E-ISSN: 2347-5129
P-ISSN: 2394-0506
(ICV-Poland) Impact Value: 5.62
(GIF) Impact Factor: 0.549
IJFAS 2017; 5(6): 28-33

www.fisheriesjournal.com
Received: 06-09-2017
Accepted: 07-10-2017

Luc Gangbè
(1) National Institute of Agricultural Research of Benin 01 Po Box 884 Cotonou, Benin
(2) Hydrobiology and Aquiculture Laboratory of Abomey-Calavi University 01 Po Box 526 Cotonou, Benin

Hyppolite Agadjihouèdé
The Valley Aquaculture' School of the Agricultural University of Kétou Po Box 43 Kétou, Benin

Philippe A. Lalèyè
Hydrobiology and Aquiculture Laboratory of Abomey-Calavi University 01 Po Box 526 Cotonou, Benin

Correspondence
Luc Gangbè
(1) National Institute of Agricultural Research of Benin 01 Po Box 884 Cotonou, Benin
(2) Hydrobiology and Aquiculture Laboratory of Abomey-Calavi University 01 Po Box 526 Cotonou, Benin

Growth of the post-larvae shrimp *Macrobrachium vollenhovenii* (Herklots, 1857) fed with food riches in earthworms and termites

Luc Gangbè, Hyppolite Agadjihouèdé and Philippe A Lalèyè

Abstract
The growth of the post-larvae in captivity depends quantitatively and qualitatively on food rich in protein. The present study was aimed to test four (04) feed rations on the growth of post-larvae in captivity. The pilot R1 ration (Raanan) is obtained in business, the R2 ration contains cornstarch and the rations R3 and R4 are respectively made up with the earthworms and termites flour. The post larvae weight of 0.23 ± 0.02 g are bred for ninety days and simultaneously in twelve vats (0.23 m^3) and twelve basins (1 m^3). The average values obtained for the weight in vats are 0.6 ± 0.15 g; 0.41 ± 0.25 g; 0.40 ± 0.13 g; 0.35 ± 0.1 g respectively for shrimp batches corresponding to rations R1, R2, R3 and R4. In basins, these weights are 0.45 ± 0.22 g for R1 and R2 and 0.40 ± 0.20 g and 0.31 ± 0.18 g, respectively, for R3 and R4. The survival rate varies between 42.02% ± 31.45 and 65.22 ± 17.39% in vats and 10.33 ± 4.73% and 20.67 ± 2.08% in basins. The high values of the Food Conversion index from 1.44 g/g to 2.8 g/g and the Proteinic Rate of Efficiency from 0.50 g/g and 0.98 g/g confirm the low rations performance in basins.

Keywords: *Macrobrachium vollenhovenii*, growth, post-larvae, feed rations

1. Introduction
The shrimps represent a significant source of proteins and reserves for the populations [1], especially in the developing countries. They contribute in addition to the other halieutic products to 22% of the food ration against 20% and 58% for the ruminants and the monogastric ones [2]. In Benin, fishing is one of the important levers of development since it contributes to 4% of the GDP [3]. According to the studies realized in Benin by certain researchers [4-8], the fall of fishes and shrimps productivity of the water levels is confirmed each day. In such situations, a successful domestication of halieutics species would be a recommended solution [9]. *Macrobrachium vollenhovenii* (Herklots, 1857), giant shrimp species of fresh water belonging to the family of Palaemonidae [10, 11], seems to be a potential candidate for the aquiculture by its big size and with a strong fruitfulness [12].This species is abundant in the captures during the risings [13, 14]. In captivity, the growth of the post-larvae depends on the content of calcium and especially on protein rate [14-16]. The feed ingredients classically used as sources of proteins in the food formulation are with importance the fish meal and the soya bean oil cake. The fish meal is from animal origin with approximately 39% of rough proteins whereas the soya bean oil cake is from vegetable origin with approximately 35% rough protein [17]. These two food ingredients cost expensive and are sometimes inaccessible, which could not allow a fast return of investment in aquiculture. The present study aims to seek and test other alternative sources of proteins on the survival and the growth of the post-larvae *M. vollenhovenii* bred in basins and vats. In such conditions, it is necessary to improve the local by-products in the feeding of post-larvae shrimp.
The earthworm flour (45-70% of rough proteins) and the termites flour (46% of rough protein approximately) are the two sources used to partly compensate the fish meal in the food of the post-larvae shrimp.

