

Maconellicoccus hirsutus (Hemiptera: Pseudococcidae) in Brazil: Recent Spread, Natural Enemies, and New Hosts

Authors: David dos S. Martins, Maurício J. Fornazier, Ana Lúcia B. G. Peronti, Mark P. Culik, Carlos Alberto S. Souza, et. al.

Source: Florida Entomologist, 102(2) : 438-443

Published By: Florida Entomological Society

URL: <https://doi.org/10.1653/024.102.0225>

BioOne Complete (complete.BioOne.org) is a full-text database of 200 subscribed and open-access titles in the biological, ecological, and environmental sciences published by nonprofit societies, associations, museums, institutions, and presses.

Your use of this PDF, the BioOne Complete website, and all posted and associated content indicates your acceptance of BioOne's Terms of Use, available at www.bioone.org/terms-of-use.

Usage of BioOne Complete content is strictly limited to personal, educational, and non-commercial use. Commercial inquiries or rights and permissions requests should be directed to the individual publisher as copyright holder.

BioOne sees sustainable scholarly publishing as an inherently collaborative enterprise connecting authors, nonprofit publishers, academic institutions, research libraries, and research funders in the common goal of maximizing access to critical research.

Maconellicoccus hirsutus (Hemiptera: Pseudococcidae) in Brazil: recent spread, natural enemies, and new hosts

David dos S. Martins¹, Maurício J. Fornazier^{1,*}, Ana Lúcia B. G. Peronti², Mark P. Culik¹, Carlos Alberto S. Souza³, Renato C. Taquez¹, José S. Zanuncio Junior¹, and Renan B. Queiroz¹

Maconellicoccus hirsutus (Green) (Hemiptera: Pseudococcidae), the pink hibiscus mealybug, is an invasive pest from southern Asia or Australia that now has a worldwide distribution in tropical and subtropical regions (Sagarra & Peterkin 1999; Chong et al. 2008; Garcia Morales et al. 2016). In the Americas, this mealybug was first detected in 1993 on the island of Grenada (Michaud & Evans 2000). It was first noted in South America in Guyana (Tambasco et al. 2000), and it now also is present in Brazil, Colombia, French Guiana, Suriname, and Venezuela (Culik et al. 2013a, b; Garcia Morales et al. 2016). In Brazil, it was first detected in 2010 in the state of Roraima in northern Brazil, bordering Guyana and Venezuela (Marsaro Junior et al. 2013). By 2012, it had spread to the southern part of the state of Espírito Santo, in southeastern Brazil, about 3,400 km from Roraima (Culik et al. 2013a). Since 2010, *M. hirsutus* has spread to 9 other Brazilian states, including Pará (northern region) (Morais 2016; Peres-Filho et al. 2017); Alagoas, Bahia, Maranhão, and Pernambuco (northeastern region) (Silva et al. 2013a, b; Nakayama & Virgens Filho 2014; Oliveira et al. 2014; Souza et al. 2014; Broglio et al. 2015; Fornazier et al. 2017; Ramos et al. 2018); Mato Grosso (central-western region) (Morais et al. 2015; Peres-Filho et al. 2017); São Paulo (southeastern region) (Morais et al. 2015; Peronti et al. 2016); Rio Grande do Sul, and Santa Catarina (southern region) (Alexandre et al. 2014; Morais 2016). Based on these records, *M. hirsutus* was removed from the Brazilian List of Absent Quarantine Pests (A1) on 18 Dec 2013 (Brasil 2013). *Maconellicoccus hirsutus* is considered to be a quarantine pest, and may be a threat to agriculture in countries where it has been introduced because of its polyphagous behavior, invasiveness, and high reproductive potential (Cermeli et al. 2002; Martínez Rivero 2007). It has been reported from more than 350 species of host plants, in 222 genera and 78 botanical families, and may be a potential pest of many economically important crops, including fruits, fibers, grains, ornamental, and timber species (Garcia Morales et al. 2016).

This note summarizes recent research on the geographical spread, host plants, and natural enemies of *M. hirsutus* in Brazil since its reported establishment in this country 8 years ago (Marsaro Junior et al. 2013), and its dissemination and hosts in Espírito Santo State, southeastern Brazil, since it was first noted in this region in 2012 (Culik et al. 2013a). One hundred and three *M. hirsu-*

tus-infested host plant samples were collected and geo-referenced (longitude, latitude) from 34 municipalities of Espírito Santo by professionals of the State Inspection Service of Agricultural and Forest Defense Institute of Espírito Santo (Idaf), the Capixaba Institute for Research and Technical Assistance and Rural Extension (Incaper), and the Executive Committee for the Planning of Cacao Crops (Ceplac/ES). Mealybug specimens were preserved in Eppendorf tubes (5 mL) with 70% alcohol, and mounted on microscope slides (Gullan 1984), with identification of the species made based on morphological characteristics of the adult female (Miller 1999; Miller et al. 2014) at the Laboratory of Entomology, Universidade Estadual Paulista “Júlio de Mesquita Filho” (FCAV/UNESP). A map with isotherms and *M. hirsutus* sampling points in Espírito Santo was prepared using ESRI ARCGIS 10.0, Arcmap software (ESRI 2011) and the Meteorological Information System/Incaper climatological database (Incaper 2018).

