

NEW RECORDS AND SPECIES OF *BELAPHOPSOCUS* (PSOCOPTERA: LIPOSCOLIDIDAE)

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ABSTRACT - *Belaphopsocus murphyi*, new species, is described and illustrated from Sentosa Island (Singapore). This is the first record of the genus in the Oriental region. The species is closely related to *B. vilhenai* Badonnel from tropical Africa. The third known species of the genus, the neotropical *B. badonneli* New, is here recorded from Paraguay and the male is described for the first time. A revised identification key to the genera of Liposcelididae is provided. Lectotypes for *Belapha schoutedeni* Enderlein and *Belapha globifer* (Laing) are designated.

INTRODUCTION

The family Liposcelididae (often called Liposcelidae, for correct formation of the family name see Lienhard, 1990) is usually divided into two subfamilies, Liposcelidinae and Embidopsocinae, containing one and seven genera respectively. About 95% of the described Liposcelid species belong to three of these genera, which are very widely distributed: *Liposcelis* Motschulsky, 1852 (about 100 spp., world-wide distribution); *Embidopsocus* Hagen, 1866 (about 40 spp., known from all main zoogeographical regions); *Belaphotroctes* Roesler, 1943 (16 spp., North America, South America, Africa and unpublished material from the Oriental region examined by the author). For the remaining seven more or less aberrant species of the family five additional genera have been erected: *Embidopsocopsis* Badonnel, 1973 [*E. newi* Badonnel, 1973, Brazil]; *Chaetotroctes* Badonnel, 1973 [*C. lenkoi* Badonnel, 1973, Brazil]; *Belapha* Enderlein, 1917 [*B. schoutedeni* Enderlein, 1917, Zaire (Enderlein, 1917; Badonnel, 1948, 1949), Angola (Badonnel, 1955, 1973, 1977); *B. globifer* (Laing, 1925), Guyana]; *Belaphopsocus* Badonnel, 1955 [*B. vilhenai* Badonnel, 1955, Angola (Badonnel, 1955, 1969), Zaire (Badonnel, 1969); *B. badonneli* New, 1971, Brazil (New, 1971), Colombia (Badonnel, 1986), Mexico (Garcia Aldrete, 1988)] and *Troctulus* Badonnel, 1955 [*T. machadoi* Badonnel, 1955, Angola].

The aim of the present paper is to describe a new species of *Belaphopsocus* from Singapore, the first representative of this genus known from the Oriental region, and to give the first description of the male of the usually parthenogenetic Neotropical species *B. badonneli* on the basis of a sample from a bisexual population from Paraguay. The diagnosis of the genus is

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revised, with special attention on the morphology of the pretarsal claw and maxillary palpus, and its position within the family is briefly discussed. A revised identification key to the genera of Liposcelididae is provided.

Only a thorough phylogenetic analysis of the whole family would reveal whether splitting to such a high number of genera is really justified, but here it is only important to state that *Belaphopsocus* is undoubtedly a monophyletic group, characterized by the following autapomorphies unique in Psocoptera: 1) pretarsal claw with adhesive vesicle; 2) antennae only 9 segmented; 3) maxillary palpus with second article very long and strongly asymmetric at apex and 4th (=terminal) article very much enlarged.

The new species of *Belaphopsocus* described below is dedicated to Prof. D. H. Murphy (National University of Singapore) on the occasion of his 60th birthday but also as an acknowledgement of his contribution to the Asiatic fauna during more than 30 years of activity in Singapore and especially for his important collecting effort of Psocoptera.

ABBREVIATIONS

Depositories of material examined - BMNH : British Museum (Natural History), London, UK; DEI : Deutsches Entomologisches Institut, Eberswalde, Germany; MHNG : Muséum d'Histoire naturelle, Genève, Switzerland; MRAC : Musée Royal de l'Afrique Centrale, Tervuren, Belgium.

Abbreviations used in descriptions - $F+tr$: length of hind femur, trochanter included; T : length of hind tibia; t_1, t_2 : length of hind tarsomeres (from condyle to condyle); Ant : length of antenna; f_1-f_7 : length of flagellomeres; SI : length of prothoracic humeral seta; $Mv10$: length of ventral marginal seta of 10th abdominal tergum; P_1-P_4 : articles of maxillary palpus.

