EFFECT OF THREE STOCKING DENSITIES AND THREE DIETS ON GROWTH AND SURVIVAL OF POST LARVAL *MACROBRACHUIM VOLLENHOVENII* (HERLOT'S 1857) DECAPODA; PALAEMONIDAE)

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ABSTRACT

Growth and survival rate of *Macrobrachium vollenhovenii* (Herklots) post larvae reared in aquaria were monitored for 98 days at 3 stock densities and for 84 days in the specimens fed with three different compounded meals .Specimens at the stock density of 16 ind.m^2 27 ind.m^2 and 54 ind.m^2 showed specific growth rates of 0.52% , 0.96% and 0.64% obtaining a daily weight gain of 0.008g d^{-1} , 0.009gd^{-1} and 0.005g d^{-1} respectively. Growth obtained from animals that fed on meal CM_3 (48.5% crude protein content) was better compared to the growth rates of 0.02 g.d^{-1} determine in specimen that relied on meal CM_1 (55% crude protein content) and CM_2 (30.6% crude protein content) respectively. Survival rates of 50% were determined in all levels of the feed experiment while 100% survival was calculated in all stock densities except in the 54-ind.m^2 density, which gave 40% survival. These results are exhaustively discussed in relation to the culture of Macrobrachium vollenhovenii.

KEY WORDS: Stocking densities, Meal, growth, Survival, and *Macrobrachium vollenhovenii*.

INTRODUCTION

Growth studies in aquatic organisms are usually investigated in relation to both environmental and inherent factors such as temperature, sexual dimorphism, predation, food and survival. which influences growth in several ways (Sarver, et al, 1982; Malecha ,1986). Sarver et al (1982) emphasized that environmental factors are site specific such that growth data from species reared in different environments should be compared with caution.

Several authorities have studied growth in many species of crustaceans including *Macrobrachium rosenbergii* (Sandifer and Smith 1975; Willis et al 1976; Willis and Berrigam,1977), *M. acanthurus* and *M. carcinus* (Dobkin et al 1974) and *Austropomabius pallipes* (Pratten 1980) etc. Studies on the growth of crusteceans in relation to several kinds of compounded feeds produced from different raw materials are also reported in literature (Viola et al,1988; Manik et al 1977; Destajo and Dejarme,1982; D'Abramo et al 1981; Davis and Robinson.1986). Gutherie and Tarver(1981) reported that the mean final size of specimens under culture was lower at higher densities and when they were fed with unacceptable supplemental diets. Survival rates of specimens also depend on stock densities and the length of the growth period (Sandifer and Smith,1975; Prah,1982; Gordon,1978; Udo and Taege, 1989).

In this study, the author provides for the first time data on the growth of *Macrobrachium vollenhovenii* stocked at different densities and on individuals fed with compounded feeds produced from local sources of raw ingredients. *M. vollenhovenii* is the largest fresh water shrimp in West Africa (Prah,1987; Udo and Taege,1991) and its potential for culture is being investigated in Calabar, Nigeria and Hamburg, Germany. The species is locally preferred as delicacy and a shrimp species of great economic importance to artisanal fisheries. It is presently over fished (Enin,1994) and may become unavailable or extinct in the future. Its biology and culture potentials must be discovered now for its subsequent cultivation. Powell(1982) recorded a maximum length of 180 mm for the species but the largest available individual now is about 130 mm long (Enin,1994).

MATERIALS AND METHODS

All post larvae were caught from the Kwa falls, which is located between latitude 5°12^1 and 5°40^{1}N and longitudes10°2^1 and10°15^{1}S in the rain forest belt of Nigeria and about 36 km from Calabar, Nigeria. In the laboratory, they were acclimatized before commencement of study. The water for the study was collected at the Kwa falls while subsequent water used for exchange and replacement were aged and stabilised tap water which had the initial pH of 4.3 and later (stabilized by addition of known quantities of sodium bicarbonate to a properly aerated tap water) 7.5 after stabilization.

