

1 **New record of *Ferrisa dasyliirii* (Cockerell, 1896) (Hemiptera: Coccomorpha:**
2 **Pseudococcidae) in Indonesia**

3 Agustin ZARKANI^{1*}, Dwinardi APRIYANTO¹, Ferit TURANLI², Mehmet Bora
4 KAYDAN³

5 ¹ Department of Plant Protection, Faculty of Agriculture, University of Bengkulu,
6 383711, Bengkulu, Indonesia

7 ² Department of Plant Protection, Faculty of Agriculture, Ege University, 35100,
8 Izmir, Turkey.

9 ³ Biotechnology Research Centre, Çukurova University, 01250, Adana, Turkey.

10 * Correspondence: agustinzarkani@unib.ac.id

11 **ABSTRACT**

12 ~~In this study,~~ the occurrence of *Ferrisa dasyliirii* (Cockerell, 1896) (Hemiptera:
13 Pseudococcidae) ~~in Indonesia is was 1st~~ reported ~~in Indonesia~~. It was found on
14 *Durio zibethinus* Murray (Malvaceae), *Gliricidia sepium* (Jacq.) (Fabaceae),
15 *Hibiscus* spp. (Malvaceae), *Psidium guajava* L. (Myrtaceae), *Solanum torvum*

Memformat: Superskrip

16 Swartz (Solanaceae), and *Theobroma cacao* L. (Malvaceae) at some regencies in
17 Bengkulu Province, Southern Sumatra, Indonesia.

18 **Key words:** Biodiversity, host plant, ~~insect pests~~, mealybugs, Sumatera,
19 Indonesia taxonomy

20 INTRODUCTION

21 *Ferrisia* Fullaway is one of the genera in Pseudococcidae (Hemiptera:
22 Coccoomorpha: Pseudococcidae) which is a group of sap-feeding insects, tapping
23 into the phloem via a stylet or piercing, a straw-like mouthpart (Williams 2004;
24 Gullan & Martin 2009). In nature, ~~this genus in life~~ can easily be recognized by
25 long glassy filaments with typical dorsal patterns formed by the dark areas of cuticle
26 that are bare of powdery white mum wax (Gullan et al. 2010; Kaydan & Gullan
27 2012). It is a genus with huge dorsal tubular ducts surrounded by a flat sclerotized
28 area containing one or more setae situated either within the border or adjacent to
29 rim and also have a couple of cerarii on anal lobust (Gullan et al. 2003, 2010).

30 ~~When it was a~~The New World genus, *Ferrisia* consists of *Ferrisia virgata*
31 (Cockerell, 1893) and *Ferrisia malvastra* (McDaniel, 1962) ~~which was known to~~
32 have been spread to southern Asia and other parts of the world as insect pests of
33 cultivated plants (Williams & Watson 1988; Williams 1996, 2004). To date, the
34 combination of based on morphological and molecular data gathered this genus
35 comprised at least ~~there are~~ 18 species of *Ferrisia* i.e *Ferrisia claviseta* (Lobdell,
36 1930); *Ferrisia colombiana* Kaydan and Gullan, 2012; *Ferrisia cristinae* Kaydan

Dikomentari [I1]: Some or same? If some then please noted the name of the region or loaction,,,or better the GPS

Memformat: Coretan

Memformat: Coretan

Memformat: Coretan

37 and Gullan, 2012; *Ferrisia dasyliirii* (Cockerell, 1896); *Ferrisia ecuadorensis*
38 Kaydan and Gullan, 2012; *Ferrisia gilli* Gullan, 2003; *Ferrisia kondoi* Kaydan and
39 Gullan, 2012; *Ferrisia malvastra* (McDaniel, 1962), *Ferrisia meridionalis*
40 Williams, 1985; *Ferrisia milleri* Kaydan and Gullan, 2012; *Ferrisia multiformis*
41 Granara de Willink, 1991; *Ferrisia pitcairnia* Kaydan and Gullan, 2012; *Ferrisia*
42 *quaintancii* (Tinsley, 1898); *Ferrisia setosa* (Lobdell, 1930); *Ferrisia terani*
43 Williams and Granara de Willink, 1992; *Ferrisia uzinuri* Kaydan and Gullan, 2012;
44 *Ferrisia virgata* (Cockerell, 1893); and *Ferrisia williamsi* Kaydan and Gullan, 2012
45 (Kaydan & Gullan 2012). These 18 species were the results of Kaydan & Gullan
46 (2012) revision on a group of eight species that ~~have been~~were described ~~before~~_by
47 Williams (1996).

48 In Indonesia, the ~~re has been~~-only striped mealybug, *F. virgata*, ~~is was~~ presented
49 ~~by~~ (Williams (2004). This species was firstly recorded as intercepted species on
50 *Zingiber officinale* Roscoe (Zingiberaceae) by quarantine inspections of San Pedro,
51 USA in 1992. Then, the species was reported found in Java, Sulawesi, Sumba as
52 polyphagous pests species on *Azadiractha indica* A. Juss (Meliaceae), *Durio*
53 *kutejensis* Becc. (Bombacaceae), *Ficus* sp. (Moraceae), *Gossypium* sp.
54 (Malvaceae), *Indigofera* sp., (Fabaceae), *Ipomoea* sp. (Convolvulacea) (Williams
55 1996, 2004). Recently, *F. virgata* predictably becomes a cosmopolitan group insect
56 pest within a broad range of host plants around Indonesia which has been commonly
57 introduced across the globe through trade or other human-migrated movements
58 (Sartiami et al. 2016). The information on the widespread of *F. virgata* could be

59 confused by other species since recent taxonomic revision of the genus *Ferrisia*
60 was published and there is no more study about those species in Indonesia.
61 Recently, Pacheco da Silva et al. (2019) re-identified some species in North-East
62 Brazil and recorded *F. dasyliirii* as a new country record.

63 Here we report *Ferrisia dasyliirii* (Cockerell, 1896), a native species of arid
64 zones in northern Mexico, that has not been recorded from Indonesia before. This
65 report includes new information on the host range and distribution of the species in
66 Indonesia.

67 MATERIALS AND METHODS

68 The specimens were collected ~~in~~ from several host plant species growing
69 around the site of Agricultural Faculty, University of Bengkulu, Bengkulu city
70 (3°45'33.0"S, 102°16'10.1"E, 50 m a.s.l.). ~~The host plants were monitored b~~
71 ~~the beginning of August to November 2019 for gaining the different instars of the~~
72 ~~mealybug species.~~ Similarly, sampling were also conducted Further investigations
73 were carried out from the same host plants species in Bengkulu Tengah regency
74 (3°42'22.7"S 102°30'11.8"E, 550 m a.s.l.) and Seluma regency (3°59'07.1"S
75 102°25'37.4"E, 60 m a.s.l.), a part of municipals in Bengkulu Province. ~~All~~
76 ~~specimens were~~ obtained from several localities in Southern Sumatra = Indonesia
77 as were shown in Figure 1.A–C.

78 The specimens were preserved in 70% ethanol and slide-mountings were
79 prepared with methods refers to Kosztarab & Kozár (1988). Species identification

Memformat: Coretan

Dikomentari [I2]:
Sampling of different instrs were done from Aug to Nov 2019.

Memformat: Coretan

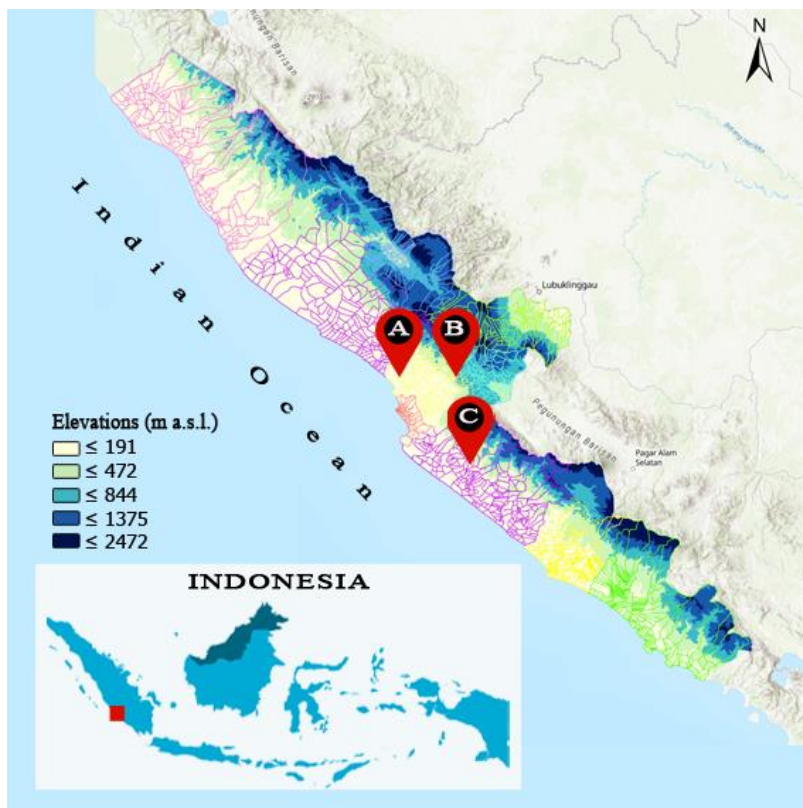
Memformat: Coretan

Dikomentari [I3]: Removed and put below as shown

Memformat: Coretan

80 was performed under light microscope and with the guide of keys mentioned in
81 Kaydan & Gullan (2012). The slide-mounted of *Ferrisia dasyirii* adult females and
82 nymphs are deposited in the mini Insect Museum, Plant Protection Department,
83 Faculty of Agriculture, University of Bengkulu (Sumatra-Indonesia). Slide
84 numbers: 300-305/1/2020. All specimens obtained from several localities in
85 Southern Sumatra—Indonesia were shown in Figure 1.A—C.

86



87

88 Figure 1. Distribution records of *Ferrisia dasyliirii* (Cockerell, 1896): A. Bengkulu
89 city (3°45'33.0"S, 102°16'10.1"E, 50 m a.s.l.); B. Bengkulu Tengah reGENCY
90 (3°42'22.7"S 102°30'11.8"E, 550 m a.s.l.); C. Seluma reGENCY (3°59'07.1"S
91 102°25'37.4"E, 60 m a.s.l.).

Dikomentari [I4]: Sampling location of

92 RESULTS AND DISCUSSION

93 *Ferrisia dasyliirii* was collected on the following host plants: *Durio zibethinus*
94 Murray (Malvaceae), *Gliricidia sepium* (Jacq.) (Fabaceae), *Hibiscus* spp.
95 (Malvaceae), *Psidium guajava* L. (Myrtaceae), *Solanum torvum* Swartz
96 (Solanaceae), and *Theobroma cacao* L. (Malvaceae). ~~The same species in similar~~
97 ~~host plants were also found in Seluma and Bengkulu Tengah reGENCYalreday. It~~
98 ~~shows that the species was established in some locations in Bengkulu Province. In~~
99 ~~these areas~~Result found that the *G. sepium* grown as a shade tree for some
100 cultivated plants such as *T. cacao* and *Coffea canephora* (Rubiaceae) as well as
101 "living supporting tree" for *Piper nigrum* (Piperaceae) ~~growth and was found~~
102 bearing more abundant population of *F. dasyliirii* ~~than the other trees where the~~
103 ~~insect were collected~~ (Figure 2). ~~In this case, As such,~~ *G. sepium* should be further
104 evaluated to ascertain whether the plant serves as a reservoir or an alternative host
105 plant for such a scale pest.

Dikomentari [I5]: Remove it but placed in methodology section

Dikomentari [I6]: Already mentioned in method

Memformat: Coretan



107

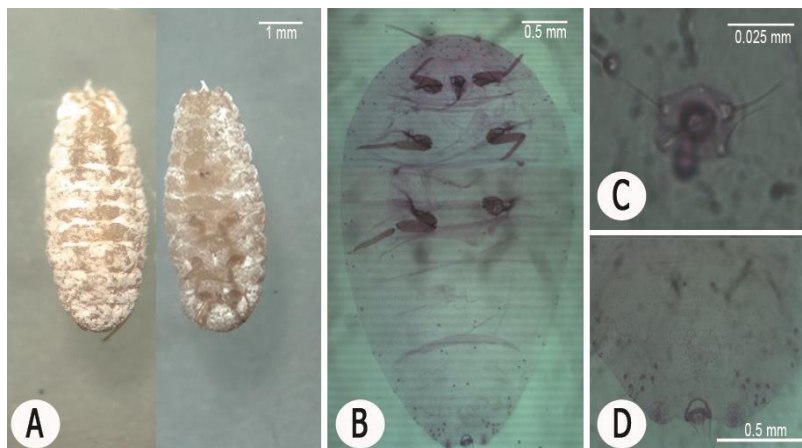
108 Figure 2. Nymphs and adults of *Ferrisa dasyliirii* (Cockerell, 1896) on the leaf
109 lower surface of *Gliricidia sepium* (Jacq.) (Fabaceae).

110 In naturelife, *F. dasyliirii* (Figure 3.A) is mostly similar with *F. virgata* in form
111 and size. The species has 8 segments antennae with ≥ 595 μm long; body elongate
112 oval with 3.10–5.30 mm long and 1.30–2.86 mm wide (Figure 3.B) ~~observed.~~ As
113 the bodies of females ~~are~~ cleared of soft contents and the cuticles stained and
114 mounted on microscope slides. They ~~are~~ could be easily distinguished easily from

Dikomentari [17]: Ur sentence very unclear. I have made suggestion according to my guess what did you want to say..

115 other taxa by their discoidal pores associated with sclerotised area around rim of
116 dorsal enlarged tubular ducts on abdomen. They are situated on outer margin of
117 sclerotised area and often with pore and its surrounding sclerotisation projecting
118 out from margin (Figure 3.C, D).

Dikomentari [18]: Dicodal pores???



119
120 Figure 3. Female of *Ferrisia dasyliirii* (Cockerell, 1896): A. In life specimens; B.
121 Slide-mounted specimen; C. Tubular duct with a minute discoidal pore touching
122 the outer margin of sclerotised area; D. Multilocular disc pores in row on abdominal
123 segment VI-VIII.

124 *Ferrisia dasyliirii* is already spread in [to](#) 22 countries [in the world which where](#)
125 Indonesia is now the second southeast Asia country reported [to have *R. dasyliirii*](#)
126 after Malaysia. Sartiami et al. (2016) firstly reported the species as an invasive
127 species attacking *Hibiscus rosasisnensis* L. and *Hibiscus* spp. (Malvaceae) in
128 Selangor and Kuala Lumpur, Malaysia. The exact time of arrival of *F. dasyliirii* in

Memformat: Font: Miring

129 Indonesia is not known but it probably ~~be brought~~ unintentionally [introduced here](#)
130 by international transportation and trade from Malaysia to Indonesia. [However,](#)
131 ~~(The wide distribution~~[abundance](#) of *F. dasyliirii* in some plants in the different
132 territories with various outbreak levels of the infestation indicates that the species
133 was probably introduced some years before its report. Besides, the species probably
134 also have already existed for a long time ago since the species is confused by *F.*
135 *virgata*.

136 The economic losses of *F. dasyliirii* has not clearly stated, but the species was
137 reported currently as a potential pest of *Salicornia bigelovii* (Torr.)
138 (Chenopodiaceae) ~~feed~~ and reproduced in 10% of commercial plantations at Baja
139 California Sur, Mexico (Magallón-Servín et al. 2019). It should be aware that the
140 mealybug species are known as the most common invaders of new geographical
141 areas and ~~capable~~[potent](#) to become a significant pest as well as virus transmission
142 vectors in many cropping systems (Hodgson 1994), and as such, further study is
143 urgently needed.

144 The slide-mounted adult females of *Ferrisia* species in southern Asia can be
145 distinguished from each other according to the following key (after Williams 2004):

- 146 1. Multilocular disc pores either absent from abdominal segment VI, or
147 occasionally numbering 1-3. Dorsal duct each with rim about same size as a
148 multilocular disc pore or smaller, with setae situated either adjacent to rim or
149 just outside it*malvastra* (McDaniel, 1962)

- 150 - Multilocular disc pores present in row on abdominal segment VI numbering at
151 least 8. Dorsal duct each with rim larger than a multilocular disc pore,
152 containing setae situated within border of rim (2)
- 153 2. Most discoidal pores associated with sclerotised area around rim of dorsal
154 enlarged tubular duct with a minute discoidal pore just touching outer margin
155 of sclerotised area, to projecting outside of margin (Figure 3.C).....
156 *dasyliirii* (Cockerell, 1896)
- 157 - Enlarged tubular duct with a minute discoidal pore not touching sclerotised rim
158 of duct opening; pore position varies from fully within sclerotised area
159 *virgata* (Cockerell, 1893)

160 ACKNOWLEDGMENT

161 This project was made possible by the Research and Community Service Institute,
162 University of Bengkulu. Cooperative Agreement No. SP DIPA-
163 042.012.400977/2019. [I think add more..those helping you even to town council all](#)

164 ..

165 CONFLICT OF INTEREST

166 The authors declare no conflict of interest.

167 REFERENCES

168 Gullan, P. J., Downie, D. A. & Steffan, S. A. 2003. A new pest species of the
169 mealybug genus *Ferrisia* Fullaway (Hemiptera: Pseudococcidae) from the United

170 States. *Annals of the Entomological Society of America* 96 (6): 723–737.
171 <https://doi.org/10.1603/0013-8746>.

172 Gullan, P. J. & Martin, J. H. 2009. *Sternorrhyncha (Jumping plant-lice, whiteflies,*
173 *aphids, and scale insects)*. pp. 957–967. In: Resh, V.H. and Cardé, R.T. (eds)
174 *Encyclopedia of Insects*, 2nd edition. San Diego: Elsevier. ISBN: 9780123741448,
175 e-ISBN: 9780080920900.

