A NEW GENUS AND SPECIES OF ACARIDAE (ACARI) PHORETIC ON *THECTOCHLORA ALARIS* (HYMENOPTERA: HALICTIDAE: AUGOCHLORINI) FROM SOUTH AMERICA

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ABSTRACT - A new genus and species of mite, *Thectochloracarus neotropicalis* gen. and sp. nov. (Acari: Acaridae), is described and figured from the deutonymphal stage (= hypopus). The mite is phoretic on the augochlorine bee, *Thectochlora alaris* (Vachal) (Hymenoptera: Halictidae: Augochlorini), collected in Argentina, Brazil, Bolivia, Guyana and Paraguay. The mites were found in a well developed acarinarium present on the anterior lower third of the first metasomal tergum of female bees. The modification of the bee's morphology for the transport of phoretic instars indicates an association between the mites and the bees which is probably mutualistic.

Key words - Acari, Acaridae, phoretic mites, Apoidea, Augochlorini, Argentina, Bolivia, Brazil, Guyana, Paraguay.

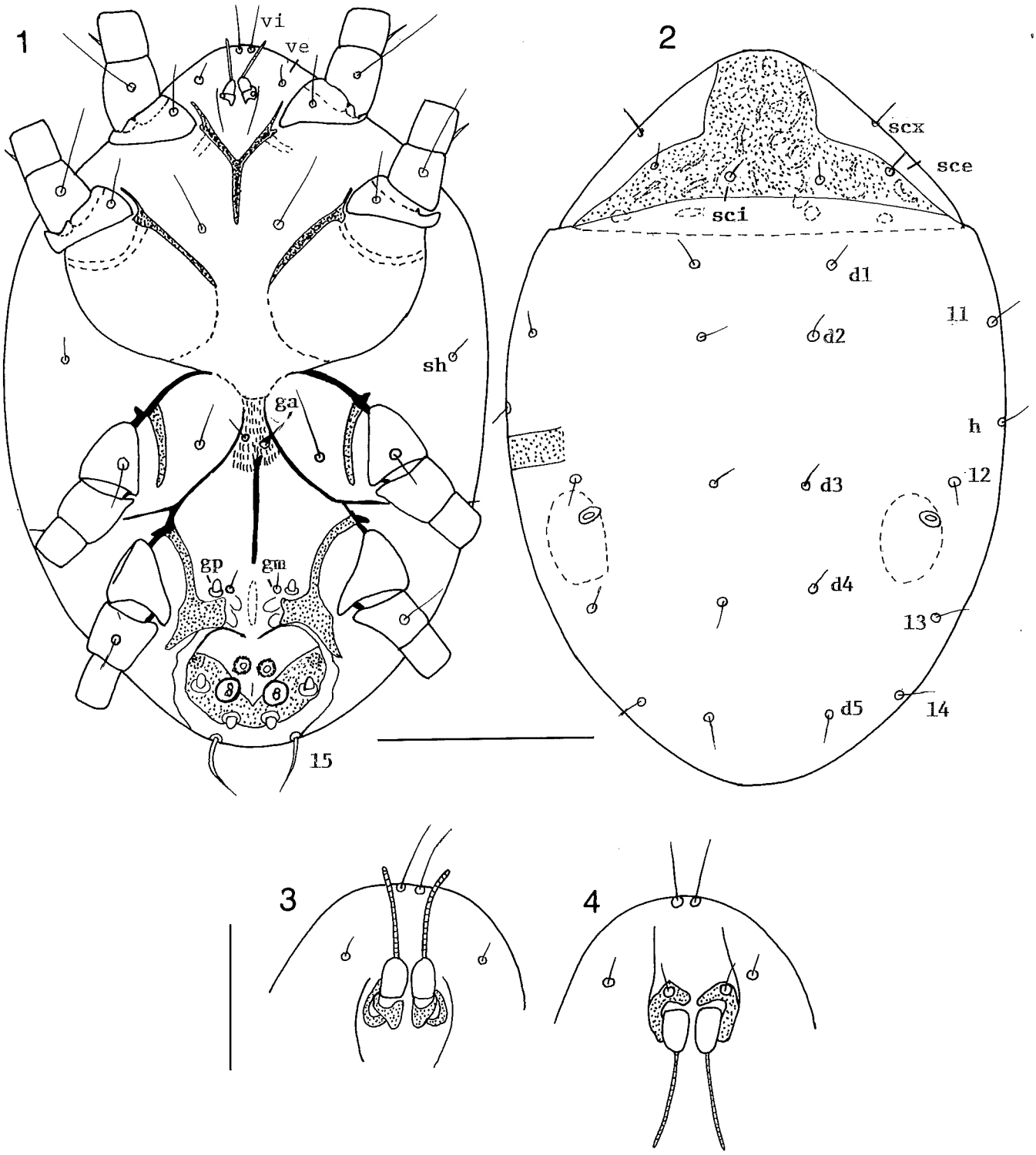
INTRODUCTION

The association between mites and bees of the family Halictidae is well documented, albeit poorly understood. Halictidae is a diverse group of relatively primitive bees which occur throughout the world. Three subfamilies are recognized: Halictinae, Nomiinae, and Rophitinae of which only the first two have had recorded associations with mites (Table 1). The Halictinae has the most species of these subfamilies and is further divided into three tribes: the Neartic and Neotropical Augochlorini, the cosmopolitan Halictini, and Nomioidini in the eastern hemisphere . No mites are presently recorded from species of Nomioidini.

Six families of mites belonging to three different suborders (Astigmata, Mesostigmata, and Prostigmata) are involved in this association (Table 1). Mites are even reported on fossil halictid bees from theTertiary amber (Engel, 1996). Up till now 17 genera and 29 species of mites have been recorded from these bees. Species in four monotypic genera (*Halictacarus*, *Laelaspoides*, *Nasutiscutacarus* and *Thectochloracarus*) are confined to their halictid hosts (Table 1). Species of *Trochometridium* areprimarily associated with Halictidae but have also been found associated with other Hymenopteran groups (Cross and Bohart, 1979; Neff and Rozen, 1995).

