POPULATION STRUCTURE OF THE MANGROVE CRAB *Ucides cordatus* (CRUSTACEA: DECAPODA; BRACHYURA) IN THE ESTUARY OF THE MAMANGUAPE RIVER, NORTHEAST BRAZIL

RÔMULO ROMEU DA NÓBREGA **ALVES**[1,*]
ALBERTO KIOHARU **NISHIDA**[2]

[1] Programa de Pós-Graduação em Ciências Biológicas (Zoologia), Departamento de Sistemática e Ecologia, Universidade Federal da Paraíba, 58059-900 João Pessoa, PB, Brasil.
*Autor para correspondência. E-mail: romulo@dse.ufpb.br
[2] Departamento de Sistemática e Ecologia, Universidade Federal da Paraíba, 58059-900 João Pessoa, PB, Brasil.

Recebido: 15/06/2003
Aceito: 09/12/2003

ABSTRACT

The crab *Ucides cordatus* (Linnaeus, 1763) or 'caranguejo-uçá', as it is known in Brazil, is one of the most conspicuous and abundant components of the epibenthic macrofauna of Brazilian mangrove ecosystems and the most exploited resource by riparian human populations. It is aimed here to study the population structure of this crustacean in the estuary of the Mamanguape river, State of Paraíba, Northeast Brazil. The research was performed between August 2000 and September 2001. An area of 1600m^2 was marked out through the mangrove habitat and the density of *U. cordatus* was determined by counting inhabited burrows. Three-hundred crabs were captured and biometrical and sexual ratio values were obtained. The mean density of inhabited burrows was 1.7 burrows m^{-2}. Males crabs were larger than females and their sexual ratio was 1.85**:** 1.00. They mate between January and March. The low dimension of captured specimens and the low values of population density here obtained confirm the observation of crab gatherers that 'caranguejo-uçá' is decreasing in that mangrove area. It is suggested the need for a management plan aiming a sustainable exploitation of this important food and profitable resource.

Key words: *Ucides cordatus* · Leaf-consuming crab · Mangrove ecosystem · Northeast Brazil

RESUMO

ESTRUTURA POPULACIONAL DO CARANGUEJO-UÇÁ *Ucides cordatus* (CRUSTACEA: DECAPODA; BRACHYURA) NO ESTUÁRIO DO RIO MAMANGUAPE, NORDESTE DO BRASIL

O caranguejo-uçá (*Ucides cordatus* Linnaeus, 1763) é um dos mais abundantes componentes da macrofauna bêntica dos manguezais brasileiros e representa um dos recursos mais explorados pelas populações ribeirinhas. Este trabalho objetivou estudar aspectos relativos à estrutura populacional do caranguejo-uçá no manguezal do estuário do rio Mamanguape, Nordeste do Brasil, buscando fornecer subsídios para uma exploração sustentável da espécie. O trabalho foi realizado entre os meses de agosto de 2000 a setembro de 2001. Foi demarcada uma área de manguezal de 1600m^2, onde foi determinada a densidade de *U. cordatus*, através da contagem do

número de tocas habitadas. 314 caranguejos foram capturados para a obtenção de dados biométricos e determinação da razão sexual. Os dados biométricos foram maiores para os caranguejos machos. A densidade média de *U. cordatus* foi de 1,7 tocas/m^2, sendo obtida uma razão sexual de 1,85 Macho para 1 fêmea. O período reprodutivo da espécie ocorreu entre janeiro e março. Os baixos valores de densidade e das dimensões da carapaça confirmam as observações dos catadores locais, sugerindo a existência de um declínio da população de *U. cordatus*, evidenciando a necessidade do estabelecimento de um plano de manejo que vise uma exploração sustentável deste recurso.
KEY WORDS: *Ucides cordatus*, Caranguejo-uçá, Manguezal, Nordeste do Brasil.

INTRODUCTION

Mangrove ecosystems, that occur predominantly on coastal zones of tropical and subtropical regions, are one of the most productive worldwide environments, being directly or indirectly of great benefit to other nearby ecosystems; and they also benefit the human communities who exploit their resources. Brazil is certainly the country in the world with the largest mangrove area, *ca.* 25,000 km^2 (LACERDA, 1984), mostly in the North (85%) according to Herz (1991).

Mangrove forests are important environments for maintaining mangrove-dwellers or temporary organisms that use local resources for some periods of their life cycle, for feeding, reproduction or as refuge against predators. Many faunal organisms of mangrove ecosystems are permanent residents, developing their whole life cycle in the estuary and frequently penetrating the mangrove habitat. However, some marine and fresh water species go to mangrove ecosystems because these habitats afford ideal conditions for the first stages of their life cycle (NASCIMENTO 1999).

Crabs are the most conspicuous and abundant components of epibenthic macrofauna of mangrove ecosystems. They carry out several ecological functions assimilating a large amount of carbon (ROBERTSON, 1986, 1991, MICHELI et al. 1991). The predominance of burrowing forms enhance oxygenation of soil and drainage of sediments (JONES 1984). *Ucides cordatus* (Linnaeus, 1763), known in Brazil as 'caranguejo-uçá', is particularly important in the biogeocycling of nutrients in mangrove ecosystems (CORRÊA JR, et al. 2000).

Besides their ecological importance, crabs are one of the most exploited resources in Brazilian mangrove areas, generating jobs and profit for people who survive from crab gathering. Kjerfve and Lacerda (1993), reviewing the management and economical sustainability of Brazilian mangrove ecosystems observed that crustacean-gathering is the most profitable activity, and gathering of *Ucides cordatus* is the most relevant (IBAMA 1995).

