CAVE *PSEUDOSINELLA* AND *ONCOPODURA* NEW TO SCIENCE

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Nine new species and two new subspecies of the genus Pseudosinella are described from caves in Indiana, Kentucky, North Carolina and Virginia. Three new species of the genus Oncopodura are described from caves in Oregon, Texas and Virginia. The Virginia species is the first cave species of the latter genus to be found east of western Illinois.

In connection with our updating of *The Collembola of North America* we have uncovered a considerable number of undescribed species of cave Collembola. Some of these, of the genera *Arrhopalites*, *Oncopodura*, and *Pseudosinella*, are so striking and clear cut that we feel it best to describe and name them before producing part II of the update. In this paper we describe nine new species of the genera *Pseudosinella* and *Oncopodura*. In a subsequent paper we shall describe the members of the genus *Arrhopalites*. The species described herein and the regions they are found in are given to the right.

First we describe several species of the genus *Pseudosinella*, which has been the subject of many studies in this country and elsewhere and whose phylogeny and classification are reasonably well understood (Christiansen, da Gama & Bellinger, 1983; da Gama, 1984). We take this opportunity to describe those for which satisfactory material is available, and to give tabular summary of these as well as other species that cannot be described at present because adequate material is not available (see Table 1). Data on these species will be entered into the BUGS DELTA program available through Grinnell College, which may be used to identify species of the genus (Christiansen, Bellinger & da Gama, 1990). Table 2 gives the character states of the new species fitting the different features discussed in the above paper.

Genus	***species***	**Region**
Pseudosinella	*bona*	Virginia
Pseudosinella	*erehwon*	Virginia
Pseudosinella	*extra*	Virginia
Pseudosinella	*espanita*	Kentucky [Tennessee?]
Pseudosinella	*flatua*	North Carolina
Pseudosinella	*fonsa*	Indiana, Ohio
Pseudosinella	*granda*	Virginia
Pseudosinella	*vespera*	North Carolina
Oncopodura	*fenestra*	Texas
Oncopodura	*hubbardi*	Virginia
Oncopodura	*mala*	Oregon [California?]

In addition to characters previously used to distinguish members of this genus, we call attention to the sense organ of the apex of the third antenna segment, whose structure is essentially similar to that described by Chen and Christiansen,

Table 1. New and Undescribed Species of Cave Pseudosinella.

species	Eyes per side	Cephalic macrochaetae R0	R1	R2	R3	S	T	Labial triangle setae	Thoracic macrochaetae II	III	Abd.II chaetotaxy					Abdomen IV macrochaetae P1	M	Tenent hair	Unguis teeth	Macrichaetae along each side of labial groove s=smooth c=ciliate	Localities
bona	1-2vg	2	+	+	-	-	-	M_1 (M_1) M_2 r E L_1 L_2	0	0	p	a	B	q_1	q_2	0	2	ac	3	0s 4c	Washington & Roanoke Co. Virginia
erehwon	0	+	+	+	-	-	-	M_1 M_2 r E L_1 L_2	2	1	p	a	B	q_1	q_2	0	2	cl-ac	3	0s 4c	Scott Co. Virginia
espanita	0	+	+	+	-	+	+	M_1 M_2 vg E L_1 L_2	3	2	p(-)	a	B	q_1	q_2	1	2	ac	3	0s 6-8c	Edmonson Co. Kentucky
extra	0	+	+	+	+	-	-	M_1 M_2 r E L_1 L_2	2	1	p	a	B	q_1	q_2	0	2	ac	3	0s 4c	Scott Co. Virginia
flatua	0	+	+	+	-	-	-	m_1 (m_1) M_2 r E L_1 L_2	0	0	p	a	B	q_1	q_2	0	2	ac	3	3s 1c	Swain Co. North Carolina
fonsa	3-4 (2?)	+	+	+	-	-	-	(M_{1s}) M_1 M_2 r E L_1 L_2	0	0	p	a	B	q_1	q_2	0	2	cl	3	0s 3-4c	Clark, Jennings & Harrison Co. Indiana, Adams Co. Ohio
granda	0	2	+	+	-	-	-	M_1 M_2 0 E L_1 L_2	0	0	p	a	B	q_1	q_2	0	2	ac	3	0s 4c	Augusta Co. Virginia
vespera	0	+	+	+	+	-	-	M_1 M_2 0 E L_1 L_2	3	2	-	a	B	q_1	q_2	0	2	ac	3	0s 4c	Swain & Rutherford Co. North Carolima
AB	0	?	?	?	?	-	-	M_1 M_2 r E L_1 L_2	0	0	p	a	B?	q_1	q_2	0	3	ac	3	0s 3c	Adair Co. Oklahoma
AC	3	+	+	+	-	-	-	M_{1s} M_1 M_2 r E L_1 L_2	0	0	?	?	?	?	?	0	2	ac	3	1s 3c	Hamilton Co. Tennessee
AD	0	+	+	+	-	+	+	M_1 M_2 0 E L_1 L_2	1	0	-?	a	B	q_1	?	1	2	cl	3	0s 3c	Medina Co. Texas
AE	3	+	+	+	-	-	-	M_1 M_2 r E L_1 L_2	0	0	p	a	B	q_1	q_2	0	2	cl	3	0s 4c	Scott Co. Virginia
AF	0	+	+	+	+	+	-	M_1 M_2 r E L_1 L_2	3	2	?	?	B	?	?	0	2	ac	2	0s 4c	Lee Co. Virginia
AG	0	+	+	+	-	-	-	M_1 M_2 vg E L_1 L_2	0	0	p	a	B	q_1	q_2	0	2	acv	3	0s 4c	Highland Co. Virginia

Table 2. Character States for BUGS DELTA Program for New Species of Cave Pseudosinella.

character state	bona	vespera	flatua	espanita	extra	fonsa	erehwon	granda	character state	bona	vespera	flatua	espanita	extra	fonsa	erehwon	granda
1	1	1	1	2	1	1	1	1	21	1	1	1	1	1	1/2	1/2/3	1
2	1	1	1	2	1	1	1	1	22	2	2	2	2	2	2	2	2
3	3/4	3	1/2	4	3	4	4	4	23	1	2	2	2	2	1-2	2	2
4	3	3	3	3	3	5	3	4	24	1	1	1	4	1	1	1	1
5	2	5	1	2	2	4	2	5	25	1	1	1	1	1	1	1	1
6	3	3	3	3	3	4	3	4	26	1-2	0	0	0	0	2-4	0	0
7	3	3	3	3	3	4	3	4	27	2	2	2	2/3	2	2	2	2
8	3	3	3	3	3	4	3	4	28	4-7	2	5-9	2	2	8/9	2	3-5
9	1	1	2	2	2	2	2	2	29	1	1	1	1	1	1	1	1
10	4	4	4	4	2	4	4	4	30	2	2	2	2	2	2	2	2
11	2	1	2	2	2	2	2	2	31	1	1	1	1	1	1	1	1
12	1	1	1	1	1	1	1	1	32	2	2	2-3	2-3	1	3	1/2	2
13	1	1	1	2	1	1	1	1	33	2.7	2.4	3.0	1.8	1.5	2.8	1.2	1.6
14	4	2	4	2	-	4	-	4	34	52-58	32-43	56-60	20-26	40-47	60-68	65-72	67-74
15	0	3	0	2/3	2	0	2	0	35	1.5-1.8	1.5-1.9	1.7-2.4	1.3-1.7	1.4-1.5	1.9-2.2	1.5	1.5-1.8
16	3	2	3	2	-	3	-	3	36	2	2	2	3	3	2	3	2
17	0	2	0	2/3	1	0	1	0	37	2	2	2	2	2	2	2	2
18	1	1	1	2	1	1	1	1	38	2	2	2	2	2	2	2	2
19	2	2	2	2	2	2	2	2	39	2	2	2	2	2	2	2	2
20	2	1	2	1	2	2	2	2	40	1	2	1	1	2	1	1	1

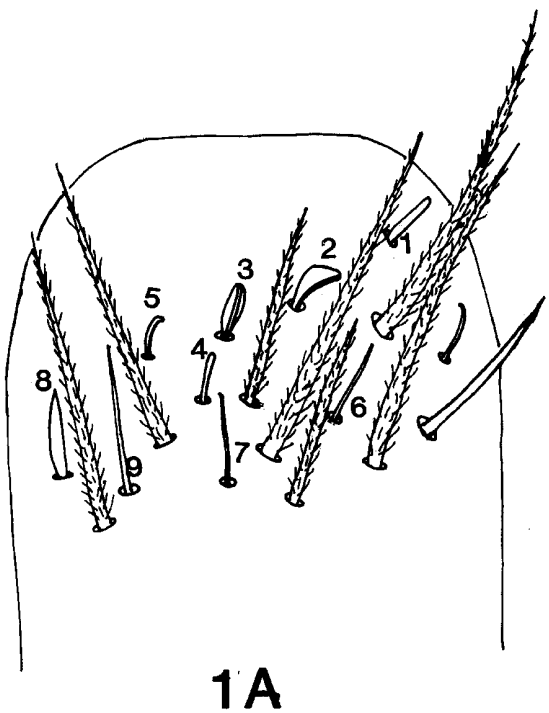


Figure 1A. Semidiagrammatic illustration of typical 3rd antennal segment apical setae.