2. Material and Methods
2.1 Sampling environment of specimens and breeding conduct
The post-larvae shrimps *M. vollenhovenii* used for the experimentation have been fished in the valley of the Mono river, in the locality of Djonogoui, a village of the commune of Athiémé, Department of Mono (figure 1) in Benin.

The collected shrimps were transported in plastic sachets filled with the thirds (1/3) of water and with two thirds (2/3) of oxygen at the station of aquiculture of Hydrobiology and Aquiculture Laboratory of Abomey-Calavi University (HAL/ACU) for the breeding tests. They were then subjected to a soft acclimatization in basins of 1 m^3 during a week. These basins were equipped with a system of ventilation and renewal water.

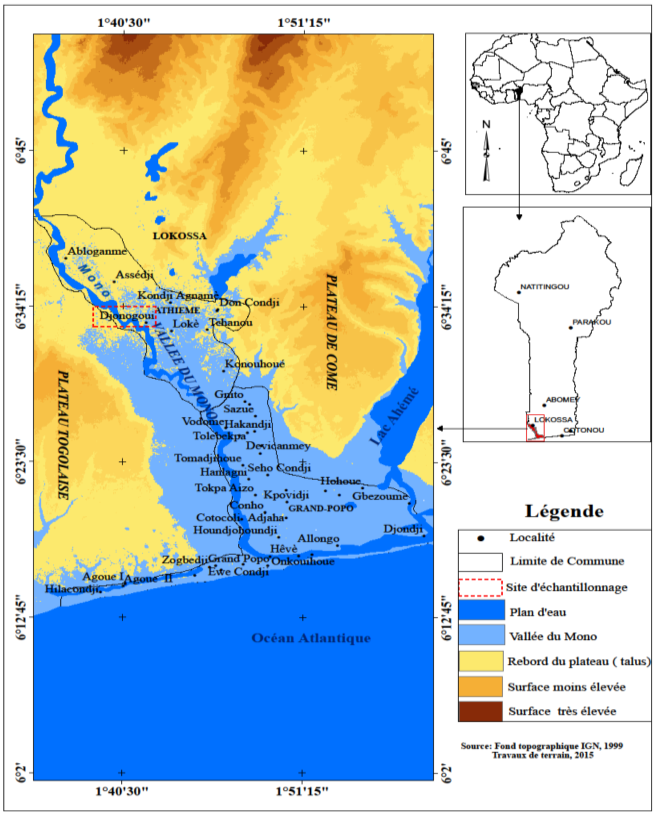

Fig 1: Chart of study's zone

2.2 Experimental device in test center

Two experimental devices were installed for the tests. The first was made up with 12 identical plastic vats of 0.23 m^3 and the second was made up with 12 identical basins of 1 m^3. The vats have been completely randomized under a hangar with direct shelter of sunrays, whereas the basins which were also laid out by total randomization have been exposed to the sun. The basins were covered at half by trays and filled with water at 2/3 of their volume. The two devices were arranged by the same system of ventilation. The twelve (12) experimental units which constituted each device arise from the three (3) repetitions made for the four rations used. In each unit, has been introduced post-larvae of individual average weight of 0.23 ± 0.02 g, it's about individuals which did not present any morphological deformation as wound and absence of corporal piece. The loading density was of 100 individuals/m^2 [18] that is 100 individuals per basin and 23 individuals per plastic vat.

2.3 Preparation of the food rations

Four foods have been tested, among which three have been manufactured in station and a pilot (Raanan) bought in business (42% of protein rate). The ingredients used for manufacture of food have been obtained in the local market. The choice of the ingredients such as cornstarch, earthworms and termites is justified by the fact that they are soft foods often used locally for shrimps fishing. The earthworms and the termites are also from potential protein sources [19; 20].

The incorporation rates of the ingredients have been obtained by the square method of Pearson [21] by taking into account the protein's requirement (25-30%) of fresh water shrimp *M. vollenhovenii* at the post-larval stage [22] and of the protein and carbohydrate content of each food ingredient (table 1).

