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**NOTES AND DRAWINGS FROM TYPE MATERIAL OF
COLLEMBOLA**

by

J. T. Salmon,

Victoria University of Wellington.

Zoology Publications from Victoria University of Wellington.

No. 66, issued December, 1974.

ABSTRACT

This paper is primarily concerned with presenting illustrations prepared where possible from type material of 36 species of Collembola belonging to the families Onychiuridae and Hypogastruridae. Some relevant notes are also included on the taxonomy of the various species.

INTRODUCTION

Many earlier descriptions of Collembola were brief and not accompanied by the sufficiently detailed drawings now regarded as necessary in modern taxonomic studies.

Over the past twenty years I have been able to visit some of the world's important repositories for type material concerned with insect taxonomy. During the examination of the collections of Collembola in these institutions I prepared many drawings from type material or from specimens of species identified by their authors. In particular I visited the British Museum of Natural History, London (for the sake of brevity designated in this paper as BMNH), the United States National Museum, Washington D.C. (USNM), the Museum of Comparative Zoology, Harvard University (MCZ), the Manchester Museum, England (MM), the Illinois State Natural History Survey, and others in both Europe and the U.S.A.

The idea behind the work was a world monograph on the Collembola. However, because the completion of such a monograph is as far away as ever, it occurred to me that some of my drawings could, if published, be beneficial to present and future workers on Collembola. Hence this paper, which is the first in a short series of papers that will include notes and figures of hitherto unillustrated or inadequately illustrated species of Collembola together with new synonymies.

ACKNOWLEDGEMENTS

In presenting this material I would like to thank the following: the Nuffield Foundation, England and the Carnegie Corporation, New York for travelling fellowships; my own University Council for refresher leave to enable me to undertake this work; and my friends and colleagues in many countries who assisted me. In particular I must mention: Mr N. Riley, Keeper of the Department of Entomology, BMNH, when I first went there, and Dr T. Clay; the late Dr W. D. Hinks, Director of MM, who located G. F. Carpenter's types for me; Dr J. F. G. Clarke, Curator of Insects, USNM, and the late Drs R. E. Snodgrass and C. J. Drake who gave me much help and encouragement while I was there; Dr P. J. Darlington at MCZ; and the late Dr H. B. Mills, Director, Illinois State Natural History Survey.

Publication of this paper is assisted by a grant from the Victoria University of Wellington Publications Fund.

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Species Covered in this Account

- Tullbergia bisetosa* Boerner
 „ *mixta* Wahlgren
 „ *affinis* Boerner
Paratullbergia callipygos Boerner
Spelaphorura willemi (Boerner)
Hymenaphorura cockleyi (Folsom)
 „ *subtenuis* (Folsom)
Protaphorura armata aurantiaca (Ridley)
 „ *pseudarmatus* (Folsom)
Onychiurus fimetarius (L)
Paronychiurus ramosus (Folsom)
Pseudonychiurus dentatus (Folsom)
Xenylla baconae Folsom
 „ *cavernarum* Jackson
 „ *corticalis* Boerner
 „ *grisea* Axelson
 „ *longicauda* Folsom
 „ *maritima* Tullberg
 „ *mucronata* Axelson
 „ *rhodesiensis* Womersley
 „ *schillei* Boerner
 „ *welchi* Folsom
Hypogastrura armata communis (Folsom)
 „ *cavicola* (Boerner)
 „ *gracilis* (Folsom)
 „ *humi* (Folsom)
 „ *macgillivrayi* (Folsom)
 „ *myrmecophila* Womersley
 „ *nivicola* (Fitch)
 „ *pseudarmata* (Folsom)
 „ *purpurascens galiciana* (Boerner)
 „ *viatica* (Tullberg)
 „ (*Cyclograna*) *boletivorus* (Packard)
Schaefferia variabilis Christiansen
Proxenyllodes reticulatus Boerner
Triacanthella alba Carpenter



Figs. 1-8 *Tullbergia bisetosa* Boerner, drawn from hypotypes in B.P. Bishop Museum, Honolulu.

- Fig. 1 Ant IV and apex Ant III x 1250
 Fig. 2 anal spine x 1250
 Fig. 3 genital opening of male x 1250
 Fig. 4 apex of PAO beside cuticular granules x 2500
 Fig. 5 section of PAO x 2000
 Fig. 6 female genital aperture x 1250
 Fig. 7 hind foot x 1250
 Fig. 8 Abd VI x 320

Tullbergia bisetosa Boerner, 1903

Figs. 1-8

This species has been reported from a number of collections in different subantarctic regions but no illustrations of it have been published.

I have recently identified specimens of *T. bisetosa* from collections made by Dr J. L. Gressitt and by K. Watson from Macquarie Island. The accompanying illustrations are from specimens collected by Dr Gressitt on the moss *Azorella* at the north end of Macquarie. These specimens are mounted on slides and deposited as hypotypes in the B.P. Bishop Museum, Honolulu.

Notes: Upper surface of Ant IV with very long simple setae and fine curved sense rods one of which is much longer than the others (Fig. 1); lower surface with many short simple setae. S.O. Ant III has three guard setae on the main organ, not two as described by Boerner, and two at the third separate sense rod. Details of the PAO and genital apertures as shown in Figs. 4, 5, and 3 respectively.

Tullbergia mixta Wahlgren, 1906

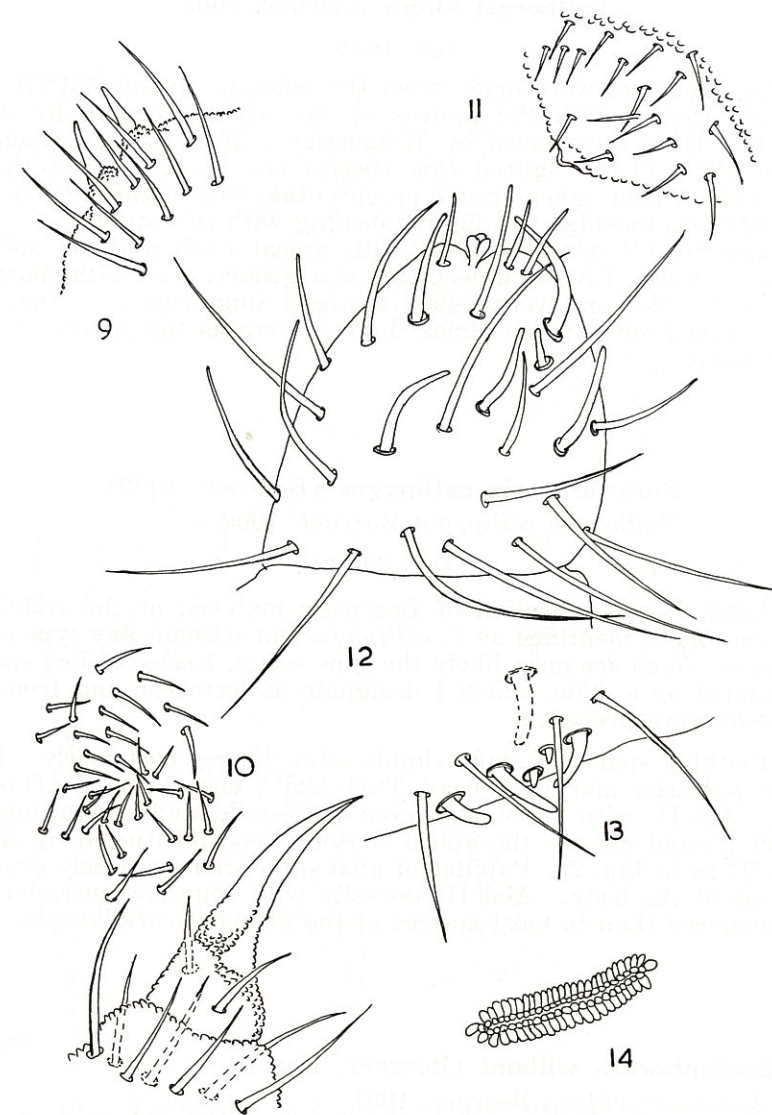
Figs. 9-15

This species was recorded by Enderlein (1909) and by Gressitt and Weber (1959) from Graham Land and the South Shetland Islands. Several specimens were also collected by T. S. and R. E. Leech in 1961 from Admiralty Bay F.I.D.S. Base, Deception Island and from Greenwich Island, South Shetland Islands. I have identified this species recently in New Zealand at Riwaka, near Nelson. This species also, has not previously been illustrated. The figures given here are from specimens from Admiralty Bay. These specimens mounted on slides are deposited as hypotypes in the B.P. Bishop Museum, Honolulu.

Notes: Clothing on Ant IV includes stout curved blunt-nosed sensory setae, three short slender tapering apical sensory setae, 6-8 longer tapering somewhat blunt-nosed sensory setae, a single short subapical sense-rod in a pit, an apical trilobed sensory vesicle, and numerous long setae especially around the posterior border of the segment (Fig. 12). SO Ant III with four bent sense clubs and two very small sense-rods in pits with four guard setae, which is a much more complicated sense organ than originally described (Fig. 13); Abd VI anterior to the anal spines, with two parallel rows of five setae each (Fig. 9); Figs. 10 and 11 show the setae of the genital region. The claw (Fig. 15) bears a number of apical tibio-tarsal setae and two basal setae, and is granulated basally. Some feet show an enlarged granule where the unguiculus should arise but this does not appear to be a normal feature. The PAO has 48-52 vesicles as in Fig. 14.

The body clothing is moderate with both short and long simple setae.

PSO one on each antennal base, one on each hind margin of head
ThI 0+0, ThII 0+0, ThIII 1+1, AbdI 0+0, AbdII 0+0, Abd III 0+0,
AbdIV 1+1, AbdV 1+1, AbdVI 0+0.



Figs. 9-15 *Tullbergia mixta* Wahlgren, drawn from hypotypes deposited with the B.P. Bishop Museum, Honolulu.

- Fig. 9 Abd VI with anal spines and associated dorsal setae x 320
 Fig. 10 genital aperture of male x 800
 Fig. 11 genital aperture of female x 512
 Fig. 12 Ant IV x 800
 Fig. 13 SO Ant III x 1000
 Fig. 14 PAO x 1280
 Fig. 15 middle foot x 1000

Tullbergia affinis Boerner, 1903

Figs. 16-19

These drawings were made from the holotype in the BMNH. They agree very closely with the figures of this species drawn by Axelson (1906) and later reproduced by Womersley (1930, p.37). Stach 1951, p.15 and 1954, pl.26) figured this species but his Fig. 1 of the PAO appears to have been taken from a species other than *affinis*. Gisin (1960, pp.19, 154) also included two figures dealing with this species.

Notes: Length 1.2 mm. Ant IV with apical knob and six sub-apical curved sense rods. PAO in a deep cuticular groove, claw with short broad seta to each side, and very small vestigial unguiculus. Anal spines strongly curved, on papillae almost half as long as the spines. Clothing of short setae.

Paratullbergia callipygos (Boerner, 1903)*Tullbergia callipygos* Boerner, 1903

Figs. 20-23

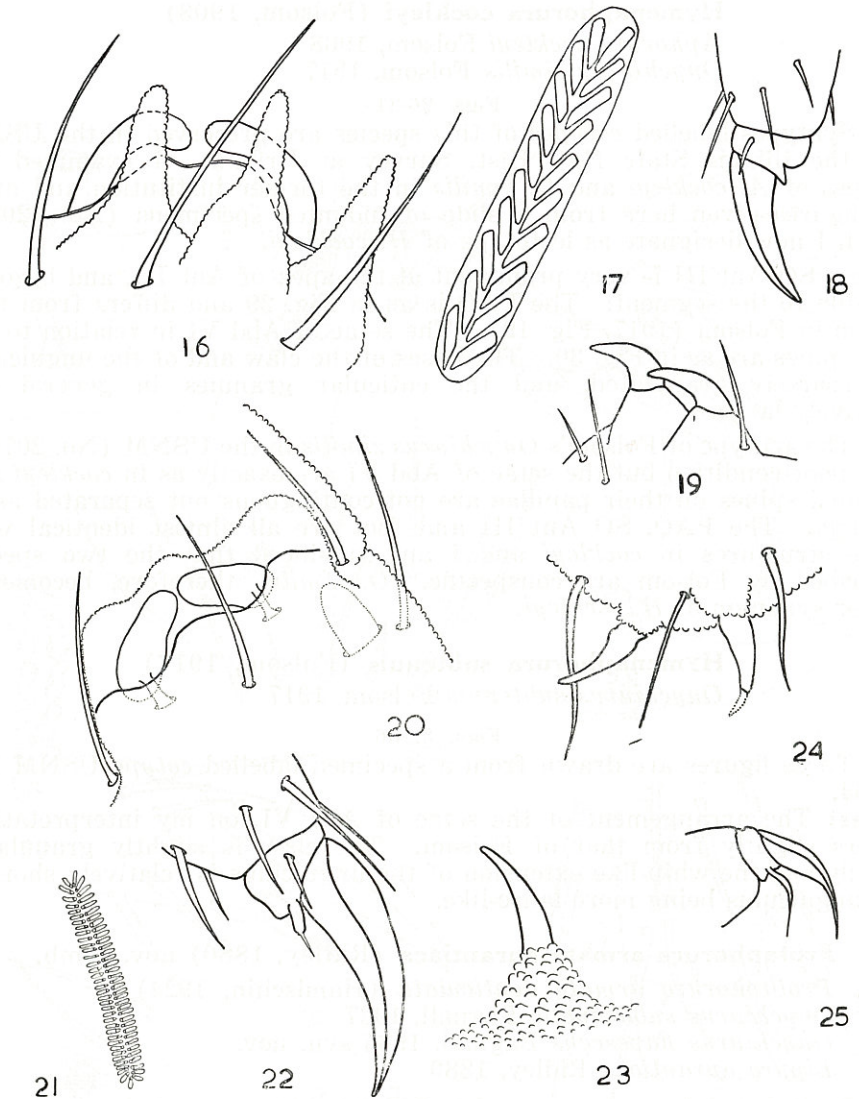
Included in the collection of Boerner's material at the BMNH is a tube of specimens identified as *T. callipygos* but without any type citation. From these, which are most likely the type series, I selected one specimen, now mounted on a slide, which I designate as lectotype and from which Figs. 20-23 were prepared.

Notes: Clothing sparse of short simple setae, longer posteriorly. PSO — ant base, posterior margin of head, ThII-Abd V each 1+1. PAO of 60-70 vesicles. Ant IV with 4-5 stout curved sense rods, and several long plain setae but I could not see the apical sensory knob mentioned by Boerner. SO Ant III as in Fig. 20. Papillae of anal spines more coarsely granulated than those of the body. Abd III dorsally with four low cuticular ridges less pronounced than in most species of the genus *Paratullbergia*.

Spelaphorura willemi (Boerner, 1901)*Aphorura willemi* Boerner, 1901*Onychiurus willemi* Boerner, 1901, sensu Salmon, 1964

Figs. 24-25

The holotype is in BMNH but is in poor condition, with the antennae missing. Boerner (1901, p.334), when he described this species included figures of the SO Ant III and PAO, and additional figures of the foot and anal spines are given here. From the drawings of the sense organs made by Boerner it is clear that this species does not belong to *Onychiurus* (*Aphorura*) and should be transferred to the genus *Spelaphorura* Bagnall, 1948.



Figs. 16-19 *Tullbergia affinis* Boerner, drawn from holotype in BMNH.

Fig. 16 SO Ant III x 1000

Fig. 18 hind foot x 400

Fig. 17 PAO x 1000

Fig. 19 anal spines x 320

Figs. 20-23 *Paratullbergia callipygos* Boerner, drawn from lectotype in BMNH.

Fig. 20 SO Ant III x 1000

Fig. 22 hind foot x 400

Fig. 21 PAO x 1250

Fig. 23 anal spine x 320

Figs. 24-25 *Spelaphorura willemi* (Boerner), drawn from holotype in BMNH

Fig. 24 apex of Abd VI showing anal spines and associated setae x 500

Fig. 25 hind foot x 500

Hymenaphorura cockleyi (Folsom, 1908)*Aphorura cockleyi* Folsom, 1908*Onychiurus similis* Folsom, 1917

Figs. 26-31

Syntypes labelled *cotypes* of this species are preserved in the USNM and the Illinois State Nat. Hist. Survey at Urbana. I examined the cotypes of *A. cockleyi* and *O. similis* in the former institution and drew the figures given here from a slide of mounted specimens (No. 12033) which I now designate as lectotype of *H. cockleyi*.

Notes: SO Ant III is very prominent at the apex of Ant III, and large in relation to the segment. The PAO is as in Fig. 29 and differs from that shown in Folsom (1917, Fig. 19). The setae of Abd VI in relation to the anal spines are as in Fig. 30. The bases of the claw and of the unguiculus are coarsely granulated, and the cuticular granules in general are relatively large.

The syntype of Folsom's *Onychiurus similis* in the USNM (No. 20763) is in poor condition but the setae of Abd VI are exactly as in *cockleyi* and the anal spines on their papillae are not contiguous but separated as in *cockleyi*. The PAO, SO Ant III and foot are all almost identical with those structures in *cockleyi* and I am convinced that the two species described by Folsom are conspecific. *O. similis*, therefore, becomes a junior synonym of *H. cockleyi*.

