Revista Brasileira de Entomologia 65(2):e20200096, 2021

SOCIEDADE BRASILEIRA DE ENTOMOLOGIA
FUNDADA EM 1937

REVISTA BRASILEIRA DE
Entomologia
A Journal on Insect Diversity and Evolution

First Occurrence and Population Dynamics of *Blissus pulchellus* (Hemiptera: Blissidae) in Brazil: a new pest of pastures in Roraima

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ARTICLE INFO

Article history:
Received 19 September 2020
Accepted 17 May 2021
Available online 23 June 2021
Associate Editor: Mariane Nickele

Keywords:
Chinch bug
Amazon
Cattle production
Brachiaria brizantha
Megathrysus maximus

ABSTRACT

Cattle production is one of the main economic activities in the state of Roraima, and insect pest attacks in pastures have a negative effect on this sector in the region. Little is known about the species that cause damage to forage fields in the state. This study presents the first report of the occurrence of the chinch bug *Blissus pulchellus* Montandon (Hemiptera: Blissidae) in Roraima, Brazil and a description of the population dynamics of this pest in pasture areas in this state. Pasture areas were sampled in nine municipalities of Roraima to detect the insect. The population dynamics study was conducted for two years in Alto Alegre municipality, two of which have *Brachiaria brizantha* cv. Marandu and one of *Megathrysus maximus* cv. Mombaça (Poaceae) crops. *Blissus pulchellus* was found in all sampled areas, except in Rorainópolis and São João da Baliza. High densities of this bug were found in in Alto Alegre. This is the first report of *B. pulchellus* in Brazil. The factors that affect the population dynamics and the damage caused by this insect pest to pastures as well as the risk of dispersal of this pest in Brazil are discussed.

Introduction

Cattle production is one of the pillars of agribusiness in the Brazilian Amazon region, which includes the state of Roraima. This biome has approximately 44.7 million hectares of pasture and 60 million heads of cattle, which represents approximately 30% of the national beef cattle herd (IBGE, 2018). In the Brazilian state of Roraima, beef cattle production is the second most important sector of its economy, with a herd of approximately 900,000 heads of cattle, an activity that continues to expand (Braga, 2016).

The expansion of livestock production in the Amazon region has led to the establishment of large areas of pasture. Due to the inadequate management of these pastures, many are degraded or undergoing degradation (Dias-Filho and Andrade, 2019), constituting the main problem of the region, including Roraima (Bendahan et al., 2018).

Factors that contribute to the degradation of pastures include the poor use of technology for management, including lack of soil correction and fertilization, inadequate planting of forage grasses, errors in animal stocking rates (undergrazing or overgrazing), and the lack of information on the management of pests, diseases and weeds (Dias-Filho and Andrade, 2019).

The main pasture pests in the Amazon are spittlebugs (Hemiptera: Cercopidae), the defoliating caterpillars *Mocis latipes* (Guenée, 1852) (Lepidoptera: Erebidae) and *Spodoptera frugiperda* (Smith, 1797) (Lepidoptera: Noctuidae) and, in some regions, termites and true bugs (Teixeira et al., 2019). In Roraima, there are few studies on pest insects associated with pastures. However, many cattle ranchers have reported severe damage caused by these organisms in the region, with negative impacts on forage production, especially in 2015 and 2016 (Fidelis, personal communication). This study reports the first occurrence of the chinch bug *Blissus pulchellus* Montandon (Hemiptera: Blissidae) in Roraima and in Brazil and describes the population dynamics of this pest in three pasture areas in the state.

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https://doi.org/10.1590/1806-9665-RBENT-2020-0096

Materials and Methods

Surveys for the detection of B. pulchellus *in Roraima*

After the first detection of *B. pulchellus* in the municipality of Alto Alegre, Roraima, in 2015, 14 pasture areas in the municipalities of Alto Alegre, Amajari, Boa Vista, Bonfim, Caracaraí, Iracema, Mucajaí, Rorainópolis and São João da Baliza were visited for the detection of *B. pulchellus*.

