TWO NEW SPECIES OF MITES OF THE GENERA *PETALOMIUM* CROSS AND *CAESARODISPUS* MAHUNKA (ACARI: HETEROSTIGMATA: NEOPYGMEPHORIDAE, MICRODISPIDAE) ASSOCIATED WITH *SOLENOPSIS INVICTA* BUREN (HYMENOPTERA: FORMICIDAE) FROM THE U.S.A.

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ABSTRACT - Two new species of myrmecophilous pygmephoroid mites, *Petalomium hofstetteri* **n. sp.** (Neopygmephoridae) and *Caesarodispus klepzigi* **n. sp.** (Microdispidae), associated with the red imported fire ant (*Solenopsis invicta* Buren) (Hymenoptera: Formicidae) are described from Louisiana, U.S.A.
Key words - Acari, Heterostigmata, Microdispidae, Neopygmephoridae, *Petalomium*, *Caesarodispus*, new species, *Solenopsis invicta*, U.S.A.

INTRODUCTION

The genus *Petalomium* Cross, 1965 (Acari: Heterostigmata: Neopygmephoridae) includes about 30 species (Khaustov, 2005), but only one (*P. krczali* Cross, 1965) has been described from the USA. Cross (1965) also mentioned nine undescribed species of *Petalomium* associated with ants from USA and Panama. At that time nothing was known about mites of the genus *Caesarodispus* Mahunka, 1977 (Acari: Heterostigmata: Microdispidae) in the USA. During a study of myrmecophilous mites associated with the red imported fire ant (*Solenopsis invicta* Buren) (Hymenoptera: Formicidae) (RIFA) in Louisiana (USA), two new species were found and are described in this paper. Also the genus *Petalomium* is placed in the family Neopygmephoridae Cross, 1965 (Khaustov, 2004).

MATERIALS AND METHODS

The materials and methods used for field collections of ant and mite specimens in this study were the same as given in Ebermann and Moser (2008). Tahir Rashid and Roberto Pereira also furnished small amounts of material from Pulaski, TN. The mites were separated from other arthropods and sent to the senior author for identification and description. In the description, the terminology follows Lindquist (1986). All measurements are given in micrometers (μm) for the holotype and 5 paratypes (in parenthesis).

Abbreviations - Different abbreviations used in the description are as follows: Ag = aggenital plate, ap = apodeme, appo = poststernal apodeme, Fe = femur, Ge = genu, Ta = tarsus, Ti = tibia, TiTa = tibiotarsus, Tr = trochanter .

Voucher specimens - All the voucher (and the type) specimens of the species discussed in this paper have been retained in the collections of Khaustov and Moser, and other institutions as mentioned in the deposition of type materials under each species.