IDENTIFICATION KEY TO THE GENERA OF LIPOSCELIDIDAE

- 1 Hind femur with a dorsal protuberance at its greatest breadth *Liposcelis* Motschulsky
Hind femur lacking such a protuberance 2
- 2 Tarsi 3 segmented (in *Belapha* second and third article often not completely separated)
..... 3
Tarsi 2 segmented (no trace of subdivision of second article) 7
- 3 Terminal article of maxillary palpus (P_4) broadened, at least 1.5x as wide in middle as third article (P_3) 6
 P_4 less than 1.5x as wide in middle as P_3 4

- 4 Field of conical sensilla on each side of frons *Chaetotroctes* Badonnel
No field of sensilla on frons 5
- 5 3 or 4 short setae on each side of sternellum *Embidopsocopsis* Badonnel
No setae on sternellum *Embidopsocus* Hagen
- 6 P₄ strongly enlarged, almost circular (Fig. 11). Pretarsal claw with fringed basal lobe (Figs 12, 13) *Belapha* Enderlein
P₄ obviously wider than other segments of maxillary palpus, but not as wide as long (Fig. 14). Pretarsal claw at most with a simple setiform or spiniform basal appendage (Fig. 15) *Belaphotroctes* Roesler
- 7 P₄ only very slightly widened, ovoid; antennae 10 segmented *Troctulus* Badonnel
P₄ strongly enlarged, almost circular; antennae 9 segmented *Belaphopsocus* Badonnel

Remarks. - This key is a revised version of that one proposed by Smithers (1990). Information concerning *Chaetotroctes*, *Embidopsocopsis* and *Troctulus* is taken from their original descriptions. Material from the following genera has been examined by the author: *Liposcelis* (MHNG), *Embidopsocus* (MHNG), *Belaphotroctes* (MHNG), *Belaphopsocus* [see below], *Belapha* [Syntypes of *B. schoutedeni* Enderlein, 1917: 63 apterous females (MRAC), 3 apterous females (DEI), all from “Kongo Kasai-Kondué” (leg. E. Luja); one of them here designated as lectotype (MRAC), the others becoming paralectotypes. - Syntypes of *B. globifer* (Laing) (= *Semnopsocus globifer* Laing, 1925): 3 macropterous females, 1 apterous females, 1 nymph and 7 slides with dissected parts of several specimens (BMNH), all material originating from Berbice (leg. H. E. Box) and mounted on slides by F. Laing; the apterous female here designated as lectotype, the others becoming paralectotypes. Remark: Laing does not explicitly mention any material in his original description, he only indicates the type locality. In the description the existence of a apterous form is not mentioned, probably because the author considered the apterous female to be a nymph (he had mounted it together with the nymph on the same slide), but both the nymph and the apterous female undoubtedly belong to the type series (syntypes)].

DESCRIPTIONS

Belaphopsocus Badonnel

Belaphopsocus Badonnel, 1955: 96. Type species: *B. vilhenai* Badonnel, 1955, by original designation and monotypy. *Belaphopsocus* (sic) Badonnel; New, 1971: 124 (incorrect subsequent spelling).

Diagnosis. - Autapomorphies: Antennae 9 segmented, very short, flagellar segments not annulated (Figs 1; 16 a, b, j). Pretarsal claw toothless, with hyaline membranous vesicle on ventral side reaching from base to tip of the claw (Figs 4, 10; 16 e, f). Maxillary palpus with

second article very long and strongly asymmetric at apex, externally overlapping third article (Fig. 9, 16 j), and with 4th (=terminal) article very much enlarged, almost circular (Figs 1, 9; 16 a, b, i, j). - Other characters: Tarsi 2 segmented. Eyes in apterous form reduced to 2 ommatidia (many ommatidia in winged form). Three ocelli in winged form, none in apterous form. Lacinial tip bifurcate, with smaller intermediate third tooth. Hind femur broadened (Figs 1; 16 a, b). Hind tibia without apical spur. Wing venation greatly reduced, in forewing two main veins (R and M) faintly marked and becoming invisible before reaching distal wing margin; hindwing with a similar vein. Abdomen subglobular (Fig. 1). Three pairs of reduced gonapophyses (Fig. 5). Phallosome simple (Figs 7, 8).

Remarks. - The very much reduced number of antennal segments in *Belaphopsocus* is an extreme stage in a general tendency towards antennal reduction in Embidopsocinae, due to conservation of larval characters in adults ("neoteny" *sensu* Badonnel). The plesiomorphous character state (antennae 15 segmented) is always realized in *Liposcelis*, *Embidopsocus*, *Embidopsocopsis* and *Chaetotroctes*, a slight tendency to a reduction of the number of flagellar segments can be observed in *Belapha* (antennae 14-15 segmented) and *Belaphotroctes* (antennae usually 14-, sometimes 15 segmented), a strong reduction is found in *Troctulus* (antennae 10 segmented) and *Belaphopsocus* (antennae 9 segmented). The apomorphous 2 segmented tarsus observed in *Belaphopsocus* and *Troctulus* (all other genera of Liposcelididae have 3 segmented tarsi in adult stage; exceptionally the second and third article are not completely separated in *Belapha*) is also a manifestation of neoteny but not necessarily a synapomorphy of these genera. The high probability of convergence in groups with a general tendency to neoteny makes a phylogenetic interpretation of such characters very difficult.

