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Taxonomy and systematics

Mites of the families Pygmephoridae and Neopygmephoridae (Acari: Pygmephoroidea) from soils in Mexico

Ácaros de las familias Pygmephoridae y Neopygmephoridae (Acari: Pygmephoroidea) de suelos en México

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Abstract

Mites of the families Pygmephoridae and Neopygmephoridae have been poorly studied in Mexico. Previous records from this group are: *Acinogaster* (*A.*) *kansensis* from Chiapas, *A.* (*A.*) *marianae* from Veracruz, *Pygmephorus americanus* from Mexico, some species of *Siteroptes* from Puebla and *Pediculaster thailandensis* from Quintana Roo. In this study we provide additional data, including specimens of Neopygmephoridae such as *Kerdabania inconspicua*, *Bakerdania exigua*, *Pseudopygmephorus agarici*, and *P. shangaiensis*; and of Pygmephoridae: *Mahunkania secunda*, *Pediculaster ignotus* and *P. gracilis*. Abundant specimens of *Pediculaster ignotus* were present in garlic crop soil.

Keywords: Prostigmata; Garlic crop; Organic soil; Phoretic mites

Resumen

Los ácaros de las familias Pygmephoridae y Neopygmephoridae de México han sido poco estudiados. Registros previos de este grupo son: *Acinogaster* (*A.*) *kansensis* de Chiapas, *A.* (*A.*) *marianae* de Veracruz, *Pygmephorus americanus* de México y especies de *Siteroptes* en muestras de Puebla, así como *Pediculaster thailandensis* del estado de Quintana Roo. En este estudio damos a conocer nuevos datos que incluyen a ejemplares de Neopygmephoridae como *Kerdabania inconspicua*, *Bakerdania exigua*, *Pseudopygmephorus agarici and P. shangaiensis*; también de la familia Pygmephoridae a *Mahunkania secunda, Pediculaster ignotus* y *P. gracilis*. La mayor abundancia de *Pediculaster ignotus* estuvo presente en suelos cultivados con ajo.

Palabras clave: Prostigmata; Cultivo de ajo; Suelo orgánico; Ácaros foréticos

Introduction

The family Pygmephoridae contains 30 genera and 350 species (Krantz & Walter, 2009). These figures have changed since the work by Kethley (1982), mainly due to recent reviews of this heterogeneous group. One of these changes is the re-establishment of the family Neopygmephoridae and the revision of generic characters to define them (Camerick, 2005; Khaustov, 2004). The most diverse genera of the families Pygmephoridae and Neopygmephoridae are *Bakerdania* Sasa, 1962 (about 100 species), *Pygmephorus* Kramer, 1877 (about 43 species) and *Pediculaster* Vitzthum, 1931 (about 95 species) (Camerick, 2010; Khaustov, 2004, 2008).

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Pygmephorid mites from Mexico cited by Hoffmann and López-Campos (2000) are *Acinogaster* (*Acinogaster*) *kansensis* Ross & Cross, 1979 (USA, Mexico, Costa Rica, Panama, Ecuador, and Brazil) from Chiapas State; *A.* (*A.*) *marianae* Cross, 1965 (Mexico, Costa Rica, Panama, Ecuador, Guyana, and Trinidad) from Veracruz State; *Pediculaster americanus* (Banks, 1904) (USA, Mexico, and Haiti) from Mexico without more data. Species of *Siteroptes* Amerling, 1861 in soil samples from Puebla are also cited without any other data (Hoffmann & López-Campos, 2000). *Pediculaster thailandensis* Camerick, 2005 on Chloropidae flies, from Playa del Carmen, Quintana Roo and from a rocky seashore on Tethinidae flies, from Tulum, Quintana Roo, Mexico, are the most recent records (Camerick, 2005).

We have been studying Prostigmata mites found in cultivated soils since 2005. Some results have already been published, particularly those about Ereynetidae from cultivated soils with a garlic (*Allium sativum* L.) crop in Guanajuato, Mexico (Vázquez-Rojas & Estrada-Venegas, 2010). Here, we publish data on the families of Pygmephoridae and Neopygmephoridae found in garlic crop soil as well as, other natural, cultivated soils and compost. We consider the genera *Mahunkania* and *Pediculaster* as members of the family Pygmephoridae and the genera *Bakerdania*, *Kerdabania* and *Pseudopygmephorus* as members of the family Neopygmephoridae, following Khaustov (2004, 2009).

Materials and methods

All samples were collected by E. Estrada and A. Equihua from different parcels at the states of Guanajuato, Mexico, Veracruz and D. F. One kilogram of soil was processed by a Berlese Funnel by E. Estrada and her team along 1 year. The following arrangement of locality data was used: Guanajuato municipalities (in italics), parcel names and 2 letters as key of that name. *Salamanca*: El Fuerte (EF), El Tajo (ET), La Cuadrilla (LC), Pozo Félix (PF), San Isidro (SI) and San Juan (SJ); *Comonfort*: La Huerta (LH); *Los Rodríguez*: Mina 5 (M5); San Luis de La Paz: El Zorrillo (EZ) and El Nacimiento (EN). Same arrangement was used for other states and habitats. Compost samples at Texcoco (Montecillo), Mexico State (MTx); soil samples from Rio Tuxtla, Veracruz state (RTV); and soil samples from crops such as corn (*Zea maiz* L. 1753), pumpkin (*Cucurbita pepo* L. 1753), coriander (*Coriandrum sativum* L. 1753), and goosefoot (*Chenopodium nuttalliae*); from parcels P.J. Capultitla in Xochimilco, Distrito Federal (PJCX). A total of 167 specimens of Pygmephoridae and Neopygmephoridae were mounted on slides and studied; these will be deposited in the collection of the second author.