176 Gullan, P.J., Kaydan, M.B. & Hardy, N.B. 2010. Molecular phylogeny and species
177 recognition in the mealybug genus *Ferrisia* Fullaway (Hemiptera:
178 Pseudococcidae). *Systematic Entomology* 35: 329–339.
179 <https://doi.org/10.1111/j.1365-3113.2009.00513.x>.

180 Hodgson, C.J. 1994. *The Scale Insect Family Coccidae: an identification manual*
181 *to genera*. UK: CAB International Wallingford. 639 pp. ISBN: 0851988822.

182 Kaydan, M.B. & Gullan, P.J. 2012. A taxonomic revision of the mealybug genus
183 *Ferrisia* Fullaway (Hemiptera: Pseudococcidae), with descriptions of eight new
184 species and a new genus. *Zootaxa* 3543: 1–65. ISBN: 9781775570462, e-ISBN:
185 9781775570479.

186 Kosztarab, M. & Kozár, F. 1988. *Scale Insects of Central Europe*. Budapest:
187 Akadémiai Kiadó. 455 pp. ISBN-13: 9789401082952, e-ISBN-13:
188 9789400940451, DOI: 10.1007/978-94-009-4045-1.

189 Magallón-Servín, P., López-Vela, M., Pedraza-Mirafuentes, M. & Servín-Villegas,
190 R. 2019. *Ferrisia dasyliirii* (Cockerell, 1896), a Potential pest of commercial
191 plantations of *Salicornia bigelovii* (Torr.) at Baja California Sur, Mexico.
192 *Southwestern Entomologist* 44 (4): 861–866. <https://doi.org/10.3958/059.044.0413>.

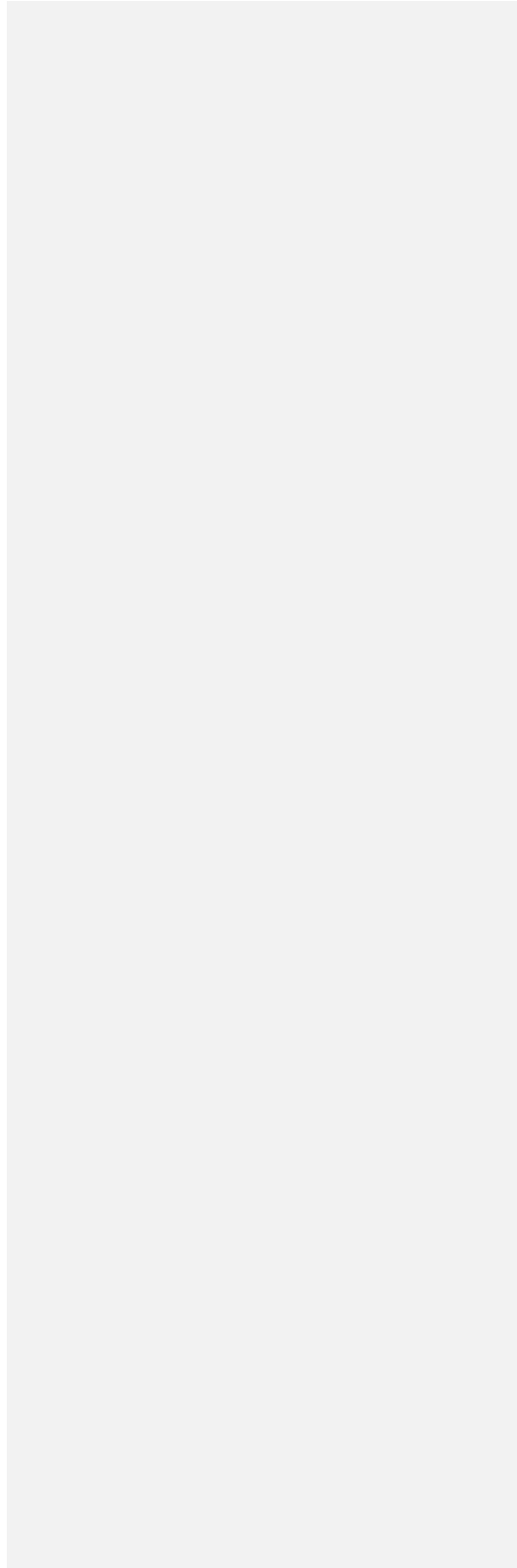
193 Pacheco da Silva, V.C., Kaydan, M.B., Silva-Torre,s C. S. A. D. & Torres, J.B.
194 2019. Mealybug species (Hemiptera: Coccoomorpha: Pseudococcidae) on soursop
195 and sugar apple (Annonaceae) in North-East Brazil, with description of a new
196 species of *Pseudococcus* Westwood. *Zootaxa* 4604 (3): 525–538.
197 <http://dx.doi.org/10.11646/zootaxa.4604.3.8>.

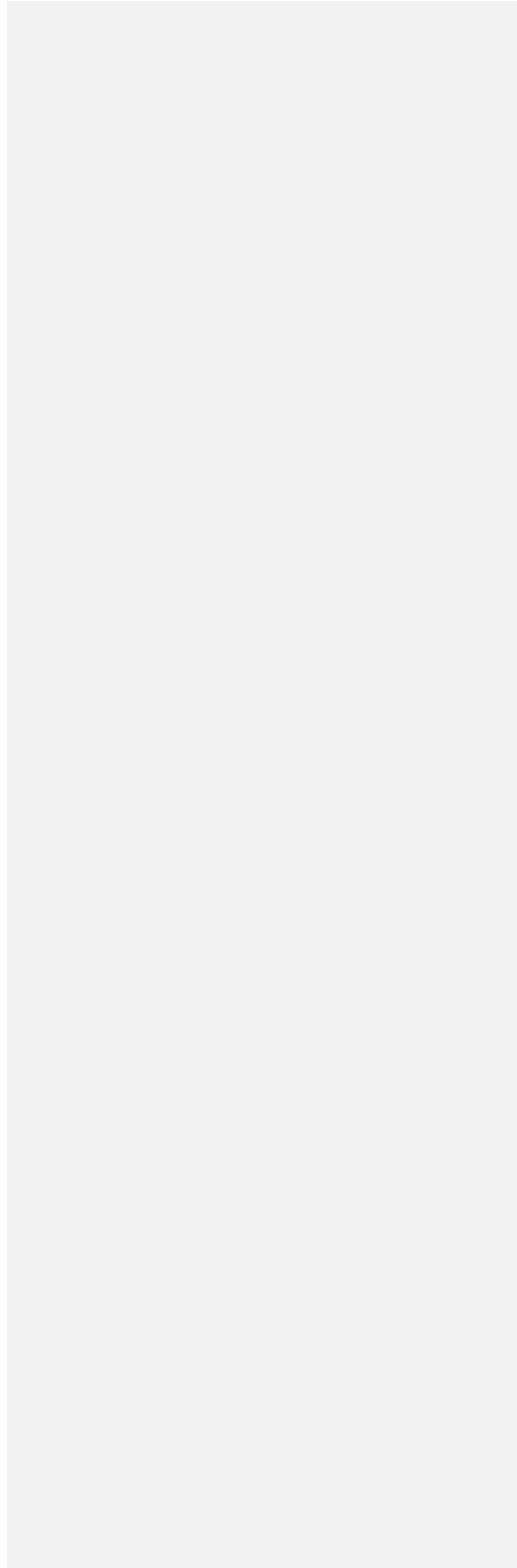
198 Sartiami, D., Watson, G.W., Mohamad, Roff, M. N. & Idris, A.B. 2016. Mealybugs
199 (Hemiptera: Coccoomorpha: Pseudococcidae) attacking *Hibiscus rosa-sinensis* L. in
200 Malaysia, with two new country records. AIP Conference Proceedings AIP
201 Publishing 1784, 060007 <http://dx.doi: 10.1063/1.4966845>.

202 Williams, D.J. & Watson, G.W. 1988. *The Scale Insects of the Tropical South*
203 *Pacific Region. Pt. 2: The Mealybugs (Pseudococcidae)*. London: CAB
204 International Institute of Entomology. 260 pp. ISBN: 0851986250.

205 Williams, D.J. 1996. A synoptic account of the mealybug genus *Ferrisia*.
206 *Entomologist's Monthly Magazine* 132 (3): 1–10. ISSN: 0013-8908.

207 Williams, D.J. 2004. *Mealybugs of Southern Asia*. Kuala Lumpur: The Natural
208 History Museum, London, and Southdene SDN BHD. 896 pp. ISBN: 9834005369.





1 **New record of *Ferrisa dasyliirii* (Cockerell, 1896) (Hemiptera: Coccomorpha:**
2 **Pseudococcidae) in Indonesia**

3 Agustin ZARKANI^{1*}, Dwinardi APRIYANTO¹, Ferit TURANLI², Mehmet Bora
4 KAYDAN³

5 ¹ Department of Plant Protection, Faculty of Agriculture, University of Bengkulu,
6 383711, Bengkulu, Indonesia

7 ² Department of Plant Protection, Faculty of Agriculture, Ege University, 35100,
8 Izmir, Turkey.

9 ³ Biotechnology Research Centre, Çukurova University, 01250, Adana, Turkey.

10 * Correspondence: agustinzarkani@unib.ac.id

11 **ABSTRACT**

12 In this study, the occurrence of *Ferrisa dasyliirii* (Cockerell, 1896) (Hemiptera:
13 Pseudococcidae) in Indonesia is reported. It was found on *Durio zibethinus* Murray
14 (Malvaceae), *Gliricidia sepium* (Jacq.) (Fabaceae), *Hibiscus* spp. (Malvaceae),
15 *Psidium guajava* L. (Myrtaceae), *Solanum torvum* Swartz (Solanaceae), and
16 *Theobroma cacao* L. (Malvaceae) at some regencies in Bengkulu Province,
17 Southern Sumatra.

18 **Key words:** Biodiversity, host plant, insect pests, mealybugs, taxonomy

19

INTRODUCTION

20 *Ferrisia* Fullaway is one of the genera in Pseudococcidae (Hemiptera:
21 Coccoomorpha: Pseudococcidae) which is a group of sap-feeding insects, tapping
22 into the phloem via a stylet or piercing, a straw-like mouthpart (Williams 2004;
23 Gullan & Martin 2009). This genus in life can easily be recognized by long glassy
24 filaments with typical dorsal patterns formed by the dark areas of cuticle that are
25 bare of powdery white mum wax (Gullan et al. 2010; Kaydan & Gullan 2012). It is
26 a genus with huge dorsal tubular ducts surrounded by a flat sclerotized area
27 containing one or more setae situated either within the border or adjacent to rim and
28 also have a couple of cerarii on anal lobust (Gullan et al. 2003, 2010).

29 When it was a New World genus, *Ferrisia* consists of *Ferrisia virgata*
30 (Cockerell, 1893) and *Ferrisia malvastra* (McDaniel, 1962) which have been
31 spread to southern Asia and other parts of the world as insect pests of cultivated
32 plants (Williams & Watson 1988; Williams 1996, 2004). To date, based on
33 morphological and molecular data there are 18 species of *Ferrisia* i.e *Ferrisia*
34 *claviseta* (Lobdell, 1930); *Ferrisia colombiana* Kaydan and Gullan, 2012; *Ferrisia*
35 *cristinae* Kaydan and Gullan, 2012; *Ferrisia dasyliirii* (Cockerell, 1896); *Ferrisia*
36 *ecuadorensis* Kaydan and Gullan, 2012; *Ferrisia gilli* Gullan, 2003; *Ferrisia*
37 *kondoi* Kaydan and Gullan, 2012; *Ferrisia malvastra* (McDaniel, 1962), *Ferrisia*
38 *meridionalis* Williams, 1985; *Ferrisia milleri* Kaydan and Gullan, 2012; *Ferrisia*
39 *multiformis* Granara de Willink, 1991; *Ferrisia pitcairnia* Kaydan and Gullan,
40 2012; *Ferrisia quaintancii* (Tinsley, 1898); *Ferrisia setosa* (Lobdell, 1930);

41 *Ferrisia terani* Williams and Granara de Willink, 1992; *Ferrisia uzinuri* Kaydan
42 and Gullan, 2012; *Ferrisia virgata* (Cockerell, 1893); and *Ferrisia williamsi*
43 Kaydan and Gullan, 2012 (Kaydan & Gullan 2012). These 18 species were the
44 results of Kaydan & Gullan (2012) revision on a group of eight species that have
45 been described before by Williams (1996).

46 In Indonesia, the only striped mealybug, *F. virgata*, is presented (Sartiami et
47 al. 1999; Williams 2004). This species was firstly recorded as intercepted species
48 on *Zingiber officinale* Roscoe (Zingiberaceae) by quarantine inspections of San
49 Pedro, USA in 1992. Then, the species was reported found in Java, Sulawesi,
50 Sumba as polyphagous pests species on *Azadiractha indica* A. Juss (Meliaceae),
51 *Durio kutejensis* Becc. (Bombacaceae), *Ficus* sp. (Moraceae), *Gossypium* sp.
52 (Malvaceae), *Indigofera* sp., (Fabaceae), *Ipomoea* sp. (Convolvulacea) (Williams
53 1996, 2004). Recently, *F. virgata* predictably becomes a cosmopolitan group insect
54 pest within a broad range of host plants around Indonesia which has been commonly
55 introduced across the globe through trade or other human-migrated movements
56 (Sartiami et al. 2016). The information on the widespread of *F. virgata* could be
57 confused by other species since recent taxonomic revision of the genus *Ferrisia*
58 was published and there is no more study about those species in Indonesia.
59 Recently, Pacheco da Silva et al. (2019) re-identified some species in North-East
60 Brazil and recorded *F. dasyliirii* as a new country record.

61 Here we report *Ferrisia dasyliirii* (Cockerell, 1896), a native species of arid
62 zones in northern Mexico, that has not been recorded from Indonesia before. This

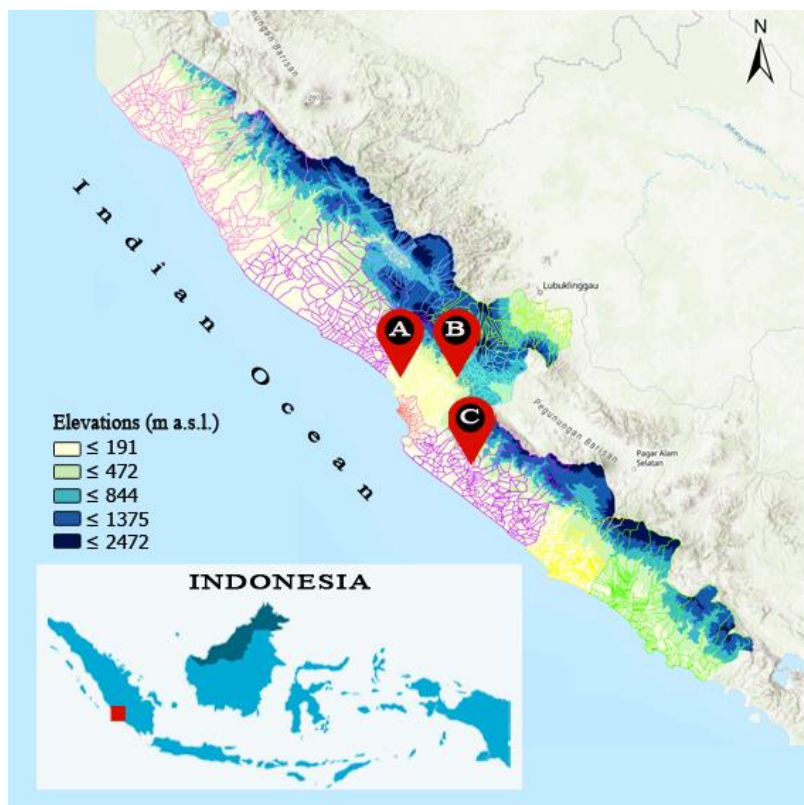
Dikomentari [DS1]: Please find the pdf of the paper and put some hots of the species on fruit trees

63 report includes new information on the host range and distribution of the species in
64 Indonesia.

65 MATERIALS AND METHODS

66 The specimens were collected in several plant species growing around the site
67 of Agricultural Faculty, University of Bengkulu, Bengkulu city (3°45'33.0"S,
68 102°16'10.1"E, 50 m a.s.l.). The host plants were monitored from the beginning of
69 August to November 2019 for gaining the different instars of the mealybug species.
70 Further investigations were carried out from the same plants in Bengkulu Tengah
71 regency (3°42'22.7"S 102°30'11.8"E, 550 m a.s.l.) and Seluma regency
72 (3°59'07.1"S 102°25'37.4"E, 60 m a.s.l.), a part of municipals in Bengkulu
73 Province. All specimens were obtained from several localities in Southern Sumatra
74 —Indonesia as shown in Figure 1.A—C.

75 The specimens were preserved in 70% ethanol and slide-mountings were
76 prepared with methods refers to Kosztarab & Kozár (1988). Species identification
77 was performed under light microscope and with the guide of keys mentioned in
78 Kaydan & Gullan (2012). The slide-mounted of *Ferrisia dasyliirii* adult females and
79 nymphs are deposited in the mini Insect Museum, Plant Protection Department,
80 Faculty of Agriculture, University of Bengkulu (Sumatra-Indonesia). Slide
81 numbers: 300-305/1/2020.



