DENSITY DEPENDANT VARIATIONS ON THE PRODUCTION AND POPULATION STRUCTURE OF *MACROBRACHIUM ROSENBERGII* REARED IN THE WETLAND POLDERS OF SOUTH INDIA

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ABSTRACT

Ranjeet K. & Madhusoodana Kurup, B. 2011. Density dependant variations on the production and population structure of *Macrobrachium rosenbergii* reared in the wetland polders of South India. Braz. J. Aquat. Sci. Technol. 16(X): 55-62. eISSN 1983-9057. Population structure and growth of freshwater prawn *Macrobrachium rosenbergii* (de Man, 1879) reared as monoculture in twenty polders of Kuttanad (South India) following modified extensive methods were studied. Stocking densities in polders varied from 15,000 to 60,000 prawns/ha. Density at the time of harvesting ranged from 9,300 to 27,100 prawns/ha. Density dependent variation in the harvested population was discernible in all the polders. At lower densities (15,000 and 25,000 prawns/ha) the proportion of undersized prawns (<50 g) were comparatively low. Morphotypes such as Small Males (SM) had lesser representation in these polders. Likewise, the preponderance of larger Blue Clawed (BC) Males increased in these treatments. The mean weight of prawns was greatly influence by the proportion of SM morphotypes in the final harvest. As a result least mean weight (52.58±4.21g) were encountered in densely stocked polders (60,000 prawns/ha). The net production varied from 257.3 to 835.5 kg/ha/8 months in lower and larger densities respectively. Statistical analysis showed that there existed no difference in terms of production between TP-4 and TP-5. Present study suggest that a stocking density of 35,000 prawns/ha would be more appropriate for monoculture of *M. rosenbergii* in the polders of Kuttanad.

Keywords: production, marketable yield, stocking density, size heterogeneity

INTRODUCTION

Macrobrachium rosenbergii (de Man 1879), the giant freshwater prawn with the trade name “Scampi”, is known to be the most commercially important freshwater prawn in Indian waters. In view of the faster growth and big size, excellent demand in export and internal markets and high price it commands, it has emerged as a prime candidate species for freshwater aquaculture (New & Valenti, 2009). However, the wide disparity in size structure of cultured stock and the skewness in their weight distribution, which is profoundly influenced by male morphotypes, apparently appear to be the most commercial disadvantage of this species. *M. rosenbergii* is known to exhibit a complex social organizational hierarchy (Ra’anan & Cohen, 1984), comprising of morphologically distinct dominant, sub dominant and subordinate animals. The size distribution of female population is almost homogeneous, while the male has three male morphotypes so differentiated are Small Males (SM), Orange Clawed Male (OC) and Blue Clawed male (BC). These morphotypes represent three developmental stages of male maturation pathway and are known to undergo transformation from SM to OC to BC (Kurup et al., 1996). This complex social structure that is basically confined to males of *M. rosenbergii* is termed “Heterogeneous Individual Growth” (HIG). HIG is one of the limiting factors for uniform growth and development of *M. rosenbergii* in the grow-out system (Ranjeet & Kurup, 2002b).

The wetlands of South India are also known to be the home ground of *M. rosenbergii*. A very lucrative natural fishery of this species is being reported in these regions (Kurup et al., 1992). Though the farming of this species has been carried out either as monoculture or polyculture at various levels in polders, no information is available with regard to its survival, growth performance, marketable yield structure and economic feasibility. Economic success of prawn culture in any locality is governed by the proper selection of stocking density and stocking size (D’Abramo et al., 1989). As stocking density increases, an increase in yield can also normally be expected, however, a corresponding increase of non-marketable prawns in the harvested population due to the decrease in mean weight is the most commercial disadvantage of this species (Smith et al., 1978). Hence any information that could reduce this size disparity in the final harvested population would be invaluable not only for evolving appropriate pre and post stocking management strategies but also to reciprocally improving the marketable yield (Malecha et al., 1981). Hence, an understanding of the factors influencing the rate of increase in size variation in *M. rosenbergii* juvenile populations deserves top most interest due to the promising potential candidature of this species for freshwater aquaculture. In the present study an attempt is made to establish the relationship between the stocking density and population structure of *M. rosenbergii* under a commercial extensive monoculture system in wetland polders of South India with a view to standardize the stocking density for maximizing yield and income.

