Acta Scientiarum

http://www.uem.br/acta
ISSN printed: 1679-9283
ISSN on-line: 1807-863X
Doi: 10.4025/actascibiolsci.v36i4.22852

Experimental study on the efficiency of different types of traps and baits for harvesting *Macrobrachium amazonicum* (Heller, 1862)

Bianca Bentes[1*], Jussara Moretto Martinelli-Lemos[2], Eduardo Tavares Paes[3], Suelly Cristina Pereira Fernandes[4], Jeanne Duarte Paula[3] and Victoria Isaac[2]

*[1]Instituto de Estudos Costeiros, Universidade Federal do Pará, Alameda Leandro Ribeiro, s/n, 68600-000, Bragança, Pará, Brazil. [2]Laboratório de Biologia Pesqueira e Manejo de Recursos Aquáticos, Universidade Federal do Pará, Belém, Pará, Brazil. [3]Instituto Sócio Ambiental e dos Recursos Hídricos, Universidade Federal Rural da Amazônia, Belém, Pará, Brazil. [4]Laboratório de Bioecologia Pesqueira, Instituto de Estudos Costeiros, Universidade Federal do Pará, Bragança, Pará, Brazil. *Author for correspondence. E-mail: bianca@ufpa.br*

ABSTRACT. *Macrobrachium amazonicum* is a freshwater prawn endemic to South America with wide distribution in Brazilian Amazon rivers. In estuary and freshwater streams of the Pará State, they are captured with different types of traps locally know matapi. This study evaluated the efficiency of traps of different sizes (large, medium and small) and baits (babassu coconut and fish) for sampling this shrimp. Samplings were conducted with 24 traps with different treatments (trap size and bait). We captured 909 specimens. Higher mean catches were observed in traps baited with babassu coconut. Interactions between babassu coconut bait and medium matapi (BM-M), and fish bait and large matapi (FISH-L) were significant. Carapace length (CL) varied significantly between sites ($F = 12.74$, $p < 0.01$). The total maximum length was 13.65 cm. Medium traps baited with babassu coconut were the most successful in the tested combinations, however, there was a clear correlation between size trap and size of shrimp, for both body weight and carapace length.

Keywords: Amazon, Guajara Bay, North Coast, freshwater prawn.

Estudo experimental da eficiências de diferentes tipologias de artes e iscas para a captura de *Macrobrachium amazonicum* (Heller, 1862)

RESUMO. *Macrobrachium amazonicum* é uma espécie de camarão endêmico da América do Sul e está amplamente distribuída nos rios da bacia amazônica brasileira. Nos estuários e cursos de água do estado do Pará são capturados com uso de armadilhas tradicionais conhecidos como 'matapis'. O presente estudo incidiu sobre as técnicas utilizadas pelos pescadores locais, no estado do Pará, além de avaliar a eficácia de diferentes tipos de armadilhas (com tamanhos grande, médio e pequeno) e iscas (de peixe ou farelo de babaçu). As amostras foram obtidas por 24 armadilhas sob diferentes tratamentos (tamanho da arte e isca). Foram capturados 909 indivíduos. As capturas médias nos locais foram maiores nas armadilhas com farelo de babaçu. As interações entre isca babaçu e matapis de tamanho médio (BM- M), e isca de peixe e grandes matapis (FISH- L) foram significativas. O comprimento da carapaça (CL) variou significativamente entre os locais ($F = 12{,}74$, $p < 0{,}01$). O comprimento máximo total registrado foi de 13,65 cm. As armadilhas de médio porte com isca de babaçu foram os mais bem sucedidos nas combinações testadas, no entanto, houve uma clara relação entre o tamanho da armadilha e o tamanho do camarão capturado, tanto em termos de peso corporal e comprimento da carapaça.

Palavras-chave: Amazônia, Baia do Guajará, Costa Norte, camarão de água doce.

Introduction

Macrobrachium amazonicum (Heller, 1862) (Decapoda, Palaemonidae) is a species of shrimp endemic to South America, where it is found in rivers and estuaries along the Atlantic coast, between Venezuela and the Paraguay river basin (HOLTHUIS, 1952). This freshwater species is widely-distributed in the SU Amazon basin, where it is known as *camarão-cascudo* ('hard-shelled shrimp') or *camarão-regional* ('local shrimp'). The species is harvested by artisanal fishermen and is popular for aquaculture due to its simple maintenance requirements (MACIEL; VALENTI, 2009; MAGALHÃES, 1985).

