

Studies on the Collembolan Genus *Hypogastrura* II

Nearctic Forms collected by Prof. F. BONET

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In my previous reports on some Japanese and North American forms of *Hypogastrura* (Amer. Midland Nat. 64 : 257-281), I have cited the importance of the setal arrangement of the body to divide them into three genera : *Ceratophysella*, *Cyclograna*, and *Hypogastrura* and the possible subdivision of them to some groups according to the chaetotaxy of body segments. In the present paper, which deals chiefly with the Mexican and the North American species collected by Prof. F. BONET and kindly forwarded to me for investigation, I have tried to make more detailed studies about the same subject.

Hearty thanks are directed to Prof. F. BONET of the Mexican National University, whose kindness has given me the opportunity of studying the present valuable materials. All of them, including type and paratype specimens of new species, are to be preserved in his Institute after investigation.

Taxonomic results obtained are to be summarised as follows :

Ant. IV: For the nomenclature of organs and structures of ant. IV, refer BONET 1945 and YOSII 1956.

1. *End bulb* (maza sensorial, Endkolben) : An end bulb is always present. In no case it is lobed in the present material.
2. *Sensory setae* (sensillas olfactorias, Sinnesstiften) : They are 7 in number in all species of *Ceratophysella* (fig. 1 A, 6c) Not only that they are same in number, but also their location is about the same. They are to be named as *a-g*. Other usual setae are also about the same in arrangement and a seta *x* is always smaller than others. In *Cyclograna* spp. they are apparently different from this pattern. In *C. pilosa* YOSII for example, the number varies from 7 to 9 and their location is not fixed, although seta *a* and *b* are always present, together with the subapical groove and lateral sensory rod near by. In *Hypogastrura* (s. str.) the number is again variable. With some restrictions the status is species specific in some forms.
3. *Subapical groove* (sensilla subapical, Subapikalgrube) : In all species at hand this groove is present. It is located dorsally near the sensilla *b* or between *b* and an opposite seta, the latter is slender, but more curving than other setae. Sensory rod (Sinnesköpfchen) in the groove is often invisible owing to the granulation of the integument.
4. *Lateral sensory rod* (sensilla lateral, Seitenstiftchen) : This is also constantly present

in all forms here treated near the base of sensilla *a*, if not obscured by integumental granules. Structures near the tip of the apical bulb is also studied (fig. 1B), but they show no specific difference among materials examined.

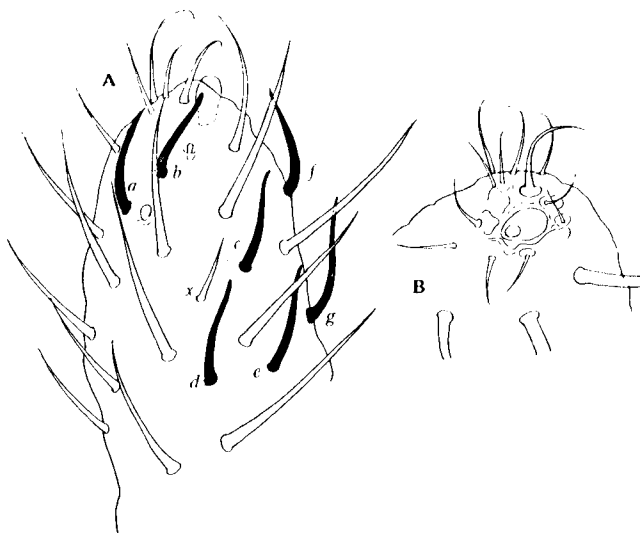


Fig. 1. *Ceratophysella pseudarmata* (FOLSOM)

A. Dorsal view of ant. IV, showing the arrangement of sensory setae (*a-g*) and *x*-seta.
B. Apical view of ant. IV.

5. Peg-like setae : There has been found some species with numerous or a few peg-like setae ventral to the segment. In these cases there is one conspicuous seta, around which these small setae are distributed. This “central seta” is usually with broad socket. In *Hypogastrura* no species with peg-like setae is hitherto reported.

Ant. III-organ : A groove with two blunt rods and with an accessory seta on each side of it. *Lateral sensory rod* (sensilla laterales, Seitenstiftchen des Ant. III) is also present, if not screened by granules of the integument. No special case as in *H. sensilis* FOLSOM is observed among the material examined.

Unguis : The form of the unguis does not differ much among the species examined. Lateral teeth is not observed in *C. cf. denticulata* BAG. *granulifera* sp. n. *Cy. cf. californica* BAC. and *Cy. hiawatha* sp. n. In *H. packardi* FOLS. both inner and lateral teeth are absent.

Unguiculus : It is setaceous and usually with one inner lamella. The length of the seta is about 1/2 of the unguis, but in *C. 12-ocellata* (BONET) it is about 2/3 of the unguis in length.

Ventral tube : Usual number of setae upon it is 4+4, but in *H. harveyi* FOLS. there are more than 10+10 setae.

Tenaculum : Rami tenaculi is usually quadridentate, but in *H. purpurescens* LUB., *H. viatica*

TULLB. etc, it is tridentate.

Tibiotarsus : fig. 3

In all species of *Hypogastruridae*, tibiotarsal setae are arranged in two etages or in two rings, ---the higher (*h*-row) and the lower (*l*-row). The latter is nearer to the base of the unguis. When closely examined, the latter is again divided into two niveau (*l*-and *l'*-row).

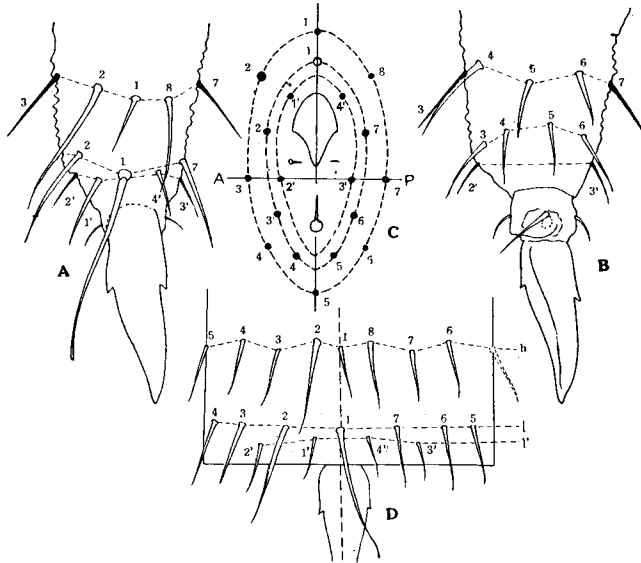


Fig. 2. Tibiotarsal chaetotaxy of *Ceratophysella* sp.

A. Anterior face, B. Posterior face, C. Diagrammatic apical view,
D. Diagrammatic view, developed by cutting along the posterior median line.

In *Ceratophysella* and *Cyclograna* these setae are arranged in the same way in all examples examined. The fore-and mid-legs are just the same in setal arrangement, while the hind-legs are slightly modied. In the formers *h*-row has 8 setae (h_1 - h_8) almost in equal distances. h_1 and h_5 are lying on the median dorsal and median ventral line of the tibiotarsus. Lower row is more complicated. *l*-row has 7 setae (l_1 - l_7) almost in equal distances and l_1 lies on the median dorsal line of the tibiotarsus. Ventral face has no median seta and l_4 and l_5 lie on each sides of the median line. *l'*-row, which is composed of 4 setae (l'_1 - l'_4) lies on the anterior face of the tibiotarsus and their location is alternative to *l*-row of setae. Thus l'_1 and l'_2 lie between l_1 - l_2 and l_2 - l_3 , while l'_3 and l'_4 lie between l_6 - l_7 and l_7 - l_1 . *l*-row of setae are larger than that of *l'*-row. l_1 is the largest and often termed as "tenent hair", even when it is not swollen at the end. Next to l_1 the seta l_2 is larger than others, while l_7 is not at all different from others, thus showing the slight asymmetry of the anterior and posterior face of the tibiotarsus. From *h*-row of setae h_2 and

h_8 are larger than others and often as large as l_1 . Upon hind-legs setal arrangement is not considerably different, but h_8 is usually missing and that it is more asymmetric than others.

In *Hypogastrura* (s. str.) the tibiotarsal chaetotaxy is modified in some way or other from the ground-plan in each species or species-groups. Furthermore, some of these setae are converted to so called "tenent hair" that their chaetal pattern must be discussed under each species.

Furcula : In *C. 12-ocellata* (BONET) the number of dental setae is variable from 7 to 5 (usually 6) and always with one long seta exceeding the mucro. In *C. tolteca* sp. n. two of them are thicker than others. Mucro has an outer lobe well developed in *C. pseudarmata* FOLS. and poorly developed in *C. 12-ocellata* (BONET)

Body setae : Usually they are setiferous and not to be discriminated from *setae sensuales*, but when body setae are somewhat modified as in *C. californica* BAC., s. s. is clearly to be discriminated. Their position is, as was already reported by CASSAGNAU 1960 and by YOSII 1960, p_3 upon th. II, III in *Ceratophysella* and p_4 in *Cyclograna* and *Hypogastrura*.

