



New records of *Trichodactylus fluviatilis* Latreille, 1828 (Decapoda: Brachyura: Trichodactylidae) in Southeastern Brazil

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Abstract

Freshwater crabs play important ecological roles in lotic ecosystems, occupying different trophic levels and participating in the detritus food chain. *Trichodactylus fluviatilis* is a freshwater crab that occurs along the Brazilian coast and inland portions of southeastern Brazil. This species occurs in rivers and in coastal and mountain streams up to more than 1,100 m above sea level. Herein we report the occurrence of *T. fluviatilis* in one of the largest Atlantic Forest remnants located on flat terrain, which contains one of the most threatened vegetation types found within this biodiversity hotspot. We collected one adult female and 15 juveniles over four sampling occasions between February and September 2015. These records extend the number of locations where the presence of *T. fluviatilis* was confirmed and contribute to the knowledge about the geographical distribution of this species in Espírito Santo state and in the Atlantic Forest. This information will prove valuable in refining distribution maps and assessing the species' threatened status, aiding in the formulation of wildlife conservation strategies for streams in the Atlantic Forest.

Keywords: Atlantic Forest Streams; Biogeography; Freshwater Crab; Lowland Forest; Natural History

Introduction

Most studies on the carcinofauna of Brazil refer to marine and estuarine species, while the exclusively freshwater species still receive little attention. Freshwater crabs play important ecological roles in lotic ecosystems, occupying different trophic levels and participating in the detritus food chain [1-4]. Because of their high biomass in some tropical streams and a generalist feeding behavior, freshwater crabs are potentially important for the regulation of energy flow in streams [5-7].

In Brazil, freshwater crabs are divided in two families, *Pseudothelphusidae* and *Trichodactylidae* [8]. This last family comprises species whose presence is confirmed throughout

continental regions of Tropical America [9] and oceanic islands of southeastern Brazil [10]. Among the species of this family, *Trichodactylus fluviatilis* Latreille, 1828 is a small-sized crab that can reach ~30 mm of carapace width, with females being larger than males [11]. The species is nocturnal and cryptic, sheltering under submerged rocks, logs, and leaves [5,7]. In Brazil, the species is distributed along the eastern coast, between the states of Pernambuco and Rio Grande do Sul [12], also including inland areas, as observed in the states of Minas Gerais and São Paulo [8,12]. This crab generally inhabits rivers and coastal and mountain streams at altitudes lower than 340 m above sea level [13], although the species can occupy altitudes above 1,100 m [14]. Currently, *T. fluviatilis* is classified in the Least Concern category according to the IUCN Red List [12].

Despite its recognized wide distribution, information on the geographical range of *T. fluviatilis* is still lacking also in the eastern portion of Brazil, as observed in the state of Espírito Santo [12]. Although Magalhães [8] reported points with occurrence of the species in this state, details about the geographic location of these records are missing. Souza-Carvalho, et al. [15] cited records from the south of Espírito Santo (municipalities of Dores do Rio Preto and Iconha) and from the central-coastal portion of the state (municipality of Serra). Additionally, at least two specimens were deposited in scientific collections, one collected in the extreme south of Espírito Santo (municipality of Mimoso do Sul; according to data available at SpeciesLink [16]) and another from the midwest of the state (Laranja da Terra; according to data available at SiBBR [17]). This corroborates the observation of Cumberlidge [12], which regarded the state of Espírito Santo as a substantial knowledge gap for the species, a situation that persists even 15 years later, especially in the northern region of the state.

Knowledge about the ecology and geographical distribution of wild species is essential for assessing the threatened status of a species and for proposing accurate biodiversity conservation strategies [18]. In this regard, wildlife surveys become important tools to support wild species conservation programs [19]. Herein, we confirm the occurrence of *T. fluviatilis* in continental streams located in the north of Espírito Santo, which constitutes the record of a new occurrence area for this species in southeastern Brazil.