In estuaries and waterways of the Pará State, Brazil, *M. amazonicum* is harvested for subsistence and for sale to local markets, thus representing both an economically and socially important species for the region (BENTES et al., 2011). The traditional traps used for harvesting the species – known locally as ‘matapis’ – are hand-made from strips of stems of spiny (*Astrocaryum* spp.) or piassava (*Raphia vinifer*) palms (Figure 1). The smaller traps are typically baited with meal made from the mesocarp of babassu palm fruit (*Orbignya speciosa*), wrapped in aninga (*Montrichardia linifera*) leaves, known locally as a ‘poqueca’. The largest traps are baited with pieces of fish of a number of species such as the silver croaker, *Plagioscion squamosissimus* (Heckel, 1840), Sciaenidae, and the tamuatá, *Hoplosternum littorale* (Hancock, 1828), Callichthydae. This type of bait is known locally as ‘munduru’.

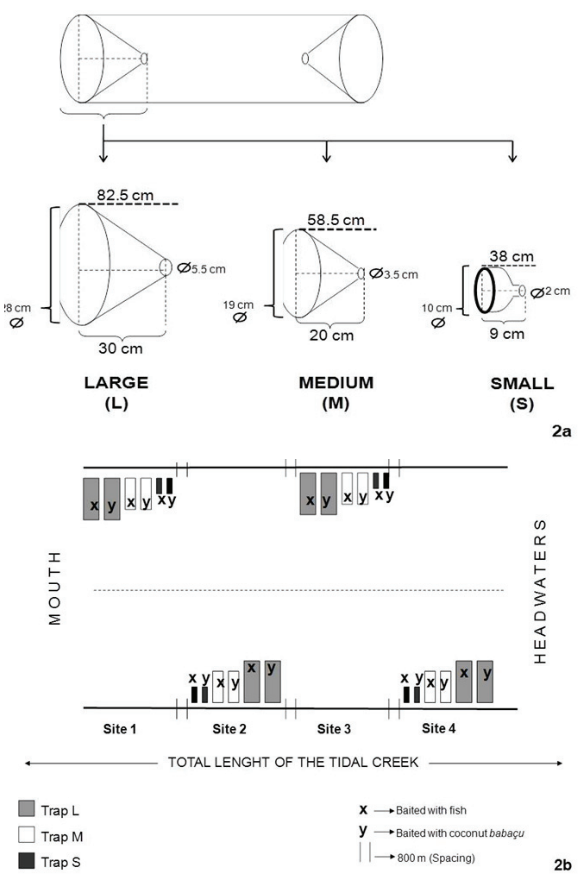

Figure 1. (a) Schematic diagram of a matapi shrimp trap, showing the dimensions of the three trap sizes employed in the present study; (b) scheme of the arrangement of the traps within each tidal creek or channel in the study area in Guajará Bay, in the Brazilian State of Pará.

Sevaral studies have shown a relationship between capture rates and both trap size and bait type (GULLAND, 1983; KUTKA et al., 1992; LOKKEBORG; BJORDAL, 1992; SOMERS; STECHEY, 1986). In the specific case of *Macrobrachium*, Fouilland and Fossati (1998) studied trap selectivity in populations of the Marquesas Islands of French Polynesia. Despite the importance of studies of this type for the improvement of commercial catches, no data are available for *M. amazonicum* in the area of the present study, in eastern Brazilian Amazonia.

The present study focused on the techniques used by local shrimpers to capture *M. amazonicum* in the islands surrounding Guajará Bay, Pará State, Brazil. In addition to evaluate the effectiveness of different types of traps and baits, the study also considered the effects of environmental variables, such as water temperature and salinity.

Material and methods

Study area

The present study was carried out in the region of Guajará Bay, part of the eastern channel of the Amazon estuary, which lies to the west of the city of Belém, Pará State (Figure 2). This narrow, elongated bay is formed by the confluence of Guamá and Moju rivers, and is bordered to the west by a series of fluvial islands, including Arapiranga, Cotijuba, and Onças, before flowing into the Marajó Bay to the north (MOREIRA, 1966). To the southeast, Combu Island lies in the mouth of the Guamá River, while Mosqueiro Island is located to the northeast, where Guajará Bay meets the Marajó Bay.

Guajará Bay is a complex of islands, tidal channels, and creeks, which is dominated by the discharge of the Amazon River, characterized by extremely turbid waters due to the high concentrations of suspended matter, which limits the penetration of sunlight. These waters are also influenced by the local semi-diurnal oceanic macrotides, which are responsible for the flooding of margins of regional channels, but only provoke a significant input of saline water during the second half of the year, when rainfall and discharge levels are at their lowest (CORDEIRO, 1987; OLIVEIRA et al., 2007). The bay and the Guamá River together receive most of the sewage discharge and rainwater runoff of the metropolitan area of Belém, which has a population of around two million inhabitants (BRAZ, 2006).