82

83 Figure 1. Distribution records of *Ferrisia dasyiriii* (Cockerell, 1896): A. Bengkulu
 84 city (3°45'33.0"S, 102°16'10.1"E, 50 m a.s.l.); B. Bengkulu Tengah regency
 85 (3°42'22.7"S 102°30'11.8"E, 550 m a.s.l.); C. Seluma regency (3°59'07.1"S
 86 102°25'37.4"E, 60 m a.s.l.).

87

RESULTS AND DISCUSSION

88

Ferrisia dasyiriii was collected on the following host plants: *Durio zibethinus*

89

Murray (Malvaceae), *Gliricidia sepium* (Jacq.) (Fabaceae), *Hibiscus* spp.

90 (Malvaceae), *Psidium guajava* L. (Myrtaceae), *Solanum torvum* Swartz
91 (Solanaceae), and *Theobroma cacao* L. (Malvaceae). The same species in similar
92 host plants were also found in Seluma and Bengkulu Tengah regency. It shows that
93 the species was established in some locations in Bengkulu Province. In these areas,
94 *G. sepium* grown as a shade tree for some cultivated plants such as *T. cacao* and
95 *Coffea canephora* (Rubiaceae) as well as "living supporting tree" for *Piper nigrum*
96 (Piperaceae) growth and was found bearing more abundant population of *F.*
97 *dasyliirii* (Figure 2). In this case, *G. sepium* should be evaluated whether the plant
98 serves as a reservoir or an alternative host plant for such a scale pest.

99

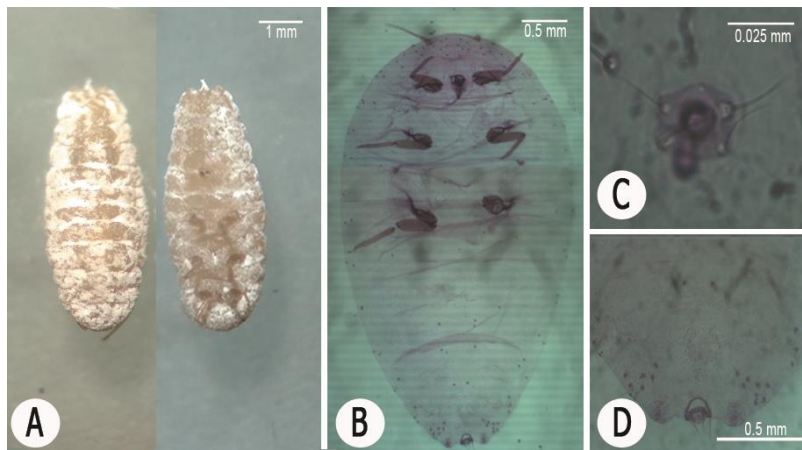


100

101 Figure 2. Nymphs and adults of *Ferrisa dasylirii* (Cockerell, 1896) on the leaf
102 lower surface of *Gliricidia sepium* (Jacq.) (Fabaceae).

103 In life, *F. dasylirii* (Figure 3.A) is mostly similar with *F. virgata* in form and
104 size. The species has 8 segments antennae with ≥ 595 μm long; body elongate oval
105 with 3.10–5.30 mm long and 1.30–2.86 mm wide (Figure 3.B). As the bodies of
106 females are cleared of soft contents and the cuticles stained and mounted on
107 microscope slides. They are distinguished easily from other taxa by their discoidal

108 pores associated with sclerotised area around rim of dorsal enlarged tubular ducts
109 on abdomen. They are situated on outer margin of sclerotised area and often with
110 pore and its surrounding sclerotisation projecting out from margin (Figure 3.C, D).



111
112 Figure 3. Female of *Ferrisa dasyliirii* (Cockerell, 1896): A. In life specimens; B.
113 Slide-mounted specimen; C. Tubular duct with a minute discoidal pore touching
114 the outer margin of sclerotised area; D. Multilocular disc pores in row on abdominal
115 segment VI-VIII.

Dikomentari [DS2]: Please rotate the figure, the head on the top then

Dikomentari [DS3]: Please make correction the figure 3B, 3C and 3D on brightness and contrast

116 *Ferrisia dasyliirii* is already spread in 22 countries which Indonesia is now the
117 second ~~southeast~~Southeast Asia country reported after Malaysia. Sartiami et al.
118 (2016) firstly reported the species as an invasive species attacking *Hibiscus*
119 *rosasinsensis* L. and *Hibiscus* spp. (Malvaceae) in Selangor and Kuala Lumpur,
120 Malaysia. The exact time of arrival of *F. dasyliirii* in Indonesia is not known but it
121 probably be brought unintentionally by international transportation and trade from

122 Malaysia to Indonesia. The wide distribution of *F. dasyliirii* in some plants in the
123 different territories with various outbreak levels of the infestation indicates that the
124 species was probably introduced some years before its report. Besides, the species
125 probably also have already existed for a long time ago since the species is confused
126 by *F. virgata*.

127 The economic losses of *F. dasyliirii* has not clearly stated, but the species was
128 reported currently as a potential pest of *Salicornia bigelovii* (Torr.)
129 (Chenopodiaceae) fed and reproduced in 10% of commercial plantations at Baja
130 California Sur, Mexico (Magallón-Servín et al. 2019). It should be aware that the
131 mealybug species are known as the most common invaders of new geographical
132 areas and potent to become a significant pest as well as virus transmission vectors
133 in many cropping systems (Hodgson 1994), and as such, further study is urgently
134 needed.

135 The slide-mounted adult females of *Ferrisia* species in southern Asia can be
136 distinguished from each other according to the following key (after Williams 2004):

- 137 1. Multilocular disc pores either absent from abdominal segment VI, or
138 occasionally numbering 1-3. Dorsal duct each with rim about same size as a
139 multilocular disc pore or smaller, with setae situated either adjacent to rim or
140 just outside it *malvastra* (McDaniel, 1962)
141 - Multilocular disc pores present in row on abdominal segment VI numbering at
142 least 8. Dorsal duct each with rim larger than a multilocular disc pore,
143 containing setae situated within border of rim (2)

- 144 2. Most discoidal pores associated with sclerotised area around rim of dorsal
145 enlarged tubular duct with a minute discoidal pore just touching outer margin
146 of sclerotised area, to projecting outside of margin (Figure 3.C).....
147 *dasyliirii* (Cockerell, 1896)
148 - Enlarged tubular duct with a minute discoidal pore not touching sclerotised rim
149 of duct opening; pore position varies from fully within sclerotised area
150 *virgata* (Cockerell, 1893)

151 **ACKNOWLEDGMENT**

152 This project was made possible by the Research and Community Service Institute,
153 University of Bengkulu. Cooperative Agreement No. SP DIPA-
154 042.012.400977/2019.

155 **CONFLICT OF INTEREST**

156 The authors declare no conflict of interest.

157 **REFERENCES**

- 158 Gullan, P. J., Downie, D. A. & Steffan, S. A. 2003. A new pest species of the
159 mealybug genus *Ferrisia* Fullaway (Hemiptera: Pseudococcidae) from the United
160 States. *Annals of the Entomological Society of America* 96 (6): 723–737.
161 <https://doi.org/10.1603/0013-8746>.
162 Gullan, P. J. & Martin, J. H. 2009. *Sternorrhyncha (Jumping plant-lice, whiteflies,*
163 *aphids, and scale insects)*. pp. 957–967. In: Resh, V.H. and Cardé, R.T. (eds)

164 *Encyclopedia of Insects*, 2nd edition. San Diego: Elsevier. ISBN: 9780123741448,
165 e-ISBN: 9780080920900.

166 Gullan, P.J., Kaydan, M.B. & Hardy, N.B. 2010. Molecular phylogeny and species
167 recognition in the mealybug genus *Ferrisia* Fullaway (Hemiptera:
168 Pseudococcidae). *Systematic Entomology* 35: 329–339.
169 <https://doi.org/10.1111/j.1365-3113.2009.00513.x>.

170 Hodgson, C.J. 1994. *The Scale Insect Family Coccidae: an identification manual*
171 *to genera*. UK: CAB International Wallingford. 639 pp. ISBN: 0851988822.

172 Kaydan, M.B. & Gullan, P.J. 2012. A taxonomic revision of the mealybug genus
173 *Ferrisia* Fullaway (Hemiptera: Pseudococcidae), with descriptions of eight new
174 species and a new genus. *Zootaxa* 3543: 1–65. ISBN: 9781775570462, e-ISBN:
175 9781775570479.

176 Kosztarab, M. & Kozár, F. 1988. *Scale Insects of Central Europe*. Budapest:
177 Akadémiai Kiadó. 455 pp. ISBN-13: 9789401082952, e-ISBN-13:
178 9789400940451, DOI: 10.1007/978-94-009-4045-1.

179 Magallón-Servín, P., López-Vela, M., Pedraza-Mirafuentes, M. & Servín-Villegas,
180 R. 2019. *Ferrisia dasyliirii* (Cockerell, 1896), a Potential pest of commercial
181 plantations of *Salicornia bigelovii* (Torr.) at Baja California Sur, Mexico.
182 *Southwestern Entomologist* 44 (4): 861–866. <https://doi.org/10.3958/059.044.0413>.

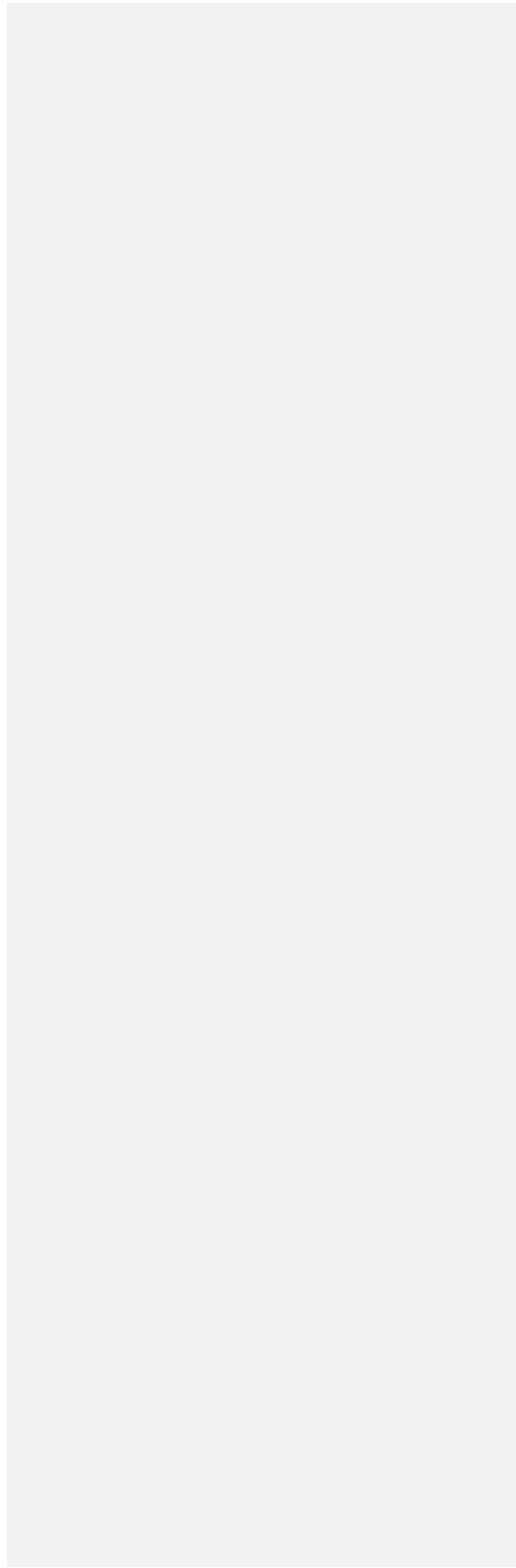
183 Pacheco da Silva, V.C., Kaydan, M.B., Silva-Torre,s C. S. A. D. & Torres, J.B.
184 2019. Mealybug species (Hemiptera: Coccomorpha: Pseudococcidae) on soursop
185 and sugar apple (Annonaceae) in North-East Brazil, with description of a new
186 species of *Pseudococcus* Westwood. *Zootaxa* 4604 (3): 525–538.
187 <http://dx.doi.org/10.11646/zootaxa.4604.3.8>.

188 Sartiami, D., Watson, G.W., Mohamad, Roff, M. N. & Idris, A.B. 2016. Mealybugs
189 (Hemiptera: Coccomorpha: Pseudococcidae) attacking *Hibiscus rosa-sinensis* L. in
190 Malaysia, with two new country records. AIP Conference Proceedings AIP
191 Publishing 1784, 060007 <http://dx.doi: 10.1063/1.4966845>.

192 Williams, D.J. & Watson, G.W. 1988. *The Scale Insects of the Tropical South*
193 *Pacific Region. Pt. 2: The Mealybugs (Pseudococcidae)*. London: CAB
194 International Institute of Entomology. 260 pp. ISBN: 0851986250.

195 Williams, D.J. 1996. A synoptic account of the mealybug genus *Ferrisia*.
196 *Entomologist's Monthly Magazine* 132 (3): 1–10. ISSN: 0013-8908.

197 Williams, D.J. 2004. *Mealybugs of Southern Asia*. Kuala Lumpur: The Natural
198 History Museum, London, and Southdene SDN BHD. 896 pp. ISBN: 9834005369.



1 **New record of *Ferrisa dasyliirii* (Cockerell, 1896) (Hemiptera: Cocomorpha:**
2 **Pseudococcidae) in Indonesia**

3 Agustin ZARKANI^{1*}, Dwinardi APRIYANTO¹, Ferit TURANLI², Mehmet Bora
4 KAYDAN³

5 ¹ Department of Plant Protection, Faculty of Agriculture, University of Bengkulu,
6 383711, Bengkulu, Indonesia

7 ² Department of Plant Protection, Faculty of Agriculture, Ege University, 35100,
8 Izmir, Turkey.

9 ³ Biotechnology Research Centre, Çukurova University, 01250, Adana, Turkey.

10 * Correspondence: agustinzarkani@unib.ac.id

11 **ABSTRACT**

12 The occurrence of *Ferrisa dasyliirii* (Cockerell, 1896) (Hemiptera:
13 Pseudococcidae) was 1st reported in Indonesia. It was found on *Durio zibethinus*
14 Murray (Malvaceae), *Gliricidia sepium* (Jacq.) (Fabaceae), *Hibiscus* spp.
15 (Malvaceae), *Psidium guajava* L. (Myrtaceae), *Solanum torvum* Swartz
16 (Solanaceae), and *Theobroma cacao* L. (Malvaceae) at some regencies in
17 Bengkulu Province, Southern Sumatra, Indonesia.

18 **Key words:** Biodiversity, host plant, mealybug, Sumatera, Indonesia

19

ABSTRAK

20 Munculnya spesies kutu putih *Ferrisa dasyliirii* (Cockerell, 1896) (Hemiptera:
21 Pseudococcidae) pertama kali di Indonesia telah dilaporkan. Spesies ini dijumpai
22 hidup pada tanaman *Durio zibethinus* Murray (Malvaceae), *Gliricidia sepium*
23 (Jacq.) (Fabaceae), *Hibiscus* spp. (Malvaceae), *Psidium guajava* L. (Myrtaceae),
24 *Solanum torvum* Swartz (Solanaceae), dan *Theobroma cacao* L. (Malvaceae) di
25 beberapa kabupaten di Provinsi Bengkulu, Sumatera Selatan, Indonesia.

26 **Kata Kunci:** Keanekaragaman hayati, tanaman inang, kutu putih, Sumatera,
27 Indonesia

28

INTRODUCTION

29 *Ferrisia* Fullaway is one of the genera in Pseudococcidae (Hemiptera:
30 Coccoomorpha: Pseudococcidae) which is a group of sap-feeding insects, tapping
31 into the phloem via a stylet or piercing, a straw-like mouthpart (Williams 2004;
32 Gullan & Martin 2009). In nature, this genus can easily be recognized by long
33 glassy filaments with typical dorsal patterns formed by the dark areas of cuticle
34 that are bare of powdery white mum wax (Gullan et al. 2010; Kaydan & Gullan
35 2012). It is a genus with huge dorsal tubular ducts surrounded by a flat sclerotized
36 area containing one or more setae situated either within the border or adjacent to
37 rim and also have a couple of cerarii on anal lobust (Gullan et al. 2003, 2010).

38 The New World genus, *Ferrisia* consists of *Ferrisia virgata* (Cockerell,
39 1893) and *Ferrisia malvastra* (McDaniel, 1962) was known to have been spread

40 to southern Asia and other parts of the world as insect pests of cultivated plants
41 (Williams & Watson 1988; Williams 1996, 2004; Sartiami et al. 2017). To date,
42 the combination of morphological and molecular data gathered this genus
43 comprised at least 18 species of *Ferrisia* i.e *Ferrisia claviseta* (Lobdell, 1930);
44 *Ferrisia colombiana* Kaydan and Gullan, 2012; *Ferrisia cristinae* Kaydan and
45 Gullan, 2012; *Ferrisia dasylirii* (Cockerell, 1896); *Ferrisia ecuadorensis* Kaydan
46 and Gullan, 2012; *Ferrisia gilli* Gullan, 2003; *Ferrisia kondoi* Kaydan and
47 Gullan, 2012; *Ferrisia malvastra* (McDaniel, 1962), *Ferrisia meridionalis*
48 Williams, 1985; *Ferrisia milleri* Kaydan and Gullan, 2012; *Ferrisia multiformis*
49 Granara de Willink, 1991; *Ferrisia pitcairnia* Kaydan and Gullan, 2012; *Ferrisia*
50 *quaintancii* (Tinsley, 1898); *Ferrisia setosa* (Lobdell, 1930); *Ferrisia terani*
51 Williams and Granara de Willink, 1992; *Ferrisia uzinuri* Kaydan and Gullan,
52 2012; *Ferrisia virgata* (Cockerell, 1893); and *Ferrisia williamsi* Kaydan and
53 Gullan, 2012 (Kaydan & Gullan 2012). These 18 species were the results of
54 Kaydan & Gullan (2012) revision on a group of eight species that were described
55 by Williams (1996).