The mites of the families Histiostomatidae (= Anoetidae), Acaridae, and Hemisarcoptidae produce a modified and specialized deutonymph, also called hypopus. This stage has vestigial mouth and is thus unable to feed. The hypopus bears two pairs of suckers on its ventral surface for attachment to the insect host. These modified deutonymphs are phoretic and have no pathogenic role. The adults of these hypopi live in the nests of the bees where they are either scavengers, commensals, or mutualists.

The mites of the families Scutacaridae and Pygmephoridae do not produce phoretic deutonymphs and it is the female that is phoretic. All mite stages are present in the nest of the bee. In the nest, scutacarids feed mainly on fungi. Thus, they are mutualistic or, in some unusual circumstances, kill the eggs of the bees. Species



Figs. 1-4. *Thectochloracarus neotropicalis* gen. and sp. nov., deutonymph - 1. Venter, 2. Dorsum, 3. Palps in normal position, 4. Palps in retroflexion. Scale line 100 μm (Figs. 1-2) and 25 μm (Figs. 3-4).

of the genus *Parapygmephorus* do not cause any harm to the bees while the females of *Trochometridium tribulatum* Cross are reported to kill the immature bees and feed upon them (Eickwort, 1979).

Mites of the suborder Mesostigmata are typically phoretic as either deutonymphs (e.g. Uropodina, Parasitidae) or adult females (e.g. Dermanyssoidea). In *Laelaspoides ordwayae* Eickwort, the only mesostigmatid known from Halictidae, adult females are phoretic and all life stages of the mites are found in the nest of the bees. Individuals feed on the pollen mass but do not harm the developing bees (Eickwort, 1979).

Herein we describe a new genus and a new species, *Thectochloracarus neotropicalis* gen. and sp. nov. (Acari: Astigmata: Acaridae), represented by its deutonymphal stage (= hypopus). This mite was collected from the augochlorine bee, *Thectochlora alaris* (Vachal) in northern Argentina, Brazil, and Guyana. This is the sixth augochlorine bees which is associated with mites; the other Augochlorini species are *Augochlora cordiaefloris* Cockerell, *Augochlorella persimilis* (Viereck), *A. striata* (Provancher), *Oligochlora eickworti* Engel, and *O. micheneri* Engel. All the mites on *T. alaris* occupied a well developed acarinarium located on the anterior lower third of the first metasomal tergum (Figs. 9-11). Setal nomenclature of the idiosoma follows that proposed by Fain (1963). All measurements in description are given in micrometers (μm).

SYSTEMATICS

Thectochloracarus gen. nov.