Hymenaphorura subtenuis (Folsom, 1917)*Onychiurus subtenuis* Folsom, 1917

Figs. 32-36

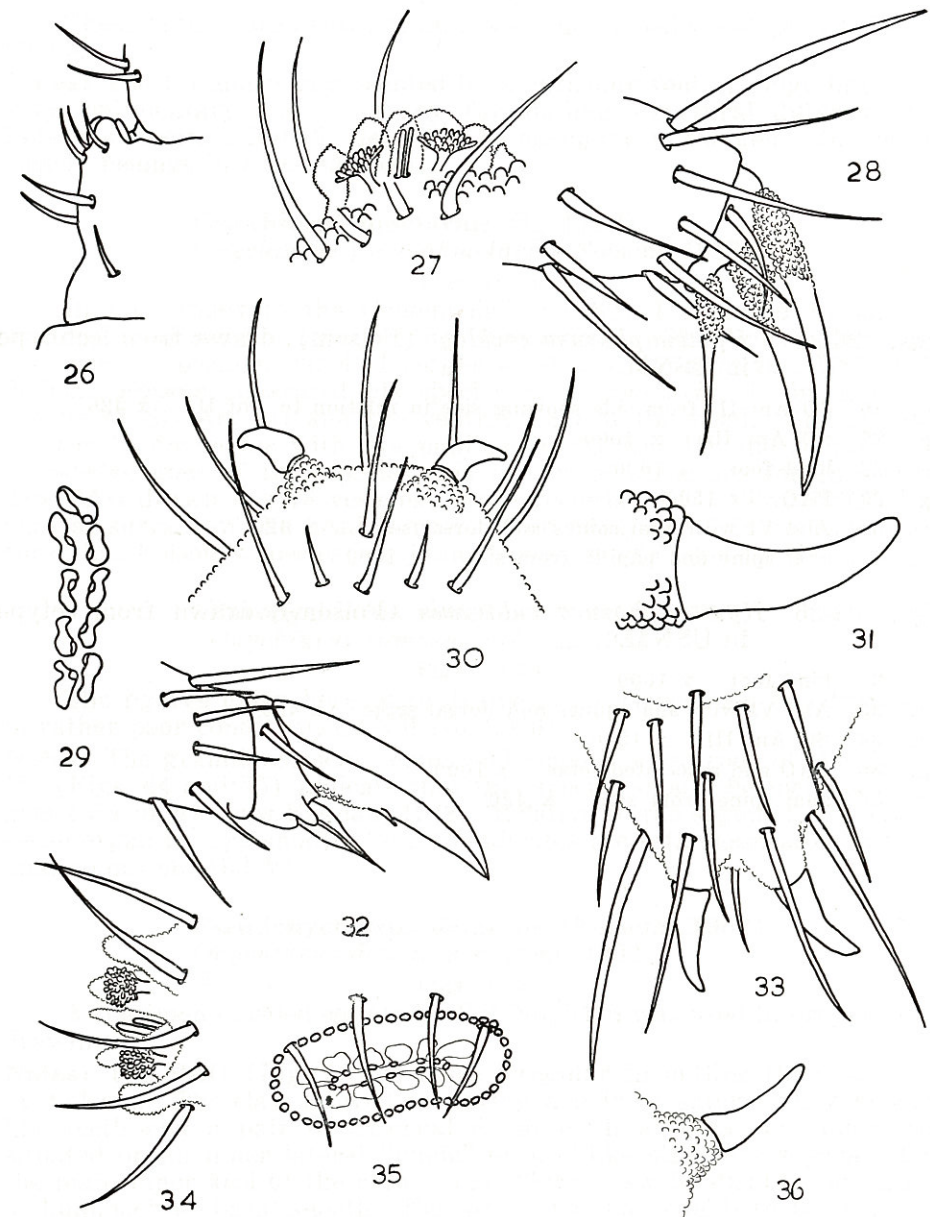
These figures are drawn from a specimen labelled *cotype* USNM No. 20764.

Notes: The arrangement of the setae of Abd VI, on my interpretation, differs slightly from that of Folsom. The claw is slightly granulated basally and the whip-like extension of the unguiculus is relatively shorter, the unguiculus being more lance-like.

Protaphorura armata aurantiaca (Ridley, 1880) nov. comb.*Protaphorura armata denticulata* (Handschin, 1924)*Onychiurus subaequalis* Bagnall, 1937*Onychiurus flavescens* Bagnall, 1935 syn. nov.*Lipura aurantiaca* Ridley, 1880

Ridley's holotype is preserved in BMNH. After examining this specimen I find that it is identical with the subspecies *denticulata* Handschin, 1924, and therefore Ridley's name *aurantiaca* takes priority over the name *denticulata* for this subspecies.

The type of *L. aurantiaca* was overlooked when my paper on the Onychiuridae was published in 1959. The hind foot which is the distinguishing structure is shown on p.135 of that paper, Fig. 12. This species is also discussed in the footnote on p.164 of my "Index to the Collembola", 1964. As Bagnall's species *flavescens* has a denticulate claw it is a synonym of this subspecies, and my placing of it as a synonym of *P. armata* in my "Index", p.166, was incorrect.



Figs. 26-31 *Hymenaphorura cockleyi* (Folsom), drawn from lectotype in USNM.

- Fig. 26 SO Ant III from side showing size in relation to Ant III x 420
 Fig. 27 SO Ant III x 1000
 Fig. 28 hind foot x 1000
 Fig. 29 PAO x 1500
 Fig. 30 Abd VI with anal spines and dorsal setae x 420
 Fig. 31 anal spine and papilla from side x 1000

Figs. 32-36 *Hymenaphorura subtenuis* (Folsom), drawn from cotype in USNM.

- Fig. 32 hind foot x 1000
 Fig. 33 Abd VI with anal spines and dorsal setae x 420
 Fig. 34 SO Ant III x 1500
 Fig. 35 PAO and associated setae x 1000
 Fig. 36 anal spine from side x 420

Protaphorura pseudarmatus (Folsom, 1917)
Onychiurus pseudarmatus Folsom, 1917

Figs. 37-40

These figures are drawn from a specimen labelled *cotype*, USNM No. 20760.

Notes: The furcula is represented by a cuticular fold or ridge but this is very rudimentary and lacks any furcula-like structural differentiation. Folsom's species originally described as belonging to the genus *Onychiurus* clearly belongs in *Protaphorura*.

Onychiurus fimetarius (L, 1758)
Onychiurus pseudofimetarius Folsom, 1917

Figs 41-43

In my "Index to the Collembola", (p.180) I recorded Folsom's *O. pseudofimetarius* as a synonym of *O. fimetarius* L. The figures drawn here are from a specimen labelled *cotype* of *O. pseudofimetarius*, USNM No. 20762. Folsom separated his species from *fimetarius* L. by the extra papilla of SO Ant III and the ventral PSO of the head. Stach (1954) records *O. fimetarius*; with five papillae in SO Ant III and so far as my knowledge goes of this species this is normal structure for this organ. The PAO drawn has 18 vesicles; Stach records 18-24. Two PSO on the ventral surface of the head is normal for *fimetarius*. It appears, therefore, that Folsom's species is a junior synonym of *O. fimetarius* L.

Paronychiurus ramosus (Folsom, 1917)
Onychiurus ramosus Folsom, 1917

Figs. 44-49

The figures given here were drawn from a specimen labelled *cotype* in rather poor condition, USNM No. 20761.

Notes: The granulated sense clubs and smooth sense rods of the SO Ant III (Figs. 44 and 45) indicate that this species should be included in the genus *Paronychiurus* Bagnall, 1948. Relative to the segment Ant III this sense organ is very small. Fig. 47 indicates the setae associated with the anal spines on Abd VI.

Pseudonychiurus dentatus (Folsom, 1902)
Onychiurus dentatus Folsom, 1902

Figs. 50-54

A specimen labelled *cotype* USNM No. 5436 was used to prepare these drawings.

Notes: The PAO (Fig. 53) is more irregular in outline than suggested by Folsom. The claw as well as having a pair of external lateral wing-like teeth and a pair of external distal teeth also has an inner tooth situated on an inner lateral "blade" or keel-like structure separate from the main inner keel of the claw. This "blade" swells distally into a kind of hummock or basal sheath (Fig. 51). The bases of both the claw and unguiculus are granulated. The papillae of the anal spines have granules much smaller than those of the surrounding cuticle (Fig. 54).

PSO as follows: Ant base 2+2, hind margin of head 1+1, ThI 0+0, ThII 2+2, ThIII 1+1, Abds I-V 2+2 each.

Figs. 37-40 *Protaphorura pseudarmatus* (Folsom), drawn from cotype in USNM.

Fig. 37 PAO x 1000

Fig. 38 SO Ant III, sectional view from side with end papilla removed x 1000

Fig. 39 anal spine x 1000

Fig. 40 fore foot x 1000

Figs. 41-43 *Onychiurus fimetarius* (L), drawn from cotype of *Onychiurus pseudofimetarius* Folsom in USNM.

Fig. 41 SO Ant III x 1000

Fig. 42 PAO x 1500

Fig. 43 forefoot x 1000

Figs. 44-49 *Paronychiurus ramosus* (Folsom), drawn from cotype in USNM.

Fig. 44 SO Ant III x 1500

Fig. 45 SO Ant III side view x 1500

Fig. 46 PAO x 1500

Fig. 47 Abd VI with anal spines and setae angled view x 530

Fig. 48 anal spine from side x 1000

Fig. 49 hind foot x 1000

Figs. 50-54 *Pseudonychiurus dentatus* (Folsom), drawn from cotype in USNM.

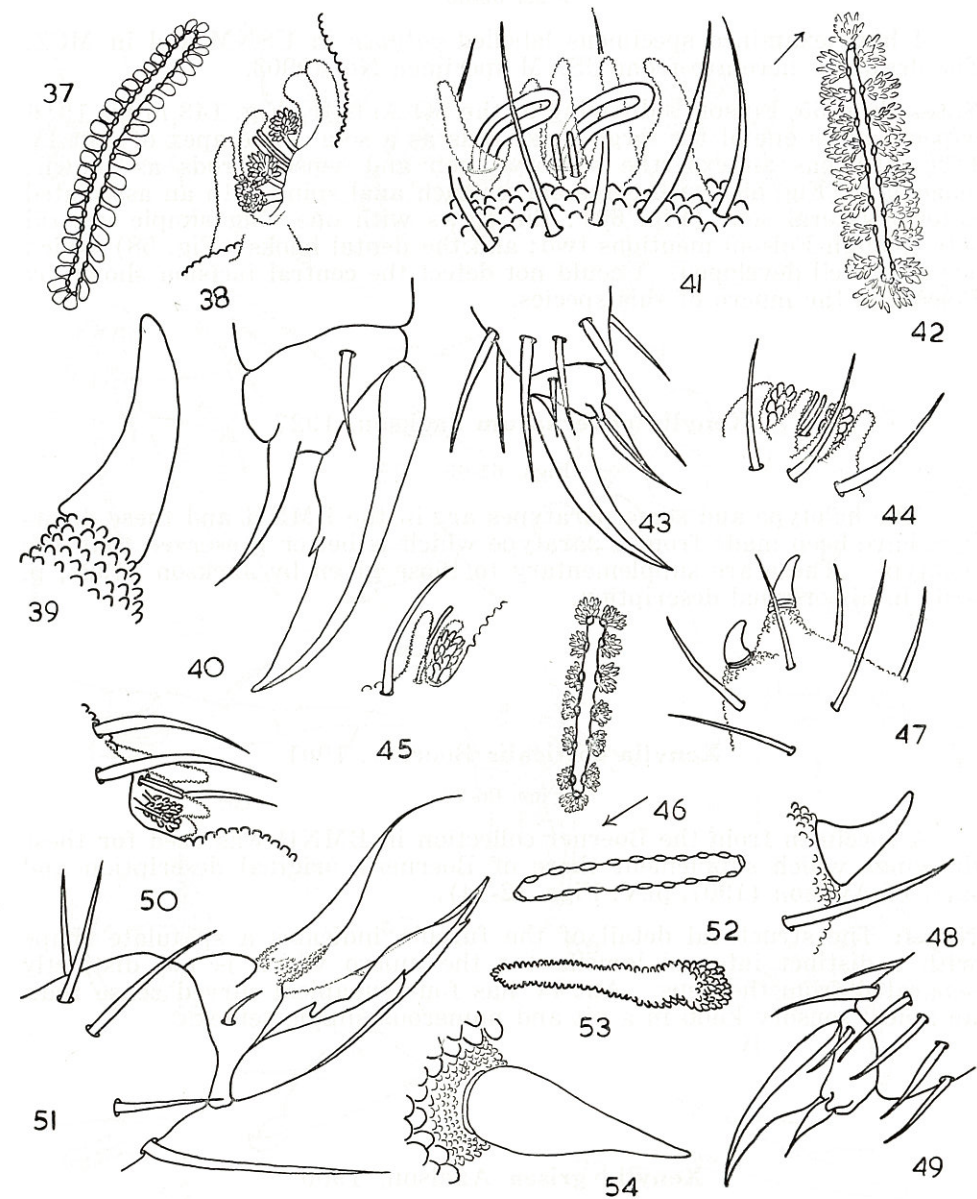
Fig. 50 SO Ant III from side x 1000

Fig. 51 middle foot x 600

Fig. 52 PAO, deep appearance at bottom of organ x 1000

Fig. 53 PAO surface appearance x 1000

Fig. 54 anal spine from side x 1000



Xenylla baconae Folsom, 1916

Figs. 55-60

I have examined specimens labelled *cotypes* in USNM and in MCZ. The drawings here are from USNM specimen No. 19903.

Notes: Fig. 55, Folsom's drawing of the SO Ant III (Fig. 143 in his 1916 paper) shows one of the large sense rods as a seta. The apex of Ant IV (Fig. 56) has an exsertile sensory knob and sensory rods as shown; tenaculum (Fig. 59) with three barbs; each anal spine with an associated anterior-lateral seta (Fig. 60): the claws with one long simple ventral seta, though Folsom mentions two; and the dental hooks (Fig. 58) which are very well developed. I could not detect the central incision shown by Folsom in the mucro of this species.

Xenylla cavernarum Jackson, 1927

Figs. 61-65

The holotype and some paratypes are in the BMNH and these drawings have been made from a paratype which is better preserved than the holotype. These are supplementary to those given by Jackson (1927, p. 486) in his original description.

Xenylla corticalis Boerner, 1901

Figs. 66-70

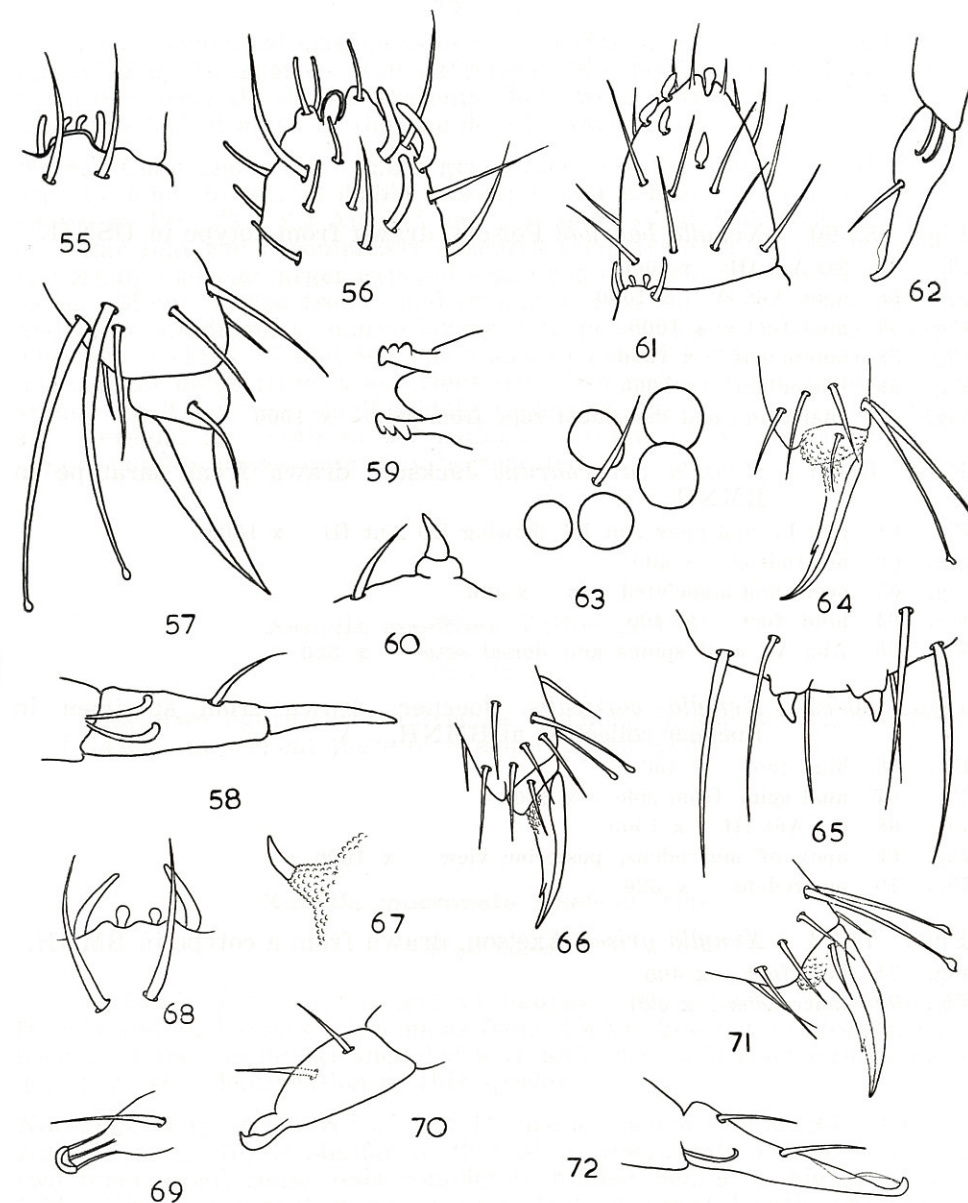
A specimen from the Boerner collection in BMNH was used for these drawings which supplement those of Boerner's original description and later of Axelson (1907, pl.V, Figs. 12-14).

