

SPECIES OF PSOCIDS (PSOCOPTERA), ASSOCIATED WITH STORED GRAINS IN MEXICO

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RESUMEN

Diez y seis especies de psócidos fueron encontradas en 82 muestras de granos almacenados en México; la mayoría de las muestras fue de maíz y de arroz. En términos de frecuencia, abundancia relativa y dominancia, las especies más importantes fueron *Liposcelis entomophila* Enderlein, *Lepinotus reticulatus* Enderlein, *Liposcelis bostrychophila* Badonnel, y *Psoquilla marginepunctata* Hagen. La mayoría de las especies encontradas han sido registradas en asociación con granos o productos alimenticios almacenados. *Liposcelis bostrychophila* es una plaga de granos y productos alimenticios almacenados.

Palabras clave. Psocoptera, granos almacenados, México

ABSTRACT

Sixteen species of psocids were found associated with stored grains in Mexico, in 82 samples studied; most of the samples were of maize and rice. In terms of frequency, relative abundance, and dominance, the most important species were *Liposcelis entomophila* Enderlein, *Lepinotus reticulatus* Enderlein, *Liposcelis bostrychophila* Badonnel and *Psoquilla marginepunctata* Hagen. Most of the species found have been recorded in association with stored grains and foodstuffs. *L. bostrychophila* has been recognized as a pest of stored grains and foodstuffs.

Key words. Psocoptera, stored grains, Mexico.

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INTRODUCTION

Psocids are small, soft bodied exopterygotes, of varied food habits that can be, however, regarded in general as herbivores or detritivores, feeding on microflora and organic debris on the surfaces where they live (Mockford, 1993). Species of psocids have been frequently recorded in association with foodstuffs and stored grains throughout the world (Badonnel, 1974; Broadhead & Hobby, 1944; Broadhead, 1954a, 1954b, 1955; Champ & Smithers, 1965; Kalinovic, 1979, Kalinovic *et al.*, 1981; Obr, 1978; Pearman, 1929, 1931, 1942; see also the extensive literature by Smithers & Lienhard, 1992). Recently, these insects have been considered as a new pest problem in the food industry (Dodd *et al.*, 1981). In Mexico, no mention has been made of psocids as pests or in association with stored grains or foodstuffs (Moreno M. & Ramírez M., 1983).

The purpose of this work is to document the species of psocids found in stored grains in Mexico, and to determine which species could be of importance as pests of stored grains; although these insects can be regarded as secondary pests, their presence should be taken into account, principally as contaminants, as value-reducing factors of the grains in storage.

MATERIAL AND METHODS

Between 1977 and 1983, 82 one kilogram samples of grains in storage, principally maize and milled rice were analyzed for species of psocids present, and for number of individuals per sample and per species (Table 3). The samples were taken from warehouses, or from grains stored in rural conditions (cribs, trojes, households), in 13 Mexican states, brought to the laboratory in Mexico City, placed in closed glass containers, and, after an incubation period of 30 days at room temperature, the psocids found in the samples were extracted manually and preserved in 80% ethyl alcohol, to be identified and counted posteriorly; of the 82 samples studied, 51 were of maize, 24 were of rice, three were of soybeans, two were of beans and one each were of shorgum and squash seeds.

RESULTS

We found 1399 psocids in the 82 samples analyzed; they belong in 16 species, representing 12 genera and eight families (Table 1). *Belaphotroctes* sp., *Embidopsocus* spp. 1 and 2 and *Liposcelis* ca. *albothoracica* are new to science, and their formal description will be treated elsewhere. *Tapinella* sp., *Lachesilla* sp., and *Archipsocus* sp., were present as immature stages and could not be identified to species for that reason. All the described species, except *Pseudorypteryx mexicanus* and *Embidopsocus citrensis* have been cited in association with stored grains or foodstuffs; the unde-

Table 1. Species of Psocoptera associated with stored grains in Mexico (82 samples, 1399 individuals).