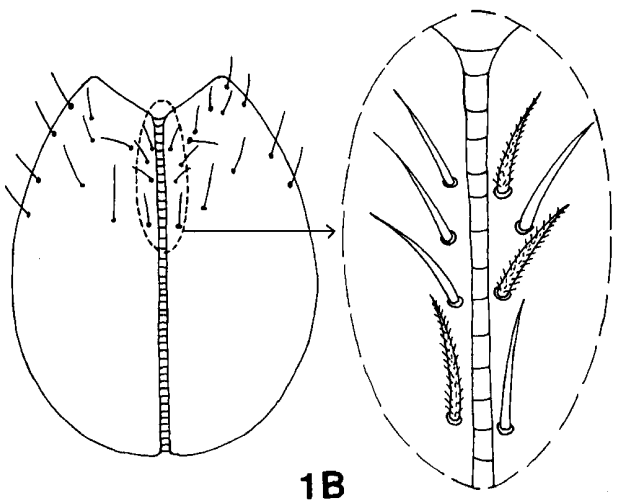


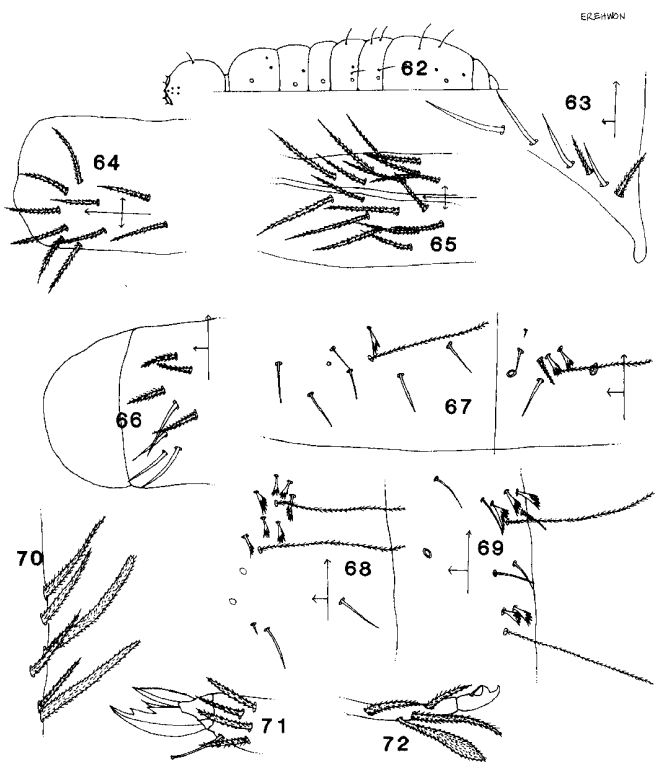
Figure 1B. Semidiagrammatic illustration of macrochaetae along ventral groove of head. Right side formula 3s1c, left side formula 2s2c.

1993, in *Sinella*. Figure 1A shows the characteristic setae of this organ and the numbering used in the species descriptions. We also have applied to this genus a characteristic used by Mari-Mutt (1986) in the genus *Lepidocyrtus*. This is the macrochaetae directly along the sides of the ventral groove of the labium from the base of the ventral triangle to the posteri-

or margin of the head. These setae are normally limited to the anterior 2/3 of the groove and are either smooth (i.e., probably with very closely appressed ciliations) or clearly ciliate (see Fig. 1B). The numbers of setae demonstrating the two different conditions is shown in the formulae (i.e. 3s 1c means three smooth and one cilaite per side).

Pseudosinella erehwon sp. nov. (Figs. 62-72)
Description: White without eyes or trace of pigment. Maximum length, omitting appendages, 1.2 mm.

Antennae 1.48-1.5 times as long as cephalic diagonal and lacking apical bulb. Antennal segment ratios 1/1.8/1.2-1.6/2.1-2.3. Subapical organ rod-like or with a small apical swelling. Lenticular organs absent or weakly developed between the third and fourth and second and third segments. Third antennal apical setae not seen clearly but setae 8 and 9 as well as a series of additional not numbered setae appear to be blunt or acuminate, curved and slightly basally enlarged. Prelabral setae 4-5-5-4; all smooth. Labial palp with three sublobal hairs. Labial triangle with seta M1 and r ciliate; remainder smooth; seta M1 distinctly shorter than M2 and seta r about half as long as M2. With 4+4 ciliate, marginal macrochaetae along anterior end of labial ventral groove. Second abdominal segment with P seta relatively long but not clearly ciliate. Fourth abdominal segment with anterior bothriotrichal complex having a supplementary seta. Trochanteral organ with 4-5 setae in arms and one external seta. Ventral tube with 9+9 to 10+10 large ciliate setae on anterior face and 10-12 on the posterior face; distolateral patches with 8-9 setae, anterior 4 ciliate and remainder smooth. Hind tibiotarsus with clearly differentiated inner large seta, only slightly longer than other large setae but cylindrical and apically blunt or truncate, situated 0.32-0.42 distance from base to apex of tibiotarsus. Unguis with 3 clear teeth; basal pair moderately large with one only slightly larger than other; distal tooth prominent and 0.65-0.71 distance from base of apex of inner unguis. Unguiculus acuminate with outer margin very finely serrate. Tenent hairs generally weakly clavate and apically curved but sometimes truncate or even acuminate. Manubrial plaque with 2 inner and 2 outer setae. Uncrenulate dens 3-3.3 times as long as mucro. Mucronal teeth subequal with basal spine slightly exceeding apex of sub apical tooth.



Figures 62-72 of Pseudosinella erehwon. All figures of type specimens. 62. Semidiagrammatic illustration of dorsal macrochaetae and pseudopores (hollow circles). 63. Setae of labial triangle, right side. 64. Posterior face of ventral tube. 65. Anterior face of ventral tube. 66. Right distolateral patch of ventral tube. 67. Second abdominal segment chaetotaxy, left side. 68. Outer bothriotrichal complex third abdominal segment, left side. 69. Bothriotrichal complex of fourth abdominal segment, left side. 70. Outstanding seta and neighboring setae of hind tibiotarsus. 71. Hind foot complex. 72. Mucro and distal end of dens.

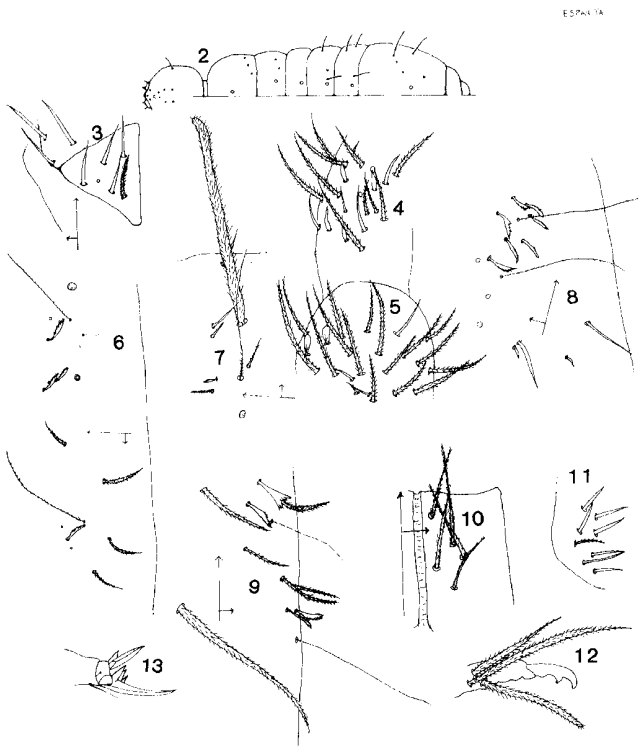
Holotype female and 9 paratypes: Canyon to Nowhere Cave, Scott Co., Virginia, 18 April & 23 May 1995, D. Hubbard Coll. (locality nos. 7819 & 7838).

Derivatio nominis: named after type locality cave.

Remarks: This unusual species has no S or T setae on the cephalic dorsum but 2 & 1 macrochaetae on the second and third thoracic segments. It shares these unusual features with only one species: the North African and European *Pseudosinella helenae* (Arbea & Jordana, 1990). It differs strikingly from this species in ungual structure (3 versus 4 inner teeth) and labial chaetotaxy (most setae smooth as opposed to all save r being ciliate in *helenae*). There are other minor differences as well. It is probably part of the *orba-vita* group of species.

Pseudosinella espanita sp. nov. (Figs. 2-13)
Description: Eyes and pigment absent. Maximum length, excluding appendages, 1.8 mm. Antennae 1.3-1.7 times as long as cephalic diagonal, without apical bulb; Antennal segment rations as: 1/1.3-2.0/1.1-1.3/2.3-3.0. Subapical sense organ a rod with a very small apical bulb. Lenticular organs weakly developed between third and fourth antennal segment, or absent. Third antennal segment apical sense organ with seta 1 unclear but apparently a minute rod; setae 2 & 3 large, flattened, and broadly oval; 4 short, swollen, and acuminate; 5 very small and acuminate; 8 slender and blunt. Second antennal segment with apical organ similar to that of third, lacking differentiated seta 1 but with 2 & 3 as in segment 3; ventral

surface with a number of differentiated setae, some medially thickened and acuminate, similar to seta 4 on the third segment. Prelabral setae 4-5-5-4; posterior row ciliate, remainder smooth. Dorsal lateral P setae absent. Labial palp with 3 sublobal hairs. Labial triangle with M^1 seta large and ciliate; R varying from minute and smooth to (rarely) absent. With 6+6 ciliate marginal macrochaetae along anterior end of labial ventral groove. The second abdominal segment P seta present and finely ciliate to smooth, and seta q2 finely ciliate. The fourth abdominal anterior bothriotricha complex lacking supplementary seta; median anterior P seta of this segment smaller and more posterior than normal. Trochanteral organ with 5-7 setae in dorsal arm and 4-5 in ventral one; no internal and 1 external seta. Ventral tube with 5+5 to 8+8 large ciliated setae on anterior face; distolateral patches with 7-10 setae, one or two finely ciliate, remainder smooth; posterior face with 4 large setae and 0-2 finely ciliate mesochaetae. Posterior leg with clear large clavate to truncate inner seta at 0.30-0.38 distance from base to apex of tibiotarsus. Unguis with 2 clear basal teeth and a third tooth so close to these as to be easily overlooked. Unguiculus acuminate with strong outer tooth. Manubrial plaque with 2-3 inner and 2 outer setae. Mucro with apical tooth twice as large as median, and without basal spine. Uncrenulate dens 2.5-3 times as long as mucro.



Figures 2-13 all of Pseudosinella espanita. All specimens from Mammoth Cave, Kentucky. 2. Semidiagrammatic illustration of dorsal macrochaetae and pseudopores (hollow circles). 3. Labial triangle setae. 4. Setae of venter of basal portion of third antennal segment. 5. Setae of dorsum of apical portion of second antennal segment, same specimen, but other antenna. 6. Second abdominal segment chaetotaxy of left side. 7. Detail of inner setae of second abdominal segment of different specimen. 8. Third abdominal segment, left side, outer bothriotrichal complex. 9. Lateral bothriotrichal complex, fourth abdominal segment, right side. 10. Left side of anterior face of ventral tube. 11. Distolateral setae of ventral tube. 12. Mucro and apex of dens. 13. Fore foot complex.

