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ECOLOGY

Traditional knowledge and variations in capture techniques used for blue land crab (*Cardisoma guanhumi*, L. 1825) along the coast of Paraíba, Brazil

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ABSTRACT. The Mamanguape estuary, located in the Paraíba State (Brazil), hosts many traditional fishing communities and Amerindian villages whose use of the regional natural resources is fundamental to their cultural and physical survival. The aim was to register the traditional local knowledge about the different fish techniques, the influence of the dynamics of the natural environment on the activities of the blue land crab, and the relationships between the sizes of their dens and the sizes of the animals themselves. The only technique used to capture blue land crab is a trap called 'mousetrap'. It was recorded different materials such as PET bottles, to build the traps. The fishermen stated that fruits are used as bait as well as sugar-cane and onions. The phases of the moon and the different tides do not significantly influence their activities as the crabs inhabit higher lands beyond the influence of normal tides. The knowledge documented here concerning the blue land crab demonstrated that these shell fish harvesters have a detailed understanding of their environment based on observations and empiricism that allows them to determine which techniques and strategies will increase their chances of capturing their prey and consequently guaranteeing their income.

Keywords: mangrove ecosystems; mousetrap; capture techniques; shell fish harvesters; *Cardisoma guanhumi*.

Conhecimento tradicional e as diferentes técnicas de captura do caranguejo goiamum (*Cardisoma guanhumi*, L. 1825) no litoral da Paraíba, Brasil

RESUMO. O estuário do Rio Mamanguape, localizado no Estado da Paraíba (Brasil), é residência de diversas comunidades de pescadores tradicionais e povos indígenas que dependem dos recursos naturais para a sobrevivência física e cultural. O objetivo foi registrar o conhecimento tradicional local sobre as diferentes técnicas de captura do goiamum, a influência dos diferentes fatores ambientais sobre a atividade de captura, e outros fatores diversos como diferença entre machos e fêmeas e o tamanho das tocas. A técnica utilizada que permite a captura é a ratoeira, construída com diferentes materiais. As iscas são frutas, cana-de-açúcar ou cebola. As fases da lua não influenciam diretamente a atividade, já que o goiamum habita áreas acima da preamar. O conhecimento dos catadores registrado neste trabalho mostra um entendimento detalhado do ambiente e do animal, construído em empiricismo e observações, que permite determinar a melhor estratégia e técnica para aumentar o sucesso de captura do goiamum, consequentemente garantindo a renda familiar.

Palavras-chave: manguezal; ratoeira; técnicas de captura; catadores; *Cardisoma guanhum.*

Introduction

Crustaceans of the Order Decapoda, Infraorder Brachyura, such as the blue land crab (*Cardisoma guanhumi*, Lattreille, 1825), mangrove root crabs (*Goniopsis cruentata*), swamp ghost crabs (*Ucides cordatus*), and swimming crabs (*Callinectes* sp.) are economically important groups for human communities that live in and around mangrove regions (Nordi, 1994, Nishida, Nordi, & Alves, 2004). The mangrove root crabs is one of the most exploited decapod crustaceans found in the mangrove swamps of Paraíba State, Brazil, and they are of great economic importance to the local communities. A die-off of the *s*wamp ghost crabs that occurred from 1998 to 2000 in the States of Paraíba and Bahia, however, obliged many of the shellfish gatherers to redirect their activities to harvesting blue land crabs, thus significantly

increasing harvesting pressure on this natural resource (Alves & Nishida, 2003).

Ethnoecological studies have shown that the environmental perceptions of members of traditional communities that harvest natural resources converge in many areas and constitute an important source of information for investigations into the ecology of those resources (Costa-Neto, 2000; 2004; Nishida et al., 2004; Alves & Albuquerque, 2005; Nishida, Nordi, & Alves, 2006; Souto, 2007, Nordi, Nishida, & Alves, 2009, Firmo et al., 2012) and can also contribute to the formulation of management plans and regulations disciplining the use of forest and water resources to help guarantee their preservation and conservation (Ruddle, 1994; Marques, 1995; Johannes, Freeman, & Hamilton, 2000; Diegues, 2001; Costa-Neto, 2004).