Table 1: Proportion of the food ingredients and proteinic centesimal composition of the rations

Ingredients	Proteins rates (%)	Feed rations			
		R1 (%)	R2 (%)	(R3) (%)	R4 (%)
Bran of wheat	14,19	-	5	5	5
Cotton oil cake	12,69	-	5	5	5
Soya bean oil cake	35,13	-	10	10	10
Fish meal	39,25	-	60	30	30
Binder	-	-	4	4	4
CMV	-	-	1	1	1
Cockle oyster	5,69	-	4	4	4
Iodized salt	-	-	0,5	0,5	0,5
Palm oil	-	-	0,5	0,5	0,5
Cornstarch flour	9,50	-	10	10	10
Earthworms	65	-	0	30	0
Termites	46,3	-	0	0	30
Total (%)		100	100	100	100
Proteins (%)		42	40	32,04	28,76

R1 = Raanan (Pilot Food); R2 = Cornstarch food; R3 = Earthworms food; R4 = Termites food

2.4 Shrimps breeding

The shrimps have been nourished with a ration of 10% of their biomass [23]. The food has been served three times per day at a rate of 40% of the ration divided into two meals, morning (08 AM) and midday (01 PM) and 60% of the ration in the evening (06 PM) in single meal. This is in connection with the rationing recommended by Griessinger *et al.* [24] for *M. rosenbergii* and according to the recommendation of Balazs et Ross [17]. The percentage of 50% of the post-larvae present in each vat and basin were taken randomly and weighed individually by means of an electronic balance (LUTRON GM-300P, carried 300 g, precision 10 $^{-2}$). The ration has been readjusted every fifteen days according to registered mortalities and average weights obtained on the level of each vat and basin.

2.5 Data processing

The collected data made possible to calculate the following parameters:

- **Zootechnical parameters**

PW: Profit in Weight (g) = Faw - Iaw;
DAP: Daily average profit = (Faw - Iaw)/T;
SGR: Specific growth rate (g/j) = (LogFaw – LogIaw) X 100/T [25];
SR (%): Survival rate = (FnX100)/ In;
Iaw = initial average Weight, Faw = final average Weight, In = Initial number, Fn = Final number; T = Experimentation period, Log = logarithm at base 10.

- **Assessment parameters of the food effectiveness**

CI: Food conversion index (g) = (Quantity of consumed food)/ (Profit in Weight);
PRE: Proteinic rate of efficiency (g/g) = consumed Protein/Profit in Weight [26];
Returns: Output of harvest (g/m^2) = (PW)/Surface.

2.6 Data analysis
To analyze the effect of various food on the survival and the growth of the post-larvae shrimp, a series of methods has been used. They are the curves and the Boxes studs. Tables gathering the zootechnical parameters and food effectiveness assessment have been also used. The test of Levene [27] or Brown and Forsythe [28] has been used to test the homogeneity of the variables outlet corresponding to the various food treatments.

The various averages are compared with the threshold of 5%. For that, variance analysis to a criterion of classification (ANOVA 1) [29], [30] and the LSD (Least Significant Difference) of Fisher [31] has been used. All these analyses have been realized with the software (STATISTICA, 2004 version 6) and StatView (SAS Institute, version 5.0.1).

3. Results
3.1 Weighted growth of the post-larvae shrimp in breeding
Figure 2 presents the evolution of the average weight of the post-larvae in vats and basins during the experimentation. In vats (figure 2), all the batches of post-larvae grew with an exponential increase in weight in the first fifteen days of the experimentation. This growth was followed by a deceleration at the level of all the rations (R1, R2, R3, R4). This growth deceleration perpetuate until the 60th day of the experimentation, when the various batches started to register a weighted profit again. The growth speed of the batch of post-larvae nourished with the R1 ration is higher than that of the batches nourished with the other rations.

As for the post-larvae bred in basins (figure 2), the weights fell in all the batches in second fifteen days after an exponential weighted growth registered in the first fifteen days of the experimentation. After the second fifteen days, the various batches of post larvae took again their growth and have maintained this pace until the end of the experiment.