Notes: The structural detail of the furcula indicates a spatulate shape with a distinct internal lamella for the mucro which is not distinctly separated from the dens. Ant IV has four subapical curved sense rods, an apical sensory knob in a pit and numerous simple setae.

Xenylla grisea Axelson, 1900

Figs. 71-72

These figures of the hind foot and mucro, drawn from a specimen labelled *cotype* in BMNH show more detail than those of Axelson (1912) and later of Stach (1949, pl.22).



Figs. 55-60 *Xenylla baconae* Folsom, drawn from cotype in USNM.

- Fig. 55 SO Ant III x 1000
 Fig. 56 apex Ant IV x 1000
 Fig. 57 hind foot x 1000
 Fig. 58 mucrodens x 1000
 Fig. 59 tenaculum x 1000
 Fig. 60 anal spine and associated seta from side x 1000

Figs. 61-65 *Xenylla cavernarum* Jackson, drawn from paratype in BMNH.

- Fig. 61 Ant IV and apex Ant III showing SO Ant III x 1000
 Fig. 62 mucrodens x 400
 Fig. 63 ocelli and associated seta x 400
 Fig. 64 hind foot x 400
 Fig. 65 Abd VI anal spines and dorsal setae x 320

Figs. 66-70 *Xenylla corticalis* Boerner, drawn from specimen in Boerner collection at BMNH.

- Fig. 66 hind foot x 400
 Fig. 67 anal spine from side x 320
 Fig. 68 SO Ant III x 1000
 Fig. 69 apex of mucrodens, posterior view x 1000
 Fig. 70 mucrodens x 320

Figs. 71-72 *Xenylla grisea* Axelson, drawn from a cotype in BMNH.

- Fig. 71 hind foot x 400
 Fig. 72 mucrodens x 320

Xenylla longicauda Folsom, 1898

Figs. 73-82

I have examined specimens of this species in the collection of BMNH identified by Boerner as well as *cotypes* No. 5075 in USNM and from these two series the figures presented here were drawn. Folsom's original drawings lacked much of the fine detail shown here.

Notes: Claw and mucro finely granulated basally, Ant IV with apical sensory knob in pit, probably exsertile, and sensory rods and clubs as shown in Fig. 73. SO Ant III has two short sense clubs behind a deep cuticular fold which completely obscures them from the front or face of the organ, and one larger exposed sense rod on each side with two guard setae. Mucro varies from equal in length to about 0.75 length of dens and in no specimens is mucro larger than dens, as suggested by Folsom. The mucro (Figs. 77 and 80) has a small elevated lamella reaching about one-quarter down from base. Dens with two posterior setae only. Anal spines small on very small widely separated papillae, the spines (Fig. 82) subequal in length to 6-7 cuticular granules. The setae normally simple but the larger ones may be serrated.

Xenylla maritima Tullberg, 1869

Figs. 83-84

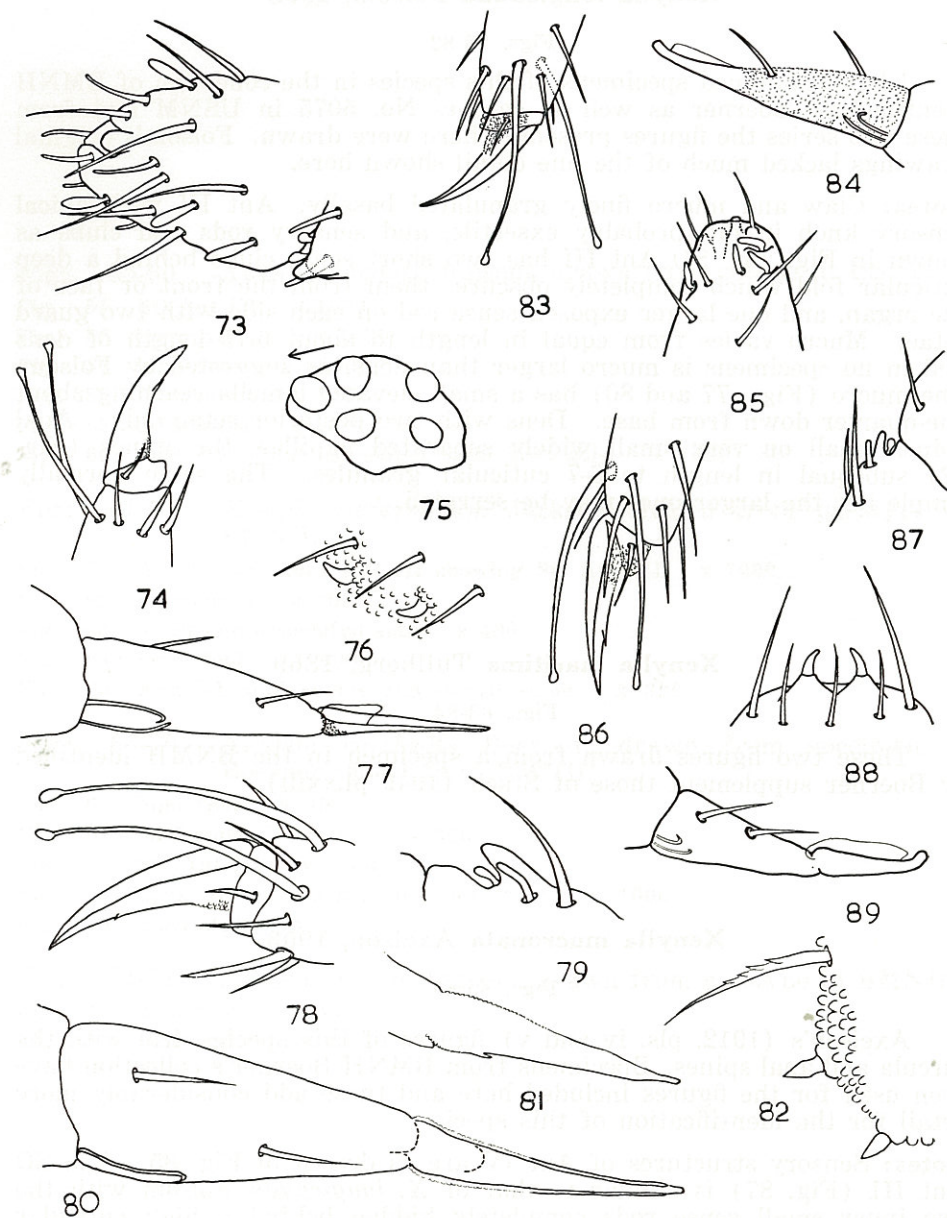
These two figures drawn from a specimen in the BMNH identified by Boerner supplement those of Stach (1949 pl.xxiii).

Xenylla mucronata Axelson, 1903

Figs. 85-89

Axelson's (1912, pls. iv and v) figures of this species deal with the furcula and anal spines. Specimens from BMNH Boerner's collection have been used for the figures included here and these add considerably more detail for the identification of this species.

Notes: Sensory structures of Ant IV are as drawn in Fig. 85. The SO Ant III (Fig. 87) is similar to that of *X. longicauda* Folsom with the two inner small sense rods completely hidden behind a high cuticular fold. The two tenent hairs of each foot of equal length (Fig. 86); papillae of anal spines contiguous; mucro incompletely separated from dens which bears two simple setae only on posterior face (Fig. 89). The species *X. longicauda* and *X. mucronata* are very similar differing mainly in the shape of the mucro and the extent of its lamella, and by the form and degree of separation of the anal spines and their papillae.



Figs. 73-82 *Xenylla longicauda* Folsom, drawn from specimen in Boerner collection BMNH and from cotype in USNM.

- Fig. 73 Ant IV and apex Ant III from cotype USNM showing sensory structures x 500
 Fig. 74 hind foot from specimen in BMNH x 500
 Fig. 75 ocelli from specimen in BMNH x 500
 Fig. 76 anal spines from specimen in BMNH x 500
 Fig. 77 mucrodens from specimen in BMNH x 500
 Fig. 78 hind foot from cotype USNM x 600
 Fig. 79 SO Ant III side view from cotype USNM x 1000
 Fig. 80 mucrodens from cotype USNM x 600
 Fig. 81 side view of mucro from cotype USNM x 600
 Fig. 82 anal spines and associated setae from above cotype USNM x 1000

Figs. 83-84 *Xenylla maritima* Tullberg, drawn from specimen in Boerner collection BMNH.

- Fig. 83 hind foot x 400
 Fig. 84 mucrodens x 400

Figs. 85-89 *Xenylla mucronata* Axelson, drawn from specimens in Boerner collection BMNH.

- Fig. 85 apex Ant IV x 320
 Fig. 86 hind foot x 400
 Fig. 87 SO Ant III from side x 1000
 Fig. 88 anal spines and dorsal setae on Abd VI x 320
 Fig. 89 mucrodens x 1000

***Xenylla rhodesiensis* Womersley, 1926**

Figs. 90-95

When Womersley (1926, p.153) described this species the figures he included were rather inadequate. Specimens labelled *cotypes* are in the BMNH and I was able to prepare new figures from these.

Notes: The tenent hairs on the feet are 1,2,2, not 2,3,3, as given by Womersley; the large central seta of the tibiotarsus (Fig. 92) is not a clavate tenent hair. The sensory structures of Ants III and IV are as shown in Figs. 93 and 94. The anal spines (Fig. 91) are very small, not bigger than three cuticular granules. Rami of tenaculum each with three barbs. Length to 0.6 mm.

***Xenylla schillei* Boerner, 1903**

Figs. 86-100

A specimen labelled *cotype* in the Boerner collection BMNH was used to prepare the accompanying figures. Drawings of the foot and furcula were included by Stach (1951, p.68).

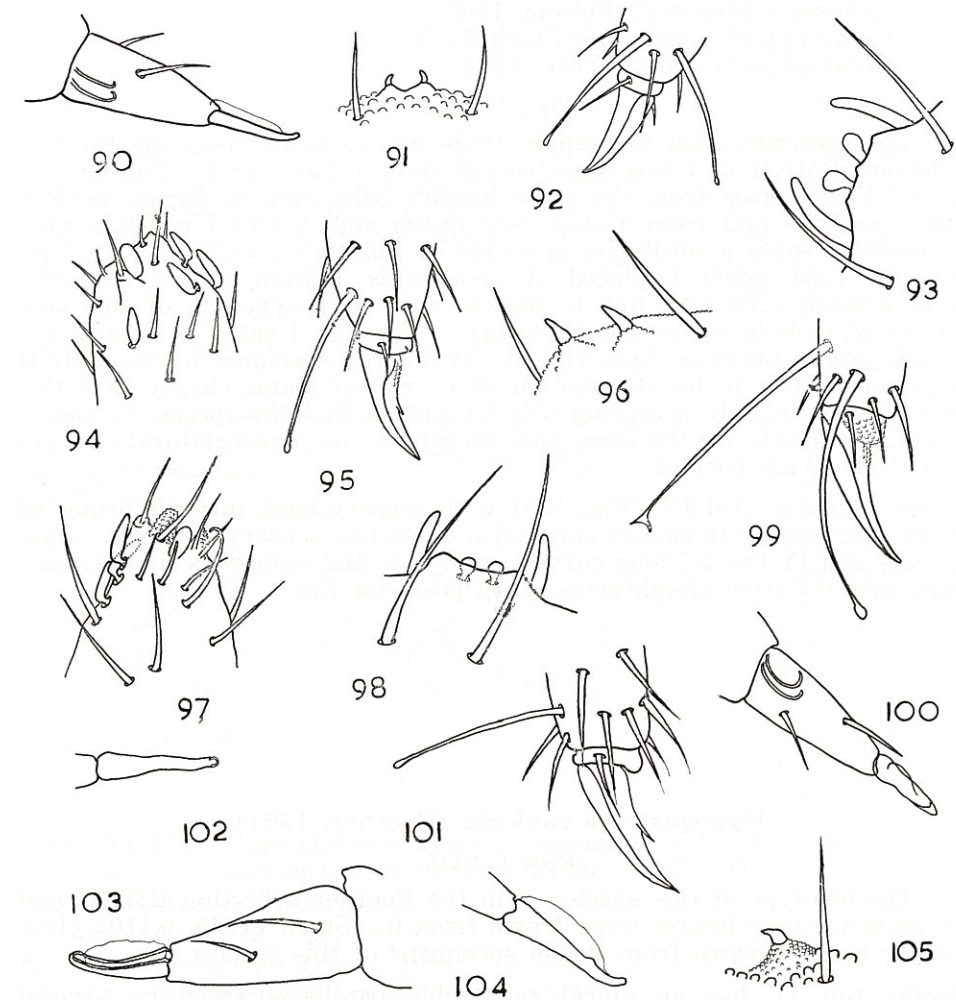
Notes: The two tenent hairs of each foot are at different levels on opposite sides of each tibiotarsus (Fig. 99). The two small sense clubs of SO Ant III are almost completely hidden by the large cuticular fold (Fig. 98).

***Xenylla welchi* Folsom, 1916**

Figs 101-105

Specimens labelled *cotypes* No. 19904 in the USNM were used to prepare these drawings which supplement those given by Folsom with his original description.

Notes: Only the front feet have a single tenent hair, the others have two each. The mucro (Figs. 102-104) varies in outline between specimens. The minute anal spines are on papillae having very fine granules (Fig. 105). Ant IV with small exsertile knob, numerous short and long tapering sense rods but no stout bent sense rods.



Figs. 90-95 *Xenylla rhodesiensis* Womersley, drawn from cotypes in BMNH.

Fig. 90 Mucrodens x 1000
 Fig. 91 Abd VI with anal spines and dorsal setae x 400
 Fig. 92 hind foot x 400
 Fig. 93 SO Ant III x 1000
 Fig. 94 apex Ant IV x 1000
 Fig. 95 fore foot x 400

Figs. 96-100 *Xenylla schillei* Boerner, drawn from cotype in BMNH.

Fig. 96 anal spines and dorsal setae on Abd VI x 400
 Fig. 97 apex Ant IV x 1000
 Fig. 98 SO Ant III x 1000
 Fig. 99 hind foot x 400
 Fig. 100 mucrodens x 400

Figs. 101-105 *Xenylla welchi* Folsom, drawn from cotypes in USNM.

Fig. 101 fore foot x 1000
 Fig. 102 posterior base of mucro x 1000
 Fig. 103 mucrodens another specimen x 1000
 Fig. 104 mucro another specimen x 1000
 Fig. 105 anal spine and seta from side x 1000

Hypogastrura armata communis (Folsom, 1898) Nov. Comb.
Achorutes communis Folsom, 1898
Ceratophysella communis Stach, 1949
Ceratophysella yuasai Yosii, 1954

Figs. 106-111

The specimen used to prepare these figures came from the Boerner collection BMNH and may be a cotype sent to Boerner by Folsom. *C. yuasai* Yosii comes from the same locality, Okayama in Japan, as Folsom's material and from Yosii's description and figures I conclude that *C. yuasai* Yosii is a subjective synonym of Folsom's species. In my "Index" in 1964 p.209 I placed *A. communis* Folsom as a subspecies of *H. armata* (Nicolet), and *C. yuasai* Yosii as a synonym of this subspecies *H. armata communis* (Folsom). Although I could not detect the sac-like organ between Ants III and IV on the specimen in the BMNH collections, Yosii in his description of *C. yuasai* states clearly that this organ is present. In accepting this I conclude that the species *C. yuasai* and *A. communis* are the same and, therefore, the nomenclatural changes set out above are correct.