Many studies have examined Brachyura crustaceans, mainly the *s*wamp ghost crabs (*Ucides cordatus*) (Nordi, 1994,Blankensteyn, Filho, & Freire, 1997; Fiscarelli & Pinheiro, 2002; Alves & Nishida, 2004; Passos & Beneditto, 2005; Nishida et al., 2006; Carvalho & Igarashi, 2009; among others), but less work has focused on the distribution and occurrence of blue land crabs (Silva & Coelho, 1960; Farias, 1980; Macedo & Koening, 1987; Silva & Oshiro, 2002; Firmo et al., 2012; Santos et al., 2016) or their physiology, morphology and histology (Pinder & Smits, 1993; Gannon, Arunakul, & Henry, 2001; Gannon & Henry, 2004; Castilho, Ostrensky, Pie, & Boeger, 2008; Oliveira-Neto, Pie, Chammas, Ostrensky, & Boeger, 2008). There have not been any studies of this crab species in Paraíba State, just occasional mentions of its existence (Souto, 2007; Nishida et al., 2006; Firmo et al., 2012). Traditional knowledge concerning blue land crabs and their natural habitat and population dynamics can provide important information about this species and serve as a starting point for more detailed investigations of this animal.

Study area

The estuary of the Mamanguape River (06º 43' to 06° 51' S and 35º 07' to 34º 54' W), located in the Paraiba State (Brazil), is approximately 24 km long and has a maximum width of 2.5 km near the coastline (Figure 1) (Nishida et al., 2004).

The Mamanguape estuary area is densely occupied by sugar cane plantations, but it also hosts many poor, traditional fishing communities and Amerindian villages whose use of the regional natural resources is fundamental to their cultural and physical survival.

The estuary of the Paraíba do Norte River (Baixo Paraíba; 06º 57' - 07º 08' S and 34º 50' - 34º 55' W) drains the cities of João Pessoa, Bayeux and Santa Rita, and (nearer its mouth) the port city of Cabedelo (Nishida et al., 2004). The harvesting of natural resources in this estuary (especially fishes, mollusks and crustaceans) has intensified in the last ten years due to human population growth on the outskirts of João Pessoa (Nishida et al., 2004). Large numbers of people now depend exclusively on these marine resources for economic survival or as an addition to their otherwise limited family incomes. the increasing of human populations have caused a reduction in the amount of unoccupied land near the mangrove area itself, and its replacement by houses, small farm plots, pastures and large sugarcane plantations.

In addition to the plant species commonly encountered in mangrove areas, *Dalbergia ecastophillum* and *Annona glabra* are frequently present in the upland areas bordering the swamp (Nishida et al., 2004).

Material and method

A number of field trips were undertaken to the study site to identify possible informants, as suggested by Viertler (2002). This author noted that it was important to establish previous contact with research subjects (in this case the fishermen/harvesters) in order to establish a relationship of familiarity and confidence that will facilitate information being passed more freely and accurately.

Preliminary interviews were undertaken with five shellfish harvesters and the information used to elaborate a semi-structured questionnaire designed to capture the perceptions that the fishermen had about blue land crabs (*Cardisoma guanhumi*) (Nordi, 1994, Marques, 2002; Viertler, 2002). Concomitantly, these preliminary studies helped in acquiring and understanding the local vocabulary, an important factor in the reformulation of the questionnaire (Marques, 2002; Albuquerque & Lucena, 2004). These first meetings allowed us to focus the interviews through objective questions and direct the dialogue towards the traditional knowledge of the biology and ecology of the blue land crabs that is reflected in the capture strategies used to harvest them. The reliability of the data was strengthened through diachronic questioning, in which the same questions were asked at different moments; the validity of the information was further confirmed by asking different people (in the same locality) the same questions (Albuquerque & Lucena, 2004).

The fishermen were questioned about the influence of the dynamics of the natural

environment on the activities of the blue land crabs, differences between males and females, and the relationships between the sizes of their dens and the sizes of the animals themselves.

