



Abh. Ber. Naturkundemus. Görlitz	Band 72 Heft 2	S. 177 – 194	2000
--	-------------------	--------------	------

ISSN 0373-7586

New Collembola Symphypleona from the tropical cloud forest of Ecuador (Insecta)

GERHARD BRETTFELD & NATHAN D. TRINKLEIN

Zoological Institute, University of Kiel, Germany and
Stanford University, Stanford, CA, USA

Abstract

Among 9 taxa of Collembola Symphypleona out of only 3 litter samples, there were 7 species new to science, which are described here. A new key to the *gracilicornis*-group of *Ptenothrix* species and a new definition of the genus *Sphaeridia* Linnaniemi, 1912, are added.

Zusammenfassung

Neue Collembola Symphypleona aus dem tropischen Nebelwald Ecuadors (Insecta).

In nur 3 Streuprobeen fanden sich unter 9 Taxa von Collembola Symphypleona 7 für die Wissenschaft neue Arten; diese werden hier beschrieben. Außerdem ist ein neuer Schlüssel für die *gracilicornis*-Gruppe der *Ptenothrix*-Arten entworfen worden, und es wird die Gattung *Sphaeridia* Linnaniemi, 1912, neu definiert.

Introduction

From 1 July to 28 July 1998, the junior author, together with Sam White and Michael Southern, all from Wake Forest University in Winston-Salem, North Carolina, U.S.A., undertook a Summer Research Project in Ecuador. They wished to study the ecological diversity of litter invertebrates in a tropical cloud forest and chose the Otonga preserve in the Cotopaxi Province, founded in 1988 by Dr Giovanni Onore of the Universidad Católica in Quito.

This preserve lies on the western slopes of the Andes at about 2000 m altitude and has a climate of moderate temperatures but high humidity because of abundant rain and mist. The steep hillsides are covered with a dense forest with many epiphytic bromeliads and mosses. On the forest floor, the litter layer is 15 to 30 cm deep and always moist.

Over 100 litter samples were collected from different altitudes and from different depths of the litter layer. The samples were treated in Berlese funnels, or were directly inspected under a dissecting microscope. Symphypleona were only found in the 3 samples A, C, and D collected 16 July 1998 from the upper 10 cm of litter of the forest floor at about 1900 m altitude. In these 3 samples, among many Collembola Arthropleona, only 29 specimens of

Symphyleona were found, but they belong to 9 taxa, 7 species of which are new to science. They are described in the following.

Since there are 2 species of the *gracilicornis*-group of *Ptenothrix* species present, a new key to this group is added for all species considered by YOSII (1969) and those described since then. One of the *Sphaeridia* species lacks the spines of the male antennae. This genus, therefore, has been redefined to include other characteristics than the antennal spines.

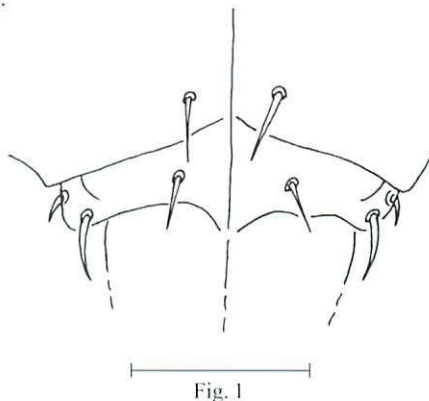
The present study is a good example of the large species diversity of the tropics, since even small collections may contain several new species.

The preparation method and the nomenclature of the chaetotaxy follow the previous papers of the senior author. The types are held in the senior author's collection. The account of the species is given in alphabetical order.

***Collophora* Richards, 1964, spec.**

3 specimens from sample A, 1 from sample C.

These 4 specimens are small (total length up to 0.4 mm) and apparently juvenile. They have not been studied.



Neelides bisetosus n. sp.

Fig. 1 Ventral head-back and basal parts of labium (bar = 25 μ m)

***Neelides bisetosus* n. sp.**

Holotype. Female (on slide, together with 2 *Sphaeridia* spec.) from sample C. No further specimens known.

Derivatio nominis. This new species is named after its diagnostic characteristic.

Diagnosis. A species of the genus *Neelides* Caroli, 1912, with 1 diagnostic characteristic: – Basomedian field of labium with 1+1 short, normal setae (apomorphy?).

Description. Total length about 0.35 mm; dens : mucro = 1.6. Pigment missing. Labrum, claws, and furca as in *Neelides minutus* (Folsom, 1901) and *Neelides folsomi* Caroli, 1912.

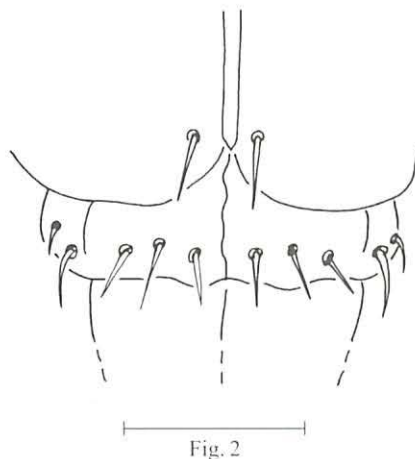


Fig. 2

Neelides minutus (Folsom, 1901)

Fig. 2 Ventral head-back and basal parts of labium (bar = 25 μ m)

Ventral head-back and basomedian field of labium each with 1+1 setae (Fig. 1).

Remarks. The single specimen of *Neelides bisetosus* n. sp. had been shrunk and compressed before mounting, therefore only the harder structures can be observed, which resemble those of *Neelides minutus* and *folsomi*. The new species differs from these species only in the mentioned labial feature: Both *Neelides minutus* (after specimens from Europe) and *folsomi* have 3+3 setae of the basomedian fields of the labium (FJELLBERG 1999) (Fig. 2), a similarity supporting the synonymy between these species as was already assumed from the uncertain and varying tooth Bp of the claws by DALLAI (1979). *Neelides diana*e (Christiansen & Bellinger, 1981), which lacks the posterior lobe of ventral tube, and *Neelides snideri* Bernard, 1975, which clearly differs from the genus *Neelides* (CHRISTIANSEN & BELLINGER 1998), should be assigned in other new genera.

Neelus fimbriatus n. sp.

Type series. 3 females (holotype female no. 1) and 1 juvenile (on slides), 3 specimens (in alc.) from sample A; 2 females and 1 male (on slides), 2 specimens (in alc.) from sample C.

