Training in Giant Freshwater Prawn Farming

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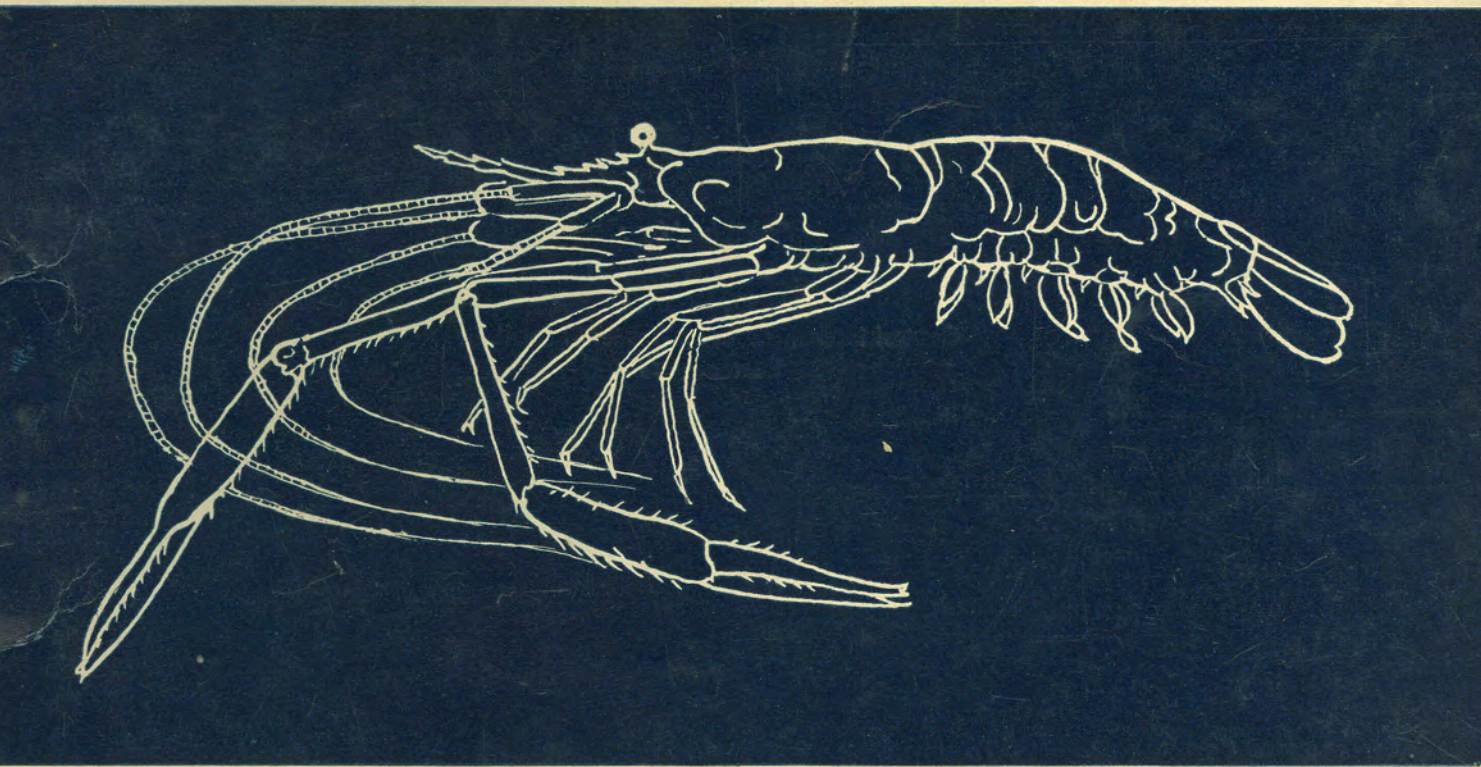

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T R A I N I N G
in
FRESHWATER PRAWN FARMING

Held at
PRAWN BREEDING UNIT
KAKINADA

Bulletin No.47

CENTRAL INLAND FISHERIES RESEARCH INSTITUTE
Barrackpore : West Bengal

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FOREWORD

In the last two decades Macrobrachium farming has assumed considerable status in aquaculture with the initial success in rearing of the giant fresh water prawn, Macrobrachium rosenbergii, by Dr. S.W. Ling of Malaysia in sixties followed by workers from several developed and developing nations.

In India, the giant fresh water prawn, Macrobrachium rosenbergii and the river prawn, Macrobrachium malcolmsonii are two fresh water prawns of great economic importance inhabiting most of the major rivers. The growing demand for these prawns, both in the local and foreign markets, and the limitations posed to procure their seed for culture in confined waters prompted CIFRI to develop an indigenous technology of seed production at the Prawn Breeding Unit of Central Inland Fisheries Research Institute, Kakinada. The technology relies upon the cultured or locally procured tubificid worms as the basic feed, often supplemented with the laboratory cultured brine shrimp nauplii. The viability of this technology is thoroughly tested and standardised for propagation in all the maritime States.

Hatchery site selection needs proximity to both sea and fresh waters, brood stock availability, consistent power supply and above all dedicated attention by a team of skilled workers. Much emphasis is laid on management, the only determining factor for the success of any hatchery. There is growing concern for alternate feeds or supplementary feeds in larval nutrition and their hygiens.

The accompanying articles provide substantial information on the CIFRI technology of seed production to establish fresh water prawn hatcheries by interested agencies both in the public and private sectors.

A.G. JHINGRAN

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GENERAL BIOLOGY OF GIANT FRESH WATER PRAWN MACROBRACHIUM ROSENBERGII (DE MAN)

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INTRODUCTION

Macrobrachium rosenbergii is the largest freshwater prawn in the world growing upto 31 cm in size. Its distribution is limited to the estuarine and freshwater zones of river mouths and back waters (0 to 20‰salinity) in the tropical and sub-tropical countries of Indopacific region. Because of its fast growth, attractive size and better meat quality, the species is quite suited for monoculture or polyculture with fish in freshwater pond systems. Successful larval rearing was achieved for the first time in sixties by Dr. S.W. Ling in Malaysia. This species was later transplanted to USA (Hawaii), Japan etc., and reared successfully. At present Macrobrachium farming is well developed in Hawaii and Thailand. This has attracted attention all over the world and in several Asian countries including India. Successful rearing has been achieved and techniques are standardised under controlled conditions. Aspects of biology of the species relevant to culture are explained in this account.

SPECIES IDENTITY

This species belongs to family Palaemonidae (under Natantia, Macrura in Decapod Crustacea) characterised by the overlapping of the pleura of second abdominal segment over those of first and third segments. M. rosenbergii can easily be identified by its large second pair of thoracic legs in male and its rostrum, which is slightly pinkish in colour with a double curvature and a teeth formula of $\frac{12 - 13}{11 - 13}$. There are distinct black bands on

the dorsal side at the junction of all the abdominal segments. In the juveniles, on the lateral sides of the carapace, several horizontal black bands are characteristic of this species. However, these disappear as the juveniles grow into subadults.

FOOD HABITS

This species is a bottom feeder and omnivorous. It accepts a variety of food items ranging from grains, worms, flesh pieces of molluscs, crustaceans, and fish & cooked egg pieces. When the prawn is soft after moulting, it is predated upon by other prawns irrespective of sizes. It eats its own moult and eggs. Hence, it is necessary to provide shades and shelters for protecting themselves during moulting during culture.

GROWTH

Like other crustaceans, the growth is not continuous because of the hard exoskeleton covering the entire body and appendages. Growth in volume takes place during every ecdysis (moult) occuring at frequent intervals of time depending upon food and climate. The inter-moult period gradually decreases with age and in the fully grown adults, the growth stops leading to senility and dealth. Fully grown adults have greenish mat of periphyton growing on the cephalothorax (Head) which indicates that the growth has stopped and hence needs harvesting in pond culture operations.

The species grews to maturity in about 4 to 5 months under pond conditions.

HABITS

The species is nocturnal in habit and most of its life activities especially moulting and hatching takes place during night hours. There is a tendency to establish territory and protect the same in the adults.

The species locates its feed mostly by touch with feelers. Food is not completely eaten because of territorial attitude and hence feeds with a higher water stability. and Attractability are suitable and are recommended to be placed in pails at corners. This will help to assess consumption from the left over feed.

SEXUALITY

Males are bigger than females. In the male, the cephalothorax is bigger in size and the abdominal space narrower. The second pair of chelate legs are longer in male than female indicating sexual dimorphism. In juveniles, males can be distinguished from the females by the presence of appendix musculina additionally on the endopod of the second abdominal appendage (pleopod), like in other Palaemonids.

Females are smaller in size with a smaller head and a broader abdominal space to serve as a brood chamber for the incubation of eggs.

MATURITY

The species grows to maturity when their sizes are around 150 mm (25 g) in females and 175 mm (35 g) in males. Maturity can

be obtained earlier under better brood stock management. In the female, gonadal maturity can be clearly seen through the head when the orange coloured ovary gradually develops and occupies most of the cephalothorax. A small male can impregnate four to five females at a time.

BREEDING MIGRATION

Mature adults form fishery mostly in the freshwater areas of estuaries, backwaters and lakes where there is a tidal effect from the sea.

Both mating and incubation takes place in freshwater and brackishwater as the species especially females in berry are migratory in habit. Although hatching can take place in freshwater, larval survival and growth takes place only in brackishwater environment in shallow canals. In this habitat, they spend their time like plankton till they are transformed into post-larvae/juveniles and become benthic in habit. Then they return back to freshwaters to grow into adults.

BREEDING

Female, when fully ripe is dull, shy and prefers corners. It becomes receptive to male when it is in soft condition only after moult and is zealously guarded by the male with its long pincers. This is called premating on puberty moult. Mating is only for a short time during which the male deposits the sperms near the genital pores of the female located at the base the

third pair of thoracic legs. After a short time, as the eggs are extruded, they get fertilised externally. The eggs are deposited into the brood chambers under the abdomen between the pleopods. The eggs are held together by tuft-like ovigerous setae developed for this purpose.

FECUNDITY

Fecundity ranges from 40 to 150 thousand eggs depending upon size of the female but an average female (200 mm) can lay about 70,000 eggs approximately. Fecundity is more in the wild than in pond reared brood stock on account of differential growth rates.

INCUBATION

The female continuously incubates the eggs and provides sufficient aeration for the developing eggs by constantly fanning the pleopods. Depending upon temperature, the incubation period lasts from 15 to 24 days.

LIFE HISTORY AND BEHAVIOUR OF THE GIANT FRESHWATER PRAWN, MACROBRACHIUM ROSENBERGII

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Details of life history and behaviour of the freshwater prawn M. rosenbergii have been given by Ling (1962), New and Singholka (1982) and Uno and Soo (1969).

The life cycle of the species consists of eggs, larvae (zoea), post-larva, juveniles, sub-adult and adult. In nature, juvenile to adult stages are spent in freshwater habitat. Maturity, mating, egg-laying and part of incubation takes place in freshwater habitat and the species migrates to suitable brackishwater environment for hatching and growth of larvae through eleven stages till they are transformed into post larvae and later juveniles. The juveniles ascend into the freshwater zones of the rivers, back waters, lakes, canals, etc., which receive the tidal influence. Larval stages are planktonic while post-larvae to adult stages are benthic in habit.

