

Taxonomic and distributional results of a freshwater crab fauna survey (Family Trichodactylidae) on São Sebastião Island (Ilhabela), South Atlantic, Brazil

Resultados taxonômicos e de distribuição de um levantamento da fauna de caranguejos de água doce (Família Trichodactylidae) da Ilha de São Sebastião (Ilhabela), Atlântico Sul, Brasil

Mossolin, E.C. and Mantelatto, F.L.

Laboratório de Bioecologia e Sistemática de Crustáceos – LBSC,
Departamento de Biologia, Faculdade de Filosofia, Ciências e Letras de Ribeirão Preto – FFCLRP,
Universidade de São Paulo – USP, Av. Bandeirantes, 3900, CEP 14040-901, Ribeirão Preto, SP, Brazil
e-mail: ecmossolin@yahoo.com.br, flmantel@usp.br

Abstract: The Island of São Sebastião is the largest and most populated island on the northern coast of São Paulo, Brazil. Despite its unquestionable importance as a State Park area, now permanently preserved, no scientific information on the freshwater decapod crustaceans living on this island is available. Here, we furnish taxonomical and distributional features of the freshwater crabs, as part of a long-term effort to identify and characterize the biology of decapod crustaceans occurring on the island. The data for the survey were obtained between July 2006 and October 2007, by sampling at 65 different points around the island, from sea level to about 200 m a.s.l., using sieves and traps. The species found were *Trichodactylus dentatus*, *T. fluviatilis* and *T. petropolitanus*. Although mature males and females were collected, ovigerous females were not. The presence of the Trichodactylidae, an exclusively freshwater group, on oceanic islands has great value in studies of biogeographical, ecological, and evolutionary processes in crustaceans, and should be a topic of future studies in order to better enhance knowledge of the relationship between island and continental populations and the mechanisms of colonization in both habitats.

Keywords: Crustacea, Decapoda, freshwater, Ilhabela, faunal survey.

Resumo: A Ilha de São Sebastião distingue-se por ser a maior e mais populosa na costa norte de São Paulo, Brasil. Apesar da indiscutível importância como área de Parque Estadual, tendo preservação permanente, nenhuma informação científica sobre os crustáceos decápodes de água doce que vivem na ilha está disponível. Apresentamos aqui aspectos taxonômicos e distribucionais dos caranguejos de água doce que constituem parte de um esforço em longo prazo para identificar e caracterizar a biologia dos macrocrustáceos decápodes desta ilha. Os dados do levantamento foram obtidos entre Julho/2006 e Outubro/2007 com um esforço de captura realizado em 65 pontos diferentes em torno da ilha, desde o nível do mar até aproximadamente 200 m acima do nível do mar, utilizando as metodologias de coleta de peneiras e armadilhas. As espécies encontradas foram *Trichodactylus dentatus*, *T. fluviatilis* e *T. petropolitanus*. Mesmo coletando machos e fêmeas adultos, fêmeas ovígeras não foram observadas. A presença dos Trichodactylidae, um grupo exclusivamente de água doce, em ilhas oceânicas tem grande valor nos estudos sobre biogeografia, ecologia e processos evolutivos dos crustáceos e deve ser um tópico de estudos futuros visando acentuar o conhecimento nas relações entre populações continentais e de ilhas e o mecanismo de colonização em ambos os habitats.

Palavras-chave: Crustacea, Decapoda, água doce, Ilhabela, levantamento da fauna.

1. Introduction

Studies on the diversity of freshwater decapod crustaceans have been sporadic and partial in the State of São Paulo. The first studies about this fauna date from the end of the 19th Century and the beginning of the 20th, and were carried out by natural historians such as Ihering (1897), Ortmann (1897), Moreira (1901), Luederwaldt (1919a; 1919b, 1929), and Mello (1967). In recent years, this fauna has received more attention in some aspects and was reviewed by Young (1998), Magalhães (1999), Melo (2003), Rocha and Bueno (2004), and Magalhães et al. (2005).

The Island of São Sebastião (also popularly called Ilhabela) is the largest and most populated island off the coast of São Paulo. Although the island covers only a small area compared to the extensive southern and southeastern coast of Brazil, scientific information on the composition of its carcinological fauna is desirable. All information about insular fauna is important, because the life-cycle characteristics of native species are sometimes different from those developed by species in the coastal region. Knowledge of their communities contributes to resolving problems related to the evolution, speciation, and distribution of

living organisms. This condition was corroborated by other studies on a nearby island (Garcia and Mantelatto, 2000; Mantelatto and Garcia, 2002; Mantelatto et al., 2004 for details).

