First record of Pauropoda (Myriapoda) on Borneo

Ulf Scheller, Per Brinck and Pehr Henrik Enckell


Pauropoda have been collected for the first time from Borneo. Eight species were found belonging to 5 genera: 3 in Pauropodidae (Allopauropus, Rabaudauropus, Stylopauropus), one in Brachypauropodidae (Brachypauropoides) and one in Eurypauropodidae (Samarangopus). Eight species were found, seven of which were new to science: 2 were not suitable for study and 5 have been described, viz. Allopauropus borneonesiota and asymmetricus, Rabaudauropus dispar, Brachypauropoides penanorum and Samarangopus segniter.

Sampling in different types of secondary rain forests showed that species diversity was unfavourably influenced by fire in combination with previous logging.

Keywords: Pauropoda, soil fauna, rain forest, distribution, Borneo, Sabah.


Introduction

In September 1989 two of us, Per Brinck and Pehr H. Enckell from the Ecology Building, University of Lund, Sweden, collected 35 specimens of Pauropoda in rain forests in the Malaysia State of Sabah, Borneo. A region about 30 km SE Sipitang was visited and collections from there were brought together both by flotation and sifting. The third of us, Ulf Scheller, has identified the specimens and described the new species.

1 Abbreviations: ad. and subad.; an adult or a subadult specimen with the number of pairs of legs indicated; juv.: a juvenile specimen with the number of pairs of legs indicated.

2 Range of variation in adult paratypes in brackets.

Systematics

Order Tetrameroacerata

Family Pauropodidae
Subfamily Pauropodinae

Genus Allopauropus Silvestri, 1902
Subgenus Decapauropus Remy, 1957

1. Allopauropus (D.) borneonesiota Scheller sp.n. Figs. 1–8.

Type locality: Borneo, 2.5 km SE Mendolong, experimental plot, forest logged but not burnt, Acacia mangium, ferns and grass.


Taxonomic remarks. A(D.) borneoesiota may be a relative of bicuspidatus Remy (1956 a:139–141) from the Madagascan region. It is very close in many respects but clearly distinguished from the new species: the posteromedian bulge of the pygidial tergum is distally triangular in borneoesiota, rounded in bicuspidatus, the styli of subuniform width, not clavate, and the anal plate is narrowing anteriorly and with cylindrical appendages, not broadest anteriorly and with tapering appendages. There may be relationships also to two more species: infurcatus Hagino (1991:1017–1019) from Japan and lamenardiei Remy (1956 b:136–139) from Réunion.

Etymology. From Latin nesiota = islander.
Description

Length. Adult 0.93 mm.

Head. Tergal setae of medium length, very little clavate, annulate, blunt. Their relative lengths, 1st row: \(a_1 = ?\), \(a_2 = 10\); 2nd row: \(a_1 = ?\), \(a_2 = 13\), \(a_3 = 11\); 3rd row: \(a_1 = 6\), \(a_2 = ?\); 4th row: \(a_1 = 5\), \(a_2 = 6\), \(a_3 = 14\), \(a_4 = ?\). Lateral setae not studied. The ratio \(a_1/a_2 = a_3\) is: 1st and 2nd rows 1:1, 3rd row 0.7 and 4th row 1.1. Length of temporal organs almost 1.2x as long as their distance apart, small spherical pistil in hind part. Head cuticle glabrous.

Antennae. Segment 4 with 5 cylindrical, blunt, annulate setae. Relative lengths of them: \(p = 100\), \(p' = 64\), \(p'' = 42\), \(r = 40\), \(u = 7\). Tergal seta \(p\) as long as tergal branch \(t\). The latter 3.6x as long as wide, as long as sternal branch \(s\) which is clavate, 2.2x as long as wide with deep anterodistal truncation. Seta \(q\) lacking. Relative lengths of flagella (base segments included) and base segments: \(F_1 = 100\), \(b_1s = 5\), \(F_2 = 59\), \(b_2s = 4\); \(F_3 = 90\), \(b_3s = 5\). The \(F_4\) 4.3x as long as \(t\), \(F_2\) and \(F_3\) 2.6 and 4.0x as long as \(s\) respectively. Distal calyces helmet-shaped, glabrous. Globulus \(g\) 1.6x as long as its greatest diameter which is a little greater than diameter of \(t\); stalk conical; capsule subspherical; = 11 bracts. Antennae glabrous.

Trunk. Setae of collum segment simple, without rudiments of secondary branches, cylindrical, blunt, annulate; lateral ones 3.4x as long as submedian ones; sternite process broad with anteromedian incision; appendages and process pubescent, very shortly on the former.

Most tergal setae lacking; on anterior tergites they are similar to those on posterior part of head. There are 4+4 setae on tergite I, ?+2 on VI.

Relative lengths of trichobothria: \(T_1 = 100\), \(T_2 = 167\) (may be broken), \(T_3 = 90\), \(T_4 = 107\), \(T_5 = 116\). All but \(T_5\) have very thin axes, proximal 1/3 glabrous, exceedingly short pubescence more outwards. The \(T_5\) with thicker axes and short oblique pubescence, most distally erect.