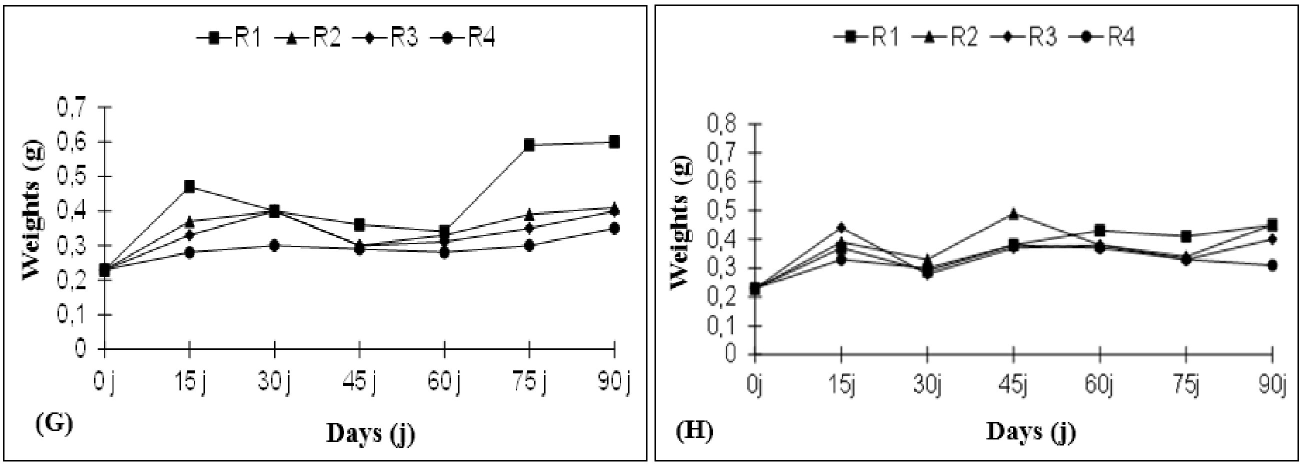

Fig 2: Evolution of the shrimp's weight in vats (G) and basins (H) during the experimentation

3.2 Zootechnical parameters and food effectiveness in vats and basins
Table 2 presents the zootechnical parameters and food effectiveness of the four rations tested in vats and basins.

In vats, the highest average values of the profit in weight (PW), specific growth rate (SGR), food conversion index (CI), proteinic rate of efficiency (PRE) and output (Returns) were registered at the level of R1 ration. The values obtained were 0.37 ± 0.30 g for PW, 0.004 ± 0.002%/j for SGR; 0.93 ± 0.13 g/g for CI, 0.39 ± 0.06 g/g for PRE and 1.6 ± 1.30 g/m^2 for Returns. On the other hand, the survival rates remained high at the level of rations R2, R3 and R4 from 57 to 65%.

In basins, the best values of these parameters (PW SGR CI PRE, Return) were carried out at the level of rations R1 and R2, presenting respective values of 0.23 ± 0.09g; 0.003 ± 0.001%/j; 1.44 ± 0.39 g/g; 0.61 ± 0.16 g/g; 0.98 ± 0.41 g/m^2 for R1 and of 0.22 ± 0.13g; 0.003 ± 0.002%/j; 1.76 ± 0.87 g/g; 0.71 ± 0.35 g/g; 0.98 ± 0.58 g/m^2 for R2. Concerning the survival rate in basins, it remains weak overall reaching maximum of 20.67% for all the rations. It was 65.32% in vats. In vats as in basins, the parameters like PW, DAP and SGR present overall equal values. In vats, the CI were lower than 1 whereas in basin it varies between 1.44 g/g and 2.8 g/g. It was the same for the PRE where the high values were obtained in basins from 0.50 g/g to 0.98 g/g while in vat these values remained low going from 0.21 g/g to 0.39 g/g. The best values of output (Returns) were obtained in vats (0.54 g/m^2 to 1.60 g/m^2 against 0.35 g/m^2 to 0.98 g/m^2 in basins).