MATERIALS AND METHODS

The data for the present study were compiled from twenty polders in Kuttanad, a wetland ecosystem of South India, where monoculture of *M. rosenbergii* was followed. The polders are traditional paddy fields lying 1m below the sea level, which were reclaimed from confluent Vembanad Lake long ago and are now separated from the lake with strong peripheral bunds. Some of these polders are used successfully as grow-outs of *M. rosenbergii*. The average water-spread area of the polders used in the present study was 1 ha. All the polders were stocked with hatchery reared post larvae (0.2 ± 0.02 g) and the farming operation extended from October 2005 to June 2006 (8 months).

The final production and population structure of prawns reared under five separate stocking densities (treatments) in the polders was assessed. Each set of treatment represented data collected from four separate polders (quadruplicates). In the first set of treatments (TP-1) the initial stocking density was kept at the rate of 15,000 larvae/ha. Similarly, the stocking densities in subsequent treatments were maintained at the rate of 25,000/ha (TP-2), 35,000/ha (TP-3), 45,000/ha (TP-4) and 60,000/ha (TP-5). Modified extensive monoculture system was followed in all treatments after harvesting paddy in February. Prior to stocking these polders were dried and lime was added at a rate of 1000 Kg/ha. Cow dung was applied as phased manuring at the end of second week at the rate of 5000 Kg/ha. Water was let in and at the end of fourth week prawn larvae were stocked. The prawns were fed initially with high protein feed (Higashimaru scampi feed) equivalent to 20% of the prawn biomass for two months and subsequently they were fed with an on-farm made feed as formulated by Kurup et al (2002) at the rate of 10% of the prawn biomass.

Nearly 10% of the water in the polders was exchanged once every week. Water quality parameters such as temperature, dissolved oxygen, transparency, water and soil pH were monitored on a monthly basis following AOAC (1985), while levels of total ammonia-nitrogen (TAN), nitrite-nitrogen and hydrogen sulfide in water samples collected during morning hours from each treatment were determined at fortnightly intervals using the Aquakit from MERCK. At the end of 8 months of culture periods, the polders were dewatered by pumping out, and the prawns were harvested by handpicking. Random samples of 500 prawns from each grow out were examined on the day of harvest. All the prawns were sorted according to their sex and morphotypes following Harikrishnan (1997). All the prawns were measured up to nearest millimeter and weighed up to nearest gram. The weight of individual morphotypes from polders within each treatment was compared by applying ANOVA. In order to assess the effect of stocking density on population characteristics and yield structure the cumulative mean values of each treatment among polders (TP-1 to 5) was compared. The variations in the mean weight, survival rate and net production among the four treatments were tested employing Duncan's Multiple Range Test (DMRT) (Gomez & Gomez, 1984).

RESULTS

Water quality parameters among the five treatments did not show any significant difference ($P>0.05$) (Table 1) and thus all water quality parameters were well within the optimum ranges. Mean values for surface water temperature ranged between 30.2°C to 31.2°C. Dissolved oxygen among the five treatments ranged between 4.38 $mg.L^{-1}$ in TP-1 to 5.68 $mg.L^{-1}$ in TP-4, whereas total alkalinity was in the range 48.61 $mg.L^{-1}$ in TP-3 to 75.58 $mg.L^{-1}$ in TP-4. The pH for water and soil were also at the optimal levels. Low levels of total ammonia-nitrogen (below 0.10 $mg.L^{-1}$) and nitrite-nitrogen (0.02 $mg.L^{-1}$) were recorded.