TROGIOMORPHA

Trogiiidae

1. *Lepinotus reticulatus* Enderlein. Campeche, Jalisco, Sinaloa: rice; Distrito Federal: squash seeds; Michoacán, Puebla: maize; Tamaulipas: soybeans (18 samples, n= 406).
2. *Trogium pulsatorium* (Linnaeus). Distrito Federal: squash seeds (1 sample, n= 34).

Psoquillidae

3. *Psoquilla marginepunctata* Hagen. Quintana Roo: maize (5 samples, n= 141).

Psyllipsocidae

4. *Pseudoryterix mexicanus* García Aldrete. Sinaloa: rice (1 sample, n= 1).
5. *Psocathropos microps* Enderlein. Morelos: sorghum; Quintana Roo: maize (2 samples, n= 2).

TROCTOMORPHA

Liposcelididae

6. *Belaphotroctes* sp. Quintana Roo: maize (2 samples, n= 24).
7. *Embidopsocus citrensis* Mockford. Quintana Roo: maize (1 sample, n= 5).
8. *Embidopsocus* sp 1. Quintana Roo: maize (1 sample, n= 1).
9. *Embidopsocus* sp. 2. Quintana Roo: maize (2 samples, n= 6).
10. *Liposcelis* ca. *albothoracica* Broadhead. Oaxaca: maize (1 sample, n= 1).
11. *Liposcelis bostrychophila* Badonnel. Campeche, Distrito Federal, Jalisco, Morelos, Sinaloa: rice; Guerrero, Morelos, Oaxaca, Quintana Roo, Tabasco, Veracruz: maize; Morelos: black beans; Tamaulipas: soybeans (24 samples, n= 329).
12. *Liposcelis entomophila* Enderlein. Campeche, Jalisco, Morelos, Sinaloa: rice; Distrito Federal, Morelos, Oaxaca, Puebla, Quintana Roo, Veracruz: maize; Jalisco, Tamaulipas: soybeans; Morelos: beans (41 samples, n= 438).

Pachytroctidae

13. *Tapinella* sp. Morelos, Quintana Roo: maize (2 samples, n= 3).

PSOCOMORPHA

Lachesillidae

14. *Lachesilla* sp. Morelos: maize (1 sample, n=1).

Ectopsocidae

15. *Ectopsocus richardsi* (Pearman). Quintana Roo: maize (4 samples, n= 6).

Archipsocidae

16. *Archipsocus* sp. Veracruz: maize (1 sample, n= 1).
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Table 2. Relative abundance of 16 psocid species in 82 samples of stored grains in Mexico

Species	No. of individuals	No. of samples
<i>Liposcelis entomophila</i>	438	41
<i>Lepinotus reticulatus</i>	406	18
<i>Liposcelis bostrychophila</i>	329	24
<i>Psoquilla marginepunctata</i>	141	5
<i>Trogium pulsatorium</i>	34	1
<i>Belaphotroctes</i> sp.	24	2
<i>Embidopsocus</i> sp. 2	6	2
<i>Ectopsocus richardsi</i>	6	4
<i>Embidopsocus citrensis</i>	5	1
<i>Tapinella</i> sp.	3	2
<i>Psocathropos microps</i>	2	2
<i>Pseudorypteryx mexicanus</i>	1	1
<i>Embidopsocus</i> sp. 1	1	1
<i>Liposcelis</i> ca. <i>albothoracica</i>	1	1
<i>Lachesilla</i> sp.	1	1
<i>Archipsocus</i> sp.	1	1

Table 3. Origin of samples of stored grains from 13 Mexican states, species of psocids found in them, and number of individuals (F: females, M: males, n: nymphs)

CAMPECHE

1. Escárcega, milled rice, *Liposcelis bostrychophila* Badonnel, 2F.
2. Escárcega, unmilled rice, *Lepinotus reticulatus* Enderlein, 42F, 2n; *Liposcelis entomophila* Enderlein, 1F.
3. Escárcega, unmilled rice, *L. reticulatus* Enderlein, 10F, 3n; *L. bostrychophila* Badonnel, 2F.
4. Escárcega, milled rice, *L. bostrychophila* Badonnel, 1F.
5. Escárcega, unmilled rice, *L. reticulatus* Enderlein, 40F, 3n.