For each visited area, at least 20 one-square meter random and equidistant points were observed to verify the occurrence of *B. pulchellus*. From these points, five 25 cm x 25 cm grass clumps, with 5 cm of soil and roots, were randomly collected for insects counts, performed according to the method described below.

Population dynamics of B. pulchellus

The study was conducted in the municipality of Alto Alegre, Roraima, Brazil. The climate in the region is Aw (savanna climate, with precipitation in driest month less than 60 mm and less than 100 mm), according to the Köppen classification (Alvares et al., 2013), with Amazon forest transition vegetation. The population levels of *B. pulchellus* were monitored in three pasture areas with a history of pest occurrence since May 2015. Two areas were planted with *Brachiaria brizantha* (Hochst. ex A. Rich.) Stapf. cv. Marandu (Poaceae): one was 60 hectares (2°50'52.36"N, 61°18'11.55"W) (area 1) and another was 12 hectares (2°50'40.09"N, 61°18'58.72"W) (area 2). The third area was planted with *Megathrysus maximus* (Jacq.) Simon & Jacobs cv. Mombaça (Poaceae), encompassing 10 hectares (2°50'37.76"N, 61°19'7.28"W) (area 3).

Areas 1 and 2 were planted with *B. brizantha* cv. Marandu for approximately 10 years, but due to the high state of degradation resulting from the severe attack by *B. pulchellus* (Figure 1A), they were replanted in May 2016, before the experiment, with the same forage grass cultivar.

Blissus pulchellus was sampled monthly from June 2016 to June 2018. In each area, five 25 cm x 25 cm grass clumps, equidistant from each other, with 5 cm of soil and roots were randomly collected. The samples were bagged, labelled, and taken to the Laboratory of

Figure 1 Area of *Brachiaria brizantha* cv. Marandu with damage of *Blissus pulchellus* (A), clump with symptoms of attack (B), adult (C), nymphs (D) and colonies (E), Roraima, Brazil.

Entomology of Embrapa Roraima. At the laboratory, the sheaths, leaves and roots and the soil were carefully observed inside a white plastic tray (50 x 70 cm), and all the insects found were counted and stored in flasks with ethanol for later identification. The density of *B. pulchellus* per square meter was estimated.

Photographs were taken of each life stage of *B. pulchellus* and the adults were measured at 40x magnification, with the aid of a stereomicroscope Leica EZ4 W with Integrated Camera of 5.0 Megapixel .

Data analysis

Pearson correlations were calculated between the insect population density and the climatic factors of the study area. Means were used for relative air humidity, maximum, average and minimum temperatures, and the sum of rainfall over seven days before the samplings. The climatic data were obtained from the Agrometeorological Monitoring System, Agritempo (Agritempo, 2020), at station TRMM.11192, located in the municipality of Alto Alegre, Roraima, which is the one closest to the study areas.

Results

Distribution of B. pulchellus in Roraima

Blissus pulchellus was found in all sampled areas, except in Rorainópolis and São João da Baliza (south of the state). High densities of this chinch bug were found in Alto Alegre, in three areas used for the study of population dynamics, and in a 700-ha pasture of *B. brizantha* cv. Marandu in Alto Alegre in 2015, 2016 and 2017 (Table 1). These pastures had the first detection of *B. pulchellus* in 2015, occurring plant death and pasture degradation (Figure 1A, B). *Blissus pulchellus* was also found in experimental areas of Embrapa Roraima in the municipalities of Boa Vista and Mucajaí, attacking *B. ruziziensis, B. brizantha* cv. Marandu, *Oryza sativa* L. and *Zea mays* L. (Table 1).

Characteristics of B. pulchellus

Macropterous adults with well-developed hemelytra were most prevalent in this study, but brachypterous (short-winged) forms were also present.