Despite its wide distribution, from the south of Florida to the south of Brazil, including Bahamas and Greater Antilles (CHACE and HOBBS 1969), this species of Crustacea: Decapoda, Brachyura, of the Ocypodidae family, has been scarcely studied (SCHOMBURKG, 1848, KAPPLER, 1881, HOLTHUIS, 1959, MANNING and PROVENZANO, 1961, BRIGHT, 1966, CHACE and HOBBS, 1969, and GERALDES and CALVENTI, 1983). In Brazil, the studies on the increasingly economical and social importance of that species, whose preservation of natural populations is currently needed, have been intensified (ALCÂNTARA FILHO 1978, COSTA, 1979, MOTA ALVES and MADEIRA, 1980, NASCIMENTO and COSTA, 1983, CASTRO, 1986, NORDI, 1992, 1994a, b, 1995, MANESCHY, 1993, BRANCO, 1993, ALMEIDA and MELLO, 1996, BLANKENSTEYN, et al. 1997, BLANKENSTEYN and CUNHA FILH,O 1997, FREIRE, 1998, MARTINEZ, et al. 1998, 1999, ALLODI and TAFFAREL, 1999, BOTELHO, et al. 1999, Ivo et al. 1999, 2000, Côrrea Jr et al. 2000, Ivo and Vasconcelos 2000, Alves 2002 and Alves and NISHIDA, 2002).

The management and protection of natural populations of *Ucides cordatus* as well as the knowledge of its bioecology and the social and economical implications of this valuable species, are the main aspects of the investigations that should be currently pursued, as suggested by Ivo and

Gesteira (1999) and Moura et al. (2000).

It is also important to consider that mangrove ecosystems are seriously threatened, mainly by human activities that impact the habitat of crabs (PONS and FISELIER, 1991, FOUDA and AL-MUHARRAMI, 1995, FARNSWORTH and ELLISON, 1997). Thus studies on those ecosystems are essentially important for establishing measures aiming their preservation. Additional studies concerning animals highly dependent on mangrove habitats can be linked to management of such ecosystems and associated fishery resources (BACON and ALLENG, 1992, HUDSON and LESTER, 1994, FOUDA and AL-MUHARRANI, 1995).

It is aimed here to study some structural aspects of population of *Ucides cordatus* in the mangrove ecosystem of the estuary of the Mamanguape river, in the State of Paraíba, Northeast Brazil. Emphases are given to aspects concerning its management and conservation as a support for establishing measures in management plans and sustainable exploitation of this resource. These aspects are crucially important for maintaining the traditional human populations exploiting this resource.

MATERIALS AND METHODS

Study area. The research was carried out in the mangrove ecosystem of the Mamanguape river, Northeast Brazil, in an area between lat 06°44' and lat 06°50' S, and between long 35°04' and long 34°55' W. The estuary here studied, from east to west is nearly 24 km long by 2.5 km wide, close to the river mouth (Fig. 1).

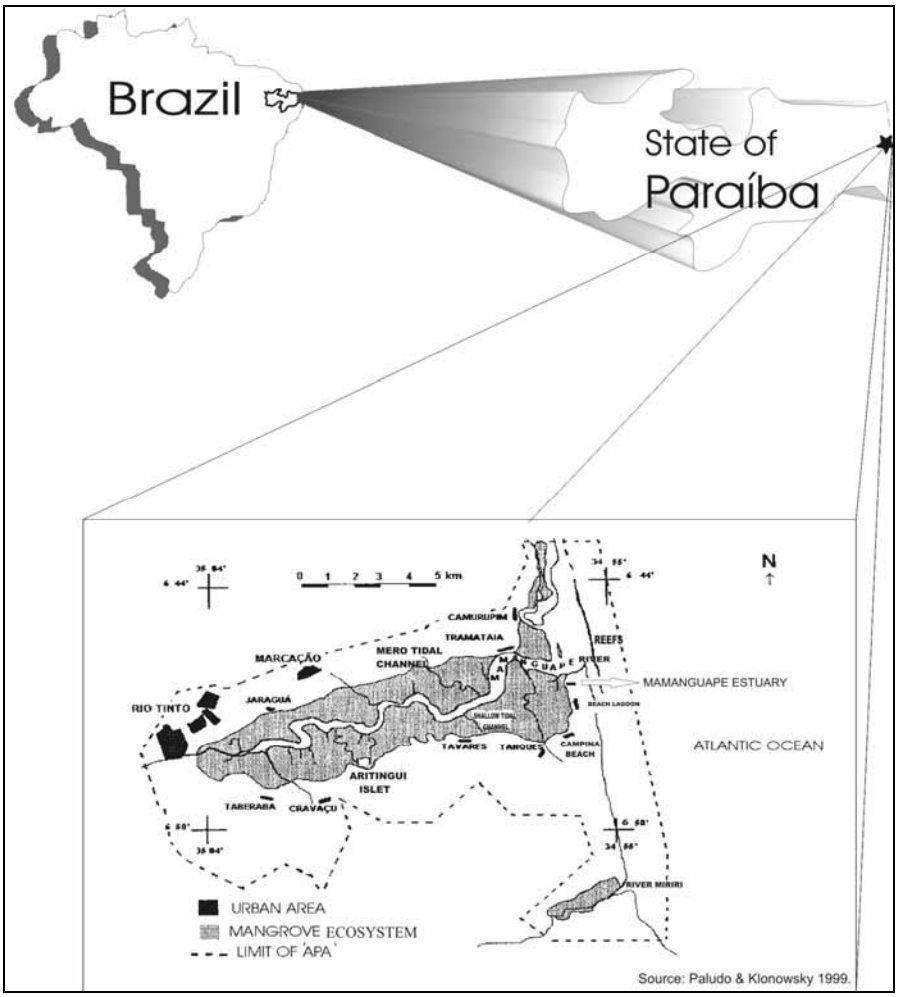

Figure 1 – Map showing the estuary of the Mamanguape river

All the area under the influence of the Mamanguape river is within the permanent protected area ('APA', in Portuguese) of 'Barra do Rio Mamanguape' of the IBAMA (the Brazilian Institute for the Environment and Natural Resources), formed also by the estuaries of the rivers Miriri and Estivas, covering 14,460 ha. In that estuary there is a large extension of mangrove habitats, islands and islets (the latter formed by sandy-clay-loam banks), and barrier reefs in the rivers mouths forming a prolonged high wall. The whole area is included in the municipalities of Rio Tinto, Marcação, and Lucena, including also some villages, north littoral of the State of Paraíba.