In Espírito Santo, *M. hirsutus* was found only in regions with annual mean temperatures from 20 to 27 °C, with 96% of *M. hirsutus* samples found in the isotherm 23 to 27 °C (Fig. 1). This annual mean temperature range (20 to 27 °C) is found in 87.6% of the area of the state. These results are consistent with previous research which indicates that temperatures most favorable for the development and reproduction of *M. hirsutus* are 25 to 27 °C, and the thermal thresholds for female development are 14.5 °C (T_{min}) and 29 °C (T_{max}) (Chong et al. 2008). In Espírito Santo, only 0.2% of its territory has annual mean temperatures below 14.5 °C, and none with annual mean temperature above 27 °C (Fig. 1). Therefore, temperatures in Espírito Santo do not represent a barrier to *M. hirsutus* population development.

Seventeen species of *M. hirsutus* host plants in 9 families were collected in Espírito Santo (Table 1). *Hevea brasiliensis* (Euphorbiaceae), *Theobroma bicolor* and *T. speciosum* (Malvaceae) are reported for the first time as hosts of *M. hirsutus* (García Morales et al. 2016). *Coccoloba uvifera* (Polygonaceae), *Morus alba* (Moraceae), *Punica granatum* (Lythraceae), and *Talipariti tiliaceum* (Malvaceae) are new *M. hirsutus* host records for Brazil. *Abelmoschus esculentus* (L.) Moench (Malvaceae), *Theobroma cacao* L. (Malvaceae), and *Solanum americanum* Mill. (Solanaceae) have been reported previously as *M. hirsutus* hosts in Espírito Santo (Culik et al. 2013a;

¹Department of Entomology, Instituto Capixaba de Pesquisa, Assistência Técnica e Extensão Rural (Incaper), PO Box 01146, 29001-970, Vitória, Espírito Santo, Brazil; E-mail: davidmartins@incaper.es.gov.br (D. S. M.), mauriciofornazier@gmail.com (M. J. F.), markculik@hotmail.com (M. P. C.), renato@incaper.es.gov.br (R. C. T.), jjzanuncio@gmail.com (J. S. Z.-J.), renan.queiroz@incaper.es.gov.br (R. B. Q.)

²Department of Phytosanitary, Faculdade de Ciências Agrárias e Veterinárias, Universidade Estadual Paulista “Júlio de Mesquita Filho”, PO Box 14884-900, Jaboticabal, São Paulo, Brazil; E-mail: anaperonti@gmail.com (A. L. B. G. P.)

³Experimental Station Filogônio Peixoto, CEPLAC, BR 101 N, km 150, CEP 29900-000, Linhares, Espírito Santo, Brazil; E-mail: spaggiari.ceplac@gmail.com (C. A. S. S.)