Table 2: Zootechnical parameters and food effectiveness of post-larvae bred in vats and basins

Breeding materials	Food rations	SR (%)	PW (g)	DAP (g/j)	SGR (%/j)	CI (g/g)	PRE (g/g)	Return (g/m^2)
Vats	R1	42,02 ± 31,45a	0,37 ± 0,30a	0,004 ± 0,003a	0,004 ± 0,002a	0,93 ± 0,13a	0,39 ± 0,06a	1,60 ± 1,30a
	R2	57,97 ± 26,20b	0,18 ± 0,10b	0,002 ± 0,002a	0,003 ± 0,001a	0,84 ± 0,27a	0,34 ± 0,11ab	0,77 ± 0,43a
	R3	65,22 ± 17,39b	0,16 ± 0,06b	0,002 ± 0,001a	0,003 ± 0,001a	0,67 ± 0,06a	0,22 ± 0,02b	0,71 ± 0,24a
	R4	62,32 ± 20,55b	0,12 ± 0,09b	0,001 ± 0,001a	0,002 ± 0,001a	0,74 ± 0,16a	0,21 ± 0,05b	0,54 ± 0,39a
Basins	R1	17 ± 2,65a	0,23 ± 0,09a	0,002 ± 0,001a	0,003 ± 0,001a	1,44 ± 0,39a	0,61 ± 0,16a	0,98 ± 0,41a
	R2	18 ± 10,44a	0,22 ± 0,13a	0,002 ± 0,001a	0,003 ± 0,002a	1,76 ± 0,87a	0,71 ± 0,35a	0,98 ± 0,58a
	R3	10,33 ± 4,73a	0,17 ± 0,03a	0,002 ± 0,000a	0,003 ± 0,000a	2,80 ± 1,38a	0,98 ±0,44a	0,74 ± 0,12a
	R4	20,67 ± 2,08a	0,08 ± 0,06a	0,001 ± 0,001a	0,001 ± 0,001a	1,74 ± 0,40a	0,50 ± 0,12a	0,35 ± 0,27a

The average values gathered on the same column and having the same letter between the rations within the same material of breeding indicate that there is not any significant difference ($p > 0.05$). SR = Survival rate; PW = profit in weight; DAP = daily average profit; SGR = specific growth rate; CI = food conversion index; PRE = Proteinic rate of efficiency; Returns = Output.

4. Discussion

4.1 Physico-chemical parameters

The physico-chemical parameters of the breeding area of the post-larvae have undergone slight variations, sometimes significant or not; this from a food ration to another, and from a breeding infrastructure to another. It is important to note that the average values of dissolved oxygen (4.5 ± 0.1 mg/L), pH (7.4 ± 0.2) and water temperature (26.8 ± 0.0 °C) obtained in vats are located in the acceptable intervals of values indicated by Griessinger *et al*. [24] for the species Macrobrachium rosenbergii (O_2 = 4-5 mg/L; pH = 7-8; Temp = 28-32 °C). In basins, they are 4.6 ± 0.1 mg/L for dissolved oxygen; 8.3 ± 0.0 for the pH and 27.8 ± 0.2 °C for temperature.

4.2 Weighted growth of the post-larvae shrimp in breeding

The exponential weighted growth noted in vats and basins in the first fifteen days of the experimentation was due to a good acclimatization of shrimps allowing them a fast adaptation to the breeding area. This agrees with the observations of Lopez *et al*. [32] who had observed a similar growth of the post-larvae of *Macrobrachium tenellum* bred in ponds. The growth deceleration noted in vats after 30 to 40 days of breeding could be justified by the fall of dissolved oxygen confirming thus the strong sensitivity of *the Macrobrachium* shrimps to the oxygen variation according to Griessinger *et al.* [24]. This oxygen fall is related to the decomposition of the remainder food by fermentation; with the result that in the last month when the ration is reduced because of shrimps biomass reduction. It is a similar result which Mariappan et Balasundaran [33] had observed on the species *Macrobrachium nobilii* where with a weak biomass, the individuals grow normally.

In basins, the variation in saw teeth observed for the weighted growth is related to the environmental characteristics since the dissolved oxygen, the pH and the temperature also moved in saw teeth. This shows that the growth decreases when the conditions are unfavorable and increases when the physicochemical characteristics become adequate. At the end of the experimentation, we note that the final average weight decreases in the batches from R1 ration to R4 ration in vats and basins. This is in connection with the highest protein rate of R1 ration (42%) and the smallest one of ration R4 (28.76%). This is justified by the fact that, compared to the other physiological stages, the post-larvae need more protein for their growth [24, 34]. The optimal rate recorded by these researchers for the enlargement is from 25 to 30% at the exotic species *Macrobrachium rosenbergii*.