As part of the Brazilian research project on systematics (PROTAX – MMA/CAPES/CNPq), and in accordance with recommendations of environmental protection agencies, which stimulated surveys of species in preserved areas, we carried out an unprecedented study on this island, involving identification of the decapod crustaceans, establishment of reference collections, and investigation of aspects of the biology of their populations. In this study, we present the results of the faunal survey of the freshwater brachyurans of São Sebastião Island.

2. Material and Methods

The animals were obtained between July 2006 and October 2007, by using sieves and traps in rivers from sea level to about 200 m a.s.l. across the Island. The sieve was used along vegetated streambanks, and the trap was installed only in deeper areas, during the afternoon, and withdrawn in the morning of the following day. The standard use for the traps was only one night, whereas the standard effort with the sieve was about 15 minutes. The number of traps was between 2 and 4, according to river configuration. The geographical coordinates of all sampling points were recorded with a GPS.

The individuals were released in the same locality where they had been caught, except those that were fixed in 70-80% EtOH for the reference collections. Voucher specimens are deposited in the following Crustacean Collections: Museum of Zoology - University of São Paulo (MZUSP), Faculty of Philosophy, Sciences and Letters of Ribeirão Preto - FFCLRP, University of São Paulo - USP (CCDB), and the collections of Ilhabela State Park.

The sex of each individual was checked, and the carapace width was measured with a digital caliper (precision: 0.01 mm).

3. Results

In total, 65 points were sampled, and populations of crabs were found in 15 of them (Figure 1 - the points where crabs were not found are indicated in the map by the symbol “°”). The species found were *Trichodactylus dentatus* H. Milne Edwards, 1853 (3 specimens), *T. fluviatilis* Latreille, 1828 (127 specimens), and *T. petropolitano* (Göldi, 1886) (44 specimens). The capture effort was similar in all areas, and the values show the relative abundance of species.

We list the points where crabs were collected (name and number), geographical coordinates, date of sample, number of individuals per sex, size range, capture method (Sieve = S or Trap = T), name and number of collection (MZUSP and/or CCDB). At all points where crabs were

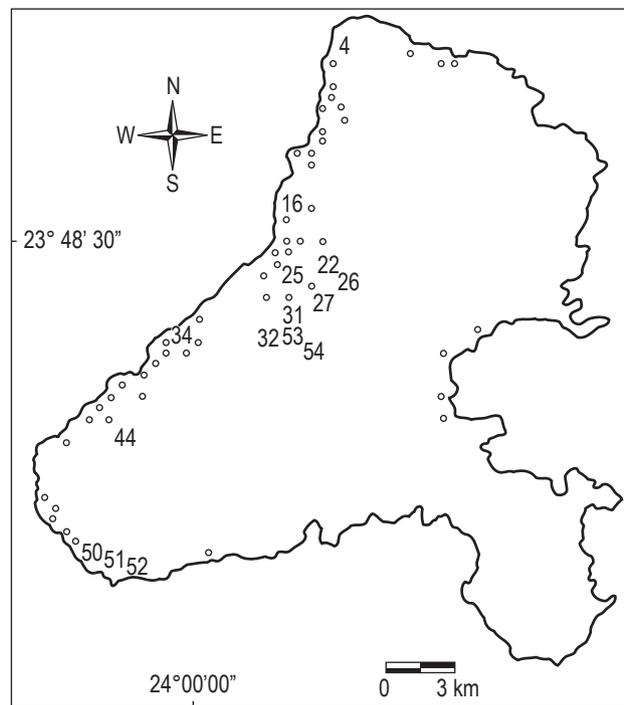


Figure 1. Map of the Island of São Sebastião, showing sampling points where trichodactylid crabs were collected (° = indicates a sampling point where no crabs were found).

found, the rivers were not influenced by tides, and the salinity was approximately 0‰.

Trichodactylus dentatus H. Milne Edwards, 1853 (Figure 2)

Material: Brazil, São Paulo, Ilha de São Sebastião: Alto da Praia do Engenho D'água (Point 16 on the map) (23° 47' 30.8" S and 45° 21' 36.9" W), 20.IX.2006, 1 ♂ 15.7 mm (S) (MZUSP 18207); Praia do Portinho (Point 34) (23° 50' 42.8" S and 45° 24' 15.6" W), 17.VII.2006, 1 ♂ 13.3 mm, 1 ♀ 21.7 mm (S) (MZUSP 18200, CCDB 2077).

Remarks: *Trichodactylus dentatus* is endemic to Brazil (Rio de Janeiro, São Paulo, Paraná and Santa Catarina). This species is commonly found in the coastal basins, and also the basin of the Upper Paraná River (Magalhães, 2003). The main characteristic that distinguishes this species from the other two caught in this study is the anterolateral margin with three small, acute teeth, where the first two are closer to each other than to the third tooth.