EGGS

Eggs are slightly oval in shape measuring 0.6 - 0.7 mm on its long axis and are bright orange in colour. Sufficient aeration is given by fanning pleopods constantly. Dead eggs and foreign matter is carefully removed by the first pair of thoracic legs. From about 12th day onwards, a light grey colour slowly develops in place of orange colour. The grey colour deepens gradually and becomes slatish. In the females in berry with eggs about to hatch, the developing eye can be seen as a black spot. Normally, hatching takes place in about 19 days at temperature of 26 - 28°C.

EMBRYONIC DEVELOPMENT

Fertilization is external and takes place as soon as the eggs are extruded. First division takes place at about 4 hours, and subsequent divisions at about 1½ hour intervals. Cleavage is completed in a day. Ventral plate is formed at the end of second day. Body rudiment in the embryo is formed on third day. Buds of appendages appear on fourth day. Optic vesicles develop during seventh day and eye pigment at the end of eighth day. Functioning of heart started on tenth day. Embryo well developed by twelvth day and further development and eloboration of parts continue till hatching.

HATCHING

Hatching starts with slow but continuous vibrations of mouth parts of larvae, accompanied by stretching of body and forcing the egg to elongate. Mouth parts vibrate vigourously followed by further body stretching. After an hour, thoracic appendages also start vibrating vigorously but intermitantly for about 10 minutes initially. The body stretches further and telson till now covering the eye and head, pushes outwards and breaks the egg shell. The telson thrusts out first followed by head. With a forceful flexion and stretching, the entire larva springs out of the shell. Immediately the larvae come down to the bottom of the tank and stay for some time inactively (called prezoea stage). Gradually, the larva gains activity. comes up and leads a planktonic life.

LARVA

There are eleven zoeal stages in the larval cycle of the species lasting from 30 to 45 days depending upon temperature, water quality and food. Identification characters, sizes and number of days (at 28°C for each stage) are given below for determining the stages and monitoring feed grades and their frequency.

STAGES	AGE (No. of days)	BODY LENGTH	PROMINENT CHARACTER
I	0 (1-2)	1.92 mm	Sessile eyes
II	2 (2-3)	1.99 mm	Stalked eyes
III	4 (3-5)	2.14 mm	Uropods appear
IV	7 (5-9)	2.50 mm	Two dorsal teeth on rostrum
V	10 (9-12)	2.80 mm	Telson narrower & elongated
VI	14 (12-18)	3.75 mm	Pleopod buds appear
VII	17 (15-20)	4.06 mm	Pleopods biramous
VIII	20 (18-22)	4.68 mm	Pleopods with setae
IX	24 (21-29)	6.07 mm	Endopods of pleopods with appendix interna.
X	28 (25-34)	7.05 mm	Three or four dorsal teeth on rostrum.
XI	31 (28-37)	7.73 mm	Teeth on half the upper dorsal margin
P.L.	36 (36-43)	7.69 mm	Teeth on upper and lower margins of rostrum

LARVAL BEHAVIOUR

These are active swimmers and planktonic in habit. They are phototactic, but direct and strong light is avoided. They swim tail up, head down and ventral side upward at an oblique angle. Upto 5th stage (about 10 days), there is a schooling

habit in the larvae as they tend to close together and move in swarms. From 6th stage onwards, the larvae gradually tend to disperse. They spend most of the their time at the surface and in mid-column, but settle down to bottom during moulting time. They actively feed on the supplied food in suspension. Their photopositive tendency can be advantageously utilised for cleaning, feeding and water changing by partially shading the rearing containers in hatchery operations.

POST - LARVA

Post-larva settles to the bottom and becomes benthic in habit. Behaviourally, it is similar to juvenile except for the under development of body parts like setae, spine teeth etc. Within a few moults, the post-larvae become juvenile. In hatchery operations, the post larvae are gradually conditioned from brackishwater into freshwater by continuous change of water lasting for a day. They are transparent and can be observed by a flash light at nights.

JUVENILES

These are crawlers, and settle to bottom or cling to the sides. There are 6 to 8 horizontal black bands prominantly situated on the carapace at this stage. As the juveniles grow into sub-adults (about 70 to 80 mm), these bands start disappearing. In nature, the juveniles perform the backward migration to freshwater and grow into adults.

PRODUCTION, ACCLIMATISATION AND TRANSPORT OF THE FRESH-WATER PRAWN (MACROBRACHIUM ROSENBERGII) SEED

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INTRODUCTION

The seed of the giant freshwater prawn, Macrobrachium rosenbergii, are not abundant in nature for commercial exploitation and culture. It was, therefore, found necessary to develop hatchery techniques for seed production.

An indigenous technique of seed production has since been developed at this Unit which is a viable technology for adoption in any maritime state of India with some adjustments in seed production season.

This is a static water system with green water or clear water as the larval rearing medium, supported by an inert (pieces of tubificid worms) feed as the principle diet. Cultivated brine shrimp (Artemia salina) nauplii also supplement the worm diet as and when they are available. This indigenous technique of seed production is described here.

PRODUCTION CYCLE

Sexually mature male and female prawns are allowed to mate and breed in freshwater or low saline water. After a brief period of incubation, the eggs hatch out and tiny larvae pass through eleven stages in brackishwater before metamorphosing into postlarvae or seed prawns.

The postlarvae are acclimatised to freshwater and are grown to maturity in freshwater ponds or artificial freshwater enclosures to repeat the cycle.

The hatchery principle is to have such a closed system for continuous production and supply of seed.

PRODUCTION COMPONENTS

Brood stock, seawater or saltwater, freshwater, brine solution, feeds, electric power supply and rearing facilities are the essential components for seed production.

Brood stock : Initially gravid females with brown or grey colour egg mass (advanced brood) should be procured from the wild (open river estuaries) for larval hatching. Subsequently, seed produced in the hatchery should be grown in small earthen ponds or wide plastic pools at a stocking density of 15 - 30,000 per hectare. They reach sexual maturity in 4 - 5 months at a minimum length of 11.0 cm and the same females could be successfully bred at least five times thereafter. Young females breed at frequent intervals of about one month duration. However, the fecundity of young females (3,000 - 7,000) is lower than the older one (1.5 - 3.0 lakhs). Hence, a large number of small or a few number of large gravid females are required for mass larval rearing trials. In nature the sex-ratio is predominently female during the peak breeding season coinciding with the monsoon months, thus a large number of gravid females can be procured.

Only the gravid females with advanced brood (brown or grey coloured brood) are netted out as the eggs hatch out in 2 - 3 days. Collection of just spawned females and their maintenance through the incubation period often results in reduced fecundity due to various factors.

Brood prawns from the wild or pond are transferred directly into rearing tanks and after the larvae hatchout the spent females are removed.

A convenient technique is to keep 2 - 3 gravid females with advanced brood in a floating meshed cage (2' x 1' x 1') with a 20 mesh/inch nylon screen bottom. A cup with feed for the adult prawn is attached inside the cage. As the eggs hatch out, the larvae pass out through the nylon screen directly into the rearing tank. The cage is removed after all the larvae are liberated in the tank.

The favourable season for seed production ranges normally from 7 - 8 months and gravid females are available during the same period. The best periods for seed production are, however, from March - April and September - November when the climatic conditions are favourable.

Water sources : Although Macrobrachium rosenbergii is a freshwater prawn, the seed are produced in brackishwater following its natural breeding behaviour.

Saline ground water or offshore/shore seawater and chlorine free freshwater should be used for proparing brackishwater of desired salinity.

Brackishwater stored for about a month or two may be used directly for larval culture. Treatment of stored water with powdered oyster shell promotes the brackishwater quality. The same quality of brackishwater should be employed for the production of seed. Aged and filtered chlorine free freshwater is essential for acclimatisation of seed to freshwater.

The quality and availability of freshwater and salt water or seawater determine the economic viability of seed production.

Feed cultures : The entire seed production technology is dependent on the availability of larval feed throughout the year. The main food items are tubificid worms and brine shrimp nauplii.

Worm culture : The culture of tubificid worms is maintained in canals filled with fermented animal manure (preferably pig manure) with a feeble flow of freshwater. Initial inoculum is brought from the local drainage ditches and the culture is established in about a month. If rice bran or rice water is applied over the bed, the worms cluster into a mass for easy harvest.

Brine shrimp culture : The brine shrimp (Artemia) culture is easily maintained in brine solution derived from salt pans or prepared with the help of common salt. The culture may be maintained in plastic pools fertilised with animal manure extract and drainage water from the worm culture. The culture is exposed to sun light to stimulate production of algae. Inoculated Artimia cysts are hatched out and multiply into large numbers in a month or two. Adults graze on the algae and fertilisation at timely intervals maintains a continuous production of algae. No aeration is necessary but the medium should not be over-fertilised.

Electricity : A dependable power supply is an absolute necessity. For a steady supply a low power generator can be kept as standby.

Rearing facilities : Rectangular or round tanks with flat bottom (capacity 200 liters and above, depth 40 - 100 cm) are suitable for larval rearing. The number and capacity of tanks depend on production targets and managerial skill.

The larval rearing unit consists of :-

a) a rearing tank with brackishwater
b) underwater aeration system
c) lights for feeding, tubes for cleaning the bottom and pump or tube (gravity flow) for water exchange; and
d) hydrography equipment (for recording environmental parameters)

This larval rearing unit is supported by brackishwater reservoirs. The ratio between the larval rearing unit and reservoir volume of brackishwater is highly variable depending on the local availability of seawater.

Various gadgets are fabricated for the operation of this unit, viz., cleaning tubes, feed grading sieves, water filteration seives, shades for lights, water siphoning tubes etc. Seedresting multi-stage tier-system is a suitable device for harvesting the seed from the rearing tank to reduce crowding and cannibalism.

For seed transport, the usual method now in vogue to transport fish seed is equally suitable. The only addition is to provide some plastic strips or Hydrilla as hold and shelter, to prevent cannibalism and to provide live feed (worms) or broken rice during transport.

PRODUCTION METHOD

The procedures followed from hatching to transport of seed to freshwater ponds are briefly outlined here :

Brood stock : Initially brood stock are procured from the wild and subsequently the laboratory produced brood stock are used. To start with, the rearing tank is filled with brackishwater. After thorough aeration gravid females with advanced brood are introduced, and fed on broken rice or apple-snail flesh. When floating cages are employed to hatch the larvae, food is offered in cups provided inside the cages, and care is taken to keep some feed always in the cups, so that the prawns do not get hungry and feed on their own eggs.

Hatching : The bottom of the rearing tank is cleaned daily and fresh/brackishwater is exchanged, if necessary until hatching. The rearing tank is examined every morning to observe the presence of any newly hatched larvae. The spent-females are removed immediately after that. The number of larvae released into the rearing tank is estimated.

If the larvae are hatched in separate tanks, they are transferred to the rearing tank. The stocking rate is calculated on the basis of the estimated number of larvae released into each tank.

Larval rearing : The larvae are reared indoor or outdoor. They pass through eleven stages and the first postlarva appears in about 22 - 32 days. The diagnostic features of the larvae are given below.