Growth at three stocking densities

Three pairs of aquaria each measuring 0.27m^2 were used for the stocking of the specimens after the initial mean weights and total lengths of the animals were measured. Each of the aquaria with replicates was stocked at the density of 16 ind.m^2 ; 27 ind.m^2 and 54 ind.m^2 respectively. In a addition to a sandy substratum, which was later replaced with muddy bottom, each aquaria was provided with adequate ' shelters '(hide-outs). The change in substratum (and the shelters) from sand to mud is related to the change in behaviour of specimens from pelagic to benthos habit as they mature (New and Singholka,1982). These specimen were fed with *Egaria radiata* and fish flesh meals at the

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Table 1 :   Percentage and proximate composition of nutrients in the compounded meals
                   for *Macrobrachium vollenhovenii* post larvae.

Food ingredients	Compounded meals code components (%)		
	CM_1	CM_2	CM_3
Groundnut	43.2	-	27.3
Shrimp meal	34.8	-	27.3
Egaria radiata meal	-	45.4	13.6
Plankton	4.3	4.5	4.5
Water lily	-	2.3	9.1
Palm oil	-	4.5	-
Binder(garri starch)	4.3	4.5	4.5
Vitamin premix	13.0	13.6	13.6
Total	99.9	99.8	99.9
Proximate composition			
Crude protein(%)	55	30.5	48.5
Ash(%)	18.3	14.9	16.4
Crude fat(%)	6.6	6.1	7.2
Nitrogen Free extract(NFE)	23.0	34.3	21.4
Others(%)	17.1	14.1	6.5
	100	100	100

feeding rate of 20% body weight divided into three rations per day. Fish in every aquaria were fed with the same meal on the same day to exclude the influence of food type on growth. This feeding rates was adjusted every 14 days until the end of the study on the 98th day when the total lengths and weights of the animals were re-measured.

Cleaning and partial replacement of water in the culture systems were carried out every two days, while complete water replacement was undertaken every 14 days. Uneaten food and other wastes were siphoned daily before next feeding to ensure the maintenance of good water quality of the culture media.

Growth with compounded food

Three types of artificially compounded food were investigated ; their constituents and proximate composition are given in table 1. Proximate analysis were done according to standard procedures; crude protein determined by the Macro kjeldal method; fat by soxhlet extraction; moisture by drying; ash by furnace ashing and Nitrogen free extract by difference(AOAC,1975).

Six aquaria each measuring 0.27m² with replicates were used for this aspect of the study. The animals were stocked at equal densities of 33 ind.m² after the initial mean weights and total lengths were determined. Feeding was carried out thrice daily at an initial rate of 20% mean body weight of animals shared to provide three rations in a day. The feeding rates were adjusted in steps of 1% every 14 days of culture to match with the new weights of the animals (New and Singholka,1982).The method of cleaning of aquaria and water exchange was as earlier described. Water qualities of dissolved oxygen and pH were monitored and regulated daily to suit the water quality of it natural habitat. The final total lengths and weights of the animals were taken including the weights of food consumed. The growth rates(including specific growth

),food conversion rates (FCR) and production efficiencies (PE)were computed according to the method used by Sandifer and Smith,(1970).

To determine the differences in growths of the treatment groups data were compared by use of one-way analysis of variance(ANOVA) and the least significance range test (Sokal and Rohlf,1970).

RESULTS

Body weights of specimen increased with time irrespective of stock density and food. Animals also modified habitat changing from pelagic to benthos habit when bottom substrate of the culture systems was changed from sand to mud. Water quality was maintained as follows: Dissolved oxygen = 6.85 and pH was between 6.75 and 7.00.

Effect of stocking density on growth.

Growth was similar in stock densities 16 and 27 ind.m² (Table II) and was different in 54 ind.m² (F_S= 8.86 ; 3 and 28 df)(P>0.05). Further test for variability confirmed that specimens stocked at 54-ind.m² density were more variable than the others. Tables II and III also show that survival and growth rates at stock densities 16 and 27 ind.m² were similar (P>0.05) while the lowest survival rates of 40% were calculated from the tanks with highest stock density of individuals.

Effect of compounded feeds on growth.