The presence, in *Belaphopsocus*, of an enlarged terminal maxillary palp segment (P_4) recalls the genera *Belaphotroctes* and especially *Belapha* (cf. identification key). But in these two genera P_2 is slightly conical, almost regularly truncated at apex and not overlapping P_3 (Figs 11, 14). The very peculiar development of P_2 together with the vesicle of the pretarsal claw are undoubtedly autapomorphies of *Belaphopsocus*.

The characteristic morphology of the pretarsal claw has already been observed by Badonnel (1955, 1969), who mentions the presence of a membranous bell-shaped pulvillus. Careful focussing at high magnifications in differential interference contrast shows that this structure is actually not a distally open "bell" but rather a completely closed vesicle with a finely rippled central carina (Figs 4, 10, 16 e-f); its membrane is arising from lateral edges and stretched from base to tip to form a continuous swelling of the ventral surface of the pretarsal claw. The outer surface of the vesicle is covered by microtrichia. It is likely that this membranous vesicle is not really homologous to the pulvillus as it is generally known in Psocoptera. In all other genera of Liposcelididae the pulvillus is lacking or only developed as a small setiform or spiniform process originating in basal half of the pretarsal claw. In other groups of Psocoptera, where the pulvillus is well developed, broad and membranous (e. g. Caeciliidae), it is never fused with the claw distally to its well delimited point of origin near the base of the claw and it is never covered by microtrichia. The vesicle observed in *Belaphopsocus*, probably an adhesive organ, is apparently a pretarsal structure unique in Psocoptera.

***Belaphopsocus vilhenai* Badonnel**

Belaphopsocus vilhenai Badonnel, 1955: 97.

Description. - female (see Badonnel, 1955), male (see Badonnel, 1969).

Biology. - The species is living in soil litter of tropical African forests.

Distribution. - Angola, Zaire (cf. Introduction).

Remarks. - See under *B. murphyi*.

***Belaphopsocus badonneli* New**

Belaphopsocus (sic) *badonneli* New, 1971: 124.

Material examined. - 13 females, 1 male, 1 nymph (MHNG), soil litter (Berlese extraction), forest school, Puerto Stroessner, Paraguay, coll. C. Dlouhy, iv.1984.

Description female. - See New, 1971.

Description male. - Coloration. Entirely brown, head slightly darker than thorax and abdomen; legs, antennae and maxillary palpi somewhat lighter than body; almost no subcuticular pigmentation.

Sculpture. Vertex (cf. Fig. 16 c) with polygonal or rounded areas usually only slightly wider than long, a few spinules within the areas. Vertical and frontal sutures well indicated by a break of sculpturing. Abdominal terga (cf. Fig. 16 d) with similar sculpture as vertex but areas transversally more elongated (2-3x wider than long), usually with several spinules.

Morphology. Apterous. Head with relatively long and thick apically truncated hairs (length 20-30 μm), average distance between them about 1-2x their length. Antennal flagellum shorter than greatest width of head capsule. Terminal segment of maxillary palpus with ventral surface densely covered by numerous short fine setal sensilla (length 3-4 μm). Pretarsal claw as in Figs 10 and 16 e-f, ventral vesicle usually fan-shaped in lateral view, inner surface smooth, outer surface with numerous microtrichia and finely rippled towards central carina. Lateral lobe of pronotum with 1 truncated humeral seta and 1 additional hair of almost the same length, median lobe of pronotum with 3/4 truncated hairs on each side respectively (in addition to the 1/1 very small pointed hairs on anterior face). A median group of 4 setae on prosternum, 2 small hairs on membranous zone between prosternum and mesosternum, 2/3 setae on each side of mesosternum and 2/1 setae on metasternum. Abdominal terga relatively densely covered with truncated hairs which are somewhat shorter than on head, average distance between them about equal to their length. 1 long marginal seta on tergum 8, 1 dorsal and 1 ventral marginal seta on each of terga 9 and 10. No particularly long setae on epiproct. Phallosome as in Fig. 8.