DISTINGUISHING CHARACTERS OF LARVAL STAGES OF
M. rosenbergii

STAGE	AGE (DAYS) RANGE	M	CHARACTERS
I	1	0	Sessile eyes, maxillipedes functional, pereiopods 1 - 2 biramous rudiments
II	2	2	Supra-orbital spine, stalked eyes, pereiopods 1 - 2 functional, 3 biramous rudiment, 5 uniramous rudiment
III	3-4	4	A dorsal rostral tooth, pereiopods, 3 - 4 biramous rudiments, 5 three segmented rudiment
IV	4-6	5	Two dorsal rostral teeth, pereiopod 3 functional, 4 biramous rudiment, 5 five-segmented uniramous.
V	5-8	7	Chromatophores prominent on mid-ventral abdomen, thoracic appendages position same as IV stage
VI	7-11	9	Buds of pleopods, pereioped 4 functional
VII	9-13	12	Pleopods biramous buds, antennal flagellum 5 - segmented
VIII	12-16	14	Pleopods exopods setose, antennal flagellum 7 - segmented
IX	14-18	17	Both rami of pleopods setose except first, endopods of pleopods with appendices internae, antennal flagellum 9 - segmented
X	17-22	20	3 - 4 dorsal rostral teeth, (i.e., 2 on carapace and 2 - 4 on the dorsal side of the rostrum antennal flagellum 12 - segmented; few setae on appendices internae also.

XI	20-26	24	Rostral teeth on half of upper dorsal margin i.e., 2 on carapace and more dorsal rostral teeth; antennal flagellum 15-segmented; exopods on thoracic appendages are less developed and setae on pleopods increase.
First post-larva	22-32	28	Exopod of third maxillipede reduced but with setae; all exopods of thoracic appendages rudimentary, without setae; 11 teeth on upper margin of rostrum and 5 on the ventral margin.

The larvae grow from an initial size of 2.0 mm to about 10.0 mm when they reach the postlarval stage.

The optimum conditions for larval culture are given below :-

	RANGE	AVERAGE
Dissolved oxygen (ppm)	4.0-6.5	5.0
Water temperature (°C)	26-30.5	29
Salinity (‰)	12-18	15
Stocking (per liter)	upto 100	60
Rearing period (days) (90% postlarvae) survival)	35-45	45
Larval survival (%)	11-40	20

The most important daily schedules are :

a) feed collection and preparation
b) Checking hydrological conditions
c) attention to hatching tanks and larval rearing tanks viz., feeding, cleaning, water change, larval hatch, treatment of any disease, etc.
d) water management (storage and treatment)

Food : Worms are cleaned in running water and sliced on a rubber mat with sharp knives. The sliced feed is washed and graded with different mesh screens (20, 40, 60 mesh/ inch) for feeding the larvae in different stages of development. A few drops of copper sulphate solution are added to the prepared feed to kill pathogens and it is washed again after five minutes treatment to clear all traces of copper sulphate. Food is given from the third or fourth day when the larvae moult to the third stage. They are fed initially three times a day, at specific time intervals (5 - 6 hours) and later as they develop this is increased to 5 - 6 times a day (3 - 4 hours interval). Indoor feeding is done by attracting the larvae with a light to a corner or side of the rearing tank, taking advantage of their photopositive behaviour. Graded feed is offered to different stages of development. Artemia nauplii are graded into fine, medium, and large with nylon sieves of different meshes and are fed to larvae at different stages of development in the evening. The leftover food and metabolites are removed from the tank bottom every morning.

Water : Maintenance of good water quality is carried out through a partial or total water exchange every two or three days interval during the morning. If the water quality deteriorates, it is changed more frequently. While changing the water, the outlet mouth is screened to prevent the live larvae to escape from the tanks. Fresh brackishwater or green water is allowed to flow-in by gravity from reservoirs or pumped-in where gravity flow cannot be maintained. Phytoplankton rich green water reduces ammonia levels in the rearing medium and increases the survival rates of the larvae. The used water from the rearing tanks is exposed to sun light

for mineralisation of metabolites and their remmoval by algae. By this method the rearing medium can be used repeatedly, thereby conserving the brackishwater.

Brackishwater is always kept in store for use in rearing tanks. It is estimated that a minimum of $1M^3$ of water is required for the production of 500 - 1000 prawn seed.

Dissolved oxygen : The aeration system is kept uniform throughout the rearing tank, creating a feeble motion in the tank. In the outdoor production system oxygen supply is effected through photysynthesis during the day and by aeration during night.

Temperature : Indoor larval rearing trials could be carriedout successfully almost throughout the year where the annual temperature range is between 24.0 and 32.0°C. The outdoor trials often suffer due to high variation in temperatures in summer and winter; however, during the other seasons, seed production could be carried out successfully.

Salinity : The salinity tends to increase during the course of larval rearing due to evaporation. This is checked by the addition of aged and filtered freshwater.

Growth : The rate of development (conversely seed production) is variable due to a combination of factors : food, temperature, water quality, etc., and they need be critically observed everyday in order to accelerate the larval growth.

Diseases : Normally no disease occurs if the quality of water is satisfactory. If any infection occurs in an epidemic form, the entire batch of larvae is destroyed. Protozoan ciliate infection is a common disease and this can be controlled with copper sulphate treatment.

Production : After the first appearance of the postlarva, it takes another two weeks for the rest larvae 90% to metamorphose to postlarvae. The number of seed produced from a tank varies between 10 and 20 per liter of the rearing medium. Depending on the water temperature, one seed production cycle is completed in 2 - 3 months.

SUMMARY OF SEED PRODUCTION

	DAYS	EQUIPMENT
Prenuptial moult, mating and spawning	2 - 3	Earthen pond/plastic pool.
Incubation	15 - 24	Earthen pond/plastic pool/ F.R.P. tank with aeration
Hatching	1 - 2	Cages, Plastic pool/F.R.P. Tanks with lights and aeration.
Larval rearing (90% seed production)	35 - 45	Plastic pool/F.R.P. tank with light and aeration, multi-stage resting tiers for postlarval settlement.
Acclimatisation to fresh water and transport	10 - 14	Plastic pool/F.R.P. tank with aeration and resting tiers.
	63 - 88	

Acclimatisation to freshwater : When 90% of the larvae metamorphosed to postlarvae, the rearing medium is exchanged with aged fresh water, or freshwater is added slowly to dilute the medium to freshwater in a period of 6 - 8 hours. When the postlarva are taken out in batches from the rearing tank, the same acclimatisation procedure is followed.

After acclimatisation to freshwater, the postlarvae (Prawn seed) are weaned from worm diet and fed on a variety of feeds that form the supplementary feed in pond culture., viz., small shrimp, crushed maize, broken rice, coconut oil cake, flesh of apple snail or bivalves, smoked tapioca, particulate organic matter from worm pits, etc. Ten or fourteen days after acclimatisation to freshwater the seed reach a size of about 2.0 - 3.0 cm and are hardy for stocking in freshwater ponds. Still smaller sizes (1.5 cm) may also be stocked directly in well prepared ponds, reducing the production costs in a hatchery. Survival rates decrease if the seed are grown for more than two weeks under crowded conditions in rearing tanks. A ten percent weekly mortality is reported.

Transport : The prawn seed are transported to farm site in polythene bags under oxygen pressure. A few weeds or plastic strips and worms are added to the packet as shelter and feed to prevent cannibalism during long distance transport. The percentage survival during transport is as high as 98 - 100. The seed must be repacked if transportation time exceeds 24 hours. Normally the seed are packed at the rate of 50/liter for long distance transport. For short distance transport of 3 - 4 hours, no oxygen packing is necessary and the seed

transported at the rate of 150 - 800/liter. Mortality during transport is caused by injury to the soft seed (moulted) and cannibalism. As the intermould period at this stage is very short no remedial measure is possible.

Stocking : Seed are stocked in a well prepared pond free from insect larvae, predatory fish and other predators. They are stocked during the early morning hours, gradually acclimatising the seed container with the pond water. The contents are slowly decanted while the seed swim freely in all directions and finally disappear, obviously settling down at the bottom or on the margin and shore vegetation.

ECONOMICS OF SEED PRODUCTION

The cost of wild seed at collection centres is Rs. 250 - 300 per thousand. Scarcity and uncertainity of availability prohibits the prospects of wild seed trade expansion.

Based on operating costs, the rearing cost for the production of one thousand seed ranges between Rs. 25 and 40. Labour accounts for the highest operating cost, followed by electricity and feed.

AVERAGE COST OF PRODUCTION OF 1000 PRAWN SEED
(based on operating costs)

	OUT DOOR 4' x 2' Pl. Pool	INDOOR 8' x 3' F.R.P.	INDOOR 16' x 4' F.R.P.
Effect volume (1)	600	500	2,500
Cost of production of 1000 seed. (Rs)	25.25	36.40	39.80
Labour (Rs.12/8 hours)	22.80	32.75	33.15
Electricity (Rs.0-50/unit)	0-55	0.90	2.70
Feeds (Rs. 0-96/liter)	1.90	2.75	3.95

By reducing the labour and power costs through the application of solar energy for the maintenance of dissolved oxygen and water quality in outdoor rearing trials, the cost of production is brought down to an average of Rs. 25 per thousand seed.

The production cost of 1000 seed varies with the labour and electricity costs. Larger containers and mass seed production reduce the production costs further in a commercial venture.

DESIGN AND CONSTRUCTION OF MACROBRACHIUM HATCHERY

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CIFRI, Kakinada

INTRODUCTION

The economic and social uplift of a developing nation depends to a large measure on evolving inexpensive production technologies appropriate to the prevailing economic and social conditions. In the present case, design and construction of a Fresh Water Prawn Hatchery were made in such a way that they are suitable for adoption by poor farmers.

The operation of commercial prawn hatcheries is usually very expensive because of the high costs of labour, water, power and feeds. A satisfactory remedy to this situation for a developing nation is to evolve an appropriate labour intensive technology, using inexpensive locally available raw materials for feed production and to use other low cost inputs. A further economically sound approach is to develop an infrastructure within the hatchery complex to produce and supply all essential inputs for uninterrupted seed production. The design for such a production technology of *Macrobrachium rosenbergii* seed is briefly explained here.

CHOICE OF HATCHERY SITE

In temperate countries, the seed are produced under temperature controlled conditions due to short duration of favourable climate.

Any site with a sub-tropical climate and low wind velocity is suitable for such a hatchery in India. The site should ensure electricity, salt-water from borewells or natural sea-water, and chlorine-free fresh water. Brood stock and larval feeds are developed and maintained within the hatchery.

ESSENTIALS OF A HATCHERY

A building with open space adjacent to it is required to accommodate the following facilities :

Brood stock : One or two 0.02 ha (20M x 10M x 1M) earthen ponds are required to provide berried females regularly.

Water requirements : The overhead tanks, one for fresh water and another for sea water or salt water, are necessary for filling and aging before use. This will facilitate gravity flow for the use of freshwater for for making mixed water for larval rearing. Brine may be collected from local salt pans or the sea-water or salt water may be exposed to sunlight for evaporation; in about a month brine is usually formed.

Water analysis kit : This is required to check water quality from time to time.

Feed cultures : Worm cultures are maintained in long shallow pig manure beds inoculated with worms and with a feeble flow of freshwater. Manure is stored in large earthen pots or excavated pits. The Artemia cultures may be maintained in round or rectangular tanks, filled with brine and fertilised with pig manure extract. The drainage water from any worm bed can also be used as a fertiliser in Artemia culture.