*Corresponding author; E-mail: mauriciofornazier@gmail.com

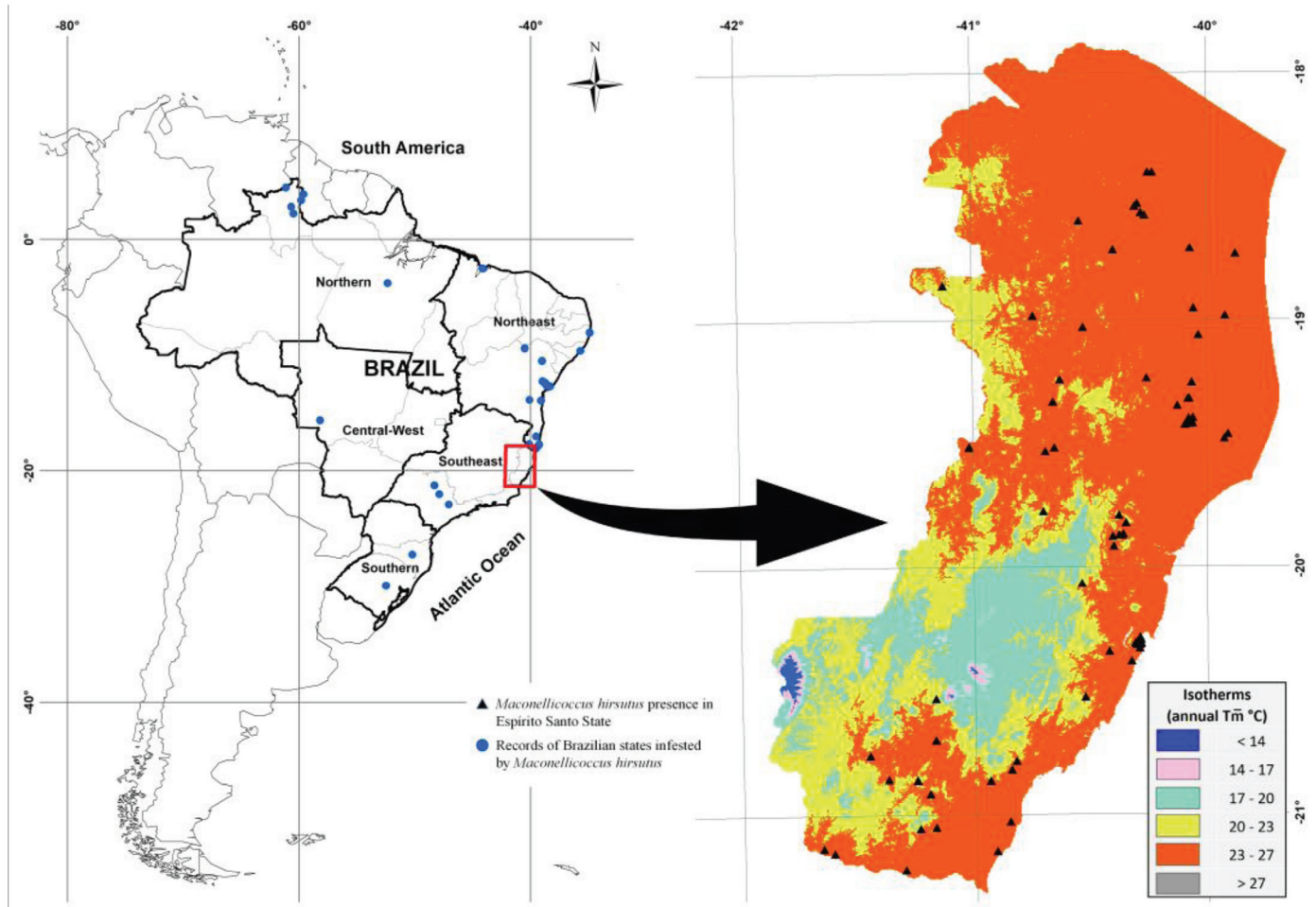


Fig. 1. Geographic distribution of *Maconellicoccus hirsutus* (Green) (Hemiptera: Pseudococcidae) in Brazil, and *M. hirsutus* collection locations in the state of Espírito Santo, Brazil.

García Morales et al. 2016; Fornazier et al. 2017), and the other 13 host species found are new *M. hirsutus* records for this state (Table 1). Highest populations of *M. hirsutus* were found associated with apical buds of young plants, resulting in deformation of shoots, leaves, and fruits, and death of inflorescences. Deformation of shoots and atrophy of terminal buds associated with high infestations of this mealybug observed in this study are similar to damage by the pest described in other studies (Martínez Rivero 2007; Morais et al. 2015; Fornazier et al. 2017). Hibiscus ($n = 30$) and cocoa ($n = 30$) were the most common plants found infested by *M. hirsutus*, and ornamental hibiscus plants (*Hibiscus rosa-sinensis* L.; Malvaceae) may be the most important hosts for dissemination of this mealybug in Espírito Santo. *Talipariti tiliaceum* (L.) Fryxell (Malvaceae) ($n = 8$) (sea hibiscus) and *Coccoloba uvifera* (L.) Crantz (Polygonaceae) (seagrape) are other hosts that may be important species for *M. hirsutus* dissemination because of their use as ornamental plants. Currently *Talipariti* is composed of 22 taxa that are found from southeastern Asia to Central and South America. Sea hibiscus was previously described as a species of the genus *Hibiscus* (Malvaceae) (Fryxell 2001), and it occurs from the southern to northeastern Brazilian coast (Morais & Magenta 2014). Seagrape (*Coccoloba uvifera*) is widely grown on coastal beaches throughout tropical America and the Caribbean, including southern Florida, where it is also used as a seaside hedge in commercial landscapes (Gilman & Watson 2014).

Plant species from 19 families have been reported as hosts of *M. hirsutus* in Brazil, including those of economic importance, such as Malvaceae ($n = 7$) and Fabaceae ($n = 6$), which are the most important host plant families in Brazil based on number of host plant species (Table 1), although Moraceae and Euphorbiaceae have the highest number of *M. hirsutus* host species worldwide (García Morales et al. 2016). Thirty-seven plant species are now reported as hosts of *M. hirsutus* in Brazil.