The estuary of the APA is covered in its margins for *ca.* 6,000 ha of a reasonably preserved mangrove ecosystem, the largest in Paraíba State. Its common trees are *Rhizophora mangle* (Rhizophoraceae), *Avicennia germinans* (Avicenniaceae), *A. schaueriana* (Avicenniaceae), *Laguncularia racemosa* (Combretaceae) and *Conocarpus erectus* (Combretaceae). The highest *R. mangle* trees reach 25m and up to 60 cm DBH (diameter at breast height); *A. germinans* trees are higher than 30m and have 65cm DBH (PALUDO and KLONOWSKI,1999).

The mangrove forest at Mamanguape is typically well preserved but with some sites that appear to be affected by anthropic actions. Local fishermen say that there is a decreasing fish

production due to agrochemicals used in nearby sugar cane plantations along the river, an aspect studied by Watanabe et al. (1994). Islands and islets are also being modified by the increasing siltation of river bed.

Field sampling.

The investigation was carried out between August 2000 and September 2001. A transection was marked out through the mangrove habitat, totalling 1600 m^2 divided into 16 quadrats of 10 m x 10 m each, delimited perpendicular to the estuarine channel. The quadrats were delimited with a thin rope and banderoles for signalling the area to be preserved from crab gathering during the period we collected the data.

An experienced gatherer helped us by catching 314 crabs which were morphometrically measured with a calliper rule to the nearest millimetre. The measurements performed were: carapace length measured from the sagittal plain on the dorsal surface of the animal, and carapace width measured transversally from the first pair of pereiopods. The carapace width corresponds to the largest body dimension. Statistical analyses of the results were performed by using the computing program Statistica for Windows, v.4 (STATSOFT, 1998).

The crab population density was estimated by counting the inhabited burrows along the 16 delimited quadrats. We preferred this technique because crabs retreat to their burrows quickly as soon as anyone is at sight. An experienced crab gatherer helped us to count all open or filled up burrow of *Ucides cordatus* (the crab covers up the burrow opening with mud until moulting is completed).

The animal sex was evaluated after a careful examination of the crab sexual external characteristics, i.e. males have narrow and long abdomen, approximately triangular with the fifth and sixth segments fused as a single segment articulated with the telson, and females have larger abdominal segments taking up almost the whole of the ventral region (MOTA ALVES, 1975). The crab reproduction period was detected from field observations.

RESULTS

Biometrical measurements

The results showed that the carapace mean length was 4.3 cm in males and 3.9 cm in females. The carapace mean width was 5.6 cm in males and 5.0 cm in females (Table 1). Distribution of individuals per size class of carapace length showed a higher percentage in the range 4.2 - 4.5cm (23%), followed by the class range 4.5 - 4.8cm (19%), and by the class range 3.9 - 4.2cm (17%) (Fig. 2). The size class of carapace width presented a higher concentration of individuals in classes smaller than 6.0 cm (82%) (Fig. 3).

Table 1 – Carapace length and width of males and females of *Ucides cordatus* in the estuary of the Mamanguape river

Values	Carapace dimensions (cm)			
	Males (n = 204)		Females (n = 110)	
	Length	Width	Length	Width
Mean	4.36	5.66	3.98	5.05
Maximum	5.8	7.1	5.5	6.7
Minimum	2.7	3.3	2.7	3.6

Standard deviation	0.442	0.616	0.505	0.586

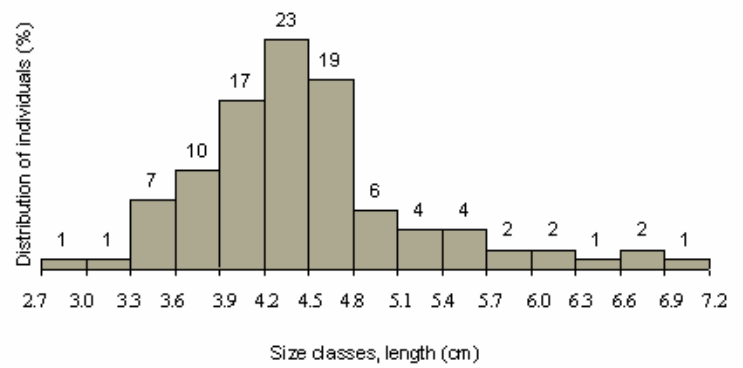

Figure 2 – Distribution of individuals of *Ucides cordatus* in size classes of carapace length, in intervals of 3 mm (closed at left and open at right)

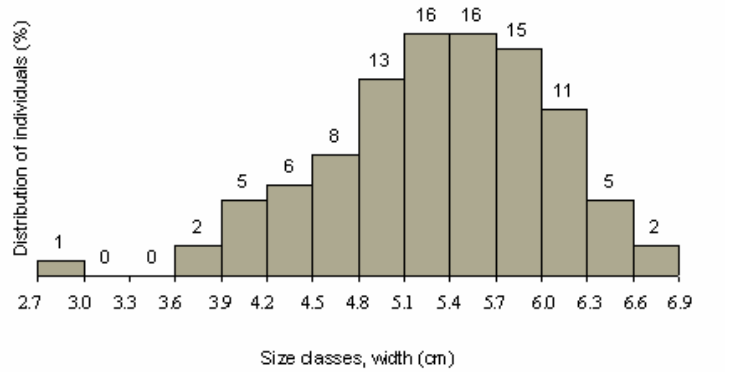

Figure 3 – Distribution of individuals of *Ucides cordatus* in size classes of carapace width in intervals of 3 mm (closed at left and open at right)

The statistical analyses of biometrical data showed that males are larger than females. The 't' test of Student for independent samples revealed that the carapace mean length of males is significantly larger than the one of females ($t = 6.88$; $df = 312$; $p < 0.01$) (Fig. 4). The carapace mean width of males is also significantly larger than the one of females ($t = 8.49$; $df = 312$; $p < 0.01$) (Fig. 5).