56 In Indonesia, the only striped mealybug, *F. virgata*, is presented (Sartiami et
57 al. 1999; Williams 2004). This species was firstly recorded as intercepted species
58 on *Zingiber officinale* Roscoe (Zingiberaceae) by quarantine inspections of San
59 Pedro, USA in 1992. Then, the species was reported found in Java, Sulawesi,
60 Sumba as polyphagous pests species on *Annona squamosa* L. (Annonaceae),
61 *Azadiractha indica* A. Juss (Meliaceae), *Durio kutejensis* Becc. (Bombacaceae),

62 *Ficus* sp. (Moraceae), *Gossypium* sp. (Malvaceae), *Indigofera* sp., (Fabaceae),
63 *Ipomoea* sp. (Convolvulaceae), *Nephelium lappaceum* L. (Sapindaceae), and
64 *Psidium guajava* L. (Myrtaceae) (Sartiami et al. 1999; Williams 1996, 2004).
65 Recently, *F. virgata* predictably becomes a cosmopolitan group insect pest within
66 a broad range of host plants around Indonesia which has been commonly
67 introduced across the globe through trade or other human-migrated movements
68 (Sartiami et al. 2016). The information on the widespread of *F. virgata* could be
69 confused by other species since recent taxonomic revision of the genus *Ferrisia*
70 was published and there is no more study about those species in Indonesia.
71 Recently, Pacheco da Silva et al. (2019) re-identified some species in North-East
72 Brazil and recorded *F. dasyliirii* as a new country record.

73

74 Here we report *Ferrisia dasyliirii* (Cockerell, 1896), a native species of arid
75 zones in northern Mexico, that has not been recorded from Indonesia before. This
76 report includes new information on the host range and distribution of the species
77 in Indonesia.

78

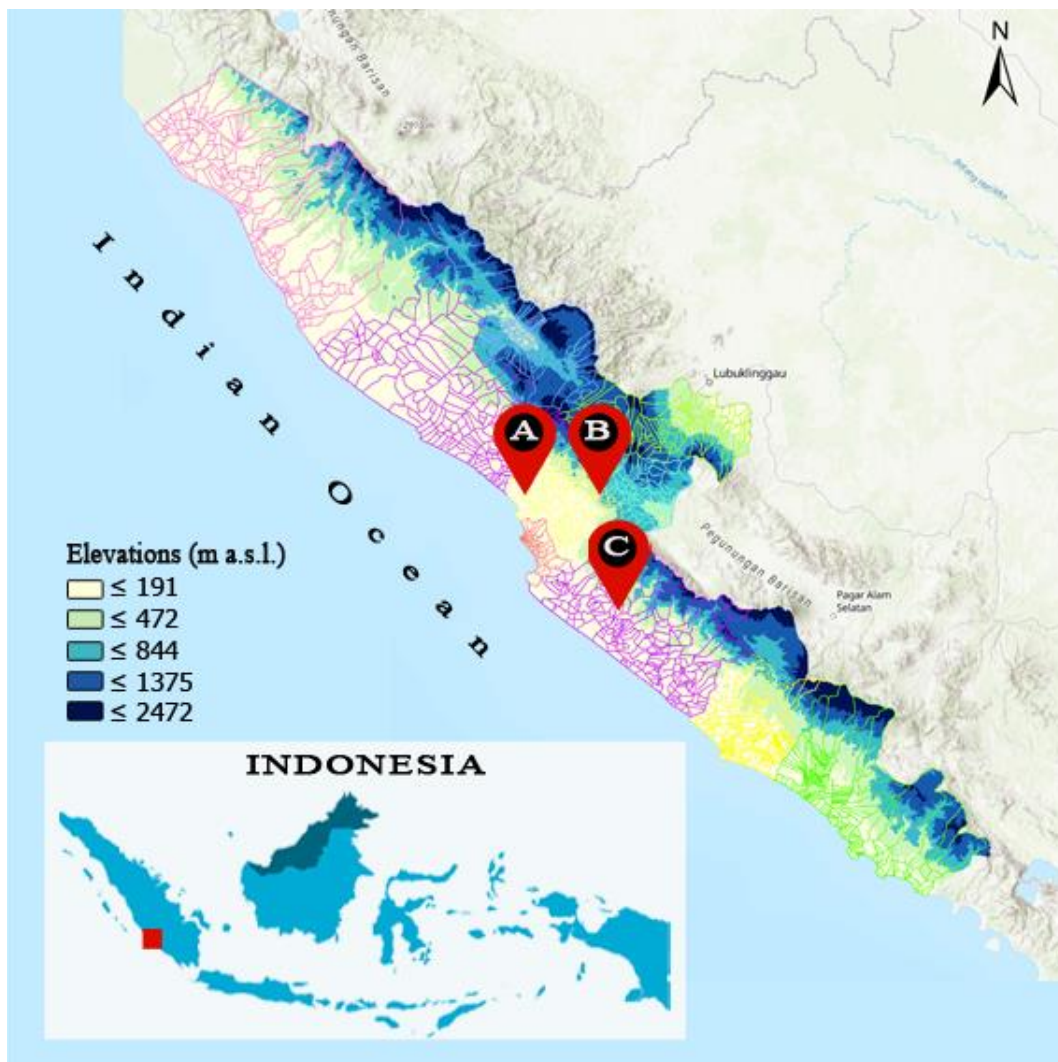
MATERIALS AND METHODS

79 The specimens were collected from several host plant species growing around
80 the site of Agricultural Faculty, University of Bengkulu, Bengkulu city
81 (3°45'33.0"S, 102°16'10.1"E, 50 m a.s.l.). Sampling of different instars were done
82 from Aug to Nov 2019. Similarly, sampling were also conducted from the same

83 host plants species in Bengkulu Tengah regency (3°42'22.7"S 102°30'11.8"E, 550
84 m a.s.l.) and Seluma regency (3°59'07.1"S 102°25'37.4"E, 60 m a.s.l.), a part of
85 municipals in Bengkulu Province. The species of *Ferrisia dasyliirii* was collected
86 on the following host plants: *Durio zibethinus* Murray (Malvaceae), *Gliricidia*
87 *sepium* (Jacq.) (Fabaceae), *Hibiscus* spp. (Malvaceae), *Psidium guajava* L.
88 (Myrtaceae), *Solanum torvum* Swartz (Solanaceae), and *Theobroma cacao* L.
89 (Malvaceae).

90 The specimens were preserved in 70% ethanol and slide-mountings were
91 prepared with methods refers to Kosztarab & Kozár (1988). Species identification
92 was performed under light microscope and with the guide of keys mentioned in
93 Kaydan & Gullan (2012). The slide-mounted of *Ferrisia dasyliirii* adult females
94 and nymphs are deposited in the mini Insect Museum, Plant Protection
95 Department, Faculty of Agriculture, University of Bengkulu (Sumatra-Indonesia).
96 Slide numbers: 300-305/1/2020. All specimens obtained were shown in Figure
97 1.A–C.

98



99

100 Figure 1. Sampling locations of *Ferrisa dasyliirii* (Cockerell, 1896): A. Bengkulu
 101 city (3°45'33.0"S, 102°16'10.1"E, 50 m a.s.l.); B. Bengkulu Tengah regency
 102 (3°42'22.7"S 102°30'11.8"E, 550 m a.s.l.); C. Seluma regency (3°59'07.1"S
 103 102°25'37.4"E, 60 m a.s.l.).

104

RESULTS AND DISCUSSION

105

Result found that the *G. sepium* grown as a shade tree for some cultivated
 106 plants such as *T. cacao* and *Coffea canephora* (Rubiaceae) as well as "living

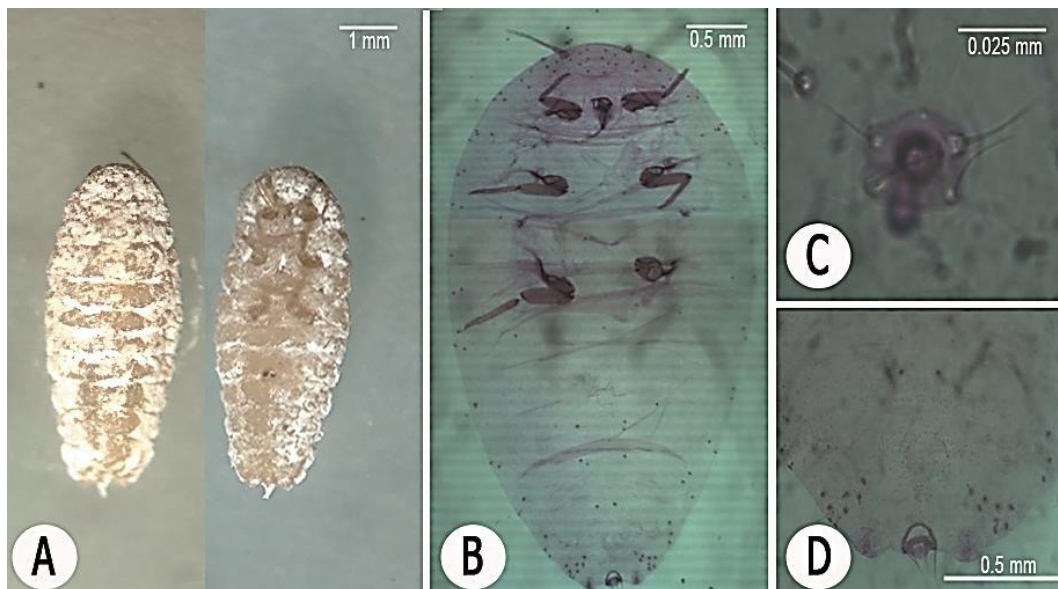
107 supporting tree” for *Piper nigrum* (Piperaceae) bearing more abundant population
108 of *F. dasyliirii* than the other trees where the insect were collected (Figure 2). As
109 such, *G. sepium* should be further evaluated to ascertain whether the plant serves
110 as a reservoir or an alternative host plant for such a scale pest.



111

112 Figure 2. Nymphs and adults of *Ferrisa dasyliirii* (Cockerell, 1896) on the leaf
113 lower surface of *Gliricidia sepium* (Jacq.) (Fabaceae).

114 In nature, *F. dasylyrii* (Figure 3.A) is mostly similar with *F. virgata* in form
115 and size. The species has 8 segments antennae with $\geq 595 \mu\text{m}$ long; body elongate
116 oval with 3.10–5.30 mm long and 1.30–2.86 mm wide (Figure 3.B) observed the
117 bodies of females cleared of soft contents and the cuticles stained and mounted on
118 microscope slides. They could be easily distinguished from other taxa by their
119 discoidal pores associated with sclerotised area around rim of dorsal enlarged
120 tubular ducts on abdomen. Discoidal pores are situated on outer margin of
121 sclerotised area and often with pore and its surrounding sclerotisation projecting
122 out from margin (Figure 3.C, D).



124 Figure 3. Female of *Ferrisa dasylyrii* (Cockerell, 1896): A. In life specimens; B.
125 Slide-mounted specimen; C. Tubular duct with a minute discoidal pore touching
126 the outer margin of sclerotised area; D. Multilocular disc pores in row on
127 abdominal segment VI-VIII.

128 *Ferrisia dasyliirii* is already spread into 22 countries in the world where
129 Indonesia is now the second Southeast Asia country reported to have *F. dasyliirii*
130 after Malaysia. Sartiami et al. (2016) firstly reported the species as an invasive
131 species attacking *Hibiscus rosasisnensis* L. and *Hibiscus* spp. (Malvaceae) in
132 Selangor and Kuala Lumpur, Malaysia. The exact time of arrival of *F. dasyliirii* in
133 Indonesia is not known but it probably unintentionally introduced here by
134 international transportation and trade from Malaysia to Indonesia. However, the
135 abundance of *F. dasyliirii* in some plants in the different territories with various
136 outbreak levels of the infestation indicates that the species was probably
137 introduced some years before its report. Besides, the species probably also have
138 already existed for a long time ago since the species is confused by *F. virgata*.

139 The economic losses of *F. dasyliirii* has not clearly stated, but the species was
140 reported currently as a potential pest of *Salicornia bigelovii* (Torr.)
141 (Chenopodiaceae) feed and reproduced in 10% of commercial plantations at Baja
142 California Sur, Mexico (Magallón-Servín et al. 2019). It should be aware that the
143 mealybug species are known as the most common invaders of new geographical
144 areas and capable to become a significant pest as well as virus transmission
145 vectors in many cropping systems (Hodgson 1994), and as such, further study is
146 urgently needed.

147 The slide-mounted adult females of *Ferrisia* species in southern Asia can be
148 distinguished from each other according to the following key (after Williams
149 2004):

- 150 1. Multilocular disc pores either absent from abdominal segment VI, or
 151 occasionally numbering 1-3. Dorsal duct each with rim about same size as a
 152 multilocular disc pore or smaller, with setae situated either adjacent to rim or
 153 just outside it*malvastra* (McDaniel, 1962)
- 154 - Multilocular disc pores present in row on abdominal segment VI numbering
 155 at least 8. Dorsal duct each with rim larger than a multilocular disc pore,
 156 containing setae situated within border of rim (2)
- 157 2. Most discoidal pores associated with sclerotised area around rim of dorsal
 158 enlarged tubular duct with a minute discoidal pore just touching outer margin
 159 of sclerotised area, to projecting outside of margin (Figure 3.C).....
 160*dasyliroi* (Cockerell, 1896)
- 161 - Enlarged tubular duct with a minute discoidal pore not touching sclerotised
 162 rim of duct opening; pore position varies from fully within sclerotised area
 163*virgata* (Cockerell, 1893)

164 **ACKNOWLEDGMENT**

165 This project was made possible by the Research and Community Service Institute,
 166 The University of Bengkulu with cooperative agreement No. SP.DIPA-
 167 042.012.400977/2019.

168 **CONFLICT OF INTEREST**

169 The authors declare no conflict of interest.

170 **REFERENCES**

171 Gullan, P. J., Downie, D. A. & Steffan, S. A. 2003. A new pest species of the
172 mealybug genus *Ferrisia* Fullaway (Hemiptera: Pseudococcidae) from the United
173 States. *Annals of the Entomological Society of America* 96 (6): 723–737.
174 <https://doi.org/10.1603/0013-8746>.

175 Gullan, P. J. & Martin, J. H. 2009. *Sternorrhyncha (Jumping plant-lice, whiteflies,*
176 *aphids, and scale insects)*. pp. 957–967. In: Resh, V.H. and Cardé, R.T. (eds)
177 *Encyclopedia of Insects*, 2nd edition. San Diego: Elsevier. ISBN:
178 9780123741448, e-ISBN: 9780080920900.

179 Gullan, P.J., Kaydan, M.B. & Hardy, N.B. 2010. Molecular phylogeny and
180 species recognition in the mealybug genus *Ferrisia* Fullaway (Hemiptera:
181 Pseudococcidae). *Systematic Entomology* 35: 329–339.
182 <https://doi.org/10.1111/j.1365-3113.2009.00513.x>.

183 Hodgson, C.J. 1994. *The Scale Insect Family Coccidae: an identification manual*
184 *to genera*. UK: CAB International Wallingford. 639 pp. ISBN: 0851988822.

185 Kaydan, M.B. & Gullan, P.J. 2012. A taxonomic revision of the mealybug genus
186 *Ferrisia* Fullaway (Hemiptera: Pseudococcidae), with descriptions of eight new
187 species and a new genus. *Zootaxa* 3543: 1–65. ISBN: 9781775570462, e-ISBN:
188 9781775570479.

189 Kosztarab, M. & Kozár, F. 1988. *Scale Insects of Central Europe*. Budapest:
190 Akadémiai Kiadó. 455 pp. ISBN-13: 9789401082952, e-ISBN-13:
191 9789400940451, DOI: 10.1007/978-94-009-4045-1.

192 Magallón-Servín, P., López-Vela, M., Pedraza-Mirafuentes, M. & Servín-
193 Villegas, R. 2019. *Ferrisia dasyliirii* (Cockerell, 1896), a Potential pest of
194 commercial plantations of *Salicornia bigelovii* (Torr.) at Baja California Sur,
195 Mexico. *Southwestern Entomologist* 44 (4): 861–866.
196 <https://doi.org/10.3958/059.044.0413>.

197 Pacheco da Silva, V.C., Kaydan, M.B., Silva-Torre,s C. S. A. D. & Torres, J.B.
198 2019. Mealybug species (Hemiptera: Coccoomorpha: Pseudococcidae) on soursop
199 and sugar apple (Annonaceae) in North-East Brazil, with description of a new
200 species of *Pseudococcus* Westwood. *Zootaxa* 4604 (3): 525–538.
201 <http://dx.doi.org/10.11646/zootaxa.4604.3.8>.

202 Sartiami, D., Sosromarsono, S., Buchori, D. & Suryobroto, B. 1999. Keragaman
203 spesies kutu putih pada tanaman buah-buahan di daerah Bogor. *In: Peranan*
204 *Entomologi dalam Pengendalian Hama yang Ramah Lingkungan dan Ekonomis.*
205 *Prosiding Seminar Nasional Perhimpunan Entomologi Indonesia (PEI)*, 16
206 Februari 1999, Bogor, Indonesia. 429–435 p.