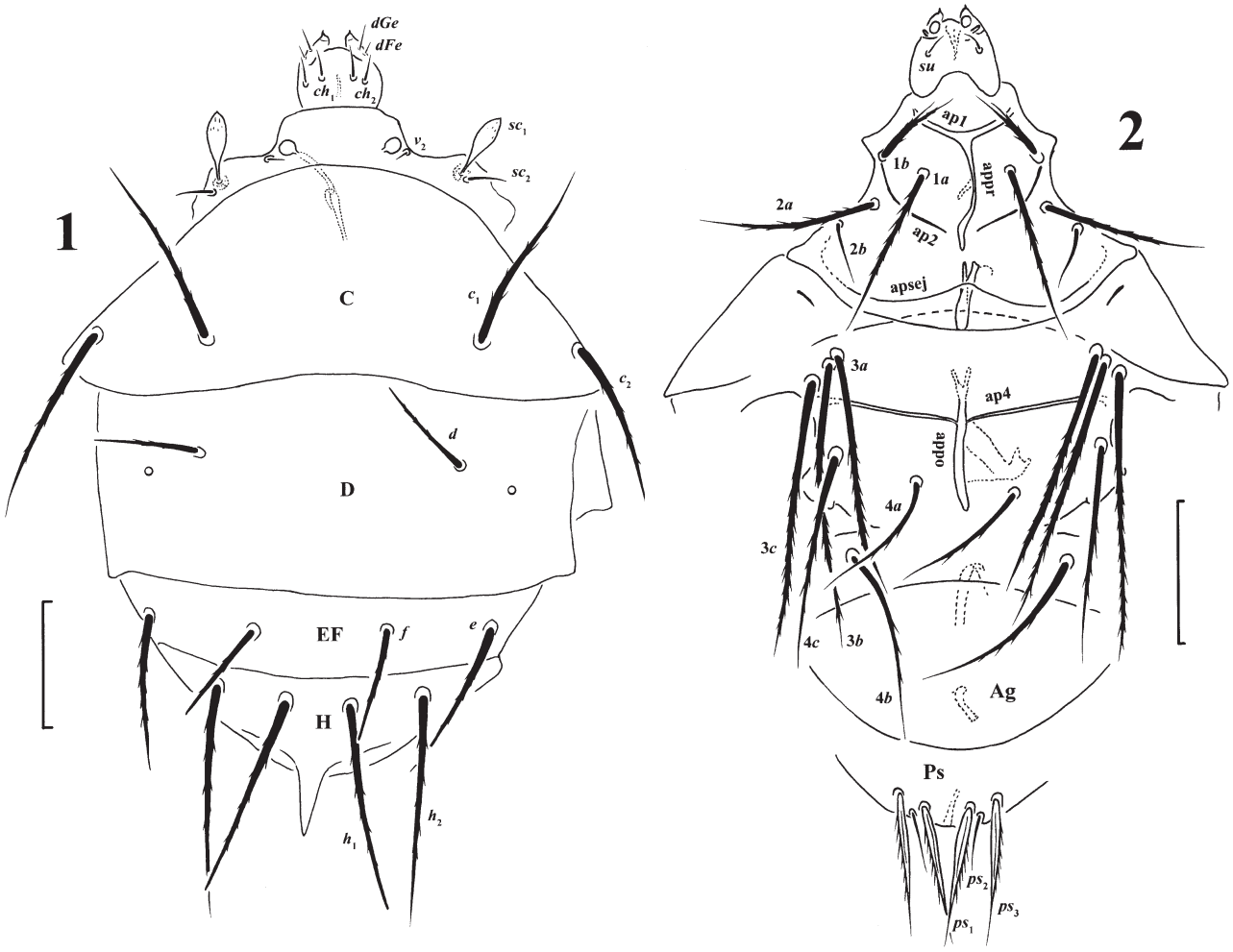
SYSTEMATICS

Family NEOPYGMEPHORIDAE Cross, 1965
Genus *Petalomium* Cross, 1965

Petalomium hofstetteri n. sp.
(Figs. 1-6, 14)

FEMALE - Idiosomal length 266 (244-289), maximum width 213 (177-215).

Dorsal idiosoma (Fig. 1) - Stigmae round. All tergites smooth. Dorsal setae barbed, except short and smooth v_2 and sc_2. Dorsal setae *d*, *f*, and h_1 blunt-ended, other dorsal setae pointed. Posterior margin of tergite H with long process. Length of dorsal setae: v_2 4 (3-5), sc_2 18 (12-18), c_1 85 (81-85), c_2 78 (70-84), *d* 44 (42-45), *e*



Figs. 1, 2. *Petalomium hofstetteri* n. sp. (Female) - 1. dorsum, 2. venter (scale bar = 50 μm).