Legs. Setae on coxa and trochanter of 9th pair of legs furcate, blunt, annulate; primary branch of coxal setae somewhat clavate, for the rest the branches are cylindrical; setae on trochanter 1.2x as long as coxal setae. More anteriorly these setae are simple without any traces of secondary branches.

Tarsus of 9th pair of legs slender, tapering, curved, 3.9x as long as its greatest diameter. Proximal seta tapering, pointed, with short oblique pubescence hairs, 0.3 of length of tarsus, 2x longer than distal seta which is subcylindrical, blunt, annulate. Cuticle of tarsus with faint pubescence.

Pygidium. Tergum. Posterior margin between \(st\) with a large triangular bulge protruding from a broad trapezoid base. Relative lengths of setae: \(a_1 = 100\), \(a_2 = 75\), \(a_3 = 109\), \(st = 41\). The \(a_1\) are thin, sickle-shaped, cylindrical, blunt, striate; \(a_2\) and \(a_3\) cylindrical, very faintly pubescent, tapering, curved inwards, \(a_2\) converging, \(a_3\) diverging, \(st\) thick, straight, leaf-shaped, blunt, glabrous. Distance \(a_1-a_2\) as long as \(a_2\), distance \(a_2-a_3\) 3x longer than distance \(a_1-a_2\); distance \(st-st\) 2.2x as long as \(st\) and 0.9 of distance \(a_1-a_2\).

Sternum. Hind margin between \(b_1\) with a broad indentation with flat bottom. Relative lengths of setae \((a_1 = 100): b_1 = 204\), \(b_2 = 73\). These setae cylindrical, blunt, \(b_1\) striate, \(b_2\) with short oblique pubescence, diverging. The \(b_1\) 1.1x as long as their distance apart; \(b_2\) 0.6 of distance \(b_1-b_2\). Anal plate narrowest posteriorly, a little broader than long with convex lateral margins; posteriorly a shallow median U-shaped indentation separating two short lobes each with a cylindrical, a little curved, blunt appendage protruding backwards; length of appendages 1.5x as long as the length of plate.

2. Allopauropus (D.) asymmetrical Scheller sp. n.

Type locality. Bomeo, 2.5 km SE Mendolong, experimental plot, cut but not burnt, Acacia mangium, ferns and grass.

Type material: Holotype: Ad.9(Q), locality as above, 1989.IX.3, loc. W4. — Paratypes: Same data as holotype, 3 ad. 9(Ọ); ibidem, formerly secondary forest, now Acacia mangium and ferns, 1 ad. 9(Q), 1 juv. 6, 1 juv. 3, 1989.IX.3, loc. W1. Holotype and paratypes in coll. ZooL Mus., Lund Univ., Sweden.

Taxonomical remarks. Many characters of the head, antennae, collum segment, trichobothria, legs and pygidium show resemblance to the Caribbean A. subauricularis Scheller (in Scheller & Muchmore 1989:174—176) known only from St. John in the Virgin Islands. It differs especially by the aspect of the anal plate (broadest anteriorly and with long posterior submedian appendages, not narrowest anteriorly and with short posterior submedian branches), the antennae (with all the discs of the flagella perpendicular to the axes, not with proximal discs oblique; with the stalk of the antennal globulus distinctly conical, not partly subcylindrical) and by the shape of the \(T_5\) (axes distally very thin, not thickened and subcylindrical).

Etymology. From Greek \(a\) = un-, \(sym\) = same and \(metron\) = measure.

Description

Length. Adults (0.53—)0.84 mm.

Head. Tergal setae of medium length, blunt, annulate; submedian ones very little clavate, lateral and sublateral ones cylindrical. Relative lengths of setae (only holotype), 1st row: \(a_1 = 10\), \(a_2 = 11\); 2nd row: \(a_1 = 11\), \(a_2 = 14\), \(a_3 = 13\); 3rd row: \(a_1 = ?\), \(a_2 = 10\); 4th row: \(a_1 = 10\), \(a_2 = 15\); lateral group: \(l_1 = 24\), \(l_2 = 12\), \(l_3 = 18\). The ratio \(a_1/a_2 = a_3\) is: 1st and 2nd rows 1:0, 3rd row ? and

4th row 1.3. Length of temporal organs a little longer than their distance apart; small pistil between posterior or margin and t¹. Head cuticle glabrous.

Antennae. Segment 4 with 4 annulate setae; p, p'
and p'' cylindrical, blunt, r tapering. Relative lengths of setae (paratypes only): p=100, p'=61–65, p''=31–34, r=53–56; p'' and u rudimentary. Tergal seta p (0.8–0.9) of the length of tergal branch r. The latter (2.7–)3.0(–3.3)x as long as wide, 1.1x as long as sternal branch s which is clavate, 1.9(–2.2)x as long as wide with deep anterodistal truncation. Seta q cylindrical, blunt, annulate, 0.6(–0.7) of the length of s. Relative lengths of flagella (base segments included) and base segments: F,1=100, bs,=5; F,2=(34–)43, bs,=5; F,3=(80–)88, bs,=5(–7). The F, (3.3–)3.5x as long as t, F,2 and F,3 (1.3–)1.6 and (3.0–)3.4x as long as s respectively. Distal calyces of F, and F,1, helmet-shaped, those of F,2 almost cylindrical; all calyces glabrous. Globulus g 1.4x as long as its greatest diameter which is 0.9 of diameter of r; stalk conical; capsule subspherical; ≈12 bracts. Antennae glabrous.