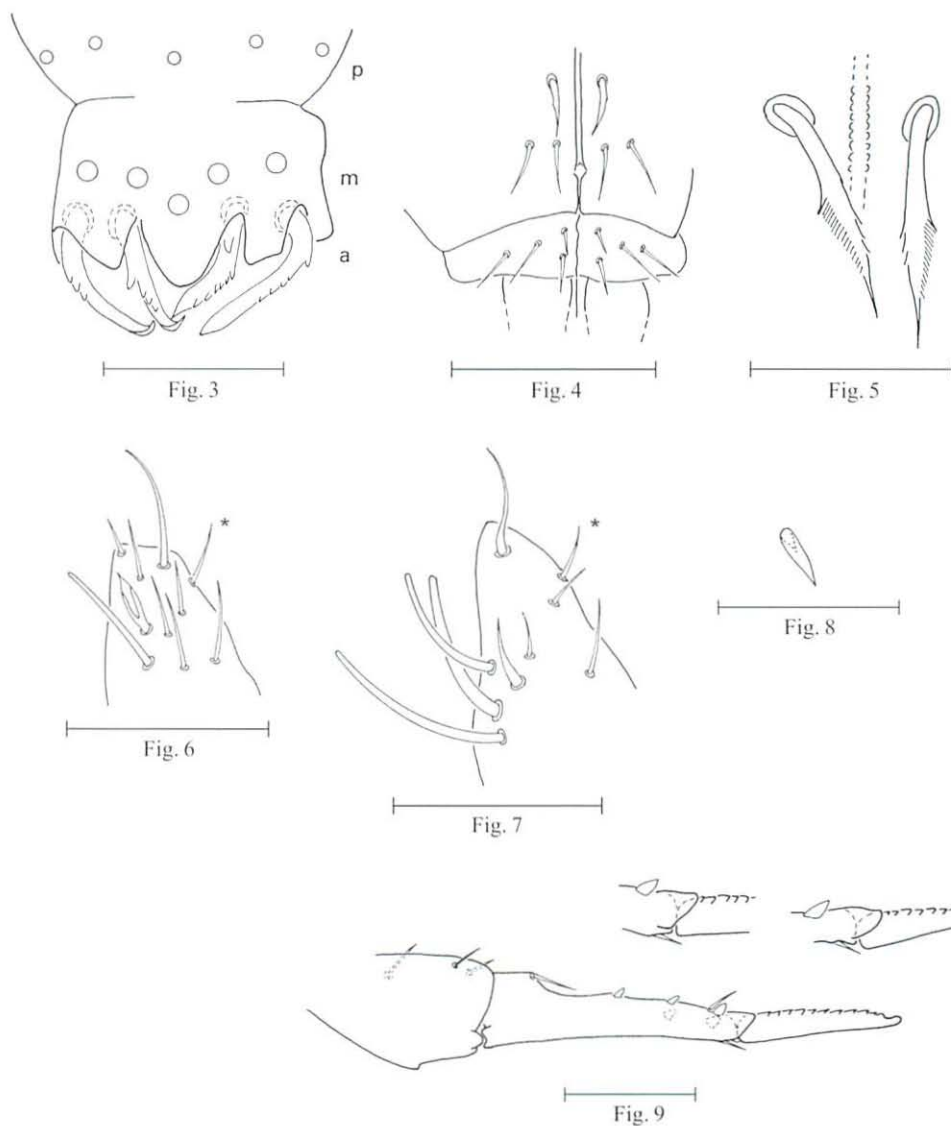
Derivatio nominis. This new species is named after the 2 ciliate setae of its ventral head-back.

Diagnosis. A species of the genus *Neelus* Folsom, 1896, with 3 diagnostic characteristics:

- Upper setal pair of ventral head-back ciliate (apomorphy; plesiomorphy: smooth setae),
- setae of labial row a thick and roughly serrate (apomorphy; plesiomorphy: smooth setae),
- posterior side of dentes with 1+1 basal setae (other species with 2+2 setae, character state not certain).

Description. Measurements and proportions. Total length up to 0.5 mm, length of neosmithuroid setae 6 – 7 μ m; manubrium : dens : mucro = 1.7 : 1.8 : 1.

Colour. Head and body white or spotted with dark brown or reddish brown.



Neelus fimbriatus n. sp.

Fig. 3 Labrum with toothed a setae (bar = 20 μ m)

Fig. 4 Ventral head-back and basal parts of labium (bar = 50 μ m)

Fig. 5 Modified setae of ventral head-back (bar = 20 μ m)

Fig. 6, 7 Tip of antennal segment IV, * = identical seta, dorso-anterior and ventro-posterior view respectively (bar = 20 μ m)

Fig. 8 Neosminthuroid seta (bar = 20 μ m)

Fig. 9 Furca with enlarged outer (left) and inner (right) distal tooth (bar = 50 μ m)

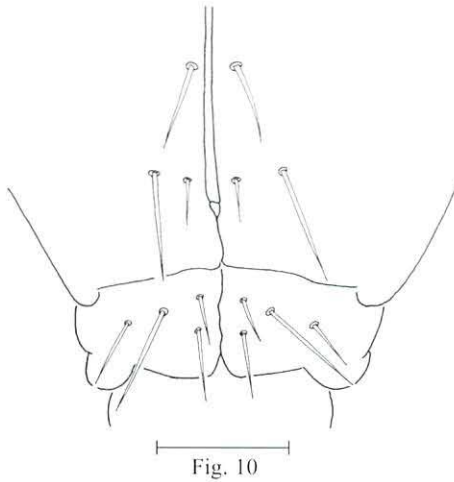


Fig. 10

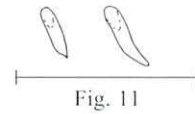


Fig. 11

Neelus murinus Folsom, 1896

Fig. 10 Ventral head-back and basal parts of labium (bar = 20 μ m)

Fig. 11 Neosminthuroid setae (bar = 20 μ m)

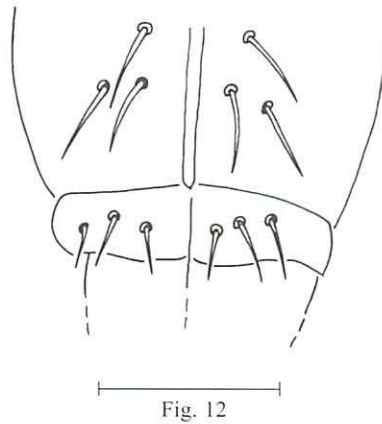


Fig. 12

Megalothorax minimus Willem, 1900

Fig. 12 Ventral head-back and basal parts of labium (bar = 25 μ m)

Chaetotaxy and special structures (only the main characteristics noted). Setae of labrum row a thick and roughly serrate (Fig. 3), of row m thick and normal, of row p thin and normal; basomedian field of labium with 4+4 setae; ventral head-back with 2+2 normal distal setae and 1+1 thicker and ciliate proximal ones (Figs. 4, 5). Antennal segment IV, dorso-anterior side of tip, with 1 forked seta, other side with 1 short spiny one (Figs. 6, 7).

Upper edge of furca base with 1 pair of short, sharply pointed neosminthuroid setae (Fig. 8). Manubrium with 3+3 setae; basal parts of dentes with 1+1 setae, tips each with 1+1 thick lateral spines (Fig. 9).