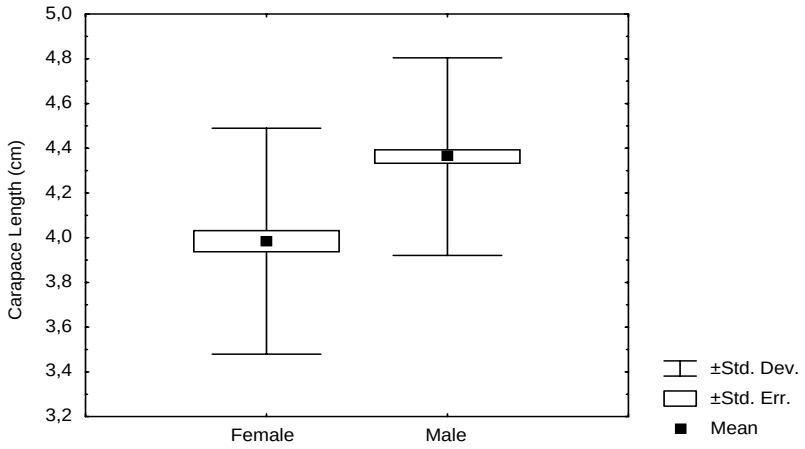

Figure 4 – Carapace length of 204 males and 110 females of *Ucides cordatus* (mean, SE, SD).

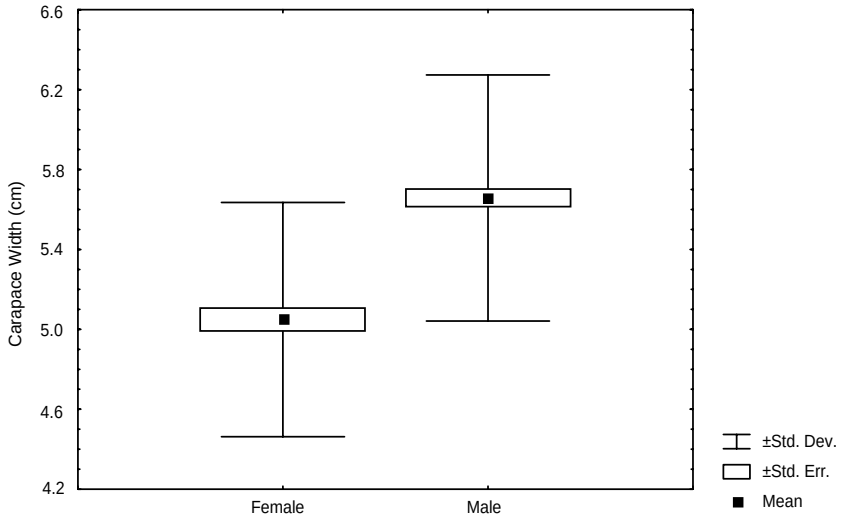

Figure 5 – Carapace width of 204 males and 110 females of *Ucides cordatus* (mean, SE, SD).

Population measurements.

Data on sexual proportion of 314 individuals sampled showed a predominance of males (204 or 65%) over the females (110 or 35%), a ratio standing at 1.85: 1.00.

The relative density of *Ucides cordatus* burrows varied from 0.7 to 3.7 burrows m^{-2}, giving a general mean of 1.7 burrows m^{-2} (Fig. 6). It was observed a larger density of crab burrows in the first eight quadrats situated on a higher topographic level close to the river mudbanks. The quadrats were reached less frequently by spring tides.

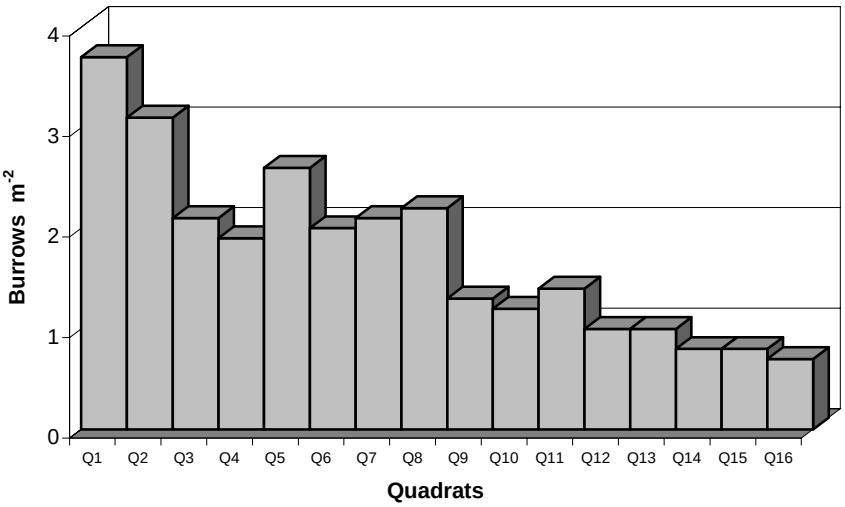

Figure 6 – Number of burrows of *Ucides cordatus* per square meter in the sixteen quadrats marked out in the mangrove area of the estuary of Mamanguape river.

An intensive movement of crabs entering and leaving their burrows was observed between January and March 2001. Mating and spawning were observed during that period, popularly known as *'andada'*. Crabs do not usually retreat to their burrows, becoming vulnerable and easily caught by the gatherers during such period.

There is a close relation between the *'andada'* and the spring tides which occurred during full moon and new moon in January, February, and March 2001. The *'andada'* draws attention also of non-gatherers who live in other areas outside the estuary boundaries.

Discussion

The biometrical data here obtained showing that *Ucides cordatus* males are larger than females, corroborate studies performed elsewhere (ALCÂNTARA-FILHO, 1978, BRANCO, 1993, MONTEIRO et al. 2000). A publication from the Superintendência para o Desenvolvimento da Amazônia / Universidade Federal do Maranhão (1983) reported that males yield 26% of flesh and females only 22%, being the former more captured than the latter.