Stocking and harvest details such as mean

Table 1 - Water quality parameters from the five treatments 1-5. Mean ± Standard deviation (Polders).

Parameters	Treatment 1 (TP-1)	Treatment 2 (TP-2)	Treatment 3 (TP-3)	Treatment 4 (TP-4)	Treatment 5 (TP-5)
Temperature (°C)	30.20 ± 3.15	30.80 ± 2.77	30.40 ± 1.52	31.20 ± 2.12	30.80 ± 2.12
Dissolved Oxygen ($mg.L^{-1}$)	4.38 ± 1.62	5.26 ± 0.84	4.82 ± 0.91	5.52 ± 1.02	5.68 ± 1.02
pH range	7.80 ± 0.46	7.70 ± 0.52	7.40 ± 0.64	7.50 ± 0.55	7.50 ± 0.55
Soil pH range	6.30 ± 0.34	6.00 ± 0.25	6.20 ± 0.28	6.30 ± 0.40	6.30 ± 0.40
Transparency (cm)	24.50±12.40	32.50±18.60	35.00±11.30	28.70±13.80	32.50±16.20
Total alkalinity ($mg.L^{-1}$)	58.45±14.40	69.24±13.10	48.61±18.90	75.58±15.30	65.48±15.80
Nitrite-N ($mg.L^{-1}$)	0.11 ± 0.05	0.14 ± 0.03	0.12 ± 0.04	0.11 ± 0.03	0.11 ± 0.03
Total ammoniacal N ($mg.L^{-1}$)	0.14 ± 0.01	0.17 ± 0.03	0.13 ± 0.05	0.11 ± 0.03	0.12 ± 0.03

Figures are means of four replicates (N= 320).
TP- Trial Polders

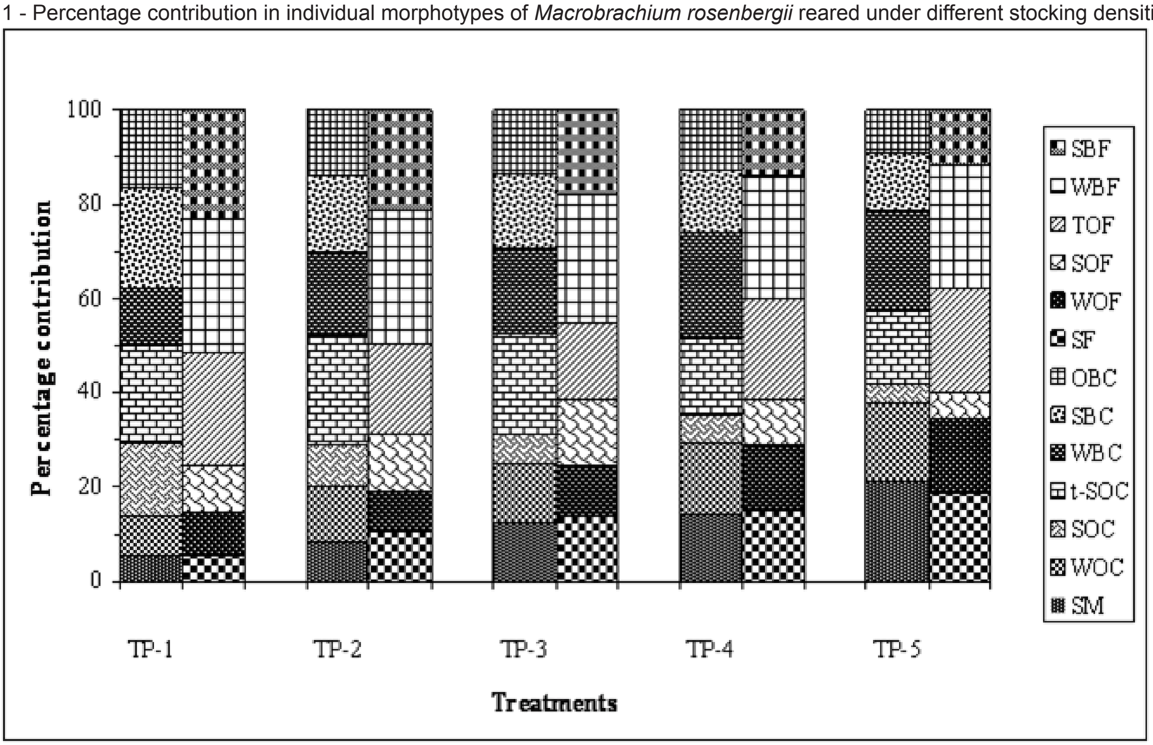
weight of prawns, percentage survival and net production for the treatments are summarized in Table 2. Final densities of *M. rosenbergii* at the time of harvest in treatments TP-1 to 5 were in order of 0.93 ± 0.21, 1.41 ± 0.25, 1.88 ± 0.40, 2.15 ± 0.54 and 2.71 ± 0.66 nos./m^2 respectively. On the contrary, the retrieval rate from the polders followed an inverse relationship with the respective stocking density. Highest survival rate was recorded from TP-1 (64%), in total contrast it was the least in TP-5 (45.7%). Mean wet weight of males and females in the final harvested population also followed similar trends similar to that of survival rate. Highest mean weight for male and female were registered in TP-1 (83.02 ± 24.92 g and 62.08 ± 19.46 g respectively), while least values in respect of males were recorded from TP-5 (54.06 ± 15.75 g) and for females TP-4 (42.10 ± 16.88 g) respectively. Male-female ratio was dissimilar at the five densities, being 1:0.72 in TP-1, 1:0.91 in TP-2, 1:0.85 in TP-3, 1:1.14 in TP-4 and 1:1.33 in TP-5.