Trunk. Setae of collum segment simple but with rudiments of secondary branches; they are subcylindrical, blunt, annulate; lateral ones (2.2–)2.3x as long as submedian ones; sternite process small, narrow, anteriorly blunt.

Most tergal setae lacking, on anterior tergites they are as on head; there are 4+4 setae on tergite I, probably 6+6 on II–V and 7+4+2 on VI. Posterior setae of tergite VI somewhat shorter than setae of the head.

Relative lengths of trichobothria: T,1=100, T,2=87(–117), T,3=(112–)114, T,4=(116–)147, T,5=?(191). All have thin axes, those of proximal and middle part of T,1 thickest; pubescence hairs short, straight, simple, oblique on the main part of T,1 and T,2 and proximal part of T,3, for the rest erect, proportionately longest on distal part of T,1 and T,2.

Legs. Setae on coxa and trochanter of 9th pair of legs furcate, subcylindrical, blunt, annulate; primary branch thickest. More anteriorly these setae are simple with short rudiments of secondary branch only.

Tarsus of 9th pair of legs slender, tapering, (4.4–)4.5(–)4.8x as long as its greatest diameter. Proximal seta tapering, pointed, very shortly pubescent, (0.3–)0.4 of the length of tarsus, (1.8–)1.9(–2.0)x as long as distal seta which is subcylindrical, blunt, annulate. Cuticle of tarsus glabrous.

Pygidium. Tergum. Posterior margin between st with a broad triangular lobe. Relative lengths of setae: a,1=100, a,2=(92–)110, a,3=118(–142), st,=(83–)100. All tapering, glabrous; a,1 straight, a little diverging; a,2, a,3 and st curved inwards, converging. Distance a,1–a,2 (0.8–)1.0 of the length of a,1, distance a,2–a,3 (1.6–)2.0x as long as distance a,1–a,3; distance st–st (1.8–)2.3x as long as st and (2.1–)2.3x as long as distance a,2–a,3.

Sternum. Hind margin between b,1 with a broad indentation. Relative lengths of setae (a,1=100): b,1=(308–)470, b,2=(101–)125. The b,2 similar to a,2 and a,3. b,3 thin, cylindrical, blunt, annulate. The b,4 (1.3–)1.4(–1.5)x as long as their distance apart; b,5 0.7(–0.9) of distance b,1–b,4. Anal plate sublinguiform, broadest anteriorly, with concave lateral margins, posteriorly divided by a V-shaped indentation separating two short triangular lobes each with two long appendages: a subdistal, submedian, posteriorly directed one which is thin, cylindrical, tapering, curved inwards, about as long as plate and; a posterolateral leaf-shaped one which is directed obliquely upwards from tergal side of plate. Plate with appendages glabrous.

3. Allopauropus (D.) proximus Remy, 1948

Material. Borneo, Mendolong, experimental plot, secondary forest of Acacia mangium, 1 juv. 5, 1989.IX.1, loc. L41(4/4); ibidem, final felling of secondary forest, in a rest of the main crop, 1 ad. 9 (♂), 1989.IX.1, loc. L41(2); ibidem, in secondary forest of young Acacia mangium, 1 ad. 9 (♂), 1989.IX.1, loc. L36(23); ibidem, cut and burnt forest, very young Acacia mangium, 2 ad. 9 (♂), 1 juv. 5, 1989.IX.1, loc. L36(24); 2.5 km SE Mendolong, experimental plot, logged secondary forest, now with young Acacia mangium and ferns, 1 ad. 9 (♂), 1 subad. 8 (♂), 1 juv. 5, 1989.IX.3, loc. W1; ibidem, not burnt after logging, young Acacia mangium and dense and high field layer of ferns and grass, 2 ad. 9 (♂, sex?), 1989.IX.3, loc. W4.

Distribution. The species has a wide discontinuous range in the tropics and subtropics in the Americas, Africa and southern Asia. From southeastern Asia it is known from the Seychelles, Pondichéry, Sri Lanka and the Palau Islands.

Genus Rabaudauropus Remy, 1953

4. Rabaudauropus dispar Scheller sp.n.
Figs. 20–30.

Type locality: Borneo, 2.5 km SE Mendolong, experimental plot, forest not burnt after logging, now very young Acacia mangium, dense and high field layer of ferns and grass.

Type material: Holotype: Ad.9 (♂), locality as above, 1989.IX.3, loc. W4. — Paratypes: Borneo, Mendolong, Acacia mangium and grass, 1 ad. 9 (♂), 1 subad. 8 (♂), 1 juv. 6, 1 juv. 3, 1 stage?, 1989.IX.1, loc. L36(23). Holotype and paratypes in coll. Zool Mus., Lund Univ., Sweden.