Drawings were made with a Zeiss compound microscope equipped with a camera lucida and then processed with Photoshop CS5. All measurements are expressed in μm and were made following the procedure by Camerick, 1996.

Description

Neopygmephoridae Cross, 1965
Pseudopygmephorus *Cross, 1965*
Type species: Pygmephorus tarsalis *Hirst, 1921; Cross, 1965: 221*
Pseudopygmephorus *agarici Zou, Gao & Ma, 1990: 373 (Figs. 1–6)*

Phoretomorph females in soil of garlic crop in Guanajuato. 10, M5, 11/04/2002; 15, LH, 16/08/2001; 4, PF, 26/07/2000; 1, EN, 13/11/2001; 1, RTV, 01/10/2004; 1, ET, 17/07/2001; 1, PF, 15/05/2002. Soil 1, PJCX, 11/04/2007.

Distribution and habitats of the species described by Zou, Jian-Rong, and En-Pei (1990)

Holotype and allotype of *P. agarici* were found in mushroom compost as well as manure in Shangai, China. Paratypes were found in mushroom compost, compost being pasteurized and on straw in greenhouses (Zou et al., 1990).

Pseudopygmephorus agarici

Size intervals from 6 studied specimens. Body 81–131 wide; 195–320 long. Length of dorsal setae of 6 specimens: v_2 8–10, sc_2 28–47, c_1 23–30, c_2 39–60, *d* 21–40, *e* 17–33, *f* 24–44; h_1 25–50, h_2 16–20. Distances between dorsal setae: v_2–v_2 21–27, sc_2–sc_2 17–24, c_1–c_1 35–47, c_2–c_2 80–111, *d*–*d* 41–60, *f*–*f* 42–61, *e*–*e* 56–78, h_1–h_1 24–42, h_2–h_2 58–82. Length of ventral setae: 1*a* 20–28, 1*b* 9–19, 2*a* 23–34, 2*b* 24–36, 3*a* 23–36, 3*b* 24–34, 3*c* 12–24, 4*a* 23–30, 4*b* 29–41, 4*c* 21–30, ps_1 11–18, ps_2 11–17, ps_3 11–20. Length of tibiotarsus solenidia: ω_1 7–9, ω_2 5–6, φ_1 3–5, φ_2 6–8.

Other species of *P. aphodii* Khaustov, 2010 (Ukraine), have been found on dung beetles *Aphodius fimetarius* (L.), and *P. smileyi* Hill & Deahl, 1978 (USA), on horse manure for commercial mushroom production (Hill & Deahl, 1978; Khaustov, 2010).

Pseudopygmephorus shangaiensis *Zou, Gao, & Ma, 1990: 375 (Figs. 7–12)*

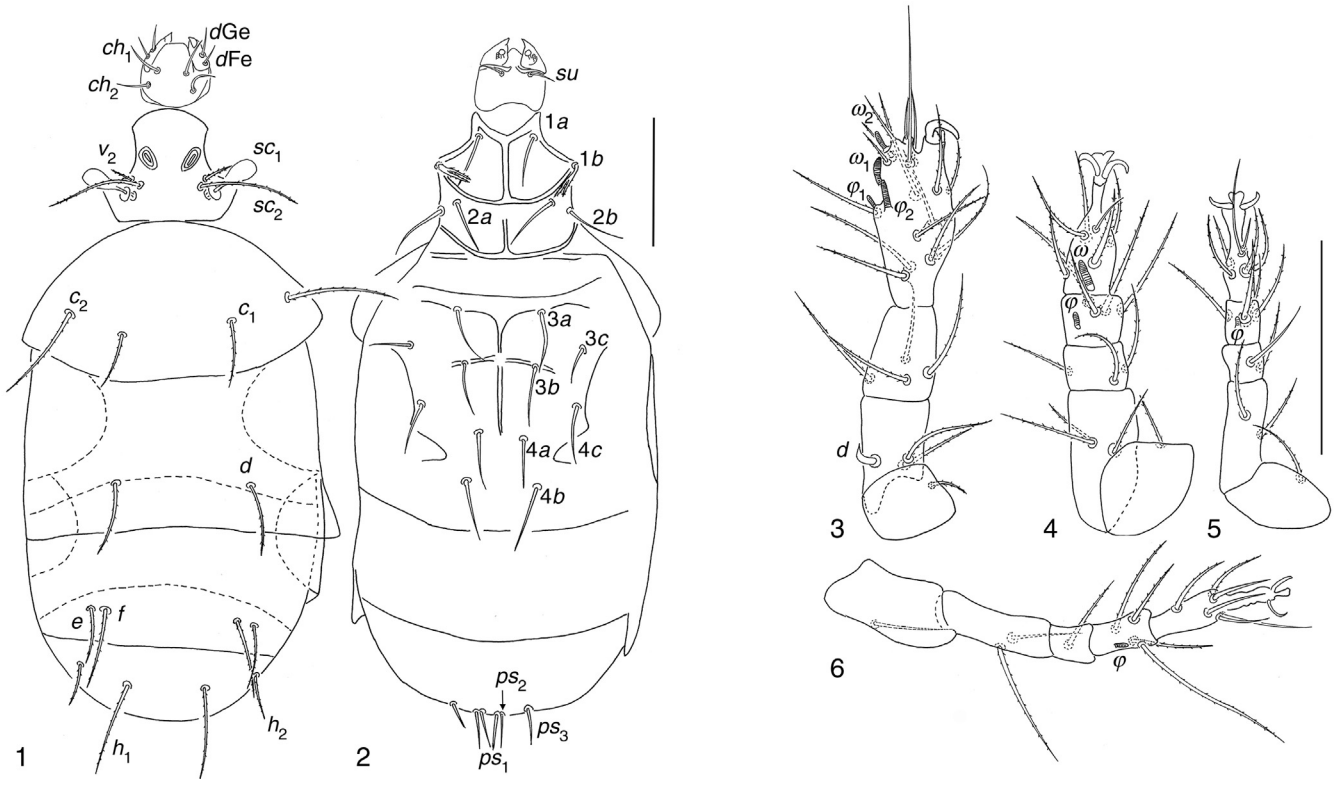
Phoretomorph females collected in compost. 8, MTx, 19/07/2005.