4.3 Zootechnical parameters of bred post-larvae

The analysis of the zootechnical parameters reveals that the R1 ration (Pilot) presents the best performances of growth (profit in weight, specific growth rate), and food effectiveness (food conversion rate, proteinic rate of efficiency and output) in the two infrastructures of breeding. This testifies to the proteinic nutritional quality of this ration which contains the higher protein rate (42%) and thus confirms that the more the protein requirement is met, the better is the growth expression. These results are similar to those obtained in the work of Mukhadhyay *et al.* [35] who observed optimal growth in the youthful of *M. rosenbergii* with a level of protein 30%, suitable at this stage.

In general, whatever the ration, the survival rates in vats were higher than those obtained in basins. The best survival rates have been registered with the rations R3 (20.67%) in basins and R4 (65.22%) in vats. The survival rates obtained in vats in the present experimentation were largely higher than those obtained by Gangbè *et al.* [9] at the youthful ones of the same shrimp species which varied between 13.75 and 20.75%. However, these rates were relatively weak compared to those obtained by Radhakrishnan *et al*. [36]. Indeed, Radhakrishnan *et al*. [36] have obtained the survival rates from 76 to 93% by feeding in aquarium the post-larvae of *M. rosenbergii* with five feed rations based on a unicellular alga (*Chlorella vulgaris*) in the place of the fish meal. These results are due certainly to the nutritional quality of the alga and the breeding conditions of aquarium, which is a miniature breeding requiring more care.

In general, it is important to note that all the batches of shrimps fed in vats have recorded better values in survival rate, feed efficiency and output than those obtained in basins.

The low values of CI (lower than 1 g/g) and of PRE (0.21 to 0.39 g/g) obtained in vats indicate that the rations used were well developed in vats than in basins. The high survival rate (65.22%) and the output (1.60 g/m^2) obtained in vats come to show that the breeding of the post-larvae has been favored in vats. In the basins exposed to the environmental conditions, the post-larvae were relatively subjected to abrupt variations of the physicochemical parameters of water. Another factor of stress is the cohabitation of the post-larvae shrimp with other small competitive animals in the basins (small shellfish, insects, earthworms), requiring an additional effort to survive. All these elements would contribute to disadvantage the breeding of the post-larvae in basins.

5. Conclusion

During the present experiments carried out on the post-larvae *of Macrobrachium vollenhovenii* in vats and basins and fed with four feed rations, the results revealed that survival, growth performances (PW, DAP, SGR) and output (Returns) obtained are better at the level of rations R1 (Raanan commercial) and R2 (with cornstarch food) whatever the type of infrastructure of breeding (vats, basins). On the other hand, the rations R3 (food containing the earthworms flour) and R4 (food containing the termite flour) offer the best survival rates (SR) and the best food effectiveness performances (CI, PRE) whatever the type of breeding infrastructure (vats, basins). Among the two infrastructures used for the breeding of the post-larvae, the vats present good conditions for a better growth and allow to well develop the feed rations. These results open other prospects research allowing to evaluate the survival and the growth of the post-larvae by improving the protein content of the rations R3 and R4 by taking care of the environmental conditions and the follow-up in the various breeding infrastructures.

6. Acknowledgements

The authors address their sincere thanks to the authorities of the Agricultural Productivity Project of West Africa

(APPWA) of the Support Program to the Agricultural Diversification (SPAD) in Benin and particularly to the Technical and Financial Partners of the World Bank which set up this financing for research on fresh water shrimps *Macrobrachium*. The first author of this publication carries out his doctoral research within this framework.