Diagnosis: Macropterous adults (Figure 1C: Length ca. 2.8-3.0 mm long; 1.0 mm wide. Body dull black; head, except for shiny clypeus pruinose, eye dark reddish brown. Antennal segments I-III dark brown, segment IV black. Labium dark brown, extending to bases of metacoxae. Pronotum: Anterior half pruinose, with area between calli and along anterior margin dull black; posterior half dull black. Scutellum dull black. Hemelytra in macropters extending just beyond apex of abdomen; mostly white, including membrane, with apical third of corium, a narrow streak extending anteriorly through middle of corium, and margin of claval commissure black. Hemelytra in brachypters extending only to tergite IV, just before first dorsal abdominal scent gland scar, remainder of abdomen exposed; mostly white, including membrane, with dark markings similar to macropters.

Blissus pulchellus is similar to *B. antillus* Leonard, *B. insularis* Barber, and *B. leucopterus* (Say). It is readily distinguished from *B. insularis* (length 3.1-3.5 mm) and *B. leucopterus* (length 3.7-4.0 mm) by the smaller size and having the pruinose anterior half of the pronotum divided by a dull black median line. It is extremely similar to *B. antillus* in size and markings on the pronotum and hemelytra, but it seems to be slightly larger and more pubescent than this species. Further details of the relationship of *B. pulchellus* with these species will be presented in a forthcoming revision by TJH. Voucher specimens from this study have been deposited in the National Museum of Natural History in Washington, D.C. and Embrapa Cerrados Entomological Collection.

Immatures: Early stage nymphs are reddish with a broad, white, dorsal band on the anterior region of the abdomen, and as they grow, they become orange or orange-brown (Figure 1D). *Blissus pulchellus* is found in colonies in the leaf sheaths (Figure 1E), where they suck sap from the plant, turning it yellow (Figure 1B), which can lead to death (Figure 1A).

Table 1
Site (municipality and geographic coordinates), hosts, planting area, sampling date and density of *Blissus pulchellus* in Roraima, Brazil.

Municipality	Coordinates	Host	Area (ha)	Date	Chinch Bug density
Alto Alegre	2°50'52.36"N, 61°18'11.55"W	*B. brizantha* cv. Marandu	60	See Figure 2	See Figure 2
	2°50'40.09"N, 61°18'58.72"W	*B. brizantha* cv. Marandu	12	See Figure 2	See Figure 2
	2°50'37.76"N, 61°19'7.28"W	*M. maximus* cv. Mombaça	10	See Figure 2	See Figure 2
	2°47'23.6"N 61°17'22.2"W	*B. brizantha* cv. Marandu	700	May/2015	1260 bugs/m²
				June/2016	1643 bugs/m²
				July/2017	450 bugs/m²
	2°48'13.7"N 61°16'58.9"W	*B. brizantha* cv. Piatã	100	May/2015	1152 bugs/m²
				June/2016	592 bugs/m²
				July/2017	60 bugs/m²
Amajari	3°30'04.5"N 61°29'57.6"W	*B. brizantha* cv. Xaraés	400	September/2017	-
Boa Vista	2°40'01.9"N 60°51'07.8"W	*B. ruziziensis, B. brizantha* cv. Marandu, *Oryza sativa*, *Zea mays*	<0.5	June 2016 and 2017	Infestation found, but not measured
Boa Vista	2°29'10.1"N 60°53'00.3"W	*B. ruziziensis*	55	July 2018	25 bugs/m²
Bonfim	2°58'46.46"N 60°21'49.12"W	*B. brizantha* cv. Marandu	60	May/2016	1.8 bugs/m²
		B. humidicola	60	May/2016	-
Caracaraí	1°28'43.9"N 60°48'58.9"W	*B. brizantha* cv. Marandu	150	May/2016	0.05 bugs/m²
Iracema	2°23'43.0"N 60°58'47.3"W	*B. ruziziensis*	60	June/2017	10 bugs/m²
Mucajaí	2°23'43.0"N 60°58'47.3"W	*B. ruziziensis, B. brizantha* cv. Marandu, *Oryza sativa*, *Zea mays*	<0.5	June/2016 and 2017	Infestation found, but not measured
Rorainópolis	0°06'25.5"N 60°35'11.2"W	*B. brizantha* cv. Marandu	1.5	July/2019	-
São João da Baliza	0°55'40.3"N 59°55'13.0"W	*B. brizantha* cv. Marandu	5	July/2019	-

