

# NORTH AMERICAN COLLEMBOLOUS INSECTS OF THE SUBFAMILY ONYCHIURINAE.

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Among our most abundant collembolans are species of *Onychiurus*. They are white (one species having a yellow variety), elongate (pl. 68), usually 1 or 2 millimeters in length, nonsaltatorial; they belong essentially to the fauna of the soil and are limited to damp situations.

The subfamily Onychiurinae comprises three genera: *Onychiurus-Tullbergia*, represented in North America by a single Californian species; and *Tetrodontophora*, a European genus with one described species.

The forms discussed in this article are:

*Onychiurus similis*, new species.

*Onychiurus cocklei* Folsom.

*Onychiurus subtenuis*, new species.

*Onychiurus litoreus*, new species.

*Onychiurus armatus* Tullberg.

*Onychiurus pseudarmatus*, new species.

*Onychiurus octopunctatus* Tullberg.

*Onychiurus dentatus* Folsom.

*Onychiurus ramosus*, new species.

*Onychiurus fimetarius* Linnaeus, Lubbock.

*Onychiurus pseudofimetarius*, new species.

*Tullbergia collis* Bacon.

These are all the species of the subfamily that are at present known in our fauna. I expect, however, that many more species will be brought to light. In Europe *armatus*, *fimetarius*, and *ambulans* are everywhere abundant. In North America the first two species are widely distributed, but *ambulans* is unknown in collections. Packard ('73) recorded *ambulans* from Washington, but his specimens are lost, and his description is broad enough to include almost any of our species with anal spines. Subsequent records of the occurrence of *ambulans* in this country have either followed Packard or have been based upon misidentifications. *Ambulans*

is to be looked for, however, especially along the Atlantic coast. In eastern Massachusetts, for example, there are many European species of Collembola that fail to appear in extensive collections from Illinois, Ohio, and New York.

Cotypes and other specimens have been deposited in the United States National Museum, Washington, District of Columbia; and in the Museum of Comparative Zoology, Cambridge, Massachusetts.

## Order COLLEMBOLA Lubbock

### Suborder ARTHROPLEONA Börner

#### Family PODURIDAE Lubbock

#### Subfamily ONYCHIURINAE Börner

*Aphorurini* BÖRNER '01a.

*Aphorurinae* BÖRNER '01b.

*Onychiurinae* BÖRNER '01c, '06.

Pseudocelli present. Eyes absent. Postantennal organs present in most species and usually well developed. Antennal base usually present, distinguished by tubercles smaller than those of the rest of the head. Third antennal segment with a characteristic distal lateral sense organ, consisting of two or three sense clubs, a pair of sense rods, and usually outer papillae with their guard setae. Mouth parts mandibulate; mandibles with apical incisive teeth and with a many-toothed molar surface. Furcula absent, except in genus *Tetrodontophora*. Anal spines present or absent. Tarsi with one or two claws. Clavate tenent hairs absent. Integument tuberculate.

#### KEY TO GENERA OF ONYCHIURINAE.

Furcula absent. Postantennal organs almost always present. Papillae of sense organ of third antennal segment almost always present, but not more than ten.

Body stout or moderately slender. Head broad. Tubercles of postantennal organs usually not numerous; simple, or compound. Unguiculus present. Sense clubs of third antennal segment two, straight or feebly bent, smooth, granulate, or tuberculate, not curving toward each other; papillae usually four or five (0-10), with usually the same number of guard setae. Fourth antennal segment with subapical papilla and usually without apical sense club. . . . *Onychiurus* Gervais, Börner, p. 639.

Body quite slender. Head narrow. Tubercles of postantennal organs usually numerous, always simple. Unguiculus present or absent. Sense clubs of third antennal segment two or three, smooth, curving toward each other, with commonly an accessory ventro-lateral isolated sense club; papillae present (two or three), absent, or represented by a cuticular ridge. Guard setae two to four. Fourth antennal segment without subapical papilla, with apical sense club. . . . .

*Tullbergia* Lubbock, Börner, p. 651.

Furcula present. Postantennal organs absent. Papillae of sense organ of third antennal segment 14 or 15 in number. . . . . *Tetrodontophora* Reuter, p. 652.

Genus *ONYCHIURUS* Gervais, Börner.*Podura* LINNAEUS 1758 (part).*Lipura* BURMEISTER 1838.*Onychiurus* GERVAIS 1841. (See Gervais 1844, p. 397.)*Anurophorus* NICOLET 1841 (part).*Adicranus* BOURLET 1842 (part).*Aphorura* MACGILLIVRAY 1893.*Onychiurus* BÖRNER 1901c, 1909.

Including also the subgenera *Protaphorura*, *Deutaphorura*, and *Kalaphorura* (Absolon 1901b), and the sections *Euaphorura* and *Absolonia* (Börner 1901b).

Body stout or moderately slender. Head relatively large; broader than, or a little narrower than, the prothorax. Antennal base well defined. Postantennal organs (rarely absent) each in a transverse groove, close to the antennal base, with relatively large tubercles, occasionally about fifty in number, but usually not numerous; and simple, tuberculate, or lobed. Sense organ of third antennal segment with usually four or five (0-10) papillae, with guard setae, a pair of sense rods, and two straight or feebly bent sense-clubs, which are smooth, granulate, or tuberculate, and do not curve toward each other. Tarsus with two claws. Furcula absent; represented in a few species by an integumental fold or by a pair of rudimentary mucro-dentes on the fourth abdominal segment; in the latter instance the tenaculum also may be represented. Anal spines 0-4, with or without papillae. Fourth antennal segment usually with curving sensory setae and with subapical papilla; usually without apical sense club.

## KEY TO SPECIES OF ONYCHIURUS.

1. Anal spines absent. Tubercles of postantennal organs compound.....  
Anal spines present..... 3
2. Body stout. Antennal organ with four papillae and two ovate erect sense clubs.....*fmietarius*, p. 649  
Body slender. Antennal organ with five papillae and two subreniform or lique sense-clubs.....*pseudofmietarius*, p. 650
3. Tubercles of postantennal organs simple..... 4  
Tubercles of postantennal organs compound.....10
4. Postantennal organs elongate-elliptical with about 18-44 closely set tubercles... 5  
Postantennal organs with about 8-14 separated tubercles..... 8
5. Pseudocelli of antennal bases 3+3..... 6  
Pseudocelli of antennal bases 2+2 or 4+4..... 7
6. Tubercles of postantennal organ not crowded together. Pseudocelli of antennal base arranged in a triangle; those of the fifth abdominal segment in a straight line on each side. Unguiculus as long as the unguis.....*armatus*, p. 644  
Tubercles of postantennal organ crowded together. Pseudocelli of antennal base almost in a straight line; those of the fifth abdominal segment in a triangle on each side. Unguiculus much shorter than unguis.....*pseudarmatus*, p. 646
7. Pseudocelli of antennal bases 2+2. Postantennal organ with about 20 tubercles.....*litorcus*, p. 644  
Pseudocelli of antennal bases 4+4. Postantennal organ with about 33-37 tubercles.....*octopunctatus*, p. 647

8. Pseudocelli of antennal bases 2+2, rarely 3+3.....*subtenuis*, p. 642  
 Pseudocelli of antennal bases 1+1..... 9
9. Anal spines contiguous. Sense clubs of antennal organ subovate, oblique.  
*similis*, p. 640  
 Anal spines separated. Sense clubs of antennal organ disklike, erect. *cocklei*, p. 640
10. Tubercles of postantennal organs distinctly branched (fig. 76). Anal papillae large.....*ramosus*, p. 648  
 Tubercles of postantennal organs with hundreds of closely set papillae (fig. 65).  
 Anal papillae reduced to rings.....*dentatus*, p. 647

ONYCHIURUS SIMILIS, new species

Plate 68, fig. 1; plate 70, figs. 12-18.

White. Body slender (fig. 1). Postantennal organs (fig. 12) each with eight to ten simple tubercles. Pseudocelli of antennal bases (fig. 1) 1+1. Posterior border of head without pseudocelli. Antennae shorter than the head. Sense organ of third antennal segment (fig. 13) with five slender papillae, four guard-setae, a pair of sense rods and two sense clubs, each consisting of a coarsely tuberculate ovate head attached obliquely to its stalk. Dorsal pseudocelli of body (fig. 1) successively: 0, 1+1, 1+1, 1+1, 1+1, 1+1, 1+1, 2+2, 0; those of the fifth abdominal segment being in two oblique pairs. Unguis (fig. 14) slender, curving, untoothed. Unguiculus about one-half as long as unguis; basal half broadly lamellate, apical half acuminate. Anal spines (figs. 15, 16) two, stout, arcuate, subequal to, or a little shorter than, hind unguis, on low contiguous papillae. Supra-anal lobe rounded (fig. 15). Clothing (fig. 17) of sparse short curving setae and few longer and stiffer setae. Cuticular tubercles small (fig. 18). Length, 1.2 mm.

This species is close to *cocklei*, from which it may be distinguished by the following key:

Body slender; unguiculus one-half as long as unguis; anal papillae contiguous; anal segment as in figure 15; papillae of antennal sense organ slender, sense clubs subovate and oblique; cuticular tubercles small.....*similis*.

Body not slender; unguiculus two-thirds as long as unguis; anal papillae separated; anal segment as in figure 23; papillae of antennal sense organ stout, sense clubs disklike and erect; cuticular tubercles large.....*cocklei*.

Abundant under damp logs, Homer, Illinois, November 25.

*Cotypes*.—Cat. No. 20763, U.S.N.M.

ONYCHIURUS COCKLEI Folsom.

Plate 68, fig. 2; plate 70, figs. 19, 20; plate 71, figs. 21-28.

*Aphorura cocklei* FOLSOM, 1908.

*Aphorura montis* BACON, 1913.

*Aphorura lutea* BACON, 1913.