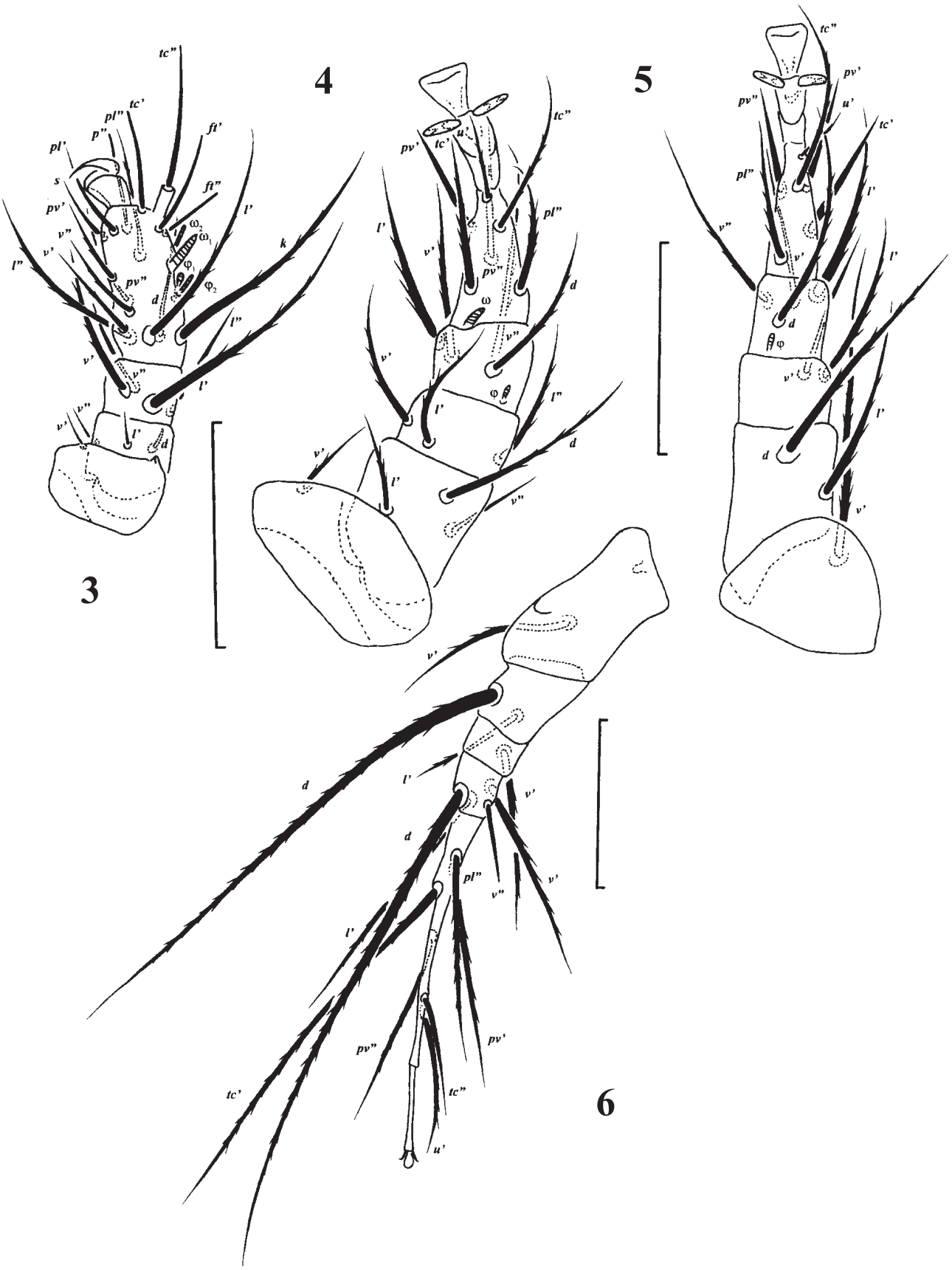
69 (58-69), *f* 44 (43-45), h_1 83 (70-83), h_2 95 (84-95). Distances between dorsal setae: v_2-v_2 50 (47-51), sc_2-sc_2 97 (94-98), c_1-c_1 105 (95-105), c_1-c_2 42 (35-42), *d*-*d* 102 (94-109), *e*-*f* 42 (37-42), *f*-*f* 55 (46-56), h_1-h_1 29 (24-29), h_1-h_2 28 (25-29).

Ventral idiosoma (Fig. 2) - All ventral setae barbed, except smooth ps_2. Presternal apodeme with gap. Apodemes 2 thin, not joined with presternal apodeme. Sejugal apodeme strongly sclerotized, thick. Apodemes 3 vestigial. Apodemes 4 long, reaching to bases of setae 3*c*. Apodemes 5 absent. Setae 1*b* bifurcate. Setae 3*a* and 3*c* situated very close to 3*c*. Posterior margin of posterior sternal plate distinctly concave. Anterior and posterior genital sclerites long and narrow. Setae ps_1 and ps_3 distinctly thickened and flattened. Length of ventral setae: 1*a* 67 (60-68), 1*b* 40 (38-45), 2*a* 67 (64-68), 2*b* 24 (21-25), 3*a* 92 (82-92), 3*b* 100 (90-102), 3*c* 102 (94-104), 4*a* 58 (46-58), 4*b* 76 (63-76), 4*c* 70 (68-72), ps_1 58 (55-63), ps_2 22 (19-23), ps_3 55 (51-56).