207 Sartiami, D., Watson, G.W., Mohamad, Roff, M. N. & Idris, A.B. 2016.
208 Mealybugs (Hemiptera: Coccoomorpha: Pseudococcidae) attacking *Hibiscus rosa-*
209 *sinensis* L. in Malaysia, with two new country records. *AIP Conference*
210 *Proceedings AIP Publishing* 1784, 060007 <http://dx.doi: 10.1063/1.4966845>.

211 Sartiami, D., Watson, G.W., Roff, M.N.M, & Ghani, I.A. 2017. A taxonomic
212 update of Takahashi's historic collection of mealybugs (Hemiptera:
213 Pseudococcidae) from Malaysia and Singapore. *Serangga* 22 (2): 91-114.

214 Williams, D.J. & Watson, G.W. 1988. *The Scale Insects of the Tropical South*
215 *Pacific Region. Pt. 2: The Mealybugs (Pseudococcidae)*. London: CAB
216 International Institute of Entomology. 260 pp. ISBN: 0851986250.

217 Williams, D.J. 1996. A synoptic account of the mealybug genus *Ferrisia*.
218 *Entomologist's Monthly Magazine* 132 (3): 1–10. ISSN: 0013-8908.

219 Williams, D.J. 2004. *Mealybugs of Southern Asia*. Kuala Lumpur: The Natural
220 History Museum, London, and Southdene SDN BHD. 896 pp. ISBN:
221 9834005369.

222

1 **New record of *Ferrisa dasyliirii* (Cockerell, 1896) (Hemiptera: Coccomorpha:**
2 **Pseudococcidae) in Indonesia**

3 Agustin ZARKANI^{1*}, Dwinardi APRIYANTO¹, Ferit TURANLI², Mehmet Bora
4 KAYDAN³

5 ¹ Department of Plant Protection, Faculty of Agriculture, University of Bengkulu,
6 383711, Bengkulu, Indonesia

7 ² Department of Plant Protection, Faculty of Agriculture, Ege University, 35100,
8 Izmir, Turkey.

9 ³ Biotechnology Research Centre, Çukurova University, 01250, Adana, Turkey.

10 * Correspondence: agustinzarkani@unib.ac.id

11 **ABSTRACT**

12 The occurrence of *Ferrisa dasyliirii* (Cockerell, 1896) (Hemiptera:
13 Pseudococcidae) was 1st reported in Indonesia. It was found on *Durio zibethinus*
14 Murray (Malvaceae), *Gliricidia sepium* (Jacq.) (Fabaceae), *Hibiscus* spp.
15 (Malvaceae), *Psidium guajava* L. (Myrtaceae), *Solanum torvum* Swartz
16 (Solanaceae), and *Theobroma cacao* L. (Malvaceae) at some regencies in
17 Bengkulu Province, Southern Sumatra, Indonesia.

18 **Key words:** Biodiversity, host plant, mealybugs, Sumatera, Indonesia

Dikomentari [I1]: Some or same? If some then please noted the name of the region or loaction,,,,,or better the GPS

Dikomentari [A22]: SOME

19

INTRODUCTION

20 *Ferrisia* Fullaway is one of the genera in Pseudococcidae (Hemiptera:
21 Coccoomorpha: Pseudococcidae) which is a group of sap-feeding insects, tapping
22 into the phloem via a stylet or piercing, a straw-like mouthpart (Williams 2004;
23 Gullan & Martin 2009). In nature, this genus ~~in life~~ can easily be recognized by
24 long glassy filaments with typical dorsal patterns formed by the dark areas of
25 cuticle that are bare of powdery white mum wax (Gullan et al. 2010; Kaydan &
26 Gullan 2012). It is a genus with huge dorsal tubular ducts surrounded by a flat
27 sclerotized area containing one or more setae situated either within the border or
28 adjacent to rim and also have a couple of cerarii on anal lobust (Gullan et al. 2003,
29 2010).

30 The New World genus, *Ferrisia* consists of *Ferrisia virgata* (Cockerell,
31 1893) and *Ferrisia malvastra* (McDaniel, 1962) was known to have been spread
32 to southern Asia and other parts of the world as insect pests of cultivated plants
33 (Williams & Watson 1988; Williams 1996, 2004). To date, the combination of
34 morphological and molecular data gathered this genus comprised at least ~~there are~~
35 18 species of *Ferrisia* i.e *Ferrisia claviseta* (Lobdell, 1930); *Ferrisia colombiana*
36 Kaydan and Gullan, 2012; *Ferrisia cristinae* Kaydan and Gullan, 2012; *Ferrisia*
37 *dasyliirii* (Cockerell, 1896); *Ferrisia ecuadorensis* Kaydan and Gullan, 2012;
38 *Ferrisia gilli* Gullan, 2003; *Ferrisia kondoi* Kaydan and Gullan, 2012; *Ferrisia*
39 *malvastra* (McDaniel, 1962), *Ferrisia meridionalis* Williams, 1985; *Ferrisia*
40 *milleri* Kaydan and Gullan, 2012; *Ferrisia multiformis* Granara de Willink, 1991;

41 *Ferrisia pitcairnia* Kaydan and Gullan, 2012; *Ferrisia quaintancii* (Tinsley,
42 1898); *Ferrisia setosa* (Lobdell, 1930); *Ferrisia terani* Williams and Granara de
43 Willink, 1992; *Ferrisia uzinuri* Kaydan and Gullan, 2012; *Ferrisia virgata*
44 (Cockerell, 1893); and *Ferrisia williamsi* Kaydan and Gullan, 2012 (Kaydan &
45 Gullan 2012). These 18 species were the results of Kaydan & Gullan (2012)
46 revision on a group of eight species that were described by Williams (1996).

47 In Indonesia, there has been only striped mealybug, *F. virgata*, was presented
48 by Williams (2004). This species was firstly recorded as intercepted species on
49 *Zingiber officinale* Roscoe (Zingiberaceae) by quarantine inspections of San
50 Pedro, USA in 1992. Then, the species was reported found in Java, Sulawesi,
51 Sumba as polyphagous pests species on *Azadiractha indica* A. Juss (Meliaceae),
52 *Durio kutejensis* Becc. (Bombacaceae), *Ficus* sp. (Moraceae), *Gossypium* sp.
53 (Malvaceae), *Indigofera* sp., (Fabaceae), *Ipomoea* sp. (Convolvulacea) (Williams
54 1996, 2004). Recently, *F. virgata* predictably becomes a cosmopolitan group
55 insect pest within a broad range of host plants around Indonesia which has been
56 commonly introduced across the globe through trade or other human-migrated
57 movements (Sartiami et al. 2016). The information on the widespread of *F.*
58 *virgata* could be confused by other species since recent taxonomic revision of the
59 genus *Ferrisia* was published and there is no more study about those species in
60 Indonesia. Recently, Pacheco da Silva et al. (2019) re-identified some species in
61 North-East Brazil and recorded *F. dasyliirii* as a new country record.

62 Here we report *Ferrisia dasyliirii* (Cockerell, 1896), a native species of arid
63 zones in northern Mexico, that has not been recorded from Indonesia before. This
64 report includes new information on the host range and distribution of the species
65 in Indonesia.

66 MATERIALS AND METHODS

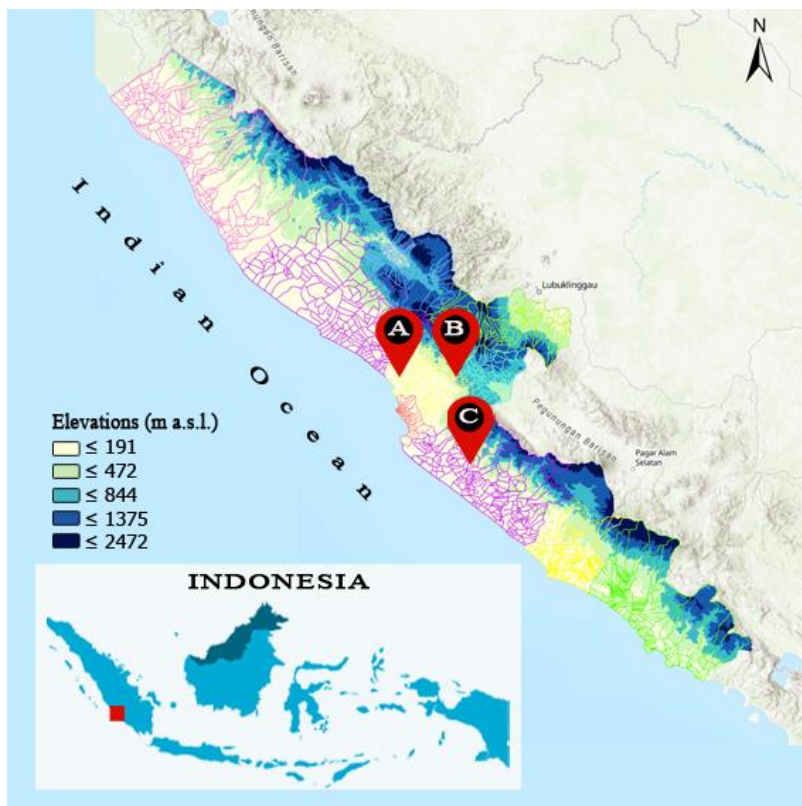
67 The specimens were collected from several host plant species growing around
68 the site of Agricultural Faculty, University of Bengkulu, Bengkulu city
69 (3°45'33.0"S, 102°16'10.1"E, 50 m a.s.l.). Sampling of different instars were done
70 from Aug to Nov 2019. Similarly, sampling were also conducted from the same
71 host plants species in Bengkulu Tengah regency (3°42'22.7"S 102°30'11.8"E, 550
72 m a.s.l.) and Seluma regency (3°59'07.1"S 102°25'37.4"E, 60 m a.s.l.), a part of
73 municipals in Bengkulu Province. The species of *Ferrisia dasyliirii* was collected
74 on the following host plants: *Durio zibethinus* Murray (Malvaceae), *Gliricidia*
75 *sepium* (Jacq.) (Fabaceae), *Hibiscus* spp. (Malvaceae), *Psidium guajava* L.
76 (Myrtaceae), *Solanum torvum* Swartz (Solanaceae), and *Theobroma cacao* L.
77 (Malvaceae).

78 The specimens were preserved in 70% ethanol and slide-mountings were
79 prepared with methods refers to Kosztarab & Kozár (1988). Species identification
80 was performed under light microscope and with the guide of keys mentioned in
81 Kaydan & Gullan (2012). The slide-mounted of *Ferrisia dasyliirii* adult females
82 and nymphs are deposited in the mini Insect Museum, Plant Protection
83 Department, Faculty of Agriculture, University of Bengkulu (Sumatra-Indonesia).

84 Slide numbers: 300-305/1/2020. All specimens obtained were shown in Figure

85 1.A–C.

86



87

88 Figure 1. Sampling locations of *Ferrisa dasyliirii* (Cockerell, 1896): A. Bengkulu

89 city (3°45'33.0"S, 102°16'10.1"E, 50 m a.s.l.); B. Bengkulu Tengah regency

90 (3°42'22.7"S 102°30'11.8"E, 550 m a.s.l.); C. Seluma regency (3°59'07.1"S

91 102°25'37.4"E, 60 m a.s.l.).

Dikomentari [I3]: Sampling location of

Dikomentari [AZ4]: Done

92

RESULTS AND DISCUSSION

93 Result found that the *G. sepium* grown as a shade tree for some cultivated
94 plants such as *T. cacao* and *Coffea canephora* (Rubiaceae) as well as "living
95 supporting tree" for *Piper nigrum* (Piperaceae) bearing more abundant population
96 of *F. dasylirii* than the other trees where the insect were collected (Figure 2). As
97 such, *G. sepium* should be further evaluated to ascertain whether the plant serves
98 as a reservoir or an alternative host plant for such a scale pest.

99



100

101 Figure 2. Nymphs and adults of *Ferrisa dasyliirii* (Cockerell, 1896) on the leaf
102 lower surface of *Gliricidia sepium* (Jacq.) (Fabaceae).

103 In nature, *F. dasyliirii* (Figure 3.A) is mostly similar with *F. virgata* in form
104 and size. The species has 8 segments antennae with $\geq 595 \mu\text{m}$ long; body elongate
105 oval with 3.10–5.30 mm long and 1.30–2.86 mm wide (Figure 3.B) observed the
106 bodies of females cleared of soft contents and the cuticles stained and mounted on
107 microscope slides. They could be easily distinguished from other taxa by their

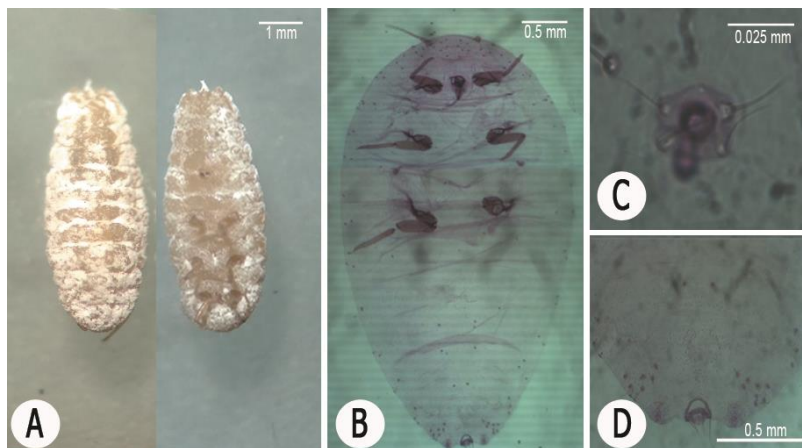
Dikomentari [I5]: Ur sentence very unclear. I have made suggestion according to my guess what did you want to say..

Dikomentari [AZ6]: Done thanks

108 discoidal pores associated with sclerotised area around rim of dorsal enlarged
109 tubular ducts on abdomen. Discoidal pores are situated on outer margin of
110 sclerotised area and often with pore and its surrounding sclerotisation projecting
111 out from margin (Figure 3.C, D).

Dikomentari [I7]: Dicodal pores???

Dikomentari [AZ8]: Yes, thanks



112
113 Figure 3. Female of *Ferrisia dasyliirii* (Cockerell, 1896): A. In life specimens; B.
114 Slide-mounted specimen; C. Tubular duct with a minute discoidal pore touching
115 the outer margin of sclerotised area; D. Multilocular disc pores in row on
116 abdominal segment VI-VIII.

117 *Ferrisia dasyliirii* is already spread into 22 countries in the world where
118 Indonesia is now the second Southeast Asia country reported to have *R dasyliirii*
119 after Malaysia. Sartiami et al. (2016) firstly reported the species as an invasive
120 species attacking *Hibiscus rosasisnensis* L. and *Hibiscus* spp. (Malvaceae) in
121 Selangor and Kuala Lumpur, Malaysia. The exact time of arrival of *F. dasyliirii* in

122 Indonesia is not known but it probably unintentionally introduced here by
123 international transportation and trade from Malaysia to Indonesia. However, the
124 abundance of *F. dasyliirii* in some plants in the different territories with various
125 outbreak levels of the infestation indicates that the species was probably
126 introduced some years before its report. Besides, the species probably also have
127 already existed for a long time ago since the species is confused by *F. virgata*.

128 The economic losses of *F. dasyliirii* has not clearly stated, but the species was
129 reported currently as a potential pest of *Salicornia bigelovii* (Torr.)
130 (Chenopodiaceae) feed and reproduced in 10% of commercial plantations at Baja
131 California Sur, Mexico (Magallón-Servín et al. 2019). It should be aware that the
132 mealybug species are known as the most common invaders of new geographical
133 areas and capable to become a significant pest as well as virus transmission
134 vectors in many cropping systems (Hodgson 1994), and as such, further study is
135 urgently needed.

136 The slide-mounted adult females of *Ferrisia* species in southern Asia can be
137 distinguished from each other according to the following key (after Williams
138 2004):

- 139 1. Multilocular disc pores either absent from abdominal segment VI, or
140 occasionally numbering 1-3. Dorsal duct each with rim about same size as a
141 multilocular disc pore or smaller, with setae situated either adjacent to rim or
142 just outside it*malvastra* (McDaniel, 1962)

- 143 - Multilocular disc pores present in row on abdominal segment VI numbering
144 at least 8. Dorsal duct each with rim larger than a multilocular disc pore,
145 containing setae situated within border of rim (2)
146 2. Most discoidal pores associated with sclerotised area around rim of dorsal
147 enlarged tubular duct with a minute discoidal pore just touching outer margin
148 of sclerotised area, to projecting outside of margin (Figure 3.C).....
149 *dasyliirii* (Cockerell, 1896)
150 - Enlarged tubular duct with a minute discoidal pore not touching sclerotised
151 rim of duct opening; pore position varies from fully within sclerotised area
152 *virgata* (Cockerell, 1893)

153 ACKNOWLEDGMENT

154 This project was made possible by the Research and Community Service Institute,
155 University of Bengkulu. Cooperative Agreement No. SP DIPA-
156 042.012.400977/2019. [I think add more..those helping you even to town council](#)
157 [all ..](#)

158 CONFLICT OF INTEREST

159 The authors declare no conflict of interest.

160 REFERENCES

161 Gullan, P. J., Downie, D. A. & Steffan, S. A. 2003. A new pest species of the
162 mealybug genus *Ferrisia* Fullaway (Hemiptera: Pseudococcidae) from the United

163 States. *Annals of the Entomological Society of America* 96 (6): 723–737.
164 <https://doi.org/10.1603/0013-8746>.

165 Gullan, P. J. & Martin, J. H. 2009. *Sternorrhyncha (Jumping plant-lice, whiteflies,*
166 *aphids, and scale insects)*. pp. 957–967. In: Resh, V.H. and Cardé, R.T. (eds)
167 *Encyclopedia of Insects*, 2nd edition. San Diego: Elsevier. ISBN:
168 9780123741448, e-ISBN: 9780080920900.