White or lemon-yellow; rather slender (fig. 2). Postantennal organs (fig. 19) with 8 to 11 simple tubercles, which are usually ovate,



elliptical or oval. Pseudocelli of antennal bases 1+1 (fig. 20). Antennae as long as, or slightly shorter than, the head. Sense organ of third antennal segment (fig. 21) with five papillae, four guard setae, a pair of sense rods, and two sense clubs, each with a stout stalk supporting a coarsely papillate disk. Dorsal pseudocelli of body segments successively: 0, 1+1, 1+1, 1+1, 1+1, 1+1, 1+1, 2+2, 0; those of the fifth abdominal segment being in two oblique pairs. Unguis (fig. 22) stout, feebly curving, untoothed. Unguiculus two-thirds as long as unguis, with sublanceolate basal lamella and acuminate prolonged apex. Anal spines two (figs. 23, 24) stout, arcuate, subequal in length to hind unguis, on prominent separated papillae. Clothing (figs. 25, 26, 27) of sparse short curving setae and fewer but longer stiff setae. Cubicular tubercles large (fig. 28). Maximum length, 2 mm.

The papillae of the antennal organ vary considerably in form; they are usually stout, and rounded or subconical, though sometimes reduced and toothlike; in one instance, six papillae occurred as an abnormality, with the usual four guard-setae. There is some variation in the clothing, as indicated in figures 26 and 27. The cuticular tubercles are larger than in any other of our species of *Onychiurus*.

*Aphorura montis* Bacon and *A. lutea* Bacon are synonymous with *A. cocklei* Folsom, as I have found from a study of several cotypes given to me by Mrs. Gertrude Bacon Chaffee.

This species was discovered by Mr. J. W. Cockle in Kaslo, British Columbia, at an altitude of 2,250 feet, where it occurred in masses so dense as to cover the snow with a carpet of gold over patches of several square yards. Some of the specimens found by Mr. Cockle were white instead of yellow.

In southern California at Bear Flats, on the slope of Mount San Antonio, at an elevation of 6,000 feet, Dr. W. A. Hilton and Miss G. A. Bacon found thousands of these insects in moist soil in a very limited area, white forms and yellow forms of all sizes occurring together; the yellow variety being, however, the more abundant.

My specimens from Oregon were taken on melting snow and under wood on moist ground.

British Columbia: Kaslo, January 31, February 23, March, J. W. Cockle.

Washington: L. Bremner (Stanford Univ.).

Oregon: Hilgard, March 4, W. A. Newcombe. Corvallis, December 25, H. E. Ewing.

California: Mount San Antonio, April, W. A. Hilton, G. A. Bacon. *Cotypes*.—Cat. No. 12033, U.S.N.M.

## ONYCHIURUS SUBTENUIS, new species.

Plate 68, fig. 3; plate 72, figs. 29-38.

White, elongate; abdomen but slightly broader than the thorax, tapering posteriorly (fig. 3). Postantennal organs (figs. 29, 30) each with 8 to 14, usually 11 to 13, tubercles, simple or occasionally biramous. Pseudocelli of antennal bases 2+2 or 3+3, arranged side by side (fig. 31). Base of head without pseudocelli. Antennae shorter than the head, with segments about as 3:3:5:8 in relative lengths. Sense organ of third antennal segment (fig. 32) with five elongate papillae, five guard setae, a pair of subclavate sense rods, and two capitate sense clubs, coarsely tuberculate. Dorsal pseudocelli of body (fig. 3) typically 0, 1+1, 1+1, 1+1, 1+1, 0, 2+2, 3+3, 0. Thus pseudocelli are absent normally on the prothorax and on the third and the sixth abdominal segments. One of the two pseudocelli is frequently absent on the first or the second abdominal segment (see beyond under variation). The pseudocelli of the fourth abdominal segment are in two oblique pairs. Those of the fifth abdominal segment are sometimes 4+4 instead of 3+3, the pseudocelli of each group being close together and in oblique alignment. Lateral and ventral pseudocelli are absent. Unguis (fig. 33) stout, curving, with inner margin unidentate one-third from the base. Ungiculus extending two-thirds as far as the unguis, subelliptically lamellate basally and acuminate apically. Anal spines (figs. 34, 35, 36) two, half as long as hind unguis, curving, on stout contiguous papillae about one-fourth as long as the spines. Supra-anal lobe (fig. 34) tapering, projecting far behind the infra-anal lobes. Clothing (fig. 37) of numerous feebly-curving setae of moderate length, interspersed with fewer longer and stiffer setae. Cuticular tubercles small (fig. 38). Maximum length, 2 mm.

*Variation.*—One small specimen, 1 millimeter in length, had 8 postantennal tubercles on the right side; another of the same length had, however, 11.

The pseudocelli of the antennal bases are 2+2 in all the Illinois specimens that I have seen; but in some of the specimens from New York and Pennsylvania there are 3+3 (fig. 31). Furthermore, the pseudocelli of the fifth abdominal segment, typically 3+3, show the variation 4+4 in some of the material from New York and Pennsylvania.

The pseudocelli of the first and second abdominal segments vary persistently in number, one of each pair being usually absent. The variations in 50 specimens taken at random fall into the following categories:

	Left.	Right.	Left.	Right.	Left.	Right.	Left.	Right.	Left.	Right.
Abd. 1.....	.....	.....	0	1	1	0	1	0	0	1
Abd. 2.....	.....	.....	0	1	1	0	0	1	1	0
Examples.....	.....	.....	15		11		7		4	
Abd. 1.....	.....	.....	0	1	0	0	1	1	1	×
Abd. 2.....	.....	.....	0	0	1	0	0	0	1	×
Examples.....	.....	.....	4		1		1		1	
Abd. 1.....	1	×	1	1	1	0	0	0	0	0
Abd. 2.....	×	×	1	0	0	0	0	1	0	0
Examples.....	1		1		1		2		1	

In a few instances pseudocelli were present in a rudimentary condition, as indicated by × in the foregoing tables.

These tables show that both pseudocelli on the left side were lacking in 30 per cent of the specimens and those of the right side in 22 per cent.

On finding these variations I examined some 80 specimens in search of the normal condition (1+1 on both segments), but failed to find a specimen that was not abnormal in material from Champaign County, Illinois, from several localities, some of which were 12 miles apart. The few specimens that I had from New York State also showed the same kind of variation. Of 15 specimens from Pennsylvania, however, 14 were abnormal and one was normal, having a pair of pseudocelli on each of the first two abdominal segments.

Schäffer ('96, p. 162) has recorded the fact that certain variations in the distribution of the pseudocelli appear sometimes to characterize entire colonies. He found that a large number of individuals of *Onychiurus armatus* from a single locality all lacked the pseudocelli of the mesothorax and of the third abdominal segment. In the case of *O. subtenuis*, however, the variation is not limited to a single locality, but occurs in 99 per cent of all the specimens from three States, the form regarded as "normal" being in fact extremely rare. The species exhibits primarily a strongly inherited variability of the pseudocelli of the first and second abdominal segments, and secondly a wide range of individual variation in the distribution of the pseudocelli on these segments.

The tooth of the unguis varies in size and is absent in some of the specimens from Pennsylvania. The setae of the body are somewhat longer in specimens from New York than in those from Illinois.

This species occurs abundantly under logs or dead leaves on damp soil.

New York: Near Keuka Lake, October 31, C. R. Crosby.

Pennsylvania: Harrisburg, November 14, H. A. Surface.

Illinois: Homer, April 2, 3, 9, May 7, 8, June 6, November 7, 25; Urbana, February 19, March 13, 17, April 5, 11, 12, 18, 19, 25, May 3.

*Cotypes*.—Cat. No. 20764, U.S.N.M.

**ONYCHIURUS LITOREUS, new species.**

Plate 68, fig. 4; plate 73, figs. 39-42.

White. Postantennal organs (fig. 39) elliptical, each with about 20 simple tubercles. Pseudocelli of antennal bases 2+2, in pairs. Base of head with 2+2 pseudocelli, in oblique pairs. Antennae shorter than the head. Sense organ of third antennal segment with five papillae, five guard setae, two ovate papillate sense clubs and probably two sense rods. Dorsal pseudocelli of body (fig. 4) 1+1 on segments one to six, inclusive; 2+2 in oblique pairs on segment seven; 3+3 on segment eight, as follows: 2+2 posterior, in oblique pairs, and 1+1 antero-lateral; pseudocelli absent on segment nine. Postero-lateral pseudocelli 1+1 on each of the first three abdominal segments. Unguis (fig. 40) long, slender, strongly curving, untoothed. Unguiculus extending less than half as far as the unguis, lamellate, with straight outer margin and short acuminate apex. Anal spines (fig. 41) two, half as long as hind unguis, stout, feebly curving, on widely separated papillae, which are half as long as the spines. Clothing of sparse minute setae, becoming longer posteriorly. Cuticular tubercles minute (fig. 42). Length, 1.3 mm.

Neponset, Massachusetts, May 4, October 10, 20, on the seashore between tide marks, under stones with *Anurida maritima*.

The cotypes of this species are in the author's collection at present.

**ONYCHIURUS ARMATUS Tullberg.**

Plate 68, fig. 5; plate 73, figs. 43-51.

*Lipura armata* TULLBERG, 1869, 1871, 1872, 1876.—LUBBOCK, 1873.—REUTER, 1876, 1890, 1895.—UZEL, 1890, 1891.—MACGILLIVRAY, 1891.—SCHÖTT, 1894 a.—LIE-PETERSEN, 1896, 1898.—CARPENTER and EVANS, 1899.—WILLEM, 1900.—EVANS, 1901.

*Lipura arctica* TULLBERG, 1876.—SCHÄFFER, 1894.—SCHÖTT, 1894 a.—LIE-PETERSEN, 1898.—LUBBOCK, 1898.

*Lipura ambulans* MEINERT, 1896.

*Aphorura armata* SCHÄFFER, 1896, 1897, 1900a, 1900b.—POPPE and SCHÄFFER, 1897.—SCHERBAKOW, 1898.—CARL, 1899, 1901.—ABSOLON, 1900a, 1900b.—WAHLGREN, 1900a, 1900b.—BÖRNER, 1901b, 1901d.—KRAUSBAUER, 1902.