Distribution and habitat of the species described by Zou et al. (1990)

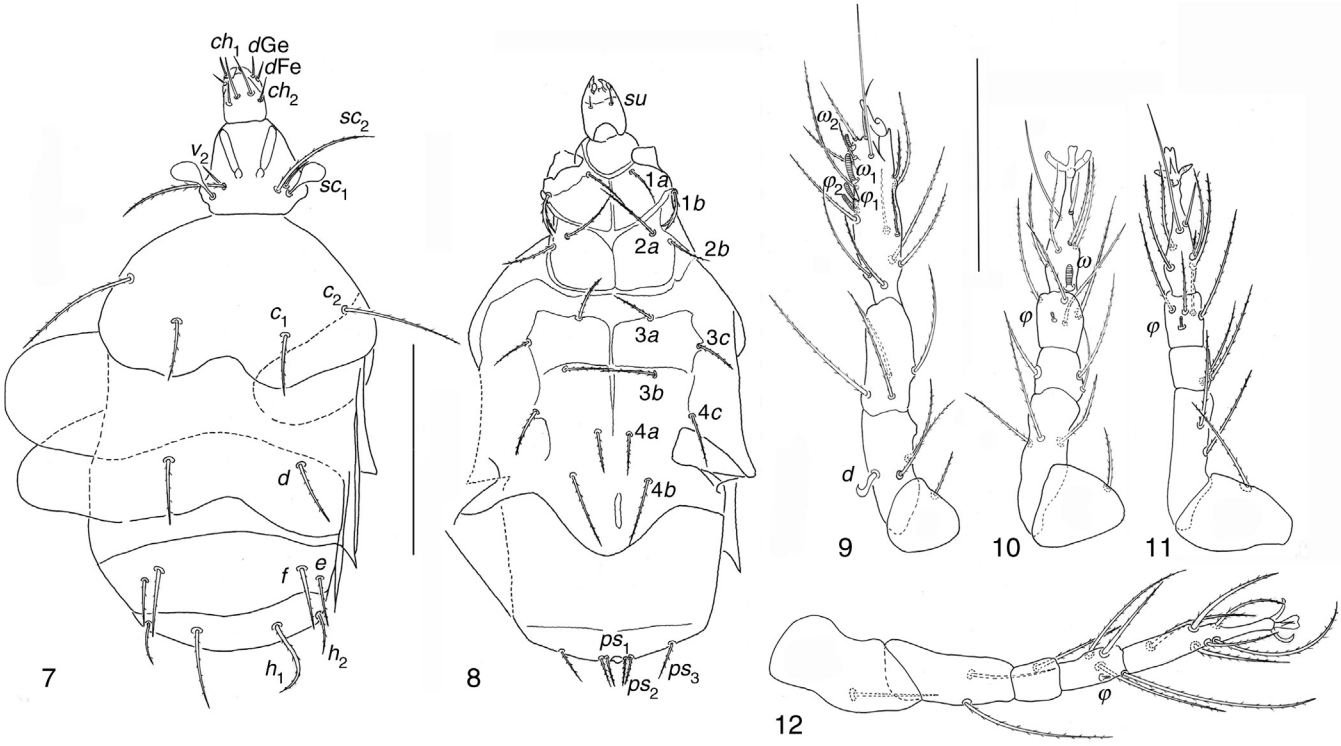
Holotype, allotype and paratypes were found on manure and mushroom compost in Shangai, China (Zou et al., 1990).

Pseudopygmephorus shangaiensis

Size intervals from 5 specimens. Body, 89–126 wide; 170–310 long. Length of dorsal setae of 5 specimens: v_2 8–10, sc_2 36–52, c_1 22–30, c_2 39–60, *d* 22–30, *e* 14–31, *f* 23–31; h_1 27–38, h_2 13–21. Distances between dorsal setae: v_2–v_2 24–32, sc_2–sc_2 18–24, c_1–c_1 38–51, c_2–c_2 80–119, *d*–*d* 43–69, *f*–*f* 44–68, *e*–*e* 47–86, h_1–h_1 22–35, h_2–h_2 54–83. Length of ventral



Figures 1–6. *Pseudopygmephorus agarici*. (1) Dorsal view; (2) ventral view; (3–6) legs I to IV. Scale bar 50 μm.



Figures 7–12. *Pseudopygmephorus shangaiensis*. (7) Dorsal view; (8) ventral view; (9–12) legs I to IV. Scale bar 50 μm.

setae: 1*a* 17–24, 1*b* 13–20, 2*a* 23–35, 2*b* 15–24, 3*a* 15–29, 3*b* 18–29, 3*c* 15–23, 4*a* 14–24, 4*b* 22–35, 4*c* 16–26, ps_1 10–18, ps_2 10–17, ps_3 16–20. Length of tibiotarsus solenidia: ω_1 7–9, ω_2 3–5, φ_1 4–5, φ_2 6–7.