Although *M. hirsutus* has a large number of natural enemies (Culik et al. 2013b; Garcia Morales et al. 2016), none were observed in the present study. In Brazil, *Anagyrus kamali* Moursi (Hymenoptera: Encyrtidae), and *Gyranoidea indica* Shafee, Alam & Agarwal (Hymenoptera: Encyrtidae) are reported as parasitoids of *M. hirsutus*, and *Chilocorus nigrita* (F.), *Cryptolaemus montrouzieri* Mulsant, *Cycloneda sanguinea* (L.), *Eriopis* (Germar), *Exoplectra* sp., *Harmonia axyridis* (Pallas), *Tenuisvalvae notata* (Mulsant) (all Coleoptera: Coccinellidae), and *Ceraeochrysa* sp. (Neuroptera: Chrysopidae) are listed as *M. hirsutus* predators (Culik et al. 2013a). *Anagyrus kamali* and *C. montrouzieri* have been the most common natural enemies associated with *M. hirsutus* in Brazil (Marsaro Junior et al. 2013; Peronti et al. 2016; Negrini et al. 2018). However, there have been no studies in Brazil to evaluate the establishment and efficiency of these natural enemies in agroecosystems where *M. hirsutus* has caused damage (Morais 2016).

We thank the Conselho Nacional de Desenvolvimento Científico e Tecnológico (CNPq), and the Fundação de Amparo à Pesquisa e Inovação do Espírito Santo (FAPES) for financial support.

Table 1. *Macronelliococcus hirsutus* (Green) (Hemiptera: Pseudococcidae) host plants in Brazil including new records and references.

Family/host plants ¹	Brazilian states ² (municipalities)	References
Anacardiaceae		
<i>Mangifera indica</i> L.	AL (Maceió)	Broglio et al. (2015)
<i>Spondias lutea</i> L.	AL (Maceió)	Broglio et al. (2015)
<i>Spondias tuberosa</i> Arruda	MA (Paço do Lumiar, São José de Ribamar)	Ramos et al. (2018)
Annonaceae		
<i>Annona muricata</i> L.***	AL (Maceió), RR (Cantá, Normandia), ES (Colatina)	Marsaro Jr. et al. (2013), Broglio et al. (2015), Negrini et al. (2018), present study
<i>Annona squamosa</i> L.***	MA (Paço do Lumiar, São José de Ribamar), RR (Cantá), ES (Pinheiros, Vitória)	Negrini et al. (2018), Ramos et al. (2018), present study
Euphorbiaceae		
<i>Hevea brasiliensis</i> (Willd. ex A. Juss.) Müll. Arg.*	ES (Linhares)	present study
Fabaceae		
<i>Centrolobium paraense</i> Tul.	RR (Boa Vista)	Marsaro Jr. et al. (2013)
<i>Erythrina variegata</i> L.	PE (Recife)	Melo & Meunier (2017)
<i>Glycine max</i> (L.) Merr.	RR (Boa Vista)	Marsaro Jr. et al. (2013)
<i>Inga edulis</i> Mart.***	RR (Boa Vista), ES (Linhares)	Marsaro Jr. et al. (2013)
<i>Mimosa caesalpinifolia</i> Benth.***	BA (Jequié, Semi arid region), PE (Semi arid region), ES (Linhares, Nova Venécia, São Mateus, Vila Pavão)	Oliveira et al. (2014), Marques et al. (2017), present study
<i>Mimosa tenuiflora</i> (Willd.) Poir.	BA and PE (Semi arid region of Brazil)	Oliveira et al. (2014)
Lamiaceae		
<i>Tectona grandis</i> L.f.	MT (São José de Quatro Marcos)	Peres-Filho et al. (2017)
Lythraceae		
<i>Punica granatum</i> L.**	ES (Viana)	present study
Malpighiaceae		
<i>Malpighia glabra</i> L.	AL (Maceió)	Broglio et al. (2015)
<i>Malpighia puniceifolia</i> L.	MA (Paço do Lumiar, São José de Ribamar)	Ramos et al. (2018)
Malvaceae		
<i>Abelmoschus esculentus</i> (L.) Moench	ES (Cachoeiro de Itapemirim)	Culik et al. (2013a), present study
<i>Hibiscus rosa-sinensis</i> L.***	BA (Camamu, Caravelas, Eunápolis, Jequié, Ibirapuá, Itamarajú, Mucuri, Nova Viçosa.), MT (<i>unidentified</i>), RR (Boa Vista, Bonfim, Pacaraima), SC (<i>unidentified</i>), SP (Campinas, Jabotocabal, São Carlos), ES (Aplacá, Atílio Vivacqua, Baixo Guandu, Boa Esperança, Bom Jesus do Norte, Castelo, Colatina, Iconha, Itapemirim, Jaguaré, Linhares, Mantenópolis, Marataízes, Mimoso do Sul, Muqui, Pinheiros, Rio Bananal, Rio Novo do Sul, Vila Velha, Vitória)	Marsaro Jr. et al. (2013), Silva et al. (2013b), Alexandre et al. (2014), Morais et al. (2015), Peronti et al. (2016), Marques et al. (2017), present study
<i>Talipariti tiliaceum</i> (L.) Fryxell**	ES (Vitória, Vila Velha)	present study
<i>Theobroma bicolor</i> Humb. & Bonpl.*	ES (Linhares)	present study
<i>Theobroma cacao</i> L.	BA (Amélia Rodrigues, Camaçari, Camamu, Candeias, Eunápolis, Feira de Santana, Itamarajú, Jequié, Mucuri, Santo Amaro, São Francisco do Conde), ES (Aguia Branca, Atílio Vivacqua, Colatina, Guarapari, Ibraçu, Jaguaré, João Neiva, Linhares, Nova Venécia, São Domingos do Norte, São Gabriel da Palha, São Mateus, Sooretama)	Silva et al. (2013b), Nakayama & Santos (2014), Fornazier et al. (2017), Marques et al. (2017), present study
<i>Theobroma grandiflorum</i> (Willd. ex Spreng.) Schum.***	AL (Maceió), MA (Paço do Lumiar, São José de Ribamar), ES (Linhares)	Broglio et al. (2015), Ramos et al. (2018), present study
<i>Theobroma speciosum</i> Willd. ex Spreng.*	ES (Linhares)	present study