Abd. IV : Some of the Mexican forms of *C. cf. denticulata* BAGN. has 2+2 pairs of median setae, in stead of usual 3+3. Such a form is already known as *C. occidentalis* GISIN 1958 from Madeira as representing a new type of chaetotaxy. There seems to exist, however, some transient forms, in which a_1 is a little laterally dislocated, or its position is quite in a niveau of m-row, thus forming a *occidentalis*-form of arrangement. The main difference between *armata*-type and *communis*-type (A and B type GISIN's) lies in the relative length of p_1 and p_2 of the segment, as was already rightly stated by CASSAGNAU 1959.

Abd. V : The chaetal arrangement of the segment is first systematised by GISIN 1949 in two types having 2+2 or 3+3 dorsal anterior setae respectively. CASSAGNAU 1960 has pointed out the fact that 2+2 type may become 3+3 type during the postembryonic development in *C. cf. denticulata* BAGN. Further investigation reveals that 2+2 type may be resulted also by the dislocation of setae to the lateral part of the segment and that it is not easy to interpret the view exactly. Fortunately, there exists a pair of *fovea* (cf. YOSII 1956 for *fovea*) on the anterior part of a-row and if we calculate the number of setae between these *foveae*, the result is roughly just the same as of GISIN's. More exactly, we may describe the position of the *fovea* in relation to seta as "*fovea lateral to p_2* " instead of "*2+2*" or "*anterior to p_3* " instead of "*3+3*".

The segment has usually a grobly granulated stripe and its posterior margin is sharply delimited from the smooth integument of the posterior segmental margin. The line of this boundary is usually in a straight line, but in *C. azteca* sp. n. and in *C. tolteca* sp. n. it is medially protruded. The grade of granulation of this part

is also important. In *C. communis* FOLS. (fig. 4 a) the granulation is minute and arranged almost regularly in transverse rows, while it is somewhat irregular in *C. exilis* Yos. (fig. 4 b) and strongly irregular in *C. troglodites* Yos. (fig. 4 c). The granulation and its grade is, however, not easy to describe objectively. When granules are arranged regularly, we may calculate the approximate number of each granules between p_1 of either side as a and that of granule rows between p_1 and the boundary of the granulated stripe as b . Thus $a=20$, $b=5$ in *C. communis* FOLS. and $a=10$, $b=2$ in *C. exilis* Yos. approximately.

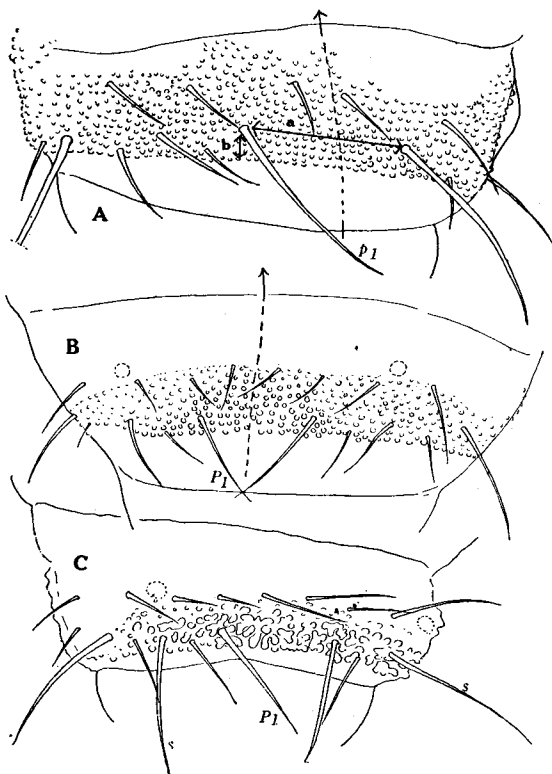


Fig. 3. Dorsal view of abd. V.

- A. *Ceratophysella communis* (FOLSOM)
- B. *Ceratophysella exilis* (YOSHII)
- C. *Ceratophysella troglodites* (YOSHII)

In the subsequent description of each species, common characters of antennae, tibiotarsus and tenaculum are abbreviated, if not specially deviated.

Armata-Group of Ceratophysella

1. ***Ceratophysella pseudarmata* FOLSOM** (Fig. 1, 4.)

Achorutes pseudarmatus : FOLSOM 1916

22 expl. Olympia, Washington USA 9. II 1949

17 expl. Banff, Alberta, Canada 21. IV 1938, O. BRYAN-leg.

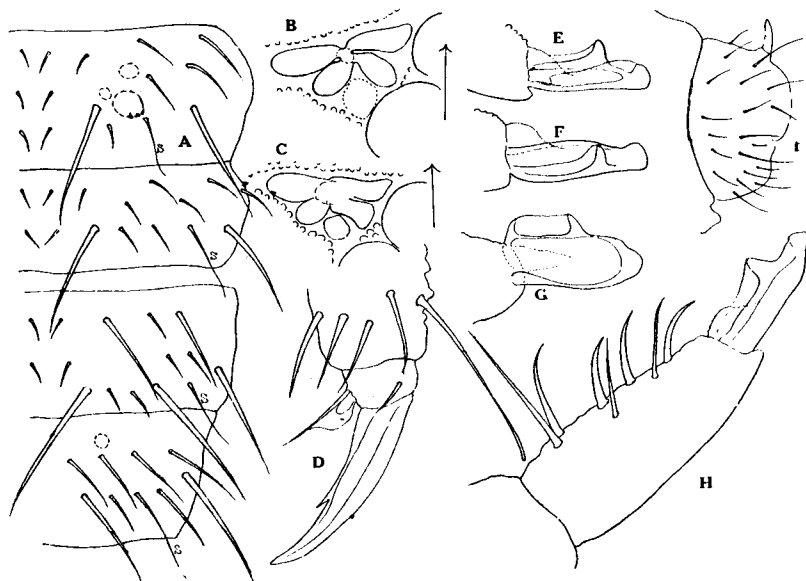


Fig. 4. *Ceratophysella pseudarmata* (FOLSOM)

A. Chaetotaxy, B, C. Postantennal organ, D. Hind claw, E, F, G. Mucro, from various directions, H. Dens and mucro, I. Abd. VI.

All of them are etiquetted as *A. pseudarmatus*. Examples from Olympia is determined by H. B. MILLS. Length 1,8mm. Body colour brownish black in mounted examples. Ant. IV ventrally without peg-like setae. An antennal eversible sac conspicuous. Eyes 8+8. Postantennal organ with two anterior tubercles in a straight line, the posterior two smaller. Accessory tubercle is rounded and situated between two posterior ones, but not encircled by them as in *Cyclograna*. Each tibiotarsus with one dorsal larger seta (1_1), whose apex is often obtusely ending. Unguis straight, with one inner and one pair of lateral teeth. Unguiculus setaceous and with broad, rounded basal lamella. Ventral tube with 4+4 setae. Furca with d/mu as 1,5. Dentes dorsally finely granulated and with 7 setae, 4 of them are thicker than others. Mucro apically rounded and with well developed outer lobe, whose anterior margin is specially modified to form a tooth-like thickening and from which a thin lamella is stretched basally. Body setae setaceous and arranged in typical *armata*-type. Larger setae may be with rough surface. Anal spines rather small, as large as a mucro in length, situated dorsally and their basal papillae are about 3 granules remote to each other. Integument is uniformly and finely granulated even on abd. V, where no special integumental structure is to be seen.

The species is easily discriminated by the unique shape of the mucro. As stated by STACH (1949, p. 150), the species is near *C. sigillata* (UZEI), but the thickening of outer

muronal lobe is more conspicuous and 4 of the dental setae are thicker than others. *Achorutes jondavi* WRAY 1946 is perhaps identical to the present form.

2. *Ceratophysella brevisensillata* Yosii

YOSII 1961

C. pseudarmata (nec FOLSOM) : YOSII 1960

14 expl. Stanford, Connecticut, USA 12. IX 1945 S. W. BROMLEY-leg.

1 expl. Blue Ridge, Virginia, USA 4. VI 1948 F. BONET-leg.

The species characterised by the minute size of s. s. upon Th. II, III. Abd. V is finely granulated and each granules are transversely arranged as $a=20-25$, $b=4$ approximately.

Communis-Group of Ceratophysella

3. *Ceratophysella communis* (FOLSOM) (Fig. 3a)

FOLSOM 1897, KINOSHITA 1916, DENIS 1927, 1936, RAPOPORT 1958, YOSII 1960

9 expl. Pasquero, Michoacan, Mexico 1. IX 1941 F. BONET-leg. 4 expl. Tabasco, Mexico
M. FAURIE-leg. 13 expl. Tucman, Argentine 19. II 1914 BARBER-leg.

In contrast to my previous conception of the species (YOSII 1960), *C. communis* and *exilis* YOSII 1956 are two different forms. In *communis* four elements of the postantennal organ are almost equal in length and shape, while it is different in *C. exilis* (YOSII 1956 Pl. 3, fig. 26). Setal arrangement of abd. IV is typical in *exilis*, but modified in *communis* (cf. YOSII 1956, Pl. 3 fig. 25 and 1960, p. 260, fig. 1). Difference in the structure of abd. V is above mentioned.