Kerdabania *Khaustov, 2009*
Type species: Kerdabania magnifica, *Khaustov, 2009: 171*
Kerdabania inconspicua *(Berlese, 1904) (Figs. 13–18)*
Pigmephorus inconspicuus *Berlese, 1904: 12*
Scutacarus centriger *Cooreman, 1951*
Pygmephorus sellnicki Krczal, 1958: 69
Kerdabania inconspicuus *(Berlese, 1904) Khaustov, 2009:183 comb. n.*

Females in soil of garlic crop in Guanajuato State. 3, M5, 01/06/2002; 1, SI, 29/07/2002, 1; SI, 10/04/2002, 1, SI, 22/08/2002; 1, EN, 13/01/2001; 1, LC, 23/04/2003; 5, EZ, 29/07/2006. Females in cultivated soil in Xochimilco, D. F.: 2, PJCX, 23/05/2007, *Coriandrum*; 1, PJCX, 27/06/2007, corn; 1, PJCX, 11/04/2007, pumpkin; 1, PJCX, 28/03/2007, goosefoot.

Distribution and habitat of the species renamed by Khaustov (2009)

The genus has worldwide distribution, except Antarctica. Forest litter and nests of small mammals and ants are known habitats. Phoresy unknown. *K. inconspicua* from Ukraine, vicinity of Poltava, soil under straw (Khaustov, 2009).

Kerdabania inconspicua

Body size interval, 232–282 wide, 107–116 long. Length of dorsal setae: v_2 9–11, sc_2 42–47, c_1 38–42, c_2 42–48, *d* 33–40, *e* 11–22, *f* 40–44, h_1 35–41, h_2 36–41. Distances between dorsal setae: v_2–v_2 14–17, sc_2–sc_2 12–19, c_1–c_1 37–45, c_2–c_2 76–93, *d*–*d* 43–58, *f*–*f* 43–60, *e*–*e* 57–72, h_1–h_1 20–27, h_2–h_2 43–55. Length of ventral setae: 1*a* 15–20, 1*b* 16–20, 2*a* 24–28, 2*b* 25–32, 3*a* 12–15, 3*b* 12–14, 3*c* 13–16, 4*a* 10–12, 4*b* 13–20, 4*c* 14–19. Length of tibiotarsus solenidia: ω_1 6–9, ω_2 4–6, φ_1 3–4, φ_2 6–9.

Bakerdania *Sasa, 1961*
Type species: Pygmephorus cultratus *Berlese, 1904; (1970)*
Bakerdania exigua *(Mahunka, 1969) (Figs. 19–24)*
Neopygmephorus exiguus *Mahunka, 1969: 533.*
Bakerdania exiguus *Mahunka, 1969; Mahunka, 1970: 348*
Bakerdania exigua *(Mahunka, 1969): Rack, 1972: 284.*

Females in garlic crop soil in Guanajuato State. 2, EN, 16/01/2002; 1, PF, 13/02/2002; 1, 17/01/2002; 1, 14/03/2002; 1, SJ, 15/03/2002; 1, EF, 18/02/2002.

Distribution and habitat of species by Mahunka (1970)

Probably cosmopolitan, known from Europe and South America (Mahunka, 1970).

Bakerdania exigua

Body chaetotaxy agrees with *B. exigua* (Mahunka, 1969) except ventral setae 4*b* (posesternals externals) which does not reach the vulva. Body 129–141 wide; 279–344 long. Length of dorsal setae: v_2 7–8, sc_2 36–42, c_1 36–40, c_2 45–52, *d* 33–40, *e* 34–40, *f* 44–50; h_1 53–62, h_2 48–53. Distances between dorsal setae: v_2–v_2 37–49, sc_2–sc_2 32–37, c_1–c_1 49–64, c_2–c_2 93–134, *d*–*d* 26–31, *f*–*f* 69–86, *e*–*e* 87–104, h_1–h_1 26–36, h_2–h_2 56–65. Length of ventral setae: 1*a* 24–32, 1*b* 26–28, 2*a* 30–36, 2*b* 41–53, 3*a* 40–44, 3*b* 41–51, 3*c* 24–27, 4*a* 39–61, 4*b* 57–67, 4*c* 23–38, ps_1 12–13, ps_2 7–9, ps_3 11–13. Length of tibiotarsus solenidia: ω_1 17–22, ω_2 8–9, φ_1 9–10, φ_2 9–10.

Pygmephoridae Cross, 1965
Pediculaster *Vitzthum, 1931*
Type species: Pigmephorus mesembrinae *Canestrini, 1880*
Pediculaster *ignotus Krczal, 1959 (Figs. 25–30)*

Phoretomorph females in soil of garlic crop in Guanajuato State. 6, PF, 15/03/2002; 36, PF, 15/05/2002; 1, EZ, 29/07/2002; 1, EN, 13/11/2001.

Distribution and habitat of species by Rack (1965) and Camerick and Coetzee (1997)

The genus *Pediculaster* is cosmopolitan, with some species inhabit dung and fungi. Common habitat is cattle dung and compost; the mites are phoretic on Diptera (Camerick & Coetzee, 1997). This genus is also known to inhabit soil, litter, mosses, and mammal droppings, mammal nests, plants and fruits (Camerick, 1996). *Pediculaster ignotus* was recorded from Hamburg-Langenhorn North, in organic material of 2–3 years of age (Rack, 1965).