*Aphorura arctica* SCHERBAKOW, 1899a, 1899b.—WAHLGREN, 1899, 1900a, 1900b.—AXELSON, 1900.—SCHÄFFER, 1900b.—SKORIKOW, 1900.

*Onychiurus armatus* BÖRNER, 1902a, 1907.—VOIGTS, 1902.—ÅGREN, 1903, 1904.—AXELSON, 1903b, 1904, 1905b, 1906.—(AXELSON) LINNANIEMI, 1907, 1909, 1911, 1912.—WAHLGREN, 1906.—SHOEBOTHAM, 1914.

*Onychiurus arcticus* AXELSON, 1903b.

*Aphorura ambulans* GUTHRIE, 1903.

*Onychiurus armatus* var. *arctica* (AXELSON) LINNANIEMI, 1909, 1912.

White. Elongate; abdomen slightly dilated (fig. 5). Postantennal organs (fig. 43) elongate-elliptical, each with 18 to 44 (usually



25 to 35) simple peripheral tubercles. Pseudocelli of head as follows: Antennal base, 3+3 (fig. 44) arranged in a triangle on each side; posterior border of head, 3+3, occasionally 4+4. Antennae almost as long as the head. Sense organ of third antennal segment (fig. 45) with five (abnormally six) papillae, five guard setae, two sense rods, and two capitate tuberculate sense clubs. Pseudocelli of body (fig. 5) as follows—Prothorax: dorsal, 0; lateral, (proximal precoxal), 1+1. Mesothorax: dorsal, 2+2; lateral (proximal precoxal), 1+1. Metathorax: dorsal, 3+3; lateral (proximal precoxal), 1+1. First, second and third abdominal segments: dorsal, 3+3. Fourth abdominal: dorsal, 3+3; postero-lateral, 1+1. Fifth abdominal: Dorsal, 3+3; antero-lateral, 1+1; the three dorsal on each side lying close together in a straight line. Sixth abdominal, 0. Unguis (fig. 46) curving, untoothed, or minutely unidentate one third from apex, especially on the front feet. Unguiculus gradually tapering, distally attenuate, as long as, or a little longer than, the unguis. Furcula represented by a crescentic fold (figs. 47, 48); tenaculum absent. Anal spines (fig. 49) two, large, almost as long as hind unguis, arcuate or almost straight, on prominent papillae one-third as long as the spines. Clothing (fig. 50) of numerous short curving setae and fewer long stiff setae, becoming longer on the posterior part of the abdomen. Cuticular tubercles moderate in size (fig. 51). Length, 1.8 mm.

In one specimen the right sense organ of the third antennal segment showed six papillae (fig. 45). Ågren ('03, p. 128) mentions the occurrence in one specimen of seven papillae and three sense clubs.

According to European writers (see Ågren, '04, p. 12) the pseudocelli of the antennal base are rarely four on each side; those of the posterior border of the head varying from two to four on each side; of the mesonotum, one to three; metanotum, one to three; fourth abdominal segment, three or four, rarely two; and those on the posterior part of the fifth abdominal segment, two to four on each side. These variations I have not yet found in this country.

The unguiculus varies a little in length, extending sometimes not quite as far as the unguis.

My North American specimens agree accurately with European descriptions and with European examples sent to me by Dr. Caesar Schäffer.

The form that Guthrie ('03, p. 97) termed *ambulans* is *armatus*, as I have found by an examination of nine of his specimens, sent to me by Prof. Henry F. Nachtrieb.

Ågren ('04, p. 12) found, from his study of the type material, that *O. arcticus* Tullberg is not specifically distinct from *O. armatus* Tullberg, being simply a large variety, 3.5 mm. in length (maximum length, 4.1 mm., according to Skorikow).

Axelson ('05*b*, p. 790; '12, p. 88) has named as *inermis* a variety of *armatus* in which the anal spines and their papillae are absent.

I have taken this species on damp soil under wood or dead leaves and under the loose bark of decaying logs. In Europe, and doubtless in this country as well, the species occurs also in moss, under stones, in decaying vegetables, in flower pots, on pools of fresh water, on the seashore under stones, wood, or seaweed, and in caves.

*Onychiurus armatus* is very common everywhere in Europe. It has been reported also from Siberia, Greenland, and other Arctic localities, and from East Africa and Chile.

Maine: Orono, F. L. Harvey

Illinois: Homer, April 3, May 7, 8, 21, June 6. Urbana, April 12, 25.

ONYCHIURUS PSEUDARMATUS, new species.

Plate 68, fig. 6; plate 74, figs. 52-60.

White, slender (fig. 6). Postantennal organs (fig. 52) elongate, elliptical, each with about 40 simple tubercles, crowded together. Pseudocelli of antennal bases 3+3 (fig. 53), arranged almost in a straight line. Posterior border of head with 2+2 pseudocelli, in oblique pairs. Antennae shorter than the head. Sense organ of third antennal segment (fig. 54) with five papillae; five guard setae; a pair of tapering sense rods; two capitate, coarsely tuberculate sense clubs; and a large subovate finely tuberculate accessory club (fig. 54). Dorsal pseudocelli of body segments (fig. 6): 0, 1+1, 1+1, 2+2, 2+2, 2+2, 2+2, 3+3, 0. Those of the first four abdominal segments are in oblique pairs; each group on the fifth abdominal segment forms a triangle. Unguis feebly curving, unidentate (fig. 55) or unarmed (fig. 56). Unguiculus extending more than half as far as the unguis, basally suboblong, apically tapering uniformly. Furcula represented by a fold (fig. 57). Anal spines (fig. 58) stout, almost straight, two-thirds as long as hind unguis, on well separated papillae one-third as long as the spines. Clothing (fig. 59) of sparse short setae, stiff or slightly curving, and fewer long stiff setae. Cuticular tubercles large (fig. 60). Length, 3 mm.

This species is much like the well known *armatus*, but shows in addition to the differences given in my key (p. 639) other differences in respect to the antennal sense organs, the length of the anal spines, the form of the rudimentary furcula, the size of the cuticular tubercles and the character of the clothing.

Alaska.—Saint Paul Island, Pribilof Group, August 6, in moss, Prof. Trevor Kincaid.

*Cotypes*.—Cat. No. 20760, U.S.N.M.

## ONYCHIURUS OCTOPUNCTATUS Tullberg.

Plate 75, figs. 61-64.

*Lipura octo-punctata* TULLBERG, 1876.—SCHÖTT, 1894.*Aphorura octopunctata* SCHÄFFER, 1900a.—FOLSOM, 1902.

White. Postantennal organs (fig. 61) elliptical, each with about 33 to 37 simple tubercles. Pseudocelli of antennal bases 4+4 (fig. 61); of posterior border of head 3+3. Antennae shorter than the head. Sense organ of third antennal segment with five papillae (fig. 62). Unguis (fig. 63) broad, curving, unidentate near the middle of the inner margin. Unguiculus a little longer than unguis, slender, gradually attenuating into a fine filament, untoothed. Anal spines (fig. 64) two, half as long as unguis, stout, feebly arcuate, on prominent papillae. Body sparsely clothed with short curving setae and occasional longer stiff setae, the latter becoming more numerous toward the extremity of the abdomen. Length, 2.7 mm.

The only examples of this species that I have seen are three from Alaska, taken by the Harriman Expedition in 1899. These specimens agree with the original description and figures except for lacking a tooth on the unguiculus. The pseudocelli of the body were not studied on account of insufficient material.

*O. octopunctata* has seldom been recorded. It was described from a single individual taken at Dudinskoe, Siberia (latitude 69° 25' N.) by the Nordenskiöld Expedition in 1875 (Tullberg, '76, p. 40). The Yenisei Expedition of the following year collected examples at Tschulkova (latitude 62° 45' N.) and the *Vega* Expedition of 1878-79 found a single specimen at Irkaipi, in Chukchi Land (latitude 68° 36' N. Schött, '94, p. 88).

Sitka, Alaska, June, Prof. Trevor Kincaid (U.S.N.M., Harriman Collection, No. 71).

## ONYCHIURUS DENTATUS Folsom.

Plate 69, fig. 7; plate 75, figs. 65-68; plate 76, figs. 69-75.

*Aphorura dentata* FOLSOM, 1902.

White (fig. 7). Postantennal organs (fig. 65) elongate, each with hundreds of closely set papillae, which arise from about 17 tubercles, the stalks of which are shown in section in figure 66. Pseudocelli of antennal bases 2+2 (fig. 67). Antennae slightly shorter than the head, with segments related nearly as 2:5:4:5 in relative lengths. Sense organ of third antennal segment (fig. 68) with five (rarely four) stout subconical papillae, five guard setae, a pair of slender fusiform sense rods and two papillate sense clubs. Unguis (figs. 69, 70) strongly curving, basally tuberculate, five or six toothed, as follows: paired pseudonychia teeth occur one-third from the base of the claw; a second pair of lateral teeth is present near the apex of the claw; and one or two distal teeth are situated on the outer margin.

Unguiculus untoothed, shorter than, or longer than, the unguis, narrowly lamellate proximally, gradually tapering or attenuating distally, tuberculate basally. Fourth and fifth abdominal segments each with 2+2 pseudocelli, in oblique pairs. Anal spines (figs. 71, 72) two, less than half as long as hind unguis, almost straight, separated basally, with papillae reduced to rings. Clothing (figs. 73, 74) of dense short curving setae, with occasional long stiff setae. Cuticular tubercles of moderate size (fig. 75). Maximum length, 4 mm.

I have here improved my original diagnosis of this species by the addition of a more precise description of the antennal sense organ and by a correction of my former statement in regard to the pseudocelli. Almost all the structures that I described as pseudocelli are in reality cuticular pits that form the sockets of exceptionally large setae, and these sockets can be distinguished by their structure from pseudocelli by means of high magnification. Most of the setae were missing in my specimens, but the occasional setae that remained in place were sufficient in number to enable me to reconstruct the arrangement of setae as given in figure 7.