Population dynamics

In the three areas sampled in Alto Alegre, *B. pulchellus* occurred since June 2016 to April 2017. The highest population density for the area 1 (on *B. brizantha* cv. Marandu) was observed at 10th June 2016, with 294 chinch bugs/m^2; after that date, the population decreased until it disappeared in April 2017. In area 2 (on *B. brizantha* cv. Marandu), the highest peak population of *B. pulchellus* was observed in July 2016, with a mean of 1,087 chinch bugs/m^2. After that date, the population decreased, and after May 2017, it was no longer found. The highest population densities of *B. pulchellus* for the area 3 (*M. maximus* cv. Mombaça) occurred in November and December 2016, with means of 8,496 and 4,906 chinch bugs/m^2, respectively. In this area, *B. pulchellus* was found until April 2017 (Figure 2). After May 2017 until the end of the experiment, small colonies of *B. pulchellus* were found in isolated sites in the area but were not collected at the points sampled.

There was no Pearson correlation ($p>0.05$) between the population levels of *B. pulchellus* and the climatic variables ($r=0.33$, $p=0.08$; $r=0.19$, $p=0.32$; $r=0.28$, $p=0.14$; $r=0.18$, $p=0.36$; $r=0.33$, $p=0.06$; for relative air humidity, maximum, average and minimum temperatures, and rainfall, respectively).

Discussion

This is the first report of *B. pulchellus* in Brazil. The species was first described in Honduras in 1951, attacking *Panicum* sp. and *Brachiaria mutica* (Forssk.) Stapf. It was also reported in Guatemala in 1959, causing damage to golf course grasses, in Panama, in *Panicum purpureum* (Ruiz) Pav. (Sweet, 2000), and in Colombia in 1989, in the areas of National Nature Parks (Rengifo-Correa and Obando, 2011).

Other *Blissus* species have been reported in Brazil, including *B. bosqi* Drake in Rio Grande do Sul (Costa, 1945); *B. leucopterus* introduced in the state of Minas Gerais from North America in 1975 (Reis et al., 1976); and *B. antillus* (Valério et al., 2015). Later, Valério et al., (2015). After analyzed the specimens collected in 1975, verified *B. leucopterus* reported in Brazil was in fact *B. antillus*. In addition, bugs of this genus reported in other regions of Brazil were also identified as *B. antillus* (Valério et al., 2015).

Damage caused by *Blissus* results from the feeding of nymphs and adults, which insert their stylets into the phloem of the host plant, interfering with nutrient dynamics, injecting toxins, or removing water (Reinert et al., 2011; Boyle and Cutler, 2012). These bugs live in groups in the leaf sheaths (Anderson et al., 2006). Plants attacked by chinch bugs become yellowish, followed by bronzing, which may lead to the death of the grass in patches (Reinert et al., 1995). These behaviours and symptoms were observed in the areas sampled in this study.

The high population densities of *B. pulchellus* observed in pastures in Roraima in 2015 and 2016 reduced forage production and required the adoption of control measures. However, producers did not have sufficient knowledge about this pest or insecticides for application, and thus, no measures were taken. The control of bugs in the genus *Blissus* is typically performed with insecticides (Vazquez et al., 2011),