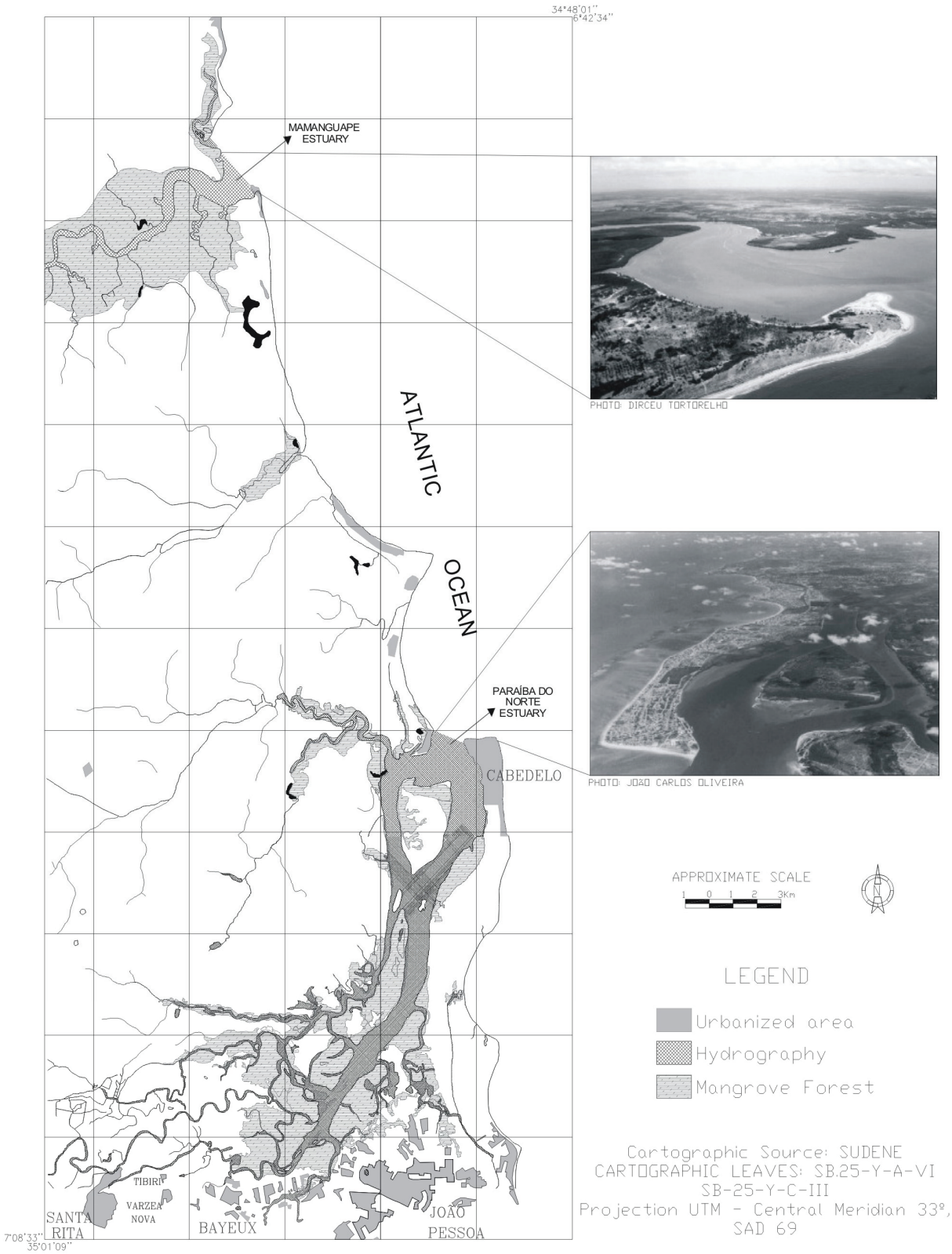

Figure 1. Map of the mangrove areas used by blue land crab harvesters, at the estuary of the Mamanguape River (Paraiba State, Brazil).

