Check List the journal of biodiversity data

NOTES ON GEOGRAPHIC DISTRIBUTION

Check List 17 (2): 595–600
https://doi.org/10.15560/17.2.595

PENSOFT

New records of *Cissoanthonomus tuberculipennis* Hustache, 1939 (Coleoptera, Curculionidae), a biological control agent of *Cardiospermum grandiflorum* Sw. (Sapindaceae), from São Paulo, Brazil

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Abstract

The geographical distribution of the weevil *Cissoanthonomus tuberculipennis* Hustache, 1939 is extended in Brazil, with new records from the municipalities of Charqueada and Piracicaba, state of São Paulo. These are the second and third records of *C. tuberculipennis* in Brazil. The specimens were collected from infested fruits of *Cardiospermum grandiflorum* Sw. (Sapindaceae) in riparian forests along watercourses.

Keywords

Atlantic Rainforest, balloon vine, geographic distribution, host plant, weevil

Academic editor: Juan Pablo Botero Rodriguez | Received 13 December 2020 | Accepted 17 March 2021 | Published 6 April 2021

Citation: Sanz-Veiga PA, Lampert S, Savaris M (2021) New records of *Cissoanthonomus tuberculipennis* Hustache, 1939 (Coleoptera, Curculionidae), a biological control agent of *Cardiospermum grandiflorum* Sw. (Sapindaceae), from São Paulo, Brazil. Check List 17 (2): 595–600. https://doi.org/10.15560/17.2.595

Introduction

The genus *Cissoanthonomus* Hustache, 1939 (Coleoptera, Curculionidae, Anthomini) was described by Hustache (1939) to accommodate *Cissoanthonomus tuberculipennis* Hustache, 1939 from Bolivia, and this species also occurs in Argentina and Brazil (Clark 2006; McKay et al. 2010; Simelane et al. 2011; Lampert et al. 2013). This weevil species has a close association with fruits of the widespread Neotropical balloon vine, *Cardiospermum grandiflorum* Sw. (Sapindaceae), which is the only known natural host plant of *C. tuberculipennis* (Clark 2006; Simelane et al. 2014).

The larvae of *C. tuberculipennis* feed and develop in the seeds of *C. grandiflorum*. The seeds of this vine are contained in a balloon-shaped, inflated capsule with up to three seeds. Each larva can consume one or all the seeds within the same fruit. The mature larva pupates inside the capsule, and the emerging adult can be dispersed together with the fruit capsule by the wind and

along watercourses (McKay et al. 2010; Lampert et al. 2013). Because of its destructive ability and potential as a biological control agent, *C. tuberculipennis* has been introduced into South Africa to control the seeds of *C. grandiflorum* (Simelane et al. 2014; Simelane and Mawela 2019), which has been confirmed as an introduced and invasive weed species of ecological and economic concern in Africa, Australia, New Zealand, and several regions of Europe (Henderson 2001; Olckers 2004; Carrol et al. 2005; Simelane et al. 2011; Gildenhuys et al. 2015; Tanner et al. 2017).

However, despite the wide native distribution of *C. grandiflorum* in South America and its even wider predicted distribution as an invasive weed (Carroll et al. 2005; Simelane et al. 2011; Gildenhuys et al. 2013), *C. tuberculipennis*, one of the most important natural enemies of *C. grandiflorum* (McKay et al. 2010), has been reported as naturally occurring only in Argentina, Bolivia, and southern Brazil (Clark 2006; McKay et al. 2010; Simelane et al. 2011; Lampert et al. 2013). In Brazil, it was reared from fruits of *C. grandiflorum* collected on the banks of the Uruguay River in Herval Grande, Rio Grande do Sul (Lampert et al. 2013).

The reports of *C. tuberculipennis* as causing damage only in fruits of *C. grandiflorum* suggests that this weevil may be a monophagous species. Therefore, as specialized seed-feeding insects are expected to match the host plants' spatial distributions, we hypothesized that *C. tuberculipennis* would also be found in association with fruits of *C. grandiflorum* occurring in southeastern Brazil. Here, we document this seed-feeding weevil in the fruits of *C. grandiflorum* in two municipalities in São Paulo. We also determine the rate of fruit infestation.