Material and Methods

The records of *T. fluviatilis* were obtained in streams associated to the Vale Natural Reserve (Reserva Natural Vale - RNV; 22,711 ha), a protected area located in the municipality of Linhares, state of Espírito Santo (19.153013 S, 40.018791 W; Figure 1). The RNV is adjacent to the Sooretama Biological Reserve (Reserva Biológica de Sooretama - RBS; 27,858 ha) and other two private protected areas (Mutum-Preto Private Natural Heritage Reserve [Reserva Particular do Patrimônio Natural Mutum-Preto - RPPN Mutum-Preto; 379 ha] and RPPN Recanto das Antas [2,212 ha]). Altogether, the four units form a continuous block of native vegetation, the Linhares-Sooretama Forest Block (Figure 1). This is one of the largest Brazilian Atlantic Forest remnants located on flat terrain (also referred as Tabuleiro Forest), which contains one of the most threatened vegetation types of this biodiversity hotspot, the lowland forest [20]. The RNV forest is classified as Perennial Seasonal Forest [21]. The Linhares-Sooretama Forest Block represents about 11% of the remaining original forest cover in Espírito Santo (based on data available in FSOSMA & INPE [22]).

According to the Köppen classification system, the climate on the RNV region is tropical with dry winter (Aw) [23]. The average annual temperature in the region is 24.3 °C, varying between 18.7 and 29.9 °C (averages of the minimum and maximum records, respectively), and the annual rainfall is 1,215 mm, with a strong variation over the years [24]. The relief varies from flat to softly undulating, with altitudes ranging between 28 and 65 m above sea level. The local drainage area is composed by a dendritic/dichotomous network formed by the affluent streams of Barra Seca River [21]. The surroundings are occupied by pasture and crop areas, especially papaya and coffee monocultures [21,24]. However, since 2007, there has been an increase in eucalyptus plantations [25].

The records of *T. fluviatilis* were obtained during a benthic macroinvertebrate assemblage sampling. Samples of aquatic invertebrates were collected on four occasions (February, April, August and September 2015) from three different streams (Alegre de Cima, Paciência and João Pedro; Figure 1). In total, eight sampling stations were selected along the streams, being located on the edge of the forest (n = 4) and inside the reserve (n = 4; Figure 1). Three samples (replicates) were collected on leaf patches located on the substrate of each sampling station, totaling 24 samples per sampling occasion. Samples were collected using a Surber sampler (0.09 m², 250 µm mesh net), transported to the laboratory in plastic bags and washed over a 500 µm mesh. The retained material was sorted, and the invertebrates found were preserved in 70% ethanol. Posteriorly, the invertebrates were identified under a stereomicroscope (40×) using identification guides [8,26].

The collection of specimens was authorized by the Instituto Chico Mendes de Conservação da Biodiversidade / Sistema de Autorização e Informação em Biodiversidade (Process SISBIO nº 21990). The collected specimens were deposited in the Zoological Collection of the Museu de Biologia Professor Mello Leitão from the Atlantic Forest National Institute (Instituto Nacional da Mata Atlântica - INMA), in the municipality of Santa Teresa, Espírito Santo.

Results and Discussion

We identified an adult specimen (female; carapace width = 29.3 mm) and 15 juveniles of *T. fluviatilis* (Figure 2) in the aquatic invertebrate assemblages collected in the streams associated to the RNV. More specifically, the specimens were found on the leaf patches collected in Alegre de Cima and Paciência streams over three of the four sampling occasions (except on the last occasion). The specimens were collected on the edge of the forest and inside the reserve in two streams (Alegre de Cima = A1, A2 and A4; Paciência = P1 and P2; Figure 1).