Type species - *Thectochloracarus neotropicalis* spec. nov. This species is represented by the deuto-nymphal stage only.

Diagnosis - *Dorsum* - With two punctate shields. Propodonotal shield abruptly narrowed in anterior half, posterior part wide and nearly reaching lateral margins of body, more sclerotized than posterior shield and with indistinct pattern of short lines. Hysterosoma with finely punctate shield and without line pattern. Both shields with very thin, with short setae. *Venter* - Coxae II and III forming incompletely closed fields, distinctly separated along midline by sclerotized and striated area, bearing setae *ga* and prolonged posteriorly by a longitudinal sclerite. Coxal setae I and III and setae *ga* and *gm* thin, setae *gp* conoides; scutorial plate with lateral conoides at same level as posterior suckers. *Palposoma*: With two bisegmented palps (length 12) articulating at each side, with very short, sclerotized basal plate bearing short seta. *Legs* - Tarsi I to IV with well developed claw; with 7-7-8-8 setae, of which 3-3-6-5 foliate and two (tarsi I and II) spoonlike (Figs. 5-8). *Solenidia* - Tarsi I with ω*2* relatively long, ω*3* in the apical third of tarsus. Genu I with σ*1* long, σ*2* present, ranging from vestigial to long.

Etymology - The new genus-group name is a combination of the names *Acarus* (meaning "mite") and *Thectochlora* (the name of the host bee).

Remarks - The genus *Thectochloracarus* (deutonymphs) differs from the other allied acarid genera (e.g., *Acarus*, *Kuzinia*, *Lackerbaueria*, and *Schulzea*) by the following characters: different shape of epimera, structure of the palposoma, shape of the anterior dorsal shield, and the chaetotaxy of the tarsi. It superficialyy resembles the genus *Halictacarus*, described from the bee genus *Halictus* in South Africa but differs from it by several important characters i.e. the different shape of the palposoma, the presence of only one pair of conoides among the coxal and genital setae, the shape of epimera II and III, and the chaetotaxy of the tarsi. The palposoma in *Halictacarus* is formed by a large base prolonged by two small palps, setae of coxae I are conoides, epimera II to IV are free, the chaetotaxy of the tarsi is very different (foliate setae on tarsi I-IV: 3-2-2-0), and tarsus IV ends in a very small claw and a strong apical seta.

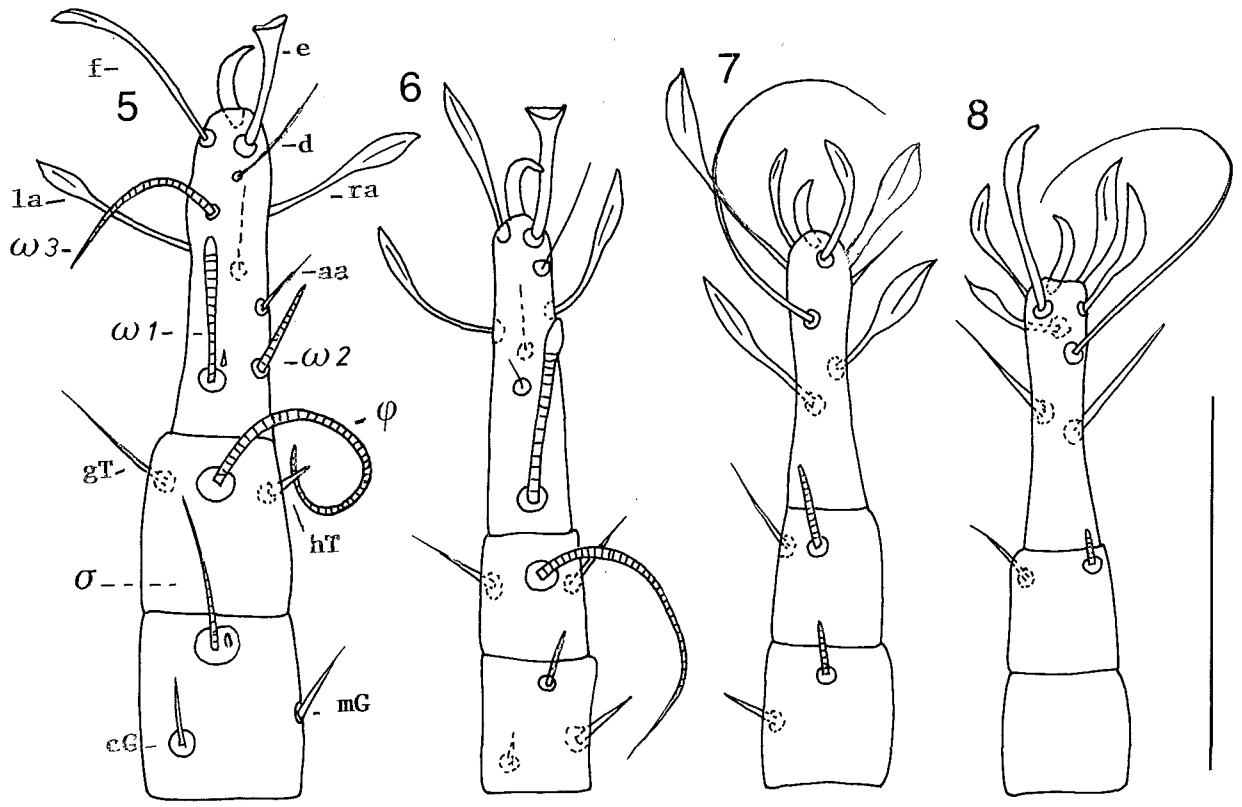
The term "conoide" used here is a new name proposed by Fain (1973) for modified setae located on the suctorial plate. They are conical, soft and collapsible structures with concentric thickenings. Possibly they act as elastic buffers facilitating the release of the mite when it detaches from the host. They have been redescribed in detail recently (Fain and Erteld, 1998).