Taxonomic remarks. The subgenus Donzelotauropus Remy in Stylopauroptus and the genus Rabaudauropus have several features in common e.g. the chaetotaxy of the tergites, the pygidial tergum provided with the setae b, and b, only and a more or less lengthened stalk of the antennal globulus g. In Rabaudauropus, however, the antennal globulus g' of the 3rd antennal segment...
has a long stalk, the sternal antennal branch has subequal anterodistal and posterodistal truncations and has also two setae, \( q \) and \( q' \). The characters most useful in distinguishing the two taxa are the seta \( q' \) on the sternal antennal branch (occur in Rabaudauropus, not in Stylopauropus (Donzelotauropus)) and the shape of the globulus \( g' \) of the 3rd antennal segment (long in Rabaudauropus, rudimentary in Stylopauropus (Donzelotauropus)).

The Borneo specimens are intermediate: the seta \( q' \) could not be discovered and the globulus \( g' \) has long broad stalk. Provisionally they have been placed in Rabaudauropus because the antennal globulus \( g \) is not so long and also less slender than it is generally in Stylopauropus and because the \( q' \) always is known to be short and thin and may has been lost here. Moreover the shape of the anal plate does not fit well in Stylopauropus and the shape of the sternal antennal branch is most alike the one in Rabaudauropus expandens Scheller (1968:301–304) from Chile which certainly is in Rabaudauropus in the sense of Remy.

**Description**

Length. Adults 0.74(−0.76) mm.

Head. Tergal setae of medium length, blunt; all clavate and densely striate except for \( a_1 \) of 2nd row, \( a_2 \) of 4th row and the lateral group which are cylindrical, annulate. Relative lengths of setae, 1st row: \( a_1=10 \), \( a_2=12(-14) \); 2nd row: \( a_1=(7)(12), a_2=(9)(14), a_3=(18-21) \); 3rd row: \( a_1=(9)(12), a_2=11(-13) \); 4th row: \( a_1=12(-15), a_2=11(-13), a_3=14(-16), a_4=6(-9) \); lateral group:

\[
\begin{align*}
l_1 &= 25(-27), l_2 = (25), l_3 = 25. \\
\end{align*}
\]

The ratio \( a_2/a_1-\quad a_1:1 \) is: 1st and 3rd rows 0.9(–1.0), 2nd row ?(1.3), 4th row (1.1–1.2). Length of temporal organs 1.6x as long as their distance apart; small pistil at posterior margin close to \( l_1 \) and \( l_2 \). Head cuticle glabrous.

Antennae. Segment 4 with 6 cylindrical blunt setae; \( p, p', p'' \) distinctly annulate, \( p''' \), \( r \) and \( u \) thinnest, almost glabrous. Relative lengths of setae: \( p=100 \), \( p'=(90-104), p''=(65-66), p'''=(19-22), r=30(-39), u=9 \). Tergal seta \( p \) 0.8(–0.9) of the length of tergal branch \( t \). The latter (3.2–3.3x as long as wide, (1.1–1.2)x as long as sternum \( s \) which is clavate, 2.4(–2.5)x as long as wide, with deep posterodistal truncation. Seta \( q \) as tergal setae of segment 4, 0.9 of the length of \( s \). Relative lengths of flagella (base segments included) and base segments:

\[
\begin{align*}
F_1 &= 100, b_3=6(-7), F_2 = 80(-116), b_5=5(-6), F_3 = 26(-43), b_8=70. \\
\end{align*}
\]

The \( F_1 \) (2.8–3.4x as long as \( F_2, F_2 \) (2.6–2.7)x as long as \( s \) and \( F_3 \) about as long as that branch. Distal calyces long, subconical, glabrous. Globulus \( g \) 1.5(–1.6)x as long as its greatest diameter which is as long as the diameter of \( t \); stalk stout, somewhat curved; \( =12 \) bracts; capsule with somewhat flattened bottom. Globulus \( g' \) of 3rd segment large, stalk stout, subcylindrical, distally cut obliquely, a sparse row of short hairs at distal margin around the hemispherical capsule. Antennae glabrous.

Trunk. Setae of collum segment of about the same length, furcate; primary branches broadly leaf-shaped with very short pubescence; secondary branches rudimentary, cylindrical, blunt, glabrous; sternite process broad, with anterior incision, granular; appendages wide with flat endsegment.

Tergal setae striate-annulate, subcylindrical on tergites I–III, cylindrical on IV–VI. There are 4+4 setae on tergite I, 6+6 on II–V, 4+4 on VI. Posterior setae of tergite VI 0.3 of their distance apart and almost as long as pygidial setae \( a_1 \).

Relative lengths of trichobothria:

\[
\begin{align*}
T_1 &= 100, T_2 = 104(-114), T_3 = (149-160), T_4 = (109-171). \\
\end{align*}
\]

All but \( T \) have very thin, straight, simple axes; pubescence hairs straight simple; on \( T_1 \) and \( T_2 \) very short and oblique in the middle, distally longer and erect; \( T_3 \) and \( T_4 \) with extremely short erect hairs in distal half; \( T_5 \) with thicker striate axes.