The present species is already reported from Japan, China, Himalaya and Argentine. Prof. BONET's materials coincide well with Japanese ones in all details.

4. *Ceratophysella tolteca* sp. n. Fig. 5

Typus : Male from Tegintlan, Pueblo, Mexico 18. IV 1946 F. BONET-leg.

Paratypes : 13 expl. Tegintlan, Pueblo, 18. IV 1946 F. BONET-leg.

9 expl. Nevada de Toluca, Vera Cruz 16. VII 1944 M. CARDENAS-leg. 28 expl. Trapacoyan,
Vera Cruz 24. V 1945 F. BONET-leg. 11 expl. Estanguela, Vera Cruz 18. IV 1946 F. BONET-leg.
10 expl. La Hoya, Vera Cruz 18. IV 1942 F. BONET-leg. 22 expl. Desierto de los Leones, DF
30. VII 1939 F. BONET-leg. 21 expl. Zempoala, DF 13. VIII 1939 F. BONET-leg. 3 expl.
Venta Chica, Hidalgo 12. IV 1940 F. BONET-leg. 2 expl. San Felipe, Oaxaca 3. XI 1947 F. BONET-leg.
4 expl. El Vegetal, Chiapas 5. I 1940 F. BONET-leg. 5 expl. Las Casas, Chiapas 6. VI 1926
A. DAMPF-leg. 8 expl. Los Sabinos, San Luis Potosi 3. IV 1942 F. BONET-leg.

Length 0.8 mm. Colour brownish dark, but deeper on dorsal side. Segmental margins pale. Ventrally and upon legs pigments are scattered in plaster form. Antennae subequal to head in length. Ant. IV ventrally with some 20-25 small peg-like setae. Eversible antennal sac present. Postantennal organ with two anterior elements strongly elongated, while other two are at right angle to them. Accessory tubercle obscure. Eyes 8+8. Unguis very slender, with one inner tooth and more basally situated lateral teeth. Unguiculus short, being about 1/3 of the unguis and its apex is not reaching the inner tooth of the unguis. Basal lamella present, rather quadrangular in form. Furcula with d/μ as 2:1. μ/ung_3 as 6/7. Dens with 7 setae, two inner distal ones are thicker than others. Outer

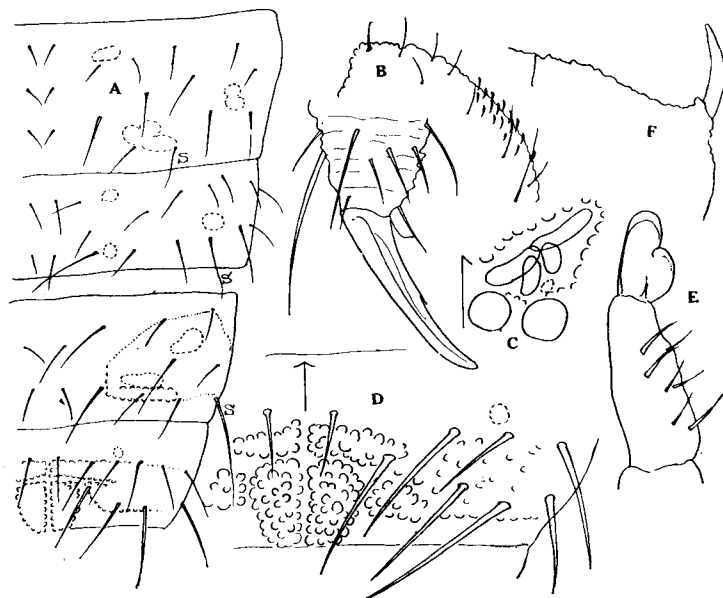


Fig. 5. *Ceratophysella tolteca* sp. n.

A. Chaetotaxy, B. Antennal tip (lateral), C. Postantennal organ, D. Abd. V (dorsal), E. Furcula, F. Anal spine.

lobe of mucro is as large as the apical one. Anal spines not well developed, 1,4 times the length of ung_3 , slightly yellowish, terminally situated and gently curving. Their basal papillae are slightly apart to each other. Chaetotaxically m_2 of Th. II, III is posteriorly dislocated. Abd. I-III of *communis* type. Abd. IV has 3+3 median setae. Abd. V is very characteristic. There is a median tubercle of low elevation, divided to paired groups of integumental granules and projecting from the niveau of the p -row of setae. Dimensional difference of body setae is not very conspicuous.

The species is unique with its peculiar tubercles of abd. V.

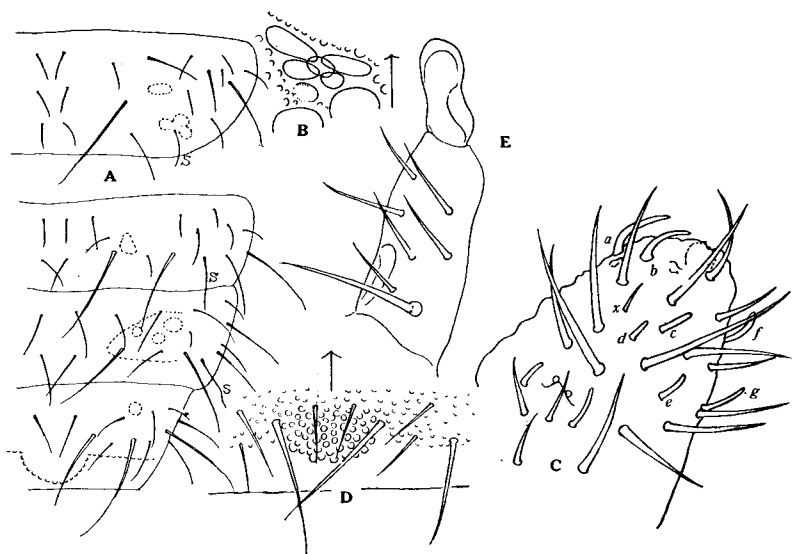
5. *Ceratophysella azteca* sp. n. Fig. 6

Typus: One male from Bosque Chaultepec, DF. 7. X 1939 F. BONET-leg.

Paratype: 3 expl. from the same lot.

4 expl. Laguna Beach, California 2. I 1949 C. TELLEZ-leg. 3 expl. Holly Wood, California 15. I 1949 C. TELLEZ-leg. 10 expl. Pomona College, California 16. I 1946 C. TELLEZ-leg. 10 expl. La Jolla, California 15. XII 1948 C. TELLEZ-leg. 12 expl. Ditto 28. XII 1948 C. TELLEZ-leg. 10 expl. Philadelphia, Pennsylvania 2. VIII 1948

Body length up to 1,5mm. Ground colour brownish yellow, but mottled with dark brown pigments on dorsal side. Antennae, head and distal two abdominal segments are more deeply pigmented. Segmental margins and the ventral side of the body pale. Of the 7 curving sensory setae of ant. IV, three dorsal ones are smaller than others. Ventrally without peg-like setae. Eversible antennal sac un conspicuous. Postantennal organ rather large, with 4 elements elongated and an accessory tubercle outside of them. Eyes 8+8, black. Unguis dorsally carinate, with one large inner tooth and a pair of lateral teeth at

Fig. 6. *Ceratophysella azteca* sp. n.

A. Chaetotaxy, B. Postantennal organ, C. Ant. IV dorsal, D. Abd. V.

about the middle. Unguiculus $1/2$ of the unguis, setaceous and with rounded basal lamella. No clavete tenent hair. Ventral tube with $4+4$ setae. Furca short, $mu+d$ being only twice the inner margin of ung_3 in length. Dens dorsally not granulated and with 7 setae. the basal outer one longer than others. Mucro broad, apically rounded and with a well developed lateral lobe. Anal spines terminal to abd. VI, yellowish, slightly curving and with papillae about 2-times the length of ung_3 . These papillae are touching to each other. Chaetotaxically it is of *occidentalis*-type. Those on abd. IV has only $2+2$ median groups of setae. Upon abd. V the granulated patch extends medially in a rounded shape posteriorly from the niveau of p-row and the place is somewhat elevated. Small grobly granulated area is present around p_2 and p_5 on abd. IV. s. s. are thin. All body setae are practically smooth.

The species is characterised, above all, by the peculiar median granulation of abd. V.

6. *Ceratophysella* cf. *denticulata* BAGNALL Fig. 7

BAGNALL 1941, GISIN 1946, 1960, CASSAGNAU 1958

USA : 6 expl. Wald, Maine 29. VIII 1944 F. BONET et M. CUNLIFFE-leg. 6 expl. Dryden, Maine 30. VIII 1948 F. BONET et M. CUNLIFFE-leg. 3 expl. Ditto, 22. V 1944 A. HOFFMANN-leg. 8 expl. Easton, New Hampshire 29. VII 1948 F. BONET-leg. 8 expl. Takoma Park, Maryland 14. VI 1948 F. BONET-leg. 10 expl. Edgewater, Maryland 26. VI 1948 F. BONET-leg. 11 expl. Washington DC. 18. VII 1948 F. BONET-leg. 3 expl. Arlington, Virginia 1. XI 1948 F. ANDRÉ-leg. 9 expl. Mt. Vernon, Virginia 15. VII 1948 F. BONET-leg. 19 expl. Urbana, Illinois 18. XI 1948 F. BONET-leg. 10 expl. Auburn, Alaska 8. XI 1948 J. Alvarez-leg.