Study design and laboratory methods

Samples of *M. amazonicum* were taken before the new moon in July, 2008, on Arapiranga (AR), Combu (CB), and Mosqueiro (MQ) islands, located in and around Guajará Bay (Figure 2). Twenty-four traps (sample units) were assembled at each site, with a total of 72 samples. Eight traps of each size – small (S), medium (M), and large (L) – were set at each location (Figure 1). The traps were baited in equal proportions with either (a) pieces of fish (tamuatá, *Hoplosternum littorale* - Callichthyidae) or (b) babassu meal (BM) (*Orbignya speciosa*) wrapped in aninga (*Montrichardia linifera*) leaves.

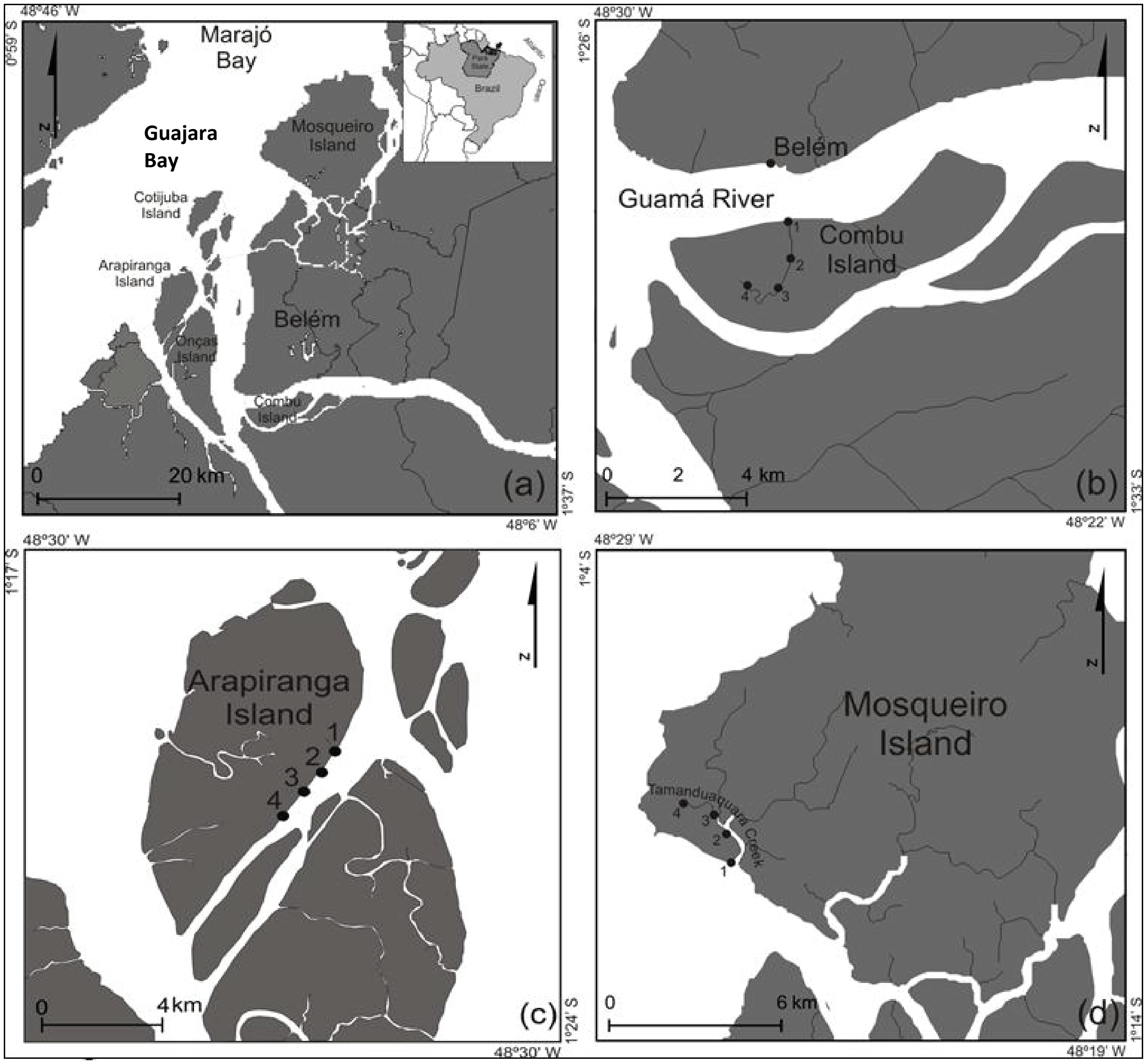

Figure 2. Location of the study area in northern Brazil (a) and the sampling sites on (b) Combu, (c) Arapiranga, and (d) Mosqueiro islands.