Methods

This study was conducted in two municipalities which are 25 km apart in São Paulo, Brazil (Fig. 1, indicated by red stars). The study area included an urban area in the Santa Rita neighborhood (22°45′18″S, 047°35′00″W, 603 m a.s.l.) in the municipality of Piracicaba, and a rural area near the Santa Luzia neighborhood in Charqueada (22°34′12″S, 047°43′05″W, 572 m a.s.l.). In the region of our study, the main vegetation type is Seasonal Semideciduous Forest (Rodrigues 1999), and at both study areas *C. grandiflorum* plants occur in riparian vegetation. The climate is Cwa (dry-winter humid subtropical climate) according to the Köppen classification, with a hot rainy summer and a dry winter (Alvares et al. 2013).

The fruits of *C. grandiflorum* were sampled in July 2020 during a collecting expedition of the Insect Taxonomy Laboratory, Luiz de Queiroz College of Agriculture, University of São Paulo – (ESALQ/USP). In Piracicaba, 303 fruits were collected from one plant located near a lake (Fig. 2A). In Charqueada, 205 fruits were collected from a plant on the bank of a watercourse (Fig. 2B). At the time of sampling, the plants had abundant developing fruits (Fig. 2C), flowers, and buds (Fig. 2D, indicated by blue arrows).

All sampled fruits were placed in a mesh bag and transported to the laboratory, where they remained for about two months until adult weevils emerged. After two months, the fruits were dissected and checked for

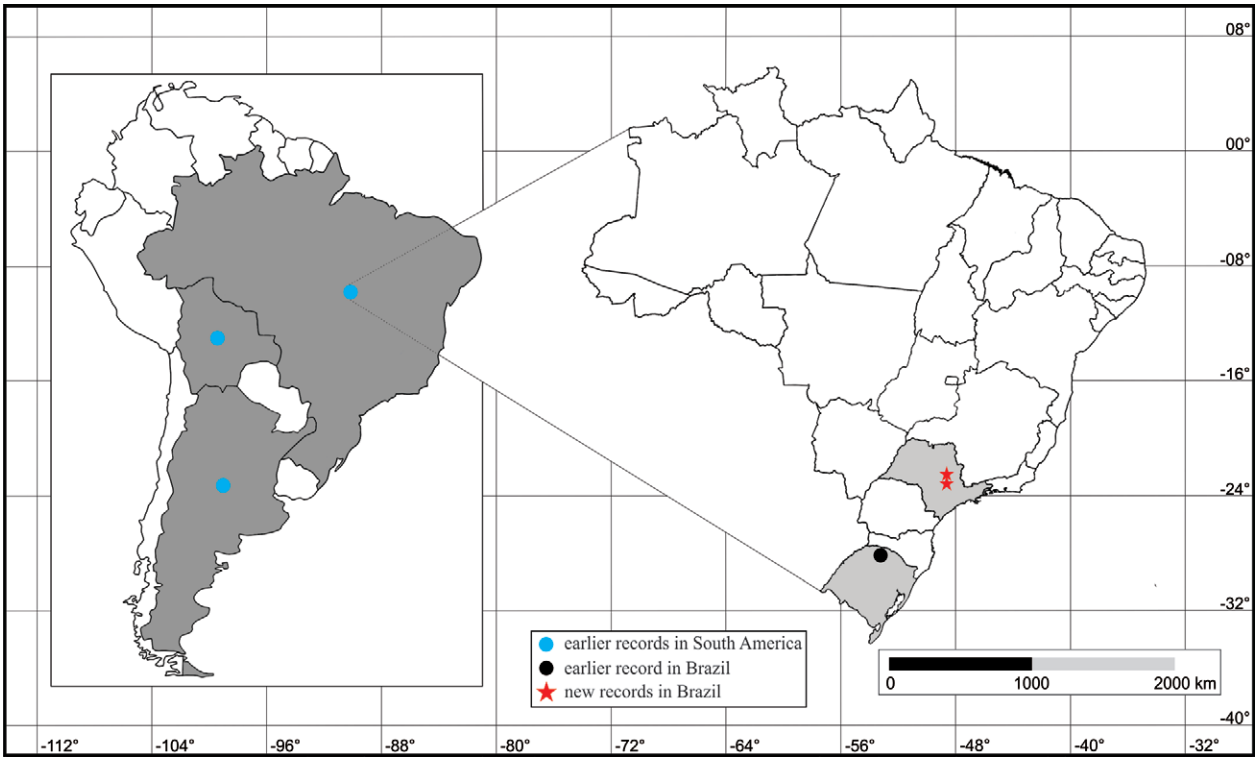

Figure 1. Distribution of *Cissoanthonomus tuberculipennis* in South America and new records in Brazil.