Dimensions(μm). Body length (in alcohol) = 800; $F+tr$ = 265 ; T = 226; t_1 = 45; t_2 = 64; Ant = 326; f_1 = 59; f_2 = 36; f_3 = 35; f_4 = 34; f_5 = 34; f_6 = 32; f_7 = 17; SI = 29; $Mv10$ = 75.

Biology. - The species lives in soil litter and has also been found in roofs of small huts thatched with fronds of palm trees, where it feeds on black moulds and *Pleurococcus*-like algae (New, 1971). Thelytokous parthenogenesis has been observed in a population from Brazil by New (1971). The male is here described for the first time. The presence of sperm in the spermatheca of females from Paraguay proves that the unique male present in the sample is not accidental; bisexuality is probably the general mode of reproduction in this population.

Distribution. - Brazil, Colombia, Mexico (cf. Introduction).

Remarks. - See under *B. murphyi*.

***Belaphopsocus murphyi*, new species**

Material examined. - Holotype female (MHNG), forest near Satellite Station, Sentosa Island, Singapore. coll. C. Lienhard, 6.xii.1988.

Paratypes. - 2 females, 1 male, (MHNG). Other material, 4 larvae (MHNG), same data as holotype.

Description female. - Coloration (Fig. 1). Head and prothorax dark brown, meso- and metathorax white (colourless) to light brown, abdomen uniformly medium brown, some dark brown subcuticular pigmentation dorsolaterally on basal half of abdomen. Legs, antennae and maxillary palpi light brown, terminal segment of maxillary palpus somewhat darker in basal half.

Sculpture. Vertex (Fig. 16 g-h) with polygonal to rounded areas, transversally hardly elongated, almost no spinules in areas but their surface slightly rugose (in particular laterally on vertex). Vertical and frontal suture well indicated by a break of sculpturing. Areas of abdominal terga (Fig. 16 k-l) transversally much elongated, usually with some spinules.

Morphology. Apterous (winged form unknown). Head with relatively long and thick apically truncated hairs (length 30-50 μ m), average distance between them about 1-2x their length. Antennal flagellum shorter than greatest width of head capsule. Terminal segment of maxillary palpus with ventral surface densely covered by numerous short fine setal sensilla (length about 4 μ m). Pretarsal claw as in Fig. 4, toothless and with fan-shaped ventral vesicle in lateral view (cf. Fig. 10), inner surface of vesicle smooth, outer surface with numerous microtrichia and finely rippled towards central carina. Lateral lobe of pronotum (Fig. 2) with 1 truncated humeral seta and 1 much smaller hair (this hair sometimes lacking), median lobe of pronotum (Fig. 2) with 2/2 truncated hairs on each side respectively (in addition to the 1/1 very small pointed hairs on anterior face). A median group of 3 setae on prosternum, 2 small hairs on membranous zone between prosternum and mesosternum, 3-4 setae on each side of mesosternum and metasternum (Fig. 3). Abdominal terga with relatively scarce truncated hairs which are somewhat shorter than on head, distance between them about 1-3x their length. 1 long marginal seta on tergum 8, 1 dorsal and 1 ventral marginal seta on each of terga 9 and 10. No particularly long setae on epiproct (Fig. 6). Gonapophyses as in Fig. 5.

Dimensions(μm) (female holotype). Body length (in alcohol) = 1250; $F+tr$ = 386 ; T = 353; t_1 = 64; t_2 = 75; Ant = 414; f_1 = 76; f_2 = 44; f_3 = 46; f_4 = 45; f_5 = 44; f_6 = 39; f_7 = 27; SI = 41; $Mv10$ = 90.

Description male. - Coloration. As female.

Sculpture. As female.

Morphology. Essentially as female. Hairs on vertex 20-30 μm long, average distance between them about 1.5-2x their length. Lateral lobe of pronotum with 1 truncated humeral seta and 1 much smaller hair, median lobe of pronotum with 2/3 truncated hairs on each side respectively (in addition to the 1/1 very small pointed hairs on anterior face). A median group of 3 setae on prosternum, 2 small hairs on membranous zone between prosternum and mesosternum, 2/3 setae on mesosternum and 2/2 setae on metasternum. Phallosome as in Fig. 7.