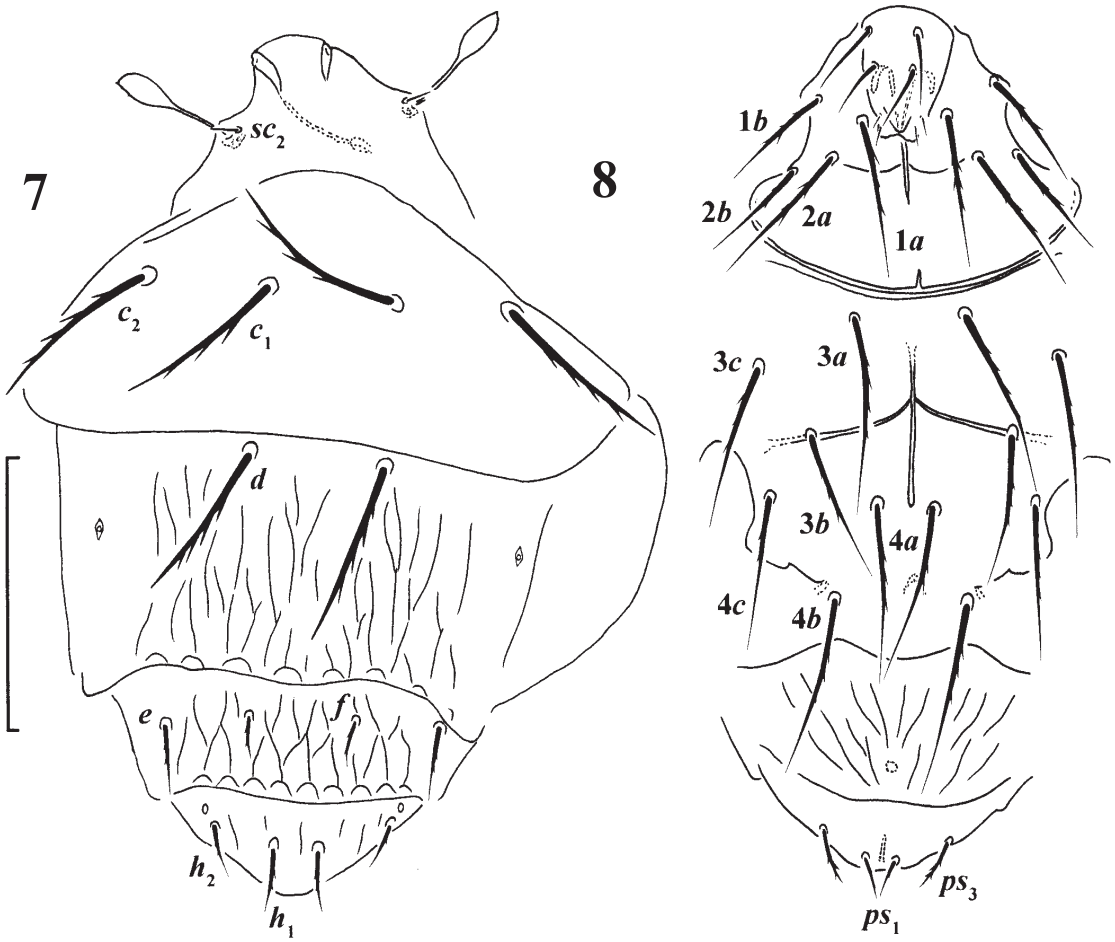
Legs (Figs. 3-6) - Leg I (Fig. 3): Tr1-Fe3-Ge4-TiTa16(4) (number of solenidia in parenthesis), solenidia ω_1 8 (8-9) > ω_2 6 (5-6) = φ_1 6 (5-6) = φ_2 6 (5-7). Solenidion ω_1 finger-shaped. Solenidion φ_1 baculiform. Solenidia ω_2 and φ_2 uniformly thin. Leg II (Fig. 4): Tr1-Fe3-Ge3-Ti4(1)-Ta6(1), solenidion ω 6 (5-6) finger-shaped. Setae *pv'* and *pv"* smooth and slightly widened. Leg III (Fig. 5): Tr1-Fe2-Ge2-Ti4(1)-Ta6, setae *v'TrIII* very long. Setae *pv'* and *pv"* smooth and slightly widened. Leg IV (Fig. 6): Tr1-Fe2-Ge1- Ti4(1)-Ta6. Tarsus long, thin, with long pretarsus and small claws and empodium. Setae *v*" on tibia IV blunt- ended, other setae on leg IV sharply pointed.

MALE, NON-PHORETIC FEMALE AND LARVA - Unknown.

Type material - Female holotype, no. 47810, USA, collected from *Solenopsis invicta*, Pineville, Louisiana, 29 May 2005 (Coll. J. Moser); paratypes: 4 females, no. 47578, 47579, 47812, 47813, with same data as holotype, 1 female, no. 48197 from the same place, 17 June 2005, 1 female, no. 48350 from the same place, 18 June 2005, 1 female, no. 48379 from the same place, 3 July 2005. All type material was collected in Moser's yard, in Pineville, LA at GPS N31.3452° W92.3984°, except no. 46183 collected in Pineville, LA at GIS N45.3981° W92.4706° and



Figs. 3-6. *Petalomium hofstetteri* n. sp. (Female) - 3. legs I, 4. leg II, 5. leg III, 6. leg IV (scale bar = 50 μm).