Holotype: female, Mammoth Cave National Park, Edmonson, Co., Kentucky, Styx River near Charon's Cascade, 4 August, 1979, E.A. Lisowski, Coll. (locality no. 4222). Paratypes: 4 females, all taken from Mammoth Cave on different dates (locality nos. 1112, 4223, 4225 & 5563).

Derivatio nominis: after the similarity between this species and *Pseudosinella espana*.

Remarks: This remarkable species is very similar to *P. espana*, found in caves in Arkansas and Missouri, but shows little relationship to any other species. The large wing tooth on the unguiculus and the absence of a basal spine on the mucro form a unique combination. In some respects these species are similar to the halophile European species *P. halophila* (Bagnal, 1939); however no specimens or recent redescriptions of this were available for comparison. *Pseudosinella anderseni* (Gisin, 1967), *petterseni* (Boerner, 1901), and the nearctic species *certa* (Christiansen & Bellinger, 1981), *rolfsi* (Mills, 1932), *sera* (Christiansen & Bellinger, 1981), and *violenta* (Folsom, 1924) all lack eyes and have ungual and unguicular wing teeth, but all have well developed basal spines on the mucro. Most differ from espanita in many other features as well.

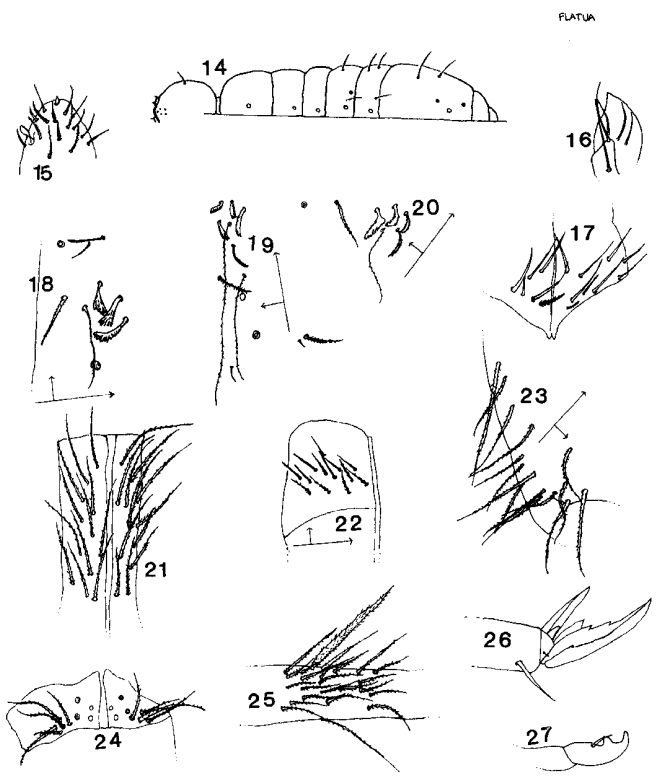
There is some variation in the posterior thoracic macrochaetae. Most of the specimens have them as shown in Table 1; however, at least one specimen has 2 on segment 2 and another has 3 on segment 3. This species is the one we list under *P. espana* in *Collembola of North America* as Edmonson, Co.(?), but examination of additional Kentucky material shows clear differences, as shown in the table below:

Feature	***espanita***	***espana***
2nd abdominal segment seta Q1	microseta	macrochaeta
Expanded apical ant.2 setae	+	-
Cephalic macrochaeta S	+	-*
Lateral posterior macrochaetae on dorsum of head	-	+

* Erroneously indicated present in CONANRG. Two single specimens taken from caves in Montgomery, Co., Tennessee, are in such poor condition that they cannot be placed with certainty. They may be *espanita* or a closely related species.

Pseudosinella flatua sp. nov. (Figs. 14-27)

Description: Eyes and pigment absent. Maximum length,



Figures 14-27 all of Pseudosinella flatua. All figures of type specimens. 14. Semidiagrammatic illustration of dorsal macrochaetae and pseudopores (hollow circles). 15. Apex of fourth antennal segment. 16. Labial palp. 17. Labial triangle setae. 18. Inner bothriotrichal complex of second abdominal segment, left side. 19. Third abdominal segment, left side, outer bothriotrichal complex. 20. Fourth abdominal segment left side, anterior bothriotrichal complex. 21. Ventral tube, anterior face. 22. Ventral tube, right side, distolateral patch. 23. Posterior face of ventral tube. 24. Manubrial plaque. 25. Median portion of hind tibiotarsus showing differentiated seta. 26. Fore foot complex. 27. Mucro and end of dens.

excluding appendages, 3 mm. Antennae 1.9-2.5 times cephalic diagonal, without apical bulb, but several small pegs are present and one of these may be apical. Antennal segment ratios as: 1/2.3-2.7/2.2-3.1/3.9-4.0. Subapical sense organ a rod bearing oval apical swelling. Lenticular organs clear between both third and fourth and second and third antennal segments. Third antennal segment apical sense organ with seta 1 minute and blunt, 2 & 3 slightly swollen, 4 & 5 slender, short, and peglike; 7 filament-like and 8 more or less medially swollen and acuminate. Pre-labral setae 4-5-5-4, all smooth. Dorsal lateral P setae absent. Labial palp with 3 sublobal hairs. Labial triangle with M^1 seta 1/3-2/3 as long as M^2, usually ciliate but sometimes smooth. With anterior 3+3 smooth and posterior 1+1 usually ciliate, marginal macrochaetae along anterior end of labial ventral groove. The second abdominal segment has a P seta that is unusually large and ciliate; seta q2 cannot be seen clearly on any specimen and may be absent. The fourth abdominal segment with supplementary seta in anterior lateral bothriotricha complex. Trochanteral organ with 9-11 unusually large setae in each arm, 12-16 internal and 1-3 external setae. Ventral tube with 11+11 to 13+13 large ciliated setae on anterior face; distolateral patches with 11-13 setae, about half finely ciliate, remainder smooth; posterior face with about 14 large to medium finely ciliate setae. Posterior leg with clear acuminate large inner seta, at 0.32-0.35 distance from base to apex of tibiotarsus. Unguis with 3 clear teeth, distalmost 0.56-0.60 from base to apex. Unguiculus acuminate without trace of outer tooth. Manubrial plaque with 2 inner and 5-9 outer setae. Mucro with apical tooth only slightly larger than median and with clear basal spine whose apex excess tip of median tooth. Uncrenulate dens 2-2 1/2 times as long as mucro.

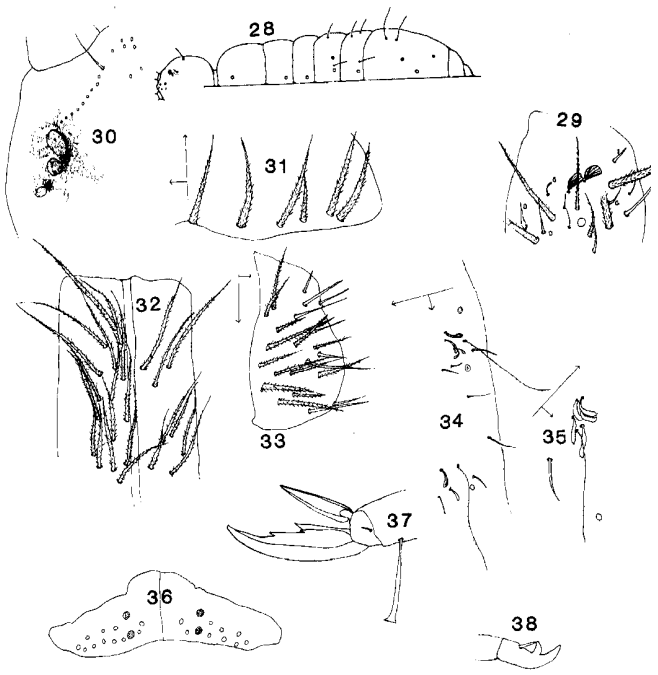
Holotype: female and 6 paratypes, Swain Co., North Carolina, Blowing Springs Cave, 18 & 22 March, 1979 (locality nos. 3985 & 3986), S. Platania & D. Ballard colls.

Derivatio nominis: from the Latin flatus, meaning blowing, after the type locality, Blowing Springs Cave.

Remarks: This species shows unusual variability in the M^1 seta of the labial triangle. The species is distinguished from the inadequately described species *maritima* (Bagnall, 1941), by the acuminate outstanding hind tibiotarsal seta. It differs from *styriaca* (Neuherz & Nosek, 1975), in lacking posterior thoracic macrochaetae. The entirely inadequately described *aggtelekiensis* (Stach, 1929) and *inaequalis* (Bagnall, 1941), cannot be distinguished from *flatua* by their original description; however, the conspecificity of troglobites on two different continents seems unlikely, and if the figure of the foot in Loksa (1961) really belongs to Stach's species, it is not at all similar. The remarkable large ciliate P seta on the second abdominal segment serves to separate this species form all Nearctic members of the genus. *Pseudosinella vespera* is also found in the type locality cave.

Pseudosinella fonsa sp. nov. (Figs. 28-38)

Description: Eyes 3-4 per side (possibly only 2 in one case), on loose eye patches. Pigment of blue granules scattered over head and body, with small darker clusters on head. Maximum length excluding appendages 2.8 mm. Antennae 1.2-1.9 times cephalic diagonal, without apical bulb; antennal segment ratios as: 2.1-2.6/2.3-2.9/3.2-4.0. Subapical sense organ peg-like with slight apical swelling. Lenticular organs weakly developed between third and fourth antennal segments, or absent. Third antennal segment apical sense organ with seta 1 small and peglike, setae 2 & 3 with slender central rod and thin oval expansion; 4 & 5 short rods; 6, 7 & 9 slender and 8 similar to these but slightly thicker. Pre-labral setae 4-5-5-4, with posterior row ciliate, others smooth. Lateral P setae absent. Labial palp with three sublobal hairs. Labial triangle with all setae ciliate, most specimens having supplementary



Figures 28-38 all of Pseudosinella fonsa. All figures of type specimens. 28. Semidiagrammatic illustration of dorsal macrochaetae and pseudopores (hollow circles). 29. Apical organ of right third antennal segment, seen from side. 30. Left eye patch. 31. Basal labial triangle setae of right side. 32. Anterior face of ventral tube. 33. Left distolateral patch of ventral tube. 34. Second abdominal segment chaetotaxy of left side. 35. Anterior bothriotrichal complex of fourth abdominal segment. 36. Manubrial plaque. 37. Hind foot complex. 38. Mucro and apex of dens.

