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THREE NEW SPECIES OF MACROCHELES
(ACARI : GAMASIDA : MACROCHELIDAE)
ASSOCIATED WITH 3-TOED SLOTHS, BRADYPUS SPP.
(EDENTATA : BRADYPODIDAE), IN BRAZIL AND SURINAM

BY G. W. KRANTZ*

ABSTRACT: Descriptions are presented of three new species of Macrocheles collected from 3-toed sloths (Bradypus spp.) and/or from scarabaeine beetles associated with these arboreal edentates. The position of the mites in the sloth-scarab system is discussed.

INTRODUCTION

Mites of the family Macrochelidae often are phoretic on insects, especially on coprophagous and necrophagous beetles and flies (KRANTZ 1978). Some species have established phoretic associations with mammals, but macrochelid-mammal liaisons generally involve nidicoly rather than phoresy (BREGETOVA and KOROLEVA 1960). During the course of an investigation on mite ectoparasites of Surinam mammals by Dr. F. LU-KOSCHUS, Catholic University, Nijmegen, a number of macrochelid mites were recovered from the fur of the 3-toed sloth, Bradypus tridactylus L., and later sent to me for determination. They proved to be females of a new and unusual species of the genus Macrocheles Latr. Several additional specimens of the same species, including a number of males and deutonymphs, were later recovered from Bradypus variegatus Schinz and B. tridactylus in Amazonas and Pará, Brazil by Dr. J. ADIS and colleagues, Instituto Nacional de Pesquisas da Amazônia (INPA), Manaus.

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Bradypus species serve as carriers for a variety of insects including dung beetles of the genera Uroxys and Trichillum (Ratcliffe 1980). U. besti Ratcliffe and T. adisi Ratcliffe collected from B. tridactylus in Amazonas are hosts for two additional new species of Macrocheles. Descriptions of the three mite species are presented below, along with a brief discussion of their position in the scarab-sloth system.

SYSTEMATICS

Macrocheles lukoschusi n. sp.

\[ \text{FEMALE (Figs. 1-7). Length of idiosoma averages } 801 \mu m (746-842 \mu m) \text{; width at level of humeral angles averages } 446 \mu m (413-495 \mu m) \text{ (n = 34). Dorsal shield (Fig. 1) somewhat abbreviated posteriorly and not covering posterior portion of opisthonotum, with a reticulate pattern which become less distinct centrally; portion of shield anterior to setae } j_6, z_2, \text{ and } s_2 \text{ generally strongly sclerotized, appearing shelf-like. Shield with 28 pairs of setae, of which all but } J_5 \text{ are smooth, insertions of setae } j_i \text{ separated by a distance equal to at least the width of one of the setal bases, } j_3 \text{ inserted at the same level; anterior and marginal setae somewhat longer than medial setae but generally shorter than the distance between their insertions; seta } J_5 \text{ short, palmate (Fig. 2); dorsum with only 20 pairs of primary pores discernible. Dorsal integumental setae smooth, equal to or somewhat shorter than marginals } r_2-r_4, s_6, S_1-S_2, S_5-S_6, \text{ and } Z_5. \text{ Sternal shield (Fig. 4) with punctate-reticulate pattern as seen on dorsal shield, anterior and lateral portions of shield are strongly sclerotized when compared to more posterior portion; sternal setae smooth, spinose, similar to dorsal setae, } lineae obliqueae anteriores \text{ distinct, forming an arch between sternal setae } 2. \text{ Metasternal shields reduced, narrowed, bearing a pair of setae (st 4) and the third pair of sternal pores. Epignyal shield somewhat rounded posteriorly, well separated from the narrow and elongate punctate-reticulate ventrianal shield; preanal setae simple, shorter than sternal, epignyal, and paranal setae; postanal seta minute. With 4 narrow sclerites fused with or adjacent to anterior margin of the ventrianal shield. Sacculus foemineus complex as in Fig. 7. Peritreme typical for the genus, extending anteriorly and curving dorsad at the level of seta } r_5 \text{ to terminate laterad to } z_2 \text{ (Fig. 1). Lateral elements of epistome greatly reduced, closely associated with a median forked element which is typical for the genus (Fig. 3); epistomatic margin strongly toothed. Fixed cheliceral digit with reduced median tooth (Fig. 5), dorsal cheliceral seta simple, not spatulate. Gnathosoma otherwise typical for genus. Chaetotaxy of legs and palpi normal, genu of leg IV with 7 simple setae (Fig. 6).} \]