The growth rates of the specimens maintained on the different compounded feeds were significantly different (F_s = 7.79 ; 2 and 18 df) (P>0.05) corresponding to the differences in the protein contents of the feeds(Table I).LSR test showed that meals CM_1 and CM_2 were similar but were different from meal CM_3 (P< 0.05) (Table V).

Table IV show the efficiencies of the various production

systems and the food conversion rates(FCR) of meal CM_3 as compared to those of the other two similar meals (P>0.05).

DISCUSSION

Influence of stocking densities on growth and survival

The stock densities of 16 ind.m^2 and 27 ind.m^2 produced similar results implying that both are probably suitable culture densities for the rearing of *M.vollenhovenii*. In stock density 27 ind.m^2 specimen grew from 0.49g to 2.277g in 98 days and at 16 ind.m^2 growth progressed from an initial weight of 1.00g to 2.67g. in the same period. Willis and Berrigan (1977)observed that juvenile shrimp stocked in ponds at the rate 5 ind.m^2 and initial mean weight of 0.76g produced shrimps weighing 48.688g in 167 days of culture and the best growth obtained from post larvae stocked at the same density which grew from 0.09g. to 29.4g. in the same period of time. In other words, the juveniles obtained faster growth(0.29gd^{-1}) than the post larvae(0.17gd^{-1}). Ling(1969) reported that *M. rosenbergii* grew faster from 6g. to 100 g. in 6 months at a stock density of 1.5 ind.m^2 while at a mean weight of 1g. at 10.0 ind. m^2 a final production of 1,121 kg/ha of shrimps (*Macrobrachium rosenbergii*) was obtained (Provenzano,1973).

Sandifer and Smith(1997) provided the growth rate of 0.022 mg.d^{-1} for *M.rosenbergii* reared in the laboratory while 0.022 gd^{-1} and 0.007gd^{-1} was estimated by Malecha et al (1980)for the same species grown in the laboratory for 334 and 238 days respectively. A growth rate of 0.117 g^{-1} was obtained in 240 days for the same species (Smith et al. 1981). Table I and II show that *M.vollenhovenii* stocked at a density of 16.0 ind.m^2 and 27.0 ind. m^2 grew at the same rate as *M.rosenbergii* while the growth of animals stocked at 54 ind.m^2 was different(P>0.05). These minor differences in the growth rates of these two species (*M.vollenhovenii* and *M.rosenbergii*) are probably related to the culture environment and stocking densities of the individuals in the two experiments. It is well known that higher stocking densities of individuals in any culture environment diminish the growth rates of species (Miyajima,1971; Smith et al 1981; Sarver et al,1982; and Bowser and Roosemark,1991). The results of this study compares fairly with that provided by Miller(1971)who gave 0.26 mm.d^{-1} as the growth rate for *M. vollenhovenii* even though the stocking sizes and densities of the species in his study were not provided.

Survival rates were high in this study (Table II) compared to those reported for *M .rosenbergii* at the densities of 215 ind. m^2. and 430 ind.m^2(58.2% and 17.8% respectively) and 11.4% and 16.9 % survival obtained at 645 and 860 ind.m^2 stock densities for specimens reared for 30days by Willis et al 1976). Wickens (1972) at even higher densities of 1222 and 1746 ind.m^2 measured 28.9% and 21.9% respectively for *M.rosenbergii* cultured for 97 days. The stocking densities in these experiment were very high compared to those investigated for this report; the low survival rates of the specimens are attributed to environmental factors(Saver et al 1982),cannibalism and high densities (Willis and Berrigan 1972). The relationship between stocking densities and survival rates is amply illustrated from the studies of Willis and Berrigan (1972) who obtained survival rates of 92%,70%,and 38% respectively from specimens stocked at 5 ,10 ,and 20 ind.m^2 densities .At the rates of 1.2, 2.5, and 3.7 ind.m^2 Gutherie and Tarver(1981) calculated survivals of 71%, 58% and 62% respectively. However these high rates of survival were related to low stocking densities .