M^1 seta about 2/3 as long as normal seta; R seta large, about half as long as M setae. With 3+3-4+4 ciliate, marginal macrochaetae along anterior end of labial ventral groove. Second abdominal segment P seta relatively large. Fourth abdominal segment anterior bothriotricha complex with supplementary seta. Trochanteral organ with 9-10 setae in each arm and numerous (>12) internal setae. Ventral tube with 11+11 to 15+15 large ciliate setae on anterior face; distolateral patches with 15-21 setae, 5-13 ciliate and remainder smooth. Posterior leg with one large inner acuminate ciliate seta, only slightly distinguished from other inner setae, at 0.31-0.39 distance from base to apex of tibiotarsus. Unguis with 3 clear inner teeth, distalmost one 0.60-0.68 from base of apex. Unguiculus without outer tooth. Manubrial plaque with 2 inner and 8-9 outer setae. Mucro with apical tooth about 2X median and with basal spine whose apex just reaches tip of median tooth. Uncrenulate dens 2 times as long as mucro.

Holotype: female and two paratype females, Peyton Spring Cave, Clark Co., Indiana, 19 August 1977, J. Lewis coll. (locality no. 3762).

Additional records: Indiana: Spring Cave, Clark Co., 11 June 1977, J. Lewis coll. (locality no. 3757); Rat Cave, Harrison Co., 20 July 1975, J. Lewis coll. (locality no. 3652); Dryden Sinks Cave, Jennings Co., 30 July 1994, J. Lewis coll. (locality no. 7747); and (?) Patton Cave, Monroe Co., 29 October 1992, H. Hobbs coll. (locality no. 7606). Ohio: Morrison's Cave, Adams Co., 2 July 1980, H. Hobbs coll. (locality no. 4618).

Derivatio nominis: from the Latin from, meaning fountain or spring, after the type locality, Peyton Spring Cave.

Remarks: The variable eye number in this cave species distinguishes it from all similar nearctic forms. The actual number of eyes is difficult to distinguish as the corneae appear to be much reduced. The single specimen from Spring Cave appears to have an asymmetrical single macrochaeta base in the center of the head. The third antennal segment sense organ is difficult to make out in Indiana specimens, but they appear to be rodlike and are definitely slightly swollen rods in the Ohio specimens. The species is very similar to *P. aera*, but the different labial and cephalic chaetotaxy as well as the difference in typical eye number serve to separate the two species. *P. fonsa* differs from *staryi* (Rusek, 1981) and *tridentifera* (Rusek, 1971) in the presence of setae M^2 and well developed R in the labial triangle. If differs from the former in several features of the second abdominal segment chaetotaxy, and from the latter in the eye distribution and ungual structure as well. It differs from *rapoporti* (de Izarra, 1965) in the absence of an apical antennal bulb, and from *stachi* (Christiansen et al., 1983) and *inaequalis* (Starch, 1960 nec Bagnall) in the eye distribution and much larger antenna/C.D. ratio (1.9-2.2 as opposed to about 1.5). The single specimen from Monroe Co. is immature; it appears to have 5+5 eyes and may represent a different species.

Pseudosinella granda sp. nov. (Figs. 39-50)

Description: Without eyes or trace of pigment. Maximum length, excluding appendages, 1.6 mm. Antennae 1.5-1.8 times cephalic diagonal, without apical end bulb. Antennal segment ratios as: 1/2.0-2.2/1.6-2.1/2.9-3.4. Subapical sense organ small and difficult to see, but apparently short, broad, and apically expanded. Lenticular organs weakly developed between second and third and third and fourth antennal segments. Apical organ of third antennal segment with seta 1 small and peglike; setae 2 & 3 with curved thickening along one margin and an ovoid, flattened blade; setae 4-8 cylindrical, slender, and blunt, with seta 8 distinctly thicker than others; seta 9 unclear but apparently short and thick and close to seta 7. Prelabral setae 4-5-5-4 with a basalmost row ciliate and others smooth. Labial palp with 3 (rarely 4) sublobal hairs. Labial triangle setae are ciliate macrochaetae with 4+4 ciliate marginal macrochaetae along labial ventral groove margin. Second abdominal segment sometimes with only two microsetae anterior to inner bothriothrix. Fourth abdominal segment anterior bothriotrichal complex with supplementary seta present. Throchanteral organ with 5-6 setae in each arm, 1-2 inner

Figures 39-50 all of Pseudosinella granda. All figures of type specimens. 39. Semidiagrammatic illustration of dorsal macrochaetae and pseudopores (hollow circles). 40. Macrochaetae at base of left antenna and R setae of cephalic dorsum. 41. Maxillary palp, left side. 42. Apical setae of third antennal segment, right side, seen from side. 43. Labial triangle setae, left side seen from below. 44. Second abdominal segment chaetotaxy, left side seta shown by dotted lines present in other specimens. 45. Manubrial plaque, right side. 46. Ventral tube setae, anterior face, seen from an angle. 47. Bothriotrichal complex of fourth abdominal segment, left side. 48. Hind foot complex. 49. Ventral tube, distolateral patch, left side. 50. Mucro and apex of dens.

setae, and 2-3 external setae. Ventral tube with 6+6 to 7+7 large ciliate setae on the anterior face, the 3+3 along the distal part of the ventral groove being distinctly heavier than the others; distolateral patches each with 8-9 large setae, 4 or 5 anterior ones ciliate and the others smooth, sometimes with one additional vestigial microseta; posterior face with 13 large ciliate setae of varying sizes, 7 along distal margin. Hind tibiotarsus with outstanding seta acuminate and weakly distinguished from other inner setae, 0.25-0.28 distance from base to apex of tibiotarsus. Unguis with 3 clear teeth, one basal clearly larger than the other; apical tooth 0.67-0.74 distance from base to apex of inner unguis. Unguiculus acuminate with smooth outer margin. Manubrial plaque with 2 inner and 3-5 outer setae. Uncrenulate part of dens 2.5-2.8 times as long as mucro. Basal mucronal spine slightly exceeding apex of anteapical tooth, which is 7/8 as long as apical tooth.

Holotype: female and four paratypes: Grand Caverns, Augusta Co., Virginia, 17 November 1994, D. Hubbard coll. (locality no. 7769).

Additional record: type locality, 6 December 1974, J. Holsinger coll. (Collection no. 3720).

Derivatio nominis: after the type locality, Grand Caverns.

Remarks: The cephalic macrochaetae are unusual: in the position where R^0 would normally be there is a pair of small macrochaetae, which we interpret as a doubled R^0 since the R^1 and R^2 setae are in their normal positions. This species is similar to *P. certa* from West Virginia, but the foot complex is strikingly different.

Pseudosinella vespera sp. nov. (Figs. 51-61)

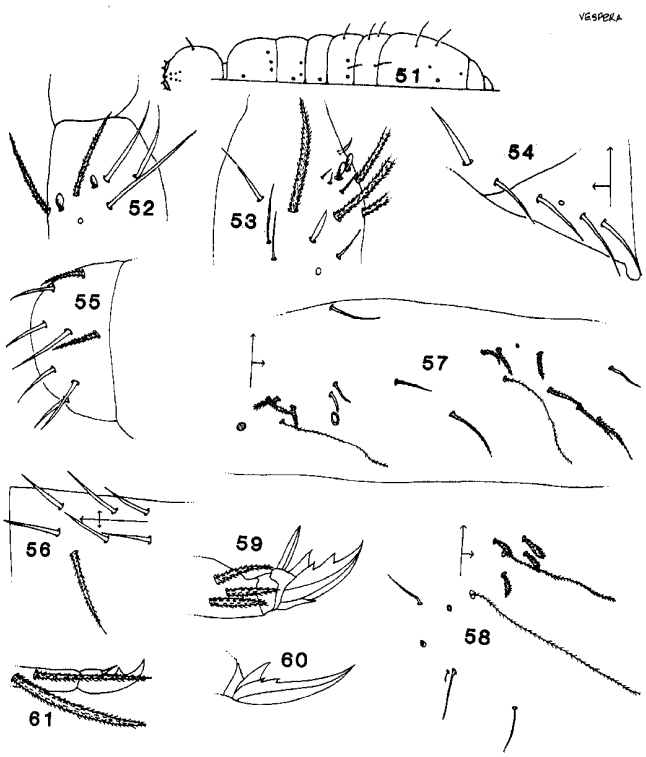
Description: Eyes and pigment absent. Maximum length, excluding appendages, 2.4 mm. Antennae 1.5-1.9 times as long as cephalic diagonal and without apical bulb. Antennal segment ratios as: 1/2.3-2.8/1.9-2.5/3.9-4.4. Subapical sense organ rod-like with a slight oval apical swelling. Lenticular organs unclear or absent. Third antennal apical sense organ (not observed clearly on type specimens) with seta 1 slender, short and blunt; setae 2 & 3 expanded, 4, 5 & 7 slender, filamentous and not acuminate; seta 8 slightly expanded medially and acuminate; seta 9 about as long but slender and blunt. Prelabral setae 4-5-5-4 all smooth. Lateral P setae absent. Labial palp not clearly seen but apparently with only 1 sublobal hair. All labial triangle setae are smooth macrochaetae except for R which is absent. Labial ventral groove with 4+4 ciliate machochatae along margin. The fourth abdominal segment anterior bothriotrichal complex lacking supplementary seta. Trochanteral organ with 5-7 setae in each arm, 3-4 internal and 2-4 external setae. Ventral tube with about 7+7 large ciliated setae on anterior face: disto-lateral patches with 8-9 setae, 1 or 2 ciliated, remainder smooth; posterior face with 2 large ciliated, and 6 medium smooth setae. Posterior leg with large inner seta acuminate and moderately distinguished from other setae, located 0.32-0.43 of the distance from base to apex of tibiotarsus. Unguis with 3 clear teeth, distalmost varying from 0.32-0.70 distance from base to apex. Unguiculus without outer tooth. Manubrial plaque with 2 inner and 2 outer setae. Mucro with apical tooth 2-2.25 larger than median and with basal spine whose apex reaches to tip of median tooth. Uncrenulate dens 2.8-4.0 times as long as mucro.

Holotype: female and one paratype female, Bat Cave, Rutherford Co., North Carolina, 6 July 1977, P. Hertl coll. (locality no. 3979).