169 Gullan, P.J., Kaydan, M.B. & Hardy, N.B. 2010. Molecular phylogeny and
170 species recognition in the mealybug genus *Ferrisia* Fullaway (Hemiptera:
171 Pseudococcidae). *Systematic Entomology* 35: 329–339.
172 <https://doi.org/10.1111/j.1365-3113.2009.00513.x>.

173 Hodgson, C.J. 1994. *The Scale Insect Family Coccidae: an identification manual*
174 *to genera*. UK: CAB International Wallingford. 639 pp. ISBN: 0851988822.

175 Kaydan, M.B. & Gullan, P.J. 2012. A taxonomic revision of the mealybug genus
176 *Ferrisia* Fullaway (Hemiptera: Pseudococcidae), with descriptions of eight new
177 species and a new genus. *Zootaxa* 3543: 1–65. ISBN: 9781775570462, e-ISBN:
178 9781775570479.

179 Kosztarab, M. & Kozár, F. 1988. *Scale Insects of Central Europe*. Budapest:
180 Akadémiai Kiadó. 455 pp. ISBN-13: 9789401082952, e-ISBN-13:
181 9789400940451, DOI: 10.1007/978-94-009-4045-1.

182 Magallón-Servín, P., López-Vela, M., Pedraza-Mirafuentes, M. & Servín-
183 Villegas, R. 2019. *Ferrisia dasylirii* (Cockerell, 1896), a Potential pest of
184 commercial plantations of *Salicornia bigelovii* (Torr.) at Baja California Sur,
185 Mexico. *Southwestern Entomologist* 44 (4): 861–866.
186 <https://doi.org/10.3958/059.044.0413>.

187 Pacheco da Silva, V.C., Kaydan, M.B., Silva-Torres, C. S. A. D. & Torres, J.B.
188 2019. Mealybug species (Hemiptera: Coccothraupidae: Pseudococcidae) on soursop
189 and sugar apple (Annonaceae) in North-East Brazil, with description of a new
190 species of *Pseudococcus* Westwood. *Zootaxa* 4604 (3): 525–538.
191 <http://dx.doi.org/10.11646/zootaxa.4604.3.8>.

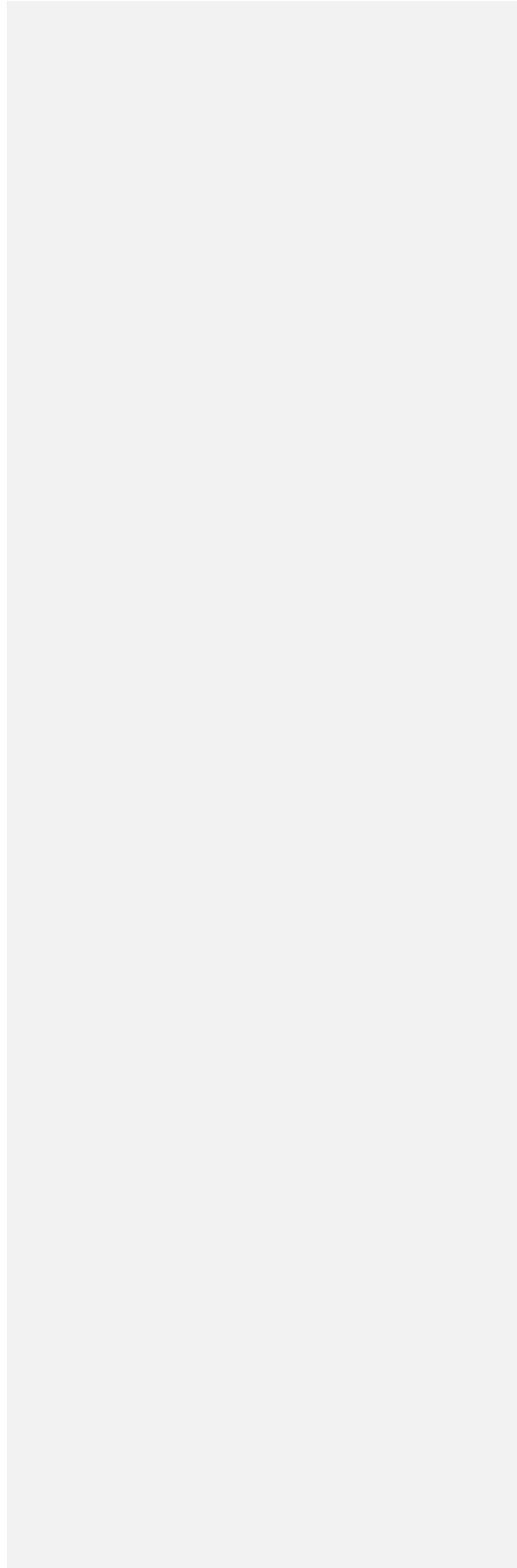
192 Sartiami, D., Watson, G.W., Mohamad, Roff, M. N. & Idris, A.B. 2016.
193 Mealybugs (Hemiptera: Coccothraupidae: Pseudococcidae) attacking *Hibiscus rosa-*
194 *sinensis* L. in Malaysia, with two new country records. AIP Conference
195 Proceedings AIP Publishing 1784, 060007 [http://dx.doi: 10.1063/1.4966845](http://dx.doi.org/10.1063/1.4966845).

196 Williams, D.J. & Watson, G.W. 1988. *The Scale Insects of the Tropical South*
197 *Pacific Region. Pt. 2: The Mealybugs (Pseudococcidae)*. London: CAB
198 International Institute of Entomology. 260 pp. ISBN: 0851986250.

199 Williams, D.J. 1996. A synoptic account of the mealybug genus *Ferrisia*.
200 *Entomologist's Monthly Magazine* 132 (3): 1–10. ISSN: 0013-8908.

201 Williams, D.J. 2004. *Mealybugs of Southern Asia*. Kuala Lumpur: The Natural
202 History Museum, London, and Southdene SDN BHD. 896 pp. ISBN:
203 9834005369.

204



1 **New record of *Ferrisa dasyliirii* (Cockerell, 1896) (Hemiptera: Coccomorpha:**
2 **Pseudococcidae) in Indonesia**

3 Agustin ZARKANI^{1*}, Dwinardi APRIYANTO¹, Ferit TURANLI², Mehmet Bora
4 KAYDAN³

5 ¹ Department of Plant Protection, Faculty of Agriculture, University of Bengkulu,
6 383711, Bengkulu, Indonesia

7 ² Department of Plant Protection, Faculty of Agriculture, Ege University, 35100,
8 Izmir, Turkey.

9 ³ Biotechnology Research Centre, Çukurova University, 01250, Adana, Turkey.

10 * Correspondence: agustinzarkani@unib.ac.id

11 **ABSTRACT**

12 In this study, the occurrence of *Ferrisa dasyliirii* (Cockerell, 1896) (Hemiptera:
13 Pseudococcidae) in Indonesia is reported. It was found on *Durio zibethinus*
14 Murray (Malvaceae), *Gliricidia sepium* (Jacq.) (Fabaceae), *Hibiscus* spp.
15 (Malvaceae), *Psidium guajava* L. (Myrtaceae), *Solanum torvum* Swartz
16 (Solanaceae), and *Theobroma cacao* L. (Malvaceae) at some regencies in
17 Bengkulu Province, Southern Sumatra.

18 **Key words:** Biodiversity, host plant, insect pests, mealybugs, taxonomy

19

INTRODUCTION

20 *Ferrisia* Fullaway is one of the genera in Pseudococcidae (Hemiptera:
21 Coccoomorpha: Pseudococcidae) which is a group of sap-feeding insects, tapping
22 into the phloem via a stylet or piercing, a straw-like mouthpart (Williams 2004;
23 Gullan & Martin 2009). This genus in life can easily be recognized by long glassy
24 filaments with typical dorsal patterns formed by the dark areas of cuticle that are
25 bare of powdery white mum wax (Gullan et al. 2010; Kaydan & Gullan 2012). It
26 is a genus with huge dorsal tubular ducts surrounded by a flat sclerotized area
27 containing one or more setae situated either within the border or adjacent to rim
28 and also have a couple of cerarii on anal lobust (Gullan et al. 2003, 2010).

29 When it was a New World genus, *Ferrisia* consists of *Ferrisia virgata*
30 (Cockerell, 1893) and *Ferrisia malvastra* (McDaniel, 1962) which have been
31 spread to southern Asia and other parts of the world as insect pests of cultivated
32 plants (Williams & Watson 1988; Williams 1996, 2004). To date, based on
33 morphological and molecular data there are 18 species of *Ferrisia* i.e *Ferrisia*
34 *claviseta* (Lobdell, 1930); *Ferrisia colombiana* Kaydan and Gullan, 2012;
35 *Ferrisia cristinae* Kaydan and Gullan, 2012; *Ferrisia dasyllirii* (Cockerell, 1896);
36 *Ferrisia ecuadorensis* Kaydan and Gullan, 2012; *Ferrisia gilli* Gullan, 2003;
37 *Ferrisia kondoi* Kaydan and Gullan, 2012; *Ferrisia malvastra* (McDaniel, 1962),
38 *Ferrisia meridionalis* Williams, 1985; *Ferrisia milleri* Kaydan and Gullan, 2012;
39 *Ferrisia multiformis* Granara de Willink, 1991; *Ferrisia pitcairnia* Kaydan and
40 Gullan, 2012; *Ferrisia quaintancii* (Tinsley, 1898); *Ferrisia setosa* (Lobdell,

41 1930); *Ferrisia terani* Williams and Granara de Willink, 1992; *Ferrisia uzinuri*
42 Kaydan and Gullan, 2012; *Ferrisia virgata* (Cockerell, 1893); and *Ferrisia*
43 *williamsi* Kaydan and Gullan, 2012 (Kaydan & Gullan 2012). These 18 species
44 were the results of Kaydan & Gullan (2012) revision on a group of eight species
45 that have been described before by Williams (1996).

46 In Indonesia, the only striped mealybug, *F. virgata*, is presented (Sartiami et
47 al. 1999; Williams 2004). This species was firstly recorded as intercepted species
48 on *Zingiber officinale* Roscoe (Zingiberaceae) by quarantine inspections of San
49 Pedro, USA in 1992. Then, the species was reported found in Java, Sulawesi,
50 Sumba as polyphagous pests species on *Annona squamosa* Linn. (Annonaceae),
51 *Azadiractha indica* A. Juss (Meliaceae), *Durio kutejensis* Becc. (Bombacaceae),
52 *Ficus* sp. (Moraceae), *Gossypium* sp. (Malvaceae), *Indigofera* sp., (Fabaceae),
53 *Ipomoea* sp. (Convolvulacea), *Nephelium lappaceum* Linn. (Sapindaceae), and
54 *Psidium guajava* (Myrtaceae) (Sartiami et al. 1999; Williams 1996, 2004).
55 Recently, *F. virgata* predictably becomes a cosmopolitan group insect pest within
56 a broad range of host plants around Indonesia which has been commonly
57 introduced across the globe through trade or other human-migrated movements
58 (Sartiami et al. 2016). The information on the widespread of *F. virgata* could be
59 confused by other species since recent taxonomic revision of the genus *Ferrisia*
60 was published and there is no more study about those species in Indonesia.
61 Recently, Pacheco da Silva et al. (2019) re-identified some species in North-East
62 Brazil and recorded *F. dasyliirii* as a new country record.

Dikomentari [DS1]: Please find the pdf of the paper and put some hosts of the species on fruit trees

Dikomentari [AZ2]: Done

Memformat: Font: Miring

Memformat: Font: Miring

Dikomentari [DS3]: Please find the pdf of the paper and put some hosts of the species on fruit trees

Dikomentari [AZ4]: Done

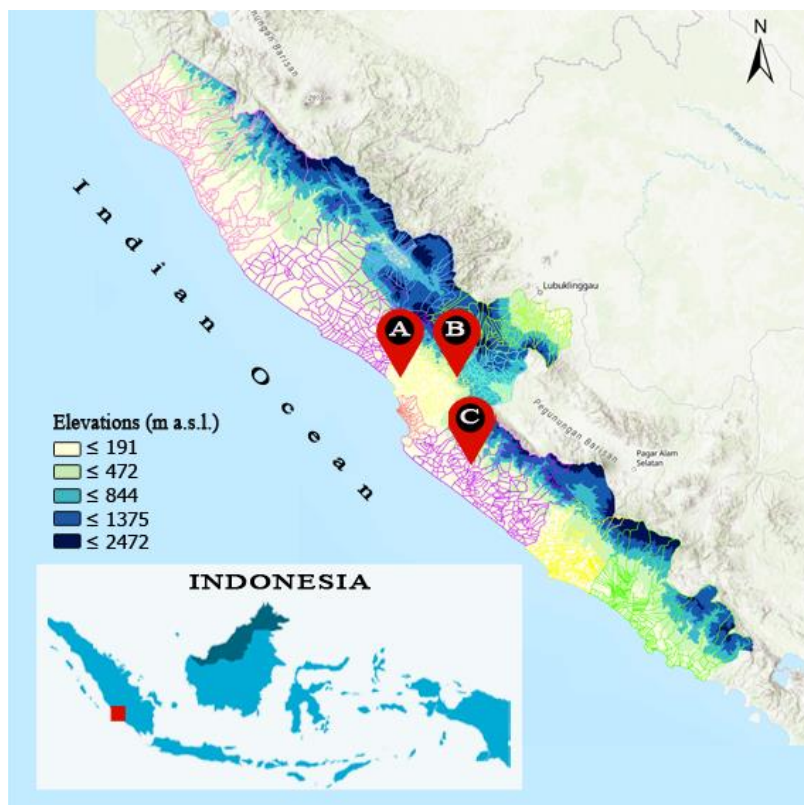
Memformat: Font: Miring

63 Here we report *Ferrisia dasyliirii* (Cockerell, 1896), a native species of arid
64 zones in northern Mexico, that has not been recorded from Indonesia before. This
65 report includes new information on the host range and distribution of the species
66 in Indonesia.

67 MATERIALS AND METHODS

68 The specimens were collected in several plant species growing around the site
69 of Agricultural Faculty, University of Bengkulu, Bengkulu city (3°45'33.0"S,
70 102°16'10.1"E, 50 m a.s.l.). The host plants were monitored from the beginning of
71 August to November 2019 for gaining the different instars of the mealybug
72 species. Further investigations were carried out from the same plants in Bengkulu
73 Tengah regency (3°42'22.7"S 102°30'11.8"E, 550 m a.s.l.) and Seluma regency
74 (3°59'07.1"S 102°25'37.4"E, 60 m a.s.l.), a part of municipalities in Bengkulu
75 Province. All specimens were obtained from several localities in Southern
76 Sumatra—Indonesia as shown in Figure 1.A—C.

77 The specimens were preserved in 70% ethanol and slide-mountings were
78 prepared with methods refers to Kosztarab & Kozár (1988). Species identification
79 was performed under light microscope and with the guide of keys mentioned in
80 Kaydan & Gullan (2012). The slide-mounted of *Ferrisia dasyliirii* adult females
81 and nymphs are deposited in the mini Insect Museum, Plant Protection
82 Department, Faculty of Agriculture, University of Bengkulu (Sumatra-Indonesia).
83 Slide numbers: 300-305/1/2020.



84

85 Figure 1. Distribution records of *Ferrisia dasyliirii* (Cockerell, 1896): A. Bengkulu
 86 city (3°45'33.0"S, 102°16'10.1"E, 50 m a.s.l.); B. Bengkulu Tengah regency
 87 (3°42'22.7"S 102°30'11.8"E, 550 m a.s.l.); C. Seluma regency (3°59'07.1"S
 88 102°25'37.4"E, 60 m a.s.l.).

89

RESULTS AND DISCUSSION

90

Ferrisia dasyliirii was collected on the following host plants: *Durio zibethinus*

91

Murray (Malvaceae), *Gliricidia sepium* (Jacq.) (Fabaceae), *Hibiscus* spp.

92 (Malvaceae), *Psidium guajava* L. (Myrtaceae), *Solanum torvum* Swartz
93 (Solanaceae), and *Theobroma cacao* L. (Malvaceae). The same species in similar
94 host plants were also found in Seluma and Bengkulu Tengah regency. It shows
95 that the species was established in some locations in Bengkulu Province. In these
96 areas, *G. sepium* grown as a shade tree for some cultivated plants such as *T. cacao*
97 and *Coffea canephora* (Rubiaceae) as well as "living supporting tree" for *Piper*
98 *nigrum* (Piperaceae) growth and was found bearing more abundant population of
99 *F. dasyliirii* (Figure 2). In this case, *G. sepium* should be evaluated whether the
100 plant serves as a reservoir or an alternative host plant for such a scale pest.

101

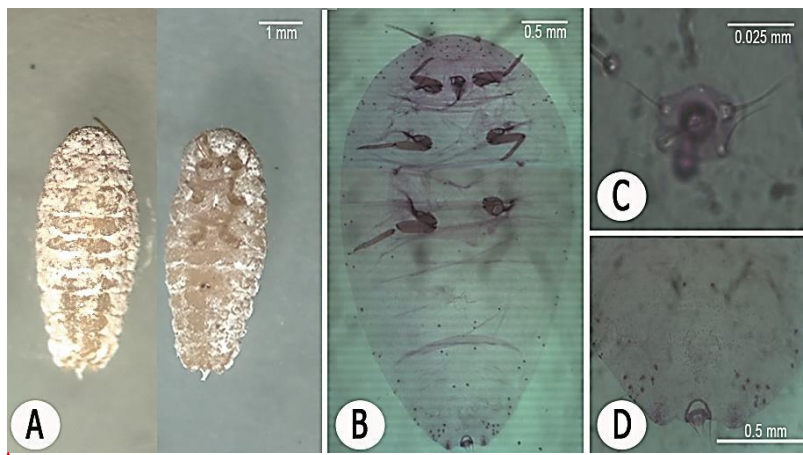


102

103 Figure 2. Nymphs and adults of *Ferrisa dasylirii* (Cockerell, 1896) on the leaf
104 lower surface of *Gliricidia sepium* (Jacq.) (Fabaceae).

