sloping bottom and control value for draining purpose. There were no dead spaces for larval settling. When aeration was given at the centre, water was lifted like an upwelling and continuous circulation from bottom to top was maintained and larvae were well dispersed. In the flat-bottom tanks, larvae settle at corners and lead to mortality. This problem was solved with the self-designed and fabricated suitable hatchery tanks. Breeding and successful larval rearing of freshwater prawn, *M. rosenbergii* in the agroclimatic regions of coastal Karnataka for the first time is an achievement in seed production in view of farming potential of the species in the region. The seed would be available to needy farmers within the vicinity. The self-designed and fabricated airlift recirculatory system and special type of hatchery tanks were found ideal for larval rearing of the *M. rosenbergii*.

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