The cotypes were collected by Prof. Trevor Kincaid, of the Harri-man Alaska Expedition, from whom I received a few additional specimens after the description was published.

Seldovia, Cook Inlet, July, under stones at tide mark (No. 62). Cook Inlet (No. 60). St. Paul Island, Bering Sea, August 1. Unalaska, September, beneath stones covered with barnacles.

*Cotypes*.—Cat. No. 5436, U.S.N.M.

ONYCHIURUS RAMOSUS, new species.

Plate 69, fig. 8; plate 76, figs. 76, 77; plate 77, figs. 78-82.

White. Postantennal organs (fig. 76) each with about 13 many-lobed tubercles, of the *fimetarius* type. Pseudocelli behind the antennal bases 2+2, with wide ringlike borders (fig. 77). Antennae shorter than the head. Sense organ of third antennal segment (fig. 78) with four papillae, three guard setae, a pair of sense rods and two capitate coarsely tuberculate sense clubs. Dorsal pseudocelli of body (fig. 8): 0, 1+1, 1+1, 1+1, 0, 0, 2+2, 2+2, 0; those of the fourth and fifth abdominal segments being in oblique pairs. Lateral and ventral pseudocelli absent. Unguis (fig. 79) stout, curving, untoothed. Unguiculus gradually tapering from base to apex, extending half as far as the unguis. Anal spines (fig. 80) two, half as long as hind unguis, arcuate, on low contiguous papillae. Clothing (fig. 81) of sparse, short, stiff setae and a few minute curving setae. Cuticular tubercles minute (fig. 82). Length, 1.3 mm.

This is the only one of our known species which has, at the same time, branched postantennal tubercles of the *fimetarius* type and



anal spines. I have found it rather common among grass roots and in the woods under damp logs.

Illinois: Homer, April 3, May 7, 8. Urbana, April 12, 18, October 26.

*Cotypes*.—Cat. No. 20761, U.S.N.M.

ONYCHIURUS FIMETARIUS Linnaeus, Lubbock.

Plate 69, fig. 9; plate 77, figs. 83–86; plate 78, figs. 87, 88.

*Podura fimetaria* LINNAEUS, 1767.—FABRICIUS, 1793.

*Lipura fimetaria* BURMEISTER, 1838.—LUBBOCK, 1868, 1873.—PACKARD, 1873.—PARONA, 1879, 1888.—OUDEMANS, 1890.—UZEL, 1890, 1891.—MACGILLIVRAY, 1891.—CARPENTER and EVANS, 1899.

*Lipura volvator* GERVAIS, 1844.

*Anurophorus fimetarius* NICOLET, 1847 (not of 1841).

*Lipura inermis* TULLBERG, 1869, 1871, 1872.—REUTER, 1890, 1895.—SCHÖTT, 1891, 1894a, 1894b, 1896.—MACGILLIVRAY, 1894.—LIE-PETTERSEN, 1896.

*Lipura wrightii* CARPENTER, 1895, 1897.

*Aphorura inermis* SCHÄFFER, 1896, 1900b.—CARL, 1899.—ABSOLON, 1900a, 1900b, 1901a, 1901b.—KRAUSBAUER, 1902.—SCHÖTT, 1902.

*Aphorura fimetaria* CARL, 1899.

*Onychiurus inermis* BÖRNER, 1902a.—VOIGTS, 1902.

*Onychiurus fimetarius* ÅGREN, 1903, 1904.—AXELSON, 1905a, 1906.—(AXELSON) LINNANIEMI, 1907, 1912.—COLLINGE and SHOEBOTHAM, 1910.—CAROLI, 1914.

White. Abdomen broad, rounded behind (fig. 9). Postantennal organs (fig. 83) elongate, each with 8 to 17 branched tubercles. Pseudocelli of head as follows: Antennal base, 2 + 2; behind antennal base, 1 + 1; posterior border of head, 1 + 1 or 2 + 2; ventral surface of head, 1 + 1. Antennae shorter than the head. Sense organ of third antennal segment (fig. 84) with four slender papillae, five guard setae, two sense rods, and two ovate erect smooth sense clubs. Pseudocelli of body (fig. 9) as follows: Prothorax—dorsal, 1 + 1; proximal precoxal segment, 2 + 2. Mesothorax—dorsal, 2 + 2; proximal precoxal, 2 + 2; antero-ventral, 1 + 1. Metathorax—dorsal, 2 + 2; proximal precoxal, 2 + 2; antero-ventral, 1 + 1. First abdominal segment: Dorsal, 3 + 3; lateral (base of ventral tube), 1 + 1; antero-lateral, 1 + 1. Second abdominal: Dorsal, 3 + 3; antero-ventral (behind ventral tube), 1 + 1; postero-ventral, 1 + 1. Third abdominal: Dorsal, 3 + 3; ventro-lateral, 1 + 1; postero-ventral, 1 + 1. Fourth abdominal: Dorsal aspect, 5 + 5 (dorsal, 3 + 3; lateral, 2 + 2); postero-ventral, 1 + 1. Fifth abdominal: Dorsal, 3 + 3; ventral, 1 + 1. Sixth abdominal: 0. Unguis (figs. 85, 86) slender, curving, untoothed. Unguiculus gradually tapering, distally attenuate, three-fourths as long as unguis. Anal spines absent. Anus ventral. Clothing (fig. 87) of sparse short setae, a little longer and stiffer on the posterior part of the abdomen. Cuticular tubercles relatively coarse (fig. 88); coarser on the head than on the body. Length, often 1.8 mm.; maximum, 2.1 mm.

I sent specimens from Massachusetts to Dr. Caesar Schäffer, who informed me that they were *Lipura inermis* Tullberg, the equivalent of *L. fimetaria* Linnaeus, Lubbock; and I was able to verify his opinion by an examination of many European specimens which he sent to me.

In Swedish specimens Ågren ('03) found 3+3 pseudocelli on the posterior border of the head and found the unguiculus to exceed the unguis in length. The same author ('04) gives the number of lateral pseudocelli of each thoracic segment as 1+1; I find, however, 2+2 and record also several lateral and ventral pseudocelli not as yet mentioned by European writers.

Packard's ('73) *Lipura fimetaria* (Linnaeus), which I examined in the Museum of Comparative Zoölogy, is this species—the *fimetaria* of Linnaeus as redescribed by Lubbock.

The form with eight or nine tubercles in each postantennal organ, found in Europe and North America, varies into forms with a larger number of tubercles, as Carpenter and Evans ('99) have noted. The species from Japan that I referred to *Aphorura inermis* Tullberg (Folsom, '99) was named *A. folsomi* by Schäffer ('00a, p. 249), and differs from *inermis* in the structure of the antennal sense organ, as I have recently found (see Börner, '09, p. 104).

The form referred to *inermis* Tullberg by Guthrie ('03) is not that species but is the form described beyond as *pseudofimetarius*, as I have found by an examination of some of Guthrie's specimens.

The Californian specimens that I have seen, collected by Miss Gertrude A. Bacon, agree with European examples.

This species is common in humus, under dead leaves, decaying logs, or loose dead bark, in moss, in flower pots in dwelling houses, and in greenhouses. In Europe it has been found also in caves and occasionally on the seashore.

*Onychiuirus fimetarius* is common throughout Europe, is widely distributed in North America, and has been reported from Africa and Sumatra.

Massachusetts: Belmont, March 27; Cambridge (in a greenhouse), February 2, 7, March 1, July 17; Salem, A. S. Packard (M. C. Z).

Pennsylvania: Hazleton, W. G. Dietz.

Florida: E. Lönnberg (see MacGillivray, '94).

California: G. Eisen (Cal. Acad. Sc.); Santa Barbara, February 28, Gertrude A. Bacon.

ONYCHIURUS PSEUDOFIMETARIUS, new species.

Plate 69, fig. 10; plate 78, figs. 89-94.

*Aphorura inermis* GUTHRIE, 1903.

White. Body slender; abdomen rounded posteriorly (fig. 10). Postantennal organs (fig. 89) elongate, each with about 16 branched

tubercles. Dorsal pseudocelli of head as follows (fig. 10): Antennal bases, 2+2; behind antennal bases, 1+1; posterior border of head, 3+3. Ventral pseudocelli of head as follows: Anterior, 1+1; posterior, 1+1. Antennae slightly shorter than the head. Sense organ of third antennal segment (fig. 90) with five slender papillae, five guard setae, two sense rods, and two subreniform smooth oblique sense clubs. Pseudocelli of body as follows—Prothorax: Pronotum, 0; proximal precoxal, 2+2; coxal, 1+1. Mesothorax and metathorax: Dorsal, 3+3; antero-ventral, 1+1; proximal precoxal, 2+2; coxal, 1+1. First abdominal segment: Dorsal aspect, 4+4; antero-ventral, 1+1; base of ventral tube, 2+2 (lateral and posterior, respectively). Second abdominal: Dorsal aspect, 4+4; postero-ventro-lateral, 1+1. Third abdominal: Dorsal aspect, 3+3; postero-ventro-lateral, 1+1. Fourth abdominal: Dorsal, 3+3; lateral, 3+3 or 2+2; postero-ventro-lateral, 1+1. Fifth abdominal: Dorsal, 3+3; postero-lateral, 1+1. Sixth abdominal: 0. Unguis (figs. 91, 92) curved, untoothed. Unguiculus extending a little more than half as far as the unguis, broadly lamellate proximally, attenuate distally. Anal spines absent. Anus ventral. Clothing (fig. 93) of short sparse setae, becoming longer and stiffer posteriorly. Cuticular tubercles relatively minute (fig. 94). Length, 1.5 mm.