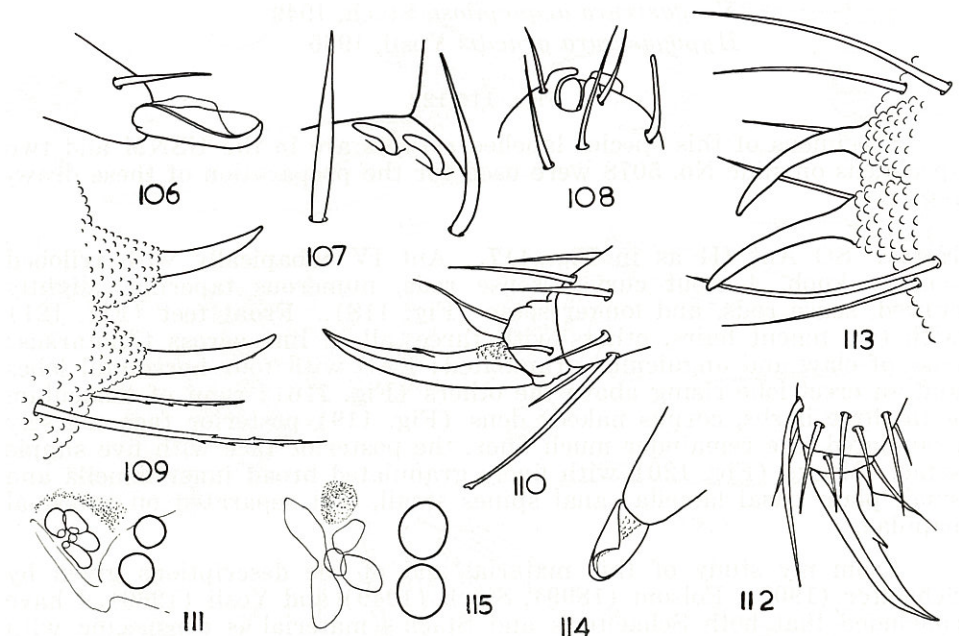
Notes: Apex of Ant IV (Fig. 108) with sensory knob in a pit protected by an overlapping thickened cap and a dome-like sensory swelling. Subapically Ant IV has 6-7 long curved sense rods and numerous simple setae. Dens with 6-7 stout simple setae along posterior face.

Hypogastrura cavicola (Boerner, 1901)

Figs. 112-115

The holotype of this species is in the Boerner collection BMNH and the accompanying figures were drawn from it. Stach (1949, p.110) gives further figures drawn from Polish specimens of this species.

Notes: Ant IV has an apical retractible papilla guarded by several slender short curved setae; 4-6 strongly bent, stout, exposed sense rods subapically and numerous simple setae. Anal spines on very stout stumpy contiguous papillae, the spines slightly longer than the hind claw. PAO with an associated "nebenhocker-like" structure (Fig. 115).



Figs. 106-111 *Hypogastrura armata communis* (Folsom), drawn from specimen in Boerner collection in BMNH.

Fig. 106 mucro and apex of dens

Fig. 107 SO Ant III x 1000

Fig. 108 apex of Ant IV x 1000

Fig. 109 anal spines with associated setae x 400

Fig. 110 hind foot x 400

Fig. 111 PAO and adjacent ocelli x 1000

Figs. 112-115 *Hypogastrura cavicola* (Boerner) drawn from holotype in BMNH.

Fig. 112 hind foot x 400

Fig. 113 anal spines and setae from above x 400

Fig. 114 mucro x 1000

Fig. 115 PAO with associated "nebenhocker" and anterior ocelli x 1000

Hypogastrura gracilis (Folsom, 1899)
Achorutes gracilis Folsom, 1899
Achorutes tullbergi Schaeffer, 1900
Neogastrura aequipilosa Stach, 1949
Hypogastrura gracilis Yosii, 1960

Figs. 116-122

Specimens of this species labelled *cotypes* are in the USNM and two specimens on slide No. 5078 were used for the preparation of these drawings.

Notes: SO Ant III as in Fig. 117. Ant IV subapically with trilobed sensory knob, 4 stout curved sense rods, numerous tapering, slightly curved, sense rods, and longer setae (Fig. 118). Front feet (Fig. 121) with two tenent hairs, others with three, all in line across tibiotarsus; base of claw and unguiculus granulated; PAO with four horizontal lobes and an erect lobe rising above the others (Fig. 116); rami of tenaculum with three barbs, corpus naked; dens (Fig. 119) posterior face coarsely granulated, the remainder much finer, the posterior face with five simple setae. Mucro (Fig. 120) with finely granulated broad inner lamella and small plain basal lamella; anal spines small, and separated on subequal papillae.

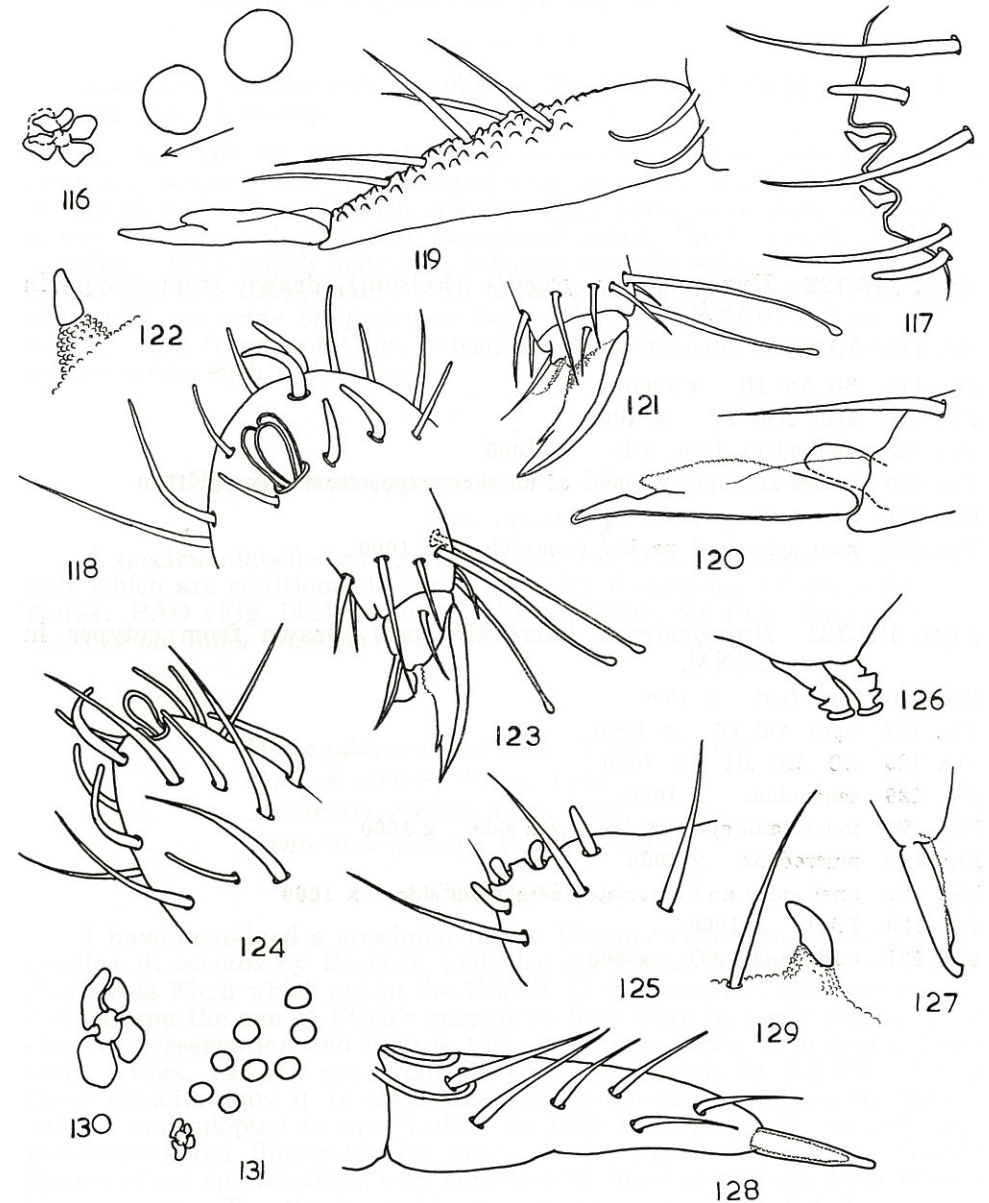
From my study of this material and of the descriptions given by Schaeffer (1900), Folsom (1899), Stach (1949) and Yosii (1960), I have concluded that both Schaeffer's and Stach's material is conspecific with that of Folsom's.

Hypogastrura humi (Folsom, 1916)
Achorutes humi Folsom, 1916

Figs. 123-131

Specimens labelled *cotypes* in USNM on slide No. 14899 were used for the preparation of these drawings.

Notes: My drawing of the SO Ant III (Fig. 125) differs slightly from that of Folsom in the displacement of the sensory rods. The three tenent hairs of each tibiotarsus are arranged with the middle one arising above the others (Fig. 123); Ant IV with apical sensory knob, sense rods and setae arranged as in Fig. 124; dens with six simple setae on posterior face (Fig. 128); mucro with posterior face finely granulated and long simple inner lamella (Figs. 127 and 128).



Figs. 116-122 *Hypogastrura gracilis* (Folsom), drawn from cotype in USNM.

- Fig. 116 PAO and adjacent ocelli x 1000
 Fig. 117 SO Ant III x 1000
 Fig. 118 apex Ant IV x 1000
 Fig. 119 mucrodens from side x 1000
 Fig. 120 mucro and apex of dens of another cotype from side x 1500
 Fig. 121 fore foot x 1000
 Fig. 122 anal spine and papilla from side x 1000

Figs. 123-131 *Hypogastrura humi* (Folsom), drawn from cotypes in USNM.

- Fig. 123 hind foot x 1000
 Fig. 124 apex Ant IV x 1000
 Fig. 125 SO Ant III x 1000
 Fig. 126 tenaculum x 1000
 Fig. 127 mucro and apex of dens from side x 1000
 Fig. 128 mucrodens x 1000
 Fig. 129 anal spine and associated seta from side x 1000
 Fig. 130 PAO x 1000
 Fig. 131 ocelli and PAO x 600

Hypogastrura macgillivrayi (Folsom, 1916)
Achorutes macgillivrayi Folsom, 1916

Figs. 132-139

Specimens labelled *cotypes* on slide No. 19900 in USNM were used to prepare these drawings.

Notes: SO Ant III (Fig. 134) has sense clubs, sense rods and guard setae and is much more complicated than was indicated by Folsom; apex of Ant IV as in Fig. 135 with apical sensory knob, stout bent, and longer tapering, sense rods but only occasional setae; PAO variable with 4-5 peripheral lobes which may vary between opposite sides of one individual (Figs. 132 and 133); mucro with broad granulated lamella (Fig. 138); dens with six setae on posterior face (Fig. 137); two or three tenent hairs to each front foot (Fig. 136), three to each of the other feet, always in line across each tibiotarsus.

Hypogastrura myrmecophila Womersley, 1926

Figs. 140-143

A specimen labelled *cotype* in BMNH was used to prepare these drawings which are additional to those given by Womersley (1926, p.156).

Notes: PAO (Fig. 142) has five peripheral lobes, not four, the unguiculus has a broad inner lamellae (Fig. 140).

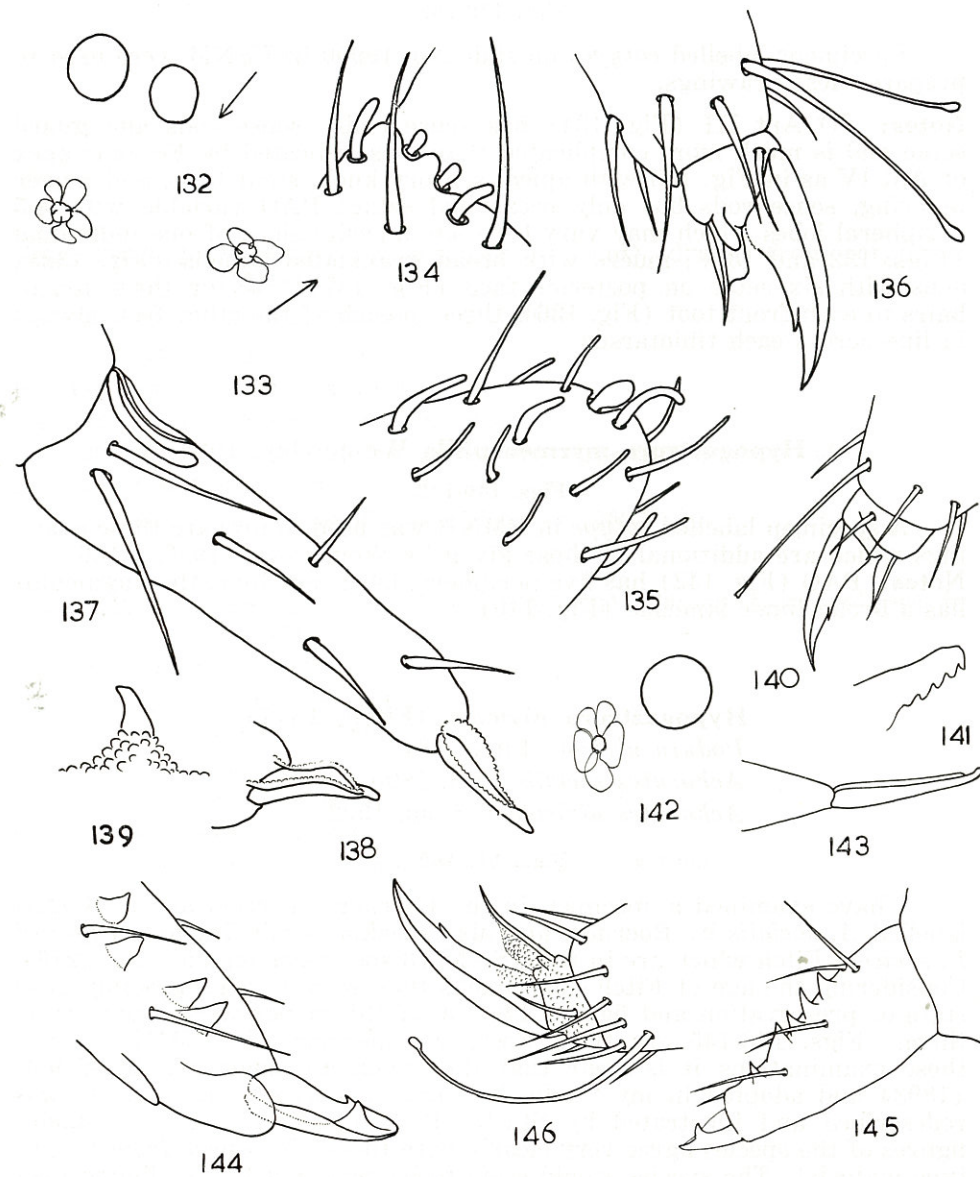
Hypogastrura nivicola (Fitch, 1847)
Podura nivicola Fitch, 1847
Achorutes socialis Uzel, 1890
Achorutes nivicola Folsom, 1902

Figs. 144-150

I have examined a specimen in the Boerner collection at the BMNH labelled *A. socialis* by Boerner, and also specimens labelled as *cotypes* of *P. nivicola* Fitch which are in the USNM (3 specimens on slide No. 5216). Considering the age of Fitch's specimens they were in a remarkably good state of preservation and figures 146-150 of this paper were drawn from them. Figs. 143-145 are from Boerner's specimens in BMNH. From these examinations it is clear that the synonymy suggested by Schott (1893) and adopted in my "Index" in 1964 is correct. *H. nivicola* was redescribed and illustrated by Stach (1949, pp. 71-77, pl.iv). Stach's figures of the species agree very clearly with those given here from Fitch's type material. The species would seem to be very widely distributed over the Northern Hemisphere.

Since these cotypes of Fitch were available in the USNM for Folsom to study, the suggestion made by Folsom (1916, p.485) that Fitch's name be suppressed in favour of *socialis* is quite out of order.

Notes: "Nebenhocker-like" structure beside PAO (Fig. 149).



Figs. 132-139 *Hypogastrura macgillivrayi* (Folsom), drawn from cotype in USNM.

Fig. 132 PAO and adjacent ocelli left side of animal x 1000

Fig. 133 PAO right side of animal x 1000

Fig. 134 SO Ant III x 1000

Fig. 135 apex Ant IV x 1000

Fig. 136 hind foot x 1000

Fig. 137 mucrodens x 1000

Fig. 138 mucro from another cotype x 1000

Fig. 139 anal spine and papilla from side x 1000

Figs. 140-143 *Hypogastrura myrmecophila* Womersley, drawn from cotype in BMNH.