Additional records: Blowing Springs Cave, Swain Co., North Carolina, 22 March and 18 May 1979, S.P. Platania coll. (locality nos. 3985 & 3986).

Derivatio nominis: from vespertilio, Latin for bat, after the type locality, Bat Cave.

Remarks: This species is distinguished from *P. granda* by



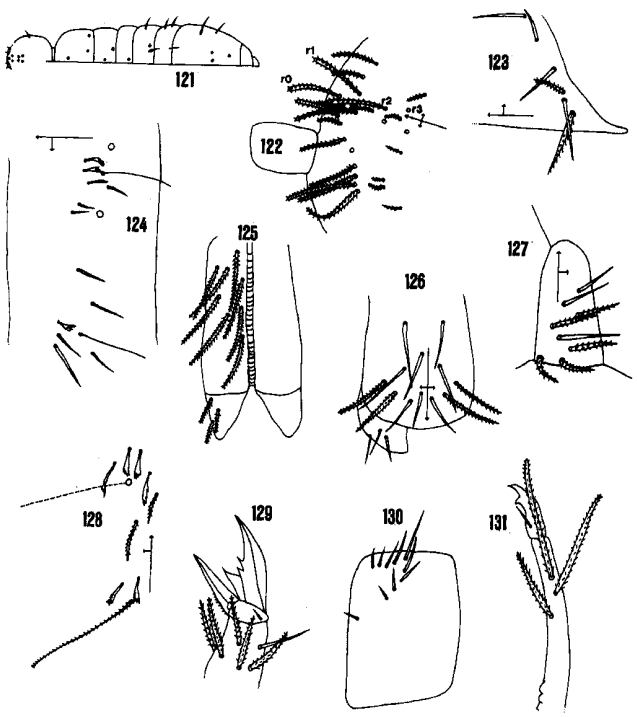
Figures 51-61 of Pseudosinella vespera. 51. Semidiagrammatic illustration of dorsal macrochaetae and pseudopores (hollow circles). 52. Apical region of second antennal segment, type specimen. 53. Apical setae of third antennal segment, right side seen from above, specimen from Swain Co. 54. Labial triangle setae, right side, type specimen. 55. Ventral tube setae, distolateral patch, right side, specimen from Swain Co. 56. Ventral tube, posterior face, seen from a posterior angle, type specimen. 57. Dorsal chaetotaxy, second abdominal segment, right side, type specimen. 58. Outer bothriotrichal complex, third abdominal segment, specimen from Swain Co. 59. Hind foot complex type specimen. 60. Hind unguis, specimen from Swain Co. 61. Apex of dens and mucro, specimen from Swain Co.

the smooth labial triangle setae. It is separated from *flatua* by the presence of posterior macrochaetae on thoracic segments 2 & 3. It is distinguished from *maritima* (Bagnall, 1941) by the acuminate tibiotarsal outstanding seta as well as habitat. It differs from the European *styriaca* (Neuherz & Nosek, 1975) in the absence of the P1 seta on the fourth abdominal segment, claw shape, and structure of setae 2 & 3 on the third antennal segment apex. It is difficult to analyze the insufficiently described New Zealand species *insoloculata* (Salmon, 1941); however *vespera* appears to differ in claw structure and a generally longer antenna. It appears to be most similar to the European cave species *virei* (Absolon, 1901) but differs in lacking the second abdominal segment p seta and the 4th abdominal segment P1 seta, as well as other minor features. Since both species are troglomorphic, conspecificity seems highly improbable.

The present collections are two populations differing strikingly in their level of troglomorphy. The Swain Co. specimens are much more troglomorphic than the Rutherford Co. ones. The fact that the cephalic chaetotaxy, thoracic macrochaetae, and other chaetotaxic features are the same in both populations indicates that they can be considered the same species. Further collections may well show intermediate conditions in caves found between these two areas.

Pseudosinella extra sp. nov. (Figs. 121-131)

Description: White without eyes or traces of pigment. Maximum length, omitting appendages, 1.5 mm. Antennae 1.38-1.5 times as long as cephalic diagonal and lacking apical bulb. Antennal segment ratios 1/2.0-2.4/1.30-1.65/3.0-3.4. Subapical organ small and rod-like. Lenticular organs weakly



Figures 121-131 all of Pseudosinella extra. All figures of type specimens. 121. Semidiagrammatic illustration of dorsal macrochaetae and pseudopores (hollow circles). 122. Detail of anterior dorsal cephalic chaetotaxy of left side. 123. Labial triangle setae. 124. Lateral chaetotaxy of second abdominal segment, left side. 125. Ventral tube, anterior face. 126. Posterior face of ventral tube. 127. Ventral tube, left side, distolateral patch. 128. Fourth abdominal segment bothriotrichal complex, left side. 129. Fore foot complex. 130. Trochanteral organ. 131. Mucro and ends of dens.

developed between third and fourth and second and third segments. Third antennal apical setae 2 & 3 small and peg-like; setae 1 & 4 curved, slender, and acuminate and about 3 times as long as setae 2 & 3. Seta 5 very small and peg-like; seta 8 curved, blunt and slightly basally enlarged; setae 6 & 7 slender curved and slightly truncate. Prelabral setae 4-5-5-4 all smooth. Labial palp with three sublobal hairs. Labial triangle with seta M1 and r ciliate; remainder smooth. Marginal macrochaetae along cephalic labial ventral groove 4+4, all ciliate. Second abdominal segment with P seta relatively long but not clearly ciliate. Fourth abdominal segment with anterior bothriotrichal complex having a supplementary seta. Trochanteral organ with five setae in arms and one external seta. Ventral tube with 7+7-8+8 large ciliate setae on anterior face and 10-12 on posterior face; distolateral patches with 8 setae, 3 smooth and remainder ciliate. Hind tibiotarsus with clearly differentiated inner large seta, only slightly longer other large setae but cylindrical and apically blunt or truncate, situated 0.32—0.37 distance from base to apex of tibiotarsus. Unguis with 3 clear teeth; basal pair large with one much larger than other; distal tooth prominent and 0.4-0.5 distance from base to apex of inner unguis. Unguiculus acuminate with outer margin serrate. Tenent hairs acuminate and apically curved. Manubrial plaque with 2 inner and 2 outer setae. Uncrenulate dens 2.1-2.8 times as long as mucro. Apical mucronal tooth about 1 1/2 times as long as basal with basal spine not quite reaching apex of subapical tooth.

Holotype: female and 1 paratype: Jack's Cave, Scott Co., Virginia, 14 June 1995, on debris, D. Hubbard coll. (locality no. 7854).

Other locality: Basil Duncan Cave, Scott Co., Virginia, 2 March 1995, D. Hubbard coll. (locality no. 7807).

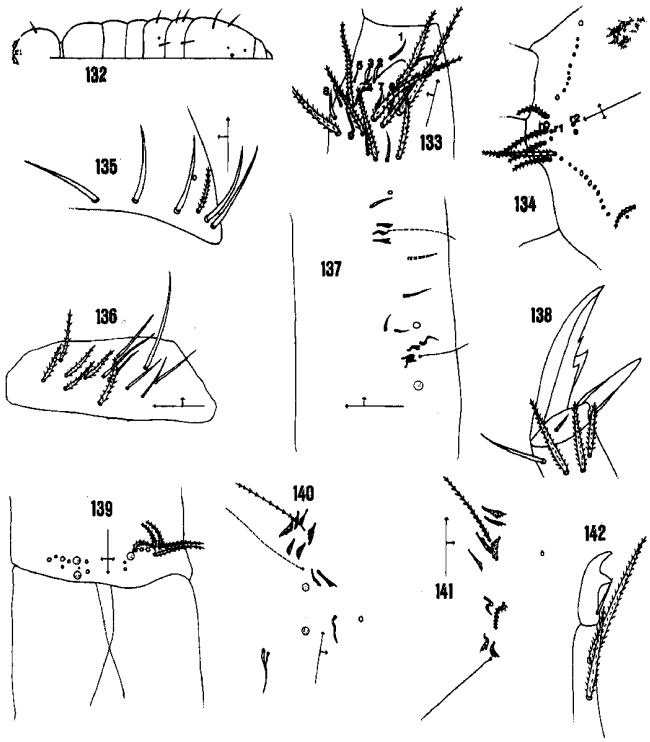
Derivatio nominis: named because the first specimens were seen after the original manuscript had been completed.

Remarks: This species is quite close to *P. vespera* from North Carolina but the ciliate r seta on the labial triangle and the presence of a p seta on the second abdominal segment, as well as the different thoracic macrochaetae, readily serve to separate the two species.

Pseudosinella bona sp. nov. (Figs. 132-142)

Description: White except for eyepatches. Eyes 1+1 or 2+2 but generally without clear cornea visible. Maximum length, omitting appendages, 2.7 mm.

Antennae 1.5-1.8 times as long as cephalic diagonal and lacking apical bulb. Antennal segment ratios 1/2.2-2.7/1.85-2.25/3.1-3.35. Subapical organ rod-like, truncate, and with a slight taper. Lenticular organs well developed, one between second and third segments and 1 or 2 between third and fourth segments. Third antennal apical setae seen clearly on only one type specimen. Setae 1, 4, 6 & 9 are acuminate slender and longer than 2 & 3 which are swollen; setae 5 & 7 are short and peg-like; seta 8 is acuminate and slightly basally swollen supplementary seta between setae 5 & 8 seen in the type is absent



Figures 132-142 all of Pseudosinella bona. All figures of type specimens. 132. Semidiagrammatic illustration of dorsal macrochaetae and pseudopores (hollow circles). 133. Apex of third antennal segment, type specimen. 134. Detail of anterior, dorsal cephalic chaetotaxy. 135. Labial triangle setae. 136. Distolateral ventral tube setae, left side. 137. Chaetotaxy of second abdominal segment, right side. 138. Fore foot complex. 139. Manubrial plaque. 140. Third abdominal lateral bothriotrichal complex, right side. 141. Fourth abdominal segment bothriotrichal complex, right side. 142. Mucro and ends of dens.

in the Washington Co. specimens. Prelabral setae 4-5-5-4; posterior most row ciliate and remainder smooth. Labial palp with three sublobal hairs. Labial triangle with seta r and rarely seta M^1 ciliate; remainder smooth. With 4+4 ciliate, marginal macrochaetae along labial ventral groove. Second abdominal segment with P seta relatively long but not clearly ciliate. Fourth abdominal segment with anterior bothriotrichal complex having a supplementary seta. Trochanteral organ with 8-15 setae in arms, 9-20 internal and 1-3 external setae. Ventral tube with 10+10 to 14+14 large ciliate setae on anterior face and 2 ciliate macrochaetae and 14-20 mesochaetae on posterior face; distolateral patches with 9-14 setae, anterior 4-7 ciliate and remainder smooth. Hind tibiotarsus with clearly differentiated acuminate inner large seta, only slightly longer other large setae, situated 0.22-0.41 distance from base to apex of tibiotarsus. Unguis with 3 clear teeth; basal pair moderately large with one only slightly larger than other; distal tooth prominent and 0.52-0.58 distance from base to apex of inner

unguis. Unguiculus acuminate with outer margin smooth. Tenent hairs acuminate. Manubrial plaque with 2 inner and 4-7 outer setae. Uncrenulate dens 2.3-2.5 times as long as mucro. Mucronal apical tooth slightly longer than subapical with basal spine slightly exceeding apex of subapical tooth.