105 In life, *F. dasylirii* (Figure 3.A) is mostly similar with *F. virgata* in form and
106 size. The species has 8 segments antennae with $\geq 595 \mu\text{m}$ long; body elongate oval
107 with 3.10–5.30 mm long and 1.30–2.86 mm wide (Figure 3.B). As the bodies of
108 females are cleared of soft contents and the cuticles stained and mounted on
109 microscope slides. They are distinguished easily from other taxa by their discoidal

110 pores associated with sclerotised area around rim of dorsal enlarged tubular ducts
 111 on abdomen. They are situated on outer margin of sclerotised area and often with
 112 pore and its surrounding sclerotisation projecting out from margin (Figure 3.C,
 113 D).



114
 115 Figure 3. Female of *Ferrisia dasyliirii* (Cockerell, 1896): A. In life specimens; B.
 116 Slide-mounted specimen; C. Tubular duct with a minute discoidal pore touching
 117 the outer margin of sclerotised area; D. Multilocular disc pores in row on
 118 abdominal segment VI-VIII.

119 *Ferrisia dasyliirii* is already spread in 22 countries which Indonesia is now the
 120 second Southeast Asia country reported after Malaysia. Sartiami et al. (2016)
 121 firstly reported the species as an invasive species attacking *Hibiscus rosasisnensis*
 122 L. and *Hibiscus* spp. (Malvaceae) in Selangor and Kuala Lumpur, Malaysia. The
 123 exact time of arrival of *F. dasyliirii* in Indonesia is not known but it probably be

Memformat: Font: Tebal, Warna font: Hitam

Dikomentari [DS5]: Please rotate the figure, the head on the top then

Dikomentari [AZ6]: Done

Dikomentari [DS7]: Please make correction the figure 3B, 3C and 3D on brightness and contrast

Dikomentari [AZ8]: done

124 brought unintentionally by international transportation and trade from Malaysia to
125 Indonesia. The wide distribution of *F. dasyliirii* in some plants in the different
126 territories with various outbreak levels of the infestation indicates that the species
127 was probably introduced some years before its report. Besides, the species
128 probably also have already existed for a long time ago since the species is
129 confused by *F. virgata*.

130 The economic losses of *F. dasyliirii* has not clearly stated, but the species was
131 reported currently as a potential pest of *Salicornia bigelovii* (Torr.)
132 (Chenopodiaceae) fed and reproduced in 10% of commercial plantations at Baja
133 California Sur, Mexico (Magallón-Servín et al. 2019). It should be aware that the
134 mealybug species are known as the most common invaders of new geographical
135 areas and potent to become a significant pest as well as virus transmission vectors
136 in many cropping systems (Hodgson 1994), and as such, further study is urgently
137 needed.

138 The slide-mounted adult females of *Ferrisia* species in southern Asia can be
139 distinguished from each other according to the following key (after Williams
140 2004):

- 141 1. Multilocular disc pores either absent from abdominal segment VI, or
142 occasionally numbering 1-3. Dorsal duct each with rim about same size as a
143 multilocular disc pore or smaller, with setae situated either adjacent to rim or
144 just outside it*malvastra* (McDaniel, 1962)

- 145 - Multilocular disc pores present in row on abdominal segment VI numbering
146 at least 8. Dorsal duct each with rim larger than a multilocular disc pore,
147 containing setae situated within border of rim (2)
148 2. Most discoidal pores associated with sclerotised area around rim of dorsal
149 enlarged tubular duct with a minute discoidal pore just touching outer margin
150 of sclerotised area, to projecting outside of margin (Figure 3.C).....
151 *dasyliirii* (Cockerell, 1896)
152 - Enlarged tubular duct with a minute discoidal pore not touching sclerotised
153 rim of duct opening; pore position varies from fully within sclerotised area
154 *virgata* (Cockerell, 1893)

155 ACKNOWLEDGMENT

156 This project was made possible by the Research and Community Service Institute,
157 University of Bengkulu. Cooperative Agreement No. SP DIPA-
158 042.012.400977/2019.

159 CONFLICT OF INTEREST

160 The authors declare no conflict of interest.

161 REFERENCES

162 Gullan, P. J., Downie, D. A. & Steffan, S. A. 2003. A new pest species of the
163 mealybug genus *Ferrisia* Fullaway (Hemiptera: Pseudococcidae) from the United
164 States. *Annals of the Entomological Society of America* 96 (6): 723–737.
165 <https://doi.org/10.1603/0013-8746>.

166 Gullan, P. J. & Martin, J. H. 2009. *Sternorrhyncha (Jumping plant-lice, whiteflies,*
167 *aphids, and scale insects)*. pp. 957–967. In: Resh, V.H. and Cardé, R.T. (eds)
168 *Encyclopedia of Insects*, 2nd edition. San Diego: Elsevier. ISBN:
169 9780123741448, e-ISBN: 9780080920900.

170 Gullan, P.J., Kaydan, M.B. & Hardy, N.B. 2010. Molecular phylogeny and
171 species recognition in the mealybug genus *Ferrisia* Fullaway (Hemiptera:
172 Pseudococcidae). *Systematic Entomology* 35: 329–339.
173 <https://doi.org/10.1111/j.1365-3113.2009.00513.x>.

174 Hodgson, C.J. 1994. *The Scale Insect Family Coccidae: an identification manual*
175 *to genera*. UK: CAB International Wallingford. 639 pp. ISBN: 0851988822.

176 Kaydan, M.B. & Gullan, P.J. 2012. A taxonomic revision of the mealybug genus
177 *Ferrisia* Fullaway (Hemiptera: Pseudococcidae), with descriptions of eight new
178 species and a new genus. *Zootaxa* 3543: 1–65. ISBN: 9781775570462, e-ISBN:
179 9781775570479.

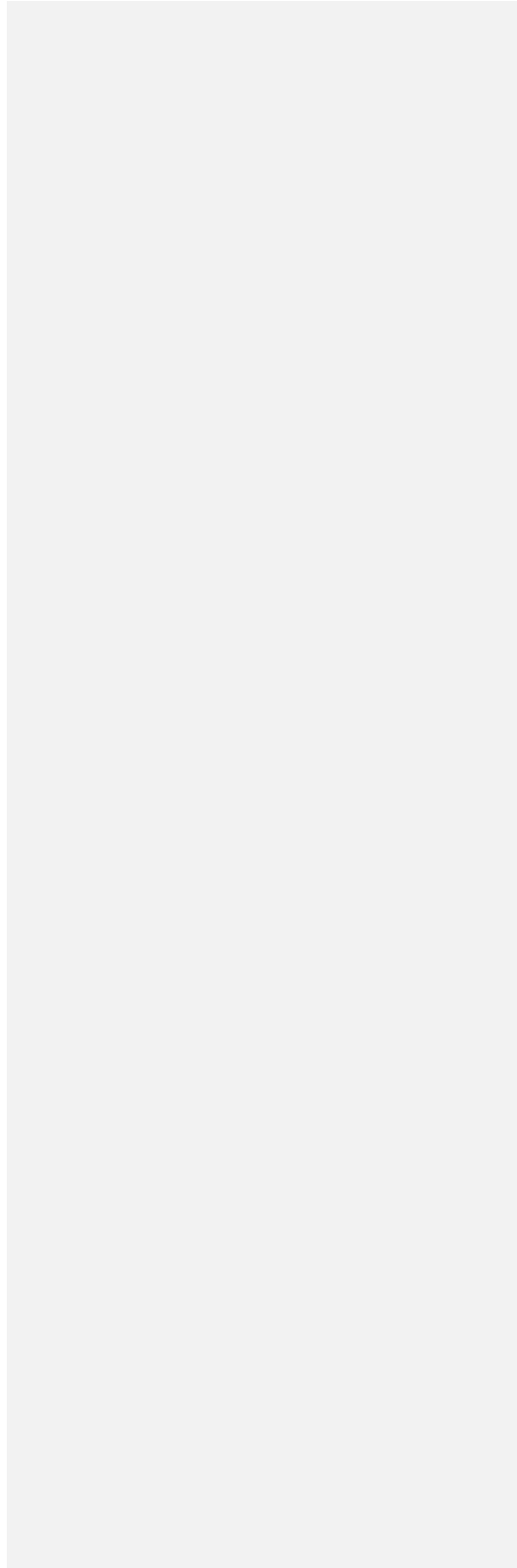
180 Kosztarab, M. & Kozár, F. 1988. *Scale Insects of Central Europe*. Budapest:
181 Akadémiai Kiadó. 455 pp. ISBN-13: 9789401082952, e-ISBN-13:
182 9789400940451, DOI: 10.1007/978-94-009-4045-1.

183 Magallón-Servín, P., López-Vela, M., Pedraza-Mirafuentes, M. & Servín-
184 Villegas, R. 2019. *Ferrisia dasyliirii* (Cockerell, 1896), a Potential pest of
185 commercial plantations of *Salicornia bigelovii* (Torr.) at Baja California Sur,

- 186 Mexico. *Southwestern Entomologist* 44 (4): 861–866.
187 <https://doi.org/10.3958/059.044.0413>.
- 188 Pacheco da Silva, V.C., Kaydan, M.B., Silva-Torres, C. S. A. D. & Torres, J.B.
189 2019. Mealybug species (Hemiptera: Coccothraupidae: Pseudococcidae) on soursop
190 and sugar apple (Annonaceae) in North-East Brazil, with description of a new
191 species of *Pseudococcus* Westwood. *Zootaxa* 4604 (3): 525–538.
192 <http://dx.doi.org/10.11646/zootaxa.4604.3.8>.
- 193 Sartiami, D., Sosromarsono, S., Buchori, D., Suryobroto, B. 1999. Keragaman
194 spesies kutu putih pada tanaman buah-buahan di daerah Bogor. In: Peranan
195 Entomologi dalam Pengendalian Hama yang Ramah Lingkungan dan Ekonomis.
196 Prosiding Seminar Nasional Perhimpunan Entomologi Indonesia (PEI), 16
197 Februari 1999, Bogor, Indonesia. 429–435 p.
- 198 Sartiami, D., Watson, G.W., Mohamad, Roff, M. N. & Idris, A.B. 2016.
199 Mealybugs (Hemiptera: Coccothraupidae: Pseudococcidae) attacking *Hibiscus rosa-*
200 *sinensis* L. in Malaysia, with two new country records. AIP Conference
201 Proceedings AIP Publishing 1784, 060007 <http://dx.doi: 10.1063/1.4966845>.
- 202 Williams, D.J. & Watson, G.W. 1988. *The Scale Insects of the Tropical South*
203 *Pacific Region. Pt. 2: The Mealybugs (Pseudococcidae)*. London: CAB
204 International Institute of Entomology. 260 pp. ISBN: 0851986250.
- 205 Williams, D.J. 1996. A synoptic account of the mealybug genus *Ferrisia*.
206 *Entomologist's Monthly Magazine* 132 (3): 1–10. ISSN: 0013-8908.

207 Williams, D.J. 2004. *Mealybugs of Southern Asia*. Kuala Lumpur: The Natural
208 History Museum, London, and Southdene SDN BHD. 896 pp. ISBN:
209 9834005369.

210
|



1 **New record of *Ferrisa dasyliirii* (Cockerell, 1896) (Hemiptera: Coccoomorpha:**
2 **Pseudococcidae) in Indonesia**

3 Agustin ZARKANI^{1*}, Dwinardi APRIYANTO¹, Ferit TURANLI², Mehmet Bora
4 KAYDAN³

5 ¹ Department of Plant Protection, Faculty of Agriculture, University of Bengkulu,
6 383711, Bengkulu, Indonesia

7 ² Department of Plant Protection, Faculty of Agriculture, Ege University, 35100,
8 Izmir, Turkey.

9 ³ Biotechnology Research Centre, Çukurova University, 01250, Adana, Turkey.

10 * Correspondence: agustinzarkani@unib.ac.id

11 **ABSTRACT**

12 The occurrence of *Ferrisa dasyliirii* (Cockerell, 1896) (Hemiptera:
13 Pseudococcidae) was first reported in Indonesia. It was found on *Durio zibethinus*
14 Murray (Malvaceae), *Gliricidia sepium* (Jacq.) (Fabaceae), *Hibiscus* spp.
15 (Malvaceae), *Psidium guajava* L. (Myrtaceae), *Solanum torvum* Swartz
16 (Solanaceae), and *Theobroma cacao* L. (Malvaceae) at some regencies in
17 Bengkulu Province, Southern Sumatra, Indonesia.

18 **Key words:** Biodiversity, host plant, mealybug, Sumatera, Indonesia

19

ABSTRAK

20 Kehadiran spesies koya *Ferrisa dasyliirii* (Cockerell, 1896) (Hemiptera:
21 Pseudococcidae) telah direkodkan untuk pertama kali di Indonesia. Spesies ini
22 dijumpai hidup pada tanaman *Durio zibethinus* Murray (Malvaceae), *Gliricidia*
23 *sepium* (Jacq.) (Fabaceae), *Hibiscus* spp. (Malvaceae), *Psidium guajava* L.
24 (Myrtaceae), *Solanum torvum* Swartz (Solanaceae), dan *Theobroma cacao* L.
25 (Malvaceae) di beberapa kabupaten di Provinsi Bengkulu, Sumatera Selatan,
26 Indonesia.

27 **Kata Kunci:** Kepelbagaian biologi, tumbuhan perumah, koya, Sumatera,
28 Indonesia

29

INTRODUCTION

30 *Ferrisia* Fullaway is one of the genera in Pseudococcidae (Hemiptera:
31 Coccoomorpha: Pseudococcidae) which is a group of sap-feeding insects, tapping
32 into the phloem via a stylet or piercing, a straw-like mouthpart (Williams 2004;
33 Gullan & Martin 2009). In nature, this genus can easily be recognized by long
34 glassy filaments with typical dorsal patterns formed by the dark areas of cuticle
35 bare of powdery white mum wax (Gullan et al. 2010; Kaydan & Gullan 2012). It
36 is a genus with huge dorsal tubular ducts surrounded by a flat sclerotized area
37 containing one or more setae situated either within the border or adjacent to the
38 rim and has a couple of cerarii anal lobust (Gullan et al. 2003, 2010).

39 The New World genus, *Ferrisia* consists of *Ferrisia virgata* (Cockerell,
40 1893) and *Ferrisia malvastra* (McDaniel, 1962) was known to have been spread
41 to southern Asia and other parts of the world as insect pests of cultivated plants
42 (Williams & Watson 1988; Williams 1996, 2004; Sartiami et al. 2017). To date,
43 the combination of morphological and molecular data gathered this genus
44 comprised at least 18 species of *Ferrisia* i.e *Ferrisia claviseta* (Lobdell, 1930);
45 *Ferrisia colombiana* Kaydan and Gullan, 2012; *Ferrisia cristinae* Kaydan and
46 Gullan, 2012; *Ferrisia dasylyrii* (Cockerell, 1896); *Ferrisia ecuadorensis* Kaydan
47 and Gullan, 2012; *Ferrisia gilli* Gullan, 2003; *Ferrisia kondoi* Kaydan and
48 Gullan, 2012; *Ferrisia malvastra* (McDaniel, 1962), *Ferrisia meridionalis*
49 Williams, 1985; *Ferrisia milleri* Kaydan and Gullan, 2012; *Ferrisia multiformis*
50 Granara de Willink, 1991; *Ferrisia pitcairnia* Kaydan and Gullan, 2012; *Ferrisia*
51 *quaintancii* (Tinsley, 1898); *Ferrisia setosa* (Lobdell, 1930); *Ferrisia terani*
52 Williams and Granara de Willink, 1992; *Ferrisia uzinuri* Kaydan and Gullan,
53 2012; *Ferrisia virgata* (Cockerell, 1893); and *Ferrisia williamsi* Kaydan and
54 Gullan, 2012 (Kaydan & Gullan 2012). These 18 species were the results of
55 Kaydan & Gullan (2012) revision on a group of eight species described by
56 Williams (1996).

57 In Indonesia, the only striped mealybug, *F. virgata*, is presented (Sartiami et
58 al. 1999; Williams 2004). This species was first recorded as intercepted species on
59 *Zingiber officinale* Roscoe (Zingiberaceae) by quarantine inspections of San
60 Pedro, the USA in 1992. Then, the species was reported found in Java, Sulawesi,

61 Sumba as polyphagous pests species on *Annona squamosa* L. (Annonaceae),
62 *Azadiractha indica* A. Juss (Meliaceae), *Durio kutejensis* Becc. (Bombacaceae),
63 *Ficus* sp. (Moraceae), *Gossypium* sp. (Malvaceae), *Indigofera* sp., (Fabaceae),
64 *Ipomoea* sp. (Convolvulacea), *Nephelium lappaceum* L. (Sapindaceae), and
65 *Psidium guajava* L. (Myrtaceae) (Sartiami et al. 1999; Williams 1996, 2004).
66 Recently, *F. virgata* predictably becomes a cosmopolitan group insect pest within
67 a broad range of host plants around Indonesia, commonly introduced across the
68 globe through trade or other human-migrated movements (Sartiami et al. 2016).
69 The information on the widespread of *F. virgata* could be confused by other
70 species since recent taxonomic revision of the genus *Ferrisia* was published and
71 there is no more study about those species in Indonesia. Recently, Pacheco da
72 Silva et al. (2019) re-identified some species in North-East Brazil and recorded *F.*
73 *dasyliirii* as a new country record.