Fig. 140 hind foot x 400

Fig. 141 ramus of tenaculum x 1000

Fig. 142 PAO and adjacent ocellus x 1000

Fig. 143 mucro from side x 1000

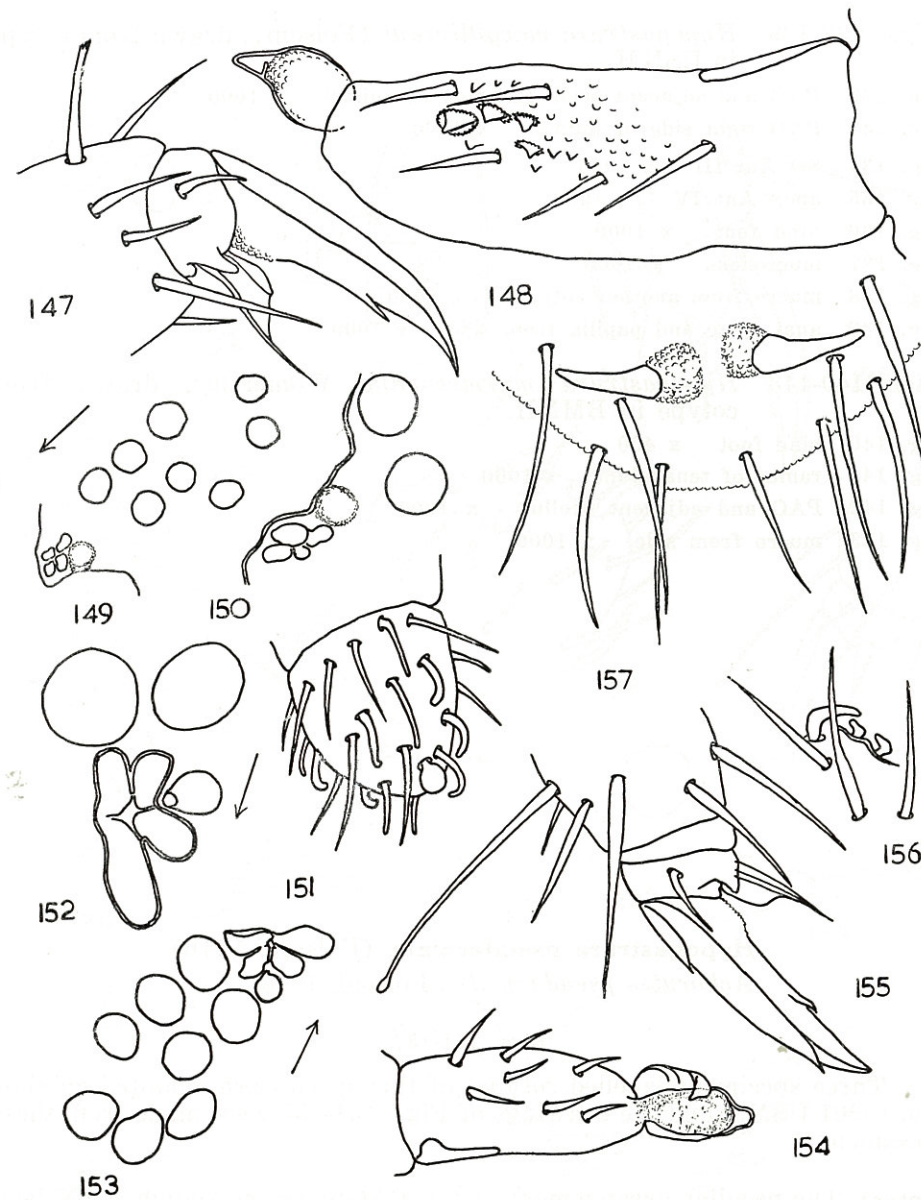
***Hypogastrura pseudarmata* (Folsom, 1916)**

Achorutes pseudarmatus Folsom, 1916

Figs. 151-157

Three specimens labelled *cotypes* of this species are mounted on slide No. 19901 USNM and the drawings of Figs. 151-157 were made from these specimens.

Notes: The peculiar arrangement of the PAO with the roundish "Nebenhooker" of Folsom adjacent to the nearest ocellus is shown in Figs. 152 and 153. SO Ant III has a slightly different displacement of the parts (Fig. 156) from that given by Folsom in his Fig. 97; each tibiotarsus has a single clavate tenent hair and a long subequal stout seta (Fig. 155); claw with a strong distal outer tooth as well as the outer basal tooth described by Folsom (Fig. 155); the papillae of the anal spines (Fig. 157) not quite contiguous as suggested in the original description; seven short simple setae on posterior face of dens (Fig. 154).



Figs. 144-150 *Hypogastrura nivicola* (Fitch), drawn from cotypes in USNM and from a specimen in the Boerner collection BMNH.

Fig. 144 mucro and apex of dens x 1000 specimen BMNH

Fig. 145 mucrodens x 400 specimen BMNH

Fig. 146 hind foot x 400 specimen BMNH

Fig. 147 hind foot x 1000 cotype USNM

Fig. 148 PAO "Nebenhooker" and ocelli right side of animal x 600 cotype USNM

Fig. 149 PAO nebenhooker-like structure and adjacent ocelli x 1000, cotype USNM

Fig. 150 mucrodens x 1000, cotype USNM

Figs. 151-157 *Hypogastrura pseudarmata* (Folsom), drawn from cotypes in USNM.

Fig. 151 Ant IV x 600

Fig. 152 PAO and adjacent ocelli x 1000

Fig. 153 PAO and ocelli right side of animal x 600

Fig. 154 mucrodens x 600

Fig. 155 hind foot x 1000

Fig. 156 SO Ant III x 1000

Fig. 157 Abd VI anal spines and setae from above x 600

Hypogastrura purpurascens galiciana (Boerner, 1903)
Achorutes purpurascens galiciana Boerner, 1903

Figs. 158-163

The *type* and specimens labelled *cotypes* of this subspecies are preserved in the BMNH but no illustrations of it have previously been published.

Notes: Mucro (Fig. 160) is relatively longer and more tapering than in *H. purpurascens* s.str: it tapers apically to a point without the slightly recurved apex characteristic of *H. purpurascens* s.str; base of claw finely granulate; the unguiculus of the fore feet (Fig. 158) has the lamella considerably reduced as compared with the other feet (Fig. 159); the fore feet have two tenent hairs, the other feet three each, all in line across the tibiotarsus; rami of tenaculum with three barbs; the four segments of the antennae related as 20:23:27:45; SO Ant III normal with two sense clubs, two sense rods and three guard setae; Ant IV with apical sensory papilla, and 5-7 subapical stout curved sense rods; PAO with 3-4 peripheral lobes (Figs. 161-162): length of *type* specimen 2 mm.

Hypogastrura (Cyclograna) boletivora (Packard, 1873)

Achorutes boletivorus Packard, 1873
Achorutes marmoratus Packard, 1873
Achorutes pratorum Packard, 1873
Achorutes armatus (Nicolet) Folsom, 1916
Hypogastrura (Cyclograna) vulgaris Yosii, 1960
Cyclograna vulgaris Yosii, 1960
Hypogastrura vulgaris Salmon, 1964

Figs. 164-171

Dr K. A. Christiansen has in his collection at Grinnell, Iowa, a *paratype* of *Cyclograna vulgaris* sent him by Dr Yosii. I have studied this specimen and also Folsom's specimens labelled *cotypes* at USNM and the material left by Packard and preserved in MCZ.

Folsom (1916) who studied Packard's material considered that the three species described by Packard (1873) were all identical with *A. armatus* of Folsom. After studying all this material I agree with the suggestions made by Yosii in 1960, p.264, that Folsom's *A. armatus* and Yosii's *C. vulgaris* are the same species. This means that the correct name for this assemblage will be *H. (Cyclograna) boletivorus* (Packard), being the first species described by Packard (page priority) in his 1873 paper. However, the peculiar spines of the dens, the lamellae of the mucro and the odd PAO seem to call for the retention of Yosii's subgenus *Cyclograna* for this and the several related species described by Yosii. The occurrence of the eversible sac between Ants III and IV, the general body form and chaetotaxy all indicate that this species is a Hypogastruran form of Collembola. This view is further strengthened by the mouth parts; the mandible is present with a distinct molar area and the maxilla head has six apical teeth.

Figs. 164-171 are from the *paratype* of *Cyclograna vulgaris* Yosii and supplement those already given by Folsom (1916) and Yosii (1960).

Notes: Dens and mucro (Figs. 169-170) with their peculiar spines and

lamellate mucro rather similar to the condition found in the genus *Clavontella*; furcula is reduced and very small, the dens and mucro being subequal in length to the hind claw; PAO is rather *Folsomia*-like on the surface but divides into three lobes as the microscope is focussed deeper into the cuticular groove in which the PAO lies.

Hypogastrura viatica (Tullberg, 1872)

Achorutes murorum (Bourlet, 1843) (Tullberg, 1869)
Achorutes viaticus Tullberg, 1872
Achorutus titahiensis Salmon, 1943
Achorutus subviaticus Bagnall, 1947
Achorutus pseudoviaticus Bagnall, 1947

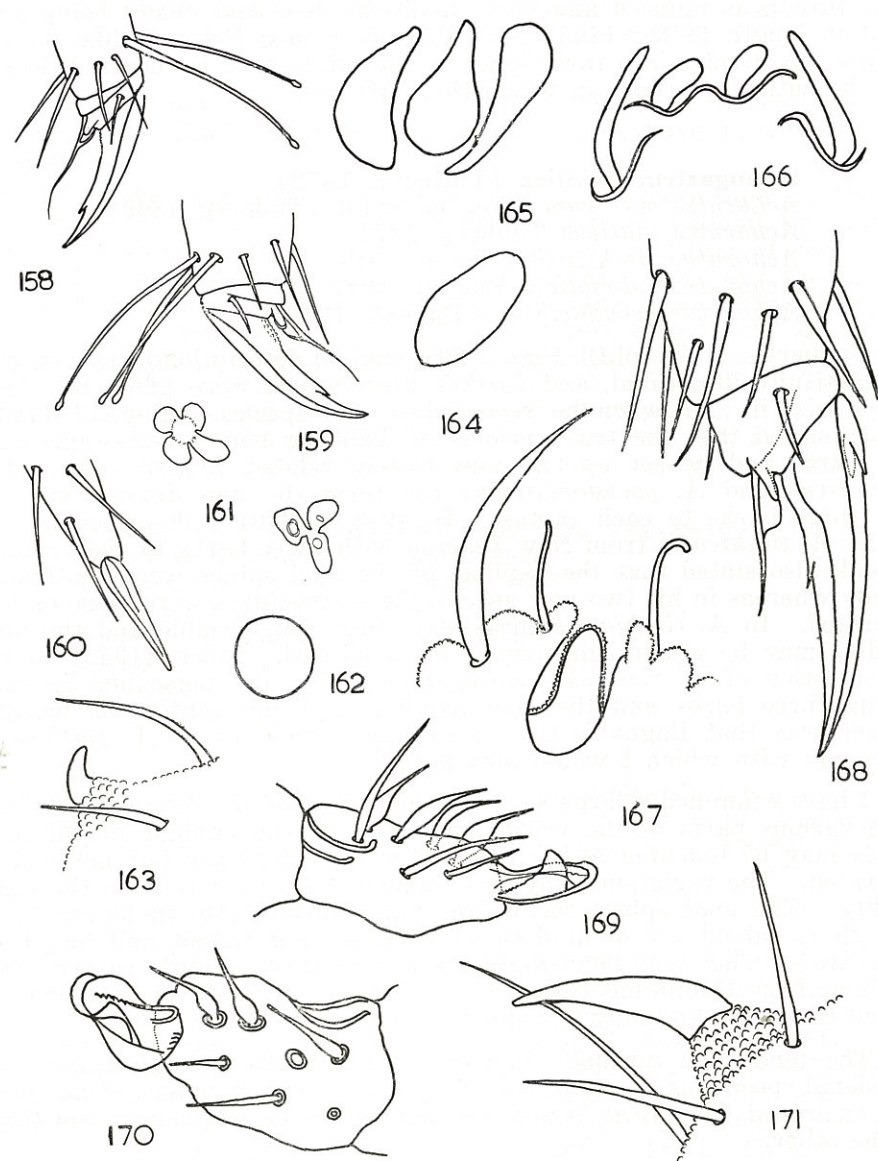
Tullberg's (1872, pl.10, Figs. 7-20) original description of this species is beautifully illustrated, and further illustrations were given by Stach (1954, pls. iii, X) when he redescribed this species. Bagnall (1941, p.220) stated that the true *viaticus* of Tullberg had a tenaculum with four barbs and he set up two new closely related British species (*A. subviaticus* and *A. pseudoviaticus*) for forms he had discovered with only three barbs to each ramus. In 1943 (p.376) I described a new species *A. titahiensis* from New Zealand with three barbs to each ramus. Bagnall also stated that the papillae of the anal spines were contiguous basally whereas in his two new species these structures were more or less separated. In *A. titahiensis* these structures are variable and the anal papillae may be either contiguous or separated. Stach (1949) in his redescription of *A. viaticus* records the rami of the tenaculum as each having three barbs and the anal papillae as being contiguous basally. He suggests that Bagnall's two species are synonyms of *A. viaticus*, a synonymy with which I would now agree.

I have examined a large series of specimens of *A. viaticus* at BMNH from various parts of the world and find that the papillae of the anal spines may be touching at their bases or close together but not widely separated. The variations may occur amongst individuals from the same locality. The anal spines themselves vary considerably in length from very short (about 1/6 of hind claw) to quite long (about half length of hind claw). They may be straight but are normally slightly curved. One specimen from Dublin has two spines on one side of the body arranged one behind the other, and only one spine on the other side.

The tenaculum normally has only three barbs to each ramus but occasional specimens do occur with four barbs to each ramus. One specimen examined from Bear Island had four barbs on one ramus and three on the other.

Re-examination of my *A. titahiensis* type material convinces me that this is simply a further, perhaps extreme, variation of *A. viaticus* Tullberg.

In the BMNH collections there are some specimens labelled *A. murorum* and presented to the museum by Lubbock in 1884 from material sent to him by Tullberg. After examining these I consider them identical with *A. viaticus* Tullberg, 1872.



Figs. 158-163 *Hypogastrura purpurascens galiciana* (Boerner), drawn from type and cotypes in BMNH.

- Fig. 158 fore foot x 400 from type BMNH
 Fig. 159 hind foot x 400 from type BMNH
 Fig. 160 mucro apex of dens x 400 from type BMNH
 Fig. 161 PAO x 1000 from type BMNH
 Fig. 162 PAO and adjacent ocellus from cotype BMNH
 Fig. 163 anal spine and setae from side x 400 from cotype BMNH

Figs. 164-171 *Hypogastrura (Cyclograna) boletivorus* (Packard), drawn from paratype of *Cyclograna vulgaris*.

- Fig. 164 PAO surface appearance x 2000
 Fig. 165 PAO deep appearance at base of organ x 2000
 Fig. 166 SO Ant III x 2000
 Fig. 167 apex Ant IV x 2000
 Fig. 168 hind foot x 600
 Fig. 169 mucrodens from side x 600
 Fig. 170 mucrodens angled view x 600
 Fig. 171 anal spine and associated setae x 600

Schaefferia variabilis Christiansen, 1951

Figs. 172-182

The *holotype* and specimens labelled *cotypes* of this species are in USNM, and these drawings made from the type material will supplement those given in the original description, some of which are difficult to decipher from having been over-reduced in publication.

Proxynellodes reticulatus (Boerner, 1909)
Hypogastrura reticulata Boerner, 1909

Figs 183-189

The *type* of this species is in the Boerner collection at BMNH. No figures were given with Boerner's original description but Yosii (1960) gives excellent figures of the chaetotaxy and some other structures of this species drawn from further specimens he collected in Central Japan.

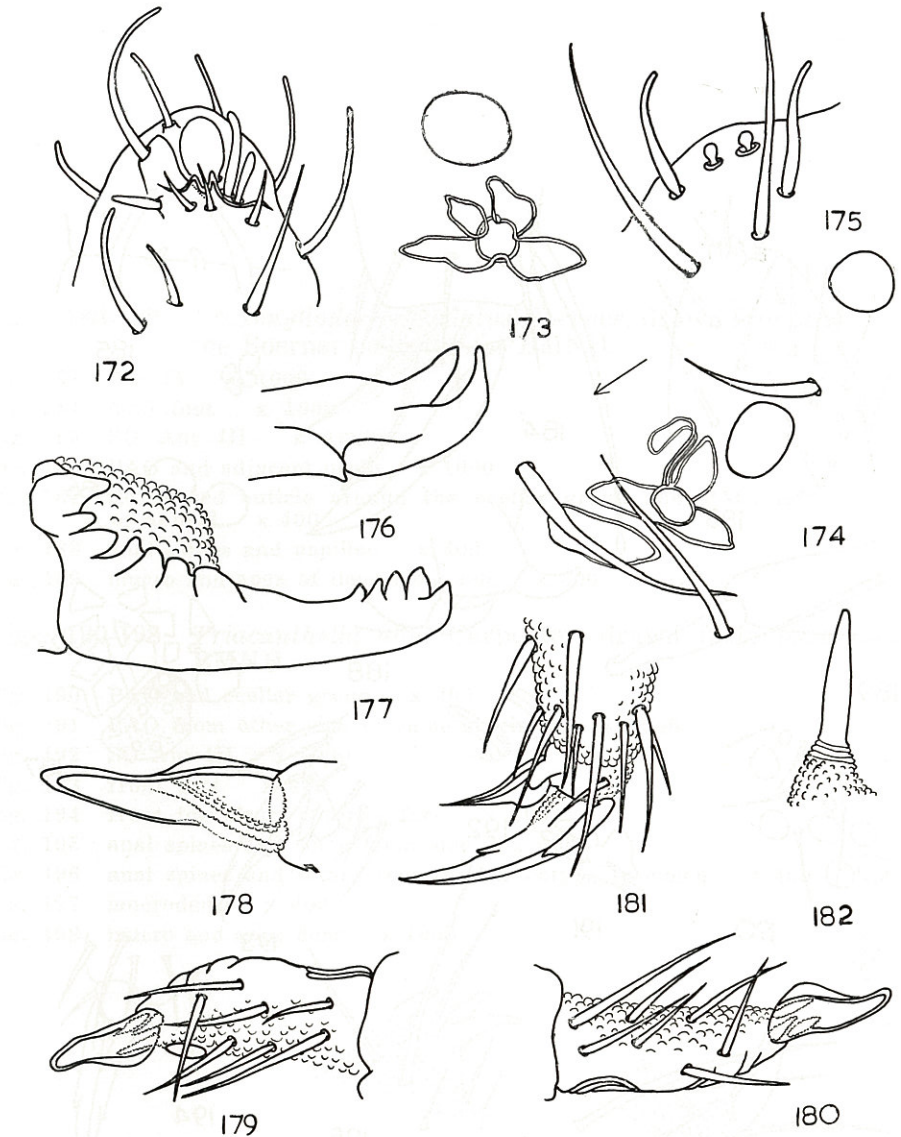
Notes: The coarse granulations of the cuticle place this species, in my view, in the genus *Proxynellodes* Denis, 1926. This I consider preferable to retaining it as a "group" in *Hypogastrura* as suggested by Yosii. Ant IV (Fig. 183) with two apical protrusible sensory sacs, 7-9 short, bladder-like sensory rods and many simple setae. PAO (Fig. 186) with four contiguous lobes arranged more or less as a cross; claw and unguiculus both granulate basally, the latter with a granulate basal finger-like process lying alongside the base of the inner lamella (Fig. 184).