The numbers of working harvesters is quite limited in these communities, and the questionnaires were responded by only 14 individuals, two from Praia de Campina in the municipality of Rio Tinto in the Mamanguape River Environmental Protection Area, eight in the surrounding areas of the municipality of João Pessoa, one in Forte Velho in the municipality of Cabedelo, and 3 in Várzea Nova in the municipality of Santa Rita. The informants were indicated by members of their own communities as being experts on the subject. Among the interviewees, four were accompanied individually during a full day of typical activities.

Results and discussion

The knowledge documented here concerning the blue land crabs demonstrated that these shell fish harvesters have a detailed understanding of their environment based on observations and empiricism that allows them to determine which techniques and strategies will increase their chances of capturing their prey and consequently guaranteeing their income.

The only technique used to capture blue land crabs is a trap called a 'mousetrap'. The 'goiamum' crabs live above the high tide level, or in the words of the shell fish collectors: 'they live on the edge of the swamp', where 'the tide doesn't reach'. According to the shell fish harvesters the soil texture in these localities does not favor the 'braceamento' technique, the use of the arm to capture the *s*wamp ghost crabs (which involves introducing one's whole arm into the mud tunnel to grab the crabs in their dens) (Nordi, 1994). According to Botelho, Santos, and Souza (2001), the blue land crab are semi-terrestrial and inhabit areas adjacent to the mangrove ecosystems and along canals in burrows above the high tide zone, and also reported by Firmo et al. (2012) in Mucuri, Bahia State, Brazil. According to the shell fish harvesters, the mousetrap technique was introduced in the 1950's or 60's based on a wooden trap used to capture opossums (*Didelphis sp.*); these later came to be made out of discarded cooking oil cans due to weight considerations.

To make a mousetrap the fishermen usually use: a wooden stick that is slightly longer than the oil can itself, a strip of rubber cut from an inner-tube that can be stretched over the long axis of the can, a circular piece of wood or plastic of the same circumference as the can, and some wire. The lid is fully removed from one end of the can (as an entrance to the trap) and a round wood (or plastic) 'trap lid' is then attached to the can by two pieces of wire that serve as hinges. The extremities of the rubber strip are fixed to the wooden trap lid and the looped end stretched over the long axis of the can. The trap trigger is set by attaching one end of the stick to the center of the inner side of the trap door lid, and then making a small hole in the closed end of the can that is slightly larger than the diameter of the wooden stick; another piece of wire is used to make a 'trigger' that holds the stick as well as a piece of bait within the trap itself. When the blue land grabs the bait the trigger will free the stick and the rubber straps will close the trap-door and imprison the crustacean.

In addition to oil cans, other materials can be used to make the mousetrap; 80% of the interviewees responded that they used traps made from oil cans, while 10% used both oil cans and PET bottles, and 10% used 6 inch PVC tubes and oil cans. Due to changes in the way cooking oil is currently being packaged, oil cans are increasing hard to find and alternative plastic materials are becoming more widely used. This same type of substitution of materials used in the manufacture of the fishing equipment was also observed with fish nets in the 1970's, when cotton netting was substituted by nylon (Miller, 2002). The shell fish harvesters stated that mousetrap made from metal cans only last from 20 days to about a month due to the corrosive effects of the salt spray environment. The PET bottles and PVC tubes have thus become more widely adopted as they last considerably longer (Figure 2)

An interesting technique was observed in which a metal-can mousetrap was accommodated within a PET bottle and then heated so that the plastic partially melted and molded itself around the can, thus when the can would finally decompose due to oxidation, a hardened PET bottle mousetrap with greater durability would be left. In spite of the fact that PVC tubes have high durability, the shell fish harvesters generally find the high cost of this material prohibitive and incompatible with their income. Another problem cited by the fishermen is related to the theft of the PVC traps by harvesters from other communities.

According to one of the interviewees, however, an important advantage of the PVC tubes is that they allow larger crustaceans to be captured as their diameters are larger than with PET bottles or metal cans (Table 1).