Body length up to 1, 4mm. Colour dark gray, mottled with black pigments. Antennae, head and posterior abdominal segments more darkly pigmented. Peg-like setae of ant. IV

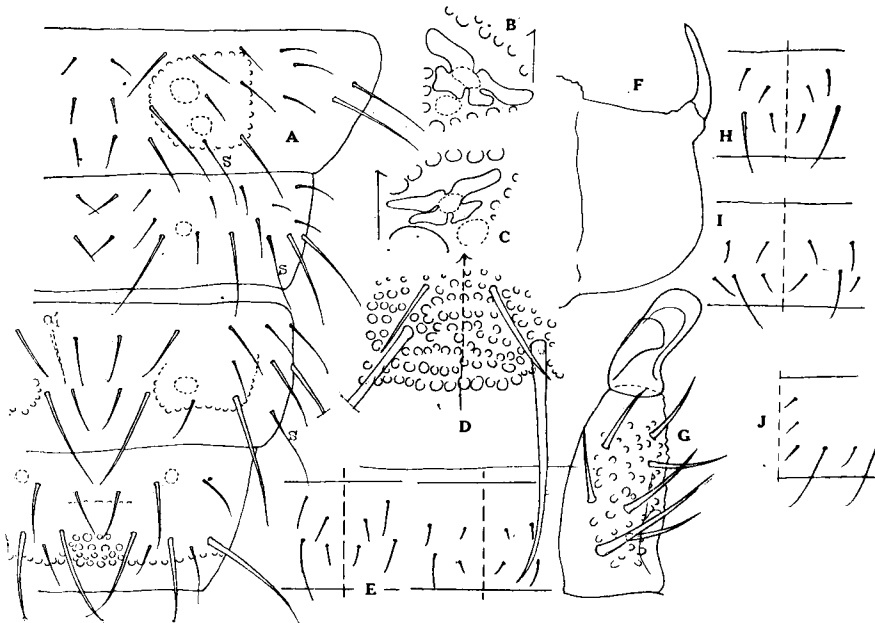


Fig. 7. *Ceratophysella* cf. *denticulata* (BAGNALL)

A. Chaetotaxy, B, C. Postantennal organ, D. Abd. V, E. Two types of Chaetotaxy of abd. IV. F: Anal spine., G. Dens and mucro, H: Chaetotaxy of abd. IV by *C. denticulata* (after GISIN 1960), I. Ditto by *C. occidentalis* (after GISIN 1960), J. Ditto by *C. denticulata* (after CASSAGNAU 1959, fig. 1a).

12-20 in number. With an eversible antennal sac. Two anterior elements of postantennal organ straightly situated and larger than other twos. Accessory tubercle posteriorly placed. Unguis with one inner tooth at about the middle. No lateral tooth is observed. Unguiculus setaceous, ca $2/3$ of the unguis and with obscure basal lamella. Ventral tube with $4+4$ setae. Dentes dorsally with fine granules and 7 slender setae. Anal spines large, slightly yellowish and their basal papillae are one granule apart to each other. Integument has granulated stripe upon head, abd. VI and upon special place of each body segments as in fig. 7a. Especially grobly granulated are the postero-median parts of abd. V, between p_1 of each side, where granules are larger and in transverse arrangement. $a=10$, $b=2$ approximately. Chaetotaxy is identical with the figure GISIN's (1960 p. 51, fig. 116) in that a_1 of abd. IV is dislocated laterally.

North American examples coincide fairly well with the description of European authors. That *C. engadinensis* GISIN might be identical with *C. denticulata* (CASSAGNAU 1958) is possible, because I have observed both types of chaetotaxy upon abd. V in my material. Recently an interesting species: *C. occidentalis* GISIN 1958 has been described from Madeira. This species which is, without doubt, nearly related to the present form in many respects, is different in having only two transverse rows of setae upon abd. V. In studying BONET's collection, I have met some individuals which might be regarded as

occidentalis in this respect. But as an additional seta a_1' in fig. 7a appears frequently on one side, it is very difficult to separate *occidentalis* from *denticulata*. Anyhow, three species: *C. cf denticulata*, *tolteca* and *azteca* are nerally related in that a_1 of abd. IV may be absent or posteriorly dislocated. *C. denticulata* is also alike to *C. gibbosa* BAGNALL 1940 of Europe, for which the author has added a note "I have a specimen from Iowa, USA". But the cited species has no eversible antennal sac and the chaetotaxy is of *armata*-type (GISIN 1949).

7. *Ceratophysella granulifera* sp. n. Fig. 8

Typus : 1 male from Edgewater, Maryland USA 24. VI 1948 F. BONET-leg.

Paratype : 12 expl from the same lot. 3 expl. Silram Springs, Illinois 13. IV 1946 C. HOFF-leg.

10 expl. Washington, DC. 20. XI 1948 F. BONET-leg. Mt. Massamitten, Virginia 4. VI 1948 E. W. BAKER et F. BONET-leg.

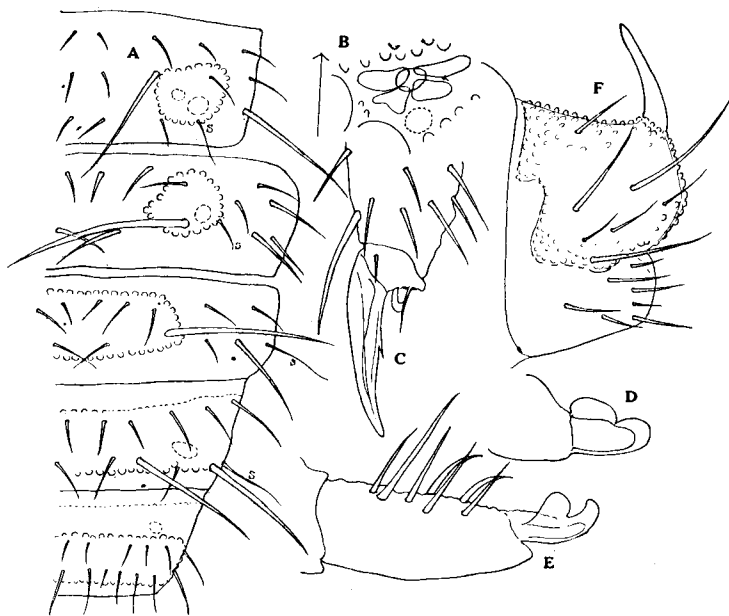


Fig. 8. *Ceratophysella granulifera* sp. n.

A. Chaetotaxy, B. Postantennal organ, C. Hind claw, D. Mucro, E. Dens and mucro, F. Abd. VI.

Body length ca. 1,0mm. Colour violet black and strongly mottled. Each segmental margins and ventral side of the body pale. Ant. IV ventrally with many peg-like short setae surrounding a normal central seta. Eversible antennal sac is poorly developed and scarcely visible. postantennal organ with two anterior tubercles larger than others and in a row. Eyes 8+8. Unguis straight and with one inner tooth at about the middle. Lateral teeth not observed. Unguiculus setaceous and short, not reaching the inner tooth of the unguis. Basal lamella rounded and small, slightly larger than the basal tubercle of the unguiculus. No tenent hair is specialised. Ventral tube with 4+4 setae. Furca with d/mu

as 1,7. Dens dorsally granulated and with 5 slender and 2 thicker setae. Mucro distally rounded and with a conspicuous outer lobe. They are thickly chitinised along their marginal portion. Anal spines strongly developed, being 1,8 times the length of ung_3 and standing side by side. Basal papillae are relatively low. Chaetotaxy is typically of *occidentalis*-type, abd. IV bearing only two transverse rows of setae. Abd. I-III have also two rows of setae as in case of *C. denisana* Yosii. Difference of larger and smaller setae is conspicuous. Integument is strongly granulated upon head and in some areas of the body segments. Th. II, III and abd. I, II have such areas in pairs. Abd. III has median granulated area, while abd. IV, V and VI are covered with such granules almost all over the segment. $a=7-9$, $b=2$. Granules between p_1 of abd. V are irregularly distributed, but not especially modified.

This species is characterised by the strong granulation of the integument and its distribution, short unguiculus and well developed outer flat of mucro. Chaetotaxy is characteristic.

8. *Ceratophysella orizabae* sp. n. Fig. 9

Typus : One female from San Felipe, Oaxaca, Mexico 3. XI 1949 F. BONET-leg.

Paratype : 19 expl from the same lot.

15 expl. Orizaba, Vera Cruz, 14. I 1942 F. BONET-leg.