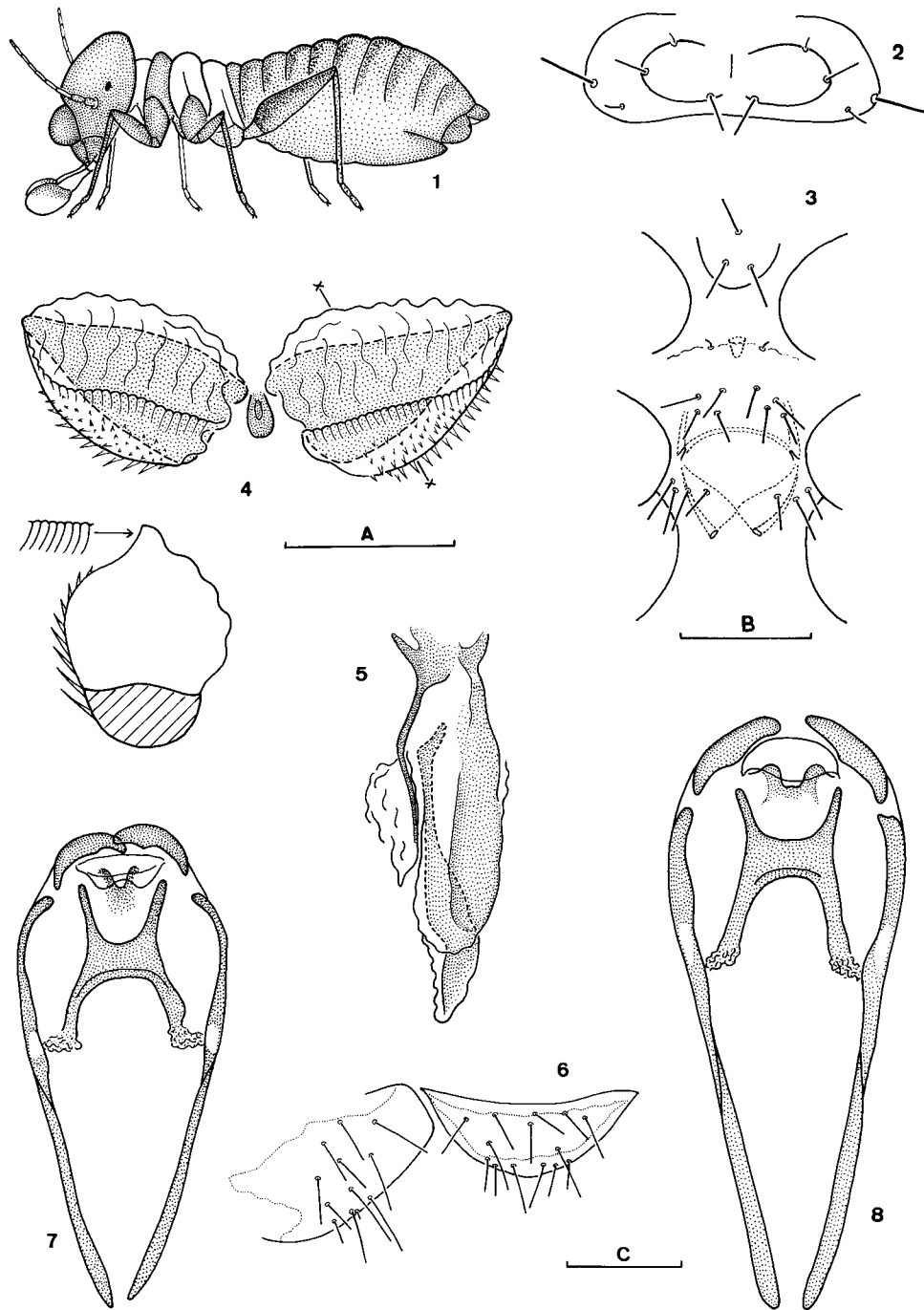
Dimensions(μm) (male allotype). Body length (in alcohol) = 1070; $F+tr$ = 268 ; T = 232; t_1 = 43; t_2 = 62; Ant = 328; f_1 = 58; f_2 = 32; f_3 = 32; f_4 = 34; f_5 = 36; f_6 = 34; f_7 = 21; SI = 28; $Mv10$ = 71.

Etymology. - This species is named in honour of Assoc. Prof. D. H. Murphy.