\[ \text{MALE (Figs. 8-12). Length of idiosoma averages } 610 \mu m (555-701 \mu m) \text{; width at level of humeral angles averages } 355 \mu m (330-371 \mu m) \text{ (n = 6). Dorsal shield (Fig. 9) rounded anteriorly, without strongly sclerotized border as in female; setae } j_1 \text{ widely separated, setae } J_5 \text{ shorter than those of female (Fig. 10), other dorsal setae generally longer. With 5 smooth pairs of setae and 3 pairs of pores in the sternitigenital region, anterior genital opening and associated internal apodemes distinct; ventrianal shield weakly fused to sternitigenital shield (Fig. 11), often with a fold at the line of juncture suggesting contiguity rather than fusion; ventrianal setae simple, paranals slightly longer than preanals. Peritreme considerably shorter than that of female, extending only slightly beyond setae } r_5 \text{ (Fig. 9). Chelicerae (Fig. 8) with short, broad digits, spermatodactyl thickened basally and narrowed distally, somewhat less than twice the length of movable digit, dorsal cheliceral seta strong, simple. Femur, genu and tibia II each with a small rounded spur ventrally (Fig. 12).} \]

\[ \text{DEUTONYMPH (Figs. 13-14). Length of idiosoma averages } 636 \mu m (550-715 \mu m) \text{; width at level of humeral angles averages } 409 \mu m (344-}

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3. Some of the specimens in the type series were not in appropriate condition for length-width measurements.
Fig. 1-8. *Macrocheles lukoschusi* n. sp.

1-7. — Female; (1) dorsum; (2) seta *J*; (3) epistome; (4) venter; (5) chelicera (paraxial); (6) genu IV; (7) sacculus and associated structures.

8. — Male, chelicera (antiaxial).
495 μm) (n = 8). Dorsal shield (Fig. 13) with light reticulate pattern; shield deeply incised mediolaterally, with incisions extending to just beyond the bases of setae z6; j1 widely separated, setae z6, z5, z4, z3, S1, and J2 clearly shorter than adjacent setae. Sternal shield (Fig. 14) narrowed, elongate; sternals 4 clearly shorter than other sternal setae, inserted on distinctive lateral extensions of the shield. Anal shield rounded or slightly pointed anteriorly, paranals longer than postanal seta; with 4 narrow sclerites lying between the sternal and anal shields. Peritreme and mouthparts similar to those of female.

■ Protonymph. Unknown.

■ Larva (embryonic) (Figs. 15-17.) Length averages 592 μm (550-633 μm) (n = 3). Dorsum with 14 pairs of setae as illustrated (Fig. 15). Venter (Fig. 16) without distinct sclerotization; with 3 pairs of sternal setae inserted posterior to a well developed tritosternum; with two pairs of preanal setae, the posterior pair being considerably longer than the anterior pair; paranal setae robust, over twice the length of the postanal seta and flanking the anal aperture, with indications of an anal shield. Opisthogaster with a series of short simple setae and pores as illustrated. Gnathosoma as in larvae of other members of the genus, hypostomatic setae 3 and capitular setae absent; palpal apotele appearing 2-tined, proximal tooth undeveloped, epistome lacking median extension (Fig. 17). Leg chaetotaxy normal for the stase.

■ Material examined. Holotype female, allotype male and 29 paratypes (3 ♀, 14 ♂, and 12 deutonymphs) ex feces in rectum or in anal region of Bradypus variegatus (?), Ilha de Curari (Rio Solimões), Várzea-forest, Amazonas, Brazil, 24 June, 1977 (J. ADIS and R. BEST, leg.) Additional paratypes from Bradypus spp. as follows: Brazil: 6 females and 2 males ex anus (?), Manaus, Amazonas, 9 June, 1978 (R. BEST, leg.); 5 females † ex anus (?), Manaus-Caracaraí highway (km 54), 5 August, 1977 (R. BEST, leg.). Surinam: 31 females, ex venter of abdomen near anus, Uitvlucht, 5 February, 1970, coll. No. 511 (F. LUKOSCHUS, leg.); 1 female from Brokopondo, Lokse Hattie, Saramacca River, 15 December, 1961 (CNHM coll. 95443. P. HERSHKOVITZ, coll.): 1 female from Paramaribo, 6 March, 1961 (CNHM coll. 93296, H. A. BEATTY, coll.). Additional unmounted material comprises a number of adults and deutonymphs collected from male, female, and infant Bradypus living in dry or periodically flooded forests in the states of Amazonas and Pará, Brazil. Mite collections from adults sloths were made primarily from sequestered fecal pellets or from the anal region of the sloth carrier. Infestations of baby sloths occurred primarily on frontal portions of the host.

