Arquivos do Museu Nacional, Rio de Janeiro, v.65, n.3, p.339-346, jul./set.2007
ISSN 0365-4508

HERMIT CRABS (CRUSTACEA, ANOMURA, DIOGENIDAE) FROM ROCAS ATOLL, BRAZIL [1]

(With 4 figures)

ALEXANDRE SANTOS DE SOUZA [2]
CRISTIANA S. SEREJO [3]

ABSTRACT: Intertidal and shallow infra-littoral samples collected in Rocas Atoll, Rio Grande do Norte State, Brazil, during October 2000, provided material for this study. As a result of this survey, four species of hermit crabs were found and are herein redescribed: *Clibanarius antillensis*, *Calcinus tibicen, Dardanus venosus* and *Paguristes tortugae*. This is the first record of *C. tibicen* and *P. tortugae* for the Rocas Atoll.

Key words: Hermit crabs. Taxonomy. Paguroidea. Diogenidae. Rocas Atoll.

RESUMO: Caranguejos ermitões (Crustacea, Anomura, Diogenidae) de Atol das Rocas, Brasil.

Amostras do entre-marés e infralitoral raso coletadas no Atol das Rocas, Estado do Rio Grande do Norte, Brasil, em outubro de 2000, proporcionaram o material para este estudo. Como resultado dessas coletas, quatro espécies de ermitões foram encontradas e são aqui redescritas: *Clibanarius antillensis, Calcinus tibicen*, *Dardanus venosus* e *Paguristes tortugae* Schmitt, 1933. Este é o primeiro registro de *C. tibicen* e *P. tortugae* para o Atol das Rocas.

Palavras-chave: Ermitões. Taxonomia. Paguroidea. Diogenidae. Atol das Rocas.

INTRODUCTION

Hermit crabs are very common in the rocky intertidal zone of tropical and warm temperate areas throughout the world. This group of crustaceans is well known by the fact of being mostly gastropod shells inhabitants. They normally choose their shells by the size - and other morphological parameters - but the shell adequacy is conditioned by their availability in the area and habitat physical factors (Scully, 1979; Hazlett, 1981). In the Brazilian coast, 46 species belonging to the families Paguridae, Diogenidae and Parapaguridae have been registered (Melo, 1999). Rocas Atoll is localized in the northeastern coast of Brazil, 267 Km E-NE from Natal City in Rio Grande do Norte State. Rocas is the unique atoll in the South Atlantic. Its ecological importance is due to the high biological productivity and also because Rocas is an important reproduction, refuge and feeding site for many marine species. Because of these characteristics, Rocas Atoll is since 1979 the first marine biological reserve of Brazil. During high tide, only two islands keep emerged: Farol and Cemitério. During low tide, in the inner area of the atoll, can be found many tide pools, which are inhabited by juveniles of fish and many marine organisms as hermit crabs. Previous knowledge of the hermit crab fauna from Rocas Atoll is found in Rieger (1998), and Melo (1999), which consists of three species: *Clibanarius antillensis* Stimpson, 1859, *C. tricolor* (Gibbes, 1850) and *Dardanus venosus* (H. Milne Edwards, 1848). A contribution for a better understanding of the decapod fauna of Rocas Atoll, Brazil, is one of the main objectives of this paper.

SYSTEMATICS

Superfamily Coenobitoidea Dana, 1851
Family Diogenidae Ortmann, 1892
Genus *Clibanarius* Dana, 1852
Clibanarius antillensis Stimpson, 1859 (Fig.1)

Clibanarius antillensis Stimpson, 1859:85; Smith, 1869:18, 39; Rathbun, 1900:144; Benedict, 1901:142, pl.6, fig.1; Moreira, 1901:29, 87; Schmitt, 1935:199;

[1] Submetido em January 7, 2007. Aceito em April 20, 2007.
[2] Museu Nacional/UFRJ. Programa de Pós-Graduação em Ciências Biológicas (Zoologia). Quinta da Boa Vista, São Cristóvão, 20940-040. Rio de Janeiro, RJ, Brasil.
Petroflex S.A. support. E-mail: alexsouza@mn.ufrj.br.
[3] Museu Nacional/UFRJ, Departamento de Invertebrados. Quinta da Boa Vista, São Cristóvão, 20940-040, Rio de Janeiro, RJ, Brasil.

1936:375; Provenzano, 1959:368, fig.5B; 1961:152; Forest & De Saint Laurent, 1967:99, fig.60; Coelho, 1971:232; Coelho & Ramos, 1972:169; Hebling, 1978:425; Coelho & Santos, 1980:143; Abele & Kim, 1986:29, 331, 339 (Fig.a); Coelho & Ramos-Porto, 1987:51; Rieger, 1998:421; Melo, 1999:48, fig.6.