Pediculaster ignotus

Characters in general agree with the genus and the species but ps_2 is different from other species in the genus because it is the shortest seta between *ps* setae.

Pediculaster gracilis *Camerick & Ueckermann, 1995. (Figs. 31–36)*

Phoretomorph females in soil of garlic crop in Guanajuato State. 2, EN, 13/12/2001; 1, EN, 13/09/2001; 2, EZ, 29/06/2002.

Distribution and habitat of species described by Camerick and Ueckermann (1995)

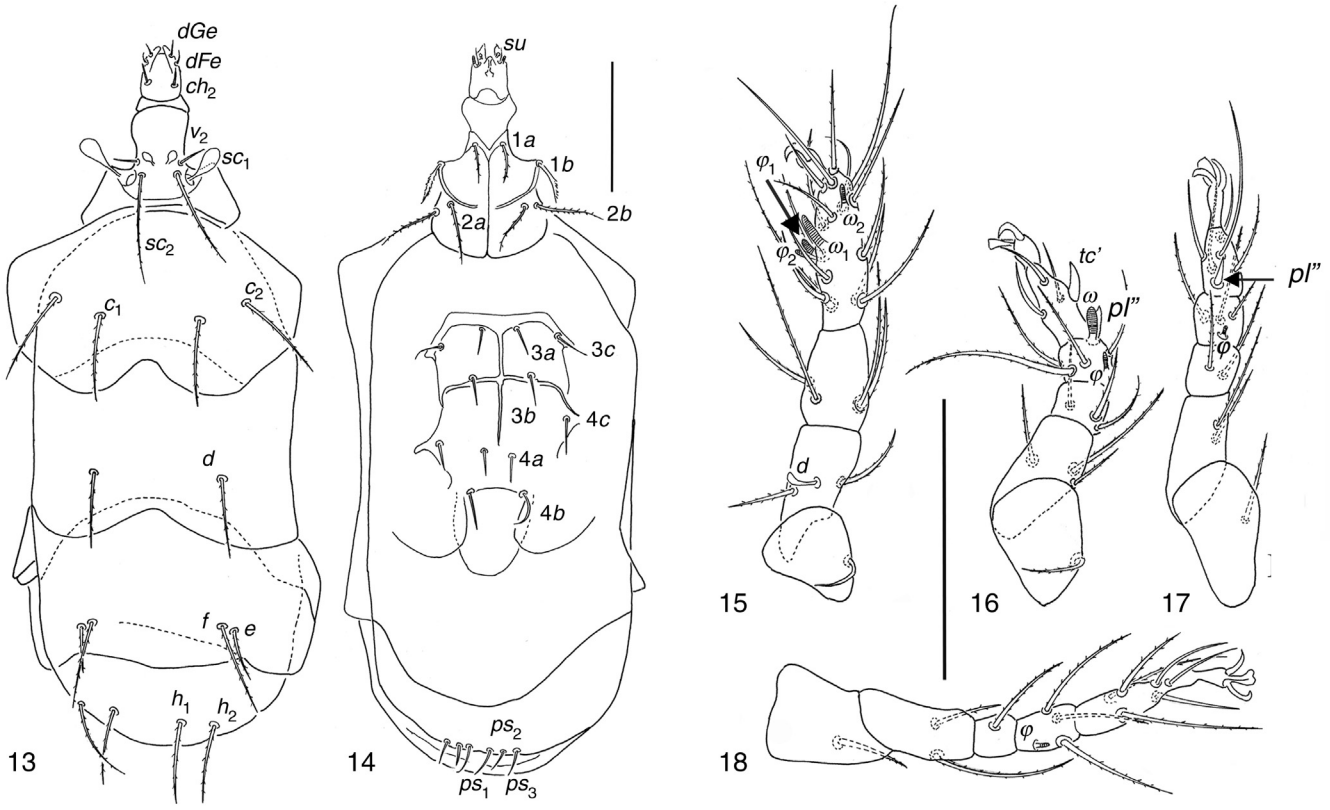
Type locality. Republic of South Africa, Johannesburg, Sandton, Innesfree Farm; habitat: horse and cow dung. Specimens also on Cynipidae (Hymenoptera) indeterminate (Camerick & Ueckermann, 1995).