Figs. 7, 8. *Caesarodispus klepzigi* n. sp. (Female) - 7. dorsum, 8. venter (scale bar = 50 μm).

no. 46923, collected in Pulaski, TN at N35.083066° W86.981746°.

Type depositions - Holotype: Deposited in National Museum of Natural History Entomological Collection, Beltsville, Maryland; USA. Paratypes: with A. Khaustov, Yalta, Crimea, Ukraine. Additional material nos. 46069 and 46183 with E. Ebermann, Graz, Austria; no. 47656 with K. Okabe, Ibariki, Japan; nos. 47578, 47579, 47812, 47813, 48197, 48350, 48379, with H. Klompen, Museum of Biological Diversity, Columbus, Ohio, USA; nos. 47581, 47591, 47607, 47620, 47622, 47624, 47657, 47672, 47723, 47793, 47821, 47899, 47922, 48175, 48198, 48348, 49768, with J. Moser, USDA Forest Service, SRS 4552, Pineville, Louisiana, USA.

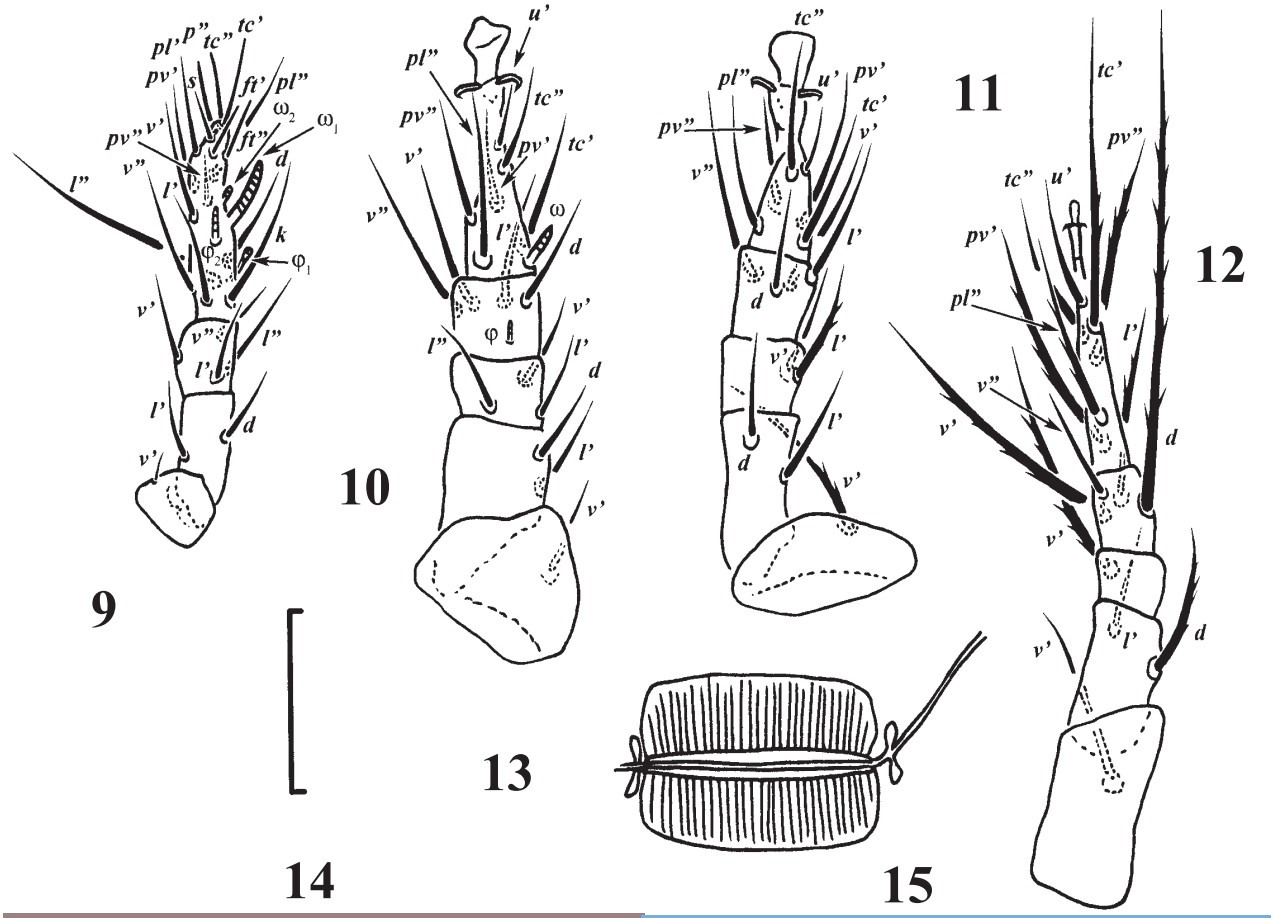
Etymology - This specific name is in honor of Richard W. Hofstetter who has contributed to the knowledge of symbioses of scolytid beetles, fungi, and mites as they relate to bark beetle population outbreak dynamics.