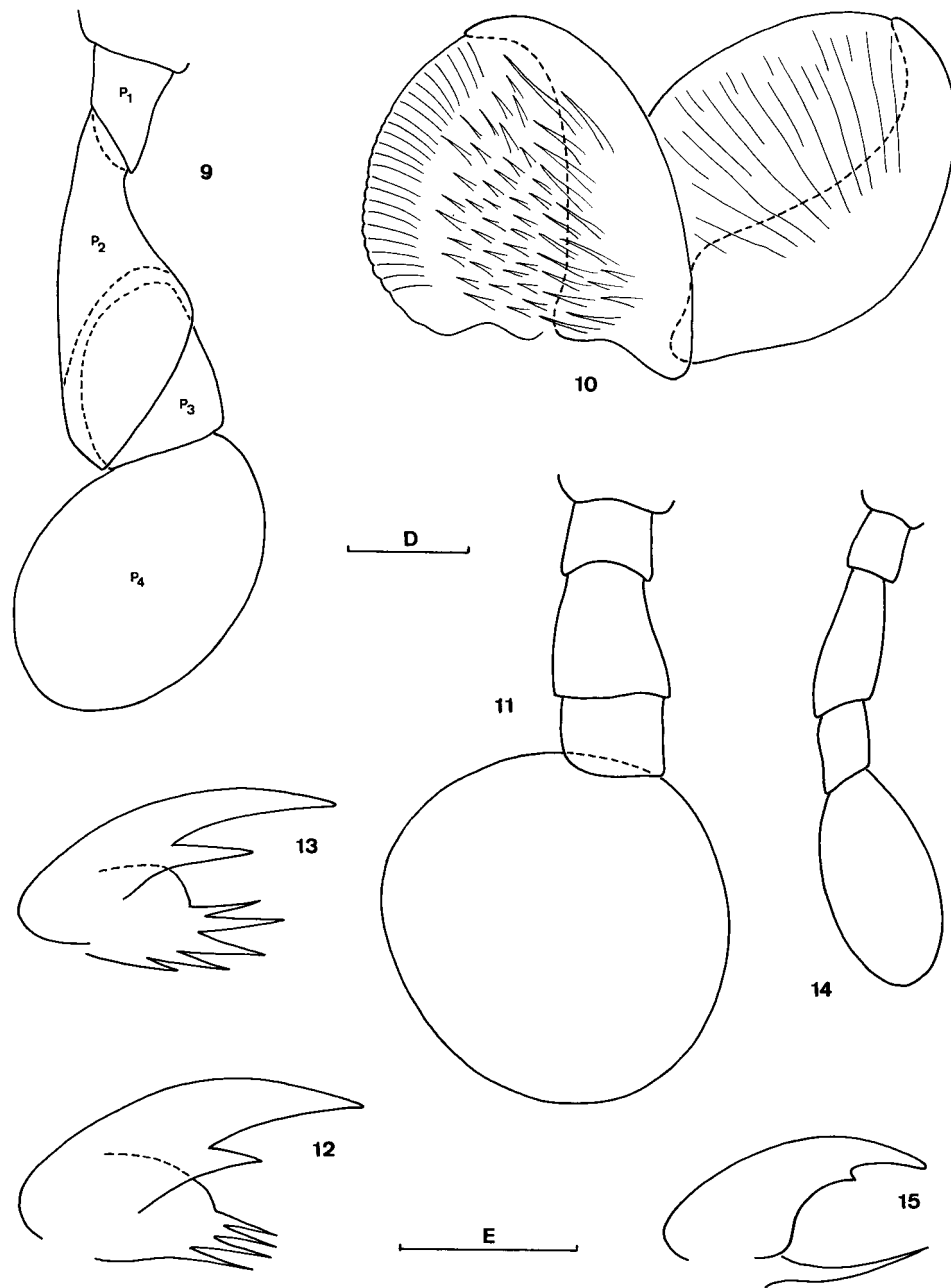
Biology. - The specimens were collected by beating vegetation. It is probable that they live on the lower parts of plants or in soil litter.

Remarks. - *B. murphyi* closely resembles *B. vilhenai* in the very light colour of meso- and metathorax, while *B. badonneli* is homogeneously brown coloured. *B. murphyi* can be distinguished from *B. vilhenai* by its dark brown prothorax (light brown as other thoracic segments in *vilhenai*, cf. fig. 191 in Badonnel, 1955) and sculpturing (areas on vertex and abdominal terga much more transversally elongated in *vilhenai*, some spinules in areas of vertex, cf. plate III D, F in Badonnel, 1955). The sculpture of *B. murphyi* is very similar to that of *B. badonneli*, but in the latter species some spinules are always present in the areas of vertex. The new species can be distinguished from both previously described species by its prothoracic chaetotaxy (greater number of hairs on lateral lobe of pronotum and only 2 setae on prosternum in *vilhenai*; greater number of hairs on median lobe of pronotum in *badonneli*; cf. figures in Badonnel, 1955 and New, 1971 respectively). The phallosome is very similar in all three species (cf. Figs 7, 8 and Fig. 71 in Badonnel, 1969).