Thectochloracarus neotropicalis spec. nov. (Figs. 1-11)

Diagnosis - As for the genus.

Description (Deutonymph) - Length and width of idiosoma on holotype: 290 x 204; in four paratypes from the same locality as holotype: 330 x 230, 304 x 195, 295 x 195, 275 x 206; in four paratypes from Curitiba (Brazil): 300 x 225, 305 x 228, 315 x 220, 298 x 231; in four paratypes from Argentina: 310 x 225, 306 x 216, 296 x 225, 294 x 210. *Dorsum* - Lengths of setae: *vi* 22, *ve* 6 (ventral), *sci* and *sce* 10, *d1* to *d5* 8 to 10, *l1* to *l4* 8-10, *l5* 25, *h* and *sh* 8-10, *scx* 20. *Solenidia* - Tarsus I: ω*1* 20, ω*2* 12, ω*3* 25. Tarsus II: ω*1* 25. Suctorial plate 22 wide, diameter of anterior suckers 9-10, of posterior suckers 13-14. Lengths of tarsi I-IV (pretarsi excluded): 38-40-34-35. Setae *d3* in holotype hidden in a deep transverse fold of dorsal cuticle.

Hosts and Localities - All specimens were collected from the augochlorine bee, *Thectochlora alaris* (Vachal). *Holotype*: Hypopus from São Paulo, Brazil (bee collected in 1964). *Paratypes*: Five deutonymphs with same data



Figs. 5-8. *Thectochloracarus neotropicalis* gen. and sp. nov., deutonymph - 5. Leg 1, 6. Leg 2, 7. Leg 3, 8. Leg 4, all legs in dorsal view. Scale line 25 μm.

as holotype; 6 deutonymphs from Varginha, Brazil (24 April 1966); 11 deutonymphs from Waranama, Guyana (November 1936); 20 deutonymphs from Argentina, 4 km N. El Carril (10 November 1966). All these mites were collected by M. S. Engel. We have also identified this species among deutonymphs collected from the same host in Curitiba, PR, Brazil (7 February 1981) by Dr. C. H. W. Flechtmann, University of São Paulo, and sent to the senior author for identification. All vouchered hosts of mites are deposited in the respective countries. Representative bees are in the collections of the American Museum of Natural History, the University of Kansas, the Cornell University Insect Collection, and the United States National Museum.

Additional specimens (non-paratypes) have been recorded from *T. alaris* from the following localities. Host bees are labelled with voucher numbers (BMOC or GCE) and are housed in the University of Kansas Natural History Museum, Snow Entomological Division, Lawrence, Kansas (KU) or the Cornell University Insect Collection, Ithaca, New York (CUIC).