¹Names according to the Catalogue of Life (2018); ²Brazilian states: AL (Alagoas), BA (Bahia), ES (Espírito Santo), MA (Maranhão), MT (Mato Grosso), PE (Pernambuco), RR (Roraima), SC (Santa Catarina), SP (São Paulo); *new host record for *M. hirsutus* (according to García Morales et al. 2016); **new host record for *M. hirsutus* in Brazil; ***new host record for *M. hirsutus* in Espírito Santo, Brazil.

Table 1. (Continued) *Maconelllicoccus hirsutus* (Green) (Hemiptera: Pseudococcidae) host plants in Brazil including new records and references.

Family/host plants ¹	Brazilian states ² (municipalities)	References
Moraceae <i>Morus alba</i> L.**	ES (Linhares)	present study
Myrtaceae <i>Psidium guajava</i> L.	AL (Maceió), RR (Normandia)	Marsaro Jr. et al. (2013), Broglio et al. (2015)
Oxalidaceae <i>Averrhoa carambola</i> L.	AL (Maceió), RR (Cantá, Normandia)	Marsaro Jr. et al. (2013), Broglio et al. (2015), Negrini et al. (2018)
Polygonaceae <i>Coccoloba uvifera</i> (L.) L.**	ES (Vitória)	present study
Proteaceae <i>Grevillea robusta</i> A. Cunn. ex R. Br.	BA and PE (Semi arid region of Brazil)	Oliveira et al. (2014)
Rosaceae <i>Pyrus</i> sp.	BA and PE (Semi arid region of Brazil)	Oliveira et al. (2014)
Rubiaceae <i>Coffea canephora</i> Pierre ex A. Froehner	BA (Mucuri)	Silva et al. (2013b)
<i>Ixora chinensis</i> Lam. (syn. <i>Ixora coccinea</i> Curtis)	BA (Metropolitan region official Salvador)	Silva et al. (2013a)
<i>Mussaenda erythrophylla</i> Schumacher & Thonn	BA (Metropolitan official region of Salvador)	Silva et al. (2013a)
Rutaceae <i>Citrus sinensis</i> (L.) Osbeck***	RR (Normandia), ES (Alegre, Jerônimo Monteiro, João Neiva)	Marsaro Jr. et al. (2013), present study
Solanaceae <i>Solanum lycopersicum</i> L.	RR (Boa Vista)	Marsaro Jr. et al. (2013)
<i>Solanum americanum</i> Mill.	ES (Cachoeiro de Itapemirim)	Culik et al. (2013a), present study
Talinaceae <i>Talinum paniculatum</i> (Jacq.) Gaertn.	BA and PE (Semi arid region of Brazil)	Oliveira et al. (2014)
Vitaceae <i>Vitis vinifera</i> L.	BA and PE (Semi arid region of Brazil)	Oliveira et al. (2014)

¹Names according to the Catalogue of Life (2018); ²Brazilian states: AL (Alagoas), BA (Bahia), ES (Espírito Santo), MA (Maranhão), MT (Mato Grosso), PE (Pernambuco), RR (Roraima), SC (Santa Catarina), SP (São Paulo); ³new host record for *M. hirsutus* (according to Garcia Morales et al. 2016); **new host record for *M. hirsutus* in Brazil; ***new host record for *M. hirsutus* in Espírito Santo, Brazil.