Legs. Setae on coxa and trochanter of 9th pair of legs furcate, blunt, with dense very short erect pubescence; primary branch leaf-shaped, secondary one a little clavate; length of secondary branch 0.7 of the length of primary one. More anteriorly secondary branch is rudimentary.

Tarsus of 9th pair of legs tapering, (3.9–4.5)(–5.0)x as long as its greatest diameter. Proximal seta 0.4 of the length of tarsus and 1.9(–2.2)x as long as distal seta; the former tapering, pointed, distally shortly pubescent; distal seta cylindrical, blunt, striate.

Pygidium. Tergum. Posterior margin almost straight with a small median, in the middle incised, bulge. Relative lengths of setae: \( a_1=100, a_2=(92-110), a_3=(230-242), s=(92-100) \). All these setae but distal part of \( a_1 \) glabrous, \( a_2 \) and \( st \) almost straight, the former cylindrical and blunt, the latter tapering and converging; \( a_2 \) and \( a_3 \) cylindrical, tapering, curved upwards. Distance \( a_2-a_1 \) 0.7(–0.9) of the length of \( a_2 \), distance \( a_3-a_2 \) (2.2–3.0)x as long as distance \( a_2-a_3 \); distance \( st–2.2 \) (–3.2)x as long as \( st \) and (2.5–3.1)x as long as distance \( a_2-a_1 \).

Sternum. Hind margin between \( b_1 \) straight with shallow V-shaped median indentation. Relative lengths of setae (\( a_1=100) \): \( b_1=280(-384), b_2=(95-98) \). Both are cylindrical, blunt; \( b_3 \) distally striate, \( b_4 \) almost glabrous, a little diverging. The \( b_5 \) 0.8 and \( b_6 \) (0.3–0.5) of their distance apart. Anal plate with two long thin appendages protruding posteriorly from a broadly triangular base; appendages cylindrical, a little diverging, distally curved inwards.
First record of Pauropoda (Myriapoda) on Borneo


Family Brachypauropodidae

Genus Brachypauropoides Remy, 1952

5. Brachypauropoides penanorum Scheller sp.n.
Figs 31–42.

Type locality: Borneo, 2.5 km SE Mendolong, experimental plot, forest not burnt after logging, now very young Acacia mangium, dense and high field layer of ferns and grass.

Type material: Holotype: Ad. 9 (Q), locality as above, 1989.IX.3, loc. W4. — Paratypes: Same data as holotype, 1 subad. 8 (Q); Mendolong, young Acacia mangium and grass, 1 juv. 5, 1989.IX.1, loc. L36(23). Holotype and paratypes in coll. Zool. Mus., Lund Univ., Sweden.

Taxonomic remarks. Eight species have been described in the genus, all from Madagascar and New Zealand. The Borneo material seems to be most close to some Madagascan species, particularly to B. actaeus Remy & Rollet (1960:218–220,232–233). However, the dissimilarities are distinct, e.g.: the setae of the posterior tergites are subcylindrical to a little clavate (not broad, leaf-shaped); the pygidial setae $b_2$ are cylindrical (not leaf-shaped); and the posterolateral corners of the anal plate are rounded (not acute). There are also separating characters in the shape of the temporal organs and the antennae.

Etymology. The penans, a Bornean forest tribe contending against the rain forest devastation.

Description

Length. Adult 0.61 mm.

Head. Tergal and lateral sides with 31 setae arranged as in fig. 31 and 32; transversal rows difficult to interpret. Relative lengths of the 5 submedian setae: 10, 12, 15, 20, 20; of lateral group: $l_1=4$, $l_2=15$, $l_3=25$. Setae leaf-shaped with distinct pubescence except $l_1$, which is cylindrical, annulate. Temporal organs with two tube-like appendages and one small bulge; longest appendage is 0.4 of the length of organ and protrudes backwards from posteromedian end; the second appendage, 0.1 of the length of organ protrudes forwards from anterolateral end; small bulge juts backwards between setae $l_1$ and $l_2$. Tergal side of head and temporal organs glabrous.

Antennae. Segment 1 with one short clavate striate seta, segment 2 with one clavate and one cylindrical annulate seta, segment 3 with one clavate seta and 3 cylindrical annulate ones. Segment 4 with 5 setae, all
cylindrical, blunt, annulate; relative lengths of them: $p=100$, $p'=91$, $p''=73$, $p'''=27$, $r=36$. Tergal seta $p$ 0.8 of the length of tergal branch $t$. The latter subcylindrical, proximal part tapering, 2.3x as long as wide, 0.9 of the length of sternal branch $s$. The latter thickest in proximal half and with anterodistal truncation, twice longer than wide; its seta $q$ cylindrical and annulate, inserted near the middle of sternal side, its length 0.7 of the length of $s$. Relative lengths of flagella (base segments included) and base segments: $F_1=100$, $bs_1=8$; $F_2$ and $F_3=78$ and their $bs=8$. The $F_1$, 3.6x as long as $t$, $F_2$ and $F_3$, 2.4x as long as $s$. Distal calyces helmet-shaped, with sparse erect simple pubescence hairs. Globulus $g$ with slender stalk, 1.5x as long as wide, its
greatest diameter 0.8 of diameter of t; 6 bracts; capsule spherical. Globulus $g'$ of 3rd segment rudimentary. Except for the calyces antennae are glabrous.