ARGENTINA - Salta Prov., Pocitor, October 1949, A.F. Prosen, KU, BMOC 96-0916-116; Buenos Aires Pr., Punta Lara, 34°49'S, 57°59'W, 20 February 1952, J. Foerster, KU, BMOC 96-0916-117; Cordoba Prov., Sierra Paz, 800 m., 22 March 1951, J. Foerster, KU, BMOC 96-0916-117.

BOLIVIA - Santa Cruz, Santiago, December 1959, KU, BMOC 96-0916-119; Santa Cruz, Santiago, November 1959, KU, GCE 64-1025-13, BMOC 96-0916-120; Santa Cruz, Santiago, November 1959, KU, GCE 64-1020-11, BMOC 96-0916-121.

BRAZIL - Sao Paulo, Rio Claro, 22°24'S, 47°33'W, March 1939, KU, BMOC 96-0916-108; Paraná, Araucaria, 25°35'S, 49°25'W, 12 January 1955, J. Moure and C. Michener, KU, BMOC 96-0916-110; Paraná, Curitiba, 25°25'S, 49°15'W, 14 December 1955, Michener and Lange, KU, GCE 64-1015-4, BMOC 96-0916-111; Minas Gerais, Varginha, 21°33'S, 45°26'W, January 1960, Alvarenga and Seabra, KU, BMOC 96-0916-112; Pará, Belem, Aurá, 1027'S, 48°29'W, 22 November 1955, Michener and Moure, KU, BMOC 96-0916-113; Pará, Belem, Aurá, 1027'S, 48°29'W, 22 November 1955, Michener and Moure, KU, GCE 64-1014-6, BMOC 96-0916-114; Pará, Belem, Aurá, 1027'S, 48°29'W, 22 November 1955, Michener and Moure, KU, BMOC 96-0916-115.

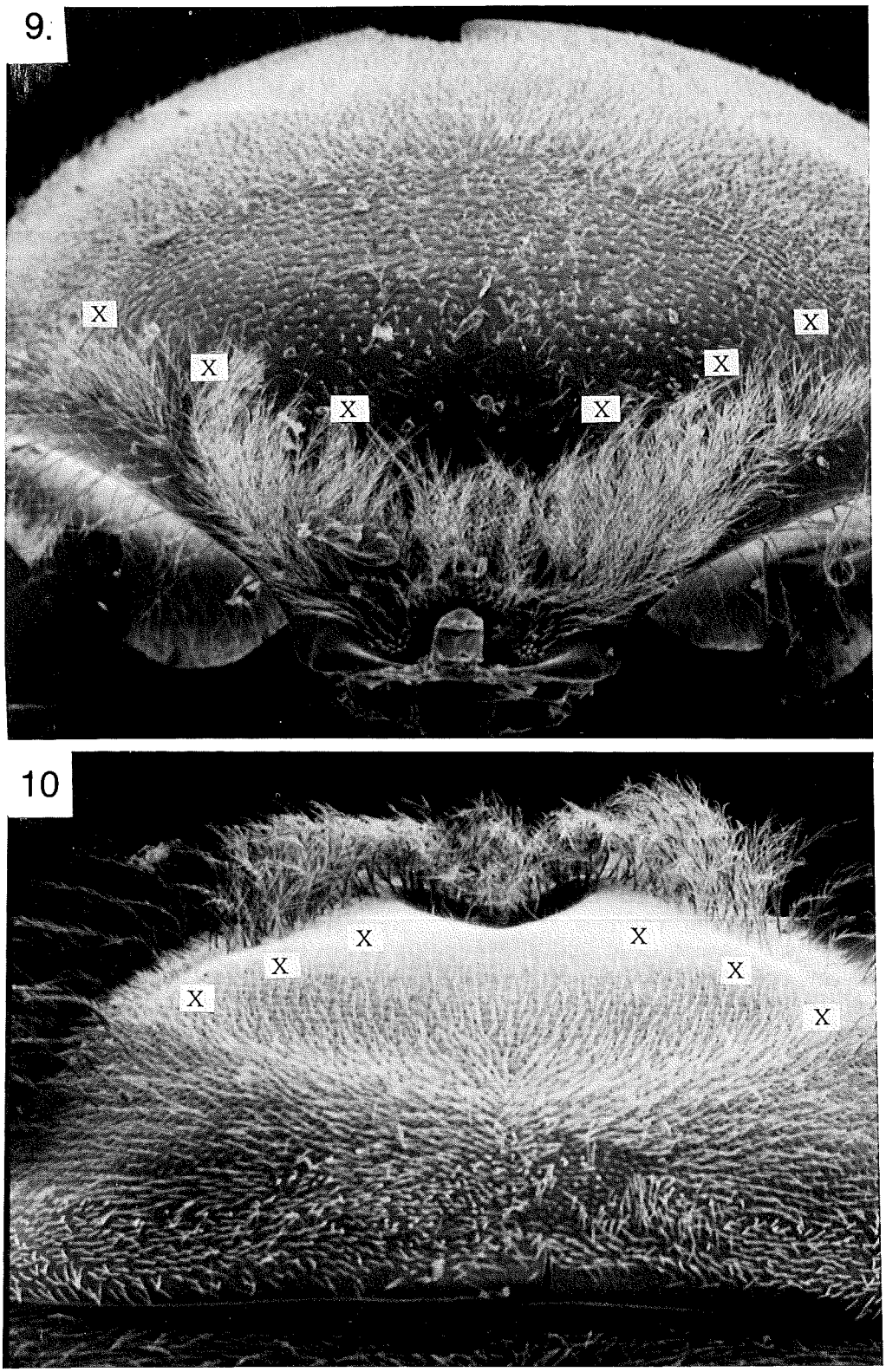
Table 1. Mites associated with bees of the family Halictidae.