Rearing tanks : Various designs are employed for larval rearing. The same larval rearing tank works well for hatching of the brood. Special cages are fabricated to separate the parent after hatching. For a small scale industry, rectangular rearing tanks of 0.5 Kl - 2.5 Kl capacity or round plastic pools of 600 - 1000 liter capacity are well suited for larval rearing. For large scale production the container capacities may be increased suitably.

Electricity : A dependable power source or a standby generator is essential.

Aeration system : One 0.5 H.P. air compressor meets the requirement of a hatchery to produce 1 million seed. One extra compressor should be kept as a standby in case of failures.

Seed transportation equipment : Sufficient number of round or square tins or plastic containers, plastic bags and two oxygen cylinders fulfil the seed transportation requirements.

HATCHERY DESIGN

The design of the hatchery is location specific. The main features of the hatchery design are :

Main building : This contains the main components of the seed production process. The area of this building depends on the seed production targets. This building will accommodate :

i Larval hatching and rearing system with fixed lines for water, power and air.

ii Brackishwater aging pools.

iii Sea water reservoirs

iv Pump house for salt water/sea water and freshwater and space for air blower and generator.

v Store room

vi Staff room

vii Garage

viii Toilet

(Item i - iii are 3' above ground level for gravity draw down)

Water reservoirs : Freshwater and seawater/salt water towers close to the pump house.

Feed cultures : Worm culture in serpentine bricklined, 1 M. wide and 15 cm deep canals filled with organic manure.

Aretemia culture : Under shade; Plastic Pool or Cement tanks filled with diluted brine, fertilised with organic manure and inoculated with Artemia cysts to build-up initial population.

i Concrete tanks for seed and brood stock management (where land is available brood stock developed in earthen ponds at the hatchery site).

ii Water circulation and drainage (Piping system)

iii Land for agricultural use with waste water and manure from worm pits.

iv Shed for keeping manures, brine, etc.

v

v Fresh water reservoirs

vi Brackish water treatment pools close to larval rearing tanks, under shade.

vii Path-ways to reach water reservoirs installations.

CONSTRUCTIONS

Main building : The eastern part of the building where seed are produced, is open directly to solar light and all the other three sides are covered with entrances, exits; windows, etc. The roof is covered with fibro-cement corrugated sheets and ventilators for air circulation.

Water towers : Two reinforced concrete towers, one for freshwater and another for salt/sea water are installed at a height of about 3 M above ground-level, protected by fibrocement corrugated sheets as covers, close to the main building.

Containers : If all the containers for different purposes are made of concrete, care should be taken to coat their inner walls and bottom with epoxy or polyester resin when used for brackishwater, sea water or brine.

Feed culture :

Worm culture : This is positioned close to seed management and brood stock tanks. The waste water from the latter tanks is utilised for circulation through the canal system.

Artemia culture : This is located in an isolated place under a shade.

Brackishwater treatment : The containers are kept close to the rearing tanks for gravity draw-down and pumping.

The design and constructional details depend on the shape and nature of the surrounding land.

MAN POWER REQUIREMENTS

This is often left to the judgement of the hatchery manager.

EQUIPMENT

As far as possible, low cost major items are procured from reliable sources and most of the operational equipments are fabricated.

PREPARATIONS BEFORE COMMENCEMENT OF HATCHERY OPERATIONS

While construction work is going on, attention may be paid to set-up the following :

—— Feed cultures
—— Storage of Brackish water
—— Aeration system
—— Lighting arrangement
—— Water circulation system (PVC pipes)

PRECAUTIONS

As far as possible galvanised metalic containers should be avoided in hatchery operations.

MANUAL OF OPERATIONS

Before the commencement of seed production, a manual of operation should be prepared to streamline the schedules of operations is a hatchery.

CONCLUSION

The design and dimension of a hatchery vary according to space and purse; conversely, the capital costs for the construction of a hatchery depend solely on the skill of the hatchery manager.

HATCHERY MANAGEMENT OF THE GIANT FRESH WATER PRAWN, MACROBRACHIUM ROSENBERGII

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INTRODUCTION

A hatchery is a prerequisite for an assured supply of pure prawn seed for commercial pond culture ventures in view of natural vagaries, creating uncertainity of their availability in nature coupled with their mixed composition. Apart from this fact, the seed of Macrobrachium rosenbergii are not abundant in nature; consequently, their cost is exhorbitant, varying between Rs. 250 - 300/1,000 seed.

Macrobrachium rosenbergii is the largest freshwater prawn known in the world and much emphasis is laid on the production of seed of this prawn under controlled conditions in many developing countries. The seed of this prawn are produced with ease under controlled conditions as the prawns mature, mate and spawn in captivity almost throughout the year.

A new technology of seed production was developed for the giant fresh water prawn, Macrobrachium rosenbergii at the Central Inland Fisheries Research Institute and the management practices now in vogue are briefly outlined below.

HATCHERY MANAGEMENT

The hatchery should be a self-contained system without dependence on imports of technology. It should work like a factory where raw materials are brought in and finished products are produced.

Optimum conditions for hatchery operation : Although the indoor water temperature ranged between 23.5° and 32.5°C during eleven months in a year for rearing the larvae, optimum temperatures favourable for mass seed production (26.0° - 30.5°C) prevailed only for about 4.5 - 8.5 months in a year. The most preferred temperature is, however, 28 - 30°C which prevailed hardly for one or two months (March and September or October) in a year.

The optimum temperature periods depend on the duration of summer and winter seasons. Usually March - April and September - October months are the best in a year but months closer to them overlap during extended favourable periods.

The optimum salinity for larval growth is 12 - 18‰ which could be manipulated.

Brood stock : One large or five small berried females are required for stocking a 0.5 Kl rearing tank which yields an average of 5,000 seed in one larval rearing cycle. At this rate a brood pond should be able to produce 200 large prawns or 1,000 small prawns for the production of one million seed. Since production of larger females is a time consuming factor (8 - 9 months), small prawns are preferred (5 - 6 months), and they should be replaced after 2 - 3 spawnings.

Both in nature and under controlled conditions the spawning activity is not uniformly the same throughout the year. Intense breeding activity generally coincides with the monsoon months. The percentage of berried individuals recorded under controlled conditions signify that the female population in a pond which should be manipulated according to hatchery requirements.

It is always necessary to maintain a surplus number of females for selection of berried individuals for synchronous hatching.

Larval rearing : Larvae hatched out within an interval of 5 - 6 days and they are stocked @ 40 - 60/liter to yield 10 - 20 seed/liter. With growing experience, stocking densities and production efficiencies could be improved. Except temperature, all other parameters are manipulated. The evaporation loss and salinity is adjusted by addition of freshwater. Dissolved oxygen (4.5 ppm) is maintained by continuous aeration system in indoor cultures. In outdoor cultures, where the seed are produced in green water, aeration is cut off for about 12 hours a day (to save power) on bright days; dissolved oxygen in the rearing medium is maintained throught photosynthetic activity. Feeding and removal of leftover food, faecal matter and any foreign matter settled at the bottom is a daily routine for successful completion of a larval cycle. Frequent water exchange reduced dissolved organic load resulted from metabolities.

One seed production cycle is completed in 45 days through water management and controlled feeding.

After 90% seed formation, the rearing medium is diluted with chlorine-free aged fresh water and the acclimatised seed are counted and packed under oxygen pressure for transportation. Utmost care should be taken to handle the seed.

Water management : A surface borewell for freshwater and a deep borewell for salt - water at the same location are the assets for a hatchery. Where coastal seawater is employed the

influence of urban and industrial drainage may be checked at the intake point. Municipal or Corporation tap water is chlorinated and hence such water should be aged sufficiently before use. A thorough aeration help to expel all the chlorine, present in water.

Mixed water of desired salinity is prepared through gravity flow from the overhead seawater and fresh water tanks and stored in reservoirs. Newly mixed seawater is the best for seed production. If there is any constraint for the continuous supply of seawater, the used water can be exposed to sun light and reused for larval rearing; however, such treatment should be continued for one year, thereby reducing the seawater requirements. Adopting this type recirculation method, the actual requirement of seawater can be reduced from about 3000 liters to 500 - 1000 liters to produce 1000 seed.

Feed cultures : Production of worms of Artemia nauplii should be manipulated in relation to the seed production target, considering their production rate as 50 ml/Worms/m^2/day and 160 ml/nauplii/Kl/day. About 1.5 - 3.0 liters of worms are required for the production of 1000 seed. Artemia nauplii are not obligatory.

While the fertilizer in the worm bed should be replaced once in six months, the brine in Artemia culture required a change once in 3 years. The particulate matter in used-up manure forms a good source of feed for adult prawns. Artemia cysts produced as a hyproduct (13 g cysts/Kl/year) can be stored for emergency use.

Seed transport : For transportation about 500 seed are packed in 6 - 8 liters of aged freshwater, Hydrilla or plastic pieces are provided to shelter and prevent cannibalism under crowded conditions. During transport live worms are added as feed. The transport mortality is normally less than 5 percent. Over exposure to direct sun should be prevented.

Losses : Losses of whole batch of larvae often occur at times of power failure or water spoilage. A standby generator or water change facility prevents such catastrophies. Losses also occur due to infection by ciliates, bacteria and fungii. It is safe to discard such batches of larvae than treat them with chemicals. As long as the same quality water is used, no major losses occur except for reasons of hunger, dissolved oxygen and injuries resulting from the larvae attaching each other.

Recording : Proper records on the monitoring of brood stock, water, hatching system, rearing system, feed cultures, hydrological conditions and seed marketing should be maintained.

Precautions : Precautions should be taken to check gasoline burning, tobacoo smoking, short-circuiting in power installation and wethandling of electrical equipment inside the hatchery.

PROBLEMS

Hatchery site : On the east coast of India the monsoon is unpredictable and can cause immense damage to the hatchery if it is constructed on the coast without shelters.

Water is one of the costly items in seed production, hence hatcheries should be located close to the sea where clean fresh water is readily available without the need to drill a well. In areas where well water is the only source of freshwater, direct use may result in larval mortality so the water should be aged before use.

Brood stock : Fecundity of laboratory bred females is always low hence stock maintenance requires manipulation of female specimen.

Larval rearing : The larval life is much longer than the marine prawns resulting in increased costs for the management. As far as possible the larval life should not be extended.

Inadequate feeding leads to delayed or prolonged metamorphosis, the older postlarvae feed upon the other smaller larvae and just metamorphosed postlarvae. This loss by cannibalism is upto 10%/week and care should be taken in husbandry practices to minimise the same. In indoor condition prawn seed are produced under continuous aeration but the uncertainity of power supply hampers seed production in many cases. A standby generator is a must for successful hatchery operation.

Phytoplankton rich waters give best seed production in outdoor cultures but excessive blooms result in supersaturation of dissolved oxygen culminating in larval mortality. Hence blooms should be controlled through water management.

Management : Proper choice of a capable manager is of utmost importance to run a prawn hatchery, as the problem in a hatchery encountered due to incompetency or careless husbandry practices.