Population structure

The structure of male and female population at the five levels of final density and the percentage contribution by weight of various male and female morphotypes to their respective harvested yield from these five sets of polders are given in Table 3. The percentage contribution by weight of individual morphotypes within the five treatments did not follow any particular trend. However, the percentage by weight of undersized SM and SF increased at higher densities and were recorded in the range of 21.4% and 13.6% respectively in TP-5, in contrast to 5.4% and 5.3% in TP-1. Percentage contribution of OC and BC by weight in the final density among the five sets of polders showed an inverse pattern with increase in final density when compared to that of SM and were recorded as 33.5% and 26.3% respectively in TP-1 and 29.2% and 15.4% respectively in TP-5. Variation in percentage of orange-clawed females and blue-clawed females did not follow any particular pattern. The mean weight of individual morphotypes in all the five sets of treatments were significantly different ($P<0.05$). The most noteworthy finding was in respect of individual weight of SM and OBC morphotypes, which lowered from 18.4 g and 147.9 g respectively in TP-1 to 11.4 g and 91.5 g respectively in TP-5. The mean weight of individual female morphotypes within the treatments was not statistically significant ($P>0.05$).

The percentage composition by number of the male and female morphotypes at different levels of initial density in the five sets of treatments (polders) is shown in Figure 1. In TP-1, which was characterized by lowest density at harvest (0.93/m^2), SBC and its transitional stage WBC and OBC constituted 53.6% of the male morphotypes while the contribution from SM

Figure 1 - Percentage contribution in individual morphotypes of *Macrobrachium rosenbergii* reared under different stocking densities.



TP- Trial Polders
SM- Small Males, WOC- Weak Orange Clawed Males, SOC- Strong Orange Clawed Males, t-SOC - Transforming Strong Orange Clawed Males, WBC- Weak Blue Clawed Males, SBC- Strong Blue Clawed Males, OBC- Old Blue Clawed Males, SF- Small Females, WOF- Weak Orange Clawed Females, SOF- Strong Orange Clawed Females, TOF- Transforming Strong Orange Clawed Females, WBF- Weak Blue Clawed Females, SBF- Strong Blue Clawed Females

Table 2 - Stocking details and yield characteristics of *Macrobrachium rosenbergii* reared under stocking density in polders. TP - trial polders.