*Pseudofimetarius* is close to *fimetarius*, the arrangement of most of the dorsal pseudocelli being essentially the same in the two species, though the former species differs in having no pronotal pseudocelli and in having 3+3 pseudocelli on the posterior border of the head (this latter condition occurring, however, as a variation in some Swedish examples of *fimetarius*). *Pseudofimetarius* differs further from *fimetarius* in having four pseudocelli on the ventral surface of the head and differs markedly in the structure of the sense organ of the third antennal segment.

This is the form that Guthrie ('03) referred to *Aphorura inermis* Tullberg, as I learned from a study of two of Guthrie's specimens, loaned to me by Prof. Henry F. Nachtrieb.

This species occurs on damp soil under decaying logs or dead leaves.

Illinois: Homer, April 2, 3, 9, May 7, 8, November 7. Urbana, March 13, 17, April 3, 5, 11, 25.

Minnesota: April 8, J. E. Guthrie (Univ. of Minn.).

*Cotypes*.—Cat. No. 20762, U.S.N.M.

#### Genus TULLBERGIA Lubbock, Börner.

*Tullbergia* LUBBOCK 1876.

*Stenaphorura* ABSOLON 1900b.

*Mesaphorura* BÖRNER 1901a.

*Boerneria* WILLEM 1902.

*Tullbergia* BÖRNER 1902b.

Body extremely slender, gradually tapering toward each end. Head relatively small, narrower than the prothorax. Antennal base absent in a few species. Postantennal organs each in a transverse groove, a little behind the antennal base, with simple tubercles, usually numerous. Sense organ of third antennal segment with two or three papillae, or with papillae absent or represented by a cuticular ridge; with two, three, or four guard setae; a pair of sense rods; and two or three sense clubs, smooth and straight or curving toward one another; in addition there is usually an isolated ventrolateral sense club. Fourth antennal segment with curving sense hairs, with apical sense club and without subapical papilla. Tarsus with one or two claws. Furcula absent. Anal spines 0-4, with additional spine-like tubercles in a few species. Pseudocelli rarely rudimentary.

**TULLBERGIA COLLIS** Bacon.

Plate 69, fig. 11; plate 78, fig. 95; plate 79, figs. 96-101.

*Tullbergia collis* BACON, 1914.

White. Slender (fig. 11); five to six times as long as broad. Postantennal organs (fig. 95) large, oblong-elliptical, each with about 75 tubercles in four parallel rows. Pseudocelli large, with wide rings. Dorsal pseudocelli of head (fig. 11) as follows: Antennal bases, 1+1; posterior border, 1+1. Antennae shorter than the head. Sense organ of third antennal segment (fig. 96) with four guard setae; four low blunt papillae, sometimes reduced to an irregular ridge; two clavate curving sense rods; two smooth clavate or subreniform sense clubs curving toward each other; and an inner clavate accessory sense club. Curving sensory setae of fourth antennal segment (fig. 97) as follows: Two outer, one dorsal, five inner. One pair of dorsal pseudocelli on each segment of the body except the anal segment. Unguis (fig. 98) stout, curving, untoothed. Unguiculus reduced, spiniform. Anal spines (figs. 99, 100) two, arcuate, as long as hind unguis, on large contiguous papillae. Clothing (fig. 101) of sparse short stiff setae. Length, 1.5 mm.

*Tullbergia collis*, the only known representative of its genus in this country, was discovered in California, in the hills near Pomona and Laguna Beach, and described by Miss Gertrude A. Bacon, who kindly sent me cotypes which have enabled me to supplement the original description.

**Genus TETRODONTOPHORA** Reuter.

*Tetrodontophora* REUTER, 1882.

*Tetrodontophora* ABSOLON, 1901c.

*Tetrodontophora* BÖRNER, 1902a.

Head and body stout. Antennal base present. Postantennal organs absent. Sense organ of third antennal segment with seven



guard setae, 14 or 15 papillae in three rows, three erect sense clubs, and two sense rods. Tarsus with two claws, the unguis being pseudonychiate (as in *Tomocerus*). Furcula present, normally developed, on the fourth abdominal segment. Tenaculum present. Anal and genital segments confluent. Abdomen posteriorly six-lobed, with two anal spines and four spine-like tubercles.

The genus *Tetrodontophora*, which has not as yet been found on this continent, is based upon the European *T. biclanensis* Waga (*gigas* Reuter), a cavernicolous species, dark blue, and of relatively large size, attaining a length of 9.2 mm.

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## EXPLANATION OF PLATES.

## PLATE 68.

- Fig. 1. *Onychiurus similis*, ×47.
2. *Onychiurus cocklei*, ×30.
3. *Onychiurus subtenuis*, ×43.
4. *Onychiurus litoreus*, ×45.
5. *Onychiurus armatus*, ×44.
6. *Onychiurus pseudarmatus*, ×25.



## PLATE 69.

- Fig. 7. *Onychiurus dentatus*,  $\times 16$ .  
 8. *Onychiurus ramosus*,  $\times 62$ .  
 9. *Onychiurus fimetarius*,  $\times 40$ .  
 10. *Onychiurus pseudofimetarius*,  $\times 61$ .  
 11. *Tullbergia collis*,  $\times 45$ .

## PLATE 70.

- Fig. 12. *Onychiurus similis*, left postantennal organ,  $\times 1120$ .  
 13. *Onychiurus similis*, left antennal sense organ,  $\times 1120$ .  
 14. *Onychiurus similis*, left hind foot,  $\times 652$ .  
 15. *Onychiurus similis*, anal segment,  $\times 166$ .  
 16. *Onychiurus similis*, left anal spine,  $\times 652$ .  
 17. *Onychiurus similis*, clothing, median dorsal line of first abdominal segment,  $\times 346$ .  
 18. *Onychiurus similis*, cuticular tubercles of body,  $\times 652$ .  
 19. *Onychiurus cocklei*, right postantennal organ,  $\times 1232$ .  
 20. *Onychiurus cocklei*, left antennal base,  $\times 200$ .

## PLATE 71.

- Fig. 21. *Onychiurus cocklei*, left antennal sense organ,  $\times 1120$ .  
 22. *Onychiurus cocklei*, left hind foot,  $\times 652$ .  
 23. *Onychiurus cocklei*, anal segment,  $\times 166$ .  
 24. *Onychiurus cocklei*, right anal spine,  $\times 400$ .  
 25. *Onychiurus cocklei*, clothing, median line of metanotum,  $\times 300$ .  
 26. *Onychiurus cocklei*, clothing, median dorsal line of first abdominal segment,  $\times 520$ .  
 27. *Onychiurus cocklei*, clothing, median dorsal line of first abdominal segment,  $\times 346$ .  
 28. *Onychiurus cocklei*, cuticular tubercles of body,  $\times 652$ .

## PLATE 72.

- Fig. 29. *Onychiurus subtenuis*, left postantennal organ,  $\times 1120$ .  
 30. *Onychiurus subtenuis*, left postantennal organ,  $\times 1120$ .  
 31. *Onychiurus subtenuis*, left antennal base,  $\times 346$ .  
 32. *Onychiurus subtenuis*, left antennal sense organ,  $\times 1120$ .  
 33. *Onychiurus subtenuis*, right hind foot,  $\times 652$ .  
 34. *Onychiurus subtenuis*, anal segment,  $\times 166$ .  
 35. *Onychiurus subtenuis*, left anal spine,  $\times 260$ .  
 36. *Onychiurus subtenuis*, anal spines,  $\times 260$ .  
 37. *Onychiurus subtenuis*, clothing, median dorsal line of first abdominal segment,  $\times 346$ .  
 38. *Onychiurus subtenuis*, cuticular tubercles of body,  $\times 652$ .

## PLATE 73.

- Fig. 39. *Onychiurus litoreus*, right postantennal organ,  $\times 504$ .  
 40. *Onychiurus litoreus*, right mid foot,  $\times 980$ .  
 41. *Onychiurus litoreus*, anal spines,  $\times 652$ .  
 42. *Onychiurus litoreus*, cuticular tubercles of body,  $\times 652$ .  
 43. *Onychiurus armatus*, right postantennal organ,  $\times 1120$ .  
 44. *Onychiurus armatus*, pseudocellus of antennal base,  $\times 1120$ .  
 45. *Onychiurus armatus*, right antennal sense organ, with six papillae as an abnormality,  $\times 1120$ .

- Fig. 46. *Onychiurus armatus*, right hind foot,  $\times 614$ .  
47. *Onychiurus armatus*, ventral aspect of rudimentary furcula,  $\times 652$ .  
48. *Onychiurus armatus*, left aspect of rudimentary furcula,  $\times 386$ .  
49. *Onychiurus armatus*, left anal spine,  $\times 386$ .  
50. *Onychiurus armatus*, clothing, median dorsal line of first abdominal segment,  $\times 346$ .  
51. *Onychiurus armatus*, cuticular tubercles of body,  $\times 652$ .

## PLATE 74.

- Fig. 52. *Onychiurus pseudarmatus*, postantennal organ,  $\times 646$ .  
53. *Onychiurus pseudarmatus*, left antennal base,  $\times 394$ .  
54. *Onychiurus pseudarmatus*, right antennal sense organ,  $\times 1120$ .  
55. *Onychiurus pseudarmatus*, left fore foot,  $\times 380$ .  
56. *Onychiurus pseudarmatus*, left hind foot,  $\times 380$ .  
57. *Onychiurus pseudarmatus*, ventral aspect of rudimentary furcula,  $\times 652$ .  
58. *Onychiurus pseudarmatus*, left anal spine,  $\times 226$ .  
59. *Onychiurus pseudarmatus*, clothing, median dorsal line of first abdominal segment,  $\times 226$ .  
60. *Onychiurus pseudarmatus*, cuticular tubercles of body,  $\times 652$ .