On the Island of São Sebastião, the specimens were found about 50 m from the beach, inhabiting areas with strong human influence such as buildings and domestic garbage. Compared with the previous literature, the low number of individuals is indicative of a small population on the Island, and inspires caution regarding its possible extinction.

Trichodactylus fluviatilis Latreille, 1828 (Figure 3)

Material: Brazil, São Paulo, Ilha de São Sebastião: Ponta das Canas (Point 4 on the map) (23° 43' 42.8" S and 45° 20' 28.0" W), 12.XI.2006, 2 ♂ 11.8 and 22.1 mm (S) (MZUSP 18194, CCDB 2069); Cachoeira da Toca (Point 26) (23° 49' 34.8" S and 45° 20' 30.3" W), 13.VIII.2006, 3 ♂ 18.9 to 29.9 mm, 1 ♀ 32.5 mm (T) (MZUSP 18197, CCDB 2074); Green Park (Point 27) (23° 49' 41.8" S and 45° 20' 51.2" W), 9.I.2007, 1 ♂ 33.6 mm, 2 ♀ 31.6 and 32.4 mm (T) (MZUSP 18190, CCDB 2072); Poço da Pedra (Point 31) (23° 50' 26.1" S and 45° 21' 33.8" W), 9.I.2007, 13 ♂ 17.2 to 27.3 mm, 21 ♀ 21.8 to 29.8 mm (T) (MZUSP 18191, CCDB 2075); Cachoeira do Veloso (Point 44) (23° 53' 04.3" S and 45° 25' 52.2" W), 19.VII.2006, 1 ♂ 9.2 mm (S) (MZUSP 18201); Porto dos Frades (Point 50) (23° 55' 44.6" S and 45° 26' 33.5" W), 13.VII.2006, 1 ♂ 20.2 mm (T) (MZUSP 18203); Cachoeira da Vista (Point 51) (23° 55' 54.9" S and 45° 26' 26.0" W), 13.VII.2006, 3 ♂ 22.9 to 32.1 mm,

15 ♀ 25.4 to 35.1 mm (T) (MZUSP 18195, CCDB 2063, CCDB 2070); Marambaia (Point 52) (23° 56' 04.0" S and 45° 25' 51.9" W), 13.VII.2006, 1 ♂ 6.2 mm (S) (MZUSP 18208), 2 ♂ 32.1 and 36.7 mm, 2 ♀ 27.2 and 33.5 mm (T) (MZUSP 18198, CCDB 2076); Poço da Escada (Point 53) (23° 50' 30.0" S and 45° 21' 32.7" W), 9.I.2007, 7 ♂ 17.9 to 26.8 mm, 13 ♀ 21.0 to 27.5 mm (T) (MZUSP 18188, CCDB 2071); Córrego do Ramalho (Point 54) (24° 50' 31.1" S and 45° 21' 34.6" W), 9.I.2007, 16 ♂ 21.8 to 33.1 mm, 23 ♀ 21.4 to 29.8 mm (T) (MZUSP 18192, CCDB 2073).

Remarks: Species endemic to Brazil, found in 11 states (Pernambuco, Alagoas, Sergipe, Bahia, Minas Gerais, Espírito Santo, Rio de Janeiro, São Paulo, Paraná, Santa Catarina and Rio Grande do Sul) (Magalhães, 2003). It lives in rivers and streams, and is common among and under rocks in mountain streams. It occurs in the coastal basins of eastern Brazil, coincident with the area formerly covered by the Atlantic Forest, and in the basin of the Upper Paraná River (Magalhães, 2003). The diagnostic characters of this species are the anterolateral margin of the carapace smooth or with 1-3 notches, and the major cheliped with the palm compressed and shorter than the dactylus.

Trichodactylus fluviatilis was the most abundant freshwater crab on the Island of São Sebastião. It was found in large and small streams, large and small waterfalls, in silt bottoms and among decomposing leaves. The localities where it occurred were somewhat impacted by humans, and were at least 200 m from the beach or above 20 m altitude. In some places, the number of collected individuals indicated the existence of good-sized populations, with more than 5 individuals per trap/night (Green Park, Poço da Pedra, Cachoeira da Vista, Poço da Escada, and Córrego do Ramalho).