Each trap contained only a single type of bait. Four sets of six traps were set at each site, separated by a distance of 800 m to each other, along either tidal channels or on the island margin (Figure 1). Each set of traps contained two devices of each size small (S), medium (M), and large (L), baited with either fish or babassu meal (Figure 2).

Traps were set and submerged over a single nocturnal tidal cycle (12 hours). They were then recovered one at a time and the contents were removed, placed in plastic bags, labeled, and stored on crushed ice in a cooler, and transported to the laboratory. Once in the laboratory, specimens of *M. amazonicum* were sexed, measured (total length and carapace length), and weighed (g) with a 0.01 g-precision balance.

Statistical methods

Weight, length and sex ratio of the specimens collected were related to trap location and type, and type of bait. Carapace lengths were allocated to one of the four classes: C1 (up to 10 mm), C2 (10-15 mm), C3 (15-20 mm), and C4 (over 20 mm), while body weights were divided into three categories: W1 (up to 5 g), W2 (5-10 g), and W3 (over 10 g).

The analysis of these data was performed by a Redundancy Analysis (RDA, automatic and manual methods) by permutation, which does not require adherence to the assumptions of the analysis of variance. In this model, the response variables are projected into a system of axes, in which the first axis explains the largest part of the variability in the data set, and the second axis explains the second largest portion, and so on, successively.

A separate matrix was constructed for each dependent variable (weight, length, and sex ratio), with each line representing a sample. All these matrices were related to a second (treatment) matrix in which the independent variables (bait type, site, trap size, and interactions) were ranked according to the procedure suggested by Legendre and Anderson (1999) and Makarenkov and Legendre (2002).

Monte Carlo tests (based on 9999 permutations) were applied to the evaluation of the robustness (significance) of the results for both methods. In the case of the manual method, the variables were included in the analysis successively according to the statistical significance (5%) of each test. The results were then expressed per factor in four columns, the first two with the values of r^2 and p (p_1) obtained using the automatic method, and the second two with the values (pr^2 and p_2) obtained by the manual method. In both cases, the r and p values were presented for all the variables examined, with the significant values indicated in bold. The analyses were run in Bioestat® 5.0 (AYRES et al., 2008) and Canoco 4.54 (TER BRAAK; SMILAUER, 1998).

Results

Catch size

A total of 909 specimens of *M. amazonicum* were captured during the present study. Average catches at each site were higher in traps baited with babassu meal (Table 1).

Table 1. Basic parameters of the catches (number of specimens captured) of *Macrobrachium amazonicum* collected using different types of bait on Arapiranga, Combu, and Mosqueiro islands in Guajará Bay, Pará State, Brazil. Mean±SD: coefficient of variation.

Bait	Arapiranga	Combu	Mosqueiro
Fish	3.13±3.11 (1.63), 4-35 [47]	11.60±2.48 (0.38), 16-86 [174]	6.50±1.84 (0.59), 12-61 [98]
Babassu	6.33±2.51 (0.65), 10-58 [95]	21.30±1.81 (4.03), 16-157 [319]	11.70±1.31 (0.29), 7-124 [176]

In the automatic RDA analysis, 61% of the variability in catch size is accounted for by the significant values of r^2 (columns 1 and 2 of Table 2). The interactions between babassu bait and medium sized matapis (BM-M), and fish bait and large matapis (FISH-L) were significant. Large- and medium-sized matapis also returned significant values, being responsible for the smallest and largest catches, respectively (Table 2).

Table 2. Results of redundancy analysis (RDA) for the effects of the different variables (including paired interactions) on the catches of *M. amazonicum* obtained during the present study in the Guajará Bay, Brazil. S = small matapi; M = medium matapi; L = large matapi; BM = babassu meal bait; FISH = fish bait; ARA = Arapiranga Island; CB = Combu Island; MOSQ = Mosqueiro Island; ST1-4 = sites 1-4 (see Figure 2); r^2 = regression coefficient obtained through the automatic method; p_1 = probability obtained by the automatic method; pr^2 = regression coefficient obtained through the manual method; p_2 = probability obtained by the manual method.

Variable	r^2	p_1	pr^2	p_2
BM-M	0.22	0.002	0.22	0
M	0.18	0.002	0	1
L	0.14	0.002	0.06	0.024
FISH-L	0.07	0.036	0	1
CCB-L	0.05	0.106	0	1
ARA	0.05	0.074	0.04	0.04
FISH	0.04	0.078	0	0.9
BM	0.04	0.078	0	1
ST4	0.03	0.178	0.04	0.086
MOSQ	0.01	0.436	0	0.882
CB	0.01	0.463	0	1
FISH-S	0.01	0.508	0.01	0.36
S	0.01	0.658	0	0.715
ST3	0	0.63	0	1
ST1	0	0.67	0	0.863
ST2	0	0.75	0	0.732
F-M	0	0.73	0	1
BM-S	0	0.92	0	1

Body weight

Consistent with its larger catches (Table 1), the Combu Island provided more than half of the total catch by weight (986.23 g or 58% of the total). However, the largest specimen was captured on the Arapiranga Island, where the average weight of shrimps was higher (Table 3).