Body length up to 1,5mm. Colour grayish. Microscopically, the integument is strongly mottled with black pigments aggregated in mosaic or plaster form on dorsal side of the

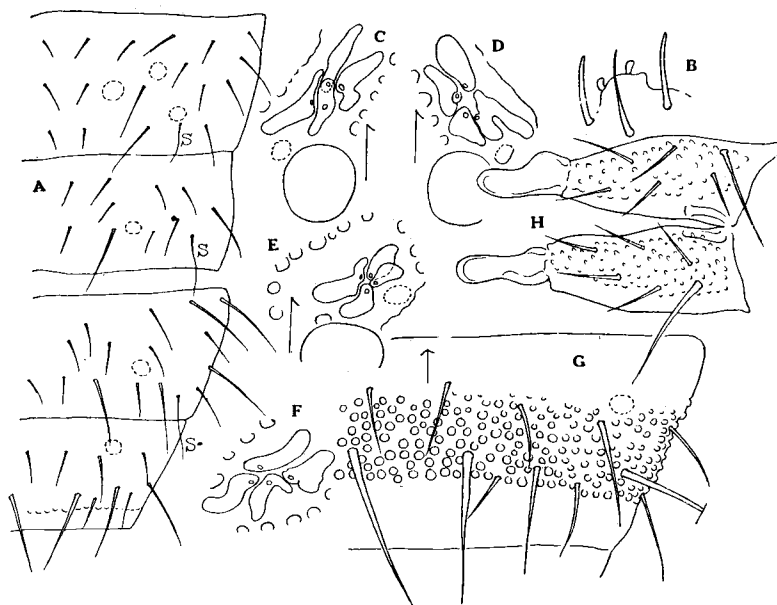


Fig. 9. *Ceratophysella orizabae* sp. n.

A. Chaetotaxy, B. Ant. III-organ, C, D, E, F. Various types of postantennal organ, G. Abd. V, H. Dens and mucro.

body and upon antennae. Each segmental margin and ventral side pale. Ant. IV ventrally with some small but not peg-like setae. Two anterior elements of postantennal organ are in a line and longer than posterior two, but all of them show strong irregularity in form and no two examples are equal in shape. An accessory tubercle is present. Eyes 8+8, intensely black. Unguis with one inner and a pair of lateral teeth as usual. Unguiculus with its setaceous apex reaching the inner tooth of the unguis. A rounded basal lamella is distinct. Ventral tube with 4+4 setae. Furcula short. Dentes have remarkably always 6 setae. Dorsal side of it is slightly granulated. Anal spine yellowish, strongly curving and with papillae basally touching to each other. d/μ as 12/5. An. sp./ung₃ as 3/2. Chaetotaxically the species is near *C. communis*, a_1 of abd. IV being dislocated. On abd. V granules are not transverse in arrangement, but $a=7-9$, $b=2$ approximately. All body setae are smooth and no great difference between larger and smaller setae is present.

The species is easily discriminated from other species of the *communis*-group by dental setae, postantennal organ and by abd. V.

9. *Ceratophysella duodecimocellata* (BONET) f. *16-ocellata* f. n. Fig. 10

Typus : One male from Nevada de Toluca, Mexico 3700m alt. 16. VII 1944 M. CARDENAS-leg.

Paratype : 4 expl. from the same lot.

5 expl. San José de la Cumbre, Michoacan 24. I 1943 F. BONET-leg.

Body 1,3 mm. Colouration brownish gray, due to the fine mottlings of dark pigments.

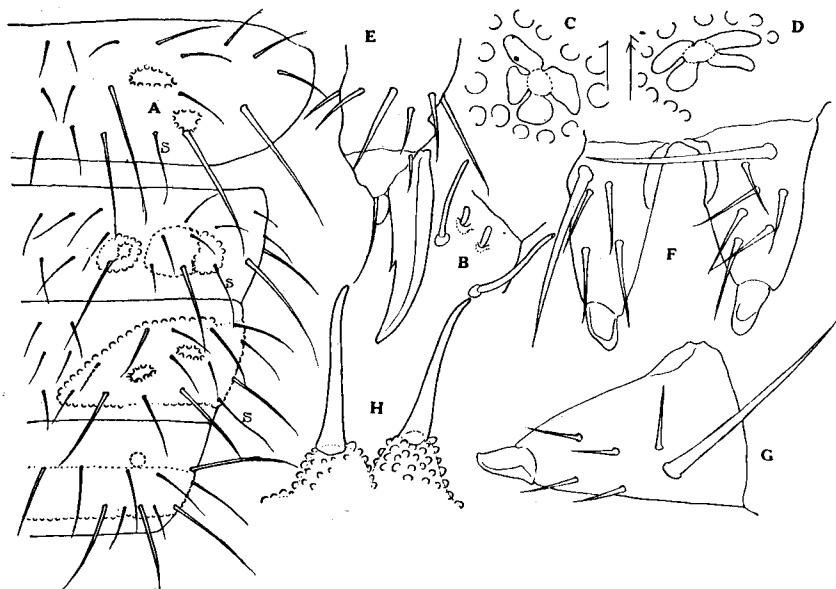


Fig. 10. *Ceratophysella duodecimocellata* (BONET) f. *16-ocellata* f. n.
A. Chaetotaxy, B. Ant. III-organ, C, D. Postantennal organ, E. Hind claw,
F, G. Furca, H. Anal spines.

Segmental margins and the ventral side pale. Ant. IV ventrally with ca. 25 small but not peg-like setae. Antennal eversible sac seemingly absent. Postantennal organ composed of 4 subequal elements in a rosette, without an accessory tubercle (?). Eyes 8+8, poorly pigmented. Unguis usual for the group. Unguiculus is with its setaceous shaft surpassing the inner tooth of the unguis and with rounded basal lamella. Tenent hair not clavated. Ventral tube with 4+4 setae. Rami tenaculi quadridentate. Furcula is feebly developed. $d+\mu/\text{ung}_3$ as 13:11. Dental setae usually 6 but variable from 5 to 7. An outer basal seta is always very strong and surpassing the mucro. Mucro is reduced to a rounded flap with involuted margins. Outer lobe is almost vestigial and may be traced only in lateral view. Anal spines terminally situated, very slender and long. Their papillae are touching to each other. An. sp./ ung_3 as 2:1. Body setae simple, smooth, slender and very long, giving the insect the setaceous impression. Their arrangement is typically of *communis*-type. Integument is rather coarsely granulated. The granulated area appears on some parts of the body as in fig. 10 A. So, for example, abd. I-IV has such area on both sides of the body. Abd. V is with a granulated stripe, where each granules are transversely dispersed. $a \approx \text{ca. } 10$, $b=2$. Abd. V and VI are also coarsely granulated.

The new form differs from *Schaefferia duodecimocellata* BONET 1945 (p. 15) by the number of ocelli. In other main characters, it is about the same with it. The form is also near *C. tigrina* HARVEY 1900 (cf. FOLSOM 1916) from Maine, USA, except that anal spines are absent in the cited species.

10. *Ceratophysella scotti* sp. n. Fig. 11

Typus: One female from Buena Vista, California, USA 25. IV 1958 D. B. SCOTT-leg.

Paratype: One male from the same lot.

Body length 1,3 mm. Colour dark, mottled strongly with black pigments dorsally and upon antennae. Ventral side and extremities pale. Antennae as long as head. Ant. IV ventrally with some 25 shorter setae, which are slightly capitate on apex. Sensory setae of dorsal side 7 in number and their arrangement is somewhat atypical for the genus in one example examined. No eversible antennal sac in two examples at hand. Postantennal organ with anterior two lobes in a line and two smaller posterior ones are incompletely encircling the accessory tubercle. Eyes 8+8, strongly pigmented. Unguis normal, with an inner and a pair of lateral teeth. Unguiculus spiny, with broad basal lamella. Tibiotarsal chaetotaxy normal for the genus. Ventral tube with 4+4 setae. Rami-tenaculi is quadridentate in typus and tridentate in another one. Furcula feebly developed. Dentes is distally converging and with 5-(6) setae, an outer basal one of which is larger than others. Dorsal side is granulose. Mucro well developed, distally rounded and with a large, flap-like inflated outer lobe. Anal spine/ ung_3 as 1,5, terminally situated and slightly yellowish. Integument is moderately granular. Abd. V has a granulated medial stripe, where each granules are not modified, but arranged rather regularly. $a=13$, $b=2$. Fovea lies anterior to a_2 . Chaetotaxy is *communis* type. Distinction of larger and smaller setae

are not conspicuous and all of them, excepting s.s. are not setaceous but rather blunt and ending abruptly on apex.

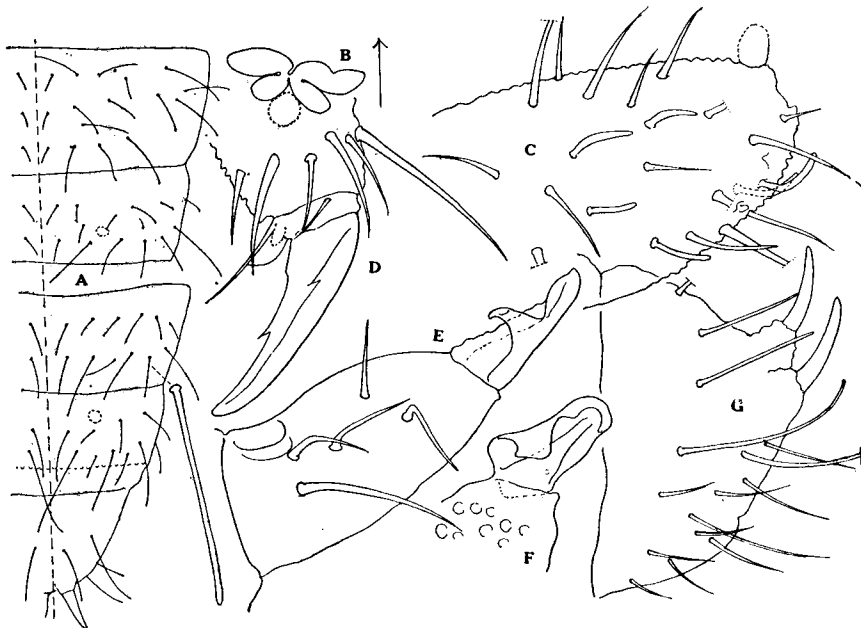


Fig. 11. *Ceratophysella scotti* sp. n.