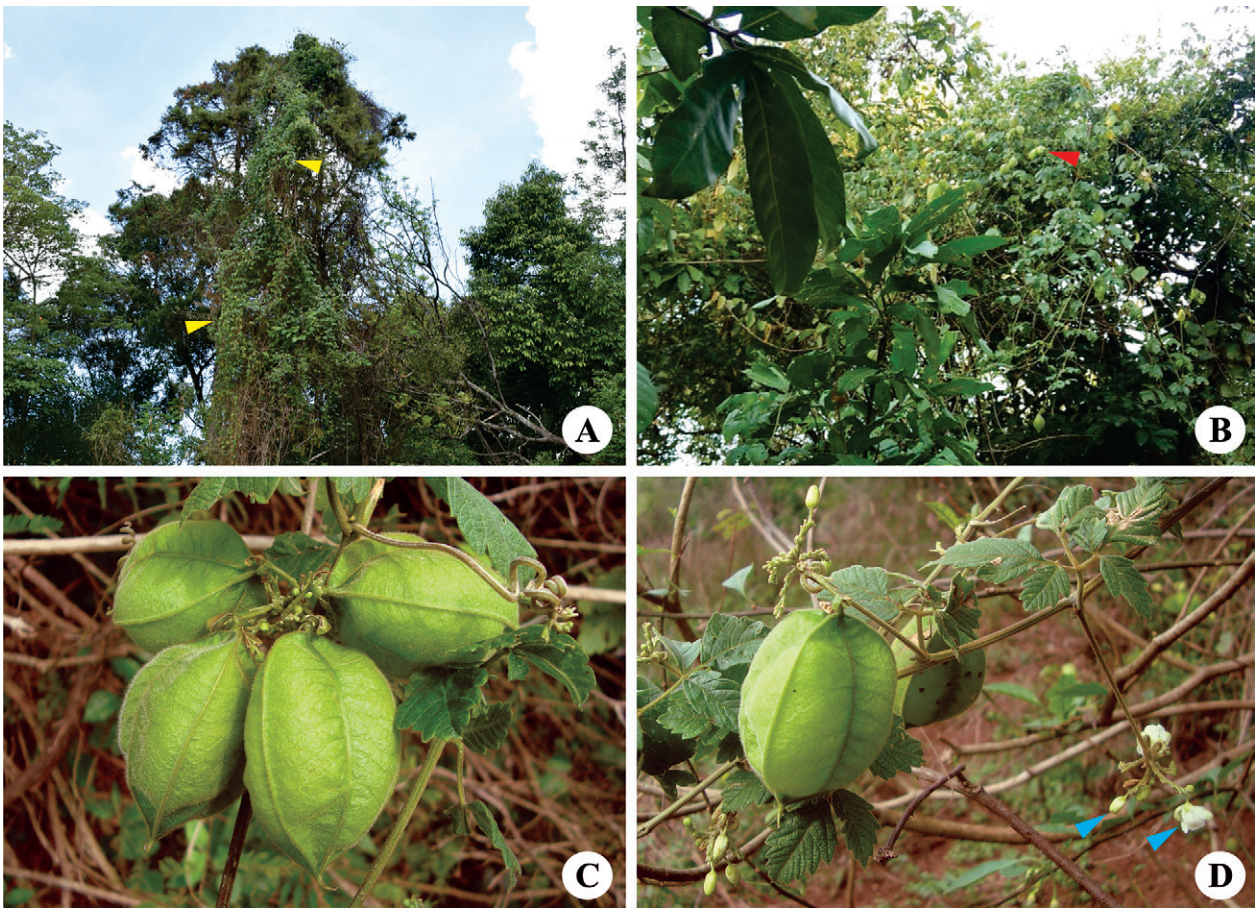

Figure 2. *Cardiospermum grandiflorum* from the municipalities of Piracicaba and Charqueada, São Paulo**. A.** Habitus of the plant near a lake in Piracicaba (indicated by yellow arrows). **B.** Habitus of the plant on the bank of a watercourse in Charqueada (indicated by the red arrow). **C.** Fruits. **D.** Buds and flowers (indicated by blue arrows).

the presence of damage, larvae, or adult weevils. The samples were checked every two days, and each emerged adult was removed and mounted on entomological pins for identification. The fruit infestation was determined by the number of fruits with insects/total number of fruits. We determined the percentage of damaged seeds as the total number of seeds with damage/total number of seeds.