Trichodactylus petropolitanus (Göldi, 1886) (Figure 4)

Material: Brazil, São Paulo, Ilha de São Sebastião: Rio da Toca (Point 22 on the map) (23° 49' 08.3" S and

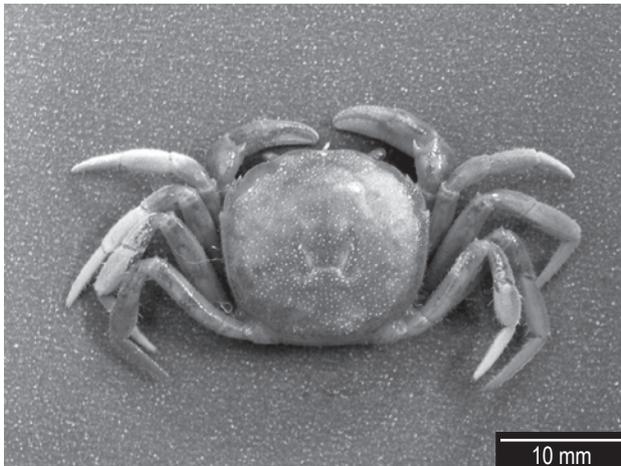


Figure 2. Male of *Trichodactylus dentatus*.

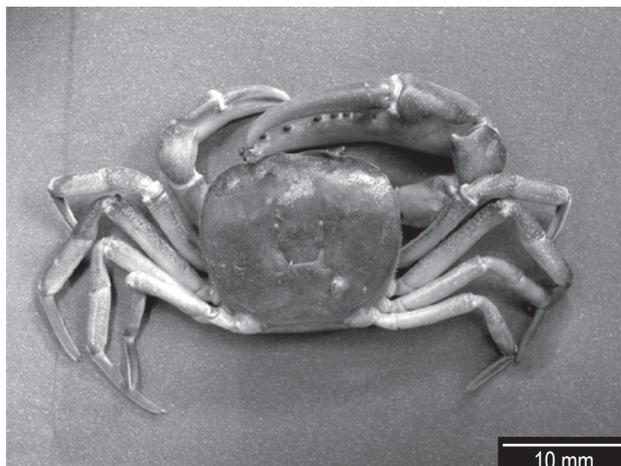


Figure 3. Male of *Trichodactylus fluviatilis*.

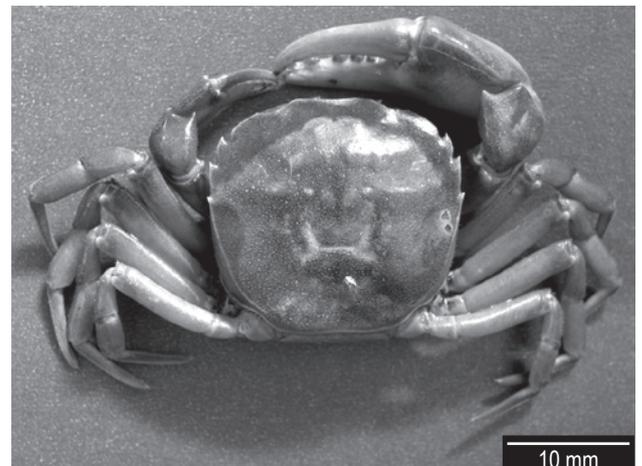


Figure 4. Male of *Trichodactylus petropolitanus*.

45° 21' 22.0" W), 13.VII.2006, 19 ♂ 6.1 to 34.5 mm, 1 ♀ 27.0 mm (S) (MZUSP 1819, CCDB 2062, CCDB 2065); Meio do Rio da Água Branca (Point 25) (23° 49' 23.2" S and 45° 21' 47.9" W), 18.VI.2006, 1 ♂ 6.2 mm (S) (MZUSP 18206); Green Park (Point 27) (23° 49' 41.8" S and 45° 20' 51.2" W), 9.I.2007, 2 ♂ 9.7 and 19.4 mm (S) (MZUSP 18204, CCDB 2067), 4 ♂ 24.5 to 31.1 mm, 11 ♂ 22.9 to 31.2 mm (T) (MZUSP 18189, CCDB 2064); Tesouro da Colina (Point 32) (23° 50' 19.9" S and 45° 22' 25.0" W), 9.I.2007, 4 ♂ 7.8 to 19.7 mm (S) (MZUSP 18202, CCDB 2068), 2 ♂ 23.5 and 27.5 mm (T) (MZUSP 18199, CCDB 2066).

Remarks: Species found in Brazil (Minas Gerais, Rio de Janeiro, São Paulo, Paraná and Santa Catarina) and Argentina (Magalhães, 2003). Its habitat and preferences are similar to those of *T. fluviatilis* (see Magalhães, 2003). The main distinguishing characteristics are the anterolateral margin with 3 large, equally spaced teeth, and the irregular carapace.