MITES	HOSTS	LOCALITY	REFERENCES
ASTIGMATA			
— HISTIOSTOMATIDAE (=Anoetidae)			
Anoetus alicola (Dujardin, 1849)	*Lasioglossum quadrinotatum*	Europe	Woodring, 1973
Anoetus debilis Woodring, 1973	*Dialictus umbripennis*	Costa Rica	Woodring, 1973
Anoetus ligulotrichus Mahunka, 1974	*Halictus ligulotrichus*	?	Mahunka, 1974
Anoetus orientalis Mahunka, 1974	*Halictus tetrazonianellus*	?	Mahunka, 1974
Anoetus szelenyi Mahunka, 1974	*Halictus holtzi*	Afghanistan	Mahunka, 1974
Anoetus tuniziensis Mahunka, 1974	*Halictus* sp.	Tunisia	Mahunka, 1974
Anoetus vexarus Woodring, 1973	*Dialictus zephyrus*	USA	Woodring, 1973
Anoetus sp.	*Dialictus lineatulus*	USA	Eickwort, 1979
Glyphanoetus nomiensis Cross, 1968	*Nomia melanderi*	USA	Cross, 1968
	Nomia nortoni	USA	Cross, 1968
Histiostoma eickworti Woodring, 1973	*Augochlora cordiaefloris*	Costa Rica	Woodring, 1973
Histiostoma halicticola Fain and Erteld, 1998	*Halictus sexcinctus*	Germany	Fain and Erteld, 1998
Histiostoma halictonida Woodring, 1973	*Halictus rubicundus*	USA	Woodring, 1973
— ACARIDAE			
Halictacarus halicti Mahunka, 1975	*Halictus* sp.	South Africa	Mahunka, 1975
Rhizoglyphus sp.	Halictid bee	?	Eickwort, unpubl. data
Sancassania boharti (Cross, 1968)	*Nomia melanderi*	USA	Cross, 1968
Sancassania sp.	*Lasioglossum leucozonium*	USA	Eickwort, 1979
	Agapostemon radiatus	USA	Eickwort, 1979
Schulzea zachvatkini Delfinado and Baker, 1976a	*Halictus* sp.	India	Delfinado and Baker, 1976a
Schulzea sp.	*Halictus* sp.	?	OConnor, 1988
	Thectochlora alaris	?	OConnor, 1988
Thectochloracarus neotropicalis gen. *et* sp. nov.	*Thectochlora alaris*	Argentina, Brazil, Bolivia, Paraguay, Guyana	Present study
— HEMISARCOPTIDAE (?)			
"*Nanacarus*" *nominis* Woodring, 1966	*Nomia melanderi*	USA	Woodring, 1966
— FAMILY ?			
Unidentified genus and species	*Oligochlora eickworti*	Dominican amber	Engel, 1996
	Oligochlora micheneri	Dominican amber	Engel, 1996

Table 1. Continued.