7. References

1. FAO, OMS. Report of the Joint FAO/WHO Expert Consultation on the Risks and Benefits of Fish Consumption, Rome, 25–29 January 2010. FAO, Rapport sur les pêches et l'aquaculture no 978. Rome, FAO, 2011, 50.
2. Brugère C, Ridler N. Global aquaculture outlook in the next decades: an analysis of national production forecasts to 2030. FAO Fisheries Circular. Rome: FAO, 2004, 47. http://www.fao.org/3/a-y5648e.pdf.
3. MAEP/DPP. Analyse Economique des Chaînes de valeurs des Filières Poisson et Crevette. Document Provisoire. Dir. de la Programmation et de la Prospective (DPP) / Min. de l'Agric., de l'Elevage et de la Pêche (MAEP)- Mai, + annexes, 2011, 107.
4. Lalèyè P, Chikou A, Philippart JC, Teugels G, Vandewalle P. Etude de la diversité ichtyologique du fleuve Ouémé au Bénin (Afrique de l'Ouest). Cybium. 2004; 28(4):329-339.
5. Villanueva MCS. Biodiversité et relations trophiques dans quelques milieux estuariens et lagunaires de l'Afrique de l'Ouest. Adaptations aux pressions environnementales. Thèse de doctorat. INPT/ENAST/Toulouse, 2004, 246.
6. Niyonkuru C, Lalèyè P, Moreau J. Croissance, mortalité, recrutement et rendement par recrue des Cichlidés dans une lagune tropicale, le lac Ahémé (Bénin), Afrique de l'Ouest. Abstrcat. Troisièmes Rencontres de l'Ichtyologie en France (RIF), 28-31 mars. SFI. Mémoires de l'Institut Océanographique Paul Ricard, 2006, 121.
7. Chikou A. Etude de la démographie et de l'exploitation halieutique de six espèces de poissons-chats (Teleostei, Siluriformes) dans le delta de l'Ouémé au Bénin. Thèse de Doctorat du 3ème cycle. FSA/ UNB, 2006, 459.
8. Agadjihouèdé H, Chikou A, Lalèyè P. Diversité et abondance des crevettes d'eau douce dans la lagune de Grand-Popo (Bas Mono) au sud du Bénin. Actes du 2ème Colloque de l'UAC des Sciences, Cultures et Technologies, Sciences agronomiques, 2009, 462-469.
9. Gangbè L, Agadjihouèdé H, Achoh M, Lalèyè P. Survie et croissance de la crevette géante d'eau douce *Macrobrachium vollenhovenii* (Herklots, 1857) nourrie en captivité à base du tourteau du coprah, de la farine et du son de maïs, Afr Science. 2016a; 12(3):126-143.
10. Monod T, Décapodes. In: DURAND JR, and LEVEQUE, C. (éds.). Flore et faune aquatiques de l'Afrique sahélo-soudanienne. ORSTOM, Paris, Tome I. 1980; 44:369-389.
11. Martin JW, Davis GE. An updated classification of the Recent Crustacea. Natural History Museum Los Angeles County, Science Serie. 2001; 39:1-24.
12. Marioghae IE. Notes of the biology and distribution of *Macrobrachium vollenhovenii* and *Macrobrachium macrobrachion* in the Lagos Lagoon (Crustacea, decapoda, Palemonidae). Rev. Zool. Af. 1982; 94(3):493-508.
13. Villé JP. Ecologie des *Macrobrachium* de Côte d'Ivoire. I-Rôle de la température et de la salinité. Ann. Univ. Abidjan. sér. E, Écologie. 1971; 4(1):317-324.
14. Aquacop. Equipment for manufacturing pellets for marine animals by moisture processing. Proceedings Symp. On Finfish Nutrition and Fishfeed Technology, Hamburg. 1978-1979, Berlin 1979, 2.
15. Nandlal S, Pickering T. Freshwater prawn *Macrobrachium rosenbergii* farming in Pacific Island countries. Hatchery Opearation. 2005; 1:40.
16. Gangbè L, Agadjihouèdé H, Chikou A, Sènouvo P, Mensah GA, Lalèyè P. Biologie et perspectives d'élevage de la crevette géante d'eau douce *Macrobrachium vollenhovenii* (Herklots, 1857): une revue. Int. J Biol. Chem. Sci. 2016; 10(2):573-598.
17. Balazs GH, Ross E. Effect of protein source and level on growth and performance of the captive freshwater prawn, *Macrobrachium rosenbergii*. Aquaculture. 1976; 7:299-313.
18. Ronnback P. Shrimp aquaculture - State of the art. Swedish EIA Centre, Report 1. Université suédoise des sciences agronomiques (SLU), Uppsala, ISBN 9-157-66113-8. https://fr.wikipedia.org/wiki/%C3%89levage_de_crevettes. 2001.
19. Sogbesan AO, Ugwumba AAA. Nutritional Evaluation of Termite (*Macrotermes subhyalinus*) Meal as Animal Protein Supplements in the Diets of *Heterobranchus longifilis* (Valenciennes, 1840) Fingerlings. Turkish Journal of Fisheries and Aquatic Sciences. 2008; 8:149-157.
20. Roghaye F. A review on earthworm *Esienia fetida* and its applications, Annals of Biological Research. 2012; 3(5):2500-2506.
21. Bolboaca SD, Jantschi L, Sestras AF, Sestras RE, Pamfil DC, Pearson-Fisher. Chi-Square Statistic Revisited. 2011; 2:528-545.
22. Fair PH, Fortner AR. The role of formula feeds and natural productivity in culture of the prawn *Macrobrachium rosenbergii.* Aqua-culture. 1981; 24:233-243.
23. FAO MAG/88/006. Manuel pratique pour l'élevage de penaeus monodon en bassin, 1991. http://www.fao.org/docrep/field/003/AC034F/AC034F00.htm.
24. Griessinger JM, Lacroix, Gondouin DP. Elevage de la crevette tropicale d'eau douce. ISBN 2-905434-31-7, 1991, 394.
25. Brown E. Metabolism In The Physiology of Fishes Vol. 1. Academic PrPss Inc. New York, 1957.
26. Osborne TB, Merdel LB, Ferry EL. A method for expressing numerically the growth promoting value of proteins. Journal of Biochemistry. 1919; 37:223 224.
27. Levene H. Robust tests for the equality of variance, in Contributions to Probability and Statistics, ed Olkin I., editor. (Palo Alto, CA: Stanford University Press), 1960, 278-292.
28. Brown MB, Forsythe AB. Robust tests for equality of variances. J Am. Stat. Assoc. 1974; 69:364-367.
29. Scherrer B, Biostatistique. Gaëtan Morin éditeur, Québec, 1984, 850.
30. Dagnelie P. Théorie et méthodes statistiques. Applications agronomiques, Tome II. Les presses agronomiques de Gembloux, Gembloux, 1984, 463.
31. Saville DJ. Multiple comparaison procedures: the pratical