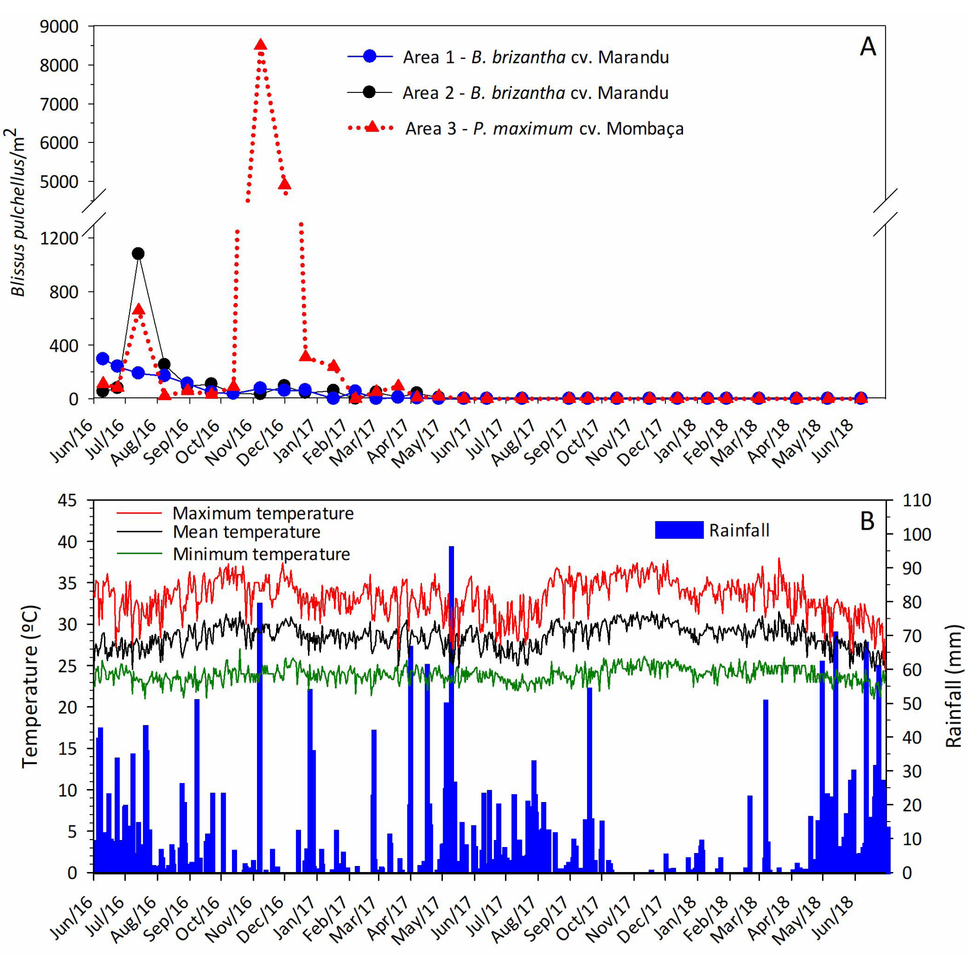

Figure 2 Population dynamics of *Blissus pulchellus* (A) and climatic data (B) (maximum, mean and minimum temperatures and rainfall) in the municipality of Alto Alegre, Roraima, Brazil, from June 2016 to June 2018.

with the fungus *Beauveria bassiana* (Balsamo) Vuillemin (Boyle and Cutler, 2012), and especially with the planting of resistant varieties (Rangasamy et al., 2006; Rangasamy et al., 2015). The chemical control of *B. pulchellus* would be inefficient, because this species has a history of resistance to insecticides (Sweet, 2000). This phenomenon has also been observed in other *Blissus* species (Cherry and Nagata, 2005; Cherry and Nagata 2007; Vazquez et al., 2011). Therefore, the use of resistant varieties is recommended, such for the St. Augustine grass (*Stenotaphrum secundatum* (Walter) Kuntze) germoplasms which are resistant to *B. insularis* Barber, e.g. Captiva, Floratam, FX-10, Raleigh and a set of plant introductions, which are sources of *B. insularis* resistance for future St. Augustinegrass breeding efforts (Milla-Lewis et al., 2017).