Material examined – Rocas Atoll, pool, in *Nodilittorina vermeijii* Bandei & Kadolsky, 1982 shell, MNRJ, 19092, 1♂, C.Serejo and M.C.Rayol coll., 09/XI/2001; Rocas Atoll, pool, in *Olivella watermani* McGinty, 1940 shell, MNRJ, 19093, 1♂, C.Serejo and M.C.Rayol coll., 25/X/2001; Rocas Atoll, pool, in *Nassarius sp, Olivella watermani* McGinty, 1940, *Columbela mercatoria* (Linneus, 1758), *Natica sp* and Turridae shells, MNRJ, 19094, 20♂ e 45♀ (40 ovigerous), S.N.Brandão, N.Magalhães and C.R.Tavares coll. 03/VII/2001; Rocas Atoll, pool, in *Nassarius sp, Olivella* N. *watermani* e *Columbela mercatoria* shells, MNRJ, 19095, 21♂ e 48♀ ovigerous, S.N.Brandão, N.Magalhães and C.R.Tavares coll., 16/VII/2001; Rocas Atoll, pools, in *Olivella watermani* shell, MNRJ, 19096, 1♂, C.Serejo and M.C.Rayol coll., 22/X/2001; Rocas Atoll, in front of seamark, in *Engina turbinella* Kiener, 1836, *Olivella watermani* shells and Vermetidae tube, MNRJ, 19097, 3♂, P.S.Young, P.C.Paiva and A.A.Aguiar coll. 14/X/2000; Rocas Atoll, pool, MNRJ 19098, 5♂ and 4♀ ovigerous, P.S.Young, P.C.Paiva and A.A.Aguiar coll., 17/X/2000; Rocas Atoll, South channel, MNRJ, 19099, 1♂, P.S.Young, P.C.Paiva and A.A.Aguiar coll., 05/X/2000; Rocas Atoll, pool, MNRJ, 19100, 1♂, P.S.Young, P.C.Paiva and A.A.Aguiar coll., 13/X/2000; Rocas Atoll, pool, MNRJ, 19106, 1♂, C.Serejo and M.C.Rayol coll., 31/X/2001; Rocas Atoll, pool, MNRJ, 19107, 1♂, C.Serejo and M.C.Rayol coll., 29/X/2001.

Diagnosis – Walking legs, dactylus shorter than propodus; dactylus, propodus and carpus with a single broad longitudinal light stripe bordered by dark stripes in lateral surface; merus with two light stripes.

Description – Shield length varying from 1.5 to 4.5mm. Rostrum triangular, short, slightly beyond lateral projections (Fig.1A). Cephalic shield subrectangular, covered by minute concavities. Cervical suture almost straight (Fig.1A). Antennular peduncle longer or subequal to ocular peduncle. Antennal peduncle generally of the same length of eyestalk, or ending near cornea. Antennal acicle with strong spines.