Temperature plays an important role in seed production. Prolonged summer or winter seasons are the major vitiating factors so the optimum temperature period should be best utilised for extensive larval culture and seed production. In other months the hatchery activity may be reduced to limited production at reduced stocking densities. The unpredictable cyclones often cause much havoc to the hatcheries and counter measures should be worked out to meet such catastrophies.

ENVIRONMENTAL PARAMETERS AND THEIR CONTROL IN HATCHERY MANAGEMENT : PHYSICO CHEMICAL FACTORS

——— J.B. Rao
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Giant Freshwater prawn, Macrobrachium rosenbergii, has a peculiarity in its life cycle with reference to its environmental factors. The habitat of the prawn from seed to adult is in freshwater, while the larval development from egg to the post larvae, occur in the low saline waters (Brackishwater). Hence it is interesting to know the physico-chemical factors of the culture medium for the successful rearing of the freshwater prawn from egg to post larvae. The important parameters of the culture water area discussed below :-

W A T E R

For the proper maintenance of the brood stock of M. rosenbergii a ready freshwater supply is essential. There are different sources from which freshwater is obtained. Water obtained from the Municipal water supply contains chlorine which is not desirable. Hence to dechlorinate the water it is aerated at least for a period of 2 days (48 hours) before use. Bore-well and open well waters can also be used provided it does not have salinity. Since water from this source will contain very low level of oxygen, these water need to be well aerated before use. Surface water such as river, canal and irrigation channels are not recommended for use unless the quality is well checked. These waters generally contain a high amount of plankton or micro organisms which brings in

imbalance in the quality of water. Also it may contain toxic materials like pesticides, distillory wastes, molasses, etc. and therefore is not recommended without proper chemical analysis.

As described earlier, this prawn has two phases of life cycle viz. freshwater and brackishwater (low saline water). The sea water is essential for mixing with freshwater to bring it to the desired salinity for the larval development of this species. Again sea water collection site is also to be judiciously explored especially because of the discharge of toxic chemicals, pesticides etc., at the river mouth or at the brackishwater canal inlets from the sea. It is also necessary to wait for high tidal waters at the river or canal mouths. To avoid all these complications it is better to collect sea water directly from the shore/offshore.

PHYSICAL FEATURES

Dissolved oxygen : i) Life of living organisms depends on oxygen either in the terrestrial forms or aquatic forms. Therefore, this parameter is most vital for the hatchery management. Methodology of oxygen estimation is given in the appendix. In the rearing medium oxygen should be maintained as close as possible to the saturation point and for this aerators or air compressors are used to create feeble current in the water tank to maintain saturation point of oxygen. The causes for oxygen depletion in the rearing medium are due to the following factors; (i) the metabolic wastes of the larvae get accumulated in the tank (ii) excess unutilised food get

degenerated and pollute the tank bottom. It also indirectly depletes the oxygen levels by chemical change. Hence change of water with the ready mixed water of desired salinity is highly essential.

To nullify these adverse effects in a small hatchery with plastic pools, daily cleaning of the tank bottom by siphoning out is practised with the reduction of 30% of the volume of water and replacing with fresh mixed water. Thus excess food and metabolic wastes in the bottom of the tank are removed every day.

Optimum level of oxygen requirement for this species is found to range between 4.0 & 6.5 ppm (average 5 ppm.)

ii) Salinity : For the successful rearing of M. rosenbergii hatchlings, salinity is one of the important factors to be maintained in the medium. After repeated experiments with various salinity ranges by mixing seawater and freshwater, it was found that the ideal range is 12 - 18‰ with the average level being 15‰. The salinity of water is found to increase in the rearing medium due to evaporation loss. Therefore, it is essential to check the salinity of water often and freshwater is added to the medium to bring it to the desired level.

In small hatchery tanks during the course of water change a sudden fluctuation in sality is often experienced due to the operator's error which is to be avoided at any cost.

Procedure for the salinity determination is presented in the appendix.

iii) Water temperature : In nature the growth of an organism increases with the increase of temperature. Accordingly larvae of this species grow and molt more quickly when the temperature increases in the selected range. The optimum temperature range is determined as 26° - 30.5°C. However, larval development could be carried out successfully throughout the year in laboratary with the controlled condition where the annual water temperature ranges between 24° and 32°C. By repeated experiments two peak seasons were observed for the larval development, one between pre-summer (March - April) and the other from July to November. Larval development takes considerable time below optimal range of temperature so it is not economical period. Likewise temperature beyond 32°C is found to be lethal for the zoea. However, gradual change of temperature will not effect the growth of the zoea but sudden change in temperature will adversely effect the zoea and may cause mortality.

Temperature control is possible only by air-conditioning the hatchery during the seasons. Experiments in two sets viz. out-door trials and indoor trials, conducted at Prawn breeding unit, Kakinada show that the out door trials could be carried out successfully only during the peak seasons and the tolerance level exceed during the off-season viz. peak summer and winter. High temperature easily reaches the bottom in shallow tanks and therefore shading is essential. The results obtained from the experiments show that the optimum water temperature for the hatchery management is 26 - 30.5°C with an average at 29°C.

pH

This parameter is important to determine the quality of water. pH is expressed in terms of numerical value, if the

value of pH is 7 it is neutral water. If the value is less than 7 the water is called acidic and the value above 7 is alkaline. Alkalinity of water is due to the dissolved salts like chloride in the water. Slightly alkaline water in fish culture is desirable since it acts as a disinfectant and maintains the health and well being of the fish. This is essential for adult prawn of M. rosenbergii also. Acidic waters are not at all desirable as the organism will be affected with infection, and thus help to spread the diseases. For larval rearing in brackishwater the pH will be high. This parameter has little significance in the larval rearing of M. rosenbergii. pH of water can be determined by a Lovibond comparator with the desired indicator discs like phenol red and Bromothymal/ pH paer is also used but the/blue. potency of this chemical paper looses due to long preservations and gives wrong reading. It is found that the pH levels between 7.0 - 8.5 is ideal for the hatchery.

L I G H T

Direct sun light on the larvae are harmfull and therefore, this is to be prevented in the clear water system. Light is no doubt required for the growth of the larvae and therefore shading the rearing tank is essential.

a) Hydrogen sulphide : This is harmful for the prawn larvae and it takes a heavy toll of prawn larvae if present in the medium even in small quantity.

b) Chlorine : Chlorine in the water reduces the oxygen content to lethel levels and hence it is essential to remove the same by aeration.

c) Nitrites and Nitrates : Post larvae of M. rosenbergii are highly succeptible to these chemicals resulting in poor growth and survival; however, the lower levels of nitrite at 0.1 ppm and nitrate upto 10 ppm in the water medium is tolerable.

d) Manganese : A very low concentration of manganese in the medium will not have any adverse effect on the growth and survival of the larvae.

d) Iron : High iron levels appear to be detrimental for the hatchery management, a way out has been suggested to reduce this content by atmospheric oxidation.

RECIRCULATION AND HYGINE

Two methods are generaly adopted to economise the utilisation of water which should have the same quality of the rearing medium. One is recirculation and filteration and the other is 'Green Water' culture.

In the first system biological filters are used to remove all the biota by adding ozone, or water exchange to the tune of 6 times the volume of rearing tank per day through biological filters with no addition of water excepting the replacement of evaporation loss.

There is another technique in which the larval rearing water is filtered through graded sand gravel filter, here the water is circulated mechanically or by a pump.

A new technique has been developed in the Prawn Breeding Unit where the used water is allowed to get direct sunlight for a few days when the biota like plankton grow and die and settle to the bottom. After ageing the clear water is once again used after testing the required salinity.

Green water culture : Due to various disadvantages in the green water culture, this system is not adopted in the rearing tanks. Firstly green water will not thrive at more than 12‰ salinity whereas the average salinity requirement for the hatchery is 14‰. Hence the water is used only for exchange purposes. The water can not be used for more than three days. It has dissolved oxygen problem also.

Diseases : Protozoan ciliate infection is the only disease commonly encountered in this species which can be controlled by 0.4 ppm copper sulphate solution treatment. If the infection occur in epidemic form it is essential to destroy the entire batch of larvae. Normally if the water quality is found good no infection will occur.

A P P E N D I X

Determination of temperature : Generally temperature of a water body is determined with the help of a centrigrade thermometer graduated in 0.1 ^{o}C scales or for more accurate results in 0.01 ^{o}C scales.

Temperature of surface water may be obtained by dipping the thermometer directly in the water for about one minute. Subsurface temperature of a deep water system may be determined with the help of a reversible thermometer. This

thermometer may be placed at any desired depth and the mercury column indicating the water temperature made fixed by means of a trigger arrangement. Then the temperature is noted and the thermometer may be reset for further observations.

Determination of dissolved oxygen : Dissolved oxygen in water can be determined to a fairly accurate extent by using Winkler's method. The principal behind the method is oxidation of divalent Mn ions to basic hydroxides of higher valency states by reaction with dissolved oxygen. When the solution is acidified in presence of iodine ion, the Oxidised Mn again reverts to divalent state and iodine, equivalent to the original dissolved oxygen content of the water. This iodine is titrated with standard Sodiumthiosulphate ($Na_2S_2O_3$) solution.

Reagents :

a) Alkaline iodide : Dissolve 700 g pure potassium hydroxide (KOH) and 150 g potassium iodide (Kl) in 1 litre of distilled water.

b) Managanous sulphate : Dissolve 480 g manganous sulphate ($Mnso_4$) in 1 litre of distilled water.

c) Concentrated sulphuric acid : ($H_2 SO_4$)

d) 0.1 (N) Potassium dichromate : Dry crystaline ($K_2Cr_2O_7$) in an oven at 125°C, cool in dessicator, and weight accurately 4.904 g. Dissolve it in distilled water and make up the volume to 1 litre.

e) 0.025 (N) Sodium thiosulphate : Dissolve 24.82 g of crystaline sodium thiosulphate ($Na_2S_2O_3$) in 700 ml of distilled water, add 4.0 g of borax as stabiliser and make the volume up to 1 litre. Standardise the strength of this solution to exactly 0.1 (N) by titrating against 0.1 (N) $K_2Cr_2O_7$. Take 25 ml of $K_2Cr_2O_7$ in a conical flask, add 1 ml of alkaline iodide, 2 ml of conc. H_2SO_4 and titrate with 0.1 (N) $Na_2S_2O_3$ solution using starch as indicator near the end point. Achieve the end point as soon as blue colour turns colourless. Dilute 125 ml of this standardised stock solution of 0.1 (N) $Na_2S_2O_3$ to 500 ml.

f) Starch solution : Add 2 g powdered starch and 30 ml 20%. NaOH solution in about 350 ml distilled water. Stirr until a thick, almost clear, solution is obtained. Neutralise the alkalinity with Hcl and acidify with 1 ml glacial acetic acid to get a stable starch solution.

Procedure : Collect the water sample in 100 ml bottle and add immediately 1 ml of $MnSO_4$ and 1 ml of alkaline iodide reagents. Mix the solution thoroughly to develop a floculant precipitate. Add 2 ml of concentrated H_2SO_4 to dissolve the precipitate, and titrate 50 ml of the dissolved solution with 0.025 (N) $Na_2S_2O_3$ using starch as indicator. If the water sample is rich in organic substances, nitrite may occur in sufficient amount and interfere with the analysis. In such cases sodium azide modification should be used by adding 10 g NaN_3 in 1 litre of alkaline iodide reagent.