A. Chaetotaxy, B. Postantennal organ, C. Ant. IV. D. Fore claw, E. Dens and mucro, F. Mucro, G. Anal spines.

The species is dedicated to Dr. D. B. SCORR of California, the collector of the species. With its peculiar form of dentes, the species is nearly related to *C. 12-ocellata* (BONET) *f. 16 ocellata* YOSII from Mexico. But it may be separated from it by well developed outer lobe of mucro and by blunt body setae.

11. *Ceratophysella maya* sp. n. Fig. 12

Typus: One female from Desierto de los Leones, DF. Mexico 14. VII 1941 F. BONET-leg.

Paratype: 4 expl. from the same lot.

2 expl. Ditto 30. VII 1939 F. BONET-leg.

Body length 1,3mm. Colour grayish olive by the mottled arrangement of black pigments, which are concentrated especially upon antennae, head and distal abdominal segments. Ventral side and segmental margins pale. Ant. IV is beset with very numerous peg-like setae on ventral side. A central seta among them is not conspicuous. Antennal eversible sac present. Four elements of the postantennal organ are in parallel rows and an accessory tubercle is outside of them. Eyes 8+8. Unguis stout, normally toothed. Unguiculus small, its apex not attaining the inner tooth of the unguis and with broadly rounded basal lamella. Ventral tube with 4+4 setae. Furca not well developed. Dentes

is dorsally granulated and with 7 setae, of which 2 inner distal ones are thicker than others. Mucro is distally rounded, an outer flap is larger than the apical one and strongly upwright in form. Anal spine rather small, being shorter or subequal to ung_3 , dorsally situated and their papillae are about 4 granules apart to each other. mu/ung_3 as 3/5. Integument is minutely granulated. Abd.V is medially also minutely but regularly granulated and a fovea lies antero-lateral to a_3 . $a=8$ (8–9), $b=3$. Body setae are feeble and no great dimensional difference among them, but some setae as m_2 on th. II, III, p_2 on abd. I–IV and p_1 on abd. V are larger than others, thus indicating the *communis*-type of chaetotaxy.

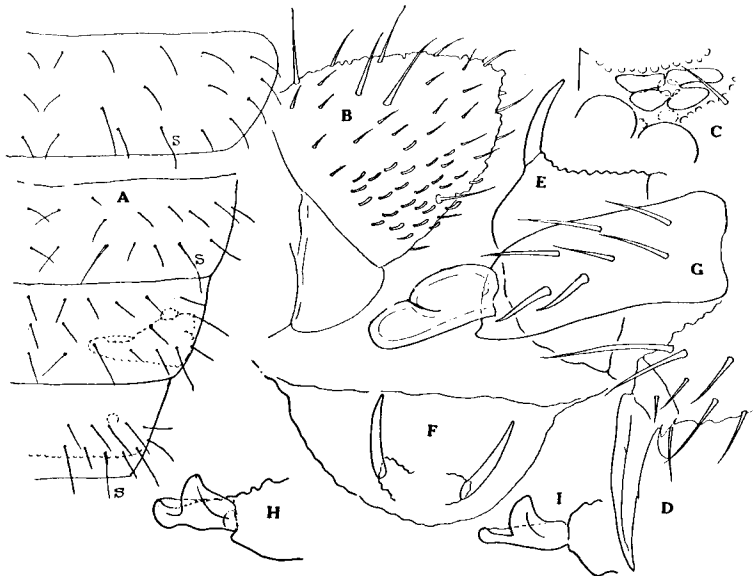


Fig. 12. *Ceratophysella maya* sp. n.

A. Chaetotaxy, B. Ant. IV (ventral), C. Postantennal organ, D. Hind claw, E, F. Anal spines, G. Dens and mucro, H, I. Mucro.

The species is characterised by feeble body setae and larger outer flap of the mucro. It is, therefore, comparable to *C. sigillata* UZEL of Europe. But the cited species has no peg-like setae upon ant. IV (cf. STACH 1949) and her chaetotaxy is *armata*-type (GISIN 1960, p. 44).

Genus *Cyclograna* YOSII 1961

12. *Cyclograna loricata* (YOSII)

Hypogastrura loricata; YOSII 1960

1 expl. Easton, New Hampshire, USA 27. VII 1948 E. W. BAKER et al-leg.

The species is unique having 3+3 horns upon head representing sd_1 , sd_4 and sd_5 .

13. *Cyclograna hiawatha* sp. n. Fig. 13

Typus : One male from Washington, DC. USA 18. XII 1948 F. BONET-leg.

Paratype : 21 expl. from the same lot.

8 expl. Blue Ridge, Virginia, USA 4. VI 1948 F. BONET-leg.

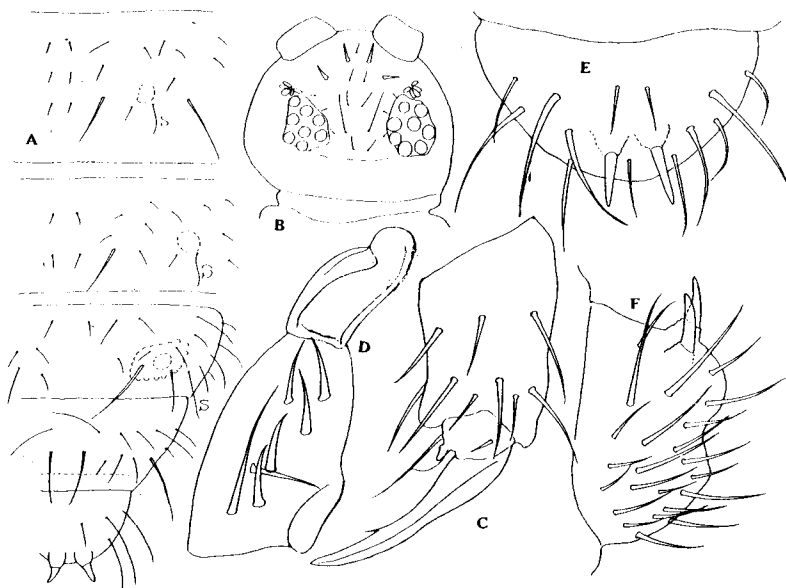


Fig. 13. *Cyclograna hiawatha* sp. n.

A. Chaetotaxy, B. Disposition of cephalic spines, C. Hind claw, D. Dens and mucro, E, F. Abd. VI.

Length ca. 1,0mm. Colour dark gray and strongly mottled. Segmental margins are pale. Ant. IV ventrally with numerous peg-like setae. Antennal eversible sac distinct. Head with 2+2 spines representing sd_4 and d_5 . Postantennal organ of *Cyclograna*-type. Eyes 8+8. Unguis rather slender compared with other species. One obscure inner tooth is either present or absent. No lateral tooth is observed in profile of the unguis. Unguiculus setaceous, reaching 1/2 of the unguis and with basal lamella rather membranaceous and flap-like. No tenent hair. Ventral tube with 4+4 setae. Furca normal. Dentes with 5 thick and 2 slender setae. Mucro apically rounded and with well developed outer lobe. Anal spines short and situated dorsally upon abd. VI. Chaetotaxy is slightly *plurichaetotic* upon abd. I-IV, while head, th. II, III and abd. V, VI are normal in chaetal arrangement. Usual setae are short and, therefore, not easy for chaetal studies. On th. II, III p_2 is larger than others and s. s. is at the position of p_4 . Chaetal arrangement of abdominal segments denotes the relationship of the present species to the *communis*-type of *Ceratophysella*, p_2 being larger than p_1 . Setae are in two rows upon abd. V. Location of Fovea is not determined, the segment being very warty. Integument is moderately granulated upon

head. Such granulated area lies in pairs upon abd. I-IV. Abd. V with finely granulated stripe posteriorly and $a=15$, $b=3-4$.

The new species is very near *C. horrida* YOSII 1960, having 2+2 cephalic horns representing sd_4 and d_5 . But these horns are more elongated than in the cited species. It is also characterised by shorter anal spines, feebly developed body setae and slender unguis. Chaetotaxically, *C. hiawatha* is plurichaetotic upon abd. I-IV, but not so upon abd. V and VI, while all segments are plurichaetotic in the cited species. (YOSII, 1960 p. 260, fig. 10).