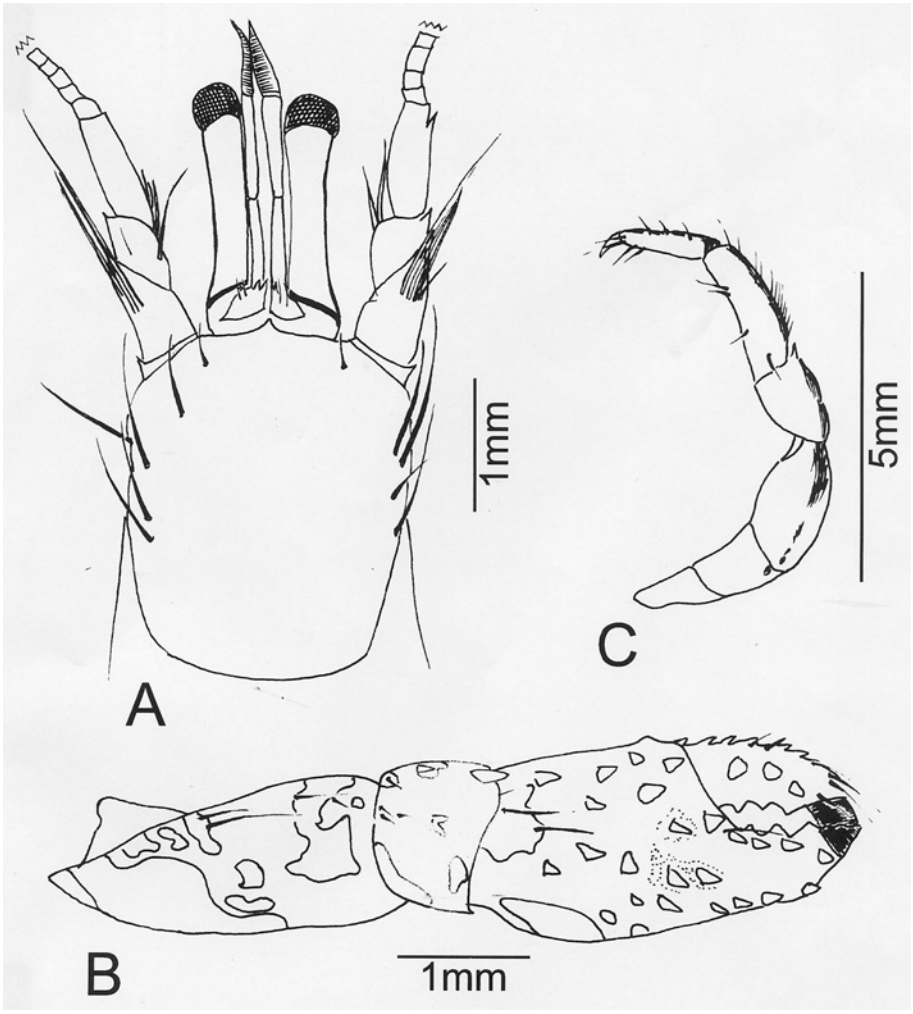

Fig.1- *Clibanarius antillensis* Stimpson, 1859, ♂, MNRJ 19092. (A) shield and cephalic appendages, dorsal view; (B) right cheliped, lateral view; (C) second left walking leg, lateral view.

Eyestalk thin and longer than front width, tapering in middle and broadening at cornea. Ocular acicles triangular, close to each other medially and with spines on superior branch, which decrease in length from middle to external margin. Chelipeds subequal; dorsal region of chela with coarse spines; left slightly larger. Chela and carpus with sparse setae, merus surface excavated, finger tip spooned (Fig.1B) and corneous. Walking leg with sparse setae, dactyl shorter than propodus (Fig.1C). Carpus of first pair of walking legs with one or two spines on antero-dorsal margin and with one spine in the same region of the second pair of legs. Dactyls and propodus of the second left walking leg slightly flattened and with a little conspicuous dorsolateral ridge.

Distribution – Western Atlantic: USA (Florida), Bermudas, Gulf of Mexico, Panama, West Indies, North of South America. Brazil: from Ceará to Santa Catarina, including Rocas Atoll (Melo, 1999).

Type-locality – Barbados (Provenzano, 1959; Abele, 1986).

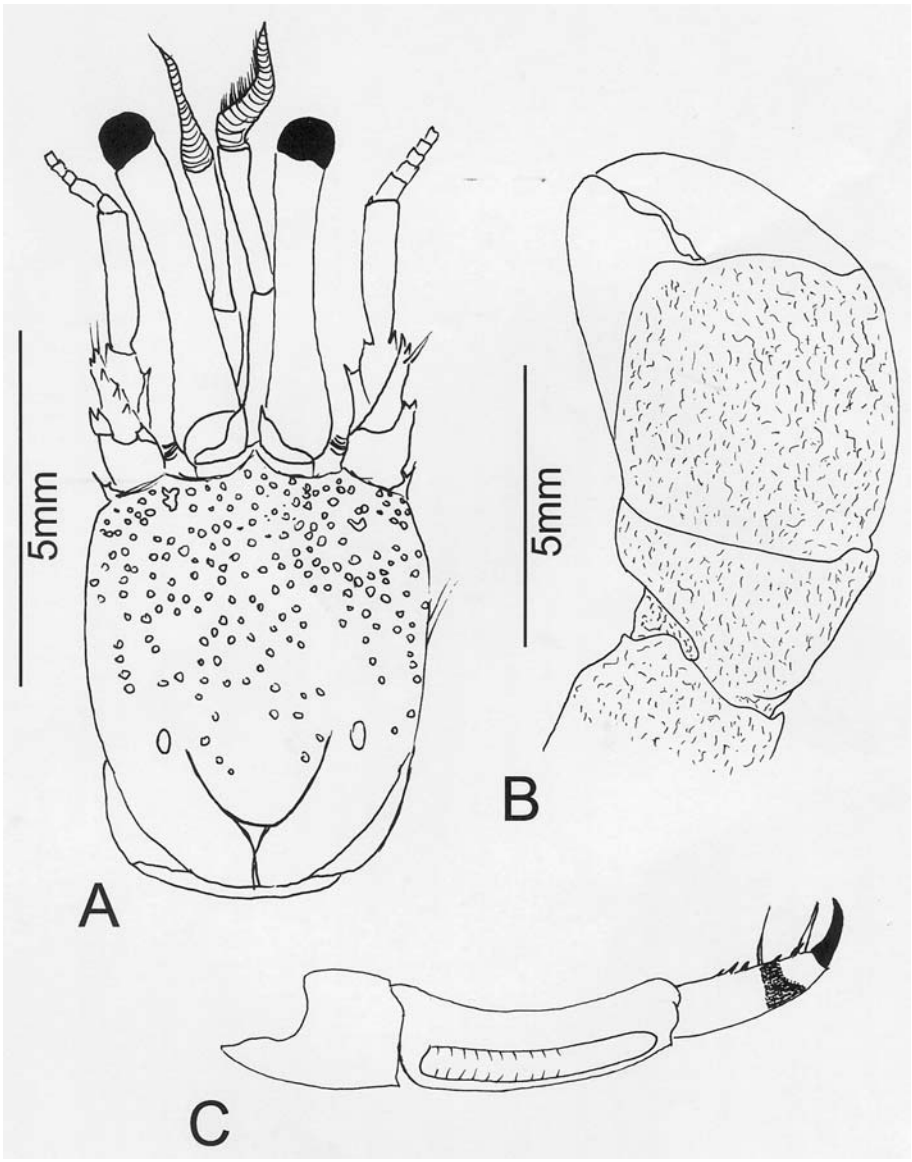

Fig.2- *Calcinus tibicen* (Herbst, 1791), ♂, MNRJ 19101. (A) cephalic region, dorsal view; (B) left cheliped, lateral view; (C) second left walking leg, lateral view.