Table 3. Basic parameters of the body weight of the *M. amazonicum* specimens captured using different types of bait on Arapiranga, Combu, and Mosqueiro islands in Guajará Bay, Pará State, Brazil.

	Mean±SD (median) and range of the weight (g) of the *M. amazonicum* specimens collected [25, 75% quartiles] at:		
Bait	Arapiranga	Combu	Mosqueiro
Fish	2.8±3.11 (1.6), 0.1-14.2 [0.9, 3.12]	2.2±2.46 (1.2), 0.1-15.9 [0.6, 2.5]	1.5±1.84 (0.8), 0.2-11.9 [0.5, 1.6]
Babassu	2.1±2.51 (1.4), 0.13-17.4 [0.8, 2.34]	1.9±1.85 (1.2), 0.1-10.7 [0.6, 2.7]	1.5±1.31 (1.3), 0.1-8.6 [0.6, 1.8]

Altogether the independent variables accounted for 27.0% (first canonical axis: 16.3%, second canonical axis: 10.7%) of the variation in shrimp biomass, with the shrimp of smaller weight (W1) being captured mainly by medium-sized matapis baited with babassu meal (BM-M), middleweight shrimp (W2) being caught on Combu Island, and the largest individuals (W3) being captured in the large matapis (Table 4 and Figure 3).

Table 4. Results of redundancy analysis (RDA) for the effects of the different variables (including paired interactions) on the body weight of *M. amazonicum* specimens captured during the present study in the Guajará Bay. S = small matapi; M = medium matapi; L = large matapi; BM = babassu meal bait; FISH = fish bait; ARA = Arapiranga Island; CB = Combu Island; MOSQ = Mosqueiro Island; ST1-4 = sites 1-4 (see Figure 2); r^2 = regression coefficient obtained through the automatic method; p_1 = probability obtained by the automatic method; pr^2 = regression coefficient obtained through the manual method; p_2 = probability obtained by the manual method.

Variable	r^2	p_1	pr^2	p_2
L	0.14	0.0001	0.14	0
S	0.08	0.0014	0.02	0.123
BM –M	0.08	0.0032	0.06	0.007
CB	0.07	0.0031	0.07	0.001
FISH–L	0.07	0.0085	0.01	0.379
BM-L	0.06	0.0144	0	1
M	0.06	0.0084	0	1
ARA	0.04	0.0436	0	1
BM –S	0.04	0.0524	0	1
MOSQ	0.04	0.0757	0.03	0.092
FISH	0.02	0.2444	0	0.947
BM	0.02	0.2472	0	1
FISH-S	0.02	0.2486	0	1
ST1	0.02	0.2867	0.03	0.086
ST4	0.02	0.3111	0.01	0.325
ST2	0.01	0.6291	0.01	0.718
ST3	0	0.8809	0	1
FISH-M	0	0.96	0	1

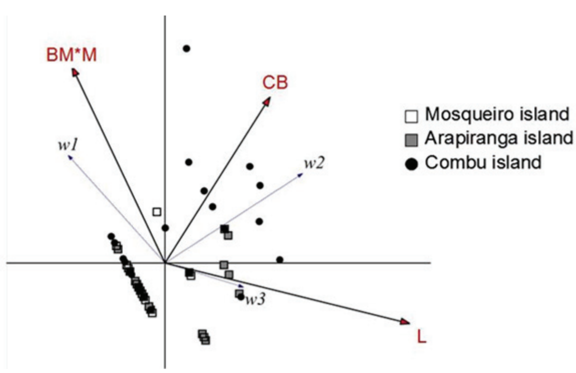

Figure 3. Ordination diagram for the first two axes from the redundancy analysis of body weight of *M. amazonicum* specimens captured in the Guajará Bay: CB = Combu Island; BM*M = interaction of the babassu meal bait with medium-sized traps; L = large trap; W1 = body weight < 5 g; W2 = body weight 5-10 g; W3 = body weight > 10 g.

Body length

Mean carapace length (CL) varied significantly between sites ($F = 12.74$, $p < 0.01$); the highest values were registered on Combu Island, followed by Arapiranga and Mosqueiro (Tables 5 and 6). Overall, 31.3% of the variability in CL was related to the factors tested (16.6% on the first canonical axis, and 14.7% on the second). Most of the variability in CL classes was derived from the interaction between medium-sized matapis and babassu bait. Classes C3 and C4 were mostly captured on Combu Island, while classes C2 and C3 were captured preferentially by the babassu-medium matapi combination (Figure 4).