Holotype: female and 10 paratypes: Goodwin's Cave, Roanoke Co., Virginia, 4 June 1995, on debris, D. Hubbard coll. (locality no. 7845), same cave Big Formation Room, 1 August 1973 (locality no. 4319).

Other locality: Lowe's Cave, Washington Co., Virginia, 7 September 1979, Holsinger et al. coll. (locality no. 4319).

Derivatio nominis: Latin bonum = good, named after type locality cave.

Remarks: This striking species was first sent to the senior author in 1974 by Ferguson; however the two specimens were not adequate for a description. An additional 2 poor specimens were sent by John Holsinger in 1979 from Washington Co. When David Hubbard started making extensive collections of Collembola in Virginia caves we suggested he return to Goodwin's Cave to see if the species could be rediscovered. He did so and sent a fine series of specimens.

The species is unusual in always having clear eye pigment but in only one specimen could we see an obvious indication of a cornea. It is close to the Virginia species *P. granda* but is clearly distinguishable on the basis of the eye pigment and the large ciliate r seta in the labial triangle. It also resembles *P. gisini* but can easily be separated on the claw shape. One specimen from Washington Co. has seta M^2 ciliate on one side but all populations show specimens with the typical labial chaetotaxy shown in Table 1.

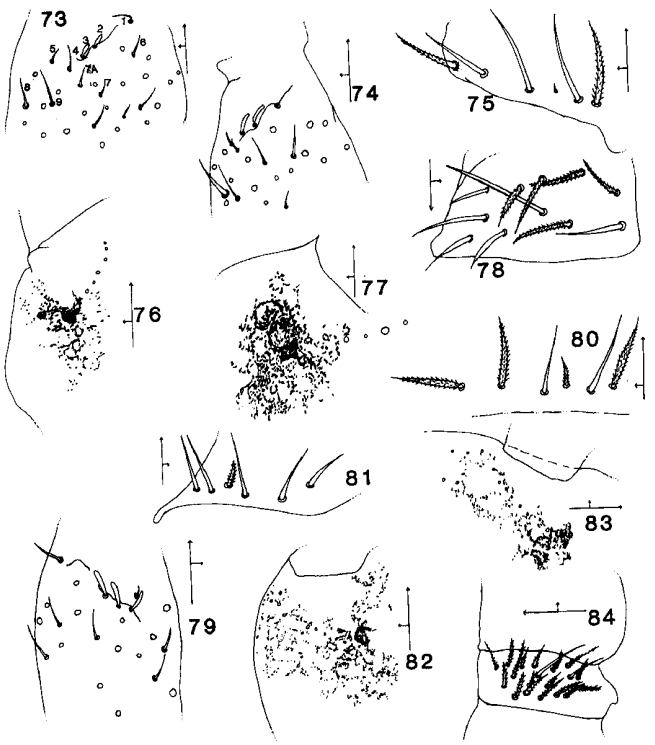
Pseudosinella gisini

This species is abundant in the caves of Pocahontas, Greenbrier, and Monroe counties, West Virginia. It also has one questionable record from Mercer county. More recently it has been collected from two caves in Rutherford Counties North Carolina and one cave in Lee County Virginia. The discovery of these two amazingly disjunct populations necessitated a thorough reexamination of the species. This led to the discovery that *Pseudosinella gisini gisini* has a very unusual structure of the third antennal segment apical setae. This is the existence of a supplementary seta which we call seta 7a (see Fig. 73). Both the disjunct populations lack this seta and have third antennal apical setae more typical of the genus (see Figs. 74 & 79). All subspecies of *P. gisini* share an unusually long seta 1. The *gisini* specimens vary in the labial ventral groove chaetotaxy from all smooth to one pair smooth and the others ciliate; however the majority have the 3 anterior setae smooth and the other pair ciliate. All specimens of the disjunct populations have all 4+4 setae ciliate. The two disjunct populations are sufficiently similar to the West Virginia ones that we feel specific separation is unwarranted; however, they are sufficiently distinct that we feel subspecific status should be given. The strong possibility that further intermediates may be uncovered with additional cave exploration reinforces the adoption of subspecific status. We name them and give their characteristics in Table 3.

Descriptions:

Pseudosinella gisini virginia subspecies nov. (Figs. 74-78)

Maximum length 2 mm. Body and appendages white. Blue pigment limited to region of eyes, and a scattering of granules over remainder of dorsum of head. Eyes generally 2+2 but a few specimens have these very obscure and may have only 1+1 eye. One specimen has distinctly darker pigmentation on anterior half of the dorsum of head. Tenent hair occasionally acuminate but generally weakly truncate. Unguiculus occasionally with very slight inner swelling on one pair of legs but generally without such. Ventral tube features as shown in Figure 78 and Table 3. Other features as in *P. gisini gisini*.



Figures 73-84 of Pseudosinella gisini. 73. Apical setae of apex of third segment of gisini gisini. Large setae with only bases shown. Figures 74-78 all of gisini virginia. 74. Apical third antennal setae as in Figure 73. 75. Labial triangle setae, right side. 76-77. Eyepatches, left side in two different specimens. 78. Setae of distolateral patch of ventral tube. Figures 79-84 of gisini carolina. 79. Apical setae of third antennal segment, as in Figure 73. 80-81. Labial triangle setae of two specimens from the same cave. 82-83. Eyepatch regions of same two specimens. 84. Setae of distolateral patch of ventral tube.

Holtype: female and 6 female paratypes, Spangler Cave, Lee Co., Virginia, 29 March 1995, D. Hubbard coll. (locality n. 7815).

Pseudosinella gisini carolina subspecies nov. (Figs. 79-84)

Maximum length 3 mm. Pigment varying from completely lacking or blue, limited to eye regions to dark around eyes and with a wash of granules over remainder of the dorsum of head and body. Eyes 1+1 to lacking. Tenent hairs generally acuminate but occasionally truncate or weakly clavate. Unguiculus with or without slight basal swelling. Ventral tube chaetotaxy as shown in Table 3 and Figures 84. Other features as in *P. gisini gisini*.

Holotype: female and 4 female paratypes, McGrath Fissure, Rutherford Co., North Carolina, 25 November 1994, Cato & Christ Holler colls. (locality no. 7774).

Other collection: Rumbling Bald Cave, Lake Lure, Rutherford Co., North Carolina, 2 July 1977, P. Hertl coll. (locality no. 3973).

The nature of this species and its distribution poses a presently unsolvable puzzle. The species is large (adult size mostly 3-5 mm) and readily recognizable. Extensive collections have been made in caves between the two disjunct populations and the West Virginia sites. It is very unlikely that it occurs in more than a few intermediate caves. Given the extensive surface collections done in this region it is highly unlikely that it occurs outside of caves. This would indicate a long occupation in caves and a troglobite nature. On the other hand, the fact that the species is weakly troglomorphic in a number of features (clavate or truncate tenent hairs often present, pigment and eyes present) plus the widely disjunct distribution would appear to point to a troglophile species with relatively recent invasion of caves.

ONCOPODURA

The other genus we shall deal with in this paper is *Oncopodura* (Carl & Lebedinsky, 1905).

This genus and the family Oncopoduridae have been reviewed by a number of authors, including Bonet (1943), and Szeptycki (1977a, b); most recently Deharveng (1988) has reviewed the literature, established species groups of *Oncopodura*, and proposed taxonomic use of new characters. Christiansen and Reddell (1986) described two new species from Mexican caves and discussed the Mexican fauna.

We have discovered a number of new cave and edaphic species in the course of our work updating the *Collembola of North America*. Most species of the genus appear to be troglobitic and this is true of the new species we have discovered from North America. Several of these species are too poorly represented by specimens to merit description. Table 4 indicates some of the diagnostic characteristics of these species, as well as all described cave species of the genus so far known from North America.

The genus is remarkably uncommon in collections, and most species we have seen are represented by very few specimens. Because of the extreme fragility of specimens and the deciduous nature of the diagnostic scales and spines, many are unsuitable for description. In the case of *O. fenestra*, in many hundreds of samples from the caves of Travis and Williamson counties in Texas only 5 specimens have been recovered, with no more than two from any one cave. Since the habitat in which they were found does not appear exceptional in any way,

Table 3. Distinguishing Characteristics of Subspecies of Pseudosinella gisini.

subspecies	Labial triangle setae	eyes per side	3rd antennal segment seta 7a	macrochaetae each side of labial ventral groove S = smooth C = ciliate	unguiculus basal swelling	ventral tube anterior face distal row setae	disto lateral ventral tube setae per side	disto lateral smooth setae per side
gisini	M1 M2 r E L1 L2 M1 M2 r E L1 L2	2-3	+	4s + 0c - 1s + 3c	(+)+	2(3)	13-24	2-5
virginia	M1 M2 vg E L1 L2	(1?) 2	-	4c	(+) -	1	10-11	4-5
carolina	M1 M2 r E L1 L2 M1 M2 r E L1 L2	0-1	-	4c	+ , -	2,3	19-24	2-3

s = "smooth", c = clearly ciliate .