Trunk. Setae of collum segment subcylindrical, blunt, annulate, secondary branch rudimentary, extremely small; anterolateral seta 1.2x as long as submedian one. Sternite process blunt, anterior margin with short erect pubescence; appendages 2–segmented, glabrous.

Tergites I, III and VI entire, II, IV and V transversely 2-parted. Number of setae on tergites (if two values they are anterior and posterior group respectively; subad. 8 in brackets): I 30(22), II 15+20(14+13), III 30+19(12+11), IV 21+18(14+12), V 15+12, VI 4+4 (8+6). Setae on anterior tergites leaf-shaped, blunt, with distinct pubescence of simple oblique hairs; more posteriorly these setae are narrower, a little lanceolate or even subcylindrical. Cuticle of tergites glabrous.

Relative lengths of trichobothria: $T_1=100$, $T_2=101$, $T_3=85$, $T_4=125$, $T_5=131$. They have simple, most proximally glabrous, axes; proximal half of $T_3$ strongly clavate, distal half very thin, annulate; other trichobothria have thin, distally extremely thin and curved whiplike axes with short pubescence of simple erect hairs.

Legs. All legs 5-segmented. Setae on coxa and trochanter of 9th pair of legs similar, simple, cylindrical, annulate, without any traces of secondary branches. More anteriorly these setae are of the same shape but with short, cylindrical, glabrous rudiments of secondary branches.

Tarsus of 9th pair of legs tapering, 2.4x as long as its greatest diameter. Proximal seta tapering, pointed, with short oblique pubescence; distal seta cylindrical, blunt, annulate; the former 0.3 of the length of tarsus and about as long as the latter. Cuticle of tarsus glabrous.

Pygidium. Tergum. Hind margin with a shallow indentation between $a_1$. Relative lengths of setae: $a_1=10$, $a_2=19$, $a_3=20$, $s=4$. The $a_1$ seta, shortly spatulate, $a_2$ and $a_3$ leaf-shaped with parallel lateral margins, pubescence as on setae of tergites; $a_2$ somewhat diverging, $a_2$ and $a_3$ very much so; $st$ very short, cylindrical, blunt, glabrous, converging. Distance $a_1-a_2$, 2.5x as long as $a_1$, distance $a_2-a_3$, 1.1x as long as distance $a_1-a_2$; distance $st-st$ 6x longer than $st$ and 0.9 of distance $a_1-a_2$.

Sternum. Posterior margin between $b_1$ rounded with a low bulge having a shallow median incision. Relative lengths of setae (pygidial $a_1=10$): $b_1=67$, $b_2=17$, $b_3=12$. These setae cylindrical: $b_1$ tapering, pointed, striate; $b_2$ blunt, with oblique pubescence, diverging; $b_3$ blunt, striate, curved inwards. The $b_1$ 1.3x as long as distance $b_1-b_2$, $b_2$, 0.7 of distance $b_1-b_2$ and $b_3$, 0.2 of distance $b_1-b_3$. Anal plate widens from its base, lateral margins diverging and forming posterolateral lobes just at broadest part of plate which is a little behind the middle; a wedge-shaped lobe protrudes backwards from posterior margin; lobe with two appendages which protrude backwards from sternal side near its base; appendages cylindrical, curved inwards, blunt, with sparse oblique pubescence; length of appendages 0.7 of the length of plate.

Family Eurypauropodidae
Subfamily Eurypauropodinae

Genus Samarangopus Verhoeff, 1934

6. Samarangopus segniter Scheller sp.n.

Description

Length. Adult 0.86 mm.

Head. Setae $mp$, $ma$ and those of the $lp$-row cylindrical, blunt, striate; those of $la$- and $pe$-rows tapering, striate. Vertex: Only one seta, $l=8 \mu m$. Tempus: Not studied closely, probably no setae. Frons: no frontal pores; close to anterior part of temporal organ small subglobular frontal verruca, $l=1 \mu m$. Index of frontal setae: median row, 2 setae, $mp=13$, $ma=7$, $mp-ma=3$; lateral row, 4 setae, $lp_1=12$, $lp_2=lp_3=lp_4=14$, $lp_5=lp_6=lp_7=lp_8=8$, $lp_9=11$, $lp_1=15$; anterior row, 2 setae, $la_1=9$, $la_2=11$, $la_3=9$, $la_4-la_5=13 \mu m$. Distance $la_1-la_2-la_3-la_4=1.4$. Peristomial setae, 5 in number, $pe$ and $pe$ lacking here, $pe_9=9$, $pe_8=8$, $pe_7=15$, $pe_6-pe_7=11$, $pe_5-pe_6=2$, $pe_4-pe_5=3$, $pe_3-pe_4=7$, $pe_2-pe_3=10 \mu m$.

