Preliminary Studies of Collembola at the Brookville Ecological Research Center, Including New Records of Indiana Springtails

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Abstract

More than 16,000 Collembola were collected and examined during a 3-year study at the Brookville Ecological Research Center in east-central Indiana. Research data are presented, including records of 10 species new to the state.

Studies of plant and animal ecology at the Brookville Ecological Research Center (BERC) in east-central Indiana were begun in 1970. A farm of 110 acres at the upper end of the Brookville Lake site was leased to Earlham College and Miami University by the Army Corps of Engineers and was utilized in this research.

Collembolan study at the center was instituted to inventory the species present, to record changes in springtail populations as the abandoned farm undergoes succession, and to add to the understanding of the dynamics of collembolan populations.

Methods

Regular monthly sampling of Collembola started in August 1970, and during the following 36 months, 33 collection visits were made to the Brookville Ecological Research Center (BERC). A total of 162 cores was taken. Two abandoned crop fields were selected for regular monthly sampling, and areas for occasional sampling were selected in the woodlot, pasture, and floodplain crop field. The last year of cropping at BERC was 1969 when Field 1 was planted in corn and Field 2 in soybeans. Field 3, a rotation crop field still being farmed by the neighbor adjacent to the center on the east, was added for regular sampling in May of 1971. All of the areas from which samples were taken have been soil mapped by the U.S. Soil Conservation Service. The three regularly sampled crop fields were mapped as Ockley, 0-2% slope, with slight erosion. Field 1 is silt loam texture, and Field 2 is loam. During the 3-year study, more than 16,000 Collembola were collected and examined; 12,396 of these were from Fields 1, 2, and 3. Cores 10 cm in diameter and, depending on soil conditions, varying between 5 cm and 10 cm in thickness were collected and transported to the laboratory. A heat separating funnel was used to extract the Collembola.

This study considers the springtails in 10 family or subfamily groups. The Isotomidae because of the extreme variations within the family have been divided into three subfamilies, and the Sminthuridae into two subfamilies. For statistical consideration, specimens determined to species during the research have been recombined into the 10 larger groupings.

Species Present

Fifty-seven species occurring at BERC are listed. Asterisks denote six records new to Indiana, and unless otherwise noted, specimens were collected from cropland sites.

Mesaphorura clavata (Mills)
Hymenaphorura subtenuis (Folsom,) floodplain
Protaphorura encarpata (Denis)
Xenylla grisea Axelson
X. humicola (Fabricius)
* *Hypogastrura denticulata* (Bagnall,) floodplain
H. matura (Folsom)
Odontella cornifer Mills
Friesea clavisecta Axelson
Pseudachorutes lunatus Folsom, floodplain
P. saxatilis Macnamara
P. subcrassoides Mills
P. undescribed species
Paranura cacca Folsom, woodlot
Neanura pseudoquadrioculata Stach
Micanurida undescribed species
Tomocerus species
Folsomides parvus Folsom
F. stachi Folsom
* *Isotomodes tenuis* Folsom
Holotoma elongata (MacGillivray)
Folsomia fimetaria (Linné)
Proisotoma near *hankoi* Stach
P. minuta (Tullberg)
* *P. vernoga* (Wray)
Isotomurus palustris (Müller)
* *I. palustris balteatus* (Reuter,) woodlot
Spinisotoma dispersa Wray
Pseudisotoma sensibilis (Tullberg)
Isotoma tigrina olivacea (Tullberg)
I. cunotabilis Folsom
I. viridis Bourlet
Vertagopus cinerea (Nicolet)
Orchesella ainsliei Folsom
O. hexfasciata (Harvey)
Sinella curviseta Brook
Entomobrya multifasciata (Tullberg)
Entomobryoides purpurascens (Packard)
Pseudosinella rolfsi Mills
P. violenta (Folsom)
Lepidocyrtus cinereus (Folsom)
L. near *paradoxus* Uzel
L. unifasciatus James, woodlot
Neelides minutus (Folsom)
Megalothorax incertoides Mills, floodplain
Sminthurides aquaticus (Bourlet)
S. hyogramme Pedigo
Sphaeridia pumilis (Krausbauer)
Arrhopalites caecus (Tullberg)
Sminthurinus aureus (Lubbock)
* *S. aureus novus* Mills
S. elegans (Fitch,) pasture
S. elegans cancellus Maynard, woodlot
* *Sphyrotheca curvisetis* (Guthrie,) woodlot
Bourletiella hortensis (Fitch)
Deuterosminthurus repandus (Ågren)
Ptenothrix unicolor (Harvey,) pasture

Following the suggestion of Dr. Peter Bellinger that *Neanura barberi* (Handschin) is a Mexican species, the name *N. pseudoquadrioculata* Stach is substituted for specimens previously reported (5) as *N. barberi*.

