

New Species of *Tenuisvalvae* (Duverger) (Coleoptera: Coccinellidae) Feeding on *Parthenolecanium perlatum* (Cockerell) (Hemiptera: Coccidae) in Citrus Crop

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Abstract

A new species of Hyperaspini, *Tenuisvalvae quadripunctata* sp. nov. is described and illustrated. The genus is now represented by 11 species, all native of South America, and the new taxon is integrated into the existing key to species of the genus. Ecological data for *T. quadripunctata* sp. nov. and a list with prey and host plants to the species of the genus *Tenuisvalvae* are provided.

Introduction

The South American taxa of Hyperaspini (Coleoptera: Coccinellidae) were revised by Gordon & Canepari (2008) and ten species of *Tenuisvalvae* (Duverger 1989) were recognized. Most of them are important biological control agents.

Tenuisvalvae is characterized by having 11 articulated antennae with antennal bases partially concealed; apical maxillary article slightly emarginated apically; mandibular retinaculum strongly curved, apex rounded; clypeus and frons joined at feeble angle; protibia weakly modified, narrow not flanged; abdominal postcoxal line extended to or nearly to posterior margin, incomplete; male ventrite VI weakly modified; female ventrite VI triangular. *Tenuisvalvae* and *Hyperaspis* Chevrolat in Dejean, 1833 are distinguishable only in the female genitalia. *Tenuisvalvae* have female genitalia with coxites long, slender, while *Hyperaspis* coxites basically transverse (Gordon & Canepari 2008).

The aim of the present work is to describe a new species from Brazil collected in citrus crop. The new species is compared to other species of the genus and comments on its biology are included. The new taxon is integrated into Gordon & Canepari (2008) key to species.

Material and Methods

In this paper, we describe a new member of the genus *Tenuisvalvae* collected in Cerro Azul (24°96'24" S, 49°30'63" W, 318 m a.s.l.), Paraná State, Brazil, feeding on *Parthenolecanium perlatum* (Cockerell, 1898) (Hemiptera: Coccidae) in citrus (*Citrus reticulata* Blanco) crop. It was collected both, immature and adults of the species.

Layer digital images were made at the Universidade Federal do Paraná with a Leica DMC 2900 digital camera attached to a Leica M205C stereomicroscope. Digital photos were combined by using the software Leica LAS Multifocus.