The specimens were identified based mostly on Hustache (1939) and Clark (2006) and by comparison with specimens from the Entomological Collection "Padre Jesus Santiago Moure", Department of Zoology, Federal University of Paraná (DZUP). Voucher specimens are deposited in the Entomological Collection of the Museum of Entomology "Luiz de Queiroz" (MELQ), Department of Entomology and Acarology, Luiz de Queiroz College of Agriculture (ESALQ/USP). The sampling was licensed by the National System of Biodiversity Information (SISBIO), authorization numbers 61549-4 and 75681-1.

The habitus of adults was photographed with a Leica M205C stereomicroscope equipped with a Leica DFC 450 camera. The plants were photographed in the field with a Nikon D7200 camera. Digital photographs were enhanced using Photoshop CS6 to correct the color and make minor corrections (e.g., remove debris). The distribution map was composed using Quantum GIS v. 2.8. Latitude and longitude were obtained in each area, using a Garmin 78S GPS receiver.

Results

The weevils that emerged from fruits of *C. grandiflorum* were identified as *Cissoanthonomus tuberculipennis* Hustache, 1939 (Coleoptera, Curculionidae). These are the first records of this weevil from the municipalities of Charqueada and Piracicaba, state of São Paulo, and the second and third records of *C. tuberculipennis* in Brazil.

Cissoanthonomus tuberculipennis Hustache, 1939

Figure 3A, B

New records. BRAZIL – **São Paulo** • Piracicaba, Santa Rita neighborhood; 22°45′18″S, 047°35′00″W; 603 m alt.; 10.VII.2020; M. Savaris, S. Lampert, P.A. Sanz-Veiga leg.; reared from fruits of *Cardiospermum grandiflorum* Sw. (Sapindaceae); 20 specimens (♂, ♀); MELQ ESALQENT00073-92 • Charqueada, SP 308 road, near Santa Luzia neighborhood; 22°34′12″S, 047°43′05″W; 572 m alt.; 12–31.VII.2020; P.A. Sanz-Veiga leg.; reared from fruits of *Cardiospermum grandiflorum* Sw. (Sapindaceae); 20 specimens (♂, ♀); MELQ ESALQENT00093-112.

Figure 3. Habitus of *Cissoanthonomus tuberculipennis*. **A.** Adult in lateral view, highlighting the strong dorsal protuberances on the middle of the elytra (indicated by black arrows). **B.** Adult in frontal view, highlighting the greatly enlarged anterior femora (indicated by green arrow) with large toothlike expansion in the ventral region (indicated by blue arrow) and small preapical tooth (indicated by red arrow). Scale bars = 1 mm.

Identification. *Cissoanthonomus tuberculipennis* belongs to the monotypic genus *Cissoanthonomus*. The species can be identified by the body covered by light-brown setae, darker on apical half of the elytra (Fig. 3A) (Lampert et al. 2013). Other distinguishing features are: head deeply constricted behind eyes; anterior femora greatly enlarged (Fig. 3B, indicated by green arrow), bearing a large tooth in the mid-ventral region (Fig. 3B, indicated by blue arrow) and a small tooth pre-apically (Fig. 3B, indicated by red arrow); mid-dorsum of elytra with strong protuberances (Fig. 3A, indicated by black arrows); and elytral humeri acutely produced (Clark 1989, 2006).

Geographic distribution in Brazil. Rio Grande do Sul (Herval Grande) (Lampert et al. 2013); São Paulo (Charqueada and Piracicaba) (this publication).

Discussion

The first adults of *Cissoanthonomus tuberculipennis* started to emerge from fruits of *Cardiospermum grandiflorum* only a few days after the fruits were collected from the field. Larvae and pupae were observed in fruits mainly in July and August. By the end of August, a total of 10 adults emerged from fruits from the Santa Rita neighborhood (Piracicaba) and 32 specimens from fruits from the rural area near Santa Luzia (Charqueada). One month later, in September, most individuals of *C. tuberculipennis* remained inside the fruits, which were then dissected and checked for the presence of weevils. Lampert et al. (2013) also observed immature and mature forms in fruits collected in August in southern Brazil. In Argentina, however, Simelane et al. (2014) reported the presence of *C. tuberculipennis* associated with *C. grandiflorum* in two periods of the year, April–May and September–October.