Pediculaster gracilis

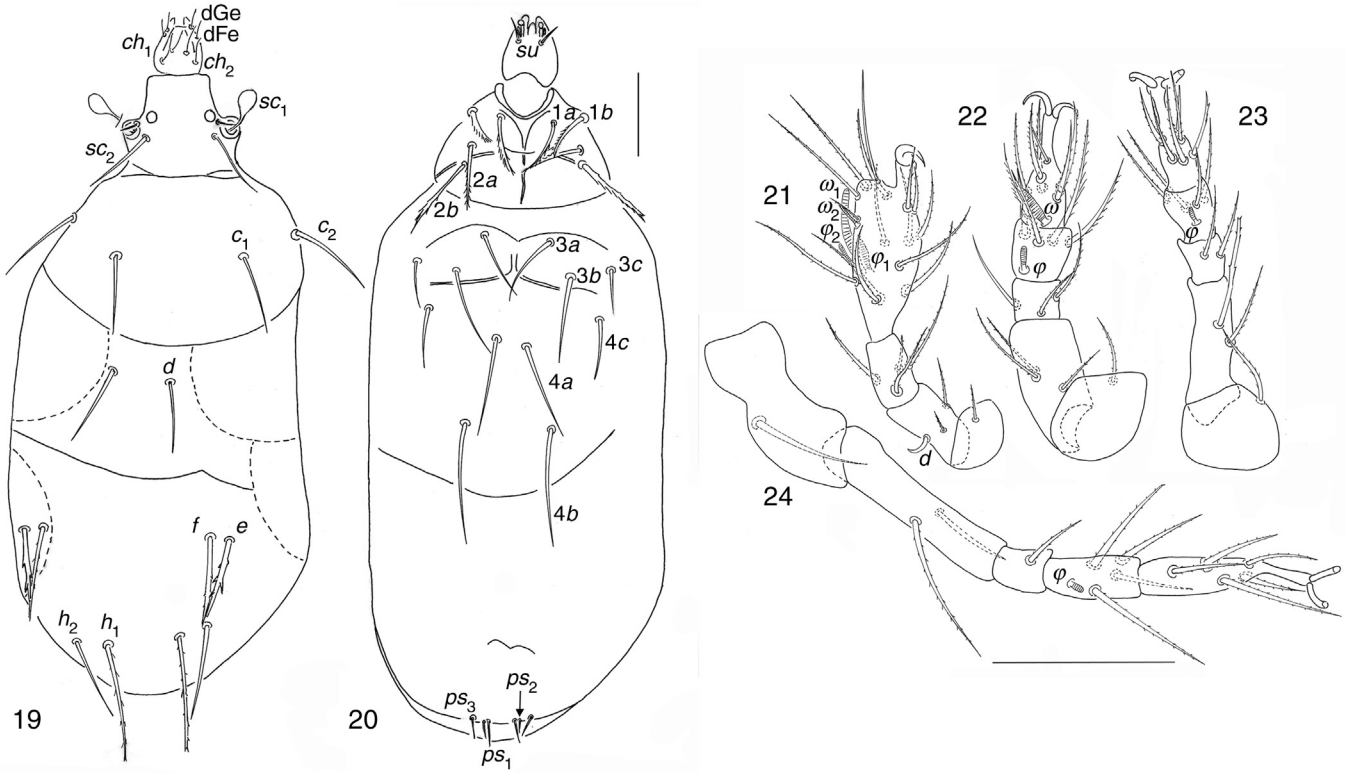
Ventral side: Apodeme 3 not interrupted between setae 3a.

Mahunkania *Rack, 1972*
Type species: Mahunkania hallensis *Rack, 1972*: *278*
Mahunkania secunda *Rack, 1975 (Figs. 37–42)*

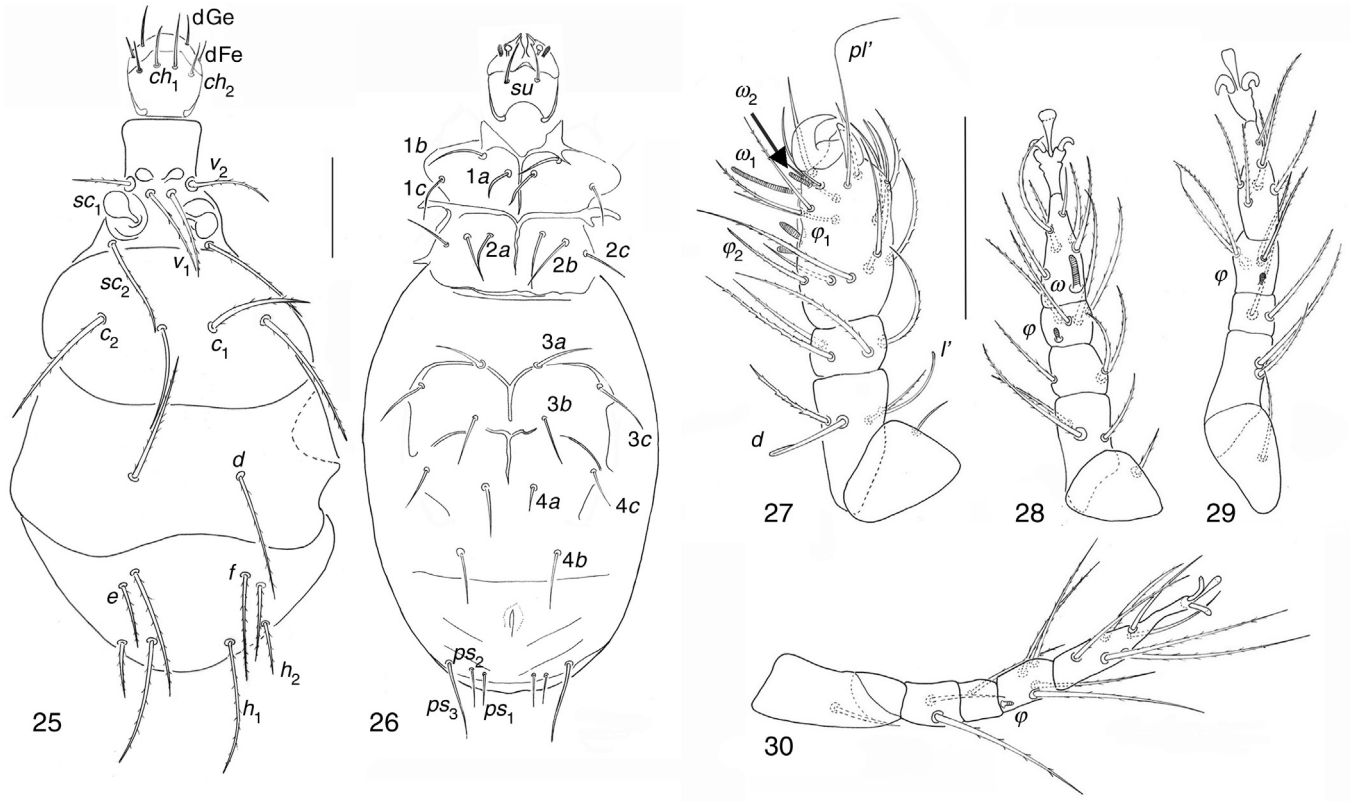
Phoretomorph females in soil of garlic crop in Guanajuato State. 3, PF, 15/05/2002.