Summary

Maconellicoccus hirsutus (Green) (Hemiptera: Pseudococcidae) is an invasive and highly polyphagous pest with a worldwide distribution in tropical and subtropical regions. This study reports the geographical distribution, natural enemies, and host plant species of *M. hirsutus* in Brazil 8 years after its first report in this country. *Maconellicoccus hirsutus* is now distributed in 11 Brazilian states, in all major geographic regions of the country. Samples ($n = 103$) of plants infested by *M. hirsutus* were collected in the state of Espírito Santo, Brazil, with 96% of them found within the isotherm 23 to 27 °C. *Hevea brasiliensis* (Euphorbiaceae), *Theobroma bicolor* (Malvaceae), and *T. speciosum* (Malvaceae) are reported for the first time as hosts of *M. hirsutus*, and *Coccoloba uvifera* (Polygonaceae), *Morus alba* (Moraceae), *Punica granatum* (Lythraceae), and *Talipariti tiliaceum* (Malvaceae) are new hosts of *M. hirsutus* in Brazil. Thirty-seven host plant species of *M. hirsutus* are now confirmed in Brazil.

Key Words: geographical spread; *Hevea brasiliensis*; pink hibiscus mealybug; *Theobroma bicolor*; *Theobroma speciosum*

Sumario

Maconellicoccus hirsutus (Green) (Hemiptera: Pseudococcidae) é praga invasora e altamente polífaga distribuída nas regiões tropicais e subtropicais do mundo. Este estudo relata a distribuição geográfica, inimigos naturais e espécies de plantas hospedeiras de *M. hirsutus* no Brasil após oito anos de seu primeiro relato. *Maconellicoccus hirsutus* se encontra distribuída em onze estados em todas as regiões geográficas do Brasil. Foram coletadas 103 amostras de plantas infestadas com *M. hirsutus* no estado do Espírito Santo com 96% delas encontradas na isoterma 23 to 27 °C. *Hevea brasiliensis* (Euphorbiaceae), *Theobroma bicolor* (Malvaceae), e *T. speciosum* (Malvaceae) são relatadas pela primeira vez como hospedeiras de *M. hirsutus*, e *Coccoloba uvifera* (Polygonaceae), *Morus alba* (Moraceae), *Punica granatum* (Lythraceae), e *Talipariti tiliaceum* (Malvaceae) são novas constatações para o Brasil. Trinta e sete plantas hospedeiras de *M. hirsutus* são agora relatadas no Brasil.

Palavras Chave: cochonilha-rosada-do-hibisco; dispersão geográfica; *Hevea brasiliensis*; *Theobroma bicolor*; *Theobroma speciosum*