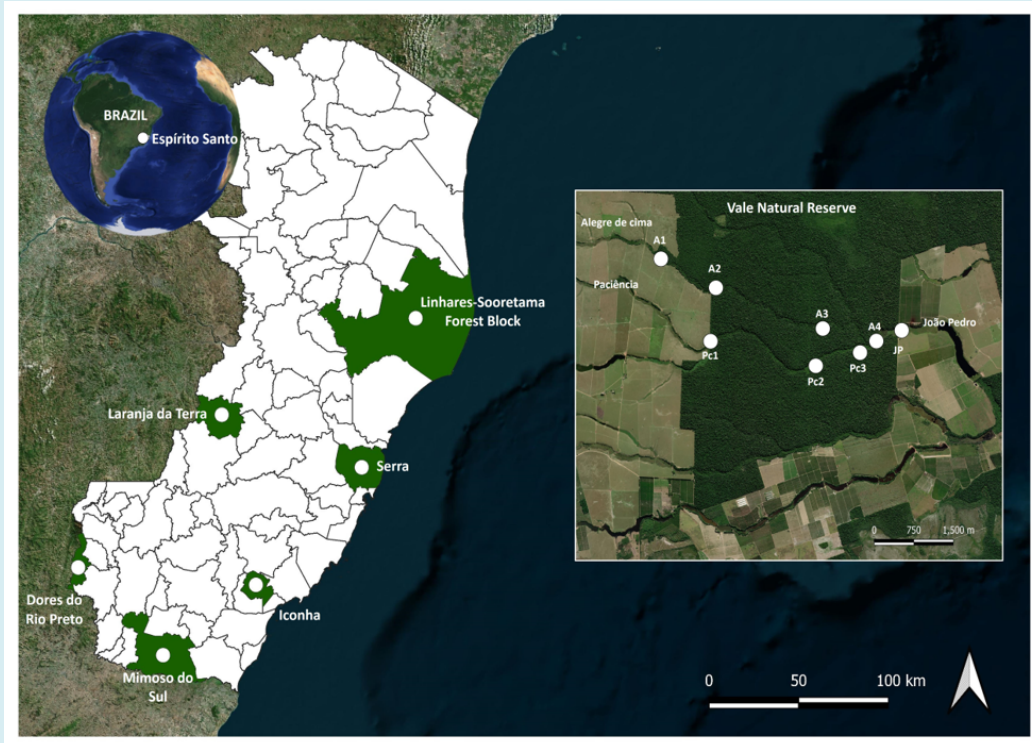


Figure 1: Location of the Linhares-Sooretama Forest Block in the north of Espírito Santo, southeastern Brazil, with the location of previous confirmed records of *Trichodactylus fluviatilis* in the state (Dores do Rio Preto, Iconha, Laranja da Terra, Mimoso do Sul and Serra) (A). The studied streams and the location of sampling stations are also indicated (A = Alegre de Cima, Pc = Paciência, JP = João Pedro) (B) [Source of the satellite images: Google Maps].

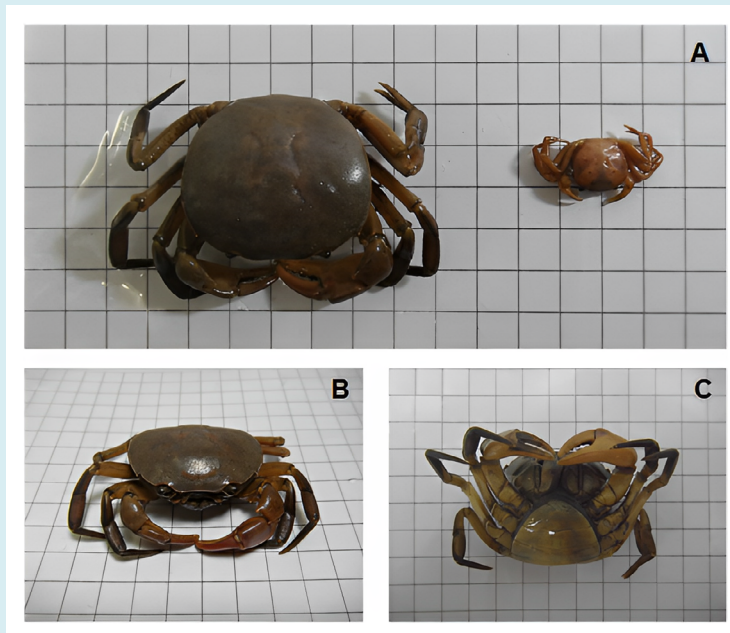


Figure 2: Adult female (left) and juvenile specimen (right) of *Trichodactylus fluviatilis* collected in the streams associated to the Vale Natural Reserve (A). The front (B) and ventral (C) views of the adult female are also showed. Note the anterolateral margin of the carapace with only one tooth (according to Mossolin and Mantelatto [10]). Grids are 7 x 7 mm.