Remarks. *Neelus fimbriatus* n. sp. clearly differs from the other 3 *Neelus* species (*Neelus desantisi* Najt, 1971, *labralisetosus* Massoud & Vannier, 1967, *murinus* Folsom, 1896), although the setae of ventral head-back are known only in *Neelus murinus* (Fig. 10, original observation). These setae and those of the basomedian fields of the labium (FJELLBERG 1999) differ between the genera, apparently also between the species, and should be considered in future descriptions (these setae in *Megalothorax minimus* Willem, 1900, see in Fig. 12 for comparison). In antennal segment IV, the thick apical sensillum lies on the ventro-posterior side, i. e. oppositely to the forked seta as figured here (Figs. 6, 7) and as figured with *N. labralisetosus* but not as figured with *N. murinus* by MASSOUD & VANNIER (1967). For the genus *Neelus*, the neosminthuroid setae are first described here; they are also present in *N. murinus* (Fig. 11), which means that all 3 genera of the Neelida have such modified setae of the furca base. The thick apical spines of the dentes also occur in the other species, but here in *N. fimbriatus* they seem to be thicker than usual.

***Pararrhopalites ecuadorensis* n. sp.**

Holotype. Male (bleached, on 3 slides) from sample D. No further specimens known.

Derivatio nominis. This new species is named after Ecuador, the country of the type locality.

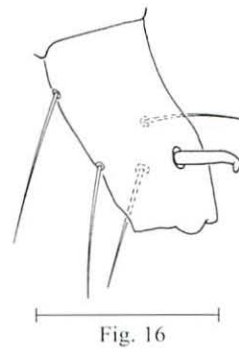
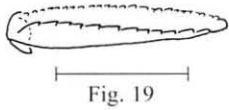
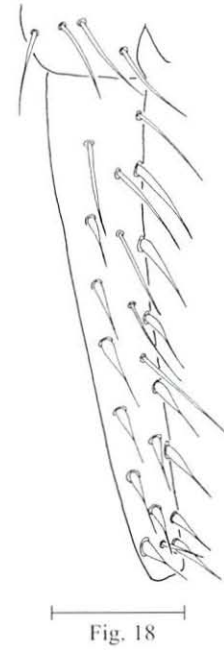
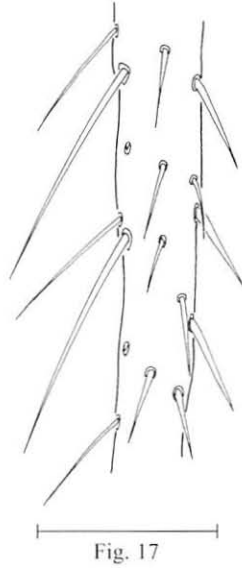
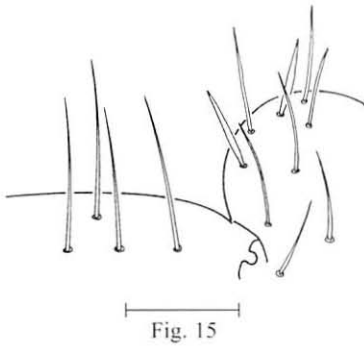
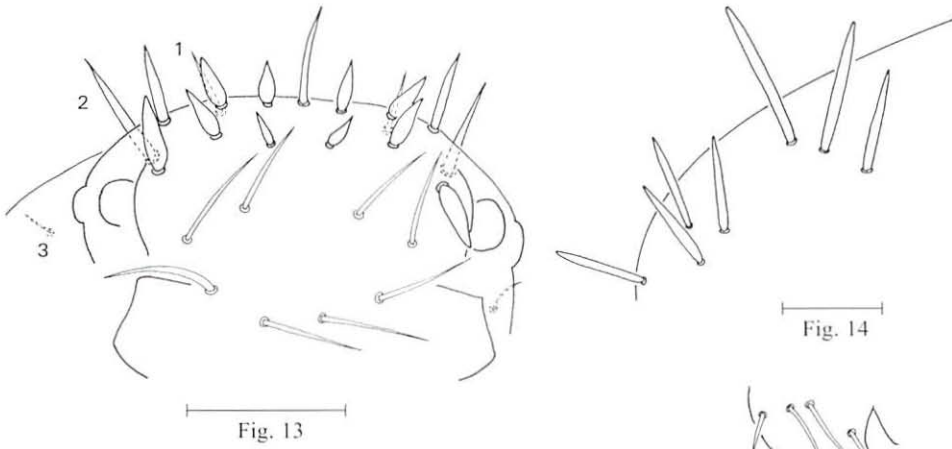
Diagnosis. A dark species of the genus *Pararrhopalites* Bonet & Tellez, 1948, with 5 diagnostic characteristics (character states within the genus *Pararrhopalites* uncertain):

- Eye patches with 2+2 ommatidia,
- head apex with 5+5 thick spinelike setae,
- antennal segment IV with 12 subsegments,
- antero-dorsal part of large abdomen with long spinelike setae,
- dorsal part of small abdomen with 3 thickened setae.

Description. Measurements and proportions. Total length 0.5 mm, head 0.18 mm, antennal segment IV = 312 μ m, mucro 60 μ m; whole antenna : head length (down to edge of clypeus) = 2.8, antennal segment I : II : III : IV = 1 : 2 : 4 : 11, mucro : dens : manubrium = 1 : 2.5 : 2.2.

Colour. Eye patches black; black violet pigment in particular on head apex and dorsal and lateral parts of large abdomen, other parts of head grey violet, small abdomen with few pigment, ventral side of abdomen unpigmented; antennae dark, legs slightly pigmented, furca unpigmented.

Chaetotaxy and special structures. Eye patches with 2+2 ommatidia; apex with 5+5 thick spinelike and 3 longer setae, setal pair 2 of dorsal head-back also longer than others (Fig. 13); labrum only with normal setae; ventral head-back with 3+3 oval organs. Antennal segment IV with 12 subsegments, basal and apical ones longer than others. Anterior part of large abdomen with thick and long spinelike setae (Fig. 14), posterior part with normal ones; 4+4 ventral setae. Dorsal part of small abdomen with 3 setae thicker than others (Fig. 15). Ventral tube with 1+1 setae; retinaculum with 1 seta. Trochanter III with 1 thick and blunt spine (Fig. 16), other trochanters and all femora only with normal setae; each tibiotarsus with 4 oval organs in row pe, tibiotarsus III with 2 long and minutely scaled outer setae IIIpe and IVpe (Fig. 17); claws slender with or without minute inner tooth,



Pararrhopalites ecuadorensis n. sp.