Antennae. Segments 1–4 and whole the antennal branches glabrous; chaetotaxy of the former: 2/2+2g'f'. Setae subcylindrical-tapering, striate, on segment 4 $p=11$, $p'=12$, $p''=8 \mu m$; no $p''$, $u$ and $r$. Sternal branch with deep anterior truncation, posterior margin $=14$, $\phi$ of base = 7, maximum $\phi$ = 9, $q=10 \mu m$. Type locality: Borneo, 2.5 km SE Mendolong, experimental forest, now very young Acacia mangium forest, dense and high field layer of ferns and grass. Type material: Holotype: Ad. 9(9), locality as above, 1989.IX.3, loc. W4. Holotype in coll. Zool. Mus., Lund Univ., Sweden.

Taxonomical remarks. The species is similar to the Madagascan S. saproxyliphilus Remy (1956 a: 223–225) from which it is distinguished e.g. by proportionately shorter bases of the antennal flagella, distal part of the trichobothrium $T_3$ clavate (not corotate), much more longish anal plate with tapering posterior branches (not distally widened) and by the large lanceolate setae $b_3$ (not thin, tapering).

Etymology. From Latin segniter = slow.
Posterior margin/length of $g$ = posterior margin/maximum $\phi = 1.6$, maximum $\phi/\phi$ of base = 1.3. Tergal branch a little clavate, $l = 16$, $\phi$ of base = 4, maximum $\phi = 6$ $\mu$m; pore not identified; length of $t/\text{maximum } \phi = 2.5$. Globulus $g$, $l = 9$, $\phi = 5.5$, $\phi$ of base = 1.5 $\mu$m; number of bracts = 10, their length = 4.5, capsule spherical, $l = 3$ $\mu$m. Relative lengths of flagella (base segments included): $F_1$ = 100, $F_2$ = 47, $F_3$ = 92. Lengths of base segments, $b_s$ = 12, $b_s$ = 8, $b_s$ = 13 $\mu$m. The $F_1$ 3.9x as long as $t$, $F_2$ and $F_3$ and $F_4$ and 4x longer than $s$ respectively. Calyces of $F_1$ conical, those of $F_2$ and $F_3$ hemispherical, distinctly smaller.

**Trunk.** Setae of collum segment similar, furcate, branches subequal in length, short, blunt, annulate; base segment as long as branches. Sternite process granular, broadly triangular with shallow anteromedian incision; appendages wide, cylindrical, glabrous, apices flat.

Tergites with 4 main types of protuberances: 1. large, wedge- or leaf-shaped, with thin cylindrical shaft; they are on anterior margin of tergite I, lateral margins of I–V and posterolateral corners of VI; those of anterior margin of I are broadly wedge-shaped with widened base and thin cylindrical shaft; the other, except the small ones just anterior of the trichobothria $T_2$, are leaf-shaped, base not widened, shaft cylindrical (Figs. 46, 49, 50); 2. smaller, cylindrical or in the shape of an upside down truncated cone with a small umbrella-like organ protruding from an apical cavity, the most distal part of organ just at the surface of cuticle; these protuberances irregularly distributed, on VI in two transversal rows (Figs. 46, 48, 49, 50); 3. small conical blunt erect teeth distributed on all the tergites (e.g. Fig. 48, 49); 4. small flat blunt teeth in groups of 4–6 at posterior margins of I–V (Figs. 47,
48). On II-IV bare patches with smooth surface, 2+3 in number on II, 2+2 on III and 2+3 on IV.

Number of marginal protuberances: I, 27 (anterior and lateral); II, 1 (small)/10; III, 5/7; IV, 6/5; V, 7/4; VI, 5 or 6/1.

All trichobothria but $T_1$ with very thin and distally curled axes which are glabrous except for the most distal part which has a minute pubescence. The $T_1$ with thicker axes, increasing in width, in the distal 1/3 forming large clavate endswelling covered with a dense short pubescence arranged in rows transversely. Lengths of trichobothria: $T_1$=102, $T_2$=100, $T_3$=45 and 49, $T_4$=81, $T_5$=70 μm. Ratio $T_5/T_4=0.5$.

Legs. All legs 5-segmented. Setae on coxa and trochanter of 9th pair of legs furcate with thin, cylindrical, blunt, striate branches; the latter long and subserial on trochanter but on coxa they are much shorter and one of the branches is 2.5x as long as the other. More anteriorly one of the branches is rudimentary, glabrous.

Tarsus of 9th pair of legs tapering, somewhat curved, glabrous, 1.8x as long as its greatest diameter; two tergal setae, both tapering, pointed, glabrous; length of proximal one = 10, distal one = 4.5 μm; the latter proportionately much thicker than the former. Proximal seta 0.3 of the length of tarsus and 2.2x as long as distal seta. Setae similar on leg 1. All legs with large main claw and small straight anterior secondary claw. On femur of leg 1 a triangular and almost glabrous plate, 1 = 3 μm, protrudes from anterior side.