	TREATMENTS				
	TP-1	TP-2	TP-3	TP-4	TP-5
Stocking Particulars					
Number per ha.	15,000	25,000	35,000	45,000	60,000
Mean weight (g)	0.2±0.02	0.2±0.02	0.2±0.02	0.2±0.02	0.2±0.02
Biomass per ha. (kg)	3.0	5.0	7.0	9.0	12.0
Harvest Details					
Number per ha.	9314	14125	18890	21578	27100
Mean weight (g)	72.2±28.8	64.5±20.9	58.4±20.1	56.6±18.8	52.6±19.4
Gross production (kg/ha)	280	315	568	757	842
Net production (kg/ha)	257.3	309.8	554.2	745.3	835.5
Survival (%)	64.0	56.2	54.8	48.1	45.7
Mean male weight (g)	83.0±24.9	75.1±19.2	65.3±14.5	58.9±15.4	54.1±11.4
Mean female weight (g)	62.1±19.5	58.5±13.6	50.4±18.4	42.1±16.9	44.7±15.5
Sex ratio (M:F)	1:0.72	1:0.91	1:0.85	1:1.14	1:1.33

was highly insignificant (8%). On the contrary, in TP-5 with a final density of 2.71/m^2, the percentage contribution of blue clawed males showed a perceptible decline to 39.4% in contrast to remarkable increase in the percentage contribution of SM to 28.1%. It would thus appear that while a direct relationship could be noticed in the proportion of SM with respect to the increase of density, the percentage of BC morphotypes showed an inverse relationship (Fig. 1). Almost identical to their male counterparts, variations in the morphotypic composition of harvested female population were also discernible in relation to stocking density. It could also be seen that in higher densities (TP-4 and TP-5), the cumulative percentage of SOF and its advanced stages viz. TOF, WBF and SBF together accounted for 69.7 and 67.3% respectively, on the contrary, in TP-1 and TP-2, the percentage contribution of these groups were found high (78.4 and 70.6% respectively).

Yield characteristics

Density dependant variations in the mean weight of harvested population could be observed in the five treatments, showing highest mean weight of 72.15 g in TP-1 against 52.58 g registered in TP-5 (Table 2). Mean weight in respect of various male and female morphotypes are given in Table 3. Invariably, the mean

Table 3 - Percentage contribution and mean weight of male and female morphotypes among the five treatments (polders).

		Male morphotypes			Female morphotypes		
Treatment		SM	OC	BC	SF	TOF	WBF
TP-1	Sample size (*n*)	151	319	395	118	124	153
	Contribution by weight (%)	5.4	33.45	26.27	8.12	7.82	4.35
	Mean weight (g)	18.41	79.83	97.7	16.04	60.95	76.80
	Standard deviation	5.82	11.63	19.82	3.11	16.78	17.93
TP-2	Sample size (*n*)	115	293	463	95	123	124
	Contribution by weight (%)	9.87	36.44	18.34	12.88	3.29	5.65
	Mean weight (g)	25.6	76.13	108.21	12.55	52.38	66.94
	Standard deviation	7.49	23.69	30.51	2.64	13.04	18.03
TP-3	Sample size (*n*)	137	203	444	124	112	122
	Contribution by weight (%)	14.66	27.37	23.91	6.79	8.17	3.78
	Mean weight (g)	18.23	60.43	92.81	12.26	51.18	65.41
	Standard deviation	6.57	18.82	24.56	3.66	12.74	14.06
TP-4	Sample size (*n*)	129	272	424	129	117	112
	Contribution by weight (%)	14.59	26.89	18.83	12.44	4.69	5.29
	Mean weight (g)	15.57	46.55	75.99	13.50	48.40	61.14
	Standard deviation	6.87	12.82	23.56	3.31	17.22	15.40
TP-5	Sample size (*n*)	115	203	343	135	123	94
	Contribution by weight (%)	21.36	29.24	15.36	7.23	3.01	2.08
	Mean weight (g)	11.35	48.98	61.24	13.55	46.24	52.30
	Standard deviation	2.61	17.44	19.43	2.85	18.66	15.66