- Fig. 13 Apex of head (bar = 50 μ m)
- Fig. 14 Thick setae of anterior part of large abdomen (bar = 50 μ m)
- Fig. 15 Setae of posterior part of large abdomen and of dorsal part of small abdomen (bar = 50 μ m)
- Fig. 16 Spine of trochanter III (bar = 50 μ m)
- Fig. 17 Long setae of tibiotalarsus III (bar = 50 μ m)
- Fig. 18 Posterior side of dens seen from outer side (bar = 50 μ m)
- Fig. 19 Mucro (bar = 50 μ m)

tunica missing; empodial filaments exceeding claws. Manubrium with 7+7 normal setae; anterior side of dens with long setae of formula 3+1,3,2,2,1,(1),1, posterior side mainly with basally thickened setae, without short papillae (Fig. 18); mucro without seta, anterior edge sharp without furrow, both posterior edges toothed, tip round (Fig. 19).

Remarks. *Pararrhopalites ecuadorensis* n. sp. has 2+2 ommatidia and thus only resembles *P. oculus* Bonet & Tellez, 1948, from Mexico, all other known species have another number of ommatidia. *P. ecuadorensis* differs from that species by several characteristics: Pigment black instead of yellow and orange, antennae longer (ratio of antennae : head = 2.8 instead of 2 in male and ratio of segment I to IV = 11 instead of 7 in male), setae of head apex thick instead of lancet-shaped, antennal segment IV with 12 subsegments instead of 9, dorso-anterior side of large abdomen with long and thick setae instead of short and stout ones, tibiotarsus III with 2 long setae instead of 3, and anterior side of dens with at least 12 setae instead of 9.

This number of differences clearly shows that this single male belongs to a separate species.

***Ptenothrix fuscamaculata* n. sp.**

Holotype. Female (bleached, on 3 slides) from sample D.

Paratype. 1 juvenile female (pigmented, on 3 slides) from sample D.

Derivatio nominis. This new species is named after its colour pattern of brown spots.

Diagnosis. A light species of the genus *Ptenothrix* Börner, 1906, with 8 diagnostic characteristics (character states not always certain):

- Head and body with small brown spots,
- head apex with 3+3 thick spinelike setae (number plesiomorphic; apomorphy: more pairs of spines),
- head clypeus with 2 thick spinelike median setae (number plesiomorphic; apomorphy: more clypeal spines),
- thick spinelike setae behind bothriotrichia ABC and D (apomorphy; plesiomorphy: normal setae),
- furca base with 2+2 thick spines (apomorphy; plesiomorphy: 1+1 or without thick spines),
- long thickened setae of posterior part of small abdomen of equal length,
- seta a0 of upper anal valve as a thick spinelike seta (apomorphy; plesiomorphy: normal seta),
- claws without cavity (plesiomorphy; apomorphy: cavity present).

Description. Measurements and proportions (of holotype female). Total length 1.4 mm, head 0.7 mm, mucro 220 μ m, appendices anales 100 μ m; whole antenna : head length = 2.4, antennal segment I : II : III : IV = 1 : 5.8 : 6.6 : 1.1, mucro : dens : manubrium = 1 : 2.8 : 2.4, appendices anales : unguis III inner edge = 1.1, mucro : unguis III inner edge = 2.3, appendices anales : mucro = 0.5, long anterior spines of large abdomen : mucro = 0.3 – 0.4, short dorsal spines of large abdomen : mucro = 0.1 – 0.2, ratio of outer setae of dentes E1 – E4 = 1 : 1 : 4.3 : 6.5.

Colour. Eye patches black; background colour whitish yellow, brown pigment in spots on head and abdomen; antennae dark, basal segments of legs with dark apical spots (Fig.20).

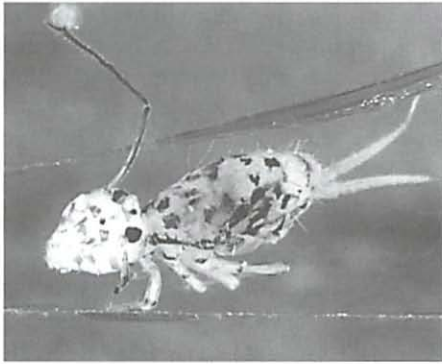


Fig. 20

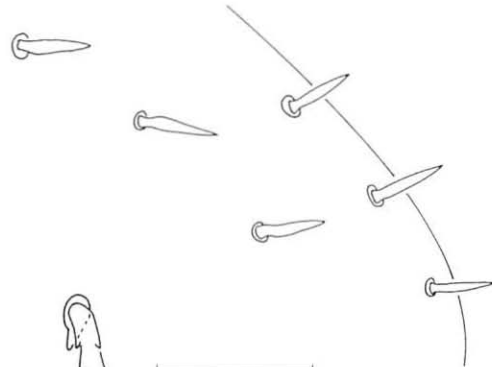


Fig. 21

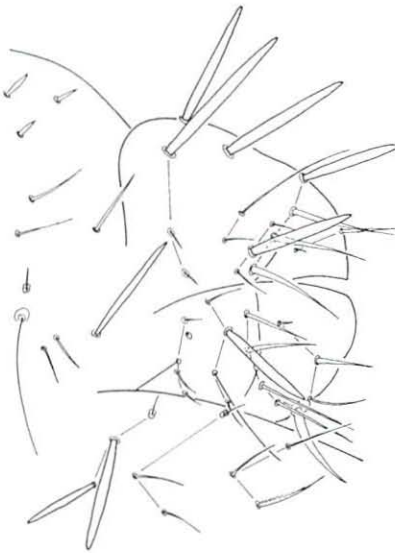


Fig. 22



Fig. 23

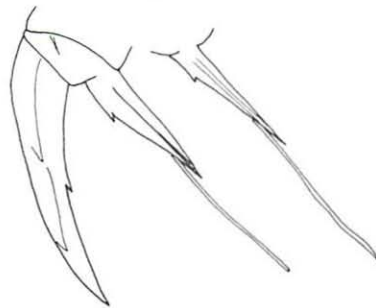


Fig. 24

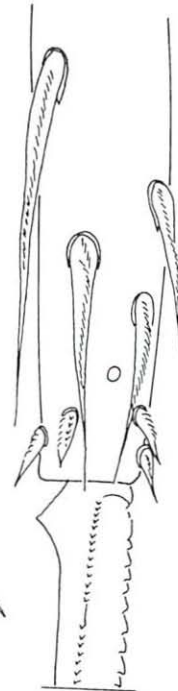


Fig. 25

Ptenothrix fuscamaculata n. sp.

Fig. 20 Habitus and colour pattern, total length without furca about 1.4 mm.