The data we obtained showing that males predominate on females, confirm data from Castro (1986) who investigated mangrove ecosystems in the State of Maranhão. However, Alcântara-Filho (1978) reported more females in mangrove ecosystems of the estuary of the Ceará river in the State of Ceará; both States in Northeast Brazil. Margalef (1977) state that such variability is commonly found in crabs and other crustaceans, due mainly to reproductive migration and differences in behaviour, lifespan and mortality rate.

The values of crab density here obtained were lower or similar to data reported from other mangrove ecosystems of Northeast Brazil. However, they were higher than the values reported from mangrove ecosystems of South and Southeast Brazil and from Jamaica and the Dominican Republic. Burrow densities of *Ucides cordatus* reported from Brazilian and South American mangrove ecosystems are represented in Table 2. A wide variation of results have been reported due probably to particularities of each mangrove habitat. Paiva (1997) observed that some characteristics of *U. cordatus* (a leaf-consuming crab) like length, mean weight and population

density, are related to organic matter richness of several mangrove ecosystems in Brazil. However, some results presented by Paiva (1997) are not new, being not appropriate for comparing with our data. Despite unavailable data on population densities of *U. cordatus* at Mamanguape mangrove habitats, local crab gatherers assign the current reduction of its natural stock to a high crab mortality which happened in 1998.

Table 2 – Density of individuals of *Ucides cordatus* in the mangrove ecosystem of the estuary of the Mamanguape river and in other Brazilian and American mangrove ecosystems

Localities and authors	Density m^{-2}
Jamaica (WARNER, 1969)	0.2 - 1.5
Dominica (CHACE and HOBBES, 1969)	2.17
Pará (ALMEIDA and MELLO, 1996)	6.0
Estuary of the rivers Cachorros and Estreito dos Coqueiros, MA* (CASTRO, 1986)	1.9 - 4.6
Ceará river, CE* (COSTA, 1972)	4.0
Ceará river, CE* (ALCÂNTARA FILHO< 1978)	4.45 - 5.17
This work	0.7 - 3.7 (mean 1.7)
Ilha do Paiva, SE* (NASCIMENTO and COSTA, 1983)	4.8
Baía de Laranjeiras, PR* (BLANKENSTEYN et al. 1997)	0.7 - 2.6
Itacorubi, SC* (BRANCO, 1993)	1.1

* Acronyms for the States of: MA – Maranhão; CE – Ceará; SE – Sergipe; PR – Paraná; SC – Santa Catarina

The higher values of burrow density we registered at some elevated sites close to the river mudbanks, decreasing towards the inland, were also reported at mangrove habitats of the Ilha do Paiva in the State of Sergipe, Northeast Brazil (NASCIMENTO and COSTA 1983). We also consider that some other physical factors like water level, sediment drainage, and soil humidity and salinity, affect the crab population distribution along the river mangrove habitat. Blankensteyn et al. (1997) observed that tidal channels or drainage sites, where water from spring tides remains for a longer time, are places with reduced crab population.

Despite the reasonable state of preservation of the mangrove ecosystem we studied, there are some areas being affected by anthropic actions, due mainly to sugar cane cultivation. Watanabe et al. (1994) reported water contamination in one of the estuary tributaries from sugar cane plantations. Skilleter and Warren (2000) suggest that even slight modifications of the physical structure of a mangrove habitat, may cause significant damage on biodiversity and abundance of macrobenthic organisms.

The reduction of mangrove areas in the State of Rio de Janeiro, Southeast Brazil, is reported by Bergallo et al. (2000) as one of the main reasons to consider *Ucides cordatus* as a threatened species, which is also intensively captured as food and as a profitable resource by local dwellers. In the State of São Paulo, Southeast Brazil, *U. cordatus* is an endangered species also due to anthropic actions (Secretaria do Meio Ambiente-SP 1998).

The period the crabs mate, from January to March, is the same observed by the gatherers and as reported elsewhere (COSTA, 1972, ALCÂNTARA FILH,O 1978, NASCIMENTO and COSTA, 1983, CASTRO, 1986, MONTEIRO, et al. 2000, and GÓES et al. 2000). The period of

'andada' was also reported by Nordi (1994a) who state that the gatherers associate this movement of crabs to tides, an aspect also reported by Castro (1986) who observed such event mainly after spring tides. *Ucides cordatus* specimens are caught easily during the *'andada'*. The gatherers say that the increase in the occurrence of plantules of *Rhizophora mangle*, much preferred by leaf-consuming crabs, indicates a decrease of crab populations.

Considering the relevant ecological function of *Ucides cordatus*, its population decrease may cause modifications in the mangrove habitat. Koch and Wolff (2002) point out that epifaunal species contribute about 75% to the faunal biomass in mangrove ecosystems (*U. cordatus* 63% and deposit-feeding crabs 12%), indicating the important role of this faunal group which channels directly the energy and nutrients fluxes in the ecosystem.

The pressure exerted by crab gatherers on *Ucides cordatus* population is mainly due to the fact that they catch males smaller than 4.5 cm of carapace length (disobeying the current Brazilian environmental legislation), which is a risk to overfishing. Diele (2000) suggests that the low growth rate of *U. cordatus* means that this species is highly vulnerable to overfishing and that decrease in number of larger males in overexploited areas indicates a likely reduction in the capacity of the ecosystem to buffer negative actions on its natural condition; and if the pressure continues, the production will be markedly lower. In this case it will be important to observe the resilience of mangrove habitats in such conditions.

CONCLUSIONS

The present work reinforces the need for a management plan of *Ucides cordatus* in the estuary of the Mamanguape river, besides the preservation of the crab habitat. We believe that not only controlled exploitation and the governmental supervision are important normative approaches to sustainability, but also the socioecological contextualization of local population of crab gatherers. They are usually ignored by the authorities when elaborating regulations on resource exploitation.

Some suggestions aiming to improve the current situation follow: (1) to study the bioecological potential of the mangrove ecosystems biota and ameliorate their alternatives of exploitation; (2) to organize structurally and functionally the human community involved in the crab catch and commercialization by providing courses, talks and better professional qualification, as well as formation of producer co-operatives, and social, medical and financial assistance; (3) to restructure the *'defeso'* system (in defence of crabs), through debates with experts, governmental authorities and crab gatherers. The latter could receive a financial support for their participation in defence of the *Ucides cordatus* and the mangrove ecosystem management and protection.