DISTRITO FEDERAL

6. Milled rice, *L. bostrychophila* Badonnel, 3F.
7. Broken cacahuazintle maize, *L. entomophila*, 7F, 2M, 3n.
8. Squash seeds, stored two months, *L. reticulatus* Enderlein, 2F; *Trogium pulsatorium* (Linnaeus), 11F, 14M, 9n.

GUERRERO

9. Atoyac de Alvarez, maize, *L. bostrychophila* Badonnel, 24F.

Table 3. *Continues*

10. Atoyac de Alvarez, maize, *L. bostrychophila* Badonnel, 4F.

JALISCO

11. Guadalajara, milled rice, *L. bostrychophila* Badonnel, 4F.
 12. Guadalajara, soybeans, *L. entomophila* Enderlein, 12F, 2M.
 13. Guadalajara, milled rice, *L. entomophila* Enderlein, 1F.
 14. Guadalajara, milled rice, *L. reticulatus* Enderlein, 1F; *L. entomophila* Enderlein, 2F.

MICHOACÁN

15. Ocurio, maize, *L. reticulatus* Enderlein, 41F.

MORELOS

16. Xoxocotla, maize, *L. entomophila* Enderlein, 40F.
 17. Puente de Ixtla, milled rice, *L. entomophila* Enderlein, 2F.
 18. Xoxocotla, maize, *Tapinella* sp., 2n; *Lachesilla* sp., 1n.
 19. Puente de Ixtla, milled rice, *L. entomophila* Enderlein, 2F.
 20. San Vicente, milled rice, *L. bostrychophila* Badonnel, 8F.
 21. San Vicente, milled rice, *L. bostrychophila* Badonnel, 5F.
 22. San Vicente, milled rice, *L. bostrychophila* Badonnel, 4F.
 23. Tetela del Volcán, Jamapa beans, *L. entomophila* Enderlein, 5F.
 24. Tetela del Volcán, black beans, two years in storage, *L. bostrychophila* Badonnel, 8F.
 25. Zacatepec, sorghum, *Psocathropos microps* Enderlein, 1F.
 26. Jumiltepec, maize, *L. entomophila* Enderlein, 4F.
 27. Ocuituco, maize, *L. bostrychophila* Badonnel, 15F; *L. entomophila* Enderlein, 7F.

OAXACA

28. Juchitán, maize, Zapalote chico, *L. bostrychophila* Badonnel, 6F.
 29. Juchitán, maize, Zapalote chico, *L. bostrychophila* Badonnel, 13F; *L. entomophila* Enderlein, 4F; *L. ca. albothoracica* Broadhead, 2F.

PUEBLA

30. Cuetzalan, maize, *L. reticulatus* Enderlein, 1F; *L. entomophila* Enderlein, 2F, 2n.
 31. Tzinacapan, maize, in troje, *L. entomophila* Enderlein, 12F, 1M.

QUINTANA ROO

32. Rancho Yuras, maize, *Embidopsocus citrensis* Mockford, 4F, 1M.
 33. Chunyaxché, maize, *Belaphotroctes* sp., 10F, 2M.
 34. Rancho Yuras, 5 Km. W Vigía Chico, maize ears with covering leaves, *L. entomophila* Enderlein, 2F, 1M, 1n; *L. bostrychophila* Badonnel, 5F; *Embidopsocus* sp. 1, 1F.
 35. Chunyaxché, maize, *Embidopsocus* sp. 2, 1F, 2M.
 36. Chan Ka' Veracruz, maize, stored one year, *L. bostrychophila* Badonnel, 42F.