Four additional species were recorded for the first time from Indiana during 1973, *Anurophorus laricis* Nicolet (Fayette County,) *Orchesella folsomi* Maynard (Wayne County,) *Sminthurinus quadrimaculatus* (Ryder) (Wayne County,) and *Sminthurus dorsalis* Banks (Wayne County.)

This paper lists 10 new records, bringing the total species and forms of Collembola known to occur in Indiana to 124 (5, 6, 7.)

Study of Populations

The 10 groups into which specimens have been placed and the species predominating in each are as follows:

Onychiuridae: *Protaphorura encarpata* (Denis) and *Mesaphorura granulata* (Mills)
Hypogastruridae: *Hypogastrura matura* (Folsom)
Entomobryidae: *Orchesella ainsliei* Folsom, *Pseudosinella violenta* (Folsom,) *Entomobrya spp.*, and *Lepidocyrtus spp.*
Isotomidae
Anurophorinae: *Folsomides parvus* Folsom
Proisotominae: *Proisotoma minuta* (Tullberg,) *P.* near *hankoi* Stach, *Folsomia fimetaria* (Linné)
Isotominae: *Isotoma cunotabilis* Folsom

Tomoceridae: species not determined
Neanuridae: *Pseudachorutes spp.* and *Micanurida sp. nov.*
Sminthuridae
Sminthuridinae: *Sminthurides aquaticus* (Bourlet) and *Sphaeridia pumilis* (Krausbauer)
Sminthurinae: *Sminthurinus aureus* (Lubbock)

To arrive at the overall ranking of the prominence of the 10 groups reported in Table 1, collections from the three cropland sites were compared using the formula for prominence values from Beals (1). Beals' formula has been used in collembolan population studies in Indiana by Pedigo (9, 10) and by Pedigo and others in Iowa (4, 8.)

$$\text{Prominence Value} = (\text{density})\ (\sqrt{\text{frequency}}) \quad \text{where;}$$

$$\text{Density} = \frac{\text{number of individuals of a species collected; and}}{\text{number of cores collected}}$$

$$\text{Frequency} = \frac{\text{number of cores in which species occurred}}{\text{number of cores collected}}$$

TABLE 1. *Prominence values and 3-year totals for 10 groups of Collembola collected in Fields 1, 2, and 3 during the period August 1970 through July 1973.*

Family or Subfamily Group	Prominence Value	Total Number Taken 1970-1973
Entomobryidae	42.756	4,022
Onychiuridae	28.032	2,699
Proisotominae	17.455[1]	2,136[1]
Hypogastruridae	12.275	1,474
Anurophorinae	9.836	1,266
Sminthuridinae	6.592	799
Sminthurinae	5.368	633
Isotominae	3.814	539
Tomoceridae	1.810	274
Neanuridae	1.672	225

[1] An aggregation of 799 specimens of *Proisotoma* from Field 1, April 1970, elevates Proisotominae substantially above Hypogastruridae. The two groups probably occur in nearly equal numbers.

The 3-year's data reflected an uneven distribution of Collembola both by species and by numbers of each species found in the cropland samples studied. The micro-habitats collected were small (235 cm^3 to 785 cm^3;) yet two sizeable species aggregates were taken, 799 *Proisotoma* near *hankoi* Stach and 441 *Folsomides parvus* Folsom. Other species collected in aggregates of 175 or more were *Isotoma eunotabilis* Folsom and *Hypogastrura matura* (Folsom.)

Christiansen, in a comprehensive review of the bionomics of Collembola (3), notes that some scientists feel that the disturbances of the soil normally encountered in agriculture are of little importance to collembolan populations. Other feel that the reverse is true. BERC studies support both positions, measuring substantial but very short lived depression of numbers of springtails in the surface soil after plowing and planting of a row crop.

The first BERC samples were collected from Fields 1 and 2 in August 1970 about 16 months after plowing and fitting for the row crops in the spring of 1969. From the data in Table 2, one may infer that if there was an initial disturbance of the collembolan populations, recovery required less than 16 months.