Differential diagnosis - The new species considerably differs from all known *Petalomium* species by the close position of setae 3*a* and 3*b* to the setae 3*c* (3*a* and 3*b* situated far away from setae 3*c* in other species).

ECOLOGY

Phoretic females of the 36 specimens of *Petalomium hofstetteri* were taken from flying alates of RIFA nests in May, June, July, and September (Fig. 16). Although the alates were also most abundant during these months (except September), the absence of mite phoresy in winter suggests that *P. hofstetteri* peak populations are in the spring. This mite was taken from alates that flew from nine of the nests, nos. 3, 7, 9, 11, 12, 13, 18, 19, and 20. Nest nos. 2, 7, 9, 12, 13, and 19 produced only one female. Four other nests, nos. 20, 3, 18, and 11, yielded 2, 4, 6, and 14 females respectively. Hence, it appears that *P. hofstetteri* may have been common in only two or three nests. Twenty mites were taken from female alates, but only seven from the male alates; one mite was taken from a single worker collected from Tennessee. Most females dropped off alates soon after being placed in alcohol or lactophenol. Only ten of 36 remained attached to their phoretic hosts.

Related species from this genus do not appear to be parasitoids or predators, because some species of this genus feed on fungi. This may suggest that *Petalomium*



Figs. 9-13. *Caesarodispus klepzigi* n. sp. (Female) - 9. legs I, 10. leg II, 11. leg III, 12. leg IV, 13. pharynx (scale bar = 20 µm). Fig. 14. *Petalomium hofstetteri* n. sp. (Female) - dorsum, no. 48348, differential interference contrast (scale bar = 100 μm). Fig. 15. *Caesarodispus klepzigi* n. sp. (Female) - dorsum, no. 48172, differential interference contrast (scale bar = 100 μm).

hofstetteri may also be fungivorous (Cross, 1965; Ebermann and Rack, 1982). *Petalomium hofstetteri* and its possible associated fungus or fungi may then play an important nutritional role for RIFA colonies, similar to that of other insects (Klepzig *et al.*, 2001).

Family MICRODISPIDAE Cross, 1965
Genus *Caesarodispus* Mahunka, 1977

Caesarodispus klepzigi n. sp.
(Figs. 7-13, 15)

FEMALE - Idiosomal length 155 (145-183), maximum width 105 (105-110).

Gnathosoma - Dorsally with two long setae. Palps not elongate, with two setae each. Pharynx well sclerotized and wide (Fig. 13).

Dorsal idiosoma (Fig. 7) - Stigmae oval. Tergites D, EF, and H with distinct microsculpture as on Fig. 7. Dorsal setae barbed, except short and smooth sc_2. Dorsal setae c_1, c_2, and *d* blunt-ended, other dorsal setae pointed. Length of dorsal setae: sc_2 6 (6-8), c_1 33 (32-36), c_2 36 (36-37), *d* 35 (33-36), *e* 14 (13-14), *f* 11 (11-12), h_1 14 (14-17)), h_2 12 (12-13). Distances between dorsal setae: sc_2-sc_2 28 (26-28), c_1-c_1 22 (22-24), c_1-c_2 18 (18-20), *d*-*d* 24 (24-25), *e*-*f* 16 (14-16), *f*-*f* 17 (17-20), h_1-h_1 9 (9-10), h_1-h_2 12 (10-12).