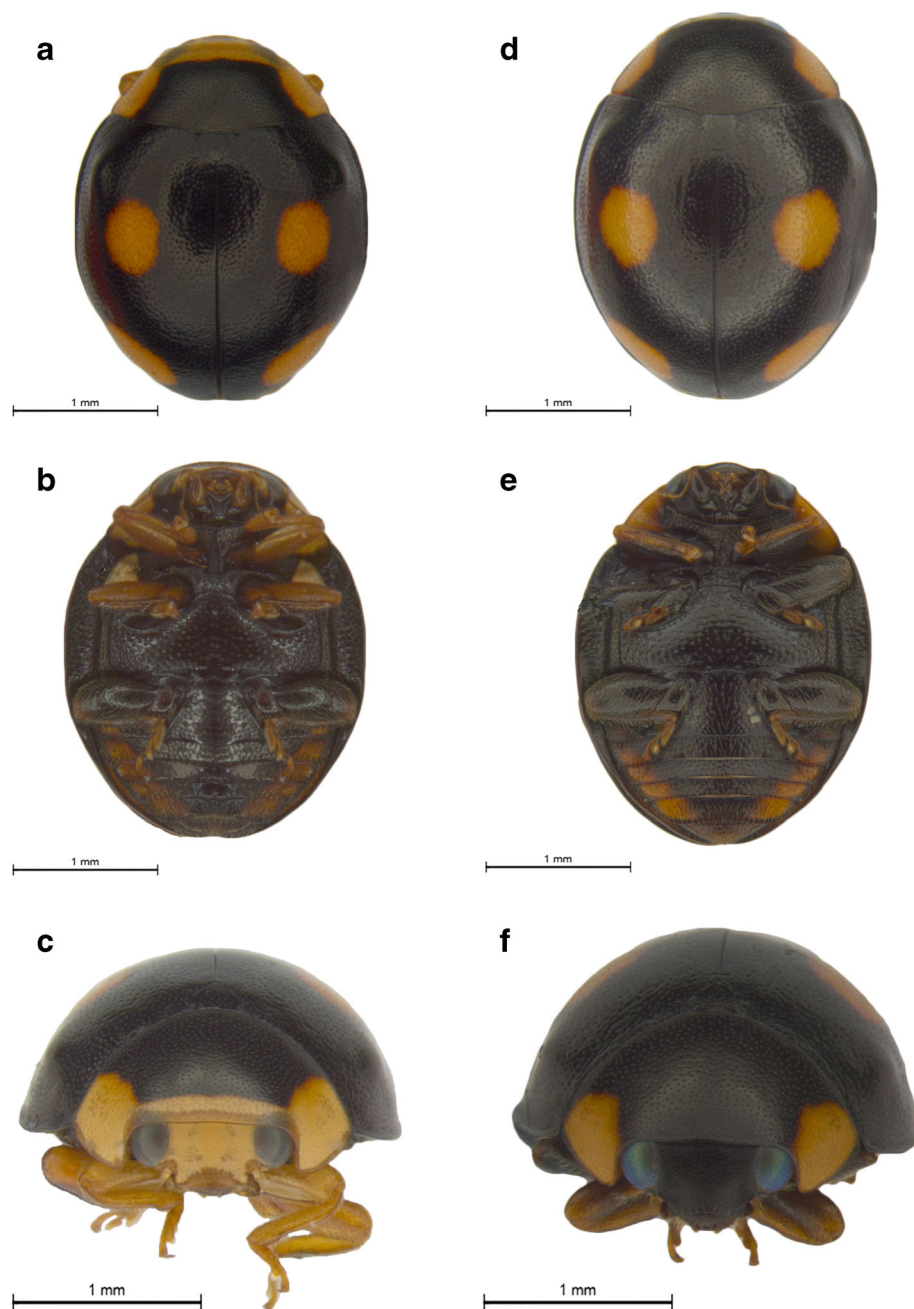


Fig 1 *Tenuisvalvae quadripunctata* sp.nov. Male habitus: **a** dorsal, **b** ventral, **c** frontal view. Female habitus: **d** dorsal, **e** ventral, **f** frontal.

Terminology used in this paper follows Gordon & Canepari (2008) and Ślipiński (2007). Types were deposited in Coleção Entomológica Pe. J. S. Moure, Departamento de Zoologia, Universidade Federal do Paraná, Curitiba, Brazil (DZUP).

The coccid specimens were mounted on microscopic slides following the method described by Granara de Willink (1990) and identified according to morphological characteristics of the adult female as described by Granara de Willink (1999). Voucher specimens were deposited in Departamento de Fitossanidade, Universidade Estadual Paulista (FCAV/UNESP).

Results and Discussion

Tenuisvalvae quadripunctata Santos & Almeida sp. nov.
(Figs 1a–f and 2a–h)

Type material. Holotype: “BRAZIL. Paraná, Cerro/Azul, Paraná, 17/IX/2016,/LSBC leg.” “DZUP/401406”.