In Brazil, *B. antillus* has been reported to cause damage to tanner grass [*Brachiaria arrecta* (T. Durand & Schinz) Stent (1924)], para grass [*B. mutica*] and brachiaria or tangola grass (a natural hybrid of these two grasses) (Valério et al., 2015). These grasses are grown in poorly drained soils, and they are exclusively propagated by seedlings, when there is possible dispersal of the pest. In Roraima, attacks by *B. pulchellus* have been observed in *B. brizantha*, *B. ruziziensis* Germain & Evrard and *M. maximus* cv. Mombaça. Additionally, the population densities of *B. pulchellus* in Roraima have been much higher than those observed for *B. leucopterus* and/or *B. antillus* in other regions of Brazil, where the highest densities were 580 chinch bugs/m^2 (*B. antillus*) in tangola grass in Mato Grosso do Sul (Valério, 2000). The high infestations of *B. pulchellus* in Roraima (1,087 chinch bugs/m^2 in *B. brizantha* cv. Marandu and 8,496 chinch bugs/m^2 in *M. maximus* cv. Mombaça), with severe damage, may be a threat to livestock production in this region. *B. brizantha* cv. Marandu is the main cultivar used as forage grass in the Amazon, occupying approximately 65% of the area used for grazing. Pasture degradation, which is common in this region (Bendahan et al., 2018; Dias-Filho and Andrade, 2019), may favor attacks by *B. pulchellus*, which in turn, may accelerate the pasture degradation process. In 2016, in two of the pasture areas surveyed in this study, grasses were killed due to attack by *B. pulchellus* and had to be replanted in 2016. In addition, as observed in the population dynamics study, even after replanting, *B. pulchellus* remained in the area and continue to cause damage to the grasses.

No correlation was detected between the population levels of *B. pulchellus* and the climatic variables during the sampled period. However, the high densities of *B. pulchellus* in 2016 in Roraima seem to be related to the low rainfall that occurred before the population dynamic study, in 2015 and the first months of 2016. During this period, the El Niño phenomenon occurred in Brazil, which caused prolonged droughts in the North region, even during the rainy season (INMET, 2017). In 2015, the annual cumulative rainfall in Alto Alegre was 1,315 mm, with a long period of drought from September 2015 to April 2016 (143 mm), whereas in 2016, the annual cumulative rainfall was 1,916 mm, and the rainfall events during that period of the year were more constant and intense (632 mm) (Agritempo, 2020). The occurrence of this climate phenomenon may have favoured both the degradation of pastures and the occurrence of the pest, considering the high soil moisture increases nymph mortality (Majeau et al., 2000), in addition to favouring infection by entomopathogenic fungi (Boyle and Cutler, 2012). The intense and constant rains of 2017 and 2018 must have had a negative effect on the population of *B. pulchellus*, which was found at extremely low densities. However, longer studies are needed to better understand the factors influencing the population dynamics of this pest.

The occurrence of *B. pulchellus* in several regions of Roraima poses a risk of dispersal of this pest to other Brazilian states. As observed in this study, this pest can reach high densities and cause damage to forage grasses, becoming an important pest of pastures.

Acknowledgments

Empresa Brasileira de Pesquisa Agropecuária – Embrapa for financial support (Grant No. 13.16.05.028.00.00). Coordenação de Aperfeiçoamento de Pessoal de Nível Superior (CAPES) (Finance Code 001). Mention of trade names or commercial products in this publication is solely for the purpose of providing specific information and does not imply recommendation or endorsement by the USDA. The USDA is an equal opportunity employer.

Conflicts of interest

The authors declare no conflicts of interest.

Author contribution statement

EGF planned and designed the study, collected field data, analyzed the samples in laboratory and wrote the manuscript. RO, as student collected field data and analyzed the samples in laboratory. ABB contributed to the planning and designing of the study. JRV guided and mediated contacts culminating in the species identification; and reviewed the manuscript. GSC reviewed the manuscript. All authors read, revised, and approved the manuscript. TJH identified *B. pulchellus* and provided diagnostic information to distinguish it from related species.

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