Idiosomal venter (Fig. 8) - All ventral setae barbed. Presternal apodeme with distinct gap. Apodemes 2 very thin, joined with presternal apodeme. Sejugal apodeme strongly sclerotized, arch-like. Apodemes 3 absent. Apodemes 4 long, reaching beyond setae 3*b*. Apodemes 5 absent. Posterior margin of posterior sternal plate distinctly convex in middle part. Aggenital plate with distinct longitudinal microsculpture. Setae ps_2 absent. Length of ventral setae: 1*a* 23 (23-26), 1*b* 20 (20-22), 2*a* 29 (29-30), 2*b* 18 (18-20), 3*a* 31 (31-33), 3*b* 26 (26-28), 3*c* 27 (27-28), 4*a* 32 (31-33), 4*b* 31 (31-33), 4*c* 27 (27-30), ps_1 9 (9-11), ps_3 11 (11-12).

Legs (Figs. 9-12) - Leg I (Fig. 9): Tr1-Fe2-Ge4-TiTa16(4) (number of solenidia in parenthesis), setae *v"* absent on femur I, solenidia ω_1 8 (8-9) > ω_2 3 (3-4) < φ_1 6 (5-6) > φ_2 4 (4-5). Solenidion ω_1 finger-shaped. Solenidion φ_1 baculiform. Solenidia ω_2 and φ_2 uniformly thin. Leg I distinctly shorter than leg II. Tibiotarsus I without claw. Leg II (Fig. 10): Tr1-Fe2-Ge3-Ti4(1)-Ta6(1), setae *v"* absent on femur II, solenidion ω 6 (6-7) finger-shaped. Leg III (Fig. 11): Tr1-Fe2-Ge2-Ti4-Ta6. Tarsi II and III with simple equal claws. Leg IV (Fig. 12): Tr1-Fe2-Ge1-Ti4-Ta6. Tarsus with short pretarsus and small claws and empodium.

MALE AND LARVA - Unknown.

Type material - Female holotype, no. 48431, USA, collected from *Solenopsis invicta*, Pineville, Louisiana, 8 July 2005 (Coll. J. Moser); paratype: 1 female, no. 48345 from the same place, 18 June 2005, 1 female, no. 48392 from the same place, 3 August 2005, 1 female, no. 48177 from the same place, 7 June 2005. Holotype, paratypes, and additional material were collected in Pineville LA at GPS N31.3452° W92.3984°.

Type depositions - Holotype: Deposited in National Museum of Natural History Entomological Collection, Beltsville, Maryland; USA. Paratypes: With A. Khaustov, Yalta, Crimea, Ukraine. Additional material, nos. 48172, 48184, 48389, 48430, with J. Moser, USDA Forest Service, SRS 4552, Pineville, Louisiana, USA.

Etymology - This specific name is dedicated to Kier D. Klepzig who has contributed to the knowledge of complex interactions of symbiosis and competition among insects, fungi, and mites.

Differential diagnosis - The new species is most similar to *C. gaius* Mahunka, 1977, but differs by having setae c_1, c_2, and *d* almost 3 times longer than *f* (subequal in *C. gaius*), and by the solenidion ω_2 more than 2 times shorter than ω_1 (subequal in *C. gaius*).

Remarks - Mahunka (1977) described the genus *Caesarodispus* without including a description of leg chaetotaxy for its type species *C. gaius*. The study of leg chaetotaxy of *C. klepzigi* shows that it has only two setae on each femora I and II. This character previously has never been found in the mite family Microdispidae and, therefore, the placement of *C. klepzigi* in the genus *Caesarodispus* is tentative.

ECOLOGY

Phoretic females of the nine individuals of *Caesarodispis klepzigi* were taken from flying alates of RIFA nests in May, June, July, and August, but were most common during June and July (Fig. 16). This mite was taken from alates of four nests, but mostly (5 females) from only one of the nests. Individual mites were only weakly attached to their alate hosts; all had detached from the alates, and were found in the alcohol or lactophenol sediments. Three had ridden on females and seven on males, but none were seen on workers. Although the biology of *C. klepzigi* is unknown, other microdispids may feed on fungi, feeding habits possibly similar to those of scutacarids (Cross, 1965; Kaliszewski *et al*., 1995). This suggests that the presence of *C. klepzigi* and its possible associated fungus or fungi may play an important nutritional role for RIFA colonies, similar to that of other insects (Klepzig *et al*., 2001).