Fig. 21 Thick setae of slight protuberance of large abdomen (bar = 50 μ m)

Fig. 22 Abdominal segments V and VI and furca base (bar = 100 μ m)

Fig. 23 Modified setae of tibiotarsus III (bar = 50 μ m)

Fig. 24 Claw and empodium III and empodium I (bar = 50 μ m)

Fig. 25 Distal part of furca and part of mucro, outer side to the left (bar = 50 μ m)

Chaetotaxy and special structures (chaetotaxy of antennae and legs not studied). Eye patches with 8+8 ommatidia and 2+2 short setae; apex and frons of head with 3+3 thickened setae (2 pairs of medium length, 1 pair shorter), frons also with 6+6 very short setae; clypeus of head with 2 median spinelike setae, formula of middle setae 1,1,2,2,1,1,2,2 (see Figs. 26, 27, but all setae in *P. fuscamaculata* stouter). Setae of dorso-anterior part of large abdomen long and thickened, of middle and posterior part short and stout, and of slight posterior protuberance more thickened (Fig. 21); region behind bothriotrichia ABC with 2+2 long thickened setae as on anterior part; furca base with 2+2 long thickened and 1+1 rough setae (Fig. 22). Abdominal segment V behind bothriotrix D with 1+1 long thickened setae as on anterior part of large abdomen. Dorsal part of abdominal segment VI with 8 long thickened setae A3, m1, DL2, P1, a0 (M', M, N, H, a0 after YOSII 1969), seta sa normal, sa' very short; ventral part of segment VI with 1+1 long thickened setae VI2 (L after YOSII 1969), setae sa1 very short, sa2 normal; appendices anales pointed, smooth, and curved (Fig. 22). Tibiotarsus III with 2 curved, coarsely toothed setae (Fig. 23); claws without central cavity, with 2+2 lateral teeth and small inner tooth; empodial filaments I and II flattened and pointed, filaments III long and blunt (Fig. 24). Formula of anterior setae of dens 3,2,1,1...1, outer and inner setae of posterior side basally toothed, distal ones more than proximal, the most proximal ones only rough; mucro without seta, inner posterior edge with about 26, outer 42 teeth (Fig. 25).

Remarks. *P. fuscamaculata* n. sp. has a slight abdominal protuberance with thicker spines. These features, according to SNIDER 1990, are arguments to assign it to the genus (or subgenus) *Papirioides* Folsom, 1924, although the typical species of that genus have a long and club-shaped abdominal protuberance. We do not follow the opinion of Snider, since YOSII & LEE (1963: 32) stated that the members of *Papirioides* lack the setae G of abdominal segment VI (as do the *Ptenothrix* males, YOSII 1969). In *Ptenothrix fuscamaculata*, also in both *Papirioides* species in SNIDER (1990), however, in the females the setae G (= P2) are present, thus they do not belong to that genus but to *Ptenothrix*. The question is whether this characteristic is really valid to define the genus *Papirioides* (see also GREENSLADE 1994); further studies are needed to find such a feature.

More comments to this new species see below with the other new *Ptenothrix* species.

Ptenothrix rubra n. sp.

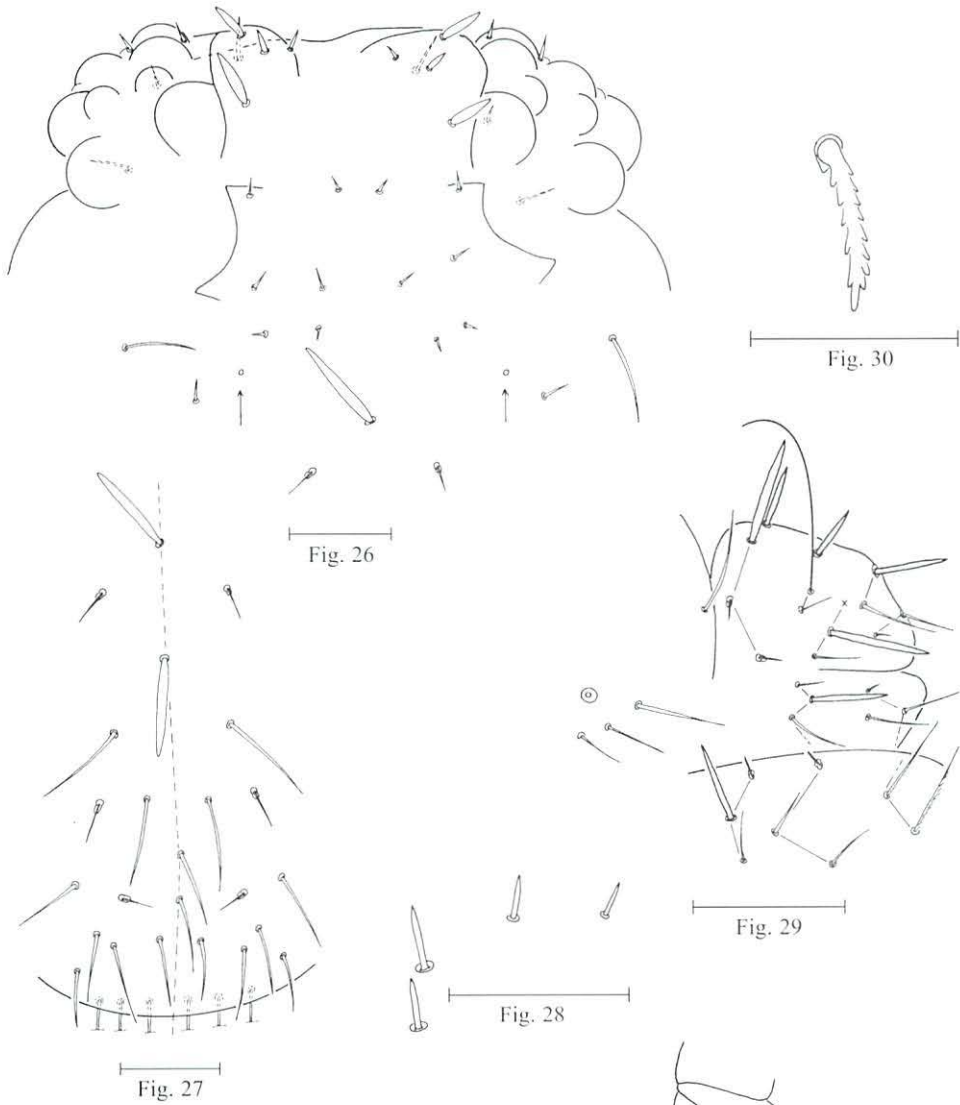
Holotype. Male (bleached, on 3 slides) from sample C.

Paratype. Male (pigmented, on 3 slides) from sample D.

Derivatio nominis. This new species is named after its red-violet colour.

Diagnosis. A red species of the genus *Ptenothrix* Börner, 1906, with 8 diagnostic characteristics (character states not always certain):

- Head and body with quite uniform red-violet pigment,
- head apex with 3+3 thick spinelike setae,
- head clypeus with 2 thick spinelike median setae (number plesiomorphic; apomorphy: more clypeal spines),
- only normal setae behind bothriotrichia ABC and D (plesiomorphy; apomorphy: thick spines),
- furca base with 1+1 thick spinelike setae (plesiomorphy; apomorphy: 2+2 thick spines),
- thick spinelike setae of small abdomen of different length,



Ptenothrix rubra n. sp.