Genus *Calcinus*
Dana, 1851
Calcinus tibicen
(Herbst, 1791) (Fig. 2)

Cancer tibicen Herbst, 1791:25, pl. 23, fig.7.
Pagurus sulcatus H. Milne Edwards, 1836:279; 1848: 64.
Calcinus sulcatus – Smith, 1869:17, 39; Rathbun, 1900: 144; Benedict, 1901: 141, pl.5, figs.3, 3a; Moreira, 1901:27, 86; Verril, 1908:439, figs.56, 57, pl.28, fig.7.
Calcinus tibicen – Rankin, 1900:533, pl.17, fig.1; Schmitt, 1924:94; 1935:198, figs.60a, b; 1936:376; Provenzano, 1959:363, fig.4; 1961:152; Forest & De Saint Laurent, 1967:106; Coelho, 1971:232; Coelho & Ramos, 1972:170; Hebling, 1978:425; Coelho & Santos, 1980:143; Abele & Kim, 1986:28, 353, fig.c; Coelho & Ramos-Porto, 1987:52; Rieger, 1998:422; Melo, 1999:42, fig.2.

Material examined – Rocas Atoll, pool, MNRJ, 19101, 1♂ and 2♀ ovigerous, P.S.Young, P.C.Paiva and A.A.Aguiar coll., 23/X/2000.

Diagnosis – Carapace surface smooth and bare. Eyestalks longer than front width. Propodus of second walking leg broader than its counterpart in right leg, and with a lateral longitudinal groove.

Description – Length of cephalic shield varying from 4.6 to 6.0mm. Rostrum triangular, acute, projecting toward beyond lateral projections (Fig.2A). Cephalic shield longer than broad, surface with minute fine concavities (Fig.2A). Antennular peduncle (Fig.2A) reaching non-pigmented portion of eyestalks. Antennal peduncle (Fig.2A) reaching at least the last third of eyestalk. Ocular acicle armed with 5-7 white-tipped spines.

Eyestalk slender (Fig.2A), curving gently outward. Ocular acicle acute, with one or two spines. Chelipeds unequal; left (Fig.2B) much larger than right. Fingers moving obliquely, with acute tips. Both chelipeds entirely smooth. Walking legs smooth, but with tufts of setae on ventral margins of dactyl. Propodus of the second walking leg larger than its counterpart on the right, with a broad longitudinal groove (Fig.2C) on the outer face.

Distribution – Western Atlantic: USA (Florida) and Bermudas. Brazil: from Ceará to São Paulo, including Fernando de Noronha Archipelago (Rieger, 1998; Melo, 1999), and Rocas Atoll.

Type-locality – unknown.

Remarks – This is a well known species for the Western Atlantic coast. However, this is the first record of C*alcinus tibicen* from Rocas Atoll.

Genus *Dardanus*
Paulson, 1875
Dardanus venosus (H. Milne Edwards, 1848)
(Fig.3)

Pagurus venosus H. Milne Edwards, 1848: 61; Stimpson, 1859:82.
Petrochirus insignis - Rathbun, 1900:144.
Pagurias insignis – Benedict, 1901:141.
Pagurus arrosor – Moreira, 1901:24.
Pagurus arrosor var. *divergens* - Moreira, 1906:133, pl. 4, fig.1.
Dardanus venosus – Verril, 1908:441, fig.58, 59, pl.26, figs.4a, 5a; Schmitt, 1924:95; 1935:201, fig. 2; 1936:376; Holthuis, 1959:153; Provenzano, 1959:374, fig.6; 1961:153; Forest & De Saint Laurent, 1967:94; Coelho, 1971:232; Biffar & Provenzano, 1972:778; Coelho & Ramos, 1972:168; Coelho & Santos, 1980:143; Abele & Kim, 1986:29, 341, figs.g-i; Coelho & Ramos-Porto, 1987:50; Rieger, 1998:420; Melo, 1999:64, fig.20.
Pagurus insignis – Bouvier, 1918:6.

Material examined – Rocas Atoll, Barretinha channel, MNRJ, 19102, 1♂, P.S.Young, P.C.Paiva and A.A.Aguiar coll., 05/X/2000.