## PLATE 75.

- Fig. 61. *Onychiurus octopunctatus*, right postantennal organ,  $\times 434$ .  
62. *Onychiurus octopunctatus*, right antennal sense organ,  $\times 868$ .  
63. *Onychiurus octopunctatus*, left hind foot,  $\times 434$ .  
64. *Onychiurus octopunctatus*, left anal spine,  $\times 425$ .  
65. *Onychiurus dentatus*, right postantennal organ, etc.,  $\times 1120$ .  
66. *Onychiurus dentatus*, deeper structure of postantennal organ,  $\times 868$ .  
67. *Onychiurus dentatus*, base of right antenna,  $\times 254$ .  
68. *Onychiurus dentatus*, left antennal sense organ,  $\times 1120$ .

## PLATE 76.

- Fig. 69. *Onychiurus dentatus*, right hind foot,  $\times 346$ .  
70. *Onychiurus dentatus*, right mid foot, concave aspect,  $\times 346$ .  
71. *Onychiurus dentatus*, anal spines,  $\times 400$ .  
72. *Onychiurus dentatus*, right anal spine,  $\times 400$ .  
73. *Onychiurus dentatus*, clothing, median dorsal line of first abdominal segment,  $\times 166$ .  
74. *Onychiurus dentatus*, clothing, median line of metanotum,  $\times 166$ .  
75. *Onychiurus dentatus*, cuticular tubercles of body,  $\times 652$ .  
76. *Onychiurus ramosus*, left postantennal organ,  $\times 1120$ .  
77. *Onychiurus ramosus*, left antennal base,  $\times 652$ .

## PLATE 77.

- Fig. 78. *Onychiurus ramosus*, right antennal sense organ,  $\times 1640$ .  
79. *Onychiurus ramosus*, left hind foot,  $\times 980$ .  
80. *Onychiurus ramosus*, anal spine,  $\times 980$ .  
81. *Onychiurus ramosus*, clothing, median line of first abdominal segment,  $\times 346$ .  
82. *Onychiurus ramosus*, cuticular tubercles of body,  $\times 652$ .  
83. *Onychiurus fimetarius*, right postantennal organ,  $\times 1120$ .  
84. *Onychiurus fimetarius*, left antennal sense organ,  $\times 1120$ .  
85. *Onychiurus fimetarius*, right hind foot,  $\times 486$ .  
86. *Onychiurus fimetarius*, right hind foot,  $\times 466$ .

## PLATE 78.

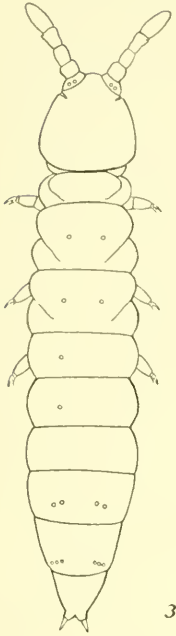
- Fig. 87. *Onychiurus fimetarius*, clothing, median line of first abdominal segment,  $\times 346$ .
88. *Onychiurus fimetarius*, cuticular tubercles of head,  $\times 1120$ .
89. *Onychiurus pseudofimetarius*, right postantennal organ,  $\times 1120$ .
90. *Onychiurus pseudofimetarius*, left antennal sense organ,  $\times 1120$ .
91. *Onychiurus pseudofimetarius*, left hind foot,  $\times 652$ .
92. *Onychiurus pseudofimetarius*, left hind foot,  $\times 780$ .
93. *Onychiurus pseudofimetarius*, clothing, median line of first abdominal segment,  $\times 346$ .
94. *Onychiurus pseudofimetarius*, cuticular tubercles of head,  $\times 1120$ .
95. *Tullbergia collis*, right postantennal organ,  $\times 1120$ .

## PLATE 79.

- Fig. 96. *Tullbergia collis*, right antennal sense organ,  $\times 1680$ .
97. *Tullbergia collis*, dorsal aspect of fourth antennal segment of right side,  $\times 1120$ .
98. *Tullbergia collis*, left fore foot,  $\times 652$ .
99. *Tullbergia collis*, anal spines,  $\times 652$ .
100. *Tullbergia collis*, right anal spine,  $\times 652$ .
101. *Tullbergia collis*, clothing, median line of first abdominal segment,  $\times 520$ .



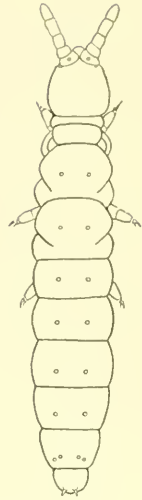




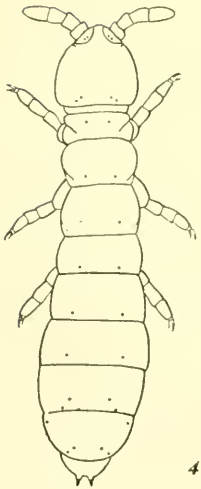
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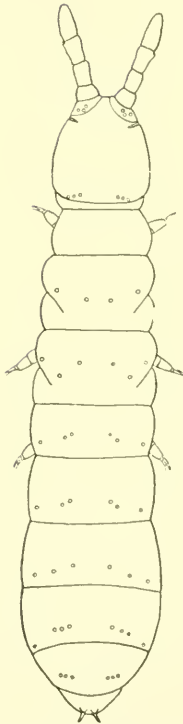
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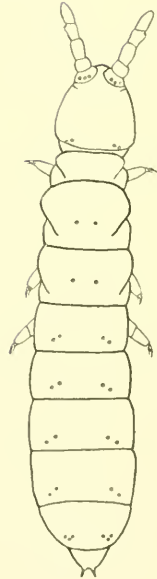


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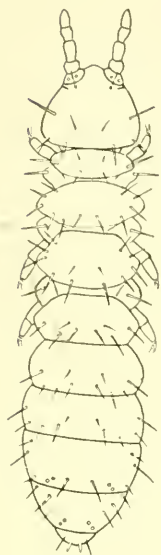
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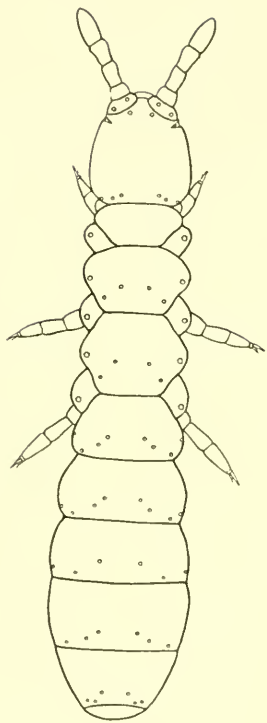
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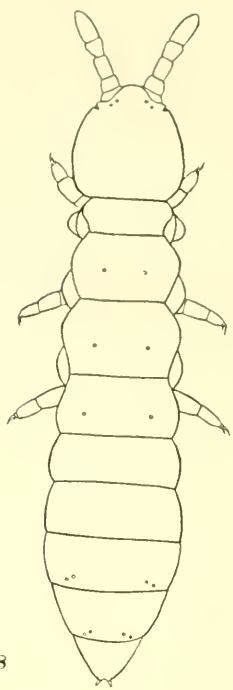




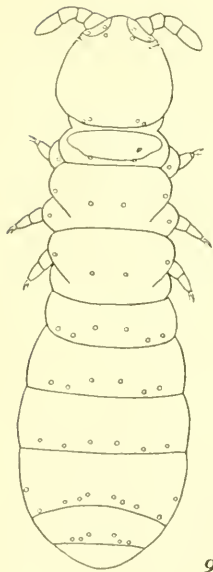
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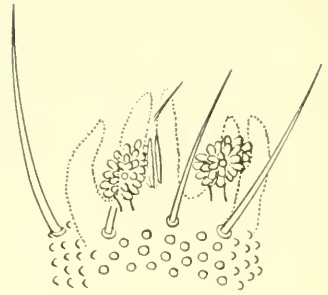
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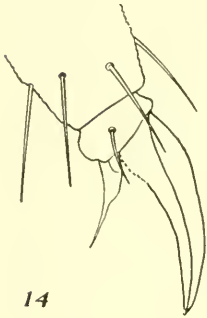




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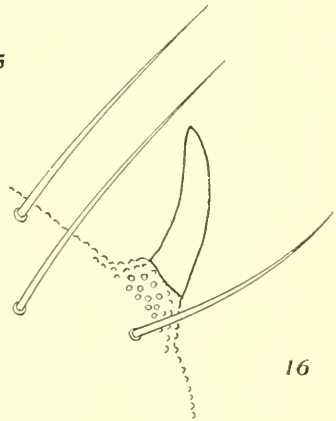
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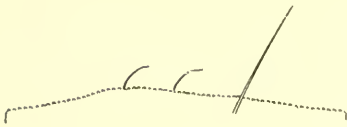
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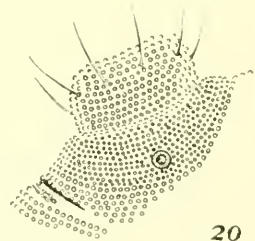
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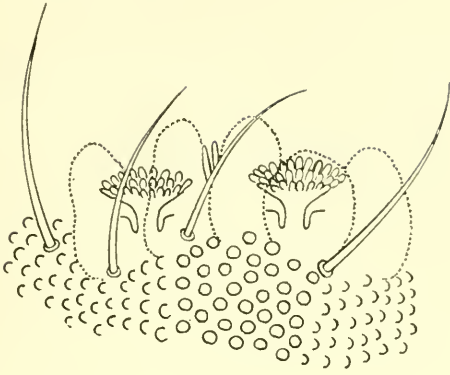


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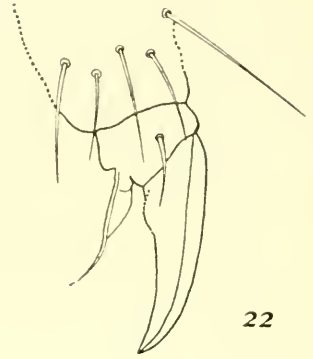
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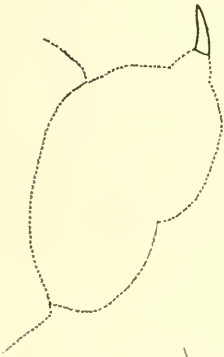