The holotype female, allotype male and a paratype deutonymph will be deposited in the collection of the Instituto Nacional de Pesquisas da Amazônia (INPA), Manaus, Brazil. Paratypes will be placed in the following collections: U.S. National Museum Washington, DC; Field Museum of Natural History, Chicago; British Museum (Natural History), London; Catholic University, Nijmegen, The Netherlands; Oregon State University, Corvallis, and Dr. J. ADIS, INPA, Manaus.

■ Remarks. M. lukoschusi is provisionally referred to the pisentii species group (COSTA 1967) on the basis of its short, palmate setae J5 and its sternal shield sclerotization and ornamentation. In addition, there appear to be strong parallels in morphology of immature stases between M. lukoschusi and known pisentii group members. However, M. lukoschusi differs from the pisentii habitus in that the sacculi (Fig. 7) are distinctly separated rather than forming a single globular entity. Furthermore, M. lukoschusi lacks well developed lateral epistomatic elements (Fig. 3), and the male possesses a weakly joined holovenital shield (Fig. 11) rather than separate sternitige-

4. Three embryonic larvae were removed from three of these females for study (see description).
5. "CNHM" refers to the Field Museum of Natural History, Chicago.
Fig. 9-17: *Macrocheles lukoschusi* n. sp.

9-12. — Male: (9) dorsum; (10) seta J₄; (11) venter; (12) portion of leg II.
13-14. — Deutonymph: (13) dorsum; (14) venter.
15-17. — Larva: (15) dorsum; (16) venter; (17) epistome.

Fig. 18-19: *Macrocheles inae* n. sp., female.

(18) epistome; (19) genu IV.
nital and ventrianal elements as described for other members of the assemblage (COSTA, op. cit).

The inclusion of *M. lukoschusi* in the *pisentii* species group would extend the known Old World range of the group (BREGETOVA and KOROLEVA 1960, EVANS and HYATT 1963, COSTA 1967) to include the New World tropics.

*M. lukoschusi* is named in honor of Dr. F. LUKOSCHUS, Catholic University, Nijmegen, The Netherlands, who first acquainted me with this species in 1971.

Macrocheles *inpae* n. sp.

**FEMALE** (Figs. 18-22). Length of idiosoma averages 581 μm (560-616 μm); width at level of humeral angles averages 343 μm (330-374 μm) (n = 11). Dorsal shield (Fig. 20) reticulate throughout, with 28 pairs of short setae, of which only j5 are weakly pectinate; with 22 pairs of primary dorsal pores. Dorsal integumental setae similar to marginais. Sternal shield (Fig. 22) strongly punctate-reticulate; *lineae obliquae anteriores* and *linea media transversa* well developed, with two transverse *lineae* posterior to *l. m. t.* which converge at the sites of sternal pores 2, with a series of additional *lineae* as illustrated; sternal setae short, simple. Metasternal shields reduced, narrowed, bearing *st 4* and the third pair of sternal pores. Epigynial shield narrow, truncate posteriorly, weakly reticulate, abutting avoid ventrianal shield; preanalns and other opisthogastric setae simple, shorter than epigynial or paranal setae; postanal seta minute. Sacculus formineus complex as in Fig. 21. Peritremes typical for genus, extending anteriorly and dorsal at the level of setae *r 5* and terminating anterad to *z 1* (Fig. 20). Epistome (Fig. 18) tripartite, with a strongly toothed epistomatic margin; chelicerae and other gnathosomatic elements typical for genus. Chaetotaxy of legs and palpi normal, genu of leg IV with 6 simple setae (Fig. 19).

**MALE AND IMMATURE STASES.** Unknown.

**MATERIAL EXAMINED.** Holotype female and 8 paratype females ex *Uroxyx besti* on *Bradypus tridactylus* (? sex), Manaus (INPA), Amazonas, Brazil, 28 May, 1978 (R. BEST, leg.). Additional collections as follows: 2 females ex *Uroxyx besti* on *B. tridactylus* (♂), Manaus (INPA), 2 June, 1977 (J. ADIS and R. BEST, leg.); 2 females ex *Trichillum adisi* on *B. tridactylus*, Manaus (INPA), 28 May, 1978 (R. BEST, coll.).