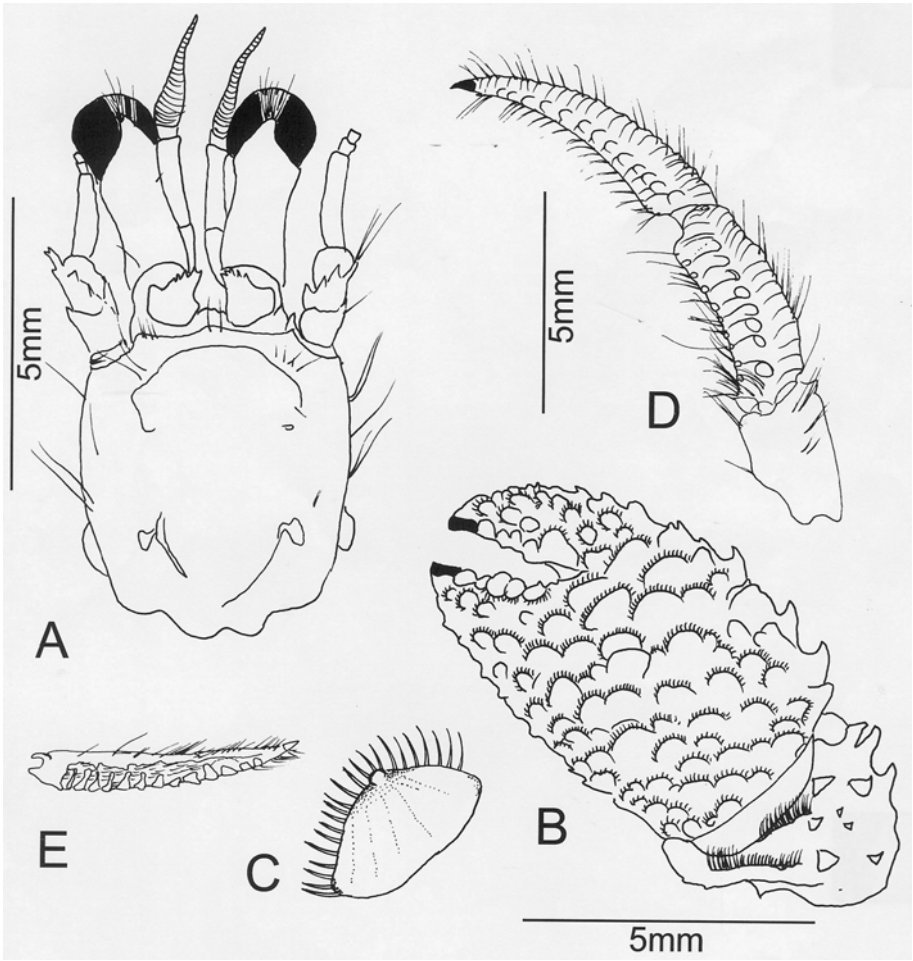

Fig.3- *Dardanus venosus* (H. Milne Edwards, 1848), ♂, MNRJ 19102. (A) cephalic region, dorsal view; (B) carpus and chela, lateral view; (C) cheliped tubercle in detail; (D) carpus, propodus and dactyl of second left walking leg; (E) dactyl, ventral view.

Diagnosis – Antennal peduncle not exceeding eyestalk length. Chela covered by scale-like tubercles and setae. Second left walking leg with longitudinal lateral ridge, crossed by transverse rugae. Dactyls of walking legs with setae.

Description – Cephalic shield length 5.0mm. Rostrum absent. Lateral projections forming acute angles at antero-lateral corners of carapace. Cephalic shield slightly longer than front width, smooth, with a few setae and some lines near lateral margins (Fig.3A). Antennular peduncle exceeding cornea tip by one third of the last antennular segment, when paralleled to each other. Antennal peduncle reaching cornea tips. Antennal acicle short, reaching at least half length of the eyestalk and bearing short acute spines.

Eyestalk robust and with a central constriction, extending to the tip of antennal peduncle and reaching slightly more than ¾ of front width in length. Tuft of setae behind the expanded cornea. Ocular acicles well separated, with straight internal margins and tips with spines (Fig.3A). Chelipeds unequal, the left much larger than right. Finger tips black, corneous, and spooned. Major chela (Fig.3B), external surface covered by scale-like tubercles (Fig.3C) bordered by fan-like fringe of apressed setae; inner surface smooth; dorsal margin of propodus with 7 acute horn-like spines projecting forward and continue as a row of shorter spines along the mobile dactyl and carpus; carpus with shorter and sharper spines scattered over surface. Right chela narrower, without scale-like tubercles on external surface and with long setae present. Walking legs with dactyls longer than propodus; the ones of the first pair larger than that of the second pair. Dactyl with several robust setae; other segments with fewer setae along dorsal and ventral margins. Second left walking leg (Fig.3D) markedly different from the others; propodus and dactyl broadened, fringed with setae and with a longitudinal lateral ridge paralleled by a slight groove. Ridge crossed by numerous rugae (Fig.3E).

Distribution – Western Atlantic: Eastern USA, Bermudas, North of South America. Brazil: from Pará to Rio de Janeiro, including Fernando de Noronha Archipelago and Rocas Atoll (Melo, 1999).