Recognizing that the 1970 data from Fields 1 and 2 did not reflect a disturbance, regular collection was initiated from Field 3, a rotation crop field on the adjoining farm. The first sample from this field was taken May 11, 1971, with a newly emerged corn crop present. The effect of the cropping activities on Collembola in the top 10 cm was drastic. Only two specimens were extracted. This compares with samples the same day from Fields 1 and 2 of 169 and 549. The number of Collembola in samples from Field 3 continued to be appreciably lower than the other two fields through June, July, and August (Table 2). The September sample of 258 from Field 3 compared favorably with 379 from 1 and 264 from 2, indicating a high degree of recovery. Samples from all three locations in September showed large numbers of Onychiuridae and Entomobryidae. Samples from Fields 1 and 2 also contained large numbers of *Folsomides parvus* Folsom (63 and 67, respectively.) This species was not present in the sample from Field 3.

TABLE 2. *Monthly collection of Collembola from Fields 1, 2, and 3.*

	1970-1971 Field			1971-1972 Field			1972-1973 Field		
Month	1	2	3	1	2	3	1	2	3
August	185	295	—	190	237	24	34	76	13
September	211	216	—	379	264	258	123	22	0
October	—	—	—	251	171	52	131	241	148
November	218	202	—	108	262	53	66	63	66
December	142	326	—	97	99	58	112	39	73
January	—	—	—	109	197	42	286	66	51
February	120	43	—	255	130	10	85	98	27
March	176	350	—	—	—	—	237	131	158
April	980	523	—	305	352	202	465	137	134
May	169	549	2	98	93	38	123	28	48
June	303	78	48	81	144	60	100	38	80
July	251	54	15	97	91	40	221	65	14
Totals	2755	2636	65	1970	2021	837	1983	1004	812

During the 3-year study, *F. parvus* has been an important species well represented in samples from all BERC collection sites except Field 3. The group total for Anurophorinae in Table 1 is made up almost entirely of this species. Table 3 compares the occurrence of *F. parvus* (individuals showing two eyes on each side) with *F. stachi* (individuals showing one eye on each side.)

A second disturbance of Field 3, one which did not seem to adversely affect collembolan numbers, took place in April 1972 when after a light disking of the corn stubble, oats was seeded. A thin stand

of 3-inch high oats was present April 26 when the monthly sample was collected. The collection of 202 individuals compared favorably with 305 from Field 1 and 352 from Field 2. During May and June the oats was pastured off leaving a partial stand of red clover which provided less than 60% crown cover. Pasturing continued, and severe soil compaction resulted. Tilth of the soil, poor even in 1971 when corn was planted, deteriorated during 1972. Although Field 3 was pastured throughout 1973, emergence of various weeds, particularly foxtail (*Setaria sp.*) improved the cover, possibly contributing to an increase in collembolan populations that year. In spite of densely compacted surface soil, in September 1973 Field 3 yielded a sample with 254 specimens compared with 46 from 2 and 157 from 1. Table 2 presents the 3-year's data from the cropfields.

TABLE 3. *Occurrence of* Folsomides parvus *Folsom and* Folsomides stachi *Folsom in Fields 1, 2, and 3 during the 3-year study.*

		Folsomides parvus		*Folsomides stachi*	
Field Number	Total Collections	Collections with Species	Number of Individuals	Collections with Species	Number of Individuals
1	33	22	455	3	4
2	33	18	785	1	1
3	26	1	1	4	8

Considerations for Future Research

Sampling techniques and evaluation of data must take into account the occurrence of both large and moderately large aggregate populations. Investigations must consider separately and in various combinations the effects of numerous factors on species association, population dynamics, species behavior, seasonal response, and possibly other collembolan responses. Following are eight important factors to consider:

1) Soil type—particularly as it relates to the internal moisture holding capacity, organic content, pH, and soil aggregate makeup.

2) Soil structure—reflecting many management considerations, *e.g.*, cropping sequence, manuring, irrigation, reduced tillage practices, regulated grazing, and artificial drainage.

3) Chemical additives—fertilizer, pH amendments, pesticides, and pollutants.

4) Site disturbance—fitting for agricultural crops, pasturing, compaction by vehicles or animals (including people,) flooding, clearing, and urbanization.

5) Established plant cover—species of plant present, the growth habits of the predominating vegetation, and the thrift of the stand.

6) Fauna—with particular reference to species predatory to Collembola or symbiotic with them.

7) Flora—with particular reference to the micro-flora [see Bellinger (2) p. 63].

8) Climate—temperature, moisture (both amount and distribution over time), sunlight and wind.

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