The records here reported for the RNV complement the known distribution of *T. fluviatilis* in the state of Espírito Santo. Our records are approximately 245 km away from the municipality of Dores do Rio Preto, ~195 km away from Iconha, ~140 km away from Laranja da Terra, ~255 km away from Mimoso do Sul, and about 110 km away from the municipality of Serra (based on data available in the literature and scientific collections; see the introduction for details), where the previously known specimens were collected in the state (Figure 1). According to Souza-Carvalho, et al. [15], *T. fluviatilis* is formed by four main lineages associated with distinct hydrographic basins and geographical regions and should be considered a species complex. The population of RNV is part of the Lineage 1 proposed by Souza-Carvalho, et al. [15], which covers the southern region of Bahia state to the central and southern regions of Espírito Santo. Hence, the records from RNV are the first records of the species complex and, consequently, of the Lineage 1 in the northern portion of Espírito Santo.

The low abundance of *T. fluviatilis* recorded during our study in RNV, especially for adults, can be attributed mainly to the fact that the samples were collected during daytime, when *T. fluviatilis* is less active. In this regard, we highlighted that the species is nocturnal [5,7]. Furthermore, adults of freshwater crabs tend to remain hidden under submerged rocks and trunks [7]; and juveniles are commonly found on submerged leaf patches, where they have facility in food capture, protection against predators and reduction on intraspecific competition with adults [3,4]. These facts may have contributed to the high number of captures of juveniles of *T. fluviatilis* in the present study and thereby difficult the capture of adults, as samples were collected on submerged leaf patches.

Despite freshwater vertebrate species have been considered the most threatened in some regions, the status of freshwater invertebrates remains poorly defined [6]. Threats to freshwater tropical crabs have an anthropogenic origin, including the loss or alteration of their habitat and water pollution [6,27]. In this regard, it is noteworthy that the studied streams are located in a fragmented landscape and receive wastewater from the surrounding urban and rural areas dedicated to agricultural and pastoral activities. This can significantly change the physical, chemical and biological characteristics of the water in streams and rivers. According to Cumberlidge, et al. [6], while anthropogenic disturbances affecting freshwater crabs are practically inevitable in developing regions, it is necessary to strike a balance between development and habitat protection to ensure the conservation of wild species. This is even more relevant because the species that are less sensitive to habitat changes and occupy a wide geographic distribution may also experience significant population declines as a result of

human actions [28].

Biogeographic studies are important to improve our understanding of the phylogenetic relationships between species and the processes regulating their distribution [29]. Additionally, to know the distribution of species is essential in a context of constant biodiversity loss in order to contribute to conservation policies. Although this study does not suggest an expansion of *T. fluviatilis* distribution, our records increase the number of locations in Espírito Santo and provide a new report within the previously established range distribution of the species in the Atlantic Forest, assisting in refining distribution maps and providing information for a better assessment of the species' threatened status. In this regard, it is important to highlight that the geographic distribution of carcinofauna in South America remains poorly studied. And the registration of new areas of occurrence for freshwater decapods is particularly important for less known regions or regions exposed to anthropogenic changes [30], as most of the areas in the Atlantic Forest domain.

Authors Contributions

Hugo Silva Cavaca [Data collection and analysis, interpretation and writing]

Hilton Entringer Jr [Data analysis, interpretation and writing]

Ana Carolina Srbek-Araujo [Conceptualization, data analysis, interpretation and writing]

Conflicts of Interest

The authors declare that there are no conflicts of interest associated with this publication.

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