Type-locality – Guadeloupe (Provenzano, 1959; Abele and Kim, 1986)

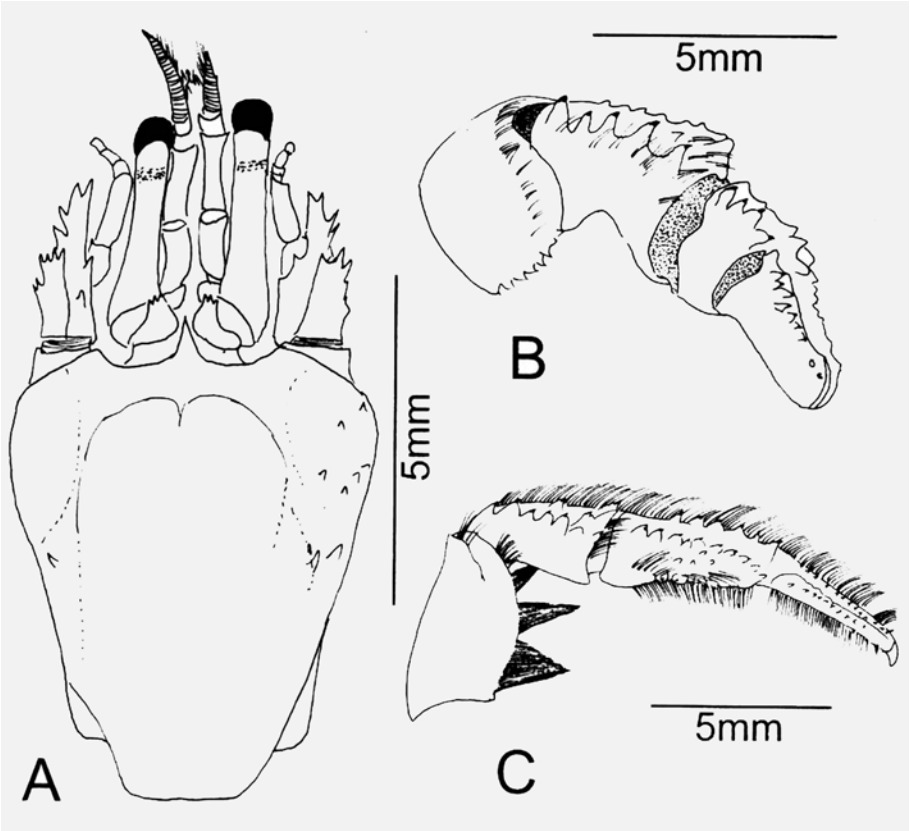

Fig.4- *Paguristes tortugae* Schmitt, 1933, ♂, MNRJ 19105. (A) cephalic region, dorsal view; (B) left cheliped, dorsal view; (C) second right walking leg, lateral view.

Genus *Paguristes*
Dana, 1851
Paguristes tortugae
Schmitt, 1933 (Fig.4)

Paguristes tortugae Schmitt, 1933:7, fig.4; 1935:204, fig.64; Wass, 1955:134; Provenzano, 1959:388, figs.11A, B; 12D; 1961:155;

Holthuis, 1959:131, fig.21, 22a; Williams, 1965:119, fig.96; 1984:205, fig.44; Forest & De Saint Laurent, 1967:74, figs.7, 18, 27, 38 e 46; Coelho & Ramos, 1972:167; Hebling, 1978:425; Abele and Kim, 1986:31, 351 (Figs.g, h); Coelho & Ramos-Porto, 1987:48; Rieger, 1998:419; Melo, 1999:88, fig.42.

Material examined – Rocas Atoll, Barretinha channel, MNRJ, 19103, 2♂, 1♀, P.S.Young, P.C.Paiva and A.A.Aguiar coll., 05/X/2000; Rocas Atoll, pool with calcareous algae nodule, MNRJ, 19104, 9♂, 7♀ (4 ovigerous), P.S.Young, P.C.Paiva and A.A.Aguiar coll., 25/X/2000; Rocas Atoll, pool, in *Leucozonia nassa* Gmelin, 1791 shell, MNRJ, 19105, 1♂, S.N.Brandão, N.Magalhães and C.R.Tavares coll., 10/VII/2001.

Diagnosis – Rostrum well developed, triangular. Eyestalk and antennule white, with black bands. Cheliped with corneous and spooned fingertips. Dactyl of walking legs slightly longer than propodus.

Description – Length of cephalic shield varying from 4.4 to 7.1mm. Rostrum large, triangular, toward beyond side branches of front. Cephalic shield longer than broad (Fig.4A). Antennular peduncle reaching base of cornea or slightly longer. Antennal peduncle reaching three-fourths of eyestalk length. Antenna short, not reaching finger tips of cheliped and sparsely setose, with very short setae. Acicle covered by setae and armed with two spines on inner margin and at least three on outer edge, termination prominent.