MITES	HOSTS	LOCALITY	REFERENCES
PROSTIGMATA			
— SCUTACARIDAE			
Imparipes apicola (Banks, 1914)	*Dialictus* spp.	USA	Delfinado and Baker, 1976b
	Evylaeus quebecensis	USA	Delfinado and Baker, 1976b
	Lasioglossum sp.	Mexico	Delfinado and Baker, 1976b
Imparipes floridensis Delfinado and Baker, 1976b	*Halictus ligatus*	USA	Delfinado and Baker, 1976b
Imparipes ithacensis Delfinado and Baker, 1976b	*Dialictus rohweri*	USA	Delfinado and Baker, 1976b
Imparipes mexicanus Delfinado and Baker, 1976b	*Evylaeus* sp.	Mexico	Delfinado and Baker, 1976b
Imparipes neotropicus Delfinado and Baker, 1976b	*Dialictus* sp.	Chile	Delfinado and Baker, 1976b
Imparipes vulgaris Delfinado and Baker, 1976b	*Lasioglossum titusi*	USA	Delfinado and Baker, 1976b
Nasutiscutacarus ampliatus Beer and Cross, 1960	*Nomia* sp.	Philippine Islands	Beer and Cross, 1960
Nasutiscutacarus anthrenae Beer and Cross, 1960	*Nomia strigata*	Indonesia	Beer and Cross, 1960
Scutacarus eickworti Delfinado and Baker, 1976b	*Dialictus nymphaearum*	USA	Delfinado and Baker, 1976b
— PYGMEPHORIDAE			
Parapygmephorus costaricanus Rack and Eickwort, 1979	*Agapostemon nasutus*	Costa Rica	Rack and Eickwort, 1979
		Mexico	Cross, 1965
Parapygmephorus halictinus Cross, 1965	*Agapostemon virescens*	USA	Cross, 1965
Siteroptes cerealium Kirchner, 1864	*Halictus senilis*	Egypt	Mohamed and Soliman, 1976
— TROCHOMETRIDIIDAE			
*Trochometridium tribulatum** Cross, 1965	*Halictus farinosus*	USA	Cross, 1965
	Nomia melanderi	USA	Cross, 1965
	Sphecodes arvensiformis	USA	Cross, 1965
MESOSTIGMATA			
— LAELAPIDAE			
Laelaspoides ordwayae Eickwort, 1966	*Augochlorella persimilis*	USA	Eickwort, 1966
	Augochlorella striata	USA	Eickwort, 1966

*This species has also been found on a non-halictid bee in the USA: *Calliopsis andreniformis* (Andrenidae: Panurginae: Calliopsini) (Cross, 1965).



Figs. 9-10. Acarinarium of *Thectochlora alaris* female (scanning electron micrographs) - 9. Anterior view of first metasomal tergum with mites removed, 10. Dorsal view of first metasomal tergum with mites removed (X= sites of the mites).