Fig. 26 Apex and frons of head (bar = 50 μ m)

Fig. 27 Clypeus of head (bar = 50 μ m)

Fig. 28 Short setae of posterior part of large abdomen (bar = 50 μ m)

Fig. 29 Abdominal segments V and VI and furca base; ventral anal valve not completely visible (bar = 100 μ m)

Fig. 30 One of the 2 modified setae of tibia-tarsus III (bar = 50 μ m)

Fig. 31 Claw and empodium III (bar = 50 μ m)

- seta a0 of upper anal valve as thick spinelike seta (apomorphy; plesiomorphy: normal seta),
- claws with cavity (apomorphy; plesiomorphy: cavity absent).

Description. Measurements and proportions (of 2 adult males). Total length 0.8 and 0.9 mm, head 0.44 mm, mucro 110 and 130 μm ; whole antenna : head length = 2.9, antennal segment I : II : III : IV = 1 : 6.4 : 8.4 : 1.5, mucro : dens : manubrium = 1 : 3.2 : 2.5, mucro : unguis III inner edge = 2.2, long anterior spines of large abdomen : mucro = 0.4 – 0.5, short dorsal spines of large abdomen : mucro = 0.1 – 0.15, ratio of outer setae of dentes E1 – E4 = 1.2 : 1 : 4 : 6.2.

Colour. Eye patches black; head and body with red-violet pigment, most intensely on dorsal part of large abdomen, head and small abdomen lighter, lateral sides of large abdomen with few irregular pale spots and ventral side pale; antennae and legs red-violet, also claws pigmented, furca with little pigment but also mucro pigmented.

Chaetotaxy and special structures (chaetotaxy of antennae and legs not studied). Eye patches with 8+8 ommatidia and 2+2 short setae; apex and frons of head with 3+3 thickened setae (2 pairs of medium length, 1 pair shorter), frons also with 6+6 very short setae; clypeus of head with 2 median spinelike setae, formula of middle setae 1,1,2,2,1,1,2,2 (Figs. 26, 27). Setae of dorso-anterior part of large abdomen long and thickened, of middle and posterior part short and stout (Fig. 28); region behind bothriotrichia ABC only with normal setae; furca base with 1+1 long thickened and 1+1 rough setae (Fig. 29). Abdominal segment V behind bothriothrix D with long but normal setae. Dorsal part of abdominal segment VI with 8 thickened setae A3, m1, DL2, P1, a0 (M', M, N, H, a0 after YOSII 1969) but setae m1 and DL2 thinner and shorter than other thick ones, seta sa normal, sa' very short; ventral part of segment VI with 1+1 thickened setae VI2 (L after YOSII 1969) of medium length, setae sa1 very short, sa2 normal (Fig. 29). Tibiotarsus III with 2 curved, coarsely toothed setae (Fig. 30); claws with central cavity, with 2+2 lateral teeth and 2 small inner teeth; empodial filaments long, thin and pointed (Fig. 31). Formula of anterior setae of dens 3,2,1,1...1, outer and inner setae of posterior side basally toothed, distal ones more than proximal, the most proximal ones only rough; mucro without seta, inner posterior edge with about 25, outer with about 35 teeth.

Remarks: We are convinced that *Ptenothrix rubra* n. sp. is a separate species, since the chaetotaxy of the males does not principally differ from their females (YOSII 1969). The female should be known, however, to confirm and complete this description.

Remarks to the two new *Ptenothrix* species. The two new *Ptenothrix* species differ in their colour pattern and in some chaetotaxic characteristics (e. g. in the setae of postero-lateral parts of the large abdomen and of the furca base). The colour pattern of *P. fuscamaculata* n. sp. resembles that of *P. brasiliensis* Delamare Deboutteville & Massoud, 1963, but the former has a white background with brown spots, the latter is yellow with dark blue spots. There are more differences e. g. in the thick dorsal spines of the abdominal segment VI (of equal length instead of some shorter than others), in the claws (without a cavity instead of having one), and in the empodial filaments (blunt or flattened instead of knobbed). The red colour of *P. rubra* n. sp. resembles *P. argentina* Delamare Deboutteville & Massoud, 1963, but there are differences in the thick dorsal spines of the abdominal segment VI (some shorter than others instead of all of equal length), in the seta sa of the dorsal anal valve (normal instead of short), and in the empodial filaments (pointed instead of knobbed).

The new *Ptenothrix* species have 2 thick unpaired clypeal spines and a thick seta a0 of the upper anal valve, thus belonging to the *gracilicornis*-group of *Ptenothrix* species as it was described and compared in a key by YOSII (1969). In recent years, some more species sharing these features were described. A new key, therefore, is presented here to distinguish them and the 2 new species better. In this key 15 species are considered. The position of *P. brasiliensis* and *P. utingae* is not certain since the setae of the dorsal head-back (in *P. brasiliensis*) and the anal setae sa and sa' (in both species) are not sufficiently described; they appear, therefore, twice in the key.

Key to the *Ptenothrix gracilicornis*-group of species

(some abbreviations according to YOSII 1969 added in brackets)

- 1 Spines of head apex serrate, Angola
murphyi (Delamare Deboutteville & Massoud, 1964)
 - These spines smooth or striated, never serrate 2
- 2 Dorsal part of abdominal segment VI with thick spines A3 (M') and m1 (M) 3
 - Only setae A3 (M') thick, m1 (M) and DL2 (N) setaceous, Puerto Rico
borincana Soto-Adames, 1988
- 3 Dorsal part of abdominal segment VI with thick spines DL2 (N) 4
 - These setae setaceous 13
- 4 Dorsal anal valve with setae sa' very short, sa normal 5
 - Setae sa' as long as sa 10
- 5 Setal pair 1 of dorsal head-back (setae g) as long as other setae of head apex 6
 - Setal pair 1 longer than other setae of head apex 9
 - = Setal pair 1 shorter than other setae of head apex, Brazil
brasiliensis Delamare Deboutteville & Massoud, 1963
- 6 Furca base without thick spines, Nepal *himalayensis* Yosii, 1966
 - Furca base with thick spines 7
- 7 Furca base with 1+1 thick spines 8
 - Furca base with 2+2 thick spines *fuscamaculata* n. sp.
- 8 Head and legs coloured black, Brazil *utingae* Arlé & Guimarães, 1976
 - Head and body red violet *rubra* n. sp.
- 9 (5) Head apex with 4+4 spines, Sudan *violaceopus* Hüther, 1967
 - Head apex with 5+5 or 6+6 spines, Hawaii *hawaiiensis* Snider, 1990
- 10 (4) Head apex with 3+3 or 4+4 spines 11
 - Head apex with 5+5 or 6+6 spines 12
- 11 Head apex with 3+3 spines 14
 - Head apex with 4+4 spines, Brazil *utingae* Arlé & Guimarães, 1976
- 12 Spines of head apex long and of about equal length, North America
marmorata (Packard, 1873)
 - Spines of head apex short, only pair 1 of dorsal head-back (g) longer, India
keralae Prabhoo, 1971