ACKNOWLEDGEMENTS.

We are grateful to gatherers of 'caranguejo-uçá' in Paraíba State; and to CAPES, WWF and USAID for financial supports.

LITERATURE CITED

ALCÂNTARA FILHO, P. Contribuição ao estudo da biologia e ecologia do caranguejo-uçá, *Ucides cordatus* (L. 1763) (Crustacea, Decapoda, Brachyura), no manguezal do rio Ceará (Brasil). **Arquivos de Ciências do Mar**, 18: 1 - 41. 1978.

ALLODI, M.; TAFFAREL, M. Electron microscopy of glial cells of the central nervous system in the crab *Ucides cordatus*. Braz **J. Med. Biol. Res** 32: 327 - 331. 1999

ALMEIDA, L. F,; MELLO C. F. Estudo preliminar da biologia e ecologia do caranguejo-uçá,

Ucides cordatus (Crustacea, Decapoda, Brachyura), no Município de Curuçá (PA) - Uma contribuição ao manejo de recursos em áreas de manguezais. In: ANAIS DA 3^{A} REUNIÃO ESPECIAL DA SBPC, Ecossistemas Costeiros: do conhecimento à gestão, Florianópolis, SC. **Resumo**...1996, p. 499.

ALVES, R. R. N. **Aspectos da bioecologia e captura do caranguejo-uçá *Ucides cordatus cordatus* (L., 1763) (Decapoda, Brachyura) no manguezal do estuário do rio Mamanguape, Paraíba: um enfoque social e etnoecológico**. João Pessoa, 2002, M.Sc Dissertation. Universidade Federal da Paraíba.

ALVES, R. R. N.; NISHIDA, A. K. A ecdise do caranguejo-uçá, *Ucides cordatus* (Crustacea, Decapoda, Brachyura) na visão dos caranguejeiros. **Interciencia** 27/3: 110-117. 2002

BACON, P. R.; ALLENG, G. P. The management of insular Caribbean mangroves in relation to site location and community type. In: JACCARINI, V,; E. MARTENS, E. (eds), The ecology of mangrove and related ecosystems. Kluwer **Academic Publishers**, Netherlands, p. 235-241. 1992

BERGALLO, H. G.; ROCHA, C. F. D.; VAN SLUY, S. M.; ALVES, M. A. S. **A fauna ameaçada de extinção do Estado do Rio de Janeiro**. EdUERJ, Rio de Janeiro, 2000 168 p.

BLANKENSTEYN, A.; CUNHA FILHO, D. Comercialização, morfometria e descrição de um artefato de pesca seletivo para o caranguejo do mangue *Ucides cordatus* (L. 1763) (Brachyura Ocypodidae) na Baía das Laranjeiras, Paraná. In: VII CONGRESSO LATINO-AMERICANO SOBRE CIENCIAS DO MAR (COLACMAR), Santos, **Anais...**, p. 86 - 88. 1997.

BLANKENSTEYN, A.; CUNHA FILHO, D.; FREIRE, A. S. Distribuição, estoques pesqueiros e conteúdo protéico do caranguejo do mangue *Ucides cordatus* (L. 1763) (Brachyura Ocypodidae) nos manguezais da Baía das Laranjeiras e adjacências, Paraná, Brasil. **Arq. Biol. Tecnol. V.** 40 n. 2, p. 331-349, 1997

BOTELHO, E. R. O.; DIAS, A, F.; IVO, C. T. Estudo sobre a biologia do caranguejo-uçá, *Ucides cordatus* (Linnaeus, 1763), capturado nos estuários dos rios Formoso (rio Formoso) e Ilhetas (Tamandaré), no Estado de Pernambuco. **Bol Tec Cient CEPENE,** v. 7, n. 1, p. 117-145. 1999.

BRANCO, J. O. Aspectos bioecológicos do caranguejo *Ucides cordatus* (Linnaeus,1763) (Crustacea: Decapoda) do manguezal de Itacorubi, Santa Catarina, Brasil. **Arq Biol Tecnol** v. 36, n. 1, p. 133-148, 1993.

BRIGHT, D. B. The land crab of Costa Rica. **Rev Biol Trop** v. 14, n. 2:, p. 182-203, 1996.

CASTRO, A. C. L. Aspectos bioecológicos do caranguejo-uçá, *Ucides cordatus cordatus* (Linnaeus, 1763), no estuário do rio dos Cachorros e Estreito do Coqueiro, São Luís - MA. **Bol Lab. Hidrobiol.** v.7, p. 7-26, 1986

CHACE, F. A.; HOBBS, H. H. The freshwater and terrestrial decapod crustaceans of the West Indies with special reference to Dominica. **Bull. U. S. Nat. Mus**. v. 292, p. 1-258. 1969

CORRÊA JR, J. D.; ALLODI, S.; AMADO FILH,O G. M.; FARINA, M. Zinc accumulation in phosphate granules of *Ucides cordatus* hepatopancreas. **Braz. J. Méd. Biol. Res.** 33/ 2: 217 - 221. 2000

COSTA, R.S. F**isioecologia do caranguejo-uçá, *Ucides cordatus* (Linnaeus, 1763) -Crustáceo, Decápode - do Nordeste brasileiro**. Ph D Thesis. Universidade de São Paulo. 1972.

COSTA, R. S. Bioecologia do caranguejo-uçá, *Ucides cordatus* (Linnaeus, 1763) - Crustáceo, Decápode - do Nordeste brasileiro. **Bol. Cear. Agron**. v. 20, p. 1-74. 1979

DIELE K. **Life history and population structure of the exploited mangrove crab *Ucides cordatus cordatus* (L.1763) (Crustacea: Decapoda) in the Caeté estuary, North Brazil**. Bremen, 2000. PhD Thesis. University of Bremen.