solution. American Statistician. 1990; 44(2):174-180.
32. Lopez-Uriostegui F, Ponce-Palafox JT, Arredondo-Figueroa JL, Benitez Mandujano MA, Gomez Garcia-Ulloa M, Vargasmachuca SC, *et al*. Effect of Stocking Density on Growth and Survival of the Prawn *Macrobrachium tenellum* Cultured in a Cage-Pond System, North American Journal of Aquaculture. 2014; 6(2):164-169.
33. Mariappan P, Balasundaran C. Effect of Shelters, Densities, and weight groups on survival, Growth and Limb Loss the freshwater Prawn *Macrobrachium nobilii* (henderson and Matthai, 1990). Journal of Applied Aquaculture. 2008; 15:3-4, 51-62.
34. Aarumugan P, Bhavan PS, Muralisankar T, Manickam N, Srinevassan V, Radhakrishnan S. Growth of *Macrobrachium rosenbergii* fed with mongo seed kernel, banana peel and papaya peel incorporated feeds. Int Journal of Applied Biology and Pharmaceutical Technology. 2013; 4(2):12-25.
35. Mukhadhyay PK, Rangacharylu PV, Gopa M, Jana BB. Applied Nutrition in freshwater Prawn *Macrobrachium rosenbergii* culture. Journal of Applied aquaculture. 2008; 13:317-340.
36. Radhakrishnan S, Saravana BP, Seenivasan C, Muralisankar T. Effect of dietary replacement of fishmeal with Chlorella vulgaris on growth performance, energy utilization and digestive enzymes in *Macrobrachium rosenbergii* post larvae. International Journal of Fisheries aquaculture. 2015; 7(5):62-85.