Of the fruits sampled in Piracicaba, 31.7% (n = 96 fruits) and in Charqueada, 40.5% (n = 83 fruits) were infested with *C. tuberculipennis*. These infestation levels are similar to that observed by Simelane et al. (2014) for fruits of *C. grandiflorum* from Argentina, but lower than that observed by Lampert et al. (2013) in Rio Grande do Sul, where this seed-feeding weevil damaged 64.3% of the fruits.

A total of 96 adults were reared from the fruits from Piracicaba and 95 from Charqueada. Most fruits contained one individual, but some harbored two (n = 12). Thus, the number of insects per fruit was similar to that obtained by Lampert et al. (2013) in Rio Grande do Sul and in previous studies in northern Argentina, which also recorded a maximum of two adults per fruit (McKay et al. 2010; Simelane et al. 2014). Each developing larva consumed one or two seeds per fruit, a behavior also observed by McKay et al. (2010) and Lampert et al. (2013). The percentage of damaged seeds was greater in fruits collected at Charqueada, where 32% of seeds were destroyed by *C. tuberculipennis*, versus 17% of seeds from fruits sampled at Piracicaba. In Argentina, Simelane et al. (2014) found that the infestation of fruits by *C. tuberculipennis* was temporally variable, ranging from 19% to 44% in different years and between the two reproductive seasons within the same year. Moreover, studies carried out in Africa, 12 months after *C. tuberculipennis* was introduced as the biological control agent of *C. grandiflorum*, revealed spatial differences in the percentage of seeds damaged, ranging from 18% to 47% in different regions (Simelane and Mawela 2019).

The native distribution of *C. grandiflorum*, the only known host plant of *C. tuberculipennis*, extends from southern Mexico to Argentina and Brazil (Reitz 1980; Cowan 1983; Ferrucci 1991, 1998). In Brazil, *C. grandiflorum* occurs widely, with records from states in all five geographical regions; in the south (Paraná, Santa Catarina, and Rio Grande do Sul), southeast (Espírito Santo, Minas Gerais, Rio de Janeiro, and São Paulo), centralwest (Distrito Federal, Goiás, and Mato Grosso do Sul), northeast (Maranhão and Rio Grande do Norte), and north (Amazonas, Pará, and Rondônia) (Reitz 1980; Ferrucci 1991; Somner et al. 2015).

In Brazil, *C. tuberculipennis* was reared from fruits of *C. grandiflorum* collected in the state of Rio Grande do Sul (Lampert et al. 2013). The present collection of *C. tuberculipennis* in Piracicaba and Charqueada, approximately 700 km to the north of the previous record in Brazil, represents the first record of this weevil species in São Paulo state and the second and third records in Brazil. Considering the wide distribution of *C. grandiflorum* in Brazil, together with previous information available on the insect's behavior (Lampert et al. 2013; Simelane et al. 2014) and data on its potential spatial distribution (Simelane and Mawela 2019), we believe that this specialist seed-feeding weevil may have a wide distributional range in Brazil, highlighting the necessity of further studies to assess its occurrence, in view of the range of its host plant.

Acknowledgements

We thank the Postgraduate Program in Biological Sciences (Zoology) of São Paulo state University "Júlio de Mesquita Filho" and the Postgraduate Program in Entomology of the Luiz de Queiroz College of Agriculture, University of São Paulo (ESALQ/USP). This study was supported by the Coordenação de Aperfeiçoamento de Pessoal de Nível Superior (CAPES) [grant numbers 1754572, MS; finance code 001, PASV]; and the Conselho Nacional de Desenvolvimento Científico e Tecnológico (CNPq) [grant number 141974/2014-1, SL]. We thank Eraldo Barboza and José Tadeu Weidlich Motta (Museu Botânico Municipal de Curitiba) for identifying the host plant. We also thank the anonymous reviewers and the academic editor for improving the manuscript.

Authors' Contributions

PASV reared the specimens in the laboratory; MS and PASV identified the specimens; MS and SL composed

the figures. All authors conceived the study, collected the specimens in the field, analyzed the data, and wrote the final version of manuscript.

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