Paratypes (15). “BRAZIL. Paraná, Cerro/Azul, Paraná, 17/IX/2016,/LSBC leg.” “DZUP/401408-401413” “male”; “DZUP/401407, 401414-401421” “female”

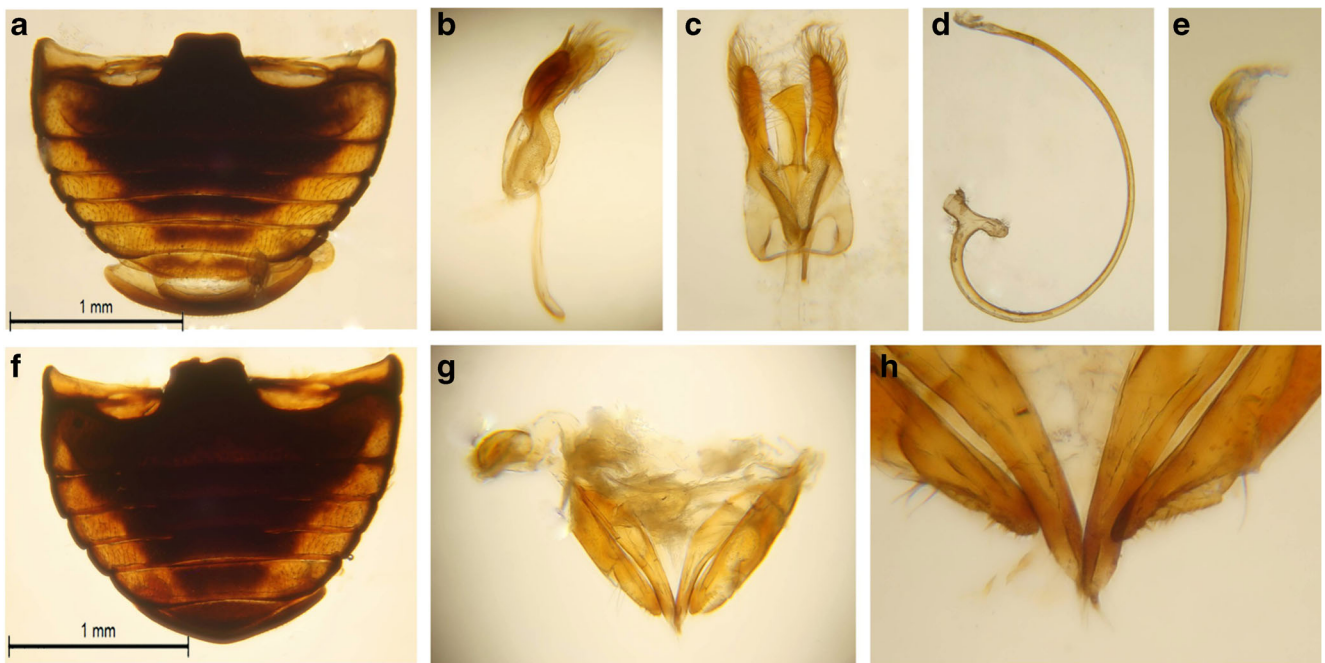


Fig 2 *Tenuisvalvae quadripunctata* sp. nov. Male: **a** abdomen, **b** tegmen lateral view, **c** tegmen ventral view, **d** penis, **e** penis apex detail. Female: **f** abdomen, **g** coxites, **h** coxites apex detail.

(18). "BRAZIL. Paraná, Cerro/Azul, Paraná, 02/IV/2016,/ LSBC leg." "DZUP/ 401422-401431" "female"; "DZUP/ 401432-401439" "male".

Holotype. Male. Length 2.3 to 2.7 mm, width 1.8 to 2.1 mm; body form oval, dorsoventrally convex, glabrous, elytra shiny (Fig 1a). Color black except pronotum mostly yellow with one large black basomedian spot, with lateral margins convex; elytron with two large yellow spots, spot on disc rounded, apical spot transverse (Fig 1a). Antennae, mouthparts, pro and midlegs, metatarsi, and propleuron yellow; mesepimeron pale; abdomen reddish yellow except median area of ventrite 1–5, dark brown (Fig 1b). Head entirely yellow; clypeal apex deeply emarginated, clypeus and frons joined at abrupt angle (Fig 1c). Prosternum with intercoxal carinae convergent, basally stemmed, reaching basal margin. Epipleuron oblique deeply grooved internally, descending externally, femoral excavations deep. Abdominal postcoxal line incomplete and recurved, less than one half distance to anterior margin of ventrite, extended nearly to posterior margin; ventrite V with apex broadly, feebly emarginated; ventrite VI broadly, feebly emarginated (Fig 2a).