14. *Cyclograna* (?) cf. *californica* (BACON) Fig. 14

BACON, 1912

6 expl. Barkeley, California, USA 1. XII 1921 C. ESSIG-leg.

Body length 1.3mm. Colour dark brown. Antennae and dorsal side is mottled with dark pigments. Antennae shorter than the head, with eversible sac between III and IV. Ant. IV ventrally with ca. 12 small peg-like setae surrounding a central seta. Postantennal organ not well investigated. Eyes 8+8, deeply pigmented. Legs granular ventrally upon trochanter, femur and distally upon tibiotarsus. Tenent hair not differentiated. Unguis stout, with one inner tooth distally from the middle. No lateral teeth is observed even in profile. Unguiculus setaceous, reaching the inner tooth and with rounded basal lamella. Ventral tube with 4+4 setae. Furca with well developed mucro, whose distal end is rounded



Fig. 14. *Cyclograna* cf. *californica* (BACON)

A. Chaetotaxy, B. p_1 , p_2 and p_3 (s.s.) of abd. V, in lateral view, C. Ventral view of ant. IV, D. Mid claw, E. Dens and mucro, F. Mucro, G. Abd. VI (lateral).

and highly involuted. Outer lobe triangular, flap-like and rather basally situated. Dens with 7 slender setae, one of which is longer than others. Anal spine slightly brownish, upon high papillae and strongly curved. Integument is granular upon head and on distal body segments. Abd. IV has a grobly granulated area on both sides of the body. Abd. V has a grobly granulated stripe and $a=18$, $b=2$ approximately. Chaetotaxy is rather curious for the genus. Setal arrangement of thoracal segments is irregular. The most common pattern is, as figured, alike to *Ceratophysella* and s.s. is at the position of p_3 , but there are some few cases in which additional 2 setae may arise asymmetrically and s.s. is then translocated to p_4 as usual for *Cyclograna*. These two setae are indicated by dotted line in fig. 13 A. Cephalic and abdominal setae are well developed and long. Their relative length indicates the *communis*-type of arrangement. Each setae are filiform, not much converging and suddenly ending. They show minute ciliation of the surface, thus contrasting definitely from spiniferous *seta sensualis*.

The above mentioned description, which is based on one slide determined by J. W. FOLSOM as *H. californicus*, differs considerably from the description and figure given by G. A. BACON 1914, who has mentioned "One long spine to each segment, except at the posterior end of the abdomen, where they are more numerous" and "Dentes bears six long hairs", but her Pl. V fig. 1 shows 8 dental setae. As the postantennal organ is not observed owing to the shrivelling of the example, and as th. II, III show chaetal abnormalities, the generic nature of the species is yet uncertain. BACON's fig. 9, 10 suggest, however, the *Cyclograna*-type of the postantennal organ.

Genus *Hypogastrura*

In my previous paper *Hypogastrura* is tentatively divided into some groups. Among them the *nivicola*-group is clearly separated from others by the chaetotaxy of head capsule, deserving to establish a subgenus within *Hypogastrura*. The name *Schoturus* MAC GILLIVRAY 1893, which has been regarded as junior synonym of *Hypogastrura* must be used for it. The subgenotype is *Schoturus nivicolus* FITCH 1847.

15. *Hypogastrura* (*Schoturus*) *harveyi* (FOLSOM) Fig. 15

Achorutes harveyi : FOLSOM 1902, 1916

1 expl. Arlington, Massachusetts, USA 10 expl. Col. Cath. 3. I 1898

All of them are etiquetted as *A. harveyi* by Prof. BONET. *Area verticalis* of the head is not divided from *area occipitalis* and is beset with only 1+1 setae. Distal end of dens is swollen ventrally as in case of *H. bengtssoni* in all materials examined. Ventral tube bears remarkably more than 10+10 setae in two rows. Ant. IV has ca. 12 sensory setae (subapical 2, outer 7 inner 2-1). Tibiotarsus has one large tenent hair (1_1) surpassing the unguis and distally swollen. Tibiotarsal chaetotaxy is alike to *Ceratophysella* in ground plan. h -row is 8, 8, 7 in number, h_8 being absent upon hind-legs. As h_2 and h_8 are considerably strong and distally clubbed to form "auxilliary" tenent hairs, exact number

of tenent hairs are 3,3,2. h_6 is also larger than others in all legs, but it is never clavate on apex.



Fig. 15. *Hypogastrura harveyi* (FOLSOM)

A, B, Tibiotarsal setae of fore-leg, from either sides, C, D, Ditto of hind legs, E, F, Setal arrangement of fore and other legs, diagrammatically disposed, G, Postantennal organ, H, Dens and mucro, I, Ventral tube.

16. *Hypogastrura* (s. str.) *packardi* (FOLSOM) Fig. 16

Achorutes packardi: FOLSOM 1902, 1916

5 expl. Havana, Illinois, USA 13. X 1948 F. BONET et H. B. MILLS-leg.

3 expl. Urbana, Illinois, USA 17. XI 1948 F. BONET-leg.

As they are heavily pigmented, my observation is restricted to following points: Ant. IV with an end bulb and 8-(9) curving sensory setae. Their arrangement is subapical 2, outer 3-(4), dorsal 1, inner 2 in two examples examined. Unguis untoothed, unguiculus short. A tenent hair is strongly elongated, far surpassing the unguis and apically swollen. Furcula well developed. Dentes dorsally smooth and with 7 slender setae, basal one of which is very long. Mucro is bidentate apically and with flat dorsal side. Chaetal arrangement is studied upon two distal segments. The larger setae, which is capitate on

apex and with rough serration is placed in a fixed order as p_1 on abd. V and VI. Other smaller setae as a-row of abd. V and VI are strongly serrated, but not capitate. s.s. of abd. V is a spiny p_2 , thus denoting the possible accommodation of the present species to the *reticulata*-Group (YOSII 1960, p. 271) of the genus. Upon tibiotarsus 1-row of setae are all normal in number and position. 1_1 is a tenent hair. h-row of setae are 8, 8, 7 and h_2 , h_3 are considerably stronger than others. As h_8 is missing upon hind-legs, they are deprived of one large seta compared to others.

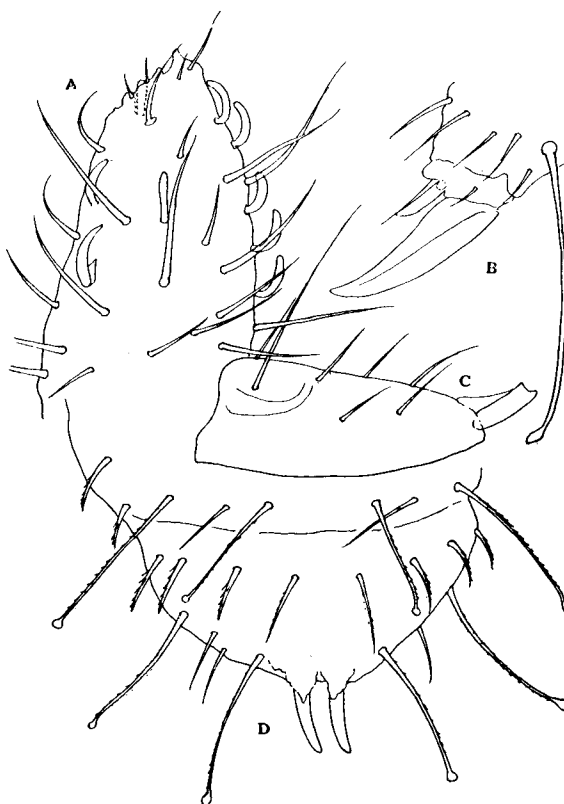


Fig. 16. *Hypogastrura packardi* (FOLSOM)
A. Ant. IV, B. Mid claw, C. Dens and mucro, D. Abdominal end.

17. *Hypogastrura* cf. *manubrialis* (TULLBERG)

Rich materials from Mexico and USA are in the collection. Ant. IV is provided with 8–11 (usually 9) sensory setae. Ant. I with or without p-seta Gisin's. Postantennal organ with 4–(6) peripheral lobes. Furca with 7 dental setae and its dorsal side is sometimes smooth and sometimes coarsely granulated. Anal spine always small.

It is difficult to decide for the moment, whether and how *H. matura* FOLS., *H. matura mexicana* HANDS. and *H. pannosa* MACNAM. may be separated.

18. *Hypogastrura* sp. A

1 expl. Cuesta de Acultingo, Vera Cruz, Mexico 16.I 1942 F. BONET-leg.

The species is near *H. trybomi* SCHÖTT 1898 from Siberia. But the mucro is simply converging and no lamellar edge is observed. Tibiotarsal setae are alike *Ceratophysella* in arrangement. Upon mid- and hind-legs, however, the median seta l_1 is dislocated to the posterior face and dorso-median ridge of the tibiotarsus is occupied by l_1' . Whether such dislocation is specific in nature is not certain.

19. *Hypogastrura viatica* (TULLBERG) Fig. 17A

10 expl. Leiden, Netherland XI 1944 T. v. HOGVEN-leg.

10 expl. Nijmegen, Netherland V. 1937 PLANT DIENST-leg.