Table 5. Basic parameters of the carapace length of *Macrobrachium amazonicum* specimens captured using different types of bait on Arapiranga, Combu, and Mosqueiro islands in the Guajará Bay, Pará State, Brazil.

	Mean±SD (median) and range of the carapace length (mm) of the *M. amazonicum* specimens collected [25, 75% quartiles] *at*:		
Bait	Arapiranga	Combu	Mosqueiro
Fish	13.32±4.99 (12.46), 1.64-27.78 [10.38, 15.62]	13.03±4.69 (12.13), 4.78-28.01 [9.58, 15.39]	12.21±7.94 (10.47), 6.45-26.42 [9.09, 13.07]
Babassu	12.42±3.99 (11.89), 5.47-30.00 [10.05, 14.14]	12.74±4.15 (11.85), 5.01-25.72 [9.36, 15.83]	11.55±3.33 (11.59), 3.36-23.37 [9.17, 13.11]

Table 6. Results of redundancy analysis for the effects of the different variables (including paired interactions) on the carapace length (C1 = length < 10 mm, C2 = 10-15 mm, C3 = 15-20 mm, C4 = length > 20 mm) of *Macrobrachium amazonicum* specimens captured during the present study in the Guajará Bay. S = small matapi; M = medium matapi; L = large matapi; BM = babassu meal bait; FISH = fish bait; ARA = Arapiranga Island; CB = Combu Island; MOSQ = Mosqueiro Island; ST1-4 = sites 1-4 (see Figure 2); r^2 = regression coefficient obtained through the automatic method; p_1 = probability obtained by the automatic method; pr^2 = regression coefficient obtained through the manual method; p_2 = probability obtained by the manual method. Or: 'For key to acronyms, see Table 2'.

Variable	r^2	p_1	pr^2	p_2
L	0.14	0.0001	0.14	0
CCB-M	0.12	0.0003	0.1	0.001
M	0.09	0.0003	0	1
S	0.08	0.002	0.02	0.075
CB	0.07	0.0011	0.08	0
FISH-L	0.07	0.0105		
CCB-L	0.05	0.0509		
MOSQ	0.05	0.0342	0.03	0.08
CCB-S	0.04	0.0501		
ARA	0.03	0.0822		
FISH	0.03	0.1445	0	0.987
CCB	0.03	0.1512		
FISH-S	0.02	0.2063	0	0.801
PT2	0.02	0.227	0.02	0.137
PT4	0.02	0.3616	0.02	0.1
PT3	0.01	0.6354		
PT1	0.01	0.6815	0.01	0.919
FISH-M	0	0.8586		

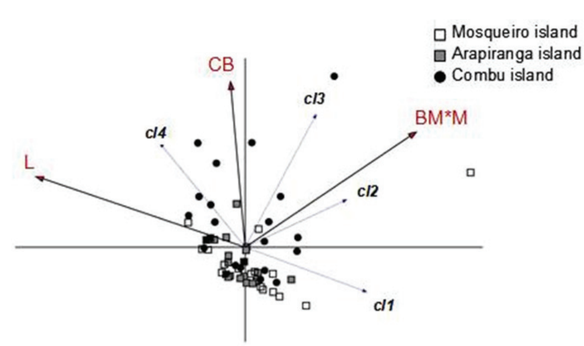

Figure 4. Ordination diagram for the first two axes from the redundancy analysis of carapace length (CL) of *M. amazonicum* specimens captured in the Guajará Bay. MQ = Mosqueiro Island; CB = Combu Island; ARA = Arapiranga Island; CL1 = carapace length < 10 mm; CL 2 = 10-15 mm; CL3 = 15-20 mm; CL4 = carapace length > 20 mm.

Sex ratio

A slightly larger number (465) of males were captured, compared with females (444); the sex ratio was effectively 1:1. Only 6.3% of the variation in the sex ratio was explained by the factors tested (Table 7). The proportion of mature females was not affected by any of the factors tested. All of the factors were tested together (Figure 5) to allow the visualization of general patterns.

Table 7. Results of redundancy analysis for the effects of the different variables (including paired interactions) on sex ratio of *Macrobrachium amazonicum* specimens captured during the present study in the Guajará Bay. S = small matapi; M = medium matapi; L = large matapi; BM = babassu meal bait; FISH = fish bait; ARA = Arapiranga Island; CB = Combu Island; MOSQ = Mosqueiro Island; ST1-4 = sites 1-4 (see Figure 2); r^2 = regression coefficient obtained through the automatic method; p_1 = probability obtained by the automatic method; pr^2 = regression coefficient obtained through the manual method; p_2 = probability obtained by the manual method. or: 'For key to acronyms, see Table 2'.