The holotype female will be deposited in the collection of the Instituto Nacional de Pesquisas da Amazônia (INPA), Manaus, Brazil. Paratypes will be placed in the following collections: U.S. National Museum, Washington, D.C.; Field Museum of Natural History, Chicago; British Museum (Natural History), London; Leiden Museum, Leiden, The Netherlands; Oregon State University, Corvallis, and Dr. J. ADIS, INPA, Manaus.

**REMARKS.** *M. inpae* shows strong similarities to members of the *subbadius* species group (FILIPPONI and PEGAZZANO 1963). The sternal ornamentation is very much like that of *M. subbadius*, as is the dorsal setation. *M. inpae* is unique in having an ovoid ventrianal shield and a strongly toothed epistomatic margin. Final referral to the *subbadius* group should be deferred until males of *M. inpae* are available for comparison with those of *subbadius* group species.

Macrocheles *uroxys* n. sp.

**FEMALE** (Figs. 23-27). Length of idiosoma averages 996 μm (949-1034 μm); width at level of humeral angles averages 633 μm (589-660 μm) (n = 8). Dorsal shield (Fig. 24) reticulate throughout, median intersigillary pattern distinctive, with 28 pairs of setae, of which all but *j 10* and *j 6* are strongly pilose distally, insertions of *j 2* and *j 3* distinctly shorter than adjacent setae, as are the non-pilose setae in the *j* and *z* series. Dorsal integumental setae shorter than marginals, lightly pilose. Sternal shield (Fig. 23) elongate, with distinctive punctate-reticulate pattern, *linea media*
FIG. 20-22 : Macrocheles inae sp., female.
(20) dorsum ; (21) sacculus and associated structures ; (22) venter.

FIG. 23-27 : Macrocheles uroxyx sp., female.
(23) venter ; (24) dorsum ; (25) chelicera (paraxial) ; (26) epistome ; (27) genu IV.
Transversa present, along with other lineae as illustrated; sternal setae simple, short. Sternal setae 4 and pores 3 inserted on small metasternal shields which flank a broad, reticulate, posteriorly truncate epigynial shield. Ventrianal shield subtriangular, nearly as broad as long, with reticulate pattern throughout; paranal setae longer than simple preanals and the postanal seta; opisthogastric setae inserted laterad to shield are shorter than preanals and distally pilose. Metapodal shields as illustrated. Peritremes typical for genus, extending anteriorly and dorsal at the level of setae r2, and terminating anterad to z1 (Fig. 24). Epistome (Fig. 26) tripartite, with weakly toothed margin; chelicerae (Fig. 25) normally developed, with two subterminal teeth on the movable digit, dorsal seta short and spatulate. Chaetotaxy of legs and palpi normal, genu of leg IV with six distally pilose setae (Fig. 27).

Male and Immature Stases. Unknown.

Material Examined. Holotype female and 5 paratype females ex Uroxys besti on Bradypus tridactylus L. (? sex), Manaus (INPA), Amazonas, Brazil, 28 May, 1978 (R. Best. leg.). Additional collections as follows: 3 females ex Uroxys besti on B. tridactylus (♂), Manaus (INPA), 2 June, 1977 (J. ADIS and R. BEST, leg.); 2 females ex anal region of B. tridactylus (♂), Manaus (INPA), 25 May, 1977 (J. ADIS and R. BEST, leg.). Additional material includes nine unmounted females from the last mentioned collection.

The holotype female will be deposited in the collection of the Instituto Nacional de Pesquisas da Amazônia (INPA), Manaus, Brazil. Paratypes will be placed in the following collections: U.S. National Museum, Washington, D.C.; Field Museum of Natural History, Chicago; British Museum (Natural History), London; Leiden Museum, Leiden, The Netherlands; Oregon State University, Corvallis, and Dr. J. ADIS, INPA, Manaus.

Remarks. The habitus of M. uroxys (Figs. 23-24) suggests an affinity with M. robustulus Berlese (COSTA 1966). Based on similarities in sternal morphology and dorsal setation, it is proposed that the species group robustulus be recognized, consisting of M. robustulus, M. uroxys, and M. mexicanus Evans and Hyatt (EVANS and HYATT 1963). Species group characters are as follows: sternal shield elongate, with punctate-reticulate pattern; setae r2-r3 pilose, longer than adjacent setae z2 and s2; J4, Z3-Z4 pilose, J5 smooth; ventrianal shield length equal to or greater than width. M. scutatifomis Petrova (PETROVA 1967) may also be accommodated in the robustulus species group but only with some modification of group limits. Setae J3 of M. scutatifomis are pilose and setae r2-r3 are subequal to, or only slightly longer than, setae z2 and s2.