FARNSWORTH, E. J.; ELLISON, A. M. Global patterns of pre-dispersal propagule predation in mangrove forests. **Biotropica, v.** 29, n. 3, p. 318-330. 1997

FOUDA, M. M.; AL-MUHARRAMI, M. An initial assessment of mangrove resources and human activities at Mahout Island, Arabian Sea, Oman. **Hydrobiol**. v. 295, n. 1-3, p. 353-362. 1995

FREIRE, A. S. **Dispersão larval do caranguejo-uçá *Ucides cordatus* (L. 1763) em manguezais da Baia de Paranaguá, Paraná**. São Paulo, 1998. PhD Thesis. Universidade de São Paulo.

GERALDES, M. G.; CALVENTI, I. B. Estudios experimentales para el mantenimiento en cautiverio del cangrejo *Ucides cordatus*. **Cienc. Interam**. v. 23, n. 1-4, p. 41-53. 1983

GÓES, P.; SAMPAIO, F. D. F.; CARMO, T. M.S.; TÔSO, G. C.; LEAL, M. S. Comportamento e período reprodutivos do caranguejo do mangue *Ucides cordatus* In: Simpósio de Ecossistemas Brasileiros: Conservação, 5. Espírito Santo. **Anais...** p. 335- -345. 2000

HERZ, R. **Manguezais do Brasil**. Instituto Oceanográfico, Universidade de São Paulo, 1991, 227p.

HOLTHUIS, L. B. The Crustacea Decapoda of Suriname (Dutch Guiana). **Zool. Verh. Rijksmus. Nat. Hist**. Leiden, v. 44, p. 1-296. 1959

HUDSON, D. A.; LESTER, R. J. G. Parasites and symbionts of wild mud crabs *Scylla serrata* (Forskal) of potential significance in aquaculture. **Aquaculture**, v. 120, p. 182-199. 1994

INSTITUTO BRASILEIRO DO MEIO AMBIENTE E RECURSOS NATURAIS RENOVÁVEIS - IBAMA. (). Os ecossistemas brasileiros e os principais macrovetores de desenvolvimento: subsídios ao planejamento da gestão ambiental. Ministério do Meio Ambiente, dos Recursos Hídricos e da Amazônia Legal, Secretaria da Coordenação dos Assuntos do Meio Ambiente, Programa Nacional do Meio Ambiente - PNMA - Brasília: MMA, 1995, 108p.

IVO, C. T. C.; DIAS, A. F.; MOTA, R. I. Estudo sobre a biologia do caranguejo-uçá, *Ucides cordatus cordatus* (Linnaeus, 1763), capturado no delta do Rio Parnaíba, Estado do Piauí. **Bol Tec Cient CEPENE** Tamandaré, v. 7, n.. 1, p. 53-84. 1999

IVO, C. T. C.; DIAS, A. F.; BOTELHO, E. R. O.; MOTA, R. I.; VASCONCELOS, J. A.; VASCONCELOS, E. M. S. Caracterização das populações de caranguejo-uçá, *Ucides cordatus cordatus* (Linnaeus, 1763), capturadas em estuários do Nordeste do Brasil. **Bol. Tec. Cient. CEPENE,** Tamandaré, v. 8, n. 1, p. 9-43. 2000

IVO, C. T. C.; GESTEIRA, T. C. V. Sinopse das observações sobre a bioecologia e pesca do

caranguejo-uçá, *Ucides cordatus cordatus* (Linnaeus, 1763), capturado em estuários de sua área de ocorrência no Brasil. **Bol. Tec. Cient. CEPEN**E 7/1: 9 - 51. 1999.

IVO, C. T. C.; VASCONCELOS, E. M. A. Potencial reprodutivo do caranguejo-uçá, *Ucides cordatus cordatus* (Linnaeus, 1763), capturado na região estuarina do rio Curimataú, Canguaretama, Rio Grande do Norte, Brasil. **Bol Tec Cient CEPENE**, v. 8, n. 1, p. 45-53. 2000.

JONES, D. **A. Crabs of the mangal ecosystem**. In: Por F. D., I Dor W (eds) Hidrobiology of the Mangal, Junk Publ, The Hague.1084. p 89 - 109

KAPPLER, A. Hollandish-Guiana. Erlebnisse und Erfahrungen wanrend eines 43 jahrigen Aufenthalts in der Kolonization,. 1881. p 1 - 383

KJERFVE, B.; LACERDA, L. D. Management and status of the mangroves of Brazil. ISME/ ITTO, Conservation and Sustainable utilization of mangrove forests in Latin America and Africa regions. Part I Latin Ameri. p.245 - 272. 1993.

KOCH, V.; WOLFF, M. Energy budget and ecological role of mangrove epibenthos in the Caeté estuary, North Brazil. **Mar. Ecol. Prog.** Ser 228: 119-130. 2002.

LACERDA, L. D. Manguezais: Florestas de beira-mar. **Ciência Hoje**, v. 3, n. 13, p. 63-70. 1984.

MANESCHY, M. C. **Pescadores nos manguezais: estratégias técnicas e relações sociais de produção na captura de caranguejo.** In: FURTADO, L. G., LEITÃO, W.; FIÚZA, A (eds). Povos das Águas: Realidade e Perspectivas na Amazônia**.**, Belém, Brasil, MCT/CNPq. 1993, p 19 - 62.

MANNING, R. B.; PROVENZANO-JR, A. J. The ocorrence of *Ucides cordatus* (Linnaeus, 1763) (Decapoda) in the United States. **Crustaceana, v.** 2, n. 1, p. 84-91. 1961

MARGALEF, R, **Ecologia.** Barcelona, Omega, 1977, 951p.

MARTINEZ, C. B. R.; HARRIS, R. R.; SANTOS, M. C. F. Transepithelial potential differences and sodium fluxes in isolated perfused gills of the mangrove crab *Ucides cordatus*. **Comp Biochem Physiol** 120 A: 227 - 237. 1998

Martinez CBR, Alvares EP, Harris RR, Santos MC F (1999) A morphological study on posterior gills of the mangrove crab *Ucides cordatus*. Tissue Cell 31/3: 380 - 389.

