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Observation of giant fresh water prawn *Macrobrachium rosenbergii* survival and growth in solar heated fish ponds

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Abstract
The present study investigates the application of greenhouse technology on the growth and survival of *Macrobrachium rosenbergii* in colder Himalayan Regions. The experimental setup for observation of prawn survival and growth consisted of two fish ponds covered by dome-shaped poly-houses for solar heating in the laboratory complex of Post Graduate Department of Zoology, University of Jammu, Jammu, J&K (32º 43´ Latitude, 74º 52´ Longitude and 309 meters above mean sea level) where climatic conditions vary from hot and humid summers (May to September) to extremely cold winters (November to February). Earlier giant freshwater prawn culture practices were carried out in stipulated period of 5-6 months of summers as 100% mortalities were observed in winters. Experiments indicted that culture of prawns in green-house ponds extended their culture period over winters with increase in their survival as well as growth as compared to open ponds.

Keywords: Poly-house culture, *Macrobrachium rosenbergii*, survival and growth, Jammu

1. Introduction
Aquaculture plays an important role in meeting the growing nutritional demands of increasing population. It includes the culture of aquatic organisms both animals (fin fishes, crabs, prawns, lobsters, mollusks, etc.) and plants such as sea weeds. Prawn culture is of great potential in generating low cost animal protein in large quantities for human consumption. Of these, *M. rosenbergii* has emerged as the species of interest due to its large size, high nutritional value and high market as well as export values [1]. Developments based on utilization of non-traditional and innovative approaches are likely to bring comprehensive improvement in its culture methods and consequently in production. Application of poly-houses in agriculture, floriculture and for shelter for human beings in colder regions is a common practice in temperate as well as other areas during winter seasons. Their use in aquaculture is very recent in India [2-6]. Water temperature is one of the important physical parameters that effect the fish growth [7, 8]. Growth rate increases with increasing water temperature, but when the temperature becomes super optimal, it has a negative instead of a stimulatory influence [9]. Optimum temperature range for freshwater prawn culture lies between 20-28 °C [10]. During winters, low temperature results in the decreased metabolic rate of fish, thereby reducing its production [11-13] and same is true for prawns as well. Green house ponds are good alternatives to maintain water temperature [6, 14, 15]. A rise of 9 °C in water temperature in a solar heated aquaculture pond was recorded in January in Phoenix, USA [16]. However, aquaculture practice in greenhouse is confined mostly to fishes and still in experimental stage in India due to lack of suitable design of greenhouse, higher investments and not available easily [4, 5]. Therefore, an attempt has been made to study its utility in increasing the survival and growth of *M. rosenbergii* during extreme winters, particularly for the first time in J&K.

2. Materials and Methods
The principle behind the working of a greenhouse pond is similar to any conventional type of greenhouse. The walls and roof of greenhouse reflect, absorb and transmit the total solar radiations during the sunshine period. A large proportion of these radiations is absorbed by water and cause a raise in its temperature. Rest part of the radiations is absorbed by the exposed surface area of the pond.

The absorbed heat energy increase the temperature of water as well as of the exposed ground which further raise the air temperature inside the room through evaporation, convection and radiation. Moreover direct air contact with water is extremely reduced. The whole process creates an environment inside the greenhouse with temperature greater than that of outside.

2.1 Experimental Greenhouse

Two crude dome-shaped greenhouses of 18x12 Ft. each with a central height of 5 Ft. were constructed over the cemented ponds for experimental purpose (Fig. 1a and 1b). The greenhouse frame was made of iron bars of 12 mm diameter, which was covered with Low Density Polyethylene (LDPE) UV stabilized film of 200-micron thickness. Front sides of both the ponds were provided with doors to allow air circulation for natural cooling during overheating. The open ponds were covered with gill net (20 mm mesh size) to prevent predation from birds. The experimental setup was located in the laboratory complex of Post Graduate Department of Zoology, University of Jammu, Jammu, J&K (32° 43´ Latitude, 74° 52´ Longitude and 309 metres above mean sea level). The region is represented by climatic conditions varying from hot and humid summers (May to September with temperature reaching 44-48 °C) to extremely cold winters (November to February with night temperature dipping to 2-6 °C).

Fig 1a

Fig 1b

Fig 1a and 1b: showing outside and inside views of a greenhouse, respectively.

Water temperatures of open and greenhouse ponds were recorded at 9:00 AM using mercury bulb thermometer. Standard methods of APHA [17] were used to measure chemical parameters and pH was noted using digital pH meter. Prawn sampling was done fortnightly for observing survival and growth (Fig. 1c and 1d). Mean Length Increment (Total Length – Previous Length) and Mean Weight Gain (Total weight – Previous weight) were recorded with the help of scale and digital weighing balance, respectively. Survival percentage was calculated by the following formula:

$$\text{Survival \%age} = \frac{\text{No. of Prawns found at the end of experiment}}{\text{No. of Prawns introduced}} \times 100$$

Fig. 1c: A live specimen.

Fig 1d: Regular Sampling

2.2 Culture Experiment

Before stocking, ponds were completely dewatered and dried to eliminate any unwanted and predatory element. After drying, the ponds were filled with water up to 3 ft. level and were fertilized by applying cow dung. Liming with $CaCO_3$ was done to maintain the desired pH of water. Post larvae @ 500/pond were introduced both in greenhouse and open ponds on 3rd of November 2015 and finally harvested on 1st of March 2016. Formulated feed with crude protein level of 35% was given twice a day @ 2-3% of body weight. Stones, bricks, PVC pipe pieces and broken earthen pots were also placed to provide hiding space.