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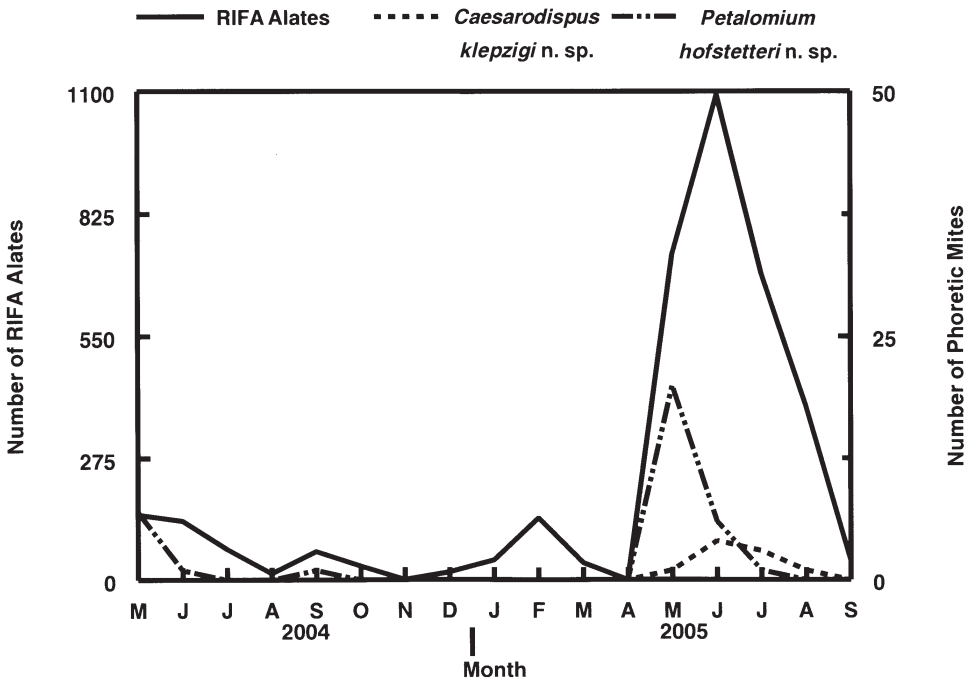

Fig. 16. Monthly totals of RIFA alates and phoretic females of *Petalomium hofstetteri* n. sp. and *Caesarodispus klepzigi* n. sp.

REFERENCES

Cross, E. A. 1965. The generic relationships of the family Pyemotidae (Acarina, Trombidiformes). Univ. Kansas Sci. Bull. 45: 29-215.

Ebermann, E. and J. C. Moser. 2008. Mites (Acari: Scutacaridae) associated with the red imported fire ant, *Solenopsis invicta* Buren (Hymenoptera: Formicidae), from Louisiana and Tennessee, U.S.A. Internat. J. Acarol. 34(1): 55-69.

Ebermann, E. and G. Rack. 1982. Zur Biologie einer neuen myrmecophilen Art der Gattung *Petalomium* (Acari, Pygmephoridae). Entomol. Mitt. aus dem Zool. Mus. Hamburg 7(115): 175-192.

Kaliszewski, M., F. Athias-Binche and E. E. Lindquist. 1995. Parasitism and parasitoidism in Tarsonemina (Acari: Heterostigmata) and evolutionary considerations. Advan. Parasitol. 35: 335-367.

Khaustov, A. A. 2004. Mites of the family Neopygmephoridae Cross, 1965 stat. n. and their position in Heterostigmata. pp 137. *In:* Russian Academy of Sciences (Ed.), VIII Russian Acarological Conference, St.-Petersburg. Zoological Institute of RAS, St.-Petersburg (in Russian).

Khaustov, A. A. 2005. A new species and records of the genus *Petalomium* (Acari: Heterostigmata: Pygmephoridae) from Crimea (Ukraine). Acarina 13(2): 173-179.

Klepzig, K. D., J. C. Moser, M. J. Lombardaro, M. P. Ayres, R. W. Hofstetter and C. J. Walkinshaw. 200l. Mutualism and antagonism: ecological interactions among bark beetles, mites, and fungi. pp. 237-269. *In*: Jeger, M. J. and. H. J. Spence. (Eds). Biotic interactions in plant-pathogen associations. CABI Publishing. New York.

Lindquist, E. E. 1986. The world genera of Tarsonemidae (Acari: Heterostigmata): a morphological, phylogenetic, and systematic revision, with a reclassification of family-group taxa in Heterostigmata. Mem. Entomol. Soc. Canada 136: 1-517.

Mahunka, S. 1977. Neue und interessante Milben aus dem Genfer Museum. XIX. Einige Angaben zur Kenntnis der Milbenfauna der Ameisennester (Acari: Acarida, Tarsonemida). Arch. Sci. Gen. 30(1): 91-106.

Tschinkel, W. R. 2006 The Fire Ants. The Belknap Press of Harvard University. Cambridge, MA. 723 pp.

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