- 13 (3) Dorso-anterior part of large abdomen with only 1+1 long spines, Melanesia
gracilicornis (Schäffer, 1898)
 – This body part with 3+3 long spines, Thailand *brouquissei* Nayrolles, 1989
 = This body part with 4+4 long spines, the Philippines *palawensis* Yosii, 1969
- 14 (11) Head and body with varying pattern of red violet pigment, Argentina
argentina Delamare Deboutteville & Massoud, 1963
 – Head and body yellow with dark blue spots, Brazil
brasiliensis Delamare Deboutteville & Massoud, 1963

Sphaeridia aspinosa n. sp.

Holotype. Male no. 2 (on slide) from sample A.

Paratype. Male no. 1 (on 2 slides) from sample A.

Derivatio nominis. This new species is named after its spineless antennae.

Diagnosis. A species of the genus *Sphaeridia* Linnaniemi, 1912, with 2 diagnostic characteristics:

- Antennae without spines (plesiomorphy; apomorphy: with spines),
- ventral tube with one pair of long and slender posterior processes (apomorphy; plesiomorphy: only with 1 posterior pair of small vesicles).

Description (mainly the differences from *Sphaeridia pumilis* (Krausbauer, 1898) s. str. are noted, see BRETFELD 1995).

Measurements. Whole length 0.14 and 0.18 mm.

Colour. Eye patches black; body colour red-violet.

Chaetotaxy and special structures. Frons of head with all pairs of setae and only with normal setae. Antennal segment II with 6, III with 4 long sensilla, without spines to form clasping antennae (Fig. 32). Dorsal side of thorax only with normal setae. Posterior side of ventral tube with small median and 1+1 slender processes with apical knob (Fig. 33). Tibiotarsus III seta IIIpi with tooth, seta IVpi smooth (Fig. 34), seta IIpe long and pointed; claws slender (Fig. 35). Furca without specific features.

Remarks. *S. aspinosa* n. sp. resembles *S. biclava* n. sp. (see below) in the main characteristics, but the ventral tube and its structures are smaller, the tips of the processes are symmetrical, and the antennae lack the usual 2 spines. Because of the median process of its ventral tube, although the process is small, *S. aspinosa* belongs to the *brevipila*-group of *Sphaeridia* species (BRETFELD & GAUER 1994), but there is no species known, the ventral tube of which is similar to this one.

The spineless antennal segments II and III look like an anomaly, since there is no other *Sphaeridia* species known which lacks these spines. Both males, however, have the same antennal structure, which is an argument for a normal feature and against an anomaly. Strictly speaking, these antennae should characterise a new genus, since the special modifications of the male antennae are genus specific (MASSOUD & BETSCH 1972). We do not name a new genus for these 2 males, because all other structures are similar or identical to those of other *Sphaeridia* species.

If this is accepted, the definition of the genus *Sphaeridia* must be altered in that no longer the two spines of antennal segments II and III are valid, but the following structures which separate it from the other genera of the Sminthuridida (BETSCH 1980, BRETFELD 1999):

1. Tibiotarsus III without a distal tibiotarsal organ (this characteristic is shared with the genera *Debouttevillea* Murphy, 1965, and *Denisiella* Folsom & Mills, 1938).
2. Mucro without a seta (separating *Sphaeridia* from the genera mentioned in entry 1).
3. Bothriotrichia ABC form an obtuse angle opening to the posterior (separating *Sphaeridia* from all other genera of the Sminthuridida and of the genera mentioned in entry 1).
4. Thorax of males without vesicles (only shared with the genus *Yosiides* Massoud & Betsch, 1972, which has more complicated antennae).

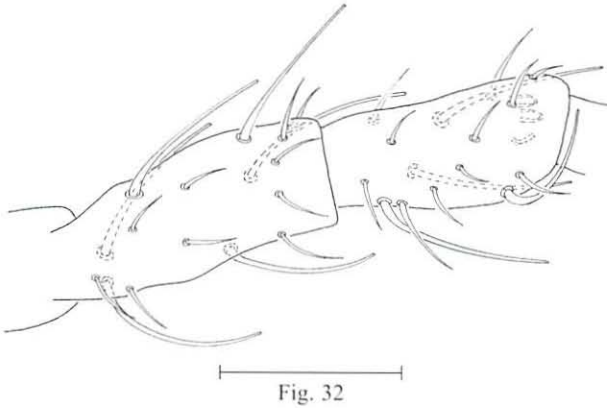


Fig. 32

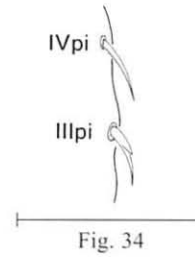


Fig. 34

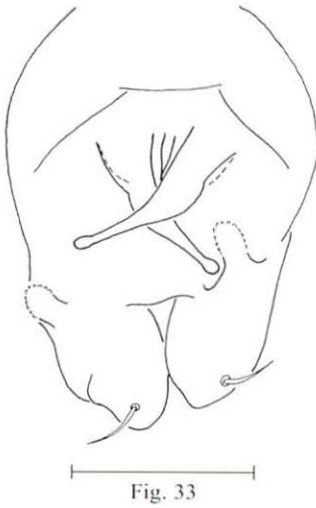


Fig. 33

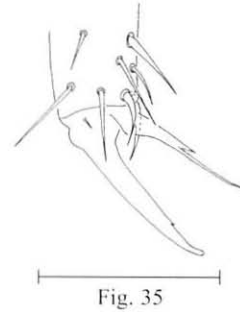


Fig. 35

Sphaeridia aspinosa n. sp.

Fig. 32 Left antennal segments II and III seen from anterior (bar = 20 μ m)

Fig. 33 Posterior side of ventral tube (bar = 20 μ m)

Fig. 34 Tibiotarsus III setae IIIpi and IVpi (bar = 20 μ m)

Fig. 35 Claw and empodium I seen from posterior (bar = 20 μ m)

Sphaeridia biclava n. sp.

Holotype. Male (on 2 slides) from sample C. No further specimens known.

Derivatio nominis. This new species is named after the 2 posterior processes of its ventral tube, which resemble clubs.

Diagnosis. A species of the genus *Sphaeridia* Linnaniemi, 1912, with 1 diagnostic apomorphy:

- Ventral tube with one pair of long and thick posterior processes (plesiomorphy: only with 1 posterior pair of small vesicles).