Calculations : Dissolved oxygen (ppm) = ml of 0.025 (N) $Na_2S_2O_3$ required for titration X 4.

Determination of salinity : Salinity of brackishwater can be calculated to a fairly accurate extent from the chlorinity of water either by using Knudesn's hydrographical table or by the salinity and chlorinity relationship formula. The chlorinity is generally estimated by precipitating the Cl ions in water as Agcl by titrating with standard $AgNO_3$.

Reagents :

a) Silver nitrate : Dissolve 5.99 g of pure $AgNO_3$ in 250 ml distilled water. Standardise the solution by titrating against standard sodium chloride solution following the same method described under procedure given below, so that 1 ml of $AgNO_3$ solution be equivalent to 5 mg.

b) Sodium chloride : Dissolve 2.6 g analytical NaCl in 250 ml of distilled water. Each ml of this NaCl contains 5 mg of Cl ions.

c) Potassium chromate : Dissolve 5 g K_2CrO_4 in 80 ml distilled water, add saturated $AgNO_3$ solution dropwise with constant stirring until a red precipitate is formed. Filter the solution and dilute to 100 ml.

Procedure : To 5 ml of sample, add a few drops of K_2CrO_4 indicator, titrate with standard $AgNO_3$ to the first appearance of permanent red colour.

Calculations :

Chlorinity (ppt) = ml of $AgNO_3$ used for titration.

Salinity (ppt) = Chlorinity (ppt) X 1.805 + 0.03.

HAZARDS IN HATCHERY MANAGEMENT

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Depending up on temperature, food consumption and water quality, every batch of larvae takes 30 to 45 days to transform into postlarvae. For large-scale hatchery operations, several batches of larvae have to be reared simultaneously in 2 or 3 crops in each breeding season. Although breeders can be raised round the year, the most favourable time to take up rearing operations would be when the ambient water temperatures are around 26 - 30°C. Management of rearing for a considerably long time for each run calls upon extreme patience and tolerance on the part of the personnel involved.

Hazards in the hatchery operations can lead to mass larval mortalities due to the factors relating to unfavourable environmental conditions, mechanical failures or power breakdowns and human negligence.

ENVIRONMENTAL FACTORS

Successful results in hatchery operations can be obtained by maintaining optimum water qualities in the rearing tanks (salinity 14 - 18‰; D.O. 4 - 6 ppm and temperature 26 - 30°C). Constant aeration will not only provide enough oxygen but also check the cultures from oxygen, carbondioxide and ammonia building to lethal levels. While limited Chlorella counts is reported to keep the ammonia levels under check,

excess of algal blooms will cause serious oxygen problems during late night hours causing mass mortalities. It should be borne in mind that zoeae are very sensitive to fluctuations of oxygen and temperature in particular. Keeping the culture water clear and hygienic by regular exchange of clean water, clearance of unutilised feed and constant aeration will give successful results. Otherwise ciliates, bacteria and other infections (Zoothamnium, Epistylis etc.,) will slowly take the upper hand and the zoeae awill be in weak and inactive by the reduced feeding activities due to adverse water conditions.

MECHANICAL FAILURES

Power breakdowns, low voltage, poor functioning of aerators are the source of problems for which standby arrangements like generator, blower and spare aerators should be kept ready for timely use. This human error factor should be tackled promptly.

HUMAN FACTORS

This type of work calls for discipline, devotion, skill and trustworthiness on the part of the workers concerned. There is need of mental involvement in the rearing aspects. Caution and care are very much needed in feeding, cleaning, change of water and handling larvae by giving minimum stress to the larvae. While changing water, identical temperature is preferred to avoid thermal shocks, although a difference of 1 to 2^{o}C is unavoidable at times. While draining or adding water, utmost care should be taken to minimise pressure stress

by providing appropriate seives etc. Slow gravitational methods for water replacement is recommended. Contamination of feed, equipment, larvae should be avoided as far as possible. Sea water need to be collected in advance at high tides/ preferably in summer. A few days are required for settlement and aging. Clean chlorine-free fresh water is added with seawater for preparation of mixture of desired salinity much in advance. This is used for changing water in the rearing tanks to avoid osmotic stress due to salinity fluctuations which can be hazardous.

. Timely cleaning or disinfection of all equipments like tubes, seives, tanks and aging of seawater/mixture water prior to hatchery operations will facilitate hygiene and efficiency of rearing work.

/from areas free from pollution

COMMON DISEASES (BIOTIC AND ABIOTIC) AND THEIR CONTROL

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I N T R O D U C T I O N

Even under efficient management, some diseases appear in a hatchery for many reasons; water quality, food quality, over feeding,improper cleaning of the tanks, etc. Hence precautionary measures are to be taken to cope up with such situations. The food cultures and mixed water should be free from extraneous living forms and organic load respectively.

COMMON DISEASES IN LARVAL CULTURE

Water quality and infected feeds are the major sources for larval infection. Inadequate diet is also often responsible for infection, since the hungry larvae attack and injure each other so as to enable the pathogens to take hold of the injured parts and multiply. Water treatment through solar exposure or use of freshly mixed water of the same quality (salinity and temperature) may solve the problem. Infected feed may also transmit diseases. Hence prepared food should always be treated with few drops of copper sulphate solution to kill any pathogens adhering to the food particles.

The treatments recommended for some of the diseases encountered in larval rearing are as ufollows :-

Fungal diseases : Small opaque white patches develop on the tails and bases of appendages and then spread to the whole body. The only remedy is to clean and disinfect the tanks and other equipment and use fresh mixed water. If majority of the larvae are infected, it is better to sacrifice the whole batch of larvae, before the disease spreads to other tanks. This type of infection often occurs due to organic load in the mixed water used for a prolonged time. It is, therefore, recommended that mixed water should not be recycled for more than a year.

Protozoan infection : Suctorians are responsible for this epizootic disease. This disease is again water borne and can be remedied only through manipulation of ideal mixed water. Some treatments are known, but most of them are of control nature only. During initial stages, treatment with copper sulphate (.4 ppm) for six hours may check infection and in severe cases the treatment should be repeated every 24 hours. Other recommended methods are ½ hour daily treatment with 0.2 ppm Malachite green or ½ hour daily treatment with 200 ppm formalin solution.

Bacterial diseases :

Red tail diseases (also known as Gaffkaemin) : This is not a common disease. This disease occurs normally in injured forms. A bacteria, Aerococcus viridans, is believed to be the cause for the infection. The colouration is also believed to be due to other factors. This disease has not yet been proved to be a problem in Macrobrachium culture, but a watch is necessary as it is reported to other crustaceans.

Black spot disease : The disease appears as a brown or black spot or lesion on the exoskeleton and spreads to other regions viz. gill filaments, legs, ventral abdominal muscles and telson. The cause is attributed to a chitin-destroying b bacteria, Benekea sp. The infection appears normally due to crowding and accumulation of left over food. Regular cleaning and water change in the larval rearing tanks will improve the situation. Application of 3 ppt sea water controls the disease in adult prawns in freshwater. A rapid check can be made with 8 ppt sea water.

ENVIRONMENTAL PROBLEMS

Often the mixed water is prepared with natural sea water without filtration or ageing, medusa stages of hydrozoans colonise and prey on the larvae. This problem does not arise if ground salt water is used for preparing mixed water. If sea water is used, in case of any emergency arising due to some fault or other, it should be filtered through nylobolt or bolting silk net, aged for a minimum period of 3 days. and then used for making mixed water.

If hydrozoan medusae appear in the larval rearing tanks, they can be checked by complete cleaning and treatment with 250 ppm formalin.

Organic load of the mixed water is the main reason for diseases. It is therefore recommended that the newly mixed water is prepared after filtration. The used water is exposed to solar light for mineralisation of the dissolved organic load and their removal through algal stripping.

FOOD CULTURE

Worm culture : Normally suctorian parasites are associated with the cultured worms. This contamination of food is checked by treatment with copper sulphate solution while preparing the feeds.

Artemia culture : Over fertilisation often results in a suctorian infection of the adults and nauplii and this is checked by treatment with liquid lime (1-2 literston). Further fertilisation and harvesting of nauplii should not be done until the population is healthy active and free from infection.

ACCUMULATION OF TOXIC ELEMENTS

Copper sulphate as low as 0.4 ppm is lethel and many other elements viz. zinc, brass, iron, redwood, cedar, teak, insecticides, galvanised steel, base concrete, and oil are known to be lethel in fresh water but their toxic levels are not known. Hence such containers should not be used in a Prawn Hatchery. In any case, if they are to be used, they s hould be coated inside with polyester resin.

GREEN WATER PROBLEM

Thick phytoplankton blooms deplete dissolved oxygen levels when aeration fails in the rearing tank. The larvae become inactive and susceptible to infection. Such blooms are checked through good water management.

GENERAL CONCLUSIONS

The following precautions may be taken to prevent and control disease causing agents :

a) Water quality : Good quality fresh and sea water are foremost considerations. The stress resulting from build up organic materials, nitrites, and ammonia in the medium promotes multiplication of pathogens. Improvement or maintenance of water quality is a primary factor in larval culture.

b) Inadequate diet is also a cause for diseases in several cases. Attention should be paid to provide timely feeding to larval and adult prawns.

c) High pH results in deposition of calcium carbonate on the prawn carapace, followed by the growth of a fungus. Epistylus on the body. This complaint may occur in brood stock pond. Hence soil quality should be checked.

d) Diseases are not considered a major problem in fresh water prawn culture; however, one should take necessary precaution to this problem.

GENERAL BIOLOGY OF INDIAN RIVER PRAWN, MACROBRACHIUM MALCOLMSONII

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INTRODUCTION

The Indian river prawn Macrobrachium malcolmsonii (H. Milne Edwards) is probably the second largest palaemonid prawn and is reported to attain a maximum length of 233 mm. The distribution of the species is limited to the river systems of Indian sub-continent and is most common in the Chilka Lake, Central India and one of the common palaemonid prawns of South India. The species is of much commercial importance in most of the rivers of eastern India and constitutes more than 98% of riverine prawn catches. This species forms a dominant fishery in the Godavari, the Krishna rivers and the Kolleru lake. In recent years, there is a strong and rapidly increasing interest in freshwater prawn culture for food and profit. The information on the biology particularly maturation and breeding of this species is highly essential and assumes special importance in the context of establishment of hatcheries for selective breeding under controlled conditions and commercial seed production.

SPECIES IDENTITY

This species belonging to family Palaemonidae (order : Decapoda) characterised by the overlapping of the pleura of second abdominal segment over those of first

and third segments. The length of the rostrum is smaller than carapace length; in juveniles, the rostrum is as long as that of carapace or slightly more. The rostrum projects beyond the antennular peduncle. The rostral formula is 9 to 11 + 1 or 2/5 to 7 (most commonly 10 to 11 + 1/6). There are 2 or 3 teeth on the carapace.

BIOLOGY

Sexuality : Generally hetero-sexual. Mature males are considerably larger than females. The males can be distinguished by the presence of appendix masculina in the second pleopod. The second pair of peripod are large. Females are generally smaller than males with a shorter and slender pair of periopods and a small head.