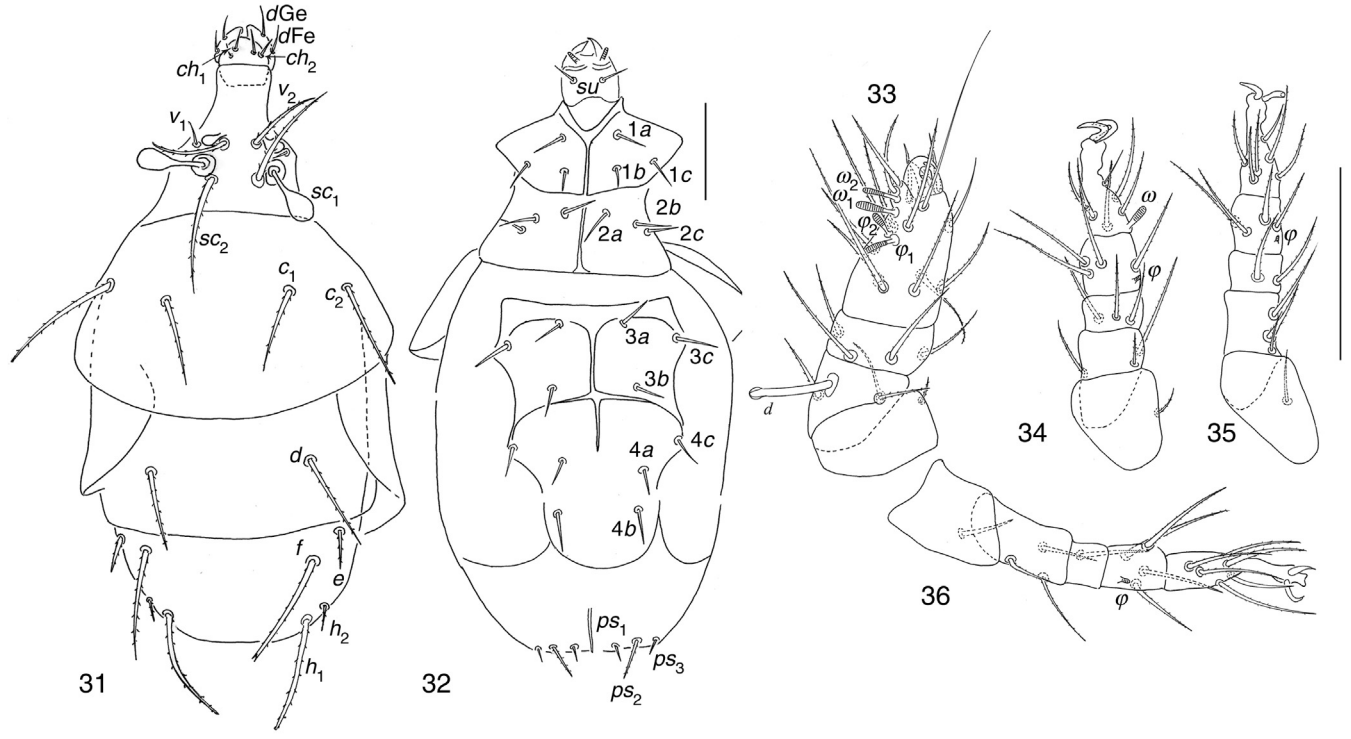
Figures 13–18. *Kerdabania inconspicua*. (13) Dorsal view; (14) ventral view; (15–18) legs I to IV. Scale bar 50 μm.