Table 4. Characteristics of US Cave Oncopodura.

species	Localities	no. inner serrate dental spines	P.A.O. lobes	lateral lamella unguis	no. setae types 7 & 8 on 2nd antennal seg.	No. setae types 7,8 & 13 on third antennal segment	No. setae types 7 & 8 on fourth antennal segment	scale on mucro	median long setae of abdominal segment 5 / length of segment	no. mucronal teeth
sp. CC	New Mexico	3?	0	+	12-14	8-10	7-8	+	?	4
cruciata	Montana	3	4	-	5	3	5	-	.3	4
sp. E	Wyoming Montana	1(0)	5-6	-	3	3	5	+	.35	4
fenestra	Texas	3	0	+	13-15	9-14	6	+	.4-.5	4
hoffi	Missouri	5	3(4)	-	5	5-6	5	-	.33-.38	4
iowae	Iowa, Illinois, Missouri	2	2	-	3	1	4	-	≈.3	4
mala	Oregon California?	2	1-4?	-	2	3	4	+	≈.3	4
tunica	California	2	5	-	2	0	10	+	≈.45	4
hubbardi	Virginia	1	5-6	+	3 (2?)	2	5	+	.37	4

this rarity is difficult to explain. The only two large series of *Oncopodura* we have seen were from rocks isolated in mid-stream, suggesting that individuals are extremely solitary and aggregate only when compelled to do so by rising water.

Both Szeptycki (1977a,b) and Deharveng (1988) have good general discussions of the taxonomic features of the group. In general we follow the model of Deharveng (1988) in the following descriptions. Among the characters he used are the types of antennal setae; we find some of these to be generally useful in descriptions, and illustrate a number of types (from his description of *O. pelissei*) which can be recognized in our species.

Oncopodura fenestra sp. nov. (Figs. 86-97)

Description: Habitus: typical of genus (see Fig. 86). Maximum length 2.0 mm. Color white without trace of pigment. Antennae 1.5-1.8 times cephalic diagonal, without apical bulb or scales. Fourth segment with subapical trio not clearly separated from other setae. Two apically sharply curved acuminate setae and one more basal short one, apically acuminate and basally expanded; a similar seta may be present near the second type 8 seta; six type 8 setae, one basal, a second and third close to each other, and three additional, widely spaced, all in a line; the basalmost of these usually has a well developed type 11 seta next to it; almost all other setae are of type 1A. Third segment with 9-14 apical and subapical type 8 setae; ventral surface with a number of very long slender setae; other setae are thick type 1A. Second segment with 12-15 type 8 setae; others are type 1A, of varying thickness and length. First antennal segment with one small type 8 seta, two ventral microsetae, and type 1A setae of varying sizes. PAO absent. Unguis moderately broad, untoothed, and with a prominent inner lamina, slightly shorter than the unguiculus; outer pretarsal seta about 1/10 length of inner unguis; inner seta minute and difficult to observe. Unguiculus acuminate, without clear basal swelling. Apically expanded seta of mesotibiotarsus clavate; most other tibiotarsal setae are large, acuminate, and extremely finely ciliate. Tenent hair slender and acuminate. Ventral tube without prominent papillae; with 4+4 type 1A setae on distolateral lobes. Tenaculum with 44 teeth and large stout acuminate ciliate seta on the corpus. Manubrial chaetotaxy not intact on any specimen seen but there are many (about 25+25) dorsal setae, at least 15 being of type 14 and at least 5 of type 4. Dens distoventrally with 4 large type 1 setae; external face basally with one extremely finely ciliate, acuminate mesochaeta, and distally with one very large curved spine having many minute scales on its median face; dorsally not intact on any specimen, but apparently with 5 large type 14 setae (2 basal, 1 medial, 2 distal) plus one medial and 2 basal small type 1A setae; internally with 3 curved, deeply serrate spines, increasing in size distally. Mucro with 4 teeth and a large scale. Fourth abdominal segment with median row of 4+4 and 1+1 posterolateral macrochaetae, and 10+10 microchaetae. Fifth abdominal segment with 4+4 posterolateral

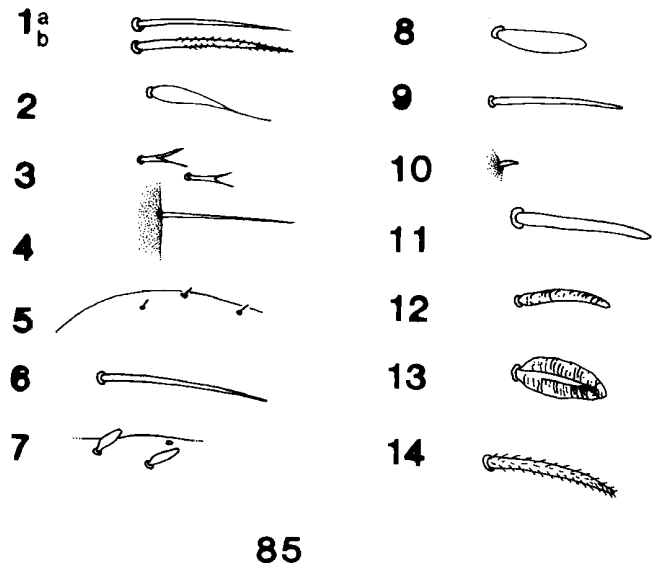
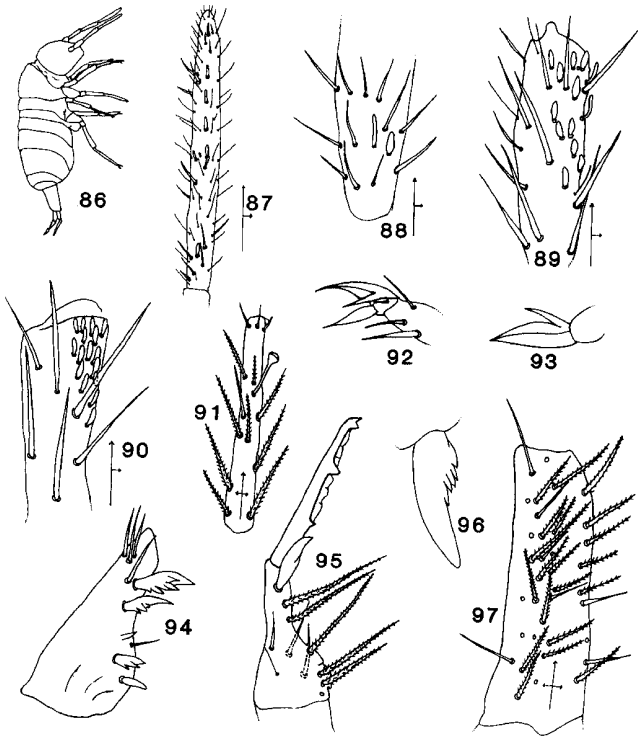


Figure 85 semidiagrammatic illustration of antennal seta types of Oncopodura modified from Deharveng (1988), see text.

Type	Description (see Fig. 85)
1A.	Normal medium to large smooth setae, gradually tapering to point.
1B.	Similar to 1A. but finely ciliate.
2.	Normal setae swollen at the base, with or without a slender apical extension.
4.	Setae similar to type 1A but prominently at right angles to body or antennal surface.
6.	Setae similar to type 1A but slightly truncate.
7.	Short blunt fusiform setae.
8.	Large blunt flattened fusiform setae.
9.	Long blunt subcylindrical setae, often thinwalled.
13.	Setae similar to type 8 but with clear striations at right angles to central axis.
14.	Marochaetae, multilaterally ciliate.



Figures 86-97 of Oncopodura fenestra. 86. Habitus, type specimen. 87. Right fourth antennal segment, type specimen. 88. Base of fourth antennal segment, specimen from Maple Run Cave, Travis Co. 89. Apex of third antennal segment, type specimen. 90. Apex of second antennal segment, type specimen. 91. Outer face of mid tibiotarsus, type specimen. 92. Hind foot complex from side, type specimen. 93. Mid unguis inner view, same specimen. 94. Inner face, right dens, type specimen. 95. Outer face, right dens and mucro, same specimen. 96. Enlarged view of distal outer spine, specimen from Sting Cave, Williamson Co. 97. Dorsum of manubrium, type specimen.

macrochaetae in rows, 3+3 small type 1A setae anteriorly, and 5+5 microchaetae in posterior half. Sixth segment with 2 rows of macrochaetae, 4 anterior and 5 in posterior row.

Holotype: Cueva de la Ventana, Travis Co., Texas, 10 February 1993, M. Wharton coll. (locality no. 7564).

Other records: Maple Rune Cave, Travis Co., Texas, 31 January 1991, J. Reddell coll. (locality no. 7332). Inner Space Caverns, Williamson Co., Texas, 6 May 1989, W. Elliott coll. (locality no. 7125). Sting Cave, Williamson Co., Texas, 7 November 1994, Reddell & Reyes colls. (locality no. 7824).

Derivatio nominis: Latin fenestra, window, after the type locality cave (ventana = window).

Remarks: This unusual species was originally identified as *O. prietoi* (Bonet, 1943), but on closer examination was seen to be very different in antennal chaetotaxy and different in other minor features. The presence of 6 type 8 setae on the fourth antennal segment distinguishes it from all other New World members of the genus; in this respect it resembles *O. lebretoni* (Deharveng, 1988), a French troglobite which is otherwise very different. The type 11 seta on the base of the fourth antennal segment is absent in the holotype but present in the specimens from Maple Run Cave and Sting Cave. The specimens from Inner Space Cave, Williamson Co. do not show the antennal structure clearly, but are otherwise similar to the type. *O. fenestra* would belong in Deharveng's group 2.2.

We have seen only 5 specimens form 4 localities among hundreds of samples from Texas caves, implying a remarkable rarity.