Maturation : The gonads are paired, elongated and flattend structures situated over the dorsal side of the stomach and hepatopancreas and are limited to the cephalothorax region.

Stages of maturity : Four maturity stages are distinguished on the basis of colour and size of the ovary in relation to the carapace cavity and ova diameter.

Stage-1 : The ovaries of immature prawn are thin, transparent confined to posterior most region of the carapace cavity. The oocytes are spherical or asymetrical with conspicuous nuclei and cytoplasm. The freshly berrid prawn with immature ovary corresponding to this stage

and the spent females can be distinguished from immature juveniles by their size and the pleopods with Ovigerous setae.

Stage-II Ovary is increasing in size and occupies about 1/4 to 1/2 of the carapace length. Yellow in colour, the ova are slightly translucent due to light deposition of yolk in the cytoplasm. The nuclei are not clearly visible. The ova are easily separated when teased out with a needle.

State-III Ovary develops further and occupies more than 3/4th of the length of the carapace cavity. Ovary light green, Ova opaque, nuclei invisible.

Stage-IV Ovary occupies entire carapace and is dark green or brownish green. Ova opaque due to heavy deposition of yolk.

Length at first maturity : The total length at first sexual maturity in females reported from different habitats is as below :

Godavari river	41 mm
Hooghly river	76 mm
Kolleru lake	83 mm

The males generally attain sexual maturity at slightly larger size groups than females.

BREEDING

Breeding season : The breeding season is determined on the basis of monthly distribution of mature and berried females in the prawn population. The breeding season in this species is mostly prolonged, extending from 8 to 9 months in the year. The breeding season of the species from different habitats are given below :

Godavari river	April to November (peak June to August/October)
Hooghly river	May to August
Kolleru lake	April to December (peak August to November)

Breeding frequency : The individual prawn of this species breeds many (usually four to five) times during peak breeding season. Berried females attain maturity by the time the berried eggs on pleopods hatchout, generally within 15 to 20 days depending on the water temperature.

Breeding ground : In rivers and lakes the species breeds in freshwater zone generally throughout its area of normal distribution. It does not perform any sort of breeding migration towards the estuarine zone. It is believed that the zoea would be washed down to the estuarine zone during monsoons, since the breeding season is linked with monsoon rains, where the latter zoeal stages undergo development in the brackishwater. The juveniles of the species start upstream movement from the estuarine zone during subsequent months. This supports the view that estuarine phase is essential for the completion of its larval development.

Fecundity : Fecundity is estimated from the counts of fertilized eggs spawned into the pleopods. The number of eggs carried by a female is related to the size of the prawn. The fecundity ranges from different habitats is given below.

Godavari river	3465 - 63080 nos.	(54 mm to 164 mm in length)
Kolleru lake	12556 - 77420 nos.	(83 mm to 165 mm in length)

Food and feeding habits : This prawn is a bottom omnivore and feeds on a variety of items including filamentous algae, tender leaves and stems of aquatic plants, grains, seeds, nuts, etc., aquatic worms, insects, crustaceans, molluscs, cut pieces of fish and another animals. It eats frequently and greedily. Food is located mainly by touch with the help of antennae and antennules.

Growth : Growth is manifested as an increase in size of the prawn, measured generally in terms of volume or weight or linear dimensions. The visible growth takes place only at the time of or immediately after moulting. Frequency of moulting depends on the age, quality and quantity of food consumed and environmental parameters. Growth is rather rapid and males grow faster than females. Studies from Kolleru lake indicated that the species exhibited fast rate of growth varied from 10 to 20 mm per month. The species grow fast and attains about 200 mm and 150 mm in length in case of males and females respectively at the end of first year and the life spawn appears to be about two years. Under mixed culture with carps in freshwater ponds with low inputs of conventional feeds of vegetable origin, the prawn attained an average size of 118.9 mm/25.3 g in 4 months time.

LIFE HISTORY AND BEHAVIOUR OF MACROBRACHIUM MALCOLMSONII (H.MILNE EDWARDS)

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I N T R O D U C T I O N

Knowledge on the life history and general behaviour in different phases of life of the species of prawns is a pre-requisite for proper management of the hatchery. Information on the life history of M. malcolmsonii including embryonic development, larval life history and general biology is known from different habitats. The life history of M. malcolmsonii consists of eggs, larvae, juveniles and adults. The prawn completes their life cycle in freshwater environment except larval stages, which requires brackishwater for their survival and development. The species is basically a freshwater prawn and breeding including egg laying, incubation and hatching takes place in the freshwater zone of the rivers and lakes throughout the area of its normal distribution in these ecosystems. It does not perform any sort of breeding migration towards the estuarine zone. It is believed that the zoeae would be washed down to the estuarine zone during monsoon season since the breeding season is linked with monsoon rains, where the later zoeal stages undergo development in the brackishwater. The juveniles of the species start upstream migration from the estuarine zone during subsequent months. This supports the view that estuarine phase is necessary for the completion of its larval development.

LIFE HISTORY

Eggs : The fertilized eggs, 12 - 14 hours after extrusion are elliptical in shape, deep yellow in colour and measures 0.82 mm x 0.52 mm. The centre of the egg is darker than its periphery and has a thin transparent membrane completely covering it. The female prawn carries her brood of eggs and takes care of them until they hatch.

Incubation : The female prawn carries the brood of eggs and takes care of them till hatching and provides aeration by means of its pleopods. The deep yellow colour of the berried eggs gradually become lighter, with the progress of embryonic development they appear as light grey. The incubation period is about 14 days at a temperature of 25.5°C.

Embryonic development :

Stage - I : (1 - 4 days) : The fertilized eggs are deep yellow in colour and the ventral plate becomes noticeable. After 48 hours of extrusion a well demarcated cellular transparent region at one end of the egg is marked. On the fourth day cephalic lobe has increased in size and differentiated in to the rudiments of different appendages viz. antinnules, antenna, mandibles and telson.

Stage - II (5 to 6 days) : The rudiments of four more cephalic appendages are formed. On the sixth day, optic rudiments are conspicuous. In the cephalo-thoracic region, a tiny heart vesicle has made its appearance. Yolk is light yellow in colour.

Stage - III (7 - 11 days) : The heart vesicle begins to pulsate more regular and rythmic. The optic vesicle appears as very thick and prominent. The carapace has developed and covers the cephalothoracic region. On the tenth day, the eye pigment becomes larger.

Stage - IV (12-14 days) : The embryo appears quite advanced. Yolk is highly reduced and appearing as blocks on 12th day. The eye pigment is almost spherical. The telson extended beyond the anterior end of the embryo, curving upwards. The abdomen has six segments, the last one continuous with the telson. The embryo shows occasional jerky movements which became more frequent near the time of hatching. The embryo continue to grow absorbing the remaining yolk and by the 14th day the development is complete.

Hatching : Hatching takes place by the increasing internal pressure of the larva by stretching of the body and movement of appendages causing the egg membrane to brust. Vibrations of the mouth parts become more and more vigorous. The body continues to stretch, and the telson which is held over the eyes and head pushes outward. The egg shell breaks and the larva comesout of the egg membrane. The parent vibrates the pleopods to disperse the larvae.

Larval behaviour : All the larval stages are active swimmers and are planktonic in habit. They are attracted by light. They swim tail first, ventral side up, with the head rather lower than the tail at an oblique angle. The early zoeal stages have a tendency of schooling behaviour but the gregarious habit gradually disappears when they grow to subsequent stages.

The photopositive behaviour of the zoea are best utilised in hatchery operations during feeding and water exchange by attracting them to a corner of the rearing tank. All the larval stages require brackishwater with a salinity of 14 ppt. At the larval stages, they prefer natural food and eat continuously. They also accept prepared feeds with less preference. The prepared feeds should be of suitable particle size. The eleventh stage zoea metamorphoses to postlarva, resumbles miniature adult prawn and ceases the pelagic habit. They permanently settle down to the bottom as crawlers or cling to submerged objects and acclimatised to fresh water conditions.

Juveniles : The postlarvae usually remain in estuarine zone for some time and start migrating up steam slowly into fresh water habitat. They are able to swim against the current and can cross rapidly the anicuts and weirs along its route by crawling. They actively feed on worms, insect larvae, clams, Pila, Acetes and pieces of fish, broken rice, grains, etc.

Larval stages : Kewalramani et al., (1971) studied the larval life history of the species in captivity and assigned sixteen larval stages. However, the studies conducted at Prawn Breeding Unit of Central Inland Fisheries Research Institute, Kakinada [illegible] indicated that there are only eleven stages from zoea I to XI and then metamorphosis to postlarva. A simplified key from the zoea I to zoea XI and postlarva is presented in Table I.

T A B L E - I

A simplified key for the identification of different larval stages of *Macrobrachium malcolmsonii*

Zoeal stage	Average total length (mm)	Recognised characters
I	1.87	Sessile eyes
II	2.03	Stalked eyes
III	2.19	Dorsal rostral tooth, sixth abdominal somite separated from telson, Uropod appeared.
IV	2.43	Two dorsal rostral teeth on carapace. Uropod biramous.
V	2.85	Telson more elogated and narrower posteriously.
VI	4.06	Uniramous buds of pleopods appeared
VII	4.76	Pleopods longer, biramous and bare.
VIII	5.24	Presence of setae on the pleopods mostly on large ramus.
IX	7.58	Small bud of appendix interna present on the endopod of second to fifth pleopods.
X	9.37	Presence of two to four minute teeth on the dorsal side of the rostrum.
XI	10.53	Presence of six to ten minute dorsal rostral teeth (minute teeth on almost entire length of rostrum).
Postlarva	11.79	Rostrum with eleven dorsal teeth and two or three ventral teeth. Behaviour of swimming like adult.

NATURAL SEED RESOURCES OF MACROBRACHIUM MALCOLMSONII

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I N T R O D U C T I O N

The freshwater prawn Macrobrachium malcolmsonii is esteemed as highly nutritious and has a great demand in export trade. Since there is a little scope to increase its production from natural systems, the only alternative is to augment the production through aquaculture enterprise. The availability of quality prawn seed in space and time is a prerequisite for successful culture operations. Efforts are being made to develop economically viable technology for the production of the seed of this species in captivity. The production of the seed of this prawn on a commercial scale is yet to reach a successful stage, and hence the need to tap the natural resources still exists. Abundant seed resources of this species have been located over the anicuts on the river Godavari, Krishna, Mahanadi and on lock and weirs along the canal system of Godavari, Western Delta for commercial exploitation and culture. The potential seed resources of M. malcolmsonii together with information on the method of collection and their transportation is described here.

METHOD OF COLLECTION

The juveniles of M. malcolmsonii have a tendency to move upstream negotiating over anicuts and weirs of the rivers. The ascent of the juvenile prawn is mainly a nocturnal phenomenon and efforts should be made to collect them at night. If a piece of cloth or a hapa is held at the lower edge of the slope of the anicut by one or two persons and another person pours a bucket full of water gently at the upper end of the slope on the pavements, the entire column of prawns can easily be washed down and collected. The quantity of collection depends on the intensity of ascent and the area covered during collection, but usually a collection made as above from one congregation may contain well over 5000 - 6000. Since there are many such spots available for collection at one side of the anicut and the next batch of prawns start ascented the disturbed area within a short period, very large quantity of seed could be collected in one night.