Tibiotarsal chaetotaxy is somewhat complicated. Upon fore-legs, both l_1 and l_2 are converted to tenent hairs, while l_7 remains unchanged. l_3 and l_6 are larger than others. h-row is represented by 8. Upon mid-legs l_1, l_2 and l_7 represent 3 tenent hairs. l_2 often missing. h-row is normal. Hind-legs is alike to mid-legs, but h-row has 7 setae, h_8 being missing. Tenent hairs are thus 2, 3, 3 in number. These results are in good accordance with the figure given by JEANNENOT 1956 (fig. 8a, 8b, 9a, 9b).

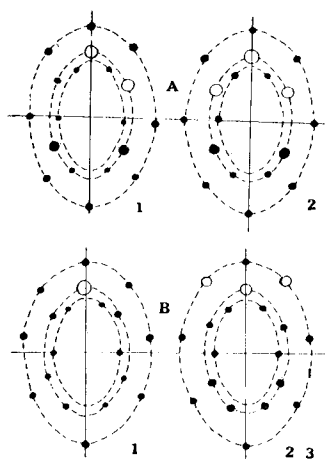


Fig. 17. Diagrammatic disposition of tibiotarsal setae in
A. *Hypogastrura viatica* (TULLBERG)
B. *Hypogastrura* sp. B.

20. *Hypogastrura* sp. B Fig. 17, B

6 expl. Cambridge, Massachusetts, USA 10. IX 1948 F. BONET-eg.

The species is near *H. purpurescens* LUB. but different in having 1, 3, 3 tenent hairs in stead of 2, 3, 3 of the cited species. From 6 examples in a slide, 5 of them are teratological with respect to the anal spines. It is strongly hypertrophic and with doubling of apex. Such case is already known in *H. purpurescens* as f. *simoneti* GISIN 1949 and its causal analysis is made by CASSAGNAU 1955. Hand in hand with the anal spines the abnormality

occurs upon unguiculus, whose setaceous shaft becomes shorter, until it does not surpasses the top of the inner lamella. Tibiotarsal setae are distributed in typical way. Upon fore-legs l_1 is converted to the tenent hair. Upon mid- and hind-legs not only l_1 but also h_2 and h_3 are tenent hairs, so that there are 1,3,3 tenent hairs in all.

Notes on *Hypogastrura guthriei* FOLSOM 1916

Prof. BONET's collection includes two slides containing 5 bleached and 6 untreated examples from Lake Pepin, Minnesota USA, 23.VIII 1899, which are seemingly paratypes of FOLSOM's description. Upon inspection it has become clear, that they are juvenile form of a *Ceratophysella* sp. having an eversible antennal sac. As other characters are not visible, no clear idea is acquired about the species.

ADDENDUM : Among the material examined a new species of peculiar *Isotomidae* is found:

Guthriella boneti sp. n. Fig. 18

Typus : One ♂ from Orizaba, Vera Cruz, Mexico 14.1 1942

Paratypus : Another 5 specimens from the same lot.

Body length 1.2mm. Colouration dorsally dark blue, paler ventrally. Antennae and other extremities are distally depicted. General shape hypogastrurid, but abdomen is posteriorly thicker and anus is terminally situated. antennae=head. Ant. ratio as 5:9:12:20. Ant. III-organ is a paired rod situated in a separate groove. Eyes 8+8, in a black eye patch. Postantennal organ somewhat elliptical, long axis is about 5 times the diameter of an eye. Its anterior margin has a slight notch at about the middle. Legs short. Tibiotarsus is distally crenulated pretending as if it is distally subsegmented.

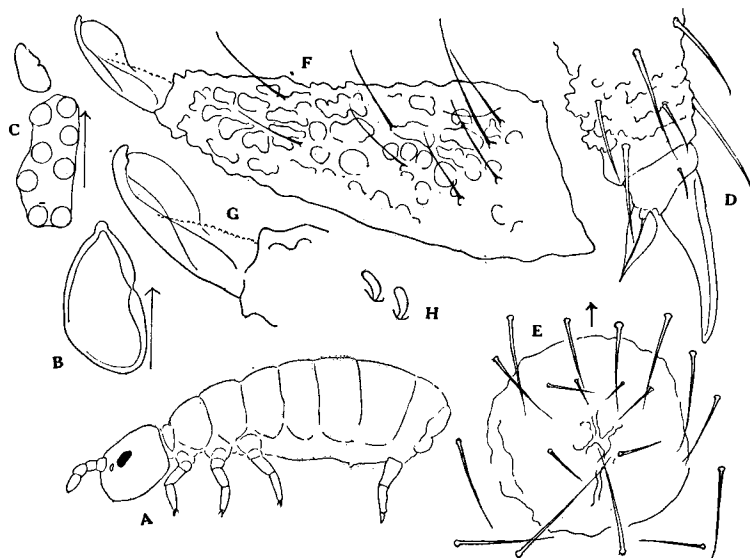


Fig. 18. *Guthriella boneti* sp. n.

A. Habitus, B. Postantennal organ, C. Eyes, D. Hind claw, E. Male genital orifice, F. Furca, G. Mucro, H. Ant. III-organ.

No tenent hair. Unguis broad, carinated and untoothed. Unguiculus with outer and broader inner lamella. Furcula not well developed. Dentes dorsally with 8-11 feeble scattered setae and the integument is roughly granulated in an irregular manner. No ventral dental setae present. De/Mu as 2,3. Mucro is spathulate or boat-form and slightly incurved. Apically it is ending in an upturned apex and there seems to exist a trace of an anteapical tooth quite near the apex. Both sides of mucro is broadly lamellate, but the inner lamella is more conspicuously broad and rounded on distal half. Rami tenaculi tridentate and corpus with one seta. Th. I is dorsally differentiated. It is pigmented and granular but no setae are observed upon it. All abdominal segments not ankylosed and abd. IV is the largest. Anal spine and the like is not present. Male genital field is surrounded by many setae, but the field itself has only 3+3 feeble setae on it. Body setae are extremely polychaetotic and no differentiation is observed among them. Integument is densely granular and each granules are pigmented as in the genus *Pseudachorutes* or *Odontella*. This is the fourth species of the genus *Guthriella*, separable from others by the peculiar form of mucro. As the genus is to be regarded one of the most archaic group of the Family *Isotomidae* its chaetal arrangement must be of great interest, if it is not polychaetotic.

Resumé

Tibiotarsal chaetotaxy is fixed in *Ceratophysella* and in *Cycograna*. In *Hypogastrura* the pattern is not different from it, but some of the setae are converted to "tenent hairs" in a specific manner. Ant. IV has 7 sensory setae in a fixed arrangement in *Ceratophysella*. In *Hypogastrura* their number and location is variable.

Granulation of the integument is often specific in *Ceratophysella*. Those of abd. V is the most important.

References

- BACON, G. A. 1912. Some Collembola of Laguna Beach. J. ent. Zool. **4** : 3 41-345.
- BAGNALL, R. S. 1934-1940. Notes on British Collembola. Entom. monthl. mag. **76** : 97-102, 163-174
- BONET, F. 1945. Nuevos Generos y Especies de *Hypogastruridos* de Mexico. Rev. Soc. Mexicana Hist. Nat. **6** : 13-45
- CASSAGNAU, P. 1959. Faune francaise des Collembolés IX. Vie et Milieu. **9** ; 476-503
- DENIS, J. R. 1924. Sur les Collembolés du Museum de Paris I. Ann. Soc. ent. Fr. **93** : 211-260
-1936. Report on Collembola, Yale North India Exped. Mem. Conn. Acad. Art Sci. **10** : 261-282.
- FOLSOM, J. W. 1902. The Identity of the Snow Flea. Psyche. **9** : 315-321.
-1916. North American Collembolous Insects of the Subfamily *Achorutinae*, *Neanurinae* and *Podurinae*. Proc. U. S. Nat. Mus. **50** : 477-525
- GISEN, H. 1946. Collembolés nouveaux ou peu connus de la Suisse. Mitt. schweiz. Entom. Ges. **20** : 218-224

-1958 Collemboles récoltés par M. Bassot a Madère. Vie et Milieu 8 : 473-478
-1960 Collembolesfauna Europas. Genf, 312 pp.
- JEANNENOT, F. 1956 *Neogastrura viatica* Tullberg. Trav. Lab. Zool. Dijon 1956 No. 18.
- RAPOPORT, E. H. 1958. Collemboles de Bahia Blanca. Rev. Soc. Entom. Argentina 21 : 29-37
- STACH, J. 1949 The Apterygotan Fauna of Poland : *Neogastruridae* et al. Polska Akad. Umiej. 341 pp.
- WRAY, D. L. 1946. New Collembola from North Carolina. Bull. Brooklyn Ent. Soc. 41 : 79-85
- YOSH, R. 1956 Monographie zur Höhlencollemboles Japans. Contr. Biol. Lab. Kyoto Univ. no. 3, 109 pp.
-1960 Studies on the Collemboles Genus *Hypogastrura*. Amer. Midland Nat. 64 : 257-281.
-1961 Further Remarks on the Collemboles Genus *Hypogastrura*. Amer. Midland Nat. 66 : 250-251