The shell fish harvesters at Tamandaré, along the southern coast of Pernambuco State, use a different technique to manufacture mousetraps that consists of using a PET bottle that is fitted within a common

powdered milk can (12.0 cm long by 10.0 cm in diameter) from which both the lid and bottom have been removed. The can provides greater rigidity to the frontal part of the bottle (where the trap-door is attached), and the larger resultant diameters of these traps allow the fishermen to capture larger specimens of blue land crabs.

Figure 2. a) PVC trap and oil can trap. Powdered milk can plus a inner pet bottle.

Table 1. Advantages and disadvantages of the different materials used to make 'mousetraps' to capture blue land crabs.

	Oil cans	PET bottles	PVC tubes
Durability	20 – 40 days	Months	Months
Price (US$)	$4.00 per 100 traps	No cost	$21 per 30 traps
Width of the blue land crab carapace captured	Up to 6.5 cm	Up to 7.0 cm	More than 7.5 cm
Time required for decomposition	< 1 year	> 300 years	> 300 years
Quantity needed to manufacture 1 trap	1 unit	2 to 5 units	1 unit
Other factors			Theft

Barboza, Neumann-Leitão, Barboza, and Batista-Leite (2008), described the identical use of mousetraps made from oil cans in the Goiana River estuary in Pernambuco State. Other workers (e.g. Nordi, 1994, Botelho, Santos, & Pontes, 2000; Firmo et al., 2012) also noted the use of 'mousetraps' for capturing blue land crab, although they did not specify what types of materials were used. Silva and Oshiro (2002) in Sepetiba Bay in Rio de Janeiro State described the use of oil can or PVC tubes. During the current study, it was observed that some of the fishermen from the Várzea Nova community (municipality of Santa Rita, Paraíba State) who harvested *s*wamp ghost crabs likewise used mousetraps to capture these crustaceans, corroborating the observations of Nordi (1994). These shell fish harvesters affirm that the use of mousetraps to capture *s*wamp ghost crabs facilitates their work and does not pollute the mangrove area as much as the use of a little net snare (which have actually been outlawed by the Brazilian environmental agency - Ibama).

In Tobago, in the Caribbean, Maitland (2002) registered that the blue land crab harvesters manufacture mousetraps from bamboo, and they are very similar to those used in the Philippines. The difference between the mousetraps used in these two localities lies in the methods used to set the trigger. To Manescky (1993), the shell fish harvesters have developed techniques and gear that (in spite of its simplicity and rustic design) can significantly increase production. The evolution of fishing methods and techniques has increased production to supply market demands (Valdemarsen, 2001).

It was observed in the present study that different materials can be used in making mousetraps as a function of their cost, durability, and the effort needed to deploy them in the field. The Brazilian Environmental Agency (Ibama) formerly considered the use of mousetraps a predatory practice (on the same level as the little net snare) although their use was subsequently liberated and legalized in 2006.

The interviewees consulted in the present work stated that fruits such as pineapples (*Ananas comosus*), oil palm fruits (*Elaeis guineensis*), papaya (*Carica papaya*), and a native mangrove fruit known as 'panã' (*Annona glabra*) are used as bait as well as sugar-cane (*Saccharum officinarum*) and onions (*Allium caepa*). The same was reported by Maitland (2002), the shell fish harvesters of Tobago utilize local fruits as bait for the blue land crab.

Fruits and onions are used because of their attractive odors, although they are relatively soft baits and the blue land crabs can often take them without triggering the trap. The expressed preference for sugar cane is related to its hard consistency, which makes it more difficult to

remove from the trigger without tripping it. Some shell fish harvesters use sugar cane that has been wiped with onions (or a fruit) to give it a more attractive odor. These fishermen also noted that the fruit odors induce the blue land to leave their dens more quickly allowing the same trap to be used a number of times on the same day.

The use of the sugar cane and native 'panã' fruits in the study areas are stimulated by their wide availability and negligible costs (sugar cane plantations are common along the coast of Paraíba State and 'panã' plants are generally associated with mangrove areas). Maitland (2002) likewise reported that local fruits and bamboo are used in the Caribbean region and the Philippines due to their availability at zero cost. Additionally, the combination of the hard consistency of sugar cane with the odor of 'panã' fruit optimizes the harvesting efforts (Marques, 1995).