Male genitalia. Parameres wide, feebly tapered to round apex (Fig 2b); penis guide three fourth length of parameres, apex wide, obliquely truncate, lateral margin with a small projection (Fig 2c); penis slender, apex curved upward with internal small membranous area basal capsule with inner arm broad, short; outer arm short (Fig 2 d–e).

Female. Similar to male except head entirely black; pronotum with median black spot extended to apex (Fig 1d–f); mouthparts black; pro and mid legs black with yellow apex; mesepimeron black (Fig 1e); ventrite VI triangular (Fig 2f). Genitalia with beak of basal unit short; connecting duct long; coxites long, slender, with stylus (Fig 2 g–h).

Geographical distribution. Cerro Azul, Paraná, Brazil.

Remarks. *Tenuisvalvae quadripunctata* sp. nov. resembles *Tenuisvalvae deyrollei* (Crotch, 1874) in color pattern, but is clearly distinguished by the shape of the spot on the pronotum (black basomedian spot with lateral margins concave), and also differs in male genitalia. The apex of penis guide in *T. quadripunctata* sp. nov. is truncate and oblique, with a small projection on one side. In *T. deyrollei*, the apex of penis guide is rounded and oblique, with a large projection on one side. *Tenuisvalvae quadripunctata* sp. nov. resembles *Tenuisvalvae rosaiensis* (Gordon & Canepari 2008) in color pattern but differs in male genitalia. The penis guide apex in *T. rosaiensis* is narrowly rounded, with a round projection on one margin and also differs on penis apex shape. Described with a single male, *Hyperaspis rosaiensis* Gordon & Canepari, 2008 was transferred to *Tenuisvalvae* by González (2010).

In the existing key to the species of *Tenuisvalvae* (Gordon & Canepari 2008), the new species is indicated to couplet 5(3) where the central pronotal spot shape will separate it



Fig 3 **a** Field area. **b** *Parthenolecanium perlatum* (Cockerell). **c** *Tenuisvalvae quadripunctata* sp.nov. larvae and *Parthenolecanium perlatum* (Cockerell). **d** *Tenuisvalvae quadripunctata* sp.nov. larvae in *Parthenolecanium perlatum* (Cockerell). **e** *Tenuisvalvae quadripunctata* sp.nov. pupa.

from *T. deyrollei*. The study of male genitalia is necessary to separate *T. rosaiensis* to *T. quadripunctata* sp. nov.

Ecological data

The municipality of Cerro Azul is an important citrus producer in Paraná State. This variety of plant, *Citrus reticulata* Blanco (tangerine) has great expression in the citrus market segment, occupying an area of approximately 4500 ha and a production of 89,000 t of fruit, the main economic activity of

the municipality (IBGE 2015). The region has a mountainous landscape, with citrus crops carried out on the slopes, based on simple techniques of cultivation, predominantly family farming, with great potential for agro-ecological or organic agriculture (Fig 3a).

Parthenolecanium perlatum (Fig 3b) is a citrus pest from Palearctic region (Hodgson 1994), currently distributed in Portugal and Poland, and in South America in Argentina, Brazil, Paraguay and Uruguay (Wyckhuys et al 2013, García Morales et al 2016). This coccid is associated mainly with *Citrus* spp. (Rutaceae), having been also recorded in two other

Table 1 *Tenuisvalvae* species, preys, host plant, and references.