Influence of food on growth and survival

The influence of protein levels and the nature of compounded feeds for cultured organisms is crucial in the promotion of growth in culture systems .Malecha et al (1981),Stanley and Moore(1983) found that only low

Table 2 : Growth and survival of *Macrobrachium vollenhovenii* stocked at three densities for 98 days. Temperature = 28± 2.0^C

Stocking density (ind.m^2)	Weight(g) Initial	Final	Length(mm) Initial	Final	Growth Rate (gd^{-1})	Growth rate (mmd^{-1})	Specific growth rate(%)	PE	Sur. (%)
16	1.01	2.68	33.30	50.00	0.02	0.17	0.52	0.60	100
27	0.50	2.28	28.60	45.10	0.02	0.16	0.96	0.40	100
54	0.55	1.18	30.90	43.90	0.01	0.13	0.44	0.53	40

Table 3 : Least significant range test on individuals at 3 stocking densities. Significant differences (P>0.05) are represented by horizontal lines

Stocking density(ind.m^2)	16	27	54
Growth rate(gd^{-1})	0.02	0.02	0.01
Specific growth rate(%)	0.52	0.96	0.44
Production efficiency(PE)	0.60	0.39	0.53

Table 4 : *Macrobrachium vollenhovenii* post larvae fed with different types supplemental feeds for 84 days. Temperature = 28 ±2.0°c

Feed type	Weight(g) Initial final	Length (mm) Initial final	Growth Rate	Growth rate	Specific growth	PE	FCR	Survival Rates
			(gd⁻¹)	(mmd⁻¹)	(%)			(%)
Cm_1	1.54 1.92	37.41 51.10	0.02	0.16	0.73	0.5	2.43	50
Cm_2	0.82 2.46	41.50 54.00	0.02	0.15	0.06	0.6	2.48	50
Cm_3	0.56 2.62	34.80 45.30	0.03	0.29	1.43	0.3	1.33	50

Table 5 : Least significant range test(LSR) on three supplementary diets fed to *Macrobrachium vollenhovenii* post larvae.
Lines represent significant differences(P>0.05).

Feed type	CM_1	CM_2	CM_3
Growth rate(gd⁻¹)	0.016	0.019	0.025
Specific growth rate(%)	0.73	0.65	1.43
FCR	2.24	2.48	1.33
Production efficiency(PE)	0.54	0.28	0.30

protein and easily fragmented compounded feeds are suitable for the growth of *M. rosenbergii*. In this study, *M.vollenhovenii* fed with meals containing 55% and 30% protein exhibited similar growth as those reported by them(Tables IV and V). The main source of protein for meals CM_1 and CM_2 were shrimp parts and *Egaria radiata* meals respectively as against meal CM_3 whose main protein source was a combination of shrimp and *Egaria* meals in low percentages (Table I). *Egaria* as the only protein component for meal CM_2 produced the least growth indicating that the meal alone and even shrimp meal was insufficient and inferior as independent meals. They however in combination became nutritious and efficient in the promotion of growth as evident from the result obtained from meal CM_3.This results might be related to the amino acid constituents of the two protein sources composing the meal which possibly complimented each other (meal CM_3) to promote growth only when administered in combination. The reason for the poor performance of meal CM_1 is not yet understood even though the component of that feed shares similar amino acid spectrum with the cultured animals. In a similar study, Destajo and Dejarme (1980) obtained survivals of 40% and 80% from the best food administered to *M. rosenbergii* and *Peneaus indicus* and concluded that the best meal produced the highest survival rates. The above stated results compared to those obtained from this study contradicts each other ; differences in the stocking densities of the animals in the two studies not withstanding. Destajo and Dejarme

(1980) studied only two animals per container (size of container not provided) as compared to the 33.0 ind.m² of this study. This implies that the stocking rates of the specimens in that study must have influenced the survival rates. It is known that the survival of individuals in culture systems is encouraged by low stocking rates.

The best FCR was calculated from those animals that fed on meal CM_3 as compared to those obtained from the other two meals, implying that meal CM_3 was superior to the others. FCR's calculated for other aquatic species fed at low to high stock densities

ranged from 1.84 to 7.40 respectively (Smith et al 1981).Higher food consumption rates indicate poor feeding, and unacceptability of food and vice versa(Destajo and Dejarme 1980; New and Singholka, 1982).

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