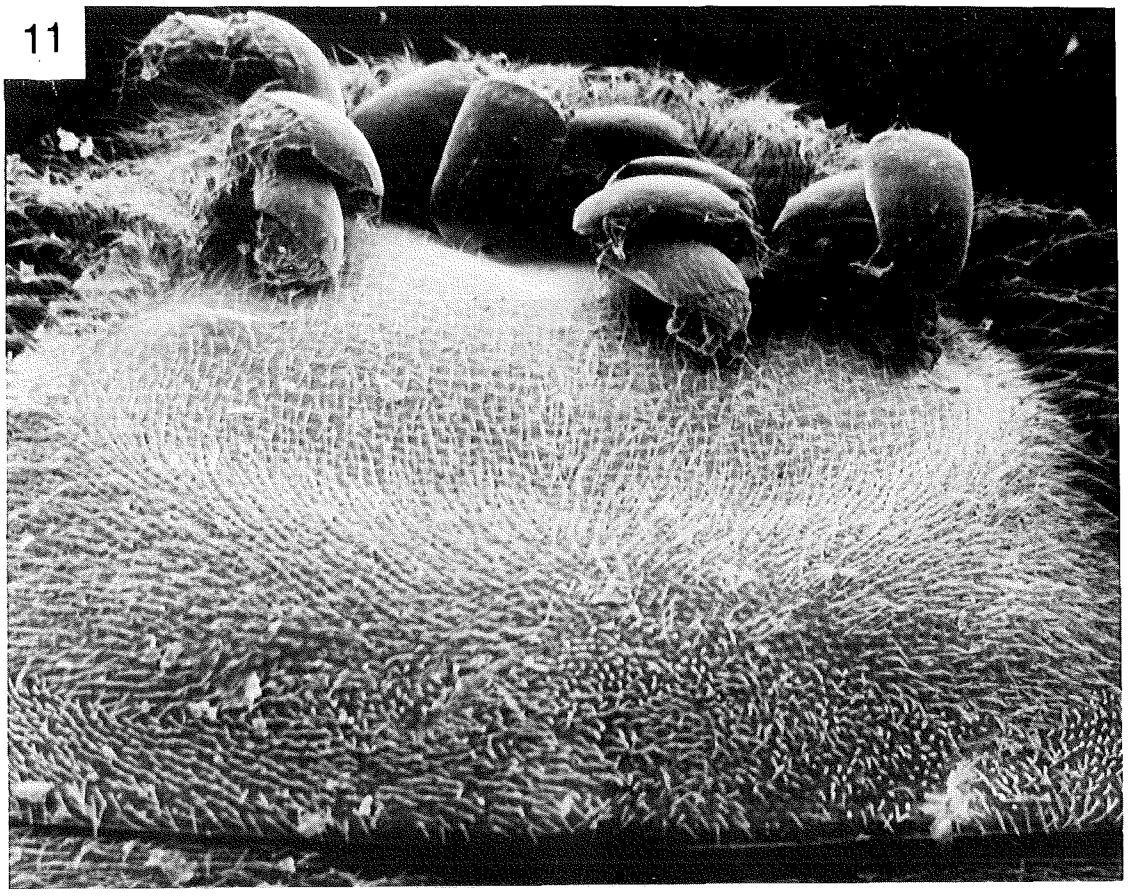


Fig. 11. Acarinarium of *Thectochlora alaris* female (electron micrograph), dorsal view of first metasomal tergum with mites present.

PARAGUAY - Dept. Guaira, Villarriica, 25°45'S, 56°26'W, January 1938, F. Schade, CUIC, BMOC 79-1123-001; "Casguazu Paso Yobay 280M," December 1950, J. Foerster, KU, BMOC 96-0916-109.

Holotype and five paratypes in the U. S. National Museum, Washington, D. C., USA; six paratypes in the University of São Paulo, São Paulo, Brazil; five paratypes in the American Museum of Natural History, New York, USA; remaining paratypes in Institut royal des Sciences naturelles de Belgique, Brussels, Belgium and the Museum of Zoology, University of Michigan, Ann Arbor.

Etymology - The specific epithet refers to the distribution of this species in the New World tropics.

DISCUSSION

The bee genus *Thectochlora* is one of 41 genera and subgenera in the halictine tribe Augochlorini of the New World (Engel, 1998, 1999). Among the augochlorines only the genera *Thectochlora* and *Oligochlora* are known to possess acarinaria. In both cases these structures are developed on the anterior surface of the first metasomal tergum of females (Figs. 9-11). Acarinaria are not present in males. The acarinarium consists of a gently concave area on the lower third of the anterior-facing surface of the first metasomal tergum. It is identical in form to acarinaria found in the halictine genus *Lasioglossum* as described by McGinley (1986) which typically harbor mites of the genus *Anoetus* (Histiostomatidae). This concavity is ventrally bordered by long, plumose setae with their apices oriented dorsally (Fig. 9). The surface of the integument in the concavity tends to be sparsely punctate or entirely smooth while the remainder of the tergum is more densely punctured. All of the punctures are relatively small. Beside the long, plumose setae demarcating the ventral margin of the acarinarium, the tergal surface is scattered with minute, simple setae. Most females of *T. alaris* encountered in the field are infested with at least a few mites. No study has examined in detail the in-nest association of *Thectochlora* and *Thectochloracarus*. The modification of the bee's anatomy for the transport of phoretic instars, however, suggests that the association of *Thectochlora* and *Oligochlora* with their mites is a mutualistic one. The presence of an acarinarium in the extinct

genus *Oligochlora* implies that the association between augochlorines and mites is quite ancient, at least as old as the Oligocene but undoubtedly much older (Engel, 1996). *Thectochlora* presently contains a single species which is distributed from northern Argentina, to Bolivia, Paraguay, Brazil and as far north as southern Guyana and Suriname. The mite occurs throughout the range of its host bee, although not every host individual we examined harbored mites.

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