References Cited

- Alexandre F, Souza GP, Ebel J, Vieira RDA, Krueger R. 2014. Levantamento de detecção da praga *Maconellicoccus hirsutus* Green (cochonilha rosada do hibisco), em cultivos urbanos de hibiscos e ornamentais em Santa Catarina, pp. 156 In Anais da 5th Conferência Nacional de Defesa Agropecuária. Florianópolis, 25–28 Nov 2014. http://www.vcnda-sc.com.br/downloads/anais_v_conferencia.pdf (last accessed 17 Jan 2019).
- Brasil. Ministério da Agricultura, Pecuária e Abastecimento. Gabinete do Ministro. 2013. Instrução Normativa Nº 59, de 18 de dezembro de 2013. Diário Oficial da República Federativa do Brasil, Brasília, Distrito Federal, Brazil, 19 de dezembro de 2013.
- Broglio SMF, Cordero EP, Santos JM, Micheletti LB. 2015. Registro da cochonilha-rosada-do-hibisco infestando frutíferas em Maceió, Alagoas, Brasil. *Revista Caatinga* 28: 242–248.
- Catalogue of Life website. 2018. Catalogue of Life: 28 March 2018. <http://www.catalogueoflife.org/> (last accessed 17 Jan 2019).
- Cermeli M, Morales Valles P, Godoy F, Romero R, Cardenas O. 2002. Presencia de la cochonilla rosada de la cayena *Maconellicoccus hirsutus* (Green) (Hemiptera: Pseudococcidae) en Venezuela. *Entomotropica* 17: 103–105.
- Chong JH, Roda AL, Mannion CM. 2008. Life history of the mealybug, *Maconellicoccus hirsutus* (Hemiptera: Pseudococcidae), at constant temperatures. *Environmental Entomology* 37: 323–332.
- Culik MP, Martins DS, Zanuncio Junior JS, Fornazier MJ, Ventura JA, Peronti ALBG, Zanuncio JC. 2013a. The invasive hibiscus mealybug *Maconellicoccus hirsutus* (Hemiptera: Pseudococcidae) and its recent range expansion in Brazil. *Florida Entomologist* 96: 638–640.
- Culik MP, Fornazier MJ, Martins DS, Zanuncio Junior JS, Ventura JA, Peronti ALBG, Zanuncio JC. 2013b. The invasive mealybug *Maconellicoccus hirsutus*: lessons for its current range expansion in South America and invasive pest management in general. *Journal of Pest Science* 86: 387–398.
- ESRI. 2011. ArcGIS Desktop: Release 10. Environmental Systems Research Institute, Redlands, California, USA.
- Fornazier MJ, Martins DS, Souza CAS, Culik MP, Chipolesch JMA, Fornazier DL, Ferreira PSF, Zanuncio JC. 2017. Invasion of the main cocoa-producing region of South America by *Maconellicoccus hirsutus* (Hemiptera: Pseudococcidae). *Florida Entomologist* 100: 168–171.
- Fryxell PA. 2001. *Talipariti* (Malvaceae), a segregate from *Hibiscus*. *Contributions from the University of Michigan Herbarium* 23: 225–270.
- García Morales M, Denno BD, Miller DR, Miller GL, Ben-Dov Y, Hardy NB. 2016. ScaleNet: a literature-based model of scale insect biology and systematics. Database. doi: 10.1093/database/bav118. <http://scalenet.info> (last accessed 17 Jan 2019).
- Gilman EF, Watson DG. 2014. *Coccoloba uvifera*: seagrape. ENH 334. Institute of Food and Agricultural Sciences Extension, University of Florida, Gainesville, Florida, USA.
- Gullan PJ. 1984. A revision of the gall-forming coccoid genus *Apiomorpha* Rüb-saamen (Homoptera: Eriococcidae: Apiomorphinae). *Australian Journal of Zoology, Supplementary Series* 97: 1–203.
- Incaper. 2018. Instituto capixaba de Pesquisa, Assistência Técnica e Extensão Rural. Sistema de Informações Meteorológicas do Incaper. <https://incaper.es.gov.br/meteorologia> (last accessed 17 Jan 2019).
- Marques TED, Koch EBA, Santos IS, Santos JRM, Mariano CSF, Delabie JHC. 2017. The diversity of ants (Hymenoptera: Formicidae) interacting with the invasive hibiscus mealybug *Maconellicoccus hirsutus* (Green 1908) (Hemiptera: Pseudococcidae) on ornamental and cultivated plants in Bahia, Brazil. *Arthropod-Plant Interactions* 12: 237–246.
- Marsaro Junior AL, Peronti ALBG, Penteado-Dias AM, Moraes EGF, Pereira PRVS. 2013. First report of *Maconellicoccus hirsutus* (Green, 1908) (Hemiptera: Coccoidea: Pseudococcidae) and the associated parasitoid *Anagyrus kamali* Moursi, 1948 (Hymenoptera: Encyrtidae), in Brazil. *Brazilian Journal of Biology* 73: 413–418.
- Martínez Rivero MA. 2007. La cochonilla rosada del hibisco, *Maconellicoccus hirsutus* (Green), un peligro potencial para la agricultura cubana. *Revista Protección Vegetal* 22: 166–182.
- Melo LL, Meunier IMJ. 2017. Evolução da arborização de acompanhamento viário em cinco bairros de Recife - PE. *Revista de Geografia, Recife* 34: 264–281.
- Michaud JP, Evans GA. 2000. Current status of pink hibiscus mealybug in Puerto Rico including a key to parasitoid species. *Florida Entomologist* 83: 97–101.
- Miller DR. 1999. Identification of the pink hibiscus mealybug, *Maconellicoccus hirsutus* (Green) (Hemiptera: Sternorrhyncha: Pseudococcidae). *Insecta Mundi* 13: 189–203.
- Miller D, Rung A, Parikh G, Venable G, Redford AJ, Evans GA, Gill RJ. 2014. *Scale Insects*, Second edition. USDA APHIS Identification Technology Program (ITP). Fort Collins, Colorado, USA. (online) <http://idtools.org/id/scales/> (last accessed 25 Jan 2019).
- Moraes JN, Magenta MAG. 2014. Floristic survey of a fragment of Restinga in the municipality of Rio Diana Santos adjacent to the state of São Paulo. *UNI-SANTA BioScience* 3: 115–121.
- Moraes EGF. 2016. Distribuição, impactos e manejo da cochonilha-rosada, *Maconellicoccus hirsutus*, no Brasil, pp. 50 In 26th Congresso Brasileiro de Entomologia. Maceió, Alagoas, Brazil, 13–17 Mar 2016.
- Moraes EGF, Peronti ALBG, Marsaro Júnior AL, Amaro GC. 2015. Cochonilha rosada, *Maconellicoccus hirsutus* (Green), pp. 328–344 In Vilela EF, Zucchi RA [eds.] *Pragas introduzidas no Brasil: insetos e ácaros*. FEALQ, Piracicaba, São Paulo, Brazil.
- Nakayama K, Virgens Filho AC. 2014. Ocorrência da cochonilha rosada em ca-cauais da Bahia e Espírito Santo. <http://www.ceplac.gov.br/restrito/lerNoticia.asp?id=2159> (last accessed 17 Jan 2019).
- Negrini M, Moraes EGF, Batista JSR, Chagas EA. 2018. Population fluctuations in pink hibiscus mealybug and its natural enemies in *Annona squamosa* (Annonaceae) in Roraima, Brazil. *Acta Amazonica* 48: 28–31.
- Oliveira JEM, Lopes FSC, Oliveira MD, Pereira VS, Freitas MTS, Oliveira JV, Aquino VB. 2014. Registro de ocorrência da cochonilha rosada *Maconellicoccus hirsutus* no Semiárido Brasileiro, In 25th Congresso Brasileiro de Entomologia. Goiânia, Goiás. 14–18 Sep 2014. <https://ainfo.cnptia.embrapa.br/digital/bitstream/item/117140/1/Eudes-13-cpatsa.pdf> (last accessed 17 Jan 2019).