Variable	r^2	p_1	pr^2	p_2
CB	0.15	0.0016	0.15	0.001
ST2	0.1	0.0098	0.1	0.005
MOSQ	0.08	0.0242	0	0.562
ST4	0.07	0.0276	0.02	0.126
M	0.03	0.2219	0	1
BM-L	0.03	0.2362	0	1
L	0.02	0.2774	0.02	0.203
ARA	0.02	0.3406	0	1
FISH-S	0.01	0.4178	0.02	0.303
FISH-M	0.01	0.383	0	1
BM -M	0.01	0.6911	0	0.888
ST1	0.01	0.6595	0	0.644
BM -S	0	0.7691	0	1
FISH	0	0.8673	0	1
FISH-L	0	0.9093	0.01	0.662
ST3	0	0.9156	0	1
FISH	0	1	0	0.959
BM	0	1	0	1

Discussion

Even recognizing the economic and ecological importance of *Macrobrachium amazonicum* in the Amazon, the life history of populations inhabiting coastal areas is still little understood (BENTES et al., 2011; MACIEL; VALENTI, 2009). Particularly, in the Guajará Bay, except the works published by Lucena-Frédou et al. (2010), which analyzed the histology of *M. amazonicum* gonads and population dynamics, other scientific papers are limited, because they have not yet been published in indexed journals. Thus, this study helps to indicate different ways of designing samples for population ecology studies.

While the larval development of *M. amazonicum* in coastal regions is dependent on brackish water habitats (BARRETO; SOARES, 1982; GUEST, 1979), the entire life cycle of the species occurs in freshwater environments in the central and western Amazon basin (GAMBÁ, 1984; MAGALHÃES, 1985). The biological parameters recorded in the present study were very similar to those found in other areas of Pará State. Relatively successful catches of *M. amazonicum* (in terms of both the number of specimens and weight) seem to be a common observation in the Combu Island (AZEVEDO, 2004; SILVA et al., 2007). The significant difference in the number and biomass of specimens captured on the three islands monitored in the present study may be related to ecological flexibility. Collart (1987) also reported a marked preference of *M. amazonicum* for turbid 'white-water' environments rich in sediments, and dissolved calcium and magnesium salts, such as ponds and floodplain lakes flooded during the high water period.

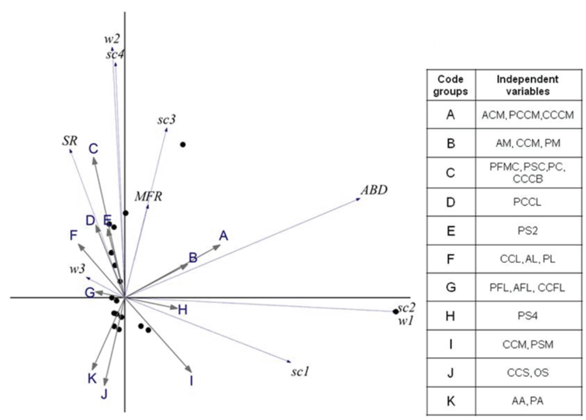

Figure 5. Ordination diagram for the first two axes from the redundancy analysis of all the samples of *M. amazonicum* (dots) captured in the Guajará Bay in relation to all the independent variables tested (group codes A-K: the independent variables responsible for the effect are nominated). CL1 = carapace length < 10 mm; CL 2 = 10-15 mm; CL3 = 15-20 mm; CL4 = carapace length > 20 mm; W1 = weight < 5 g; W2 = 5-10 g; W3 = weight > 10 g; WL = shrimp weight ⋆ large trap; WS = shrimp weight ⋆ small trap; WBM = shrimp weight ⋆ babaçu meal bait ⋆ middle trap; WC = shrimp weight ⋆ Combu Island; WFL = shrimp weight ⋆ fish bait ⋆ large trap; WBL = shrimp weight ⋆ babaçu meal bait ⋆ large trap; WM = shrimp weight ⋆ medium trap; WA = shrimp weight ⋆ Arapiranga Island; ABM = shrimp abundance ⋆ babaçu meal bait ⋆ medium trap; AM = shrimp abundance ⋆ medium trap; AL = shrimp abundance ⋆ large trap; AFL = shrimp abundance ⋆ fish bait ⋆ large trap; AA = shrimp abundance ⋆ Arapiranga island; SRC = sex ratio ⋆ Combu Island; SR2 = sex ratio ⋆ sample site 2; SRM = sex ratio ⋆ Mosqueiro island; SR4 = sex ratio ⋆ sample site 4; MFRC = mature female ratio ⋆ Combu Island; CLL = carapace length class ⋆ large trap; CLBM = carapace length class ⋆ babaçu meal bait ⋆ medium trap; CLFL = carapace length class ⋆ fish bait ⋆ large trap; CLM = length class ⋆ medium trap; ABD = abundance; SR = sex ratio.