Triacanthella alba Carpenter, 1909

Figs. 190-198

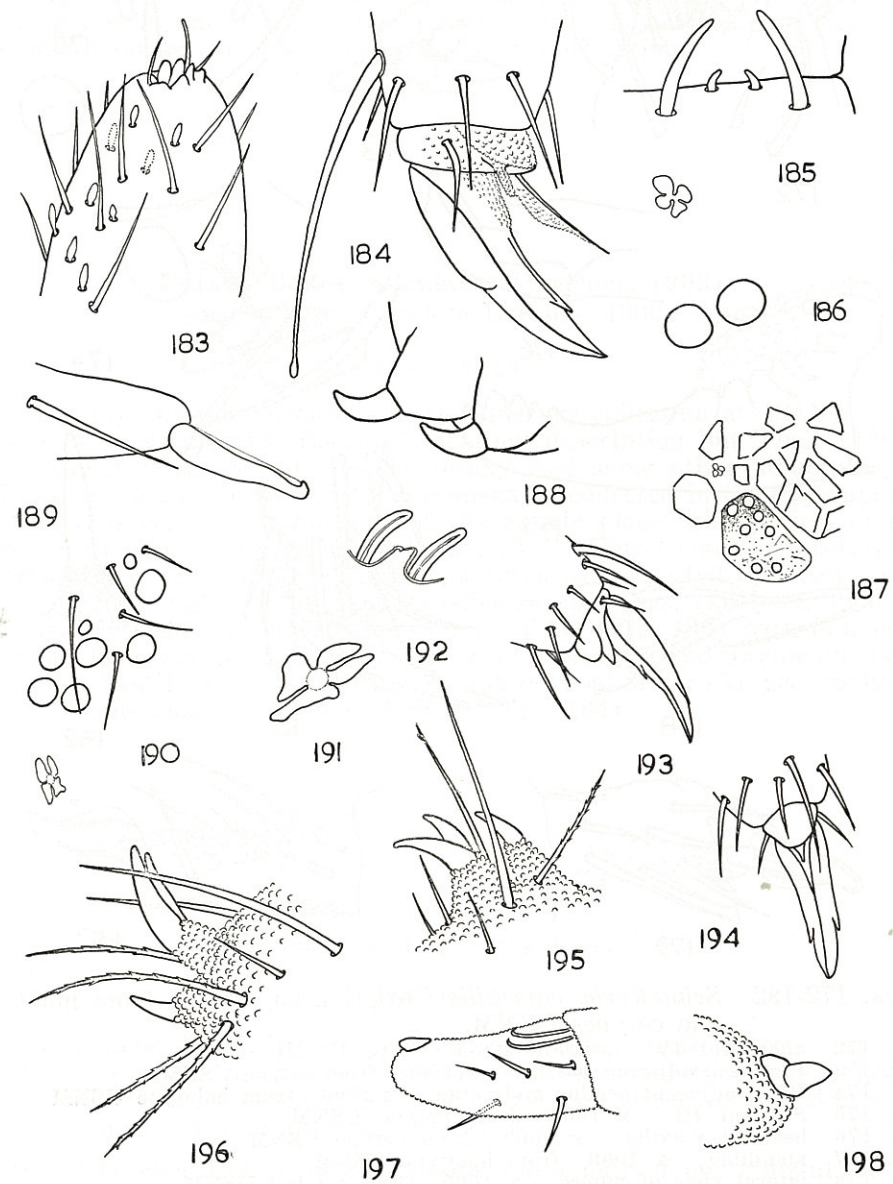
Specimens labelled *paratypes* of this subantarctic species are in BMNH and these drawings supplement those included in the original description. Two specimens labelled *cotypes* on slides in the MM were also examined but both are badly damaged.

Notes: The claw has an internal tooth and a pair of outer distal lateral teeth (Figs. 193 and 194) but no tenent hairs; clothing of both short and long simple setae with some longer serrated setae especially around the posterior region.



Figs. 172-182 *Schaefferia variabilis* Christiansen, drawn from holotype and cotypes USNM.

- Fig. 172 apex Ant IV x 1000 from cotype USNM
 Fig. 173 PAO and adjacent ocellus x 1000 from cotype USNM
 Fig. 174 PAO, adjacent ocellus and setae x 1000 from holotype USNM
 Fig. 175 SO Ant III x 1000 from cotype USNM
 Fig. 176 head of maxilla x 1000 from cotype USNM
 Fig. 177 mandible x 1000 from holotype USNM
 Fig. 178 lateral view of mucro x 1000 from holotype USNM
 Fig. 179 lateral view of mucro x 1000 from holotype USNM
 Fig. 180 mucrodens x 600 from cotype USNM
 Fig. 181 hind foot x 600 from cotype USNM
 Fig. 182 anal spine and papilla from side x 600 from holotype USNM



Figs. 183-189 *Proxenyllodes reticulatus* Boerner, drawn from the type in the Boerner collection at BMNH.

Fig. 183 Ant IV x 1000

Fig. 184 hind foot x 1000

Fig. 185 SO Ant III x 1000

Fig. 186 PAO and adjacent ocelli x 1000

Fig. 187 reticulated cuticle around the ocellar group and PAO, left hand side of animal x 400

Fig. 188 anal spines and papillae x 400

Fig. 189 mucro and apex of dens from side x 400

Figs. 190-198 *Triacanthella alba* Carpenter, drawn from paratypes in BMNH.

Fig. 190 PAO and ocellar group x 400

Fig. 191 PAO from other side of same specimen x 1000

Fig. 192 SO Ant III x 1000

Fig. 193 front foot x 400

Fig. 194 front foot from anterior face x 400

Fig. 195 anal spines and setae from side x 400

Fig. 196 anal spines and setae from another cotype specimen x 400

Fig. 197 mucrodens x 400

Fig. 198 mucro and apex dens x 1000

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*In my "Index" on p.82 this paper is recorded as being published in 1929. This date is incorrect and should be amended to 1926.

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CONCERNING THE COLLEMBOLA TULLBERGIINAE

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ABSTRACT

A review is given of the species of Tullbergiinae described by R. S. Bagnall in a series of papers published in 1935-37 and 1947. A new species of the genus *Tullbergia* is described from Australia.

INTRODUCTION

This paper is the sequel to my paper of 1959 which dealt with the Onychiuridae of the late Dr R. S. Bagnall's collections of microscope slides of Collembola in the British Museum (Natural History), London.

Examination of Bagnall's type specimens of the Tullbergiinae has led me to extensive revision of some of his species. This is set out in the following pages and figures drawn from his material, and completes the revision commenced in my 1959 paper. The same criticisms apply to Bagnall's work on the Tullbergiinae as I recorded in the introduction to my 1959 paper.

I would like to record once again my thanks to Dr T. Clay and the Director of the British Museum, (National History) for their assistance with material and the many concessions extended to me over the exceptionally long period of this study.

The invalidity of the genus *Protullbergia* Bagnall, 1947

When Bagnall erected the genus *Protullbergia*, he chose *Tullbergia trisetosa* Schaeffer as the type species, basing his separation on such variable characters as the pseudocelli, unguiculus and antennal base. These characters do not warrant generic distinction, and hence Bagnall's genus must be rejected as a subjective synonym of *Tullbergia* Lubbock, 1876.

Of the three new species described by Bagnall as belonging to his *Protullbergia* only one, *P. womersleyi*, is valid. Examination of Bagnall's specimens show that *P. salmoni* Bagnall is identical with *Tullbergia australica* Womersley, 1933, and *P. willemi* Bagnall is identical with *Dinaphorura diversispina* Womersley, 1935.

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***Tullbergia womersleyi* (Bagnall, 1947)**
Protullbergia womersleyi Bagnall, 1947

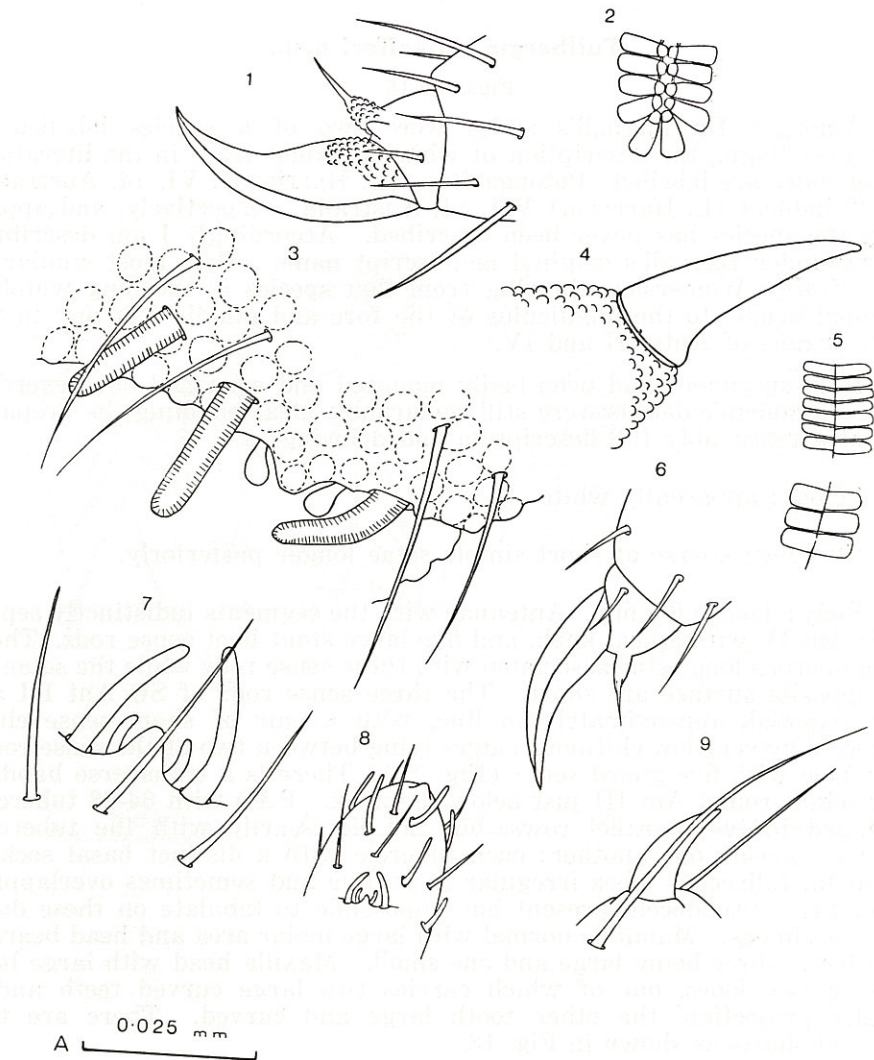
Figs. 1-4.

I have examined Bagnall's material and this is quite clearly referable to *Tullbergia*. The SO Ant III is as shown in Fig. 3 with three "laminated" superior sense rods only. Ant IV bears a small apical sensory knob, 6-8 moderately long curved sense rods and numerous long setae. PAO has 60-80 vesicles of the shape shown in Fig. 2 arranged as two parallel rows. The anal spines are 3-4 times as long as broad at their bases, on papillae, and the spines subequal to the hind claw in length. Pseudocelli are not as given by Bagnall but are as follows: 1 + 1 on each of antennal base, hind margin of head Th I — III and Abd I — V. Claw as shown in Fig. 1 with a basal seta and well developed unguiculus. Clothing moderate of short simple setae, longer posteriorly.

***Tullbergia australica* Womersley, 1933**
Protullbergia salmoni Bagnall, 1947

Figs. 5-9.

Figures 5-9 are drawn from Bagnall's paratypes of *P. salmoni* and show that the characteristic body structures of Bagnall's species are so similar to those of *T. australica* Womersley that it is impossible to separate these two species. The PAO of Bagnall's specimens have 55-63 tubercles and the SO Ant III agree exactly with that of Womersley's species with the third sense rod on the opposite side from the pair, and fully exposed. Womersley's name published in 1933 must therefore take priority.



Figs. 1-4 *Tullbergia womersleyi* Bagnall, 1947.
 Drawn from Bagnall's paratypes.

Fig. 1 hind claw
 Fig. 2 end of PAO

Fig. 3 sense organ Ant III
 Fig. 4 anal spine and papilla

Figs. 5-9 *Tullbergia australica* Womersley, 1933.
 Drawn from paratypes of *Protullbergia salmoni* Bagnall, 1947.

Fig. 5 two portions of PAO
 Fig. 7 main portion of sense organ Ant III,
 the third sense rod not shown
 Fig. 8 apex Ant IV and sense organ Ant III

Fig. 6 claw from side
 Fig. 9 anal spine and seta

Scale: A for all Figs.

Tullbergia schaefferi n.sp.

Figs. 10-15.

Amongst Dr Bagnall's slides were two of a species labelled *T. schaefferi* Bagn., the description of which I cannot trace in the literature. These slides are labelled "Potonga Bay, (L. Harrison), VI, 14, Australia" and "Lindfield (L. Harrison) VII, 14, Australia" respectively, and apparently the species has never been described. Accordingly I am describing it now under Bagnall's original manuscript name. It is most similar to *T. australica* Womersley differing from that species in the long whiplike terminal bristle to the unguiculus of the fore and middle feet and in the sense organs of Ants III and IV.

Both specimens had been badly mounted and squashed but nevertheless all taxonomic details were still remarkably clear enabling the preparation of a reasonably full description and drawing.

Colour: apparently white.

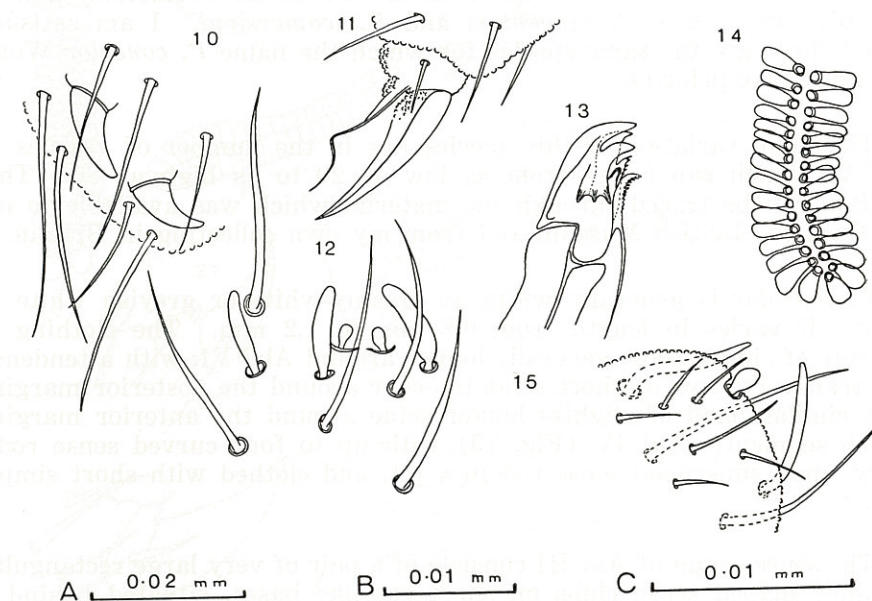
Clothing: sparse of short simple setae longer posteriorly.

Body: length 0.5 mm. Antennae with the segments indistinctly separated; Ant IV with apical knob, and five large stout bent sense rods. There are numerous long setae associated with these sense rods while the setae on the opposite surface are short. The three sense rods of SO Ant III are fully exposed, approximately in line, with a pair of short sense clubs protected by very low chitinous ridges lying between two of the sense rods; the whole with five guard setae (Fig. 12). There is a transverse band of long setae around Ant III just below the apex. PAO with 64-68 tubercles arranged in two parallel rows, but not necessarily with the tubercles exactly opposite one another; each tubercle with a distinct basal socket; the distal foliaceous lobes irregular in outline and sometimes overlapping (Fig. 14). Pseudocelli present but impossible to tabulate on these damaged specimens. Mandible normal with large molar area and head bearing four teeth, three being large and one small. Maxilla head with large base bearing two lobes, one of which carries two large curved teeth and a smaller projection, the other tooth large and curved. There are two serrated shafts as shown in Fig. 13.