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Figs 1-8. - *Belaphopsocus murphyi*, new species; Figs 1-7: 1, habitus female (lateral view); 2, pronotum female; 3, thoracic sterna female; 4, pretarsal claws female [ventral view of one pair of claws (cf. also Fig. 16 e-f) and schematic optical transverse section (x - x) through the middle of a claw, with detail of central carina in lateral view]; 5, gonapophyses female; 6, epiproct and left paraproct female; 7, phallosome male. - *Belaphopsocus badonneli* New; Fig. 8: phallosome male. - Scale bars: A = 0.01 mm (Fig. 4); B = 0.1 mm (Figs 2, 3, 6); C = 0.05 mm (Figs 5, 7, 8).



Figs 9-15. - *Belaphopsocus murphyi*, new species; Fig. 9: maxillary palpus female (pilosity not shown). - *Belaphopsocus badonneli* New; Fig. 10: pretarsal claws female (one pair of claws, in lateral view, showing outer and inner surface of vesicle, respectively at left and at right in the figure). - *Belapha schoutedeni* Enderlein; Figs 11-12: 11, maxillary palpus, female paralectotype; 12, pretarsal claw, female paralectotype. - *Belapha globifer* (Laing); Fig. 13: pretarsal claw, female lectotype. - *Belaphotroctes* sp. female; Figs 14-15: 14, maxillary palpus; 15, pretarsal claw. - Scale bars: D = 0.05 mm (Figs 9, 11, 14); E = 0.01 mm (Figs 10, 12, 13, 15).