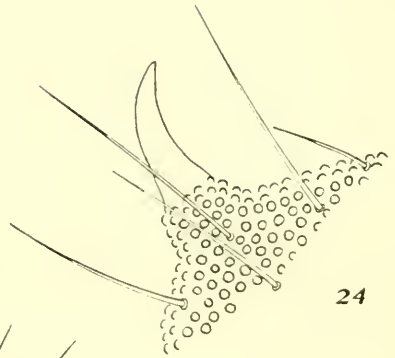
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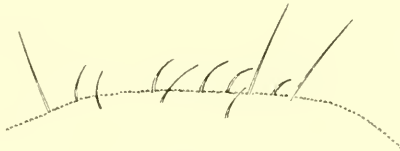
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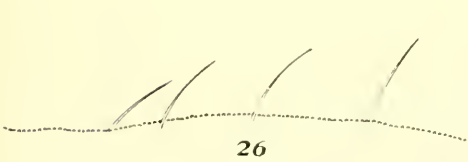
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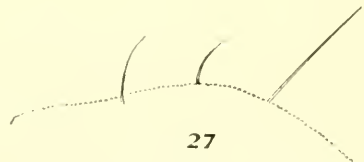
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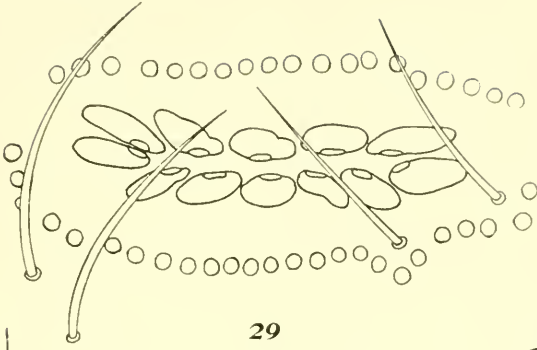
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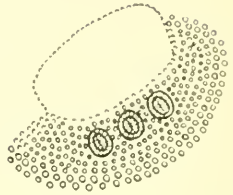
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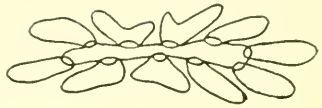




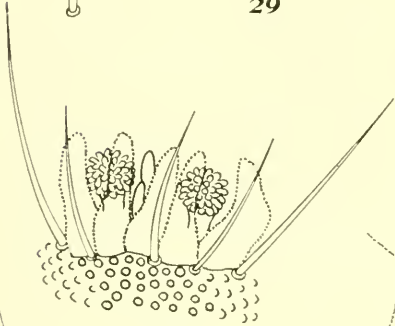
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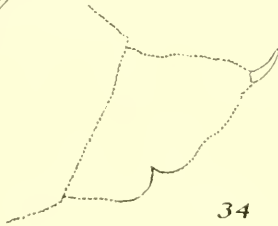
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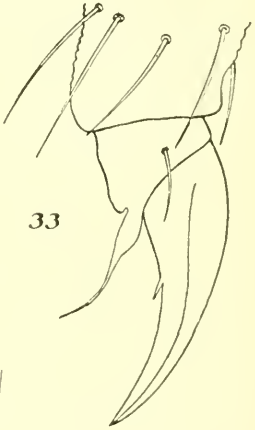
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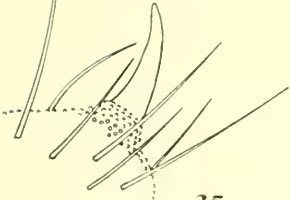
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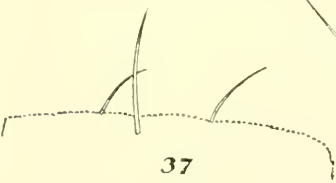
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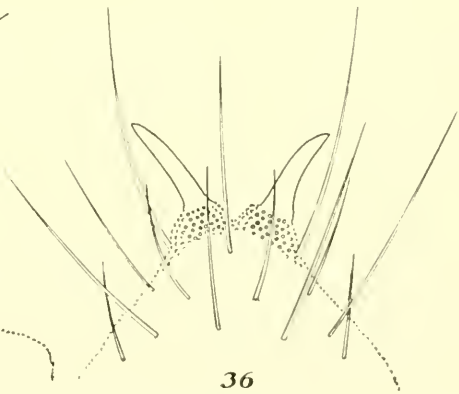
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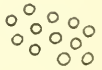
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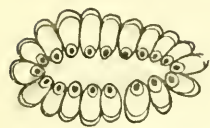


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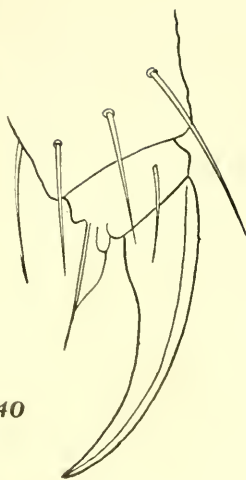




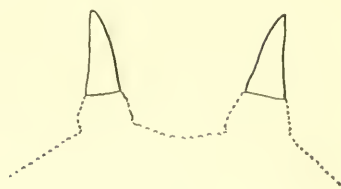
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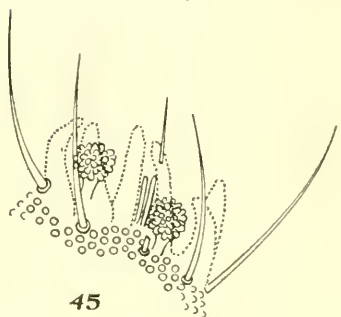
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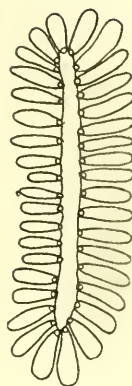
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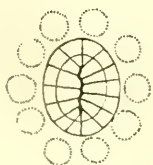
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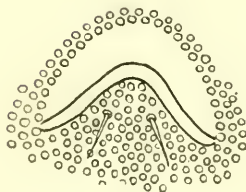
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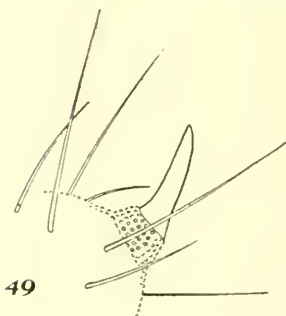
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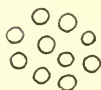
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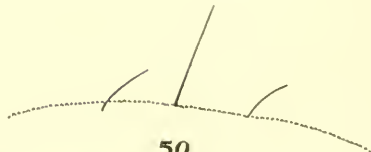
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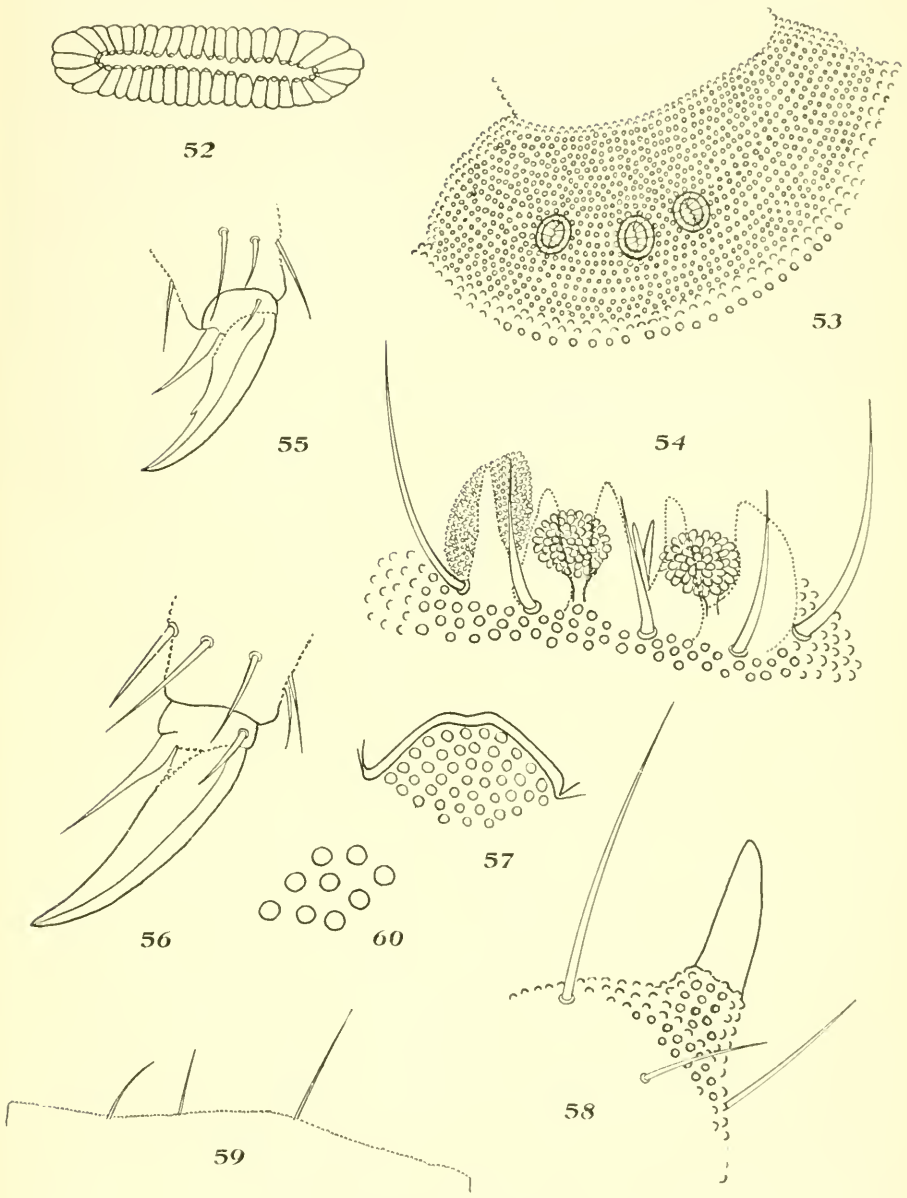
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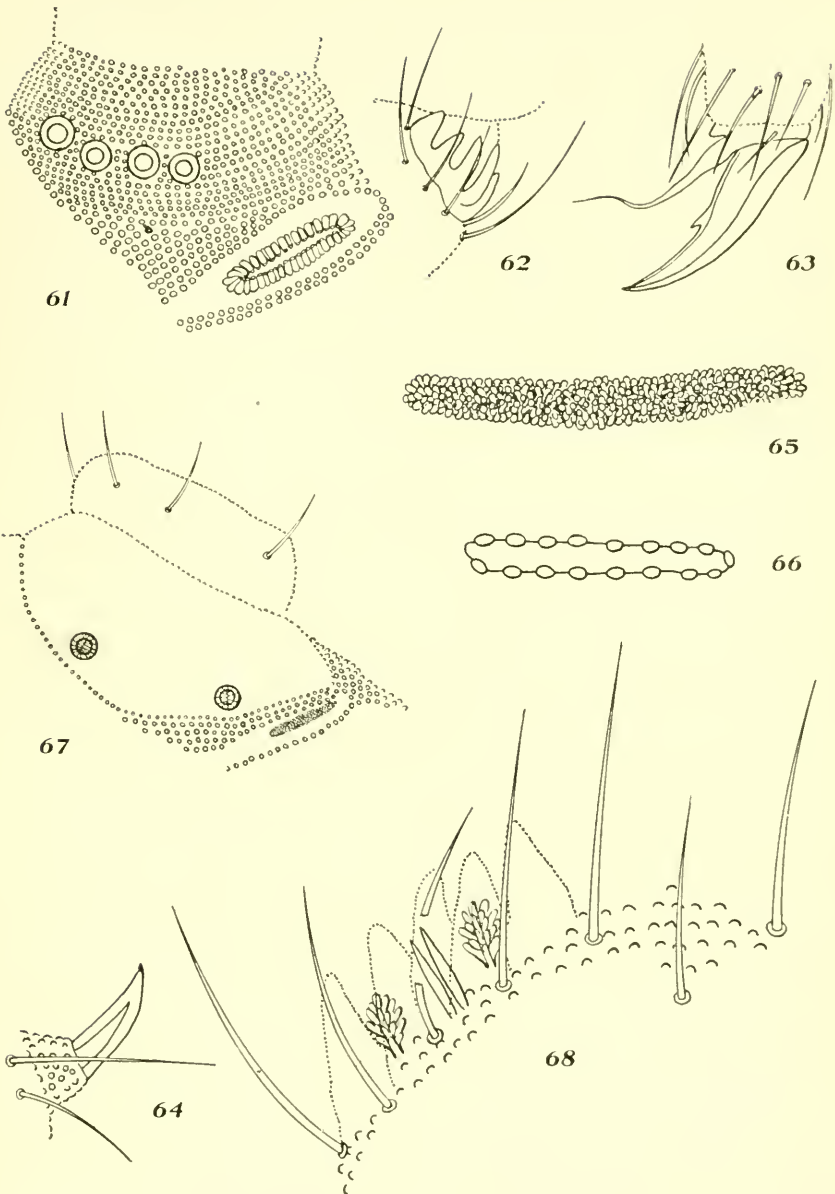