Anal spines stout, curved, on short papillae; the spines about half as long as the claws of the hind feet, and guarded by three anterior and three posterior setae each in transverse rows (Fig. 10).

Legs: claws as shown in Fig. 11, without any teeth, basally finely granulate; unguiculus bulbous and finely granulate basally, with a narrow outer lamella and the shaft projected as a long whiplike bristle overreaching the claw tip on the front feet, about reaching the tip on the middle feet and somewhat shorter on the hind feet. A moderately long basal seta to each side of claw.

Holotype (Potonga Bay specimen) and paratype (Lindfield specimen) mounted on slides in Bagnall collection, in British Museum (Natural History), London.



Figs. 10-15 *Tullbergia schaefferi* n. sp.
Drawn from holotype.

- Fig. 10 anal spines and setae
 Fig. 11 fore foot
 Fig. 12 sense organ Ant III
 Fig. 13 maxilla head
 Fig. 14 end section PAO
 Fig. 15 apex Ant IV

Scales: A for Figs. 10, 11 and 13; B for Figs. 12 and 15; C for Figs. 14.

Paratullbergia concolor Womersley, 1930*Paratullbergia carpenteri* Bagnall, 1935*Paratullbergia womersleyi* Bagnall, 1935

Figs. 16-28.

I have examined the type material of *P. concolor* Womersley and of Bagnall's two species *P. carpenteri* and *P. womersleyi*. I am satisfied that all three are the same species for which the name *P. concolor* Womersley must take priority.

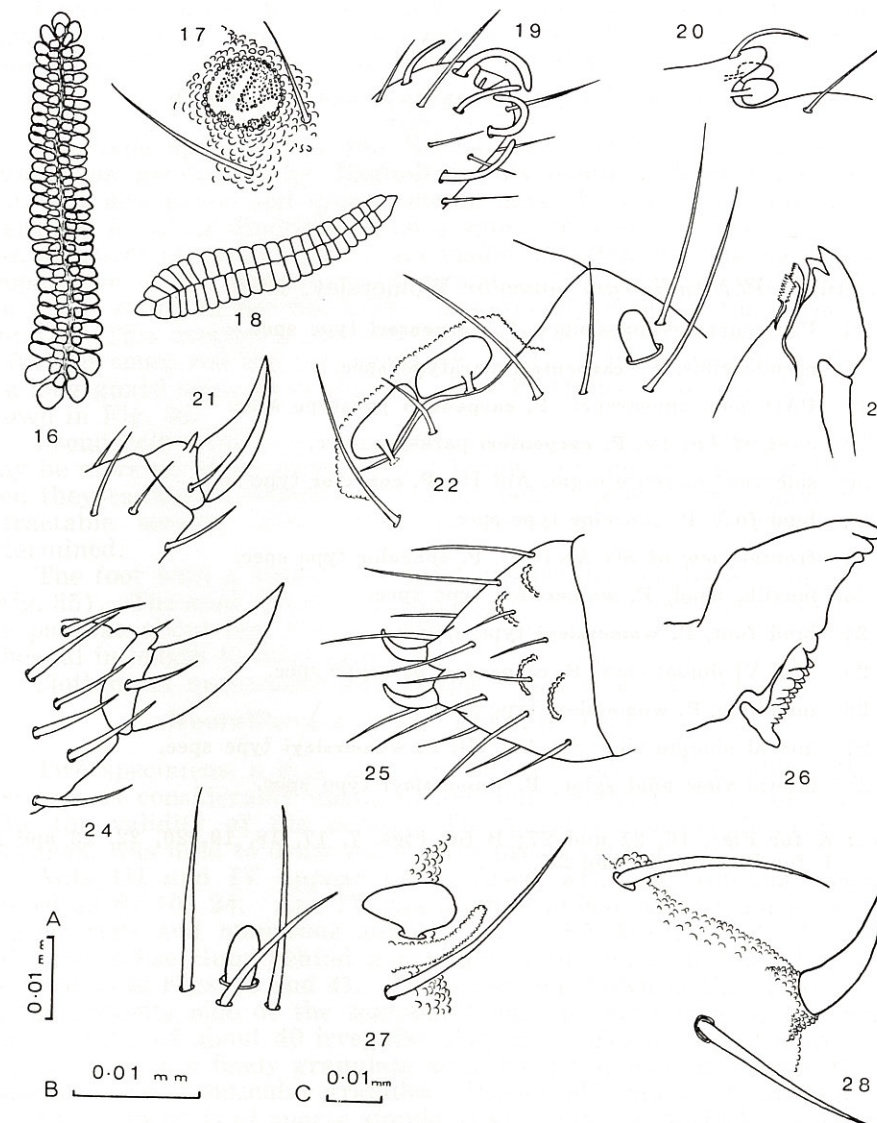
The main variation of this species lies in the number of vesicles in the PAO which can range from as low as 20 to as high as 80. This variation can be traced through the material which was available to me both from the British Museum and from my own collecting in Britain.

P. concolor is generally white, to creamy-white or greyish white in colour. It varies in length from 0.8 mm to 1.2 mm. The clothing is moderate of simple setae generally longer around Abd VI, with a tendency for a transverse row of short setae to occur around the posterior margins and a similar band of slightly longer setae around the anterior margins of each segment. Ant IV (Fig. 19) with up to four curved sense rods, a very small superficial sense rod in a pit, and clothed with short simple setae.

The sense organ of Ant III consists of a pair of very large rectangular to kidney-shaped sense clubs on short rod-like bases, situated behind a low tuberculate cuticular fold with a short central guard seta, three longer lateral guard setae and a single short straight exposed sense club to one side (Figs. 20, 22, 27). The PAO with 18-80 contiguous vesicles primarily lying at right angles to the long axis of the organ, and appearing superficially as in Fig. 18. Under closer examination the PAO shows prominent basal lobes of attachment as in Fig. 16.

Mandible with three strong apical teeth and well developed relatively small molar area (Fig. 26). Maxilla head with three apical teeth and three toothed lamellae (Fig. 23). Pseudocelli very small and obscure appearing as in Fig. 17. Abd VI and the margins of the other abdominal segments with a tendency to coarser tuberculation of the cuticle than the remainder of the body. Abd VI bears two large, curved anal spines on papillae, touching at their bases. Two chitinous tuberculate ridges occur on each side of the anterior margin of Abd VI; these are probably what Bagnall called "tooth-like projections near base". The posterior of these each carries a long simple seta on the outer edge (Figs. 25, 28).

Foot with simple untoothed claw having a fairly long basal seta to each side. Unguiculus vestigial and spine-like (Figs. 21, 24).



Figs. 16-28 *Paratullbergia concolor* Womersley, 1930.

- Fig. 16 PAO surface appearance, *P. carpenteri* type spec.
 Fig. 17 pseudocellus, *P. carpenteri* paratype spec.
 Fig. 18 PAO deep appearance, *P. carpenteri* paratype spec.
 Fig. 19 apex of Ant IV, *P. carpenteri* paratype spec.
 Fig. 20 side view of sense organ Ant III, *P. concolor* type spec.
 Fig. 21 hind foot, *P. concolor* type spec.
 Fig. 22 frontal view of SO ANT III, *P. concolor* type spec.
 Fig. 23 maxilla head, *P. womersleyi* type spec.
 Fig. 24 hind foot, *P. womersleyi* type spec.
 Fig. 25 Abd VI dorsal view, *P. carpenteri* paratype spec.
 Fig. 26 mandible, *P. womersleyi* type spec.
 Fig. 27 lateral oblique view SO Ant III, *P. womersleyi* type spec.
 Fig. 28 lateral view anal spine, *P. womersleyi* type spec.

Scales: A for Figs. 16, 21 and 27; B for Figs. 7, 17, 18, 19, 20, 22, 23 and 28;
 C for Figs. 24, 25 and 26.

Dinaphorura diversispina Womersley, 1935*Protullbergia willemi* Bagnall, 1947*Dinaphorura harrisoni* Bagnall, 1947

Figs. 29-33.

I have examined Bagnall's paratypes of *P. willemi* and his type and paratype of *D. harrisoni* and am satisfied that both of these species are conspecific with *D. diversispina* Womersley, 1935.

Austraphorura wahlgreni Bagnall, 1947

Figs. 34-37.

The type specimen in the British Museum is badly mounted and crushed as mentioned by Bagnall in his original description. In my opinion a new genus and species should never have been accepted into the literature let alone described from a single crushed specimen. Nevertheless, sufficient of the characters are visible to validate it and to permit the preparation of the accompanying figures. The genus is characterised by the large, stout, rather blade-like, transversely directed sense rod of SO Ant III. This overlies a chitinous fold with a pair of minute sense clubs. A further sense rod lies somewhat removed and below the whole SO with five long guard setae as in Fig. 34. The PAO has 18 detached vesicles as shown in Fig. 36.

Pseudocelli with 1 + 1 on antennal base and Abds IV and V. There may be more on other segments but because of the condition of the specimen they cannot be determined. The apex of Ant IV may have a small retractable sensory knob. Sensory setae of Ant IV could not be determined.

The foot with a stumpy vestigial unguiculus and basal seta, no teeth (Fig. 35). The anal spines long, slightly curved, on papillae as in Fig. 37; the papillae about one third length of spines and the spines themselves subequal in length to hind claw.

Clothing of moderately long simple setae, longer posteriorly.

Neotullbergia laingi Bagnall, 1936

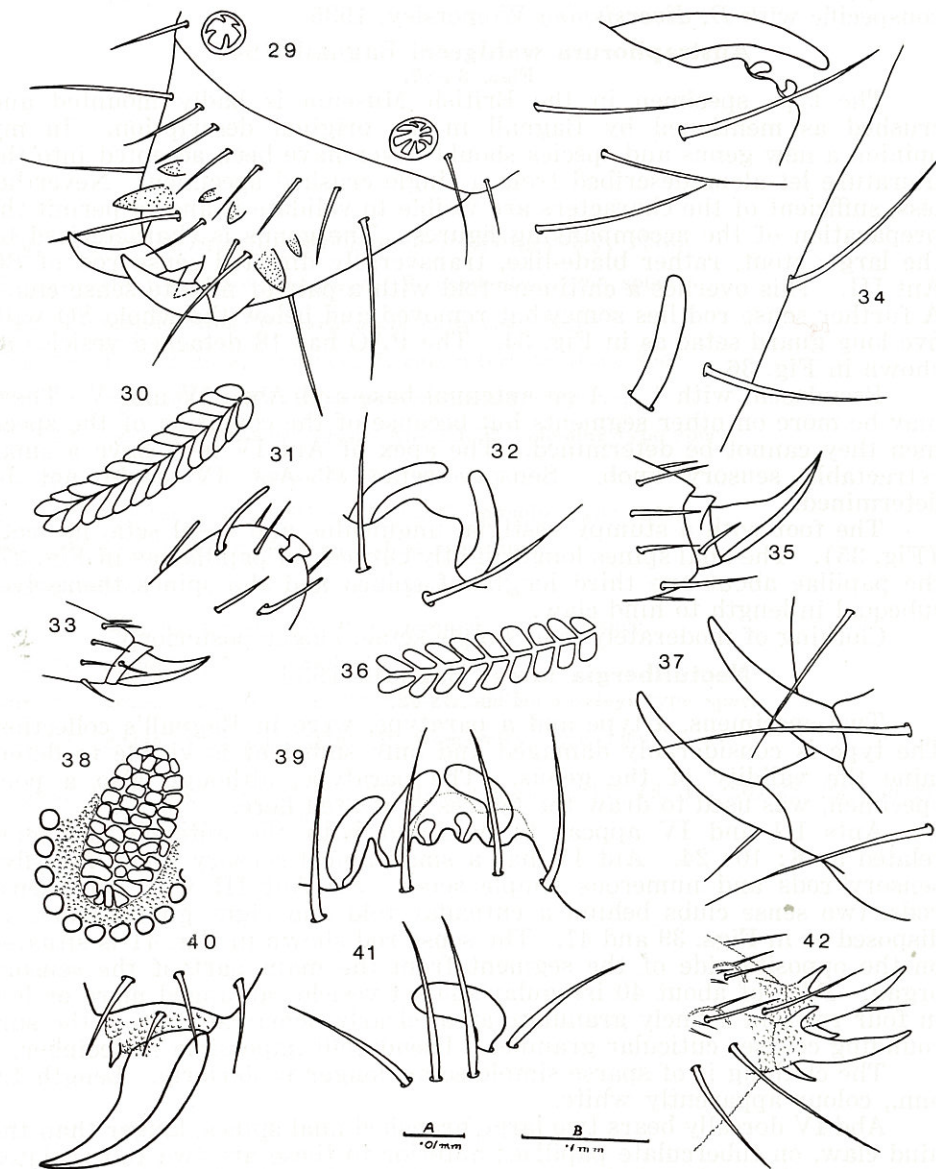
Figs. 38-42.

Two specimens, a type and a paratype, were in Bagnall's collection. The type is considerably damaged and only sufficient is visible to determine the validity of the genus. The paratype, although also a poor specimen, was used to draw the figures presented here.

Ants III and IV appear to be fused with the antennal segments related as 8: 10: 24. Ant IV has a small apical sensory knob, four-five sensory rods and numerous simple setae. SO Ant III with four sense rods, two sense clubs behind a cuticular fold and eight guard setae, all disposed as in Figs. 39 and 41. The sense rod shown in Fig. 41 is situated on the opposite side of the segment from the main part of the sensory organ. PAO of about 40 irregular shaped vesicles arranged more or less in four rows in a finely granulate area, clearly demarcated from the surrounding coarser cuticular granules. Pseudocelli impossible to decipher.

The clothing is of sparse simple setae, longer posteriorly. Length 1.0 mm., colour apparently white.

Abd IV dorsally bears two large branched anal spines, longer than the hind claw, on tuberculate papillae; anterior to these are two tuberculated chitinous ridges, the whole with setae disposed as in Fig. 42. The anal spines are four times as long as their papillae and their basal portions are also tuberculated. The branches arise basally, one dorsolateral and one ventral. These structures characterise the genus.



Figs. 29-33 *Dinaphorura diversispina* Womersley, 1935.

Drawn from paratype specimens of *Protullbergia willemi* Bagnall.

- Fig. 29 Abd VI
 Fig. 30 PAO
 Fig. 31 apex Ant IV
 Fig. 32 sense organ Ant III
 Fig. 33 hind foot

Figs. 34-37 *Austraphorura wahlgreni* Bagnall, 1947.

Drawn from type specimen.

- Fig. 34 sense organ Ant III
 Fig. 35 hind foot
 Fig. 36 PAO
 Fig. 37 anal spines

Figs. 38-42 *Neotullbergia laingi* Bagnall, 1936.

Drawn from paratype specimen.

- Fig. 38 PAO
 Fig. 39 sense organ Ant III
 Fig. 40 hind foot
 Fig. 41 fourth sensory rod Ant III
 Fig. 42 anal spines

Scale A for Figs. 30-32, 36, 38-39, 41.

Scale B for Figs. 29, 33-35, 37, 40, 42.

Metaphorura bipartita Handschin, 1921*Metaphorura boernerii* Bagnall, 1936

Figs. 43-57.

The type and several paratypes of Bagnall's *M. boernerii* together with M. W. Davies' specimens identified by Bagnall as *M. bipartita* Handschin and some specimens labelled by Bagnall as *M. denisii*, but never published as such, were examined. All of these, I am satisfied, are the same species and must be known as *M. bipartita* Handschin. The accompanying illustrations are drawn from these specimens as set out in the legend to the figures. Bagnall separates his *boernerii* from *bipartita* primarily on the presence of pseudocelli on Th I but, though Handschin did not observe these, they have been recorded by others, notably Stach (1954, p.211). This description by Stach is very full but I would add the further notes that in Bagnall's material Ant IV has six-eight stout curved sense rods and a small apical knob (Fig. 43). The SO Ant III sits behind a high cone-like integumentary fold with a papilla at each end (Fig. 45 and 51). Behind the cone-like fold is a further low fold in which are two small sense clubs flanked on each side by a large, inwardly curved, stout sense rod (Figs. 57 and 49).