3. Results and Discussions

The temperature is an important parameter for prawn growth. Temperature variation of only a few degrees in open-air ponds represents a proportionally large change for fish growth and survivability [18, 19]. Water temperature can be maintained higher in greenhouse pond system [15, 20, 21]. It can be observed from our study that due to greenhouse effect and reduced heat losses from greenhouse to ambient condition are responsible for increase of greenhouse pond temperature. The monthly variations in physico-chemical parameters of both open and greenhouse ponds are depicted in Table-1. The table indicates that water temperature varied considerably during the 120 days of culture (Fig. 2) while rest of the parameters showed no marked difference. Water temperature of greenhouse ponds was found to be 6-7 degrees higher than the open ponds with lowest temperature in the month of January, 2016. The results obtained are in accordance with that reported by various workers [3, 6, 22]. The growth pattern was found to be higher in greenhouse ponds than open ponds (Table-2). Mean length increments in centimeter (3.80±0.458, 4.80±0.360, 6.10±0.360, 7.6±0.100, 7.90±0.360, 8.60±0.300, 9.10±0.264, 10.40±0.173) and Mean weight gain in grams (0.560±0.064, 1.760±0.331, 3.640±0.180, 7.130±0.130, 8.110±0.051, 13.092±0.103, 18.253±0.019, 23.270±0.267) in case of greenhouse ponds were more than the Mean length increments (3.40±0.173, 4.40±0.100, 5.50±0.300, 6.80±0.265, 7.0±0.360) and Mean weight gain (0.552±0.25, 1.402±0.616, 2.768±0.020, 4.760±0.038, 5.747±0.058) in open-air ponds. This may be due to higher water temperature in greenhouse ponds due to greenhouse effect that lead to higher metabolic rate and comparatively higher feed intake. The slower growth patterns in open ponds were due to lower water temperature stress and poor feed intake of prawns [2-5, 12]. Also the survival rate of green house ponds was far greater (62.15%) than open ponds (0%) at the end of 120 days culture period. The 100% mortality in case of open ponds just after 75 days of experiment may be attributed to chilling cold temperatures at night during the month of January, 2016 where the day temperature is also found to be the minimum. The water quality parameters prevailing in both the experimental ponds did not show any significant variations and were within permissible limits throughout the culture period. The water temperature showed marked difference between both the experimental ponds due to greenhouse effects.

Table 1: Physico-Chemical parameters of Open and Greenhouse ponds.

Physical & Chemical Parameters	Months							
	November, 2015		December, 2015		January, 2016		February, 2016	
	Open Pond	GH Pond	Open Pond	GH Pond	Open Pond	GH Pond	Open Pond	GH Pond
H_2O Temp. (^OC)	21	27	13	20	12	19	13	21
pH	7.3	7.4	7.6	7.6	7.8	7.9	8.2	7.9
D O (mg/l)	7.9	6.8	9..2	7.2	9.4	7.2	9.2	7.3
FCO_2 (mg/l)	-	-	-	-	-	-	-	-
CO_3^{2-} (mg/l)	46	43	42	38	43	37	48	42
HCO_3^-(mg/l)	482.8	468.2	440.9	423.1	499.1	474.5	412.1	392.8
Ca^{2+} (mg/l)	38.1	33.1	39.01	33.4	42.61	35.8	28.8	26.2
g^{2+} (mg/l)	15.41	11.2	23.4	16.1	26.2	23.1	34.7	26.8
Cl^- (mg/l)	75.3	54.2	68.8	51.3	105.1	72.2	90.3	66.4

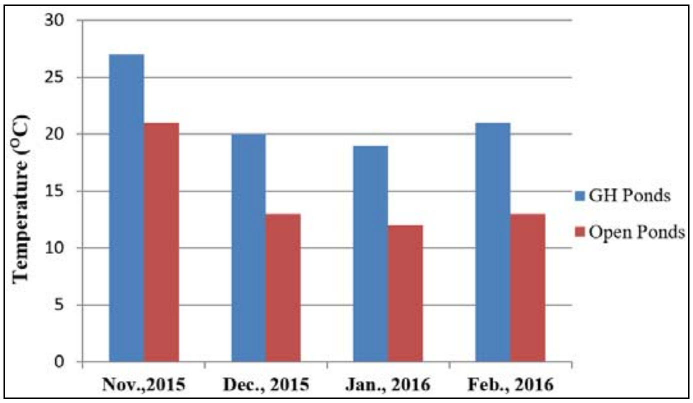

Fig 2: Variations in temperature of Open and Greenhouse ponds.

Table 2: Growth and Survival variations in Open and Greenhouse Ponds.

Days	Mean Weight Gain (gm)		Mean Length Increment (cm)		Survival %age	
	Open Ponds	GH Ponds	Open Ponds	GH Ponds	Open Ponds	GH Ponds
15	0.552±0.25	0.560±0.064	3.40±0.173	3.80±0.458	-	-
30	1.402±0.616	1.760±0.331	4.40±0.100	4.80±0.360	-	-
45	2.768±0.020	3.640±0.180	5.50±0.300	6.10±0.360	-	-
60	4.760±0.038	7.130±0.130	6.80±0.265	7.6±0.100	-	-
75	5.747±0.058	8.110±0.051	7.0±0.360	7.90±0.360	-	-
90	-	13.092±0.103	-	8.60±0.300	-	-
105	-	18.253±0.019	-	9.10±0.264	-	-
120	-	23.270±0.267	-	10.40±0.173	0	62.5

4. Conclusion

It can be concluded from the above findings that the greenhouse technology and poly-house application in aquaculture has positive impacts on the organisms being cultured. Water temperature, which is the most important physical parameter in *M. rosenbergii* culture, can be well maintained within the ideal limits using this technology. Its growth and survival can thus be enhanced using non-traditional means such as solar-heated ponds in extremely colder regions like the Himalayas.

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