Discussion

Many tropical and subtropical phoretic macrochelids have established generic or specific affinities for their scarab phorionts, even in the presence of other potential carriers (KRANTZ 1967, KRANTZ & MELLOTT 1972). Specificity of this type may be tied to coevolution with rapidly radiating scarab hosts which provide their mite associates with the isolation mechanism of niche specialization. Integrity of the mechanism is maintained by the constant reliance of the mite on the scarab carrier for escape from an impermanent and deteriorating substrate. A more exotic array of relationships occurs between the three species of Macrocheles described above, and their sloth and scarab associates. RATCLIFFE (1980) has suggested that the sloth-associated scarabs, Uroxys besti and Trichiillum adisi, are phoretic coprophages which utilize the sloth for shelter and dispersal, alternately feeding on sloth dung. Solid evidence for coprophagy exists only for T. adisi in Manaus, where larvae and pupae of this species have been obtained through rearing on sloth dung pellets. However, the absence of both species in field-collected dung suggests that neither is primarily coprophagous. Some species of Trichiillum and Uroxys are more strongly attracted to carrion than to dung (HOWDEN and NEALIS 1975, RAT-
genus KRANTZ female exclusivity occurs in the genus and MONTGOMERY prey for S. Brady pus sloth examined after three weeks of captivity (F. sloth dung samples, however, has not resulted in

The association of M. lukoschusi n. sp. with Bradypus is singular. M. lukoschusi has never been taken on sloth-associated scarabs, but it occurs commonly as a phoretic on Bradypus both in Surinam and Brazil, and often in great numbers. Most other known macrochelid-mammal liaisons appear to arise as a concomitant of nidicoly, with the macrochelid moving easily between the nest substrate and the nest builder, usually a rodent (EVANS and BROWNING 1965, BREGETOVA and KOROLEVA 1960). Sloths build no nest, so in this instance it must be assumed that the mite is more intimately involved with the mammal itself. An indication of the degree of intimacy is seen in the fact that male and deutonymphal M. lukoschusi, as well as females, occur on the sloth. The majority of specimens of M. lukoschusi have been found in the anal region of the host or in the rectum, where dung is stored during the week-long intervals between defecation episodes (WAAGE and MONTGOMERY 1976). Nematodes were observed in the anal region of a 3-toed sloth examined after three weeks of captivity (F. S. LUKOSCHUS, personal communication), suggesting that fimbiculous nematodes living in the rectum and anal region of Bradypus may serve as prey for M. lukoschusi. Other known faunal associates of the sloth such as moths (WAAGE and MONTGOMERY op. cit.) and parasitic mites (FAIN and LUKOSCHUS 1970) seem inappropriate as sources of food. More suitable prey may be available in the arboreal niches occupied by the foraging sloth, although no observations have yet been made which suggest that M. lukoschusi leaves its carrier to feed.

It is clear that further examination of sloth-scarab-mite associations will be necessary if the role of Macrocheles mites in this complex system is to be fully understood.

SUMMARY

Descriptions are given for three new species of Macrocheles associated with the 3-toed sloths, Bradypus tridactylus and B. variegatus, in Brazil and Surinam. M. inpa n. sp. and M. uroxys n. sp. are found on scarab beetles (Uroxys besti and Trichilium adisi) in which both adults and nymphs are phoretic on beetles (Uroxys besti and Trichilium adisi) which in turn infest the sloth; M. uroxys may be encountered in the fur of the sloth itself. M. lukoschusi n. sp., however, has been found only on the sloth host. M. lukoschusi is provisionally assigned to the pisentii species group and M. uroxys is included in the newly recognized robustulus species group (M. robustulus Berlese, M. mexicanus, Evans and Hyatt and, possibly, M. scutiformis Petrova). The possible nature of the relationships between the mites and their scarab and sloth associates is discussed.

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6. Generally, phoresy in Macrochelidae, regardless of host, is an activity of the female. Exceptions occur in the macrochelid genus Holocelaeno where males may be found with females on their beetle phoronts (KRANTZ 1967). A more complete loss of female exclusivity occurs in the genus Neopodocinum in which both adults and nymphs are phoretic on beetles (COSTA 1965, KRANTZ 1965). Male Macrocheles occasionally are found attached to beetles, but such an association is considered exceptional.
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