TP- Trial Polders
SM- Small Males, OC- Orange Clawed Males, BC- Blue Clawed Males
SF- Small Females, OC- Transforming Orange Clawed Females, BC- Weak Blue Clawed Females

Table 4 - Comparison of means for mean weight of prawn, survival rate and net production among the five treatments.

Variable	Source	df	Sum of Squares	Mean Square	F	Sig.
Mean weight	Between Treatments	4	12534.00	4522.61	60.73	0.001
	Within Treatments	19	2163.22	253. 86		
	Total	23	14697.22			
Survival	Between Treatments	4	13680.498	6044.31	57.86	0.001
	Within Treatments	19	2312.993	526. 83		
	Total	23	15993.491			
Net production	Between Treatments	4	729735.05	182433.92	49.23	0.001
	Within Treatments	19	40756.48	3705.134		
	Total	23	770491.53			

weight of male and female morphotypes was highest in TP-1. Contrary to this, coefficient of variation suggests a more heterogeneous nature of population in TP-4 and TP-5, which had high initial stocking density. The net production also varied considerably within the treatments. The least among the mean net production from treatments were recorded from those stocked at the rate of 1.5/m^2 (257.3 kg/ha), while the maximum production was recorded in treatments stocked at the rate of 6/m^2 (835.5 kg/ha). While comparing the means it was noticed that mean weight and survival rate among all the four treatments varied significantly (Table 4). Similarly, results of Duncan's Multiple Range test (DMRT) employed to compare mean weight, survival rate and net production also indicated that all the above production parameters were significantly ($P<0.01$) different among the five treatments (Table 5). However, regarding the net production the performance of TP-1 and TP-2 did not differ significantly. Similarly, there was no difference in the net production between TP-4 and TP-5. This directly indicates that an increase in the stocking density beyond 45,000/ha would not make any difference in production. Likewise, there was no difference in the production between stocking densities 15,000 and 25,000/ha and therefore stocking of 15,000/ha would be better option from the economic point of view.

The weight distribution patterns of prawns in the five sets of treatments at different levels of stocking density are depicted in Fig 2. In TP-1 it appeared that the males profoundly influenced the weight distribution pattern, as the preponderance of >120 g-weight groups was quite discernible (40%), whereas, in treatments 4 and 5 this weight class constituted only 20% of the final harvested population. Weight distribution of total population in these treatments were also found to be influenced much by the female morphotypes which was evident from the high percentage occurrence of weight group 50 - 80g (36%) (Figure 2). Percentage of undersized male and female morphotypes (<50 g) in the final population was glaringly high in treatments with high stocking densities (26% and 32% in treatments 4 and 5 respectively), in contrast, to a mere 12% in TP-1 with the least stocking density. It also appeared that, out of the total biomass produced from the five treatments, 88% of the yield from TP-1 belonged to >50g group and therefore, was marketable whereas in TP-5 only 68% was marketable. Likewise, the total revenue generated from the five treatments was found to be INR 56,606/- in TP-1, INR 68,156/- in TP-2, INR 1,21,924/- in TP-3, INR 1,63,966/- in TP-4 and INR 1,85,240/- in TP-5 (1 US$ = INR 46.28). It may, therefore be seen that though the yield from TP-1 formed only 30.8% of TP-5, income wise it fetches 40.3% of the latter because of large size of prawns as well as reduction in the percentage of undersized prawns. But as the stocking density increased in subsequent treatments, their percentage in yield and income with reference to TP-5 also differed significantly. Yield from TP-2 formed 37% of that of TP-5, while income increased to 44%. Similarly in TP-3, yield formed 66.3% of TP-5 but the income drawn was slightly high (70.7%). On the con-

Table 5 - DMRT results for mean weight, survival rate and net production among the five treatments. Means with same letter as superscript are homogeneous. TP- Trial Polders.