When the shell fish harvesters were asked about the feeding habits of the blue land crabs they replied that these animals feed on plants, grasses, seeds, etc. in their natural habitat, and when kept in captivity they demonstrate omnivorous tastes as well as cannibalism. We observed captive animals being fed left-overs such as rice, macaroni, corn meal, shredded coconut and pieces of fruit. Their reported cannibalism may be the result of stress provoked by overcrowding in the cages.

The *Cardisoma guanhumi* is a herbivorous crab that collects and eats fruits and grass near its den. However, terrestrial crabs also eat insects, detritus, feces, and are occasionally cannibalistic. They are principally herbivore-detritivores, but also prey for other animals, which makes them a link between primary producers and secondary consumers and an important link in the food chain of the mangrove swamp due to their considerable total biomass in this ecosystem (Jankowsky, Pires, & Nordi, 2006).

According to the shell fish harvesters interviewed, the greatest natural predators of the blue land crabs in the mangrove region are the crab-eating raccoons (*Procyon cancrivoros* - Procyonidae).

The interviewees indicated that these crab-eating raccoons are very agile and capture the blue land crabs by introducing their tails into their tunnels - and when the crab seizes the tail the raccoon will quickly withdraw it and capture the crustacean. This technique is similar to that employed by human harvesters who will introduce a branch of mangrove vegetation into the crab's tunnel so that the animal will grab onto it and can be extracted.

The raccoons will often open the mousetraps and 'steal' the blue land crab, creating competition for resources between animals and humans, with an intelligent animal on one side and the ever more refined techniques of the fishermen on the other. The raccoons have learned to open the traps to find food, and the shell fish harvesters affirm that 'the raccoons will follow the harvester to see where the traps have been set, and then come back later to steal the prize'. The raccoons will hold the trap against the ground to push the wooden rod and force open work the lid of the trap, or chew through the rubber bands holding it shut. This behavior indicates that the raccoons have learned to take advantage of the traps, and that humans, on the other hand, must keep improving their capture techniques to avoid this unwanted competition. Fishermen in the Santa Rita community have developed two modifications for their traps that impede easy opening: a) the rubber straps were moved to the inside of the can so that they could not be easily chewed; and b) the wooden rod is no longer fixed to the hinged lid, but rather simply held in a groove, so that when the trigger is released the rod will come loose. To avoid the loss of the wooden rod, however, it is loosely bound to the lid by a piece of rubber so that it won't shoot away when the trap is triggered (Figure 3 and 4).

The lunar cycle

According to McDowall (1969), natural events show many rhythmic patterns. The environment changes each day, every season, and every year, and the behaviors and abundances of animals reflect these rhythmic changes in the environment. Studies have demonstrated that lunar cycles influence the biological cycles of many estuary and mangrove species (Alves & Nishida, 2002; Naylor, 2005; Rios-Jara, 2005; Souto, 2007; Nishida et al., 2006; Vinagre, França, & Cabral, 2006; Lacerda, Barlleta, & Dantas, 2014).

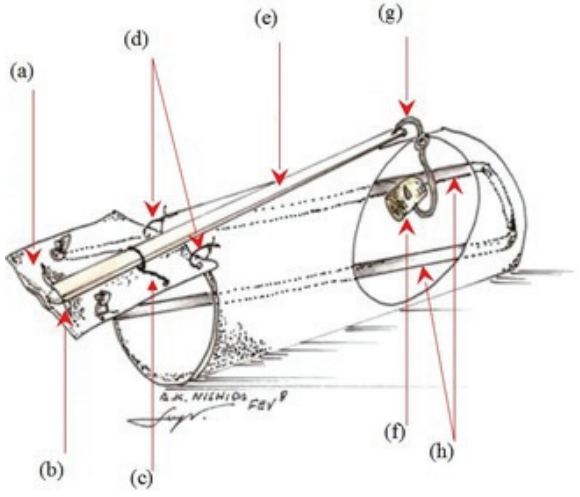

Figure 3. 'Ratoeira' trap made from a cooking oil can and a melted PET bottle. (a) lid, can; (b) groove in the lid made to hold the wooden rod; (c) rubber strip attaching the rod to the lid; (d) wire hinge; (e) wooden rod; (f) a piece of sugar cane bait; (g) wire trigger; (h) rubber strip attached inside the can.