MICHELI, F.; GHERARDI, F.; VANNINI, M Feeding and burrowing ecology of two east african mangrove crabs. **Mar. Biol.** v. 111. p. 247-254. 1991

MONTEIRO, B. R.; PARANAGUÁ, M. N.; COELHO FILHO, P. A. Estrutura populacional do caranguejo-uçá, *Ucides cordatus* (Linnaeus, 1763) no estuário do rio Paripe, Itamaracá, Pernambuco. In: Congresso de Iniciação Científica da Universidade Federal Rural de Pernambuco**,** 10, Recife, **Resumos...** 2000.

MOTA ALVES, M. I. Sobre a reprodução do caranguejo-uçá, *Ucides cordatus* (Linnaeus), em mangues do Estado do Ceará (Brasil). **Arq. Ciênc. Mar**. v. 15, n. 2, p. 85-91. 1975.

MOTA ALVES, M. I.; MADEIRA JR, P. H. Algumas considerações sobre a respiração do

caranguejo-uçá, *Ucides cordatus* (Linnaeus, 1763) (Crustacea: Decapoda). **Arq. Ciênc. Mar**. v. 20.n. (1-2, p. 63 69. 1980.

MOURA, N. F.; COELHO FILHO, P. A.; COELHO, P. A. Captura de *Goniopsis cruentata* Latreille (1803) em um manguezal do litoral norte de Pernambuco - Brasil (Crustacea, Brachyura, Grapsidae). In: MANGROVE 2000, Sustainable use of estuaries and mangroves:Challenges and prospects; Recife, **Resumos...** 2000

NASCIMENTO, S. A.; COSTA, R. S. Estudo bioecológico do caranguejo-uçá *Ucides cordatus* (Linnaeus, 1763) e do manguezal da ilha do Paiva - São Cristovão - Estado de Sergipe - Brasil. In: ENCONTRO BRASILEIRO DE GERENCIAMENTO COSTEIRO, 3. Fortaleza, **Anais**... p 313 – 323, 1983

NASCIMENTO, M. S. V. O manguezal do estuário dos rios Timonha- Ubatuba, Ceará-Piauí, Brasil: Composição, estrutura e diagnóstico socioambiental. João Pessoa, 2000. Dissertação (Mestrado) – Programa de Pós-graduação em Desenvolvimento e Meio Ambiente. Universidade Federal da Paraíba.

NORDI, N. Os catadores de caranguejo-uçá (*Ucides cordatus*) da região de Várzea Nova (PB): Uma abordagem ecológica e social. São Carlos, 1992, PhD Thesis, Universidade Federal de São Carlos, Brasil.

NORDI, N. A captura do caranguejo-uçá (*Ucides cordatus*) durante o evento reprodutivo da espécie: o ponto de vista dos caranguejeiros. **Rev. Nordestina Biol**. v. 9, n. 1, p. 41-47. 1994a.

NORDI, N. A produção dos catadores de caranguejo-uçá (*Ucides cordatus*) na região de Várzea Nova, Paraíba, Brasil. **Rev. Nordestina Biol**. v. 9, n..1, p. 71-77. 1994b

NORDI, N. O processo de comercialização caranguejo-uçá (*Ucides cordatus*) e seus reflexos nas atitudes de coleta. **Rev. Nordestina Biol.** v. 10, n. 39-46. 1995.

PALUDO, D.; KLONOWSKI, V. S. Barra de Mamanguape - PB: Estudo do impacto do uso de madeira de manguezal pela população extrativista e da possibilidade de reflorestamento e manejo dos recursos madeireiros. **Série Cadernos da Reserva da Biosfera. Mata Atlântica,** MAB, UNESCO, v. 16p. 7-54. 1999.

PAIVA, M. P. **Recursos pesqueiros estuarinos e marinhos do Brasil**. EUFC. 1997, 278 p.

PONS, L. J.; FISELIER, J. L. Sustainable development of mangroves. Landscape and Urban **Ecology**, v. 20, n. 1-3, p. 103-109. 1991.

ROBERTSON, A. I. Leaf-burying crabs: their influence on energy flow and export from mixed mangrove forests (*Rhizophora* spp) in northeastern Austrália. **J. Exp. Mar. Biol. Ecol**. p.102: 237-248. 1986.

ROBERTSON, A. I. Plant-animal interactions and the structure and function of mangrove forests ecosystems. **Austr. J. Ecology** 16: 433 - 443. 1991.

SCHOMBURKG, R Reisen in Britisch. Guiana in den Jahren 1840-1844. Im Auftrag Sr.Majestat dês konigs von Preussen, 2, xiv + 1-530. 1848.

SKILLETER, G. A.; WARREN, S. Effects of habitat modification in mangroves on the structure of mollusc and crab assemblages. **J. Exp Mar. Biol. Ecol**. v. 244, p. 107-129. 2000

STATSOFT INC **Statistica for windows**. Tulsa. 1998.

SECRETARIA DO MEIO AMBIENTE - SMA (1998) **Fauna ameaçada no Estado de São Paulo**. Secretaria do Meio Ambiente. SMA/CED. São Paulo, 56 p.

SUPERINTENDÊNCIA PARA O DESENVOLVIMENTO DA AMAZÔNIA/Universidade Federal do Maranhão. **Caracterização ambiental e prospecção pesqueira do estuário do rio Cucuruca - Maranhão.** Belém, SUDAM, 1983141 p.

WARNER, G. F. The occurrence and distribution of crabs in a Jamaican mangrove swamp**. J. Anim. Ecol**. 38: 379 - 389. 1969.

WATANABE, T.; OLIVEIRA, R. B.; SASSI, R.; MELO, G. N. MOURA, G. F.; GADELHA, C. L.; MACHADO, V. M. N.. Evidences of contamination caused by sugar-cane monoculture and associated industrial activities in water bodies of the State of Paraíba, Northeast Brazil. **Acta Limnologica Brasiliensi. v.** 5, p. 85-101. 1994.