Extrapolating from carapace length, the maximum total length recorded in the present study was 13.65 cm, a value very similar to those recorded by Silva et al. (2007) on the Combu Island (14.1 cm) and by Silva (2005) in Vigia (14.4 cm), also in northeastern Pará State. This value is much higher than those registered by Santos et al. (1999) on the Jaguaribe river in the Ceará State (9.43 cm) and by Leon (1980) on the Orinoco river, Venezuela (10.9 cm). The maximum value verified in the present study was also significantly higher than the values of 10.6 cm found by Collart and Moreira (1993) on the Careiro Island, central Amazonia, and Collart (1987) on the lower Tocantins river, Pará State. However, Borges (2003) recorded a much higher value of 17.8 cm in the Rômulo Campos Reservoir, Bahia State. Anger (2013) suggests that *M. amazonicum* is usually considered as a monophyletic clade that lives exclusively in limnic and brackish habitats. Thus, it may provide a suitable model for the reconstruction of evolutionary transitions of euryhaline shrimp from an ancestor living in the sea towards invasions of freshwater environments.

Adult male shrimp of freshwater *Macrobrachium* species tend to be larger in size than females, a pattern recorded by Silva (2005) in Vigia, and Flexa et al. (2005) in Cametá, also in northeastern Pará State. In the present study, however, while the largest specimen was male, average carapace length was greater in females. Nevertheless, we did not consider morphotypes, very well defined in farms (MORAES-RIODADES et al., 2006), but in crustaceans, male individuals are commonly larger than females, which is probably reinforced by intra-specific competition and the need to ensure successful mating with females. In turn, males that grow larger than females are targeted more intensively by shrimpers (SILVA et al., 2007), leading to the recruitment of much smaller individuals. However, this is not a common pattern in the palaemonids, in which females tend to grow larger than males, primarily in order to ensure the formation of egg yolks (BENTES et al., 2011).

In most *M. amazonicum* populations, sex ratio favors the females. Borges (2003) recorded a ratio of 3.36 females per male in the Bahia State, while Montoya (2003) recorded a ratio of 1♂: 2♀ in Venezuela. In the present study (BM M = 0.22), however, the ratio was practically 1:1. According Maciel and Valenti (2009), more continental population is usually more favorable to females.

Medium-sized traps baited with babassu meal were the most successful among the combinations tested in the present study, regarding the number of shrimp captured. This may account for the wide use of this bait and trap size among local shrimpers. However, there was a clear relationship between trap size and size of shrimp captured, in terms of both body weight and carapace length, which emphasizes trap selectivity, thus emphasizing that the best catches would be those harvesting larger specimens in size.

Additionally, the results of the study also indicate the clear preference of *M. amazonicum* for the babassu meal bait. However, while this type of bait was effective in medium-sized traps, which returned the largest catches, the larger traps were far less successful, presumably due to the size of the entrance hole and the gaps in the structure of the trap (BENTES et al., 2011), which allow the shrimp to escape after feeding on the bait. This is an important detail for the standardization of sampling procedures, in order to control the possible influence of multiple factors on the catches of the species, the use of a single type of bait is then recommended for scientific studies.

On the other hand, the lack of a relationship between the characteristics of the catch, in terms of body weight or carapace length, and bait type suggests that other operational factors may affect the capture of specimens. In a study on *M. lar* Fabricius and *M. australe* Guérin-Méneville in French Polynesia, Fouilland and Fossati (1998) found that the orientation of the trap opening, relative to the direction of the current, had a significant effect on catch rates.

Conclusion

Population structure of *M. amazonicum* is not affected by use of different baits in Guajará bay. This study shows an important detail for the standardization of sampling procedures, in order to control the possible influence of multiple factors on the catches of the species, the use of a single type of bait is then recommended for scientific studies.

Acknowledgements

Logistic support was provided by the UFPA Fishery Biology and Aquatic Resource Management Laboratory and the Center for Tropical Marine Ecology (ZMT) in Bremen, Germany. We are grateful to the biologists Leiliane Souza, Danielle Viveiros, Morgana Almeida, João G. Meirelles and Janaína Pereira for their assistance with collection and processing of specimens, and to the environmental engineer Allan Jamesson for his help with processing of sediments and the production of the map of the study area.

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Received on January 24, 2014.
Accepted on July 29, 2014.

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