Figure 4. The rubber inner the trap.

The lunar cycle has a direct influence on the tides and, by extension, on the mangrove ecosystem, influencing the biological cycles of the species that inhabit these areas and directly or indirectly affecting human activities related to harvesting and fishing in swamps and estuaries (Alves & Nishida, 2002; Nishida et al., 2006). Souto (2007) recorded the traditional knowledge fishermen have acquired concerning the influences of the rainy and dry seasons on the activities involved in harvesting marine resources. It was demonstrated the great influence that the lunar cycle has over shellfish and crab harvesting activities along the coast of Paraíba State (Nishida et al., 2006)

Nishida et al. (2006) reported the traditional knowledge of the shell fish harvesters concerning tidal variations, as expressed in their own terms such as 'Maré de lua' or moon tide – the greatest amplitude between low and high tides and 'Maré de quebramento' or breaking tide - when the variations in the amplitudes between the tides begins to diminish, (to other terms consult Nishida et al. (2006).

In terms of the capture of blue land crabs, 100% of the shell fish harvesters affirmed that the phases of the moon and the different tides do not significantly influence their activities as the crabs inhabit higher lands beyond the influence of normal tides. However, these fishermen did express personal preferences for the quarter tides of the waxing or waning moon, as there were fewer mosquitos at those times. The shell fish harvesters stated that 'when the tide is throwing' (that is, when there are greater variations between the low and high tides at the full and new moons) large numbers of a small mosquito called 'maruim' in the mangrove region interfere with their routine activities - 'when the tidal amplitude begins to increase there are too many maruim'. And oblige them to use long sleeved shirts and trousers to protect themselves or carry a tin can holding some burning vegetation that serves as a smudge-pot to produce a heavy smoke that drives off the mosquitos (called a '*boi de fogo*').

Sexual identification

The shell fish harvesters differentiate between male and female crabs by examining the width of the telson or 'tampo' as they call it, as the females have a wider telson than the males. The telson covers and protects the reproductive apparatus of the crabs, and in the females this structure is noticeably wider as it serves to carry and protect the eggs. The shell fish harvesters in Acupe, Santo Amaro (Bahia), as reported by Souto and Pacheco (2011), made the same comparisons in terms of the telson sizes, or as they called 'imbigo', or 'belly button'.

The more experienced shell fish gatherers say that they can distinguish between the dens of male and female blue land crabs by examining the feces left at the entrance to their tunnels. The males leave larger but thinner feces, while shorter but wider feces are attributed to females.

The term 'fubamba' was recorded for the first time in the Jacarapé community in the municipality of João Pessoa to designate the female blue land crabs, but this term has not yet been found to be more widely used.

The interviewees did not identify any relationship between the sizes of the dens and the sizes of the individual crabs that occupy them (with small crabs often inhabiting large dens that became unoccupied). A study undertaken by Alves, et al. (2005) did report a strict relationship between den sizes and the sizes of swamp ghost crab. In a study of the crab fauna in a mangrove area in Jamaica, Warner (1969) reported that many crab species would occupy the vacant dens of other species; *Sesarma ricordi* was observed occupying the dens of *Cardisoma guanhumi*, and juvenile specimens of *Eurytium limosum* and *Panopeus herbsti* were found in the dens of *Uca* sp.

Conclusion

The traditional knowledge concerning the biology and ecology of the blue land crabs indicates that these fishermen have developed a very close relationship with their environment. This refined knowledge has allowed the fishermen to develop and modify capture techniques and strategies that maximize harvest results. The day-to-day experiences they bring can be seen in their constant innovations and in the perfecting of their capture techniques and their planning routines to maximize resource production while minimizing their work efforts. Has the potential to be transformed into an important instrument for protecting and managing this species and guaranteeing their sustainable use.

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