Table 3. *Continues*

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37. Felipe Carrillo Puerto, maize, *L. entomophila* Enderlein, 6F.
38. José Ma. Pino Suárez, maize Nucnal, stored one year, *L. bostrychophila* Badonnel, 8F; *P. microps* Enderlein, 1n.
39. José Ma. Pino Suárez, maize, *L. entomophila* Enderlein, 1F.
40. Rancho Yuras, yellow maize in ear, *L. entomophila* Enderlein, 28F, 7M, 10n; *L. bostrychophila* Badonnel, 12F.
41. José Ma. Pino Suárez, maize, *L. bostrychophila* Badonnel, 19F, 3n; *Tapinella* sp., 1n.
42. Felipe Carrillo Puerto, maize, *Psoquilla marginepunctata* Hagen, 2F, 4M, 9n; *L. entomophila* Enderlein, 8F.
43. Felipe Carrillo Puerto, maize, *Ectopsocus richardsi* (Pearman), 2F.
44. Felipe Carrillo Puerto, maize, *L. bostrychophila* Badonnel, 2F; *L. entomophila* Enderlein, 2F.
45. Felipe Carrillo Puerto, maize, *L. entomophila* Enderlein, 20F.
46. Rancho Yuras, maize, *L. bostrychophila* Badonnel, 2F.
47. Rancho El Danto, maize in ear, *L. entomophila* Enderlein, 49F, 3M.
48. Chan Ka' Veracruz, yellow maize, *L. bostrychophila* Badonnel, 16F.
49. José Ma. Pino Suárez, maize, three months in storage, *L. bostrychophila* Badonnel, 22F; *L. entomophila* Enderlein, 6F.
50. Felipe Carrillo Puerto, maize, *L. entomophila* Enderlein, 2F.
51. Rancho El Danto, maize in ear, *L. entomophila* Enderlein, 53F, 2M.
52. José Ma. Pino Suárez, maize, four months in storage, *L. bostrychophila* Badonnel, 37F; *L. entomophila* Enderlein, 14F, 4M; *Ectopsocus richardsi* (Pearman), 2n.
53. José Ma. Pino Suárez, maize, *L. bostrychophila* Badonnel, 10F.
54. Chunyaxché, maize, *Embiodopsocus* sp. 2, 1F, 2M; *Belaphotroctes* sp. 9F, 3M.
55. Chunyaxché, maize, *L. bostrychophila* Badonnel, 12F; *L. entomophila* Enderlein, 1F; *Ectopsocus richardsi* (Pearman), 1n.
56. Rancho El Ramonal, maize in ear, *P. marginepunctata* Hagen, 23F, 31M, 8n; *L. bostrychophila* Badonnel, 1F.
57. Rancho El Ramonal, maize in ear, *P. marginepunctata* Hagen, 15F, 18M, 9n.
58. Rancho El Ramonal, maize, *L. entomophila* Enderlein, 16F; *L. bostrychophila* Badonnel, 2F.
59. Rancho El Ramonal, maize, *P. marginepunctata* Hagen, 7F, 7M, 6n.
60. Rancho El Ramonal, maize, *Ectopsocus richardsi* (Pearman), 1n.
61. Rancho El Ramonal, maize in ear, *P. marginepunctata* Hagen, 2F.

SINALOA

62. Culiacán, milled rice, *L. reticulatus* Enderlein, 12F; *L. bostrychophila* Badonnel, 6F.
63. Culiacán, unmilled rice, *L. reticulatus* Enderlein, 11F.
64. Culiacán, milled rice, *L. reticulatus* Enderlein, 13F.
65. Culiacán, unmilled rice, *L. reticulatus* Enderlein, 2F; *L. entomophila* Enderlein, 2F.
66. Culiacán, unmilled rice, *L. reticulatus* Enderlein, 26F, 6n; *L. entomophila* Enderlein, 1F.
67. Culiacán, milled rice, *L. reticulatus* Enderlein, 60F, 9n; *L. entomophila* Enderlein, 7F.
68. Culiacán, milled rice, *L. reticulatus* Enderlein, 36F; *L. entomophila* Enderlein, 1F.
69. Culiacán, unmilled rice, *L. reticulatus* Enderlein, 11F, 3n.