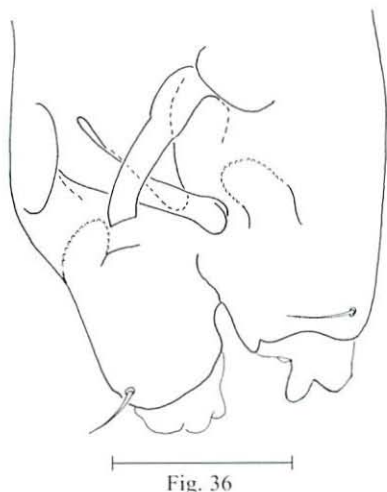
Description (mainly the differences from *Sphaeridia pumilis* s. str. are noted, see BRETfeld 1995).

Measurements. Total length 0.2 mm.

Colour. Eye patches black; body colour red-violet.

Chaetotaxy and special structures. Frons of head with all pairs of setae and only with normal setae. Antennal segment II with 6, III with 4 long sensilla (see Fig. 32), with spine each to form clasping antennae. Dorsal side of thorax only with normal setae. Posterior side of ventral tube with thick median and 1+1 thick asymmetrical processes with apex cut or knobbed respectively (Fig. 36). Tibiotarsus III seta IIIpi with tooth, seta IVpi smooth or also with tooth, seta IIpe long and pointed; claws slender. Furca without specific features.

Remarks. *S. biclava* n. sp. resembles *S. aspinosa* n. sp. (see above) in the main characteristics, but the ventral tube and its structures are larger, the tips of the processes are asymmetrical, and the antennae have the usual 2 spines. Because of the median process of its ventral tube, *S. biclava* belongs to the *brevipila*-group of *Sphaeridia* species (BRETfeld & GAUER 1994), but there is no species known, the ventral tube of which is similar to this one.



Sphaeridia biclava n. sp.

Fig. 36 Posterior side of ventral tube (bar = 20 μ m)

Sphaeridia spec.

2 females, 4 juveniles from sample C.

Females with coarsely toothed setae IIIpi and IVpi of tibiotarsus III.

These specimens may belong to the new species described above, but there is no feature shared with those males, and they cannot be assigned to another known species.

Conclusion

These few samples with Collembola Symphypleona studied here do not allow a greater ecological comparison. They show, however, as already mentioned, the great species diversity in these deep litter layers of the tropical cloud forest. Therefore, as a summary, the samples with their taxa, and the number of specimens found, are added.

Sample A (12 specimens): *Collophora* spec. (3 specimens), *Neelus fimbriatus* n. sp. (7 specimens), *Sphaeridia aspinosa* n. sp. (2 males).

Sample C (15 specimens): *Collophora* spec. (1 specimen), *Neelides bisetosus* n. sp. (1 specimen), *Neelus fimbriatus* n. sp. (5 specimens), *Ptenothrix rubra* n. sp. (1 male), *Sphaeridia biclava* n. sp. (1 male), *Sphaeridia* spec. (2 females, 4 juveniles).

Sample D (4 specimens): *Pararrhopalites ecuadorensis* n. sp. (1 male), *Ptenothrix rubra* n. sp. (1 male), *Ptenothrix fuscamaculata* n. sp. (1 female, 1 juvenile female).

Acknowledgement

The senior author would like to thank Romano Dallai, Siena, Italy, for lending specimens of *Neelides folsomi* Caroli, 1912, and *Neelus murinus* Folsom, 1896, and Mrs Margit Kruse, Zoological Institute, University of Kiel, for the photographic prints.

The junior author would like to thank William Conner at Wake Forest University, U.S.A., for advice concerning the project, and would like to thank Giovanni Onore and also the Tapia family for help and support in Ecuador.

This project was funded by a Sullivan Grant for Summer Research from Wake Forest University, U.S.A.

References

- BETSCH, J.-M. (1980): Éléments pour une monographie des Collemboles Symphypléones (Hexapodes, Aptérygotes). – Mém. Mus. Nat. Hist. Natur., NS A, Zoologie **116**: 1 – 227
- BRETFELD, G. (1995): Species diversity in males of the genus *Sphaeridia* Linnaniemi, 1912 (Collembola, Symphypleona) and a new definition of *Sphaeridia pumilis*. – Polskie Pismo Ent. **64**: 15 – 20
- (1999): Synopses on Palaearctic Collembola (W. DUNGER, ed.), Vol. II, Symphypleona. – Abh. Ber. Naturkundemus. Görlitz **71** (1): 1 – 318
- & U. GAUER (1994): Diagnostic description of the males of new *Sphaeridia* species (Insecta, Collembola) from South America. – andrias **13**: 113 – 136
- CHRISTIANSEN, K. & P. BELLINGER (1998): The Collembola of North America north of the Rio Grande, Part 4, Families Neelidae, Sminthuridae and Mackenziellidae, glossary, bibliography, index. – Grinnell Coll.: 1175 – 1520

- DALLAI, R. (1979): Investigations on Collembola. XXIV. On the systematic of Neelidae with redescription of *Neelides folsomi* Caroli. – *Animalia* **6**: 271 – 281
- FJELLBERG, A. (1999): The labial palp in Collembola. – *Zool. Anz.* **237** (1998/99): 309 – 330
- GREENSLADE, P. (1994): *Ptenothrix (Papirioides) tonsori* sp. n. (Collembola: Dicyrtomidae) from Sulawesi. – *Acta Zool. Fennica* **195**: 47 – 51
- MASSOUD, Z. & J.-M. BETSCH (1972): Étude sur les insectes Collemboles. II. – Les caractères sexuels secondaires des antennes des Symphypléones. – *Rev. Écol. Biol. Sol* **9**: 55 – 97
- & G. VANNIER (1967): Révision du genre *Neelus* Folsom 1896 (Collembola) et description de *Neelus labralisetosus* n. sp. des Iles Salomon. – *Rev. Écol. Biol. Sol* **4**: 625 – 637
- SNIDER, R. J. (1990): A contribution to the Dicyrtomidae (Collembola) of Hawaii. – *Zool. Scripta* **19**: 73 – 99
- YOSHII, R. (1969): *Dicyrtomina* and *Ptenothrix* (Insecta: Collembola) of the Solomon Islands. – *Zool. J. Linn. Soc.* **48**: 217 – 236
- & C.-E. LEE (1963): On some Collembola of Korea, with notes on the genus *Ptenothrix*. – *Contr. Biol. Lab. Kyoto Univ. No.* **15**: 1 – 37

Manuscript accepted: 13 Dec. 2000

Authors' addresses:

Dr. Gerhard Bretfeld
Zoologisches Institut der Universität Kiel
Olshausenstr. 40
24098 Kiel, Germany

Nathan D. Trinklein
796 Escondito Rd. Ap. # 8J
Stanford, CA 94305, USA