Eyestalk straight, slender, as long as width of cephalic shield. Ophthalmic acicle with 3-4 spines decreasing in size laterally. Acicles separated by rostrum (Fig.4A). Chelipeds equal, finger tips corneous and spooned. Inner margins of moving fingers of palm and of carpus straight. Chela and walking leg margins densely setose, hiding spines. External half of palm and external margin of fixed finger beset with sharp, forwardly directed hooked spines, likewise the medial area of the upper surface of palm. Internal margin of chela similarly with strong spines. Carpus of right cheliped with 5 large spines on inner margin (Fig.4B); 5 slightly smaller spines on the outer margin and 3 to 4 acute spines on anterior margin. Merus with acute corneous spine near the anterior end of superior margin and 3 similar spines on the anterior margin (Fig.4B). Inner inferior margin with 3-4 acute spines. Walking legs with dense fringes of setae along superior and inferior margins. First right walking leg (Fig.4C), merus denticulate on dorsal margin; carpus with a row of conical spines on dorsal margin and a second row of irregular spines on inner surface, aligned with a similar row of 7-9 spines on the inner face of propodus; dorsal margin of propodus with 7-8 conical, slightly corneous-tipped spines; dactyl with about 15 transverse tubercle-like ridges on superior margin, ending in a single, strong dark claw. The corresponding left walking leg is similar, but with less prominent spines. Second pair of left walking legs nearly smooth, except for two distal spines on the dorsal margin of carpus.

Distribution – Western Atlantic: EUA (North Carolina) to Brazil until Rio Grande do Sul (Rieger, 1998; Melo, 1999), including now Rocas Atoll.

Type-locality – Dry Tortugas, Florida (Schmitt, 1933).

Remarks – *P. tortugae* is widely distributed in the Western Atlantic coast, although, this is the first record for Rocas Atoll, Brazil.

ACKNOWLEDGMENTS

To Instituto Brasileiro do Meio Ambiente e dos Recursos Naturais Renováveis (IBAMA) for logistics and license for zoological capture with scientific purposes. Dr. Paulo Márcio Costa for the identification of the gastropod shells and Dr. Paulo Young and two anonymous referees for revision and suggestions on the manuscript.

REFERENCES

ABELE, L.G. & KIM, W., 1986. An Illustrated guide to the marine decapod crustaceans of Florida**. Technical Series,** Tallahassee, **8,** Parts 1 and 2:1-760.

BENEDICT, J.E., 1901. The Anomuran Collections made by the Fish Hawk Expedition to Porto Rico. **Bulletin of United States Fish Commision, 20**(2):129-148, pl.3-6.

BIFFAR, T.A. & PROVENZANO, A.J., 1972. A reexamination of *Dardanus venosus* (H. Milne Edwards) and *D. imperator* (Miers), with a description of a new species of *Dardanus* from the Western Atlantic (Crustacea, Decapoda, Diogenidae). **Bulletin of Marine Science, 22**(4):777-805.

BOUVIER, E.L., 1918. Sur une petite collection de crustacés de Cuba offerte au Muséum par M. de Boury**. Bulletin Musée Histoire Naturelle**, **24**:6-15.

COELHO, P.A., 1971. A distribuição dos crustáceos decápodos reptantes do norte do Brasil. **Trabalhos do Instituto Oceanográfico da Universidade Federal de Pernambuco**, **9/11**:223-238.

COELHO, P.A. & RAMOS A.A., 1972. A Constituição e a distribuição da fauna de decápodos do litoral leste da América do Sul entre as latitudes 5° N e 39°S. **Trabalhos do Instituto Oceanográfico da Universidade Federal de Pernambuco, 13**:133-236.

COELHO, P.A. & RAMOS-PORTO, M., 1987. Sinopse dos crustáceos decápodos brasileiros (famílias Callianassidae, Upogebiidae, Parapaguridae, Paguridae e Diogenidae). **Trabalhos do Instituto Oceanográfico da Universidade Federal de Pernambuco**, **19**:27-53.

COELHO, P.A. & SANTOS, M.F., 1980. Zoogeografia marinha do Brasil. I. Considerações gerais sobre o método e aplicação a um grupo de crustáceos (Paguros: Crustacea, Decapoda, super-famílias Paguroidea e Cenobitoidea*)*. **Boletim Instituto Oceanográfico de São Paulo**, **29**(2):139- 144.

FOREST, J. & De SAINT LAURENT, M., 1967. Campagne de la Calypso au large des cotes atlantiques de l'Amerique du Sud (1961-1962). 6. Crustacés décapodes: Pagurides. **Annales de l'Institut Océanographique**, **45**(2):47-169.

HAZLETT, B. A., 1981 - The Behavioral Ecology of Hermit Crabs. **Annual Review in Ecology and Systematics**, **12**:1-22.

HEBLING, N.J., 1978. Aspectos biológicos de alguns Crustacea Paguridea do litoral do Estado de São Paulo. **Anais da Academia Brasileira de Ciências**, **50**(3):424-425.

HERBST, J,F.W., 1782-1804. **Versuch einer Naturgeschichte der Krabben und Krebse nebst einer systematischen Bescreibung ihrer verrschiedenen,** Berlin, **Arten 1 (1782-1790)**:1-274, fig.A, pl.1-21; *2*(1791-1796):i-viii, 1-225, pl.22-46; *3*(1799-1804):1-66, pl.47-50; 1-46; pl.51-54, 1-54, pl.55-58, 1-49, pl.59-62.