Natural enemies	Family mealybug	Preys	Host plant	References
<i>Tenuisvalvae bisquinguepustulata</i> (Fabricius, 1801)	Coccoidea, Pseudococcidae	<i>Planococcus citri</i> (Risso, 1813)—Citrus mealybug		Gordon & Canepari 2008 ^a
	Coccoidea, Pseudococcidae	<i>Phenacoccus</i> sp.		Gordon & Canepari 2008 ^a
	Coccoidea, Pseudococcidae	<i>Phenacoccus manihoti</i> Matile-Ferrero, 1977—Cassava mealybug	<i>Manihot</i> <i>suculenta</i> Crantz	Herren & Neuenschwander 1991, Neuenschwander 1994, 2001 (referred as <i>Hyperaspis raynevalii</i>), Gordon & Canepari 2008 ^a
	Coccoidea, Pseudococcidae	<i>Phenacoccus herreni</i> Cox & Williams, 1981	<i>Manihot</i> <i>suculenta</i> Crantz	Kiyindou & Fabres 1987 (referred as <i>Hyperaspis raynevalii</i>)
	Coccoidea, Pseudococcidae	<i>Planococcus minor</i> (Maskell, 1897)—Pacific mealybug, Passionvine mealybug	<i>Theobroma cacao</i> L.	Francis <i>et al</i> 2012, Stocks & Roda 2011
<i>Tenuisvalvae bromelicola</i> (Sicard, 1925)	Coccoidea, Pseudococcidae	<i>Dysmicoccus brevipes</i> (Cockerell, 1893)—Pineapple mealybug		Gordon & Canepari 2008 ^a
<i>Tenuisvalvae deyrollei</i> (Crotch, 1874)	Coccoidea, Coccidae	<i>Parthenolecanium perlatum</i> (Cockerell, 1898)—Delta cochineal	<i>Citrus sinensis</i> (Linnaeus) Osbeck	Ricci 1985 (referred as <i>Hyperaspis deyrollei</i>)
<i>Tenuisvalvae notata</i> (Mulsant, 1850)	Coccoidea, Pseudococcidae	<i>Phenacoccus manihoti</i> Matile-Ferrero, 1977—Cassava mealybug	<i>Manihot</i> <i>suculenta</i> Crantz	Löhr & Varela 1990, Herren & Neuenschwander 1991, Kanika-Kiamfu <i>et al</i> 1992, Neuenschwander, 1994, 2001, Stäubli Dreyer <i>et al</i> 1997b, c (referred as <i>Hyperaspis notata</i>) Gordon & Canepari 2008 ^a
	Coccoidea, Pseudococcidae	<i>Phenacoccus herreni</i> Cox & Williams, 1981	<i>Manihot</i> <i>suculenta</i> Crantz	Löhr & Varela 1990, Stäubli Dreyer <i>et al</i> 1997c, Neuenschwander 1994, 2001 (referred as <i>Hyperaspis notata</i>), Gordon & Canepari 2008 ^a
	Coccoidea, Pseudococcidae	<i>Ferrisia virgata</i> (Cockerell, 1893)—Gray mealybug, striped mealybug, white-tailed mealybug		Stäubli Dreyer <i>et al</i> 1997b,c (referred as <i>Hyperaspis notata</i>), Barbosa <i>et al</i> 2014a,b
	Coccoidea, Pseudococcidae	<i>Phenacoccus solenopsis</i> Tinsley, 1898—Solenopsis mealybug		Barbosa <i>et al</i> 2014a,b
		<i>Phenacoccus madeirensis</i> (Green, 1923)—Madeira mealybug		Stäubli Dreyer <i>et al</i> 1997c (referred as <i>Hyperaspis notata</i>)
	Coccoidea, Dactylopiidae	<i>Dactylopius opuntiae</i> (Cockerell, 1896)—Opuntia cochineal scale		Gordon & Canepari 2008 ^a
	Coccoidea, Diaspididae		<i>Citrus sinensis</i> (Linnaeus) Osbeck var. Valência	Wolff <i>et al</i> 2004, Silva <i>et al</i> 2005
	Aphidoidea, Aphididae	<i>Toxoptera citricida</i> (Kirkaldy, 1907)—Black citrus aphid	<i>Citrus reticulata</i> Blanco	Rodrigues <i>et al</i> 2008a, b, 2010 (referred as <i>Hyperaspis notata</i>)
	Coccoidea, Pseudococcidae	<i>Maconellicoccus hirsutus</i> (Green)		Peronti <i>et al</i> 2016
<i>Tenuisvalvae quadripunctata</i> sp. nov.	Coccoidea, Coccidae	<i>Parthenolecanium perlatum</i> (Cockerell, 1898)—Delta cochineal	<i>Citrus sinensis</i> (Linnaeus) Osbeck	Present manuscript