The method of collection of juveniles from locks and weirs along the canal system are quite different from the method followed on anicuts. The juveniles migrate against the current along the banks of the canal and congregate on the moist patches of the walls, spillways, lock and sluice doors, points of water leakage on the doors, etc., to form into mats and their extent is dependent on the size of the moist patch. The collection gear consists of plastic buckets or thick polythene bags with bamboo rims in different shapes and sizes, which are hung with long ropes from the lock doors or weir regulators in such a way that they are placed just beneath the migrating juvenile mat. The moving juvenile mat after reaching the non-moist area loose their grip and fall into

the containers which is a continuous process till the migration ceases. The use of containers having smooth inner surface prevents the juveniles from crawling out and the excess water falling into these containers is got rid off by providing a few small holes at their bottom. The collections are scooped periodically and stored in hapas in live condition.

Identification of Macrobrachium juveniles :

Branchiostegal spine absent, Hepatic spine present	:	Macrobrachium
Distal part of the rostrum without dorsal teeth Basal crest distinctly elevated more than 9 dorsal teeth, 4 - 7 ventral teeth	:	M. malcolmsonii
Rostrum short, proximal keel or crest: bears 9 or 10 teeth and the distal end 1 or 2. Ventral teeth 3 or 4 rarely 5 or 6.		M. choprai
Dorsal teeth uniformly arranged, longitudinal dotted lines on carapace.	:	M. villosimanus
13 - 14 dorsal and 11 - 13 ventral rostral teeth.	:	M. rosenbergii
5 - 9 dorsal teeth and 5 - 7 ventral rostral teeth; vertical or oblique bands on the carapace	:	M. lamarrei
First 3 - 4 dorsal rostral teeth on carapace, rostrum short with 12 - 14 dorsal and 2 ventral teeth.	:	M. scabrioulum

SEED RESOURCES

At present the juveniles of M. malcolmsonii are collected from Dowlaiswaram anicut on the river Godavari, at Prakasam Barrage at Vijayawada on the river Krishna, at Jobra anicut of Cuttack on the river Mahanadi at a number of places on the locks and weirs across various canals in the Godavari western delta.

Godavari river : The upstream run of prawn juveniles over the anicut at Dowlaiswaram observed from June - February with peaks during June, September, January and February. The migrating juveniles of M. malcolmsonii are ranging between 26 and 34 mm in length. The migration of juveniles depends on the flow of water over the anicut. The maximum catch during the peak season will be in lakhs per night. The juvenile prawns collected at this anicut comprise a number of varieties such as M. malcolmsonii, M. scabriculum and M. lamarrei.

Krishna river : The juvenile prawns can be collected at spill-ways, sluices and certain points on the barrage and anicut at Vijayawada during October - January. The catch depends mostly on the regulation of the sluices and flow of water at the barrage. The juveniles of M. malcolmsonii generally ranges from 25 - 45 mm in length.

Mahanadi river : The migration of juveniles of M. malcolmsonii are observed at Cuttack over Jobra anicut. The upstream movement of the juveniles starts at dusk and continues till dawn. The peak season for collection of seed is October - December and depends on the flood and regulation

of the sluices on the anicut. The bulk of juveniles consists of M. malcolmsonii, M. scabriculum and M. lamarrei. The juveniles of M. malcolmsonii ranges from 21 - 32 mm in length. A maximum of 2 lakh juveniles of M. malcolmsonii can be collected per night during the peak season.

Godavari Western Delta : There are abundant seed resources of M. malcolmsonii located along the canal systems in the detla. The juveniles comprise M. malcolmsonii, M. scabriculum and M. lamarrei with the domination of the M. malcolmsonii in the catches in the Undi, Narsapur and Bank canals etc. The juveniles are abundant over an extended period of eight months, from August - April with a peak during October/November. The quantity of the juveniles in certain centres on these canals ranges from 13,000 - 17,000 per night with a size range of 20 - 72 mm in length. The resources are much useful to the marginal fish farmers in the locality to procure the prawn seed and stock their ponds under composite fish culture. The important collection centres of M. malcolmsonii juveniles in the Godavari Western Delta are given below :

Centre	Length range (mm)	Peak season
a) Kolleru lake :		
Lakshmipuram lock	15 - 30	October - November
Kondangi lock	18 - 40	,, ,,
Tadinada lock	25 - 71	,, ,,
b) Undi canal :		
Chilakampadu lock	21 - 75	October - November
c) Narsapur canal :		
Marteru lock	20 - 72	October - November
d) Bank canal :		
Koderu	20 - 51	November-December

TRANSPORTATION

Oxygen packing : The juveniles are packed in polythene bags under oxygen pressure when the transportation involves long distances. It is observed that about 200 - 300juveniles (50 - 75/litre) of the size range 20 - 35 mm thrive well for over 60 hours in four liters of water under oxygen packing. The survival rate ranges from 56 - 100%. During 1962 about 4,000 juveniles of M. malcolmsonii were successfully transported under oxygen packing from Rajahmundry to Tungabhadra Dam of Karnataka, covering a distance of 640 Km and a journey time of about 50 hours by rail.

Dry packing : The prawn juveniles are transported by this method during night times, involving short distances covering about 3 - 5 hours on a bicycle. The juveniles are transported during night times in dry packing using bamboo split baskets with layers of Hydrilla to serve as a cushion as well as to retain moisture. Occasional dip of the basket in water along the route is sufficient to provide the retention of the moisture. This method of transportation gives survival rate as high as 90%. The juveniles are to be conditioned for six to eight hours in synthetic hapa in the same pond before stocking.

PRELIMINARY STUDIES ON THE SEED PRODUCTION OF MACROBRACHIUM MALCOLMSONII (H. MILNE EDWARDS) UNDER CONTROLLED CONDITIONS

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I N T R O D U C T I O N

The Indian river prawn, Macrobrachium malcolmsonii is acclaimed as one of the most suitable species for culture in freshwater ponds. It possess all the characteristics for culture such as prolonged breeding season, fast growth coupled with omnivorous feeding spectrum and commands good demand as food both in the internal and external markets.

Abundant seed resources of this prawn have been located over the anicuts on the river Godavari, Krishna and Mahanadi for commercial exploitation and culture. But there is a possibility of fluctuations in availability of the seed from these wild resources. Hence, a dependable source of quality seed supply for the aquaculture industry is highly essential through the establishment of hatcheries. The primary objective of this research project is to develop a suitable method for controlled breeding of the species, determination of optimal environmental conditions for better larval growth and survival. An indigenous method of seed production of Macrobrachium malcolmsonii is developed and is under standardisation. The technique of seed production developed at this research centre is described here.

SEED PRODUCTION CYCLE

The seed production cycle constitutes culture of the berried females, hatching of the zoeae after incubation and the larval rearing through eleven stages in brackishwater till they metamorphoses into postlarvae. The postlarvae are acclimatised to freshwater and the seed prawn are reared in freshwater ponds to maturity to be used as broodere.

SEED PRODUCTION COMPONENTS

The chief seed production components of the hatchery consist of brood stock, freshwater, seawater, feeds, supply of electricity and rearing facilities.

Brood stock : Berried females and adult prawns of M. malcolmsonii are procured initially from natural waters such as rivers, canals etc., and stocked in plastic pool at a stocking density of 5 to 9 prawns per sq. meter. They are fed with broken rice, Tilapia, Acetes etc. Ground water with a salinity range of 1.5 to 3.5 ppt in different months is utilised for maintaining brood stock. Intensive breeding activity is observed during the period from July to November with a peak during August to October when the berried females will be continuously available for the rearing programme. Directly collected berried females from wild did not give good hatching, so the berried females collected periodically from the brood stock pools are released in hatching tank. After completion of hatching the zoeae are collected taking advantage of their photopositive behaviour and released into the rearing tank/pool.

Freshwater : Chlorine-free freshwater should be procured and stored for preparation of mixed water of desired salinity.

Seawater : Good sea water free from pollution should be collected, preferably during summer and stored in a tank for prepatition of rearing medium.

Feeds : The seed production mainly depends on the availability of larval feed throughout the year. At present Tubifex worms are used as diet for the zoeae with encouraging results.

Electricity : A dependable power supply is highly essential for smooth functioning of a hatchery. During power breakdowns, an emergency generator is also an sbabsolute necessity.

Resaring facilities : Round plastic pools or rectangular tanks and capacity of 300 liters and above with a depth of 40 - 80 cm are suitable for larval rearing. A plastic pool of 700 lit. capacity may be used separately for hatching purposes. These pools/tanks are fitted with aeration system. The number and capacity of these containers depend on the size of hatchery and its seed production targets. Various equipment such as cleaning tubes, feed grading sieves, water filter sieves, lights, siphoning tubes, pumps, seed resting multi-stage-tier system are required.

LARVAL REARING

Clear mixed water is used as larval medium. It should be properly aerated. About 10 to 12 hours after hatching the zoeae are collected from hatching tank and are released into the rearing pool. The following physico-chemical factors are found to be optimal for rearing the larvae.

Water temperature	26.3° - 30.3°C
Salinity	14.22 - 14.82 ppt.
Dissolved Oxygen	4.0 - 6.5 ppm

Feeding is done by attracting the larvae with a light in one corner or side of the rearing tank/pool, taking advantage of their photopositive behaviour. Feeding is initiated from the third or fourth day after hatching, when the zoeae are in II stage. The zoeae are fed with only cut pieces of Tubifex worms. Worms are cleaned and sliced on a rubber mat with a bunch of sharp knives. The cut pieces are treated with a few drops of copper sulphate to eradicate pathogens, if any, and washed with several changes of water to remove soluble matter. These pieces are passed through a number of sieves with different mesh sizes to get different grades of particle size to be utilised as feed to specific stages of zoeae. The particle size of worms which are fed for different zoeal stages are as follows :

Larval stage	Size range mm	Range of particle size in mm
II	1.81 - 2.23	0.09 x 0.08 to 0.24 x 0.19
III-IV	2.06 - 2.58	0.19 x 0.16 to 0.48 x 0.32
V-VI	2.26 - 4.45	0.35 x 0.22 to 0.64 x 0.38
VII-VIII	4.46 - 6.62	0.48 x 0.24 to 1.37 x 0.42
XI-Postlarvae	5.52 - 12.18	1.53 x 0.23 to 3.45 x 0.61

Feeding is done three times a day with 8 hours interval during the early phases of larval rearing (upto IV stage) and five times from V stage onwards with suitable intervals. Excess feed is removed by siphoning. The pools are cleaned once in 24 hours.

Everyday, depending on the quality of the medium, 25 to 50% of the water, removed and replaced with fresh mixed water of the same salinity. Recycled water did not give good results in this species. It is observed that there is no substitute to fresh mixed water.

The growth of the zoea I to postlarva appears to be in sigmoid growth fashion. The zoea I which measures from 1.73 mm to 2.03 mm in total length metamorphoses to postlarva through eleven zoeal stages and attains 11.26 mm to 12.18 mm in length within a period of 52 days after hatching. The duration from one stage to next stage varies from two to seven days. When the majority of the zoeae metamorphosed to postlarvae, the rearing medium is exchanged with freshwater is slowly to dilute the medium to freshwater. After acclimatisation to freshwater conditions, the postlarvae are stocked in a pond for further growth.