Treatment	Mean weight		Survival		Net production	
	Mean	SD	Mean	SD	Mean	SD
TP-1	72.15^a	5.07	64.00^a	6.53	257.30^c	12.90
TP-2	64.35^b	6.02	56.20^b	8.72	309.80^c	23.06
TP-3	58.41^c	4.87	54.08^b	6.71	554.20^b	32.12
TP-4	56.63^c	3.80	48.10^c	4.56	745.30^a	59.27
TP-5	52.58^d	4.21	45.70^d	3.20	835.50^a	54.01

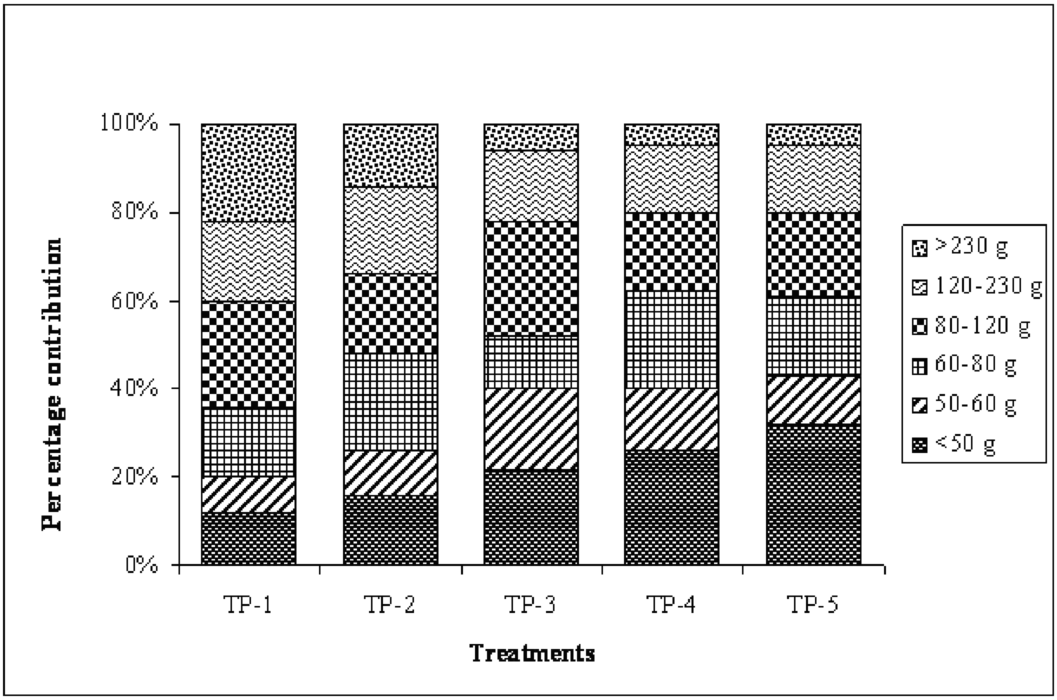


Figure 2 - Weight-wise harvest yield structure of *Macrobrachium rosenbergii* reared under different stocking densities.

trary, the yield registered from TP-4 formed 89.2% of that of TP- 5 but the income percentage reduced to 88.85%. Based on the findings of the present study it can be asserted that a stocking density of 45,000/ha would be ideal for monoculture of *M. rosenbergii*, which would be more economically viable and technically feasible in the polders of Kuttanad.