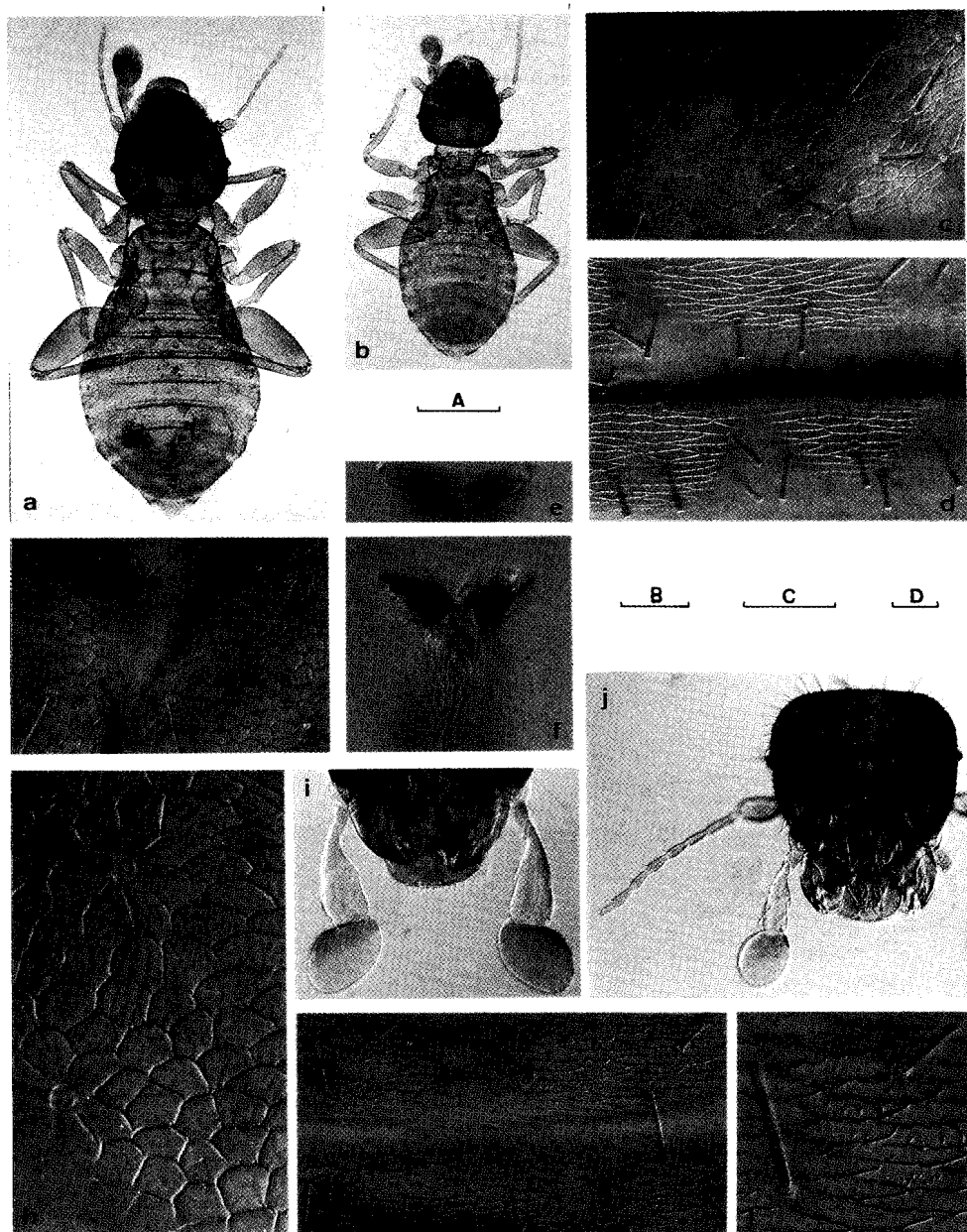


Fig. 16. - *Belaphopsocus badonneli* New; a-f: a, habitus female; b, habitus male; c, sculpture of vertex female (vertical suture indicated by a black triangle); d, sculpture of abdominal terga 4-5 female; e-f, one pair of pretarsal claws (female) observed by different focussing (e: more distal view, finely rippled central carina of vesicle visible; f: more proximal view, microtrichia on outer surface of vesicle visible; cf. also Fig. 4). - *Belaphopsocus murphyi*, new species; g-l: g, sculpture of vertex female (vertical suture indicated by a black triangle); h, same at higher magnification; i, mouthparts female; j, head male; k, sculpture of abdominal terga 4-5 female; l, same at higher magnification (tergum 4). - Scale bars: A = 0.3 mm (a, b); B = 0.1 mm (i, j); C = 0.05 mm (c, d, g, k); D = 0.01 mm (e, f, h, l). Photomicrographs of sculpture: anterior end always towards top of page; c-l: differential interference contrast.

LITERATURE CITED

- Badonnel, A., 1948. Psocoptères du Congo belge (2e note). *Revue Zool. Bot. afr.*, **40**: 266-322.
- Badonnel, A., 1949. Psocoptères du Congo belge (3e note). *Bull. Inst. r. Sci. nat. Belg.*, **25**: 1-64.
- Badonnel, A., 1955. Psocoptères de l'Angola. *Publções cult. Co. Diam. Angola*, **26**: 267 pp.
- Badonnel, A., 1969. Psocoptères de l'Angola et de pays voisins, avec révision de types africains d'Enderlein (1902) et de Ribaga (1911). *Publções cult. Co. Diam. Angola*, **79**: 152 pp.
- Badonnel, A., 1973. Psocoptères de l'Angola: IV. *Publções cult. Co. Diam. Angola*, **87**: 59-104.
- Badonnel, A., 1973. Espèces brésiliennes de la sous-famille des Embidopsocinae (Psocoptera: Liposcelidae). *Bull. Mus. natn. Hist. nat., Paris*, 3e série, no 87 (1972), Zoologie **66**: 1097-1139.
- Badonnel, A., 1977. Psocoptères de l'Angola: V. *Publções cult. Co. Diam. Angola*, **89**: 103-152.
- Badonnel, A., 1986. Psocoptères de Colombie (Insecta, Psocoptera). Missions écologiques du Professeur Sturm (1956 à 1978). *Spixiana*, **9**: 179-223.
- Enderlein, G., 1917. Beiträge zur Kenntnis der Copeognathen. IV. Zur Kenntnis der Copeognathen des Kongogebietes. *Zool. Anz.*, **49**: 257-259.
- Garcia Aldrete, A. N., 1988. The Psocids (Psocoptera), of Chamela, Jalisco, Mexico. Species diversity, abundance, distribution and seasonal changes. *Folia ent. mex.*, **77**: 63-84.
- Hagen, H. A., 1866. On some aberrant genera of Psocina. *Entomologist's mon. Mag.*, **2**: 170-172.
- Laing, F., 1925. On a new genus and species of Psocoptera from British Guiana. *Entomologist*, **58**: 289-290.
- Lienhard, C., 1990. Revision of the Western Palaearctic species of *Liposcelis* Motschulsky (Psocoptera: Liposcelidae). *Zool. Jb. Syst.*, **117**: 117-174.
- Motschulsky, V. de, 1852. Excursions entomologiques de 1852, jusqu'au 1 Juillet. Etudes entomologiques, Helsingfors **1852**, pp. 15-21.
- New, T. R., 1971. A new species of *Belaphapsocus* Badonnel from Brazil, with notes on its early stages and bionomics (Psocoptera). *Entomologist*, **May 1971**: 124-133.
- Roesler, R., 1943. Ueber einige Copeognathengenera. *Stettin. ent. Ztg*, **104**: 1-14.
- Smithers, C. N., 1990. Keys to the families and genera of Psocoptera (Arthropoda: Insecta). *Tech. Rep. Aust. Mus.*, **2**: 1-82.