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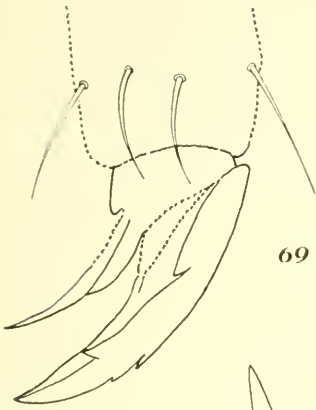




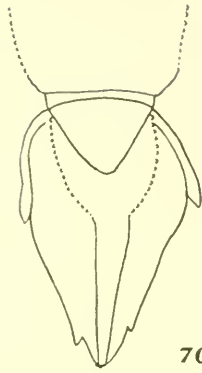
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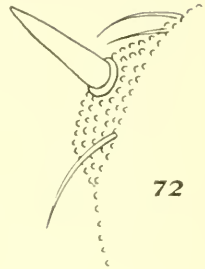




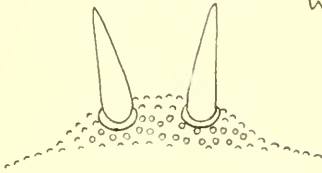
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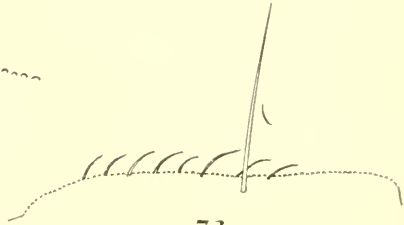
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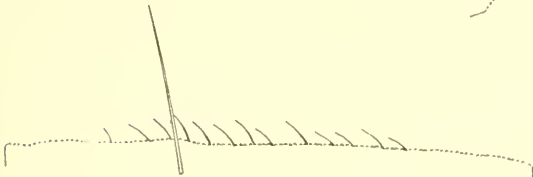
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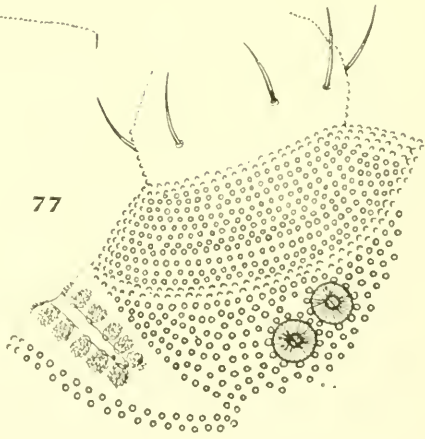
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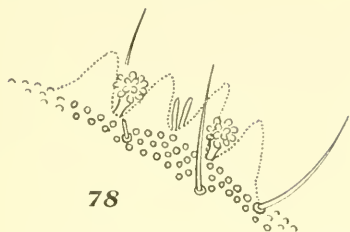
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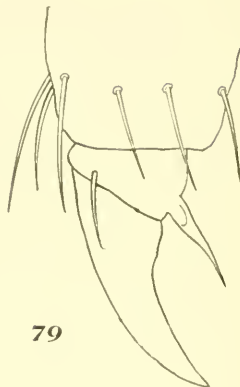
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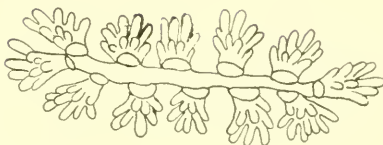
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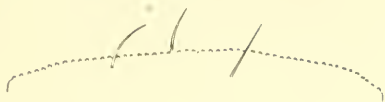


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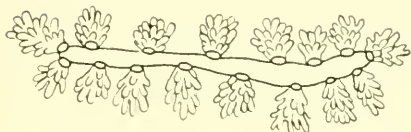




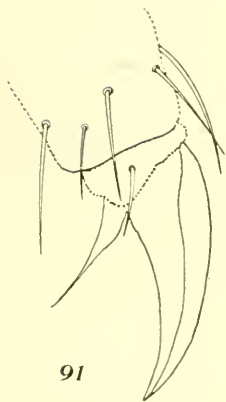
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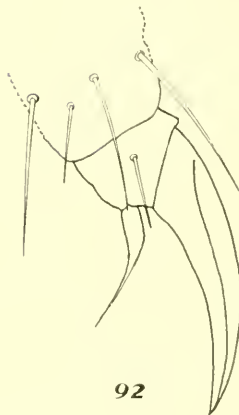
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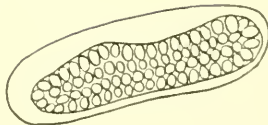


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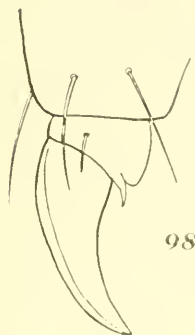
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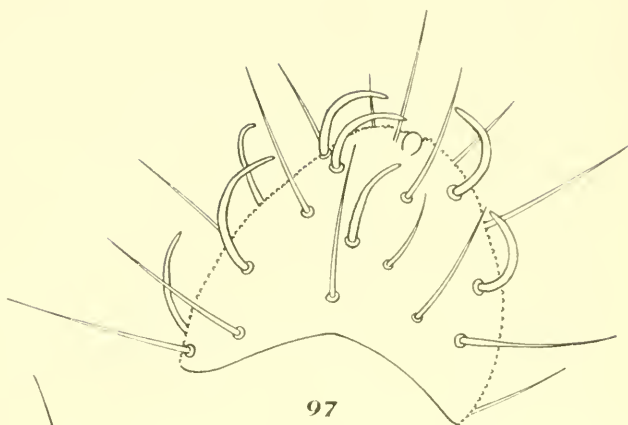
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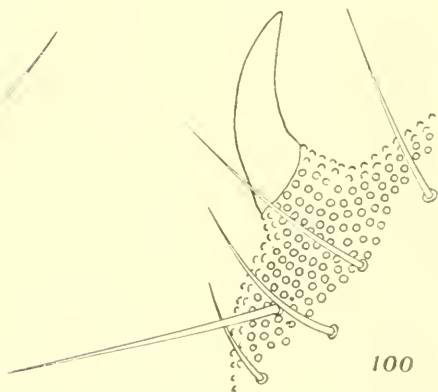
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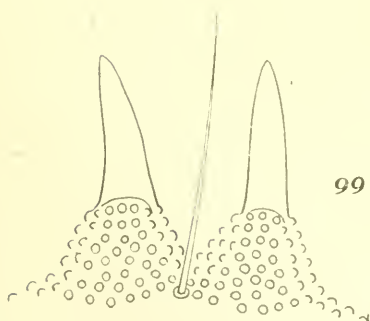
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FOR EXPLANATION OF PLATE SEE PAGE 659.