HOLTHUIS, L.B., 1959. The Crustacea Decapoda of Suriname (Dutch Guiana). **Zoologische Verhandelingen,** Leiden, **44**:1-296, fig.1-67,pl.1-16.

MELO, G.A.S., 1999. **Manual de identificação dos Crustacea Decapoda do litoral Brasileiro. Anomura, Thalassinidea, Palinuridea, Astacidea**. São Paulo: Editora Plêiade. 551p.

MILNE EDWARDS, H., 1836 - Observations zoologiques sur les Pagures et description d'un nouveau genre de la tribu des paguriens. **Annales Science Naturelle et Zoologique**, sér. 2**, 6**:257-288, pl.13-14.

MILNE EDWARDS, H., 1848. Note sur quelques nouvelles espèces du genre *Pagure*. **Annales Science Naturelle et Zoologique,** sér.3**, 10**:59-64.

MOREIRA, C., 1901. Contribuições para o conhecimento da fauna brasileira. Crustáceos do Brasil. **Archivos do Museu Nacional do Rio de Janeiro, 11**:i-iv, 1-151, pl.1-5.

MOREIRA, C., 1906. Campanhas de pesca do "Annie". Crustaceos. **Archivos do Museu Nacional do Rio de Janeiro, 13**:1-25, fig.2, pl.1-5.

PROVENZANO, A.J., 1959. The shallow-water hermit crabs of Florida. **Bulletin of Marine Science of the Gulf and Caribbean, 9**(4):349-420, figs.1-21.

PROVENZANO, A.J., 1961. Pagurid crabs (Decapoda, Anomura) from St. John, Virgin Island, with descriptions of three new species. **Crustaceana**, **3**(2):151-166, figs.1-3.

RANKIN, W.M., 1900. The Crustacea of the Bermuda Islands. With notes on the collections made by the New York University Expeditions in 1897 and 1898. **Annals of the New York Academy of Science, 12**:521-548.

RATHBUN, M.J., 1900. Results of the Branner-Agassiz Expedition to Brazil. I. The Decapod and Stomatopod Crustacea. **Proceedings of the Washington Academy of Sciences, 2**:133-156, pl.8.

RIEGER, P.J., 1998. Malacostraca – Eucarida. Paguroidea. In: YOUNG, P. S. (Ed.) **Catalogue of Crustacea of Brazil**. Série Livros 6. Rio de Janeiro: Museu Nacional. p.413-429.

SCHMITT, W.L., 1924. Report on the Macrura, Anomura and Stomatopoda collected by the Barbados-Antigua Expedition from the University of Iowa in 1918. **Studies in Natural History of Iowa Universty, 10**(4):65-99, pls.1-5.

SCHMITT, W.L., 1933. Four new species of decapod crustaceans from Porto Rico. **American Museum Novitates**, **662**:1-9, figs.1-4.

SCHMITT, W.L., 1935. Crustacea Macrura and Anomura of Porto Rico and the Virgin Islands. **Scientific Survey of Puerto Rico and Virgin Islands, 15**:125-227, fig.1-80.

SCHMITT, W.L., 1936. Macruran and Anomuran Crustacea from Bonaire, Curaçao and Aruba. Zoologische Ergebnisse einer Reise nach Bonaire, Curaçao and Aruba im Jahre 1930. No. 16. **Zoologische Jarburcher Systematische, 67**:363-378, pls.11-13.

SCULLY, E.P., 1979. The effects of gastropod shell availability and habitat caracteristics on shell utilization by the intertidal hermit crab *Pagurus longicarpus* Say. **Journal of Experimental Marine Biology and Ecology**, **37**:139-152.

SMITH, S.I., 1869. Notice of the Crustacea collected by Prof. C. F. Hartt on the Coast of Brazil in 1867. **Transactions of the Connecticut Academy of Arts and Sciences, 2**:1, pl.1.

STIMPSON, W., 1859. Notes on North American Crustacea, No. 1. **Annals of the Lyceum of Natural History of New York**, **7**:49-93, pl.1.

VERRIL, A.E., 1908. Decapod Crustacea of Bermuda: I. Brachyura and Anomura. Their distributions, variations, and habits. **Transactions of the Connecticut Academy of Arts and Sciences, 13**:299-474., figs.1-68, pls.9-28.

WASS, M. L., 1955. The decapod crustaceans of Alligator Harbor and adjacent inshore areas of Northwestern Florida. **Quarterly Journal of Florida Academy of Sciences, 18**:129-176, figs.1-13.

WILLIAMS, A.B., 1965. Marine decapod crustaceans of the Carolinas. **Fishery Bulletin of the Fish and Wildlife Service of United States, 65**(1):1-298, fig.1-252.

WILLIAMS, A.B., 1984. **Shrimps, lobsters and crabs of the Atlantic Coast of the Eastern United States, Maine to Florida**. Washington, D. C.: Smithsonian Institution Press. 550p.