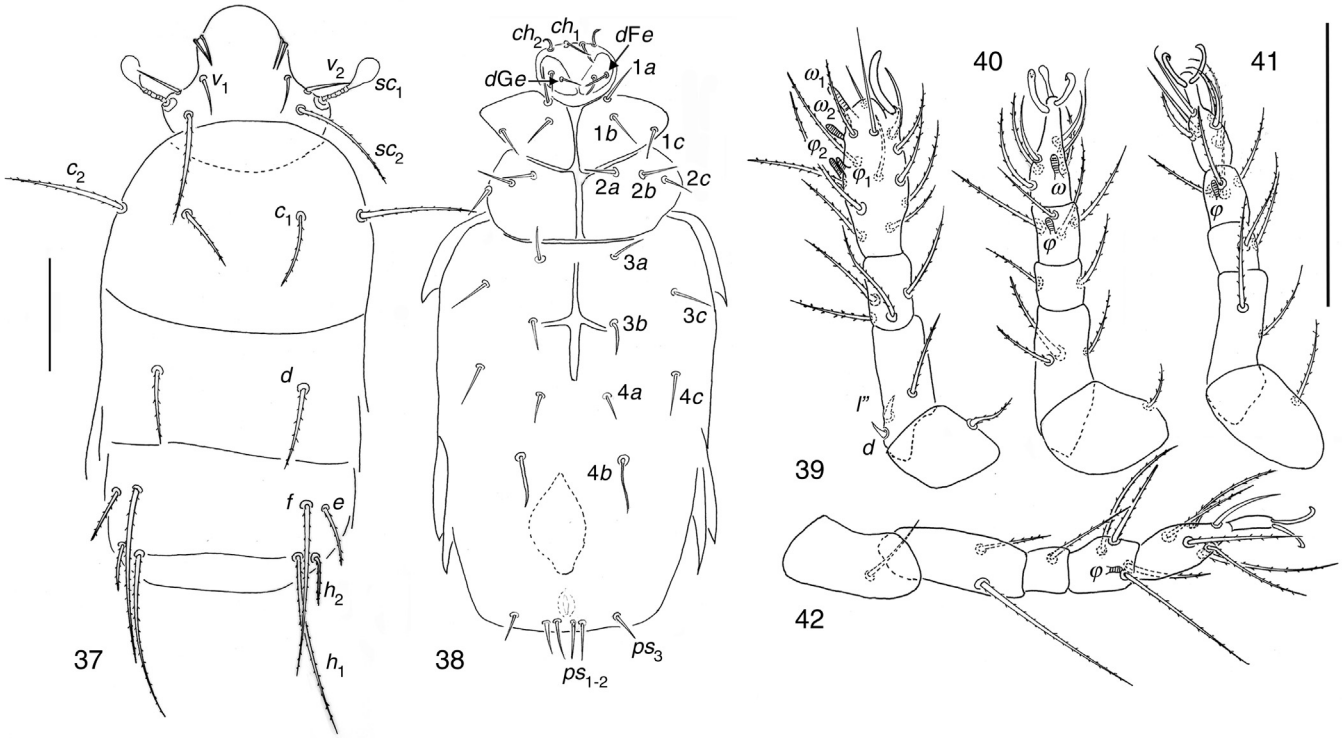
Figures 19–24. *Bakerdania exigua*. (19) Dorsal view; (20) ventral view; (21–24) legs I to IV. Scale bar 50 μm.



Figures 25–30. *Pediculaster ignotus*. (25) Dorsal view; (26) ventral view; (27–30) legs I to IV. Scale bar 50 μm.



Figures 31–36. *Pediculaster gracilis*. (31) Dorsal view; (32) ventral view; (33–36) legs I to IV. Scale bar 50 μm.



Figures 37–42. *Mahunkania secunda*. (37) Dorsal view; (38) ventral view; (39–42) legs I to IV. Scale bar 50 μm.

Distribution and habitat of species described by Rack (1972)

Mahunkania secunda was collected in Florida, USA from *Fragaria* sp. (Rack, 1972).

Mahunkania secunda

Studied specimens share with *M. secunda* the following characters after Kurosa (2002). Stigmata elongate-rectangular; prodorsal setae v_1 subequal in length to v_2; setae *e* about ½ as long as *f*; coxal setae 1*b* directly posterior to 1*a*, not reaching apodeme 2 when directed backward; coxal 1*c* neither longer nor thicker than 1*a* and 1*b*; solenidia ω_1 just apical in position, well apart from, and somewhat larger than ω_2; seta *d* on femur IV reaching apex of tibia; setae *d* (3.35) and *l″* (3.78) on femur I subequal in size.

Discussion

The biology and behavior of Pygmephorid mites have been poorly studied, and they usually have been found associated phoretically to insects but the soil relationships are not fully understood. These mites have been collected in soils with high levels of organic matter, feeding on fungi (Kurosa, 1999), in different ecosystems as soil crust in desert habitat (Villarreal-Rosas, Palacios-Vargas, & Maya, 2014), termite nests (Wang, Powell, & O'Connor, 2002) and Arctic deserts (Khaustov & Makarova, 2005). Xochimilco soils are constantly improved with organic matter from the base of the lake, where the Chinampas zone is established. Garlic crop is usually associated with pathogenic fungi in the Guanajuato fields, so these conditions favor the Pygmephorid species. These mites are also vectors of fungal pathogens of plants and may feed preferentially on these phytopathogen fungi (Krantz & Lindquist, 1979).

The genus *Bakerdania* is one of the largest genera in the Neopygmephoridae family, and includes about 100 species (Khaustov, 2008). They are found in all continents except Antarctica. These mites are piercing-sucking fungi with different feeding habits (Walter & Proctor, 2013). They inhabit litter and eutrophic habitats, where they arrive by means of phoresy on insects (Kurosa, 1999).

The genus *Pediculaster* was abundant in samples, especially in garlic crop soil, with less abundant genera such as *Bakerdania* and *Mahunkania*, yet the latter remain very rare. Specimens of *Pediculaster* appear to be common in garlic crop soil, especially *P. ignotus*. With regard to this species, the difference in size of ps_2 is notorious with respect to other *Pediculaster* species; nevertheless, this seta is similar to ps_2 of *P. ignotus* shown by Rack (1965). In the drawing 14 (page 26) of Rack's paper the ps_2 is the shorter seta and the ps_3 is the largest, as was found in the specimens of this study. All specimens of *P. ignotus* are phoretic females; we believe that their insect hosts may be the visitors in or near the garlic crop. It is clearly necessary to collect insects related to the crop searching for mites to confirm this relationship (Camerick, 1996).

Pediculaster thailandensis was only found in compost. We assume that this species may be associated with some dipteran that dwells compost. As previously, the female phoretomorph leads us to believe that the presence of these mites is linked to the presence of host insects in the crop (Camerick, 2005).

All the records presented here are new for Mexico and for the substrata where they were collected.

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