^a Gordon & Canepari 2008—label data.

host plants, *Davallia solida* (G. Forst.) Sw. (Davalliaceae) and *Platyterium veitchii* (Underw.) C. C. (Polypodiaceae) in Polish greenhouses (García Morales et al 2016).

In Brazil, *P. perlatum*, known as “pingo-de-lacre” has been reported also as pest in citrus orchards in the states of Rio de Janeiro, Paraná, and Rio Grande do Sul (Costa Lima 1936, Lepage 1938, Corseuil & Barbosa 1971, Bock & Tagarro 1995, Granara de Willink 1998, Link & Pasini 2014).

The success of biological control depends on the knowledge of both, pest species and natural enemies. However, in Brazil, survey of native species of coccinellids associated with pests of economic importance including coccoids are scarce (Wille 1926, Ben-Dov & Hodgson 1997, Almeida & Vitorino 1997, Dixon 2000, Gordon & Canepari 2008, Hodek 1973, 1996, Hodek & Honek 2009, Giorgi et al 2009, Nais & Busoli 2012, Hodek et al 2012, Castro-Guedes 2013, Peronti et al 2016, Lima et al 2016).

The South American genus *Tenuisvalvae* besides of the herein described species includes four other species that feed preferably of scale insects (Table 1). *Tenuisvalvae deyrollei* (Crotch, 1874) (referred as *Hyperaspis brethesi*) was reported preying *P. perlatum* in citrus by Ricci (1985) and it was the only predator until now mentioned in association of this coccid. This author also refers to species of *Tenuisvalvae* as important agents to biological control.

Data for South American species of *Tenuisvalvae* indicate that Pseudococcidae are most common prey. From the ten described species, four are widely documented as predators with potential as biological control agents of Coccoidea in different important crops (Table 1).

In field and in laboratory, we observed a single larva of this coccinellid under the body of each coccid (Fig 3c, d), indicating that the female of the predator lays only one egg. Larvae and pupae of *T. quadripunctata* sp. nov. are covered with white waxy filaments, which makes them look similar to mealybugs (Fig 3e). These waxy filaments also allow other Hyperaspidini, as *Brachiacantha* Chevrolat in Dejean, 1837 (Vantaux et al 2012) and *Hyperaspis* species (Ben-Dov & Hodgson 1997), which are also important predators of Coccidae and Pseudococcidae (Majerus et al 2007). Families of sternorrhynchan prey, Coccidae, Margarodidae, Pseudococcidae (Coccoidea), Aleyrodidae (Aleyrodoidea), Adelgidae, and Aphidae (Aphidoidea) are all visited or heavily guarded by ants. These waxes often completely conceal the larvae and pupae and may function in chemical or tactile mimicry of their prey or form a mechanical defense against ants. When the ants try to attack the larvae, their mandibles become covered by sticky filaments (Seago et al 2011).

All development stages of *T. quadripunctata* sp. nov. were recorded in the field area, indicating that this species can complete its total development period feeding on *P. perlatum*. Also, besides *T. quadripunctata* sp. nov., other

Coccinellidae predator species were observed on citrus leaves infested with *P. perlatum*.

Due to the importance of *Tenuisvalvae* species as a biological control agents and the new species described herein, more studies on the biology and life history of this Neotropical genus need to be developed.

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ZooBank registration number D2DCCE2B-A14B-4AAF-8EBB-EBFE3F150744.

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