On the Island of São Sebastião it was found in large, slowly flowing rivers. Most of the areas were human-impacted. This crab was found from 5 m above sea level up to 160 m a.s.l.

4. Discussion

The fresh water genus *Trichodactylus* is represented in Brazil by nine species, of which four occur in the state of São Paulo (Magalhães, 2003). The efficiency of our sampling methods revealed that the diversity of freshwater crabs on Ilha de São Sebastião is reasonable, since three of the nine known species were found there. The absence of ovigerous females is possibly explained by their cryptic behavior, as observed by Alarcon et al. (2000).

The presence of crustaceans on Ilhabela was reported first at the end of the 19th Century, but always in partial studies. Ihering (1897) was the first to publish a treatment of the island's freshwater crab fauna. He mentioned small numbers of freshwater crabs and shrimps in thundering waterfalls. In 1929, Luederwaldt, in a report exclusively on Ilhabela, recorded the occurrence of *T. fluviatilis* and *T. petropolitanus* in several cascades and rivers.

Most species of Brazilian trichodactylid crabs inhabit coastal-plain rivers, at low altitudes up to 300 m (Magalhães, 2003). However, specimens of *T. fluviatilis* and *T. petropolitanus* have been collected in rivers in the Serra de Paranapiacaba, at altitudes up to 500 m and about 65 km from the coast of the State of São Paulo (Rocha and Bueno, 2004). Additionally, *T. fluviatilis* has been reported in other areas distant from the coast, such as Cerqueira César (256 km from the coast), Piracicaba (176 km), and Corumbataí (224 km) (Mello, 1967). This information leads us to infer that the trichodactylid fauna of Ilhabela represents populations established before the island separated from the continent, since the entire life cycle of this

group occurs in fresh water. The conquest of continental waters, river headwaters, and coastal-plain rivers represents an intriguing mechanism of dispersion and should be verified in the future, comparing populations from the three hydrographic basins (i.e., insular, coastal and continental) in order to understand the evolution of the group.

Ihering (1897) suggested that the island was formerly part of parallel mountain ranges, based on the existence of a wide, uniform channel between the island and the nearby continental mountain range of the Serra do Mar. Also, the island's geological constitution does not differ from that of the nearby continent. Ilhabela's relief was formed by alkaline eruptive rocks that broke through Precambrian gneisses during volcanic episodes about 81 million years ago (Olmos, 1996). The island was formed by the elevation of the coastal mountain range, and is a remnant of the erosive process of this mountain range. The São Sebastião Channel was formed during glacial periods during the Pleistocene, and processes of sea-level fluctuation contributed to the evolution of the channel (Furtado, 1995).

Ilhabela probably had a fauna similar to the mainland prior to its isolation, a reasonable assumption because of the island's size, topography, proximity to the mainland and especially its geological history. The composition of island biotas depends on the combined effects of immigration and extinction, directly related to island size and degree of isolation (Olmos, 1996). The island is separated from the mainland by a channel only 2 km wide, and in some places not more than 10 m deep (Olmos, 1994). Ihering (1897), when analyzing the fauna of freshwater crabs, frogs, and fishes, assumed that the island was previously part of the continent.

Another factor to be considered is that the fauna of the island, including crabs, is currently subject to intense human impact. The rapid expansion of tourism and the new housing subdivisions have affected areas where the environment is theoretically protected, which has also caused damage to the animal populations. Guix et al. (1999) described the deforestation of most of the island below 300 m, and in some locations above 500 m, between the early 18th and mid-20th centuries, including all of the freshwater swamps on the coastal plains, for sugarcane and coffee production (Olmos, 1996). Despite these problems, Ilhabela has some favorable advantages for stabilization and preservation of the fauna, because of the area protected by the State Park, and the existence of areas where access for vehicles or hiking is very difficult.

The presence of the Trichodactylidae, an exclusively freshwater group, on oceanic islands has great value for studies on biogeographical, ecological, and evolutionary processes of crustaceans. Our results demonstrate that this island shares some diversity characteristics of freshwater crabs with continental populations, reinforcing the importance of this distributional pattern for understanding of the evolution of the group on the South American continent. However,

the present faunal composition of Ilhabela presents a puzzle that cannot be explained by a single factor. As previously proposed for other groups of animals (Olmos, 1996), multiple causes are implied, some of them in the distant past and others being the result of a combination of the presence of humans and our relationship with the environment.

Studies on genetic population analyses by molecular tools are in progress, to enhance our current understanding of the relationships between historical river connections and phylogeographic patterns of these freshwater crabs, as well as to assist in management decisions relating to stock assessment issues on this island.

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