- Peres-Filho O, Ben-Dov Y, Wolff VRS, Dorval A, Souza MD. 2017. *Maconellicoccus hirsutus* (Green) register in teak forest stands in the Mato Grosso State, Brazil. *Floresta e Ambiente* 24: e20150157. doi.org/10.1590/2179-8087.015715
- Peronti ALBG, Martinelli NM, Alexandrino JG, Marsaro Júnior AL, Penteado-Dias AM, Almeida LM. 2016. Natural enemies associated with *Maconellicoccus hirsutus* (Hemiptera: Pseudococcidae) in the state of São Paulo, Brazil. *Florida Entomologist* 99: 21–25.
- Ramos ASJC, Peronti ALBG, Kondo T, Lemos RNS. 2018. First record of *Crypticeria zeteki* (Cockerell, 1914) (Monophlebidae) in Brazil and *Maconellicoccus hirsutus* (Green, 1908) (Pseudococcidae) in the state of Maranhão. *Brazilian Journal of Biology* 78: 87–90.
- Sagarra LA, Peterkin DD. 1999. Invasion of the Caribbean by the hibiscus mealybug, *Maconellicoccus hirsutus* Green (Homoptera: Pseudococcidae). *Phytoprotection* 80: 103–113.
- Silva SXB, Nunes MCA, Guimarães LP, Peronti ALBG, Barreto CR, Dias MCV. 2013a. Serviço de vigilância epidemiológica detecta cochonilha rosada do hibisco no estado da Bahia, Brasil, pp. 201–202 *In* Anais da IV Conferência Nacional de Defesa Agropecuária. Belém, Brazil, 1–4 Oct 2013. <https://www.dropbox.com/sh/h94f9kli65z9aw2/AAAa9A02BAiFKXe88rg5wsEda/2013%2009%2028%20anais.pdf?dl=0> (last accessed 25 Jan 2019).
- Silva SXB, Nunes MCA, Teles CLS, Rodrigues DL, Máximo FV, Almeida MACC. 2013b. Biogeografia de *Maconellicoccus hirsutus* Green (Hemiptera: Pseudococcidae) no Estado da Bahia, Brasil, pp. 229–230 *In* Anais da IV Conferência Nacional de Defesa Agropecuária. Belém, Brazil, 1–4 Oct 2013. <https://www.dropbox.com/sh/h94f9kli65z9aw2/AAAa9A02BAiFKXe88rg5wsEda/2013%2009%2028%20anais.pdf?dl=0> (last accessed 25 Jan 2019).
- Souza CAS, Martins DS, Aguilár MAG, Siqueira PR, Neto ES. 2014. Primeira ocorrência de cochonilha-rosada [*Maconellicoccus hirsutus* (Green) Hemiptera: Pseudococcidae] em plantas de cacaueteiro no Brasil. *In* Anais do 23th Congresso Brasileiro de Fruticultura. Cuiabá, Mato Grosso, Brazil, 24–29 Aug 2014.
- Tambasco FJ, Sá LAN, Nardo EAB, Tavares MT. 2000. Cochonilha rosada, *Maconellicoccus hirsutus* (Green): uma praga de importância quarentenária já se encontra na Guiana Inglesa. *Floresta* 30: 85–93.