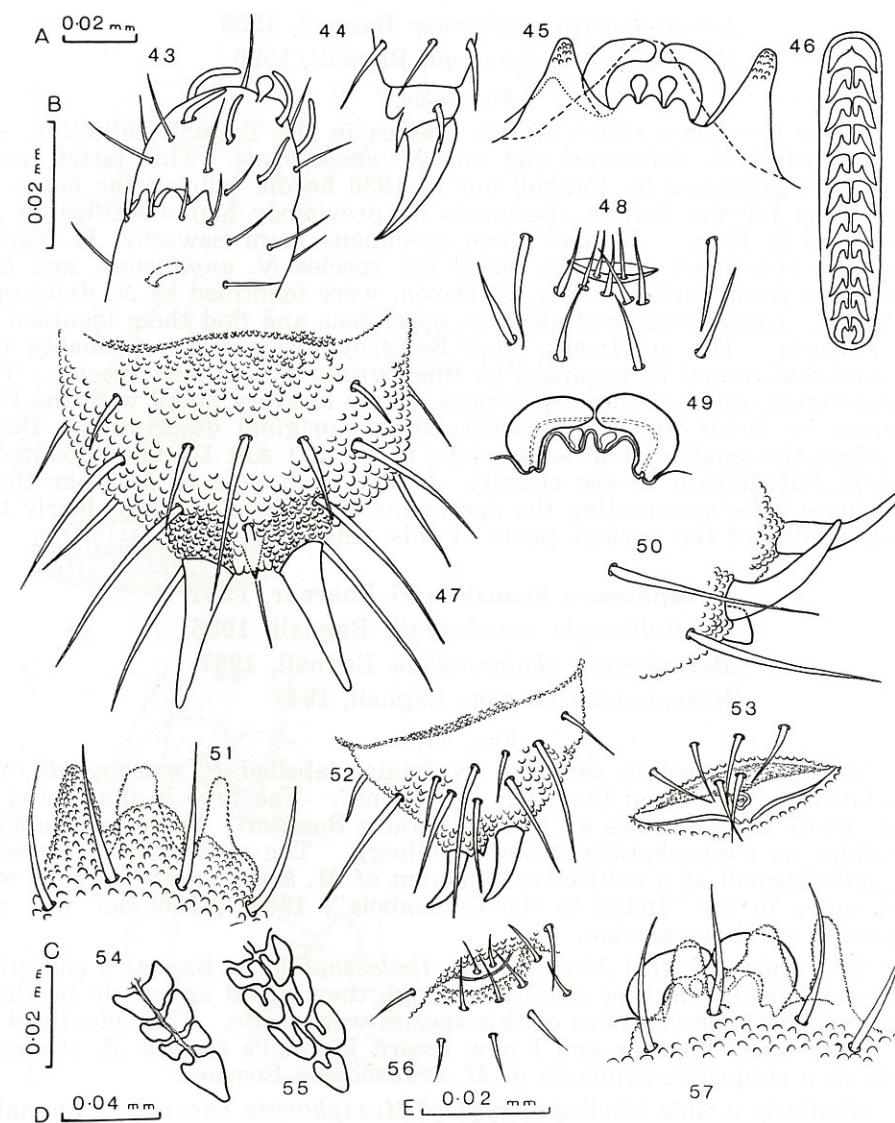
There is always a third papilla to one side (Figs. 45 and 51) and a third, stout, curved sense rod on the opposite surface of the antennal segment (Fig. 43). The SO proper has four guard setae (Fig. 57). PAO with 20-25 "U" shaped vesicles (Figs. 46 and 55) situated in a deep furrow and hence difficult to see. The vesicles appear to change in shape as focus of the microscope reaches deeper into this groove (Fig. 54).

The papillae of the annal spines are not always distinct but are generally recognisable by the smaller size of the cuticular granules as compared with those dorsally on Abd VI.

Figs. 43-57 *Metaphorura bipartita* Handschin, 1921.

- Fig. 43 Ants III and IV, *M. boernerii* type spec.
 Fig. 44 foot, *M. boernerii* type spec.
 Fig. 45 SO Ant III cone-like fold removed, *M. boernerii* paratype spec.
 Fig. 46 PAO *M. bipartita* Bag. M. W. Davies' spec.
 Fig. 47 Abd VI showing anal spines and large ventral tubercle, *M. denisi* spec.
 Fig. 48 genital aperture, *M. boernerii* type spec.
 Fig. 49 sense clubs and rear fold of SO of Ant III, *B. boernerii* paratype spec.
 Fig. 50 anal spines and papilla, *M. boernerii* type spec.
 Fig. 51 SO Ant III surface appearance, *M. boernerii* paratype spec.
 Fig. 52 Abd VI anal spines and papilla, *M. boernerii* type spec.
 Fig. 53 genital aperture, *M. boernerii* paratype spec.
 Fig. 54 end of PAO deep view, *M. boernerii* paratype spec.
 Fig. 55 end of PAO surface view, *M. boernerii* paratype spec.
 Fig. 56 genital aperture, *M. boernerii* paratype spec.
 Fig. 57 SO Ant III, *M. boernerii* paratype spec.

Scales: A for Figs. 43, 44 and 47; B for Figs. 49, 51, 54, 55 and 57; C for Fig. 50; D for Figs. 52 and 56; E for Figs. 45, 46, 48 and 53.



Neonaphorura duboscqui Denis, 1932*Tullbergia duboscqui* Denis, 1932*Neonaphorura duboscqui* Bagnall, 1935*Neonaphorura anglicanus* Bagnall, 1936*Neonaphorura duboscqui* Bagnall, 1936

Figs. 58-64.

There are seven slides of this species in the Bagnall collection, six being labelled *N. duboscqui* and one *N. devoniensis*. This latter name was never published by Bagnall but in 1936 he did publish the name *N. anglicanus* for the British specimens he previously had identified as *N. duboscqui* in 1935. Bagnall's two specimens from Sewerby, E. Yorks, were the ones upon which he based the species *N. anglicanus*, and five specimens from Petit Tor Bay, S. Devon, were identified as *N. duboscqui* of Denis. I have examined all these specimens and find them identical in all respects. The specimens from Sewerby are smaller, probably not mature, and cannot be regarded on these grounds as a new species. The postantennal organ of these specimens agrees in every detail with the Fig. 2 given by Denis for this structure in his original description. Denis mentions the small central sense clubs in the SO Ant III as undoubtedly present but difficult to see clearly. I have been able to decipher these structures after remounting the specimens and Fig. 58 shows clearly the relationships of the various parts of this sensory organ.

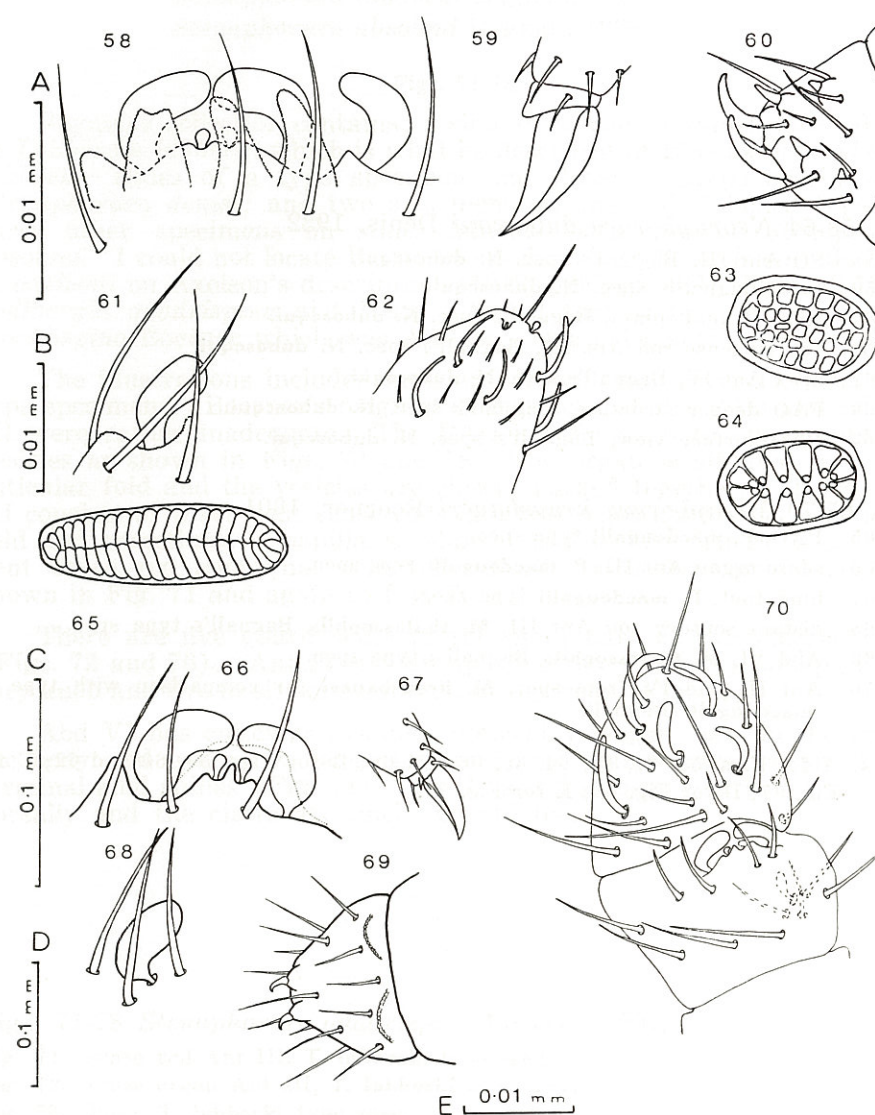
Mesaphorura krausbaueri Boerner, 1901*Paratullbergia macdougalli* Bagnall, 1936*Mesaphorura thalassophila* Bagnall, 1937*Mesaphorura baconae* Bagnall, 1947

Figs. 65-70.

Bagnall's collection contains two slides labelled *P. macdougalli*, the one labelled "type" and the other "paratype". The type is illustrated in Figs. 65-67 and identified as *M. krausbaueri* Boerner. The paratype slide identifies as *Protaphorura armata* Tullberg. The recording of *P. macdougalli* Bagnall as a subjective synonym of *M. krausbaueri* Boerner was first made in my "Index to the Collembola", 1964, p.150, but was not explained on that occasion.

Two slides labelled *Mesaphorura thalassophila* in Bagnall's collection were not labelled as type material though they would appear to be those from which his descriptions of this species were made. They identified as *M. krausbaueri* Boerner and I now record Bagnall's species *M. thalassophila* as a subjective synonym of *M. krausbaueri* Boerner.

Similarly a slide labelled as type of *Mesaphorura baconae* in Bagnall's collection identifies as *M. krausbaueri* Boerner; this subjective synonymy was first recorded in 1964 on p.151 of my "Index to the Collembola". Fig. 70 is drawn from a specimen identified by Bagnall as *M. krausbaueri* and which compares in all respects with his *P. macdougalli* material. Bagnall in his description of *P. macdougalli* says that "Ant IV is much as in *carpenteri*" but this is not so as his *P. carpenteri* I have already shown is synonymous with *P. concolor* Womersley (Fig. 19).



Figs. 58-64 *Neonaphorura duboscqui* Denis, 1932

- Fig. 58 SO Ant III, Bagnall's spec. *N. duboscqui*.
 Fig. 59 foot, Bagnall's spec. *N. duboscqui*.
 Fig. 60 Abd VI anal spines, Bagnall's spec. *N. duboscqui*.
 Fig. 61 fourth sense rod Ant III, Bagnall's spec. *N. duboscqui*.
 Fig. 62 apex Ant IV, Bagnall's spec. *N. duboscqui*.
 Fig. 63 PAO deeper structure, Bagnall's spec. *N. duboscqui*.
 Fig. 64 PAO surface view, Bagnall's spec. *N. duboscqui*.

Figs. 65-70 *Mesaphorura krausbaueri* Boerner, 1901.

- Fig. 65 PAO, *P. macdougalli* type spec.
 Fig. 66 sense organ Ant III, *P. macdougalli* type spec.
 Fig. 67 hind foot, *P. macdougalli* type spec.
 Fig. 68 distant sensory rod Ant III, *M. thalassophila* Bagnall's type spec.
 Fig. 69 Abd VI, *M. thalassophila* Bagnall's type spec.
 Fig. 70 Ant III and IV from spec. *M. krausbaueri* for comparison with type *P. macdougalli* Bagnall.

Scales: A for Figs. 58, 61, 63, 64, 65, 66 and 68; B for Figs. 59, 60 and 62; C for Fig. 67; D for Fig. 69; E for Fig. 70.

Stenaphorura quadrispina Boerner, 1901*Stenaphorura axelsoni* Bagnall, 1935*Stenaphorura denisi* Bagnall, 1935*Stenaphorura lubbocki* Bagnall, 1935*Stenaphorura absoloni* Bagnall, 1936

Figs. 71-78.

Bagnall's collection contains: a slide of a poor specimen labelled type of *Tullbergia lubbocki* which is what he described in 1935 as *Stenaphorura lubbocki*; slides of a type specimen and three paratype specimens of *Stenaphorura denisi*; and two specimens on one slide labelled type, and three other specimens on slides labelled paratypes of *Stenaphorura absoloni*. I could not locate Bagnall's specimen's of *S. axelsoni*. He based *S. axelsoni* on Axelson's description (1912, p.96, pl. VIII, Figs. 12-13) of *Tullbergia quadrispina* and I am satisfied that it is a synonym of *S. quadrispina* Boerner which was Axelson's original identification.

The illustrations included here are drawn from several of Bagnall's type specimens. Boerner's original descriptions of the PAO and SO Ant III were rather inadequate. The PAO has from 30 to 60, possibly 80, vesicles as shown in Figs. 73 and 78. The organ is situated in a deep cuticular fold and the vesicles are closely packed together. The SO Ant III consists of three bent sense rods and two sense clubs with a cuticular fold and sometimes a papilla as shown in Fig. 72. There is a fourth bent sense rod somewhat removed, usually with four guard setae as shown in Fig. 71 and again in Fig. 76.

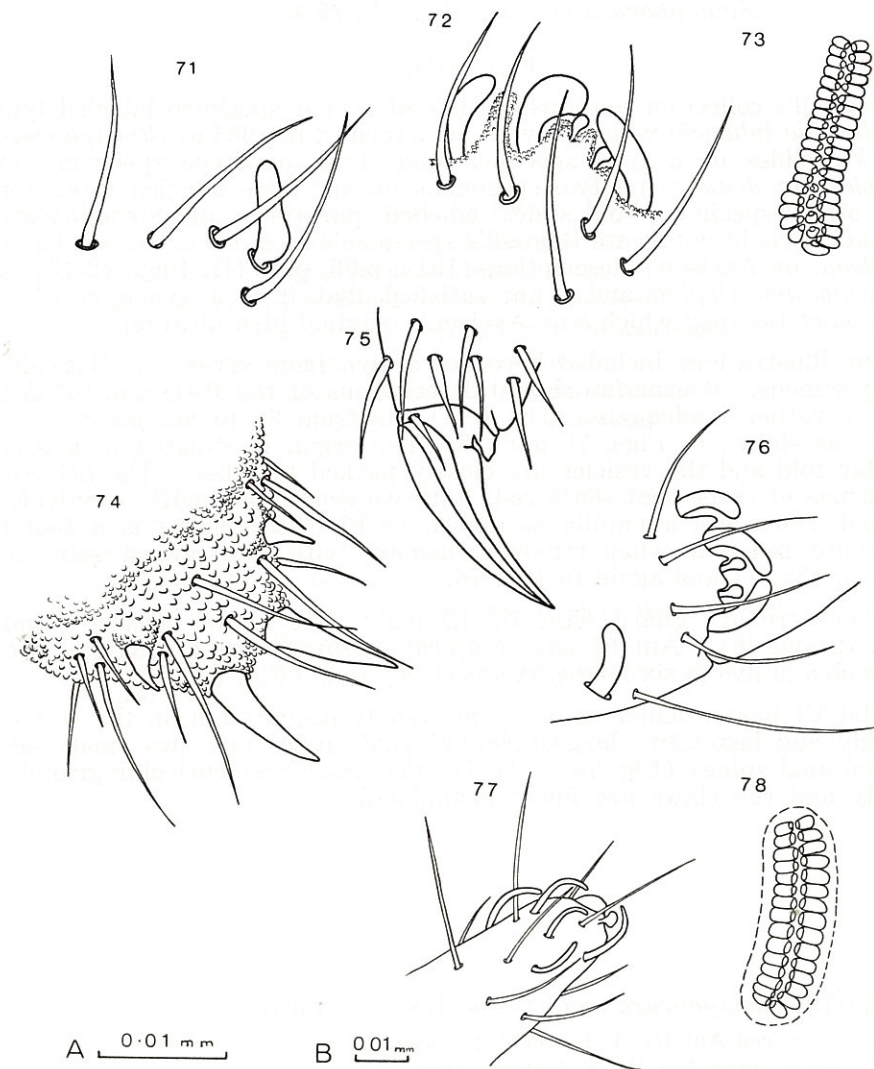
There are five guard setae to the main part of the sensory organ (Figs. 72 and 76). Ant IV has an apical sensory dome, a subapical sensory knob and five to six long curved sensory rods (Fig. 77).

Abd VI has cuticular granules noticeably larger than on the rest of the body and bears two large terminal anal spines and two small sub-terminal anal spines (Fig. 74). Th III also has larger cuticular granules dorsally and the claws are finely granulated.

Figs. 71-78 *Stenaphorura quadrispina* Boerner, 1901.

- Fig. 71 sense rod Ant III, *T. lubbocki* type spec.
 Fig. 72 sense organ Ant III, *T. lubbocki* type spec.
 Fig. 73 PAO, *T. lubbocki* type spec.
 Fig. 74 Abd VI, *P. denisi* type spec.
 Fig. 75 fore foot, *P. denisi* type spec.
 Fig. 76 sense organ Ant III, *P. denisi* type spec.
 Fig. 77 apex Ant IV, *P. denisi* paratype spec.
 Fig. 78 PAO, *P. denisi* type spec.

Scales: A for Figs. 71, 72, 74 and 75; B for Figs. 73, 76, 77 and 78.



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