74

75 Here we report *Ferrisia dasyliirii* (Cockerell, 1896), a native species of arid
76 zones in northern Mexico, that has not been recorded from Indonesia before. This
77 report includes new information on the host range and distribution of the species
78 in Indonesia.

79

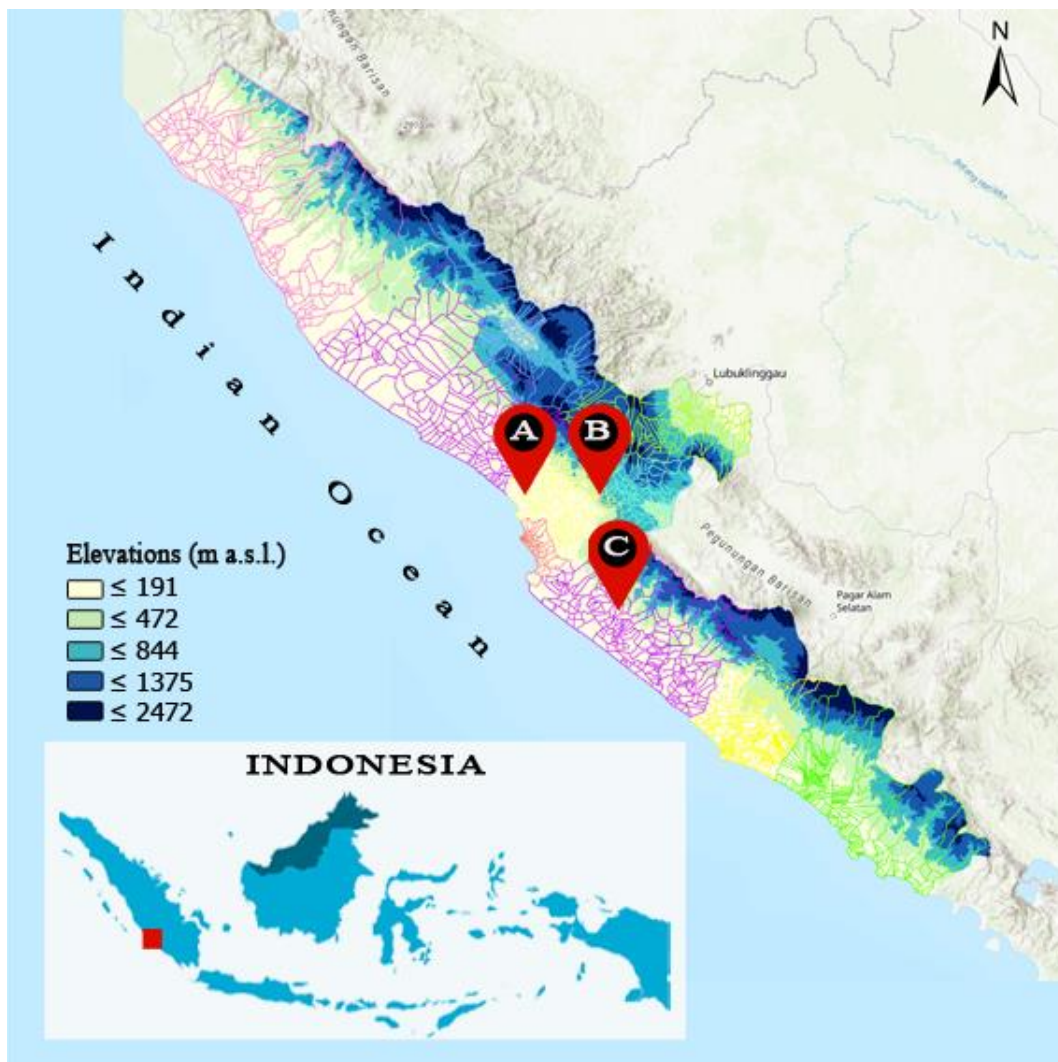
MATERIALS AND METHODS

80 The specimens were collected from several host plant species growing around
81 the site of Agricultural Faculty, the University of Bengkulu, Bengkulu city

82 (3°45'33.0"S, 102°16'10.1"E, 50 m a.s.l.). A sampling of different instars was
83 done from Aug to Nov 2019. Similarly, sampling was also conducted from the
84 same host plants species in Bengkulu Tengah regency (3°42'22.7"S
85 102°30'11.8"E, 550 m a.s.l.) and Seluma regency (3°59'07.1"S 102°25'37.4"E, 60
86 m a.s.l.), a part of municipals in Bengkulu Province. The species of *Ferrisia*
87 *dasyliirii* was collected on the following host plants: *Durio zibethinus* Murray
88 (Malvaceae), *Gliricidia sepium* (Jacq.) (Fabaceae), *Hibiscus* spp. (Malvaceae),
89 *Psidium guajava* L. (Myrtaceae), *Solanum torvum* Swartz (Solanaceae), and
90 *Theobroma cacao* L. (Malvaceae).

91 The specimens were preserved in 70% ethanol and slide-mountings were
92 prepared with methods refers to Kosztarab & Kozár (1988). Species identification
93 was performed under a light microscope and with the guide of keys mentioned in
94 Kaydan & Gullan (2012). The slide-mounted of *Ferrisia dasyliirii* adult females
95 and nymphs are deposited in the mini Insect Museum, Plant Protection
96 Department, Faculty of Agriculture, University of Bengkulu (Sumatra-Indonesia).
97 Slide numbers: 300-305/1/2020. All specimens obtained were shown in Figure
98 1.A–C.

99



100

101 Figure 1. Sampling locations of *Ferrisa dasyliirii* (Cockerell, 1896): A. Bengkulu
 102 city (3°45'33.0"S, 102°16'10.1"E, 50 m a.s.l.); B. Bengkulu Tengah regency
 103 (3°42'22.7"S 102°30'11.8"E, 550 m a.s.l.); C. Seluma regency (3°59'07.1"S
 104 102°25'37.4"E, 60 m a.s.l.).

105

RESULTS AND DISCUSSION

106

Result found that the *G. sepium* grown as a shade tree for some cultivated
 107 plants such as *T. cacao* and *Coffea canephora* (Rubiaceae) as well as "living

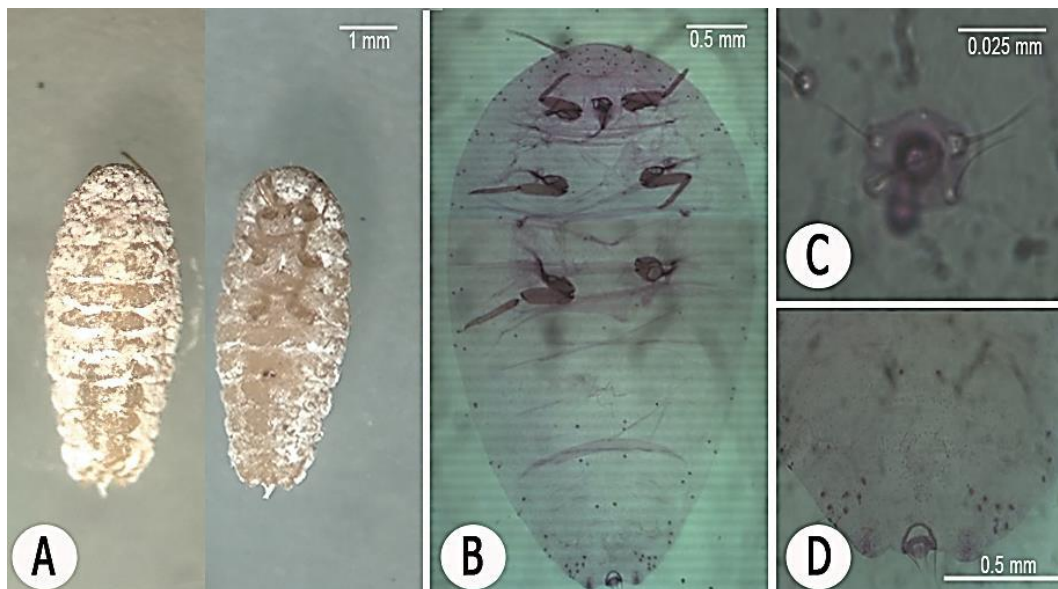
108 supporting tree” for *Piper nigrum* (Piperaceae) bearing a more abundant
109 population of *F. dasyliirii* than the other trees where the insect was collected
110 (Figure 2). As such, *G. sepium* should be further evaluated to ascertain whether
111 the plant serves as a reservoir or an alternative host plant for such a scale pest.



112

113 Figure 2. Nymphs and adults of *Ferrisa dasyliirii* (Cockerell, 1896) on the leaf
114 lower surface of *Gliricidia sepium* (Jacq.) (Fabaceae).

115 In nature, *F. dasyliirii* (Figure 3.A) is mostly similar to *F. virgata* in form and
116 size. The species has eight segments antennae with $\geq 595 \mu\text{m}$ long; elongate body
117 oval with 3.10–5.30 mm long and 1.30–2.86 mm wide (Figure 3.B) observed the
118 bodies of females cleared of soft contents and the cuticles stained and mounted on
119 microscope slides. They could be easily distinguished from other taxa by their
120 discoidal pores associated with the sclerotized area around the rim of dorsal
121 enlarged tubular ducts on the abdomen. Discoidal pores are situated on the
122 sclerotized area's outer margin and often with pore and its surrounding
123 sclerotization projecting out from the margin (Figure 3.C, D).



125 Figure 3. Female of *Ferrisa dasyliirii* (Cockerell, 1896): A. In life specimens; B.
126 Slide-mounted specimens; C. Tubular duct with a minute discoidal pore
127 touching the outer margin of the sclerotised area; D. Multilocular disc pores in a
128 row on abdominal segment VI-VIII.

129 *Ferrisia dasyliirii* is already spread into 22 countries where Indonesia is now
130 the second Southeast Asia country reported to have *F. dasyliirii* after Malaysia.
131 Sartiami et al. (2016) firstly reported the species as an invasive species attacking
132 *Hibiscus rosasisnensis* L. and *Hibiscus* spp. (Malvaceae) in Selangor and Kuala
133 Lumpur, Malaysia. The exact time of arrival of *F. dasyliirii* in Indonesia is
134 unknown, but it is probably unintentionally introduced here by international
135 transportation and trade from Malaysia to Indonesia. However, the abundance of
136 *F. dasyliirii* in some plants in the different territories with various infestation
137 outbreak levels indicates that the species was probably introduced some years
138 before its report. Besides, the species probably have already existed for a long
139 time ago since they are confused by *F. virgata*.

140 The economic losses of *F. dasyliirii* have not clearly stated, but the species
141 was reported currently as a potential pest of *Salicornia bigelovii* (Torr.)
142 (Chenopodiaceae) feed and reproduced in 10% of commercial plantations at Baja
143 California Sur, Mexico (Magallón-Servín et al. 2019). It should be aware that the
144 mealybug species are known as the most common invaders of new geographical
145 areas and capable of becoming a significant pest and virus transmission vectors in
146 many cropping systems (Hodgson 1994), and as such, further study is urgently
147 needed.

148 The slide-mounted adult females of *Ferrisia* species in southern Asia can be
149 distinguished from each other according to the following key (after Williams
150 2004):

- 151 1. Multilocular disc pores either absent from abdominal segment VI, or
 152 occasionally numbering 1-3. Dorsal duct each with a rim about the same size
 153 as a multilocular disc pore or smaller, with setae situated either adjacent to
 154 the rim or just outside it.....*malvastra* (McDaniel, 1962)
- 155 - Multilocular disc pores present in a row on abdominal segment VI
 156 numberings at least 8. Dorsal duct each with rim larger than a multilocular
 157 disc pore, containing setae situated within border of the rim (2)
- 158 2. Most discoidal pores associated with the sclerotized area around rim of a
 159 dorsal enlarged tubular duct with a minute discoidal pore just touching outer
 160 margin of sclerotized area, to projecting outside of margin (Figure 3.C).....
 161*dasyliroi* (Cockerell, 1896)
- 162 - Enlarged tubular duct with a minute discoidal pore not touching the
 163 sclerotized rim of duct opening; pore position varies from entirely within the
 164 sclerotized area
 165*virgata* (Cockerell, 1893)

166 **ACKNOWLEDGMENT**

167 This project was made possible by the Research and Community Service Institute,
 168 The University of Bengkulu with cooperative agreement No.
 169 SP.DIPA-042.012.400977/2019.

170 **CONFLICT OF INTEREST**

171 The authors declare no conflict of interest.

172

REFERENCES

- 173 Gullan, P. J., Downie, D. A. & Steffan, S. A. 2003. A new pest species of the
174 mealybug genus *Ferrisia* Fullaway (Hemiptera: Pseudococcidae) from the
175 United States. *Annals of the Entomological Society of America* 96 (6): 723–
176 737. <https://doi.org/10.1603/0013-8746>.
- 177 Gullan, P. J. & Martin, J. H. 2009. *Sternorrhyncha (Jumping plant-lice, whiteflies,*
178 *aphids, and scale insects)*. pp. 957–967. In: Resh, V.H. and Cardé, R.T. (eds)
179 *Encyclopedia of Insects*, 2nd edition. San Diego: Elsevier. ISBN:
180 9780123741448, e-ISBN: 9780080920900.
- 181 Gullan, P.J., Kaydan, M.B. & Hardy, N.B. 2010. Molecular phylogeny and
182 species recognition in the mealybug genus *Ferrisia* Fullaway (Hemiptera:
183 Pseudococcidae). *Systematic Entomology* 35: 329–339.
184 <https://doi.org/10.1111/j.1365-3113.2009.00513.x>.
- 185 Hodgson, C.J. 1994. *The Scale Insect Family Coccidae: an identification manual*
186 *to genera*. UK: CAB International Wallingford. 639 pp. ISBN: 0851988822.
- 187 Kaydan, M.B. & Gullan, P.J. 2012. A taxonomic revision of the mealybug genus
188 *Ferrisia* Fullaway (Hemiptera: Pseudococcidae), with descriptions of eight
189 new species and a new genus. *Zootaxa* 3543: 1–65. ISBN: 9781775570462,
190 e-ISBN: 9781775570479.

- 191 Kosztarab, M. & Kozár, F. 1988. *Scale Insects of Central Europe*. Budapest:
192 Akadémiai Kiadó. 455 pp. ISBN-13: 9789401082952, e-ISBN-13:
193 9789400940451, DOI: 10.1007/978-94-009-4045-1.
- 194 Magallón-Servín, P., López-Vela, M., Pedraza-Mirafuentes, M. &
195 Servín-Villegas, R. 2019. *Ferrisia dasyliirii* (Cockerell, 1896), a Potential pest
196 of commercial plantations of *Salicornia bigelovii* (Torr.) at Baja California
197 Sur, Mexico. *Southwestern Entomologist* 44 (4): 861–866.
198 <https://doi.org/10.3958/059.044.0413>.
- 199 Pacheco da Silva, V.C., Kaydan, M.B., Silva-Torre,s C. S. A. D. & Torres, J.B.
200 2019. Mealybug species (Hemiptera: Coccoomorpha: Pseudococcidae) on
201 soursop and sugar apple (Annonaceae) in North-East Brazil, with description
202 of a new species of *Pseudococcus* Westwood. *Zootaxa* 4604 (3): 525–538.
203 <http://dx.doi.org/10.11646/zootaxa.4604.3.8>.
- 204 Sartiami, D., Sosromarsono, S., Buchori, D. & Suryobroto, B. 1999. Keragaman
205 spesies kutu putih pada tanaman buah-buahan di daerah Bogor. *In: Peranan*
206 *Entomologi dalam Pengendalian Hama yang Ramah Lingkungan dan*
207 *Ekonomis. Prosiding Seminar Nasional Perhimpunan Entomologi Indonesia*
208 *(PEI), 16 Februari 1999, Bogor, Indonesia. 429–435 p.*
- 209 Sartiami, D., Watson, G.W., Mohamad, Roff, M. N. & Idris, A.B. 2016.
210 Mealybugs (Hemiptera: Coccoomorpha: Pseudococcidae) attacking *Hibiscus*

211 *rosa-sinensis* L. in Malaysia, with two new country records. AIP Conference
212 Proceedings AIP Publishing 1784, 060007 <http://dx.doi: 10.1063/1.4966845>.

213 Sartiami, D., Watson, G.W., Roff, M.N.M, & Ghani, I.A. 2017. A taxonomic
214 update of Takahashi's historic collection of mealybugs (Hemiptera:
215 Pseudococcidae) from Malaysia and Singapore. *Serangga* 22 (2): 91-114.

216 Williams, D.J. & Watson, G.W. 1988. *The Scale Insects of the Tropical South*
217 *Pacific Region. Pt. 2: The Mealybugs (Pseudococcidae)*. London: CAB
218 International Institute of Entomology. 260 pp. ISBN: 0851986250.

219 Williams, D.J. 1996. A synoptic account of the mealybug genus *Ferrisia*.
220 *Entomologist's Monthly Magazine* 132 (3): 1–10. ISSN: 0013-8908.

221 Williams, D.J. 2004. *Mealybugs of Southern Asia*. Kuala Lumpur: The Natural
222 History Museum, London, and Southdene SDN BHD. 896 pp. ISBN:
223 9834005369.

224