Pygidium. Tergum. Posterior margin between st with a pentagonal plate protruding backwards; plate with concave lateral margins, narrowest anteriorly and with obtuse posterior corners. Lengths of setae: $a_1=a_7=7$, $a_2=a_2=14$, $s=3$ μm; all blunt, glabrous, $a_1$, $a_2$, and $a_3$ thin, cylindrical, $a_4$, curved inwards, $a_5$ and $a_6$, straight, $a_7$, converging, st thick, tapering, curved outwards, diverging. Distance $a_1-a_7=10$, $a_2-a_2=27$, $a_3-a_3=35$, $a_4-a_4=9$, $a_5-a_5=4$, $s-t-st=10$ μm. Ratio $s-t-st/a_1-a_7=1.0$, $a_1/a_2-a_2=0.7$, $a_2-a_3/a_3-a_7=2.5$.

Sternum. Posterior margin between $b_3$ with 3 posterior bulges, 2 rounded lateral ones near $b_1$ and a median one with a shallow incision. Setae tapering, $b_2$ very large, lanceolate, with transparent wings; $b_3$ and distal parts of $b_1$ and $b_2$ minutely granular. Lengths of setae: $b_2=32$, $b_3=24$, $b_4=11$ μm. Distance $b_1-b_2=35$, $b_2-b_2=50$, $b_3-b_3=29$ and 30, $b_4-b_4=12$ and 13 μm. Ratio $b_3/b_2=1.1$, $b_4/b_2=1.3$.

Anal plate 1.5x as long as broad, broadest near the middle, lateral margins anteriorly convex, posteriorly concave; distal part of plate cleft by a deep V-shaped incision into two tapering branches; each branch cut squarely and provided with two appendages: a submedian, short, straight, tapering, glabrous one and a stalked, leaf-shaped, subtriangular, posteriorly directed bladder which is about 0.6 of the length of plate.

**General distribution of the genera so far found in Borneo**

The collection comprised 35 specimens from a restricted area in the neighbourhood of Mendolong in Sabah. No less than 8 species were found, belonging to 3 of the 5 families in the class. Seven of the species were new to science indicating a most diversified fauna.

Five genera were collected. Largest range has *Allopauropus* in Pauropodidae here represented by 4 species one of which only, *A. proximus*, is previously known. It is widespread and has been reported from many parts of the tropics and subtropics. Of the remaining species one could not be described and the other two show different affinities. *A. borneoesiota* points in the direction of Madagascar-Réunion but also of Japan and *asymetricus* seems to be close to a Caribbean species. Similar affinities difficult to interpret are common in incompletely known groups as the pauropods.

Another Pauropodidae genus with wide range is *Stylopauropus*, a mainly Holarctic genus with a few partly dubious records only from southern countries, viz. Remy’s *S. andinus* (1962:52-53) from Argentina which probably is a *Rabaudauropus*, two species from Australia which both are widespread in the Nearctic and the western Palearctic and may be introduced and *S. hastifer* and *karamani* both described by Remy from Madagascar and Sri Lanka respectively. The latter two, however, belong to the nominate subgenus while the Bornean material (a juvenile specimen with 3 pairs of legs only) has to be placed in the subgenus *Donzelotaupobus* the nearest records of which are from easternmost Russia (Scheller 1981) and Japan (Hagino 1991).

The genus *Rabaudauropus* into which one Bornean species has provisionally been placed is poorly known but seems to have a wide range with the nearest records from Sri Lanka (Scheller 1970) and New Caledonia (Scheller 1993). The two genera *Brachypauropoides* and *Samarangopus* in Brachypauropodidae and Eurypauropodidae respectively have discontinuous ranges from Madagascar to New Zealand. The former was earlier known from these two islands only and the latter from Madagascar, Mauritius, Java, New Caledonia and the Australian mainland. They have not
been reported from the Asian mainland but have been expected to be there as a result of the faunal interchange during the Pleistocene. The great geographical relationship between Borneo and that area is striking and the zoogeographical similarities are evident in many groups. The collection accounted for above agrees in that respect but indicates obvious relationship also to Notogaea. Probably Borneo got the major part of its Pauropoda fauna in pre-pleistocene time.

Effects of logging and fire on species diversity

Extensive tracts of everwet tropical rain forests have been burnt in Borneo both by disastrous large scale wildfires and by more or less limited impact by man. In two areas belonging to the latter category, both in the Malaysia State of Sabah, păuropods were extracted by means of water flotation and sifting from litter and surface soil layers. The investigated sites are situated at or near Mendolong, about 30 km SE Sipitang, and were covered by secondary forests of different age, most of which have been cleared and reforested with Acacia mangium in later years. Though the number of samples (6) and specimens (35) is low it is evident that the species diversity is quite unfavourably influenced by fire in combination with previous logging. In clear-felled and burnt forests (loc. L41, L36/23, L36/24, W1) at most two species were found but in a forest which had been reforested after logging but not burnt (loc. W4) 5 species were found. In this case the soil surface was well preserved also because the logs were extracted by man-power, not by tractor. Moreover, the elimination within the păuropods seems to have affected particularly species with limited ranges, while Allopauropus proximus which is widespread in the tropics and subtropics and may be rather indifferent to the ecological conditions of the environment, was found in all the sites where păuropods occurred.

References


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