DISCUSSION

The developmental pathway followed by the male morphotypes of *M. rosenbergii* is unique to this species and it follows an irreversible order from Small Male (SM) to Orange Clawed (OC) to Blue Clawed (BC) as suggested by Cohen et al (1981). The rate of transformation is greatly influenced by a series of external factors and stocking density which also alter the population composition of final harvest (Kurup et al., 1996). The results of the present study revealed that there exists a tangible difference in the morphotypic composition of this species in response to the variation in stocking density. The available reports suggest that females invariably dominate in grow-outs of *Macrobrachium rosenbergii* (Smith et al., 1978). However, in the present study, a similar trend was noticed at higher final population density. The growth rate of females is slow when compared to the male counterparts and therefore the chances of them being cannibalistically preyed by larger males increases in higher densities, especially during early phase of culture. This may result in low percentage survival of females in high densities. On the contrary, a clear preponderance of males could be noticed at the lowest density among polders which is in variance with earlier reports (Smith et al., 1981). This is primarily due to the competition for food and space faced by adult male prawns at a greater stocking density. Owing to greater struggle and due to its highly cannibalistic nature, the proportion of male population gets considerably reduced (Ranjeet & Kurup, 2002a).

In the present study, a dynamic shift in the proportion of male morphotype with density could also be discernible. At higher density, the proportion of SM was relatively high while the percentage of OC and its transitional stages showed a reduction. Interestingly, in polders with low densities, the percentage of BC was distinctly high but the weights attained by them were comparatively lesser than that of t-SOC. This may be because of the undersized male prawns, instead of passing through the transformation pathway, skipped the intermediary stages to attain the terminal growth by leapfrog transformation as reported by Harikrishnan (1997). Thus, though the prawns could attain the terminal stage of their growth, the weight gained by them was glaringly low when compared to similar morphotypes encountered at lower densities. The shift observed in the frequency of male morphotypes may be due to the complex social organizational hierarchy in *M. rosenbergii*. At high density, the percentage of SM and WOC were high and this would suggest the chances of inhibition of growth of SM by BC due to the proximity of the latter. It may, therefore, be inferred that the rate of transformation of male morphotype to its successive stages was very rapid in low density grow outs, on account of less competition and fast growth rate and this can well be attributed as the reason for the presence of OBC in low density in appreciably high proportions. One of the principal reasons why the intensive commercial production of freshwater prawn *M. rosenbergii* could not be popularized is due to the highly skewed size distribution of harvested populations. The skewed size distribution resulted from disparate growth rates or a condition termed heterogeneous individual growth or HIG (Malecha et al. 1981). Consequently, the harvested population is characterized by the preponderance of non-marketable prawns (<20 g whole body weight). As stocking increases, the total yield may also increase with a dominance of marketable individuals while there is a steady tendency in the shifting of mean length towards lower weight groups (Smith et al. 1978, Cohen et al. 1981).

In Kuttanad, a scientific culture practice for *M. rosenbergii* was lacking and most of the farmers were complying with a rather traditional type of farming which rendered farming less profitable. Understanding the immense potential for scampi farming in this wetland ecosystem and the role of a threshold stocking density for the economic viability of prawn farming in the polders, the present study was conceived and carried out. While working out the marketable yield structure and profit incurred from the culture under varied stocking densities, it could be seen that an increase in stocking density beyond a particular level was not helpful in the reciprocal improvement of the profit due to the dominance of undersized prawns in the final harvest. Optimization of stocking density also holds good since the reduction of the stocking rate below a particular level, though helpful in increasing the mean weight of prawns, would result in the poor yield and thus farming becoming economically unviable. In the present study the optimal stocking density for polders were found to be $3.5/m^2$. The relative proportion of larger OC and BC morphotypes in the final population profoundly influences the economic viability of 'scampi' farming. In order to ensure the availability of morphotypes in the harvested population in appreciable quantities, optimization of stocking density is a prerequisite. While maintaining an initial stocking density at $3.5/m^2$ in polders, a linear relationship between the economic returns and corresponding profit could be established and similar relationship could not be arrived at other stocking densities studied. Therefore, standardization of stocking densities at any levels of culture practice for *M. rosenbergii* is a prerequisite for improving in its economic yield and thereby making the farming economically sustainable.

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