Table 3. *Continues*

70.	Culiacán, unmilled rice, <i>Pseudorypteryx mexicanus</i> García Aldrete, 1M.
71.	Culiacán, unmilled rice, <i>L. reticulatus</i> Enderlein, 58F, 7n; <i>L. entomophila</i> Enderlein, 1F.
TABASCO	
72.	Cárdenas, maize, <i>L. bostrychophila</i> Badonnel, 3F.
TAMAULIPAS	
73.	Tampico, soybean, <i>L. entomophila</i> Enderlein, 30F, 5M; <i>L. bostrychophila</i> Badonnel, 2F; <i>L. reticulatus</i> Enderlein, 4F.
74.	Tampico, soybean, <i>L. entomophila</i> Enderlein, 8F, 3M; <i>L. reticulatus</i> Enderlein, 3F.
VERACRUZ	
75.	San Andrés Tuxtla, maize stored in field, <i>L. bostrychophila</i> Badonnel, 1F.
76.	San Andrés Tuxtla, maize stored in field, <i>L. bostrychophila</i> Badonnel, 9F, 6n; <i>L. entomophila</i> Enderlein, 1F.
77.	San Andrés Tuxtla, maize stored in field, <i>L. bostrychophila</i> Badonnel, 10F; <i>L. entomophila</i> Enderlein, 1F.
78.	San Andrés Tuxtla, maize in sacs without insecticide, <i>L. entomophila</i> Enderlein, 14F.
79.	San Andrés Tuxtla, maize in sacs with lime, stored seven months, <i>L. entomophila</i> , Enderlein, 7F.
80.	San Andrés Tuxtla, maize, <i>L. entomophila</i> Enderlein, 4F.
81.	San Andrés Tuxtla, maize in sacs, with insecticide, <i>L. entomophila</i> Enderlein, 6F.
82.	San Andrés Tuxtla, maize stored at home, <i>Archipsocus</i> sp., 1n.

scribed species belong in genera with species recorded from stored grains, except *Tapinella* and *Archipsocus*. Of the 16 species found, all but *Pseudorypteryx mexicanus*, *Belaphotroctes* sp., *Embidopsocus citrensis*, *Embidopsocus* spp. 1 and 2, *Liposcelis* ca. *albothoracica*, *Tapinella* sp., *Lachesilla* sp., and *Archipsocus* sp., were included by Mockford (1991) in his illustrated key to psocids found in stored foods.

The most ubiquitous species were *Liposcelis entomophila*, *L. bostrychophila* and *Lepinotus reticulatus*, present in 41, 24 and 18 samples respectively, seven species were present in only one sample, four species were present in two samples and one species each were present in four and five samples (Table 1).

As for relative abundance (Table 2), the most important species were the same three mentioned before as more ubiquitous; these, plus *Psoquilla marginepunctata*, present in five samples, represent 93.9% of the total number of individuals in the 82 samples. Five species were represented by one individual each; one species each were represental by two, three and five individuals, two species were represented by six specimens and one species each were represented by 24, 34 and 141 specimens.

Fifty two samples had one species, and the number of individuals varied in them from one to 55 (\bar{x} = 11.82). Twenty five samples had two species, and in 23 of them one species was clearly dominant. Only five samples had three species, one of them clearly dominant over the other two. The most frequent dominant species, in the 28 samples with more than one species, were *Liposcelis bostrychophila* (ten times dominant), *Lepinotus reticulatus* (eight times dominant), and *Liposcelis entomophila* (six times dominant).

It follows then, from the samples studied, that the three species mentioned above are the most important psocid species associated with stored grains in Mexico. *L. bostrychophila* has been recognized as a common stored products pest (Shires, 1982; Turner, 1987; Turner & Maude-Roxby, 1988). McFarlane (1982), has indicated that, in the humid tropics, in rice stores, the most common species may prove to be *Liposcelis entomophila*.

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