Oncopodura hubbardi sp. nov. (Figs. 98-107)

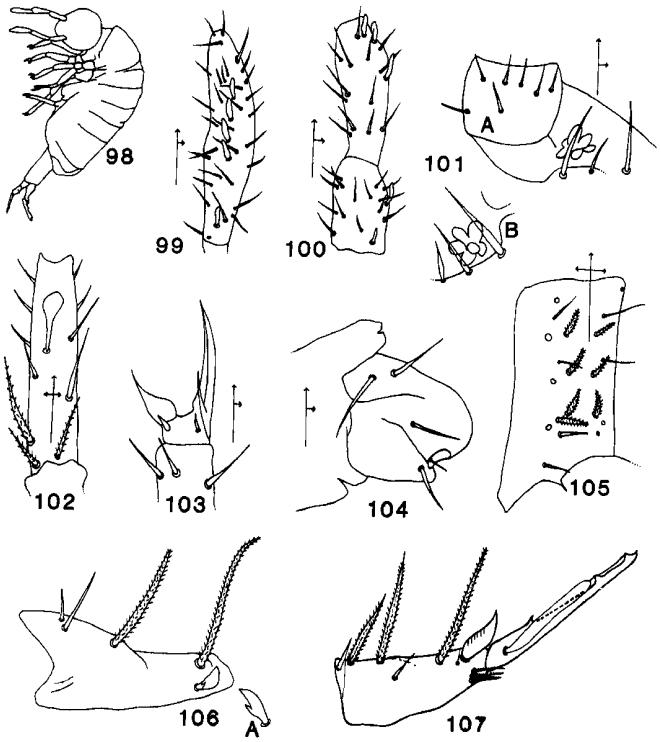
Description: Habitus: typical of genus (see Fig. 98), except that the suture between the third and fourth abdominal segment is often obsolete so that the two appear to be one segment. Maximum length 1.2 mm. Color white (yellowish in alcohol), without trace of pigment. Antennae 1.14-1.38 times as long as cephalic diagonal, without apical bulb. Fourth antennal segment with one type 6 and two type 9 setae in subapical trio: one basal and a row of 4 distal setae of type 8; other setae of type 1A or 4. Third antennal segment with 2 apical setae of type 8 and a medial one, (sometimes absent?); other setae of type 1A. Second antennal segment with 2 setae of type 8 in medial file; other setae of type 1A or intermediate between types 1A and 2. First antennal segment with distal ring of 9 setae and a few others, of type 2 or intermediate between types 2 and 1A. PAO distinct, in shallow groove, with 5-6 radiating lobes of unequal lengths. Unguis very slender, untoothed, and with pronounced slender lamina about 3/4 as long as unguiculus; pretarsal setae very small, the inner one often difficult to see and only 0.03 times length of inner unguis. Unguiculus basally strongly swollen, between 1/2 and 2/3 as long as inner unguis. Apically expanded mesotibiotarsal seta with flattened ovoid shape and pronounced ridge along one margin; 3 basal tibiotarsal setae finely ciliate, remainder smooth. Ventral tube with 4+4 large smooth setae on distolateral lobes, and 2 small curved blunt setae, often difficult to observe, in deep groove behind posterior lateral setae; pair of large apically indented papillae anteriorly at end of the ventral groove, and smaller pair, not indented, in equivalent position on posterior face. Tenaculum with 4+4 teeth and single small blunt seta on basal part of the corpus. Dorsal surface of manubrium not clearly seen, but apparently with 12+12 setae, 4+4 (5+5) of type 4 and remainder of type 14. Dens ventrodistally with 3 stout type 1A setae; external face with a small slender straight spine basally and a very large curved distal spine with a few very fine inner serrations; dorsally with 3 basal and 2 distal type 14 setae, and two basal and one medial smooth type 3 setae; inner face with one moderate distal curved spine having one (rarely two) large serrations. Mucro with 4 teeth and large basal scale. Fourth abdominal segment with medial row of 3+3 macrochaetae but otherwise not clearly seen. Fifth segment with 3+3 anterior type 1A setae and 4+4 lateral type 14 macrochaetae. Sixth segment not clearly seen, but apparently with 12 posterior macrochaetae in 3 rows of 4, 3, and 5 setae from front to back.

Holotype: and 14 paratypes: Reasor's Cave, Lee Co., Virginia on rock near stream, 13 July 1994, D. Hubbard coll. (locality no. 7739).

Other localities: Burton Cave, Lee Co., Virginia, 6 June 1994, D. Hubbard coll. (locality no. 7710); Spangler Cave, Lee Co., 29 March 1995, D. Hubbard coll. (locality no. 7815).

Derivatio nominis: after David Hubbard who collected this species and whose other incredible collections have been invaluable for this as well as other studies.

Remarks: This is the only Nearctic species combining the features of a dental scale, ungual lamella, and lobed PAO. It would fall in Deharveng's (1988) group 2.2.

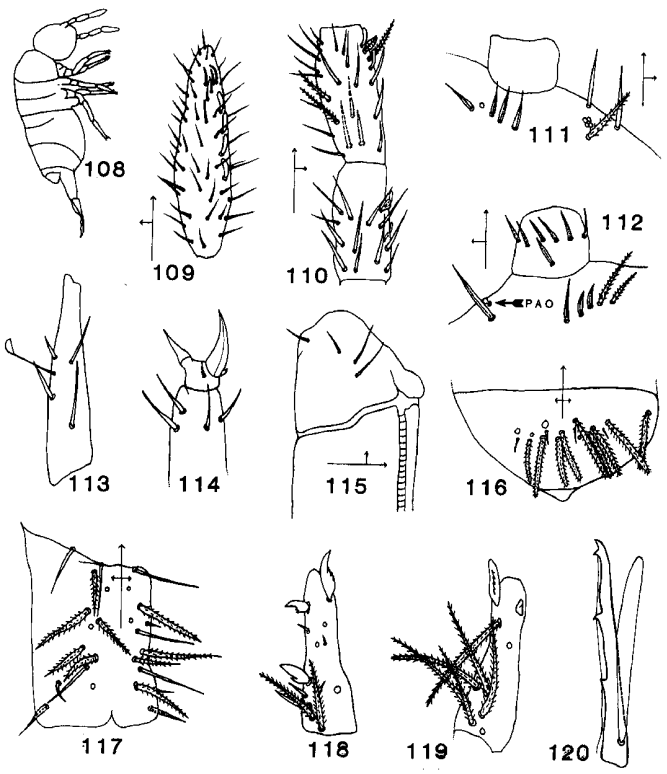


Figures 98-107 of Oncopodura hubbardi. All figures of type specimens. 98. Habitus. 99. Dorsal surface of fourth antennal segment. 100. Dorsal surface of second and third antennal segments, same specimen. 101A-B. P.A.O. of two specimens. 102. Inner face of mid tibiotarsus. 103. Fore foot complex, seen from side. 104. Ventral tube. 105. Dorsal surface of manubrium. 106. Inner face of left dens, A. distal spine from different angle. 107. Outer face of left dens.

Oncopodura mala sp. nov. (Figs. 108-120)

Description: Habitus: typical of genus (see Fig. 108). Maximum length 1.3 mm. White without trace of pigment. Antennae 0.9-1.04 times as long as cephalic diagonal, without scales. Fourth segment without apical bulb, but with a conical projection; subapical trio with sharply curved type 6 setae and one straight thick stout acuminate seta; a distal file of 4 type 8 setae; other setae of type 1A. Third antennal segment with one type 13 seta, one distal and one smaller subapical seta of type 8, about 15 dorsal setae intermediate between types 2 and 1A; ventral surface with setae of types 1A and 3. Second antennal segment with one apical and one subapical seta of type 8 , one short, spine-like apical seta, and remaining dorsal setae intermediate between types 2 and 1A; ventral surface with setae of types 1A and 3. First antennal segment dorsally with type 2 setae in apical row plus one basal; ventral surface not seen

clearly. Single unlobed, small globular PAO in type specimens; California specimens have 4 weakly to well developed lobes in small PAO. Unguis short, stout and untoothed, without lateral lamina; inner pretarsal seta about 0.3 times as long as inner unguis. Unguiculus broad, acuminate, and not basally swollen. Differentiated outer seta of mesotibiotarsus shaped like a lacrosse stick. Tenent hair slender and acuminate. Other tibiotarsal setae acuminate and smooth or finely ciliate. Ventral tube with 4 distolateral type 1A setae, and small papillae at tip of ventral groove; small canals similar to those shown by Dehaveng (1988) in *O. lebretoni* are present. Tenaculum with 4+4 teeth and a short acuminate type 14 seta on the corpus. Manubrium dorsally with 5+5 type 3 and 8+8 type 14 setae, plus 1+1 microsetae. Dens ventrally with 5 acuminate, smooth setae distally; externally with a large curved spine having many small to minute scales; dorsal surface not intact on any specimen, but with 4 long type 14 and 1-2 thick type 1A setae basally and 2 long type 14 setae and 2 microsetae medially; inner face with 2 spine-like type 1A setae basally, one large basal bidentate spine, and one smaller bi- or tridentate spine distally. Mucro with 4 teeth, crenulate lamella, and large basal scale. Fourth abdominal segment setae not clear on any specimen, but with 4+4 macrochaetae plus row of smaller type 14 setae along each posterolateral margin. Fifth abdominal segment with 4+4 stout, acuminate, ciliate setae anteriorly, medially with 2+2 slender type 1A setae, posteriorly with a row of 4+4 microchaetae, and 4 type 14 setae in an angled row on each side. Sixth segment with type 14 setae in anterior row of 6, a medial row of 3, posterior row of 5; and row of 4 microsetae between the first 2 rows.



Figures 108-120 of Oncopodura mala. 108. Habitus, type specimen. 109. Right fourth antennal segment, type specimen. 110. Third and second antennal segment, same antenna. 111. Right P.A.O. and antenna base, specimen from Eagle View Cave, Calveras Co. California. 112. Left P.A.O. and antenna base, type specimen. 113. Differentiated seta of mid tibiotarsus, type specimen. 114. Hind foot complex, type specimen. 115. Ventral tube seen from side, type specimen. 116. Chaetotaxy of 6th abdominal segment, type specimen. 117. Dorsal surface of manubrium, type specimen. 120. Mucro, type specimen.

Holotype: and 5 paratypes: Malheur Cave, elevation 1,300 m, Harney Co., Oregon, 10 November 1978, E.H. Gruber & L. Wright colls. (locality no. 3987)

Other records? (see remarks): Eagle View Cave #2, Calaveras Co., California, 29 March 1979, Rudolph coll. (locality no. 4405); Three Rivers, S. Fork Kaweah R., Tulare Co., California, 10 April 1974, P. Bellinger coll. (locality no. 3416); Tilden Park, Inspiration Point, Contra Costa Co., California, 29 July 1972, V. Landwehr coll. (locality no. 4685).

Derivatio nominis: Latin malus, -a, bad, after the type locality, Malheur ("bad fortune") Cave.

Remarks: This peculiar species is easily distinguished from all other nearctic forms by the unusual chaetotaxy of the fifth abdominal segment and the tiny PAO. The California specimens differ from the types in having lobes on the PAO, but appear otherwise identical and are best treated at resent as a geographic variety; they were erroneously identified in the Collembola of North America as *O. cruciata*, but differ from this species in antennal and dental structure and the presence of a mucronal scale.

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