

FRAGMENTA FAUNISTICA

Fragm. faun.	Warszawa, 30.11.1998	41	3	15-28
--------------	----------------------	----	---	-------

Igor J. KAPRUS

The fauna of springtails (*Collembola*) from selected habitats in Roztocze

Abstract. 158 species of *Collembola*, among them some species rare in Europe are recorded from Roztocze – an upland region in south-eastern Poland and in Western Ukraine. Coexistence of boreal-montane, montane, South-European, North-European and endemic species is the most characteristic feature of the fauna of the region.

Key words: *Collembola*, fauna of Roztocze

Author's adress: State Museum of Natural History, NASU, Lviv, Ukraine

INTRODUCTION

Today, about 2,500 species of springtails are known from Europe. However insufficient study of the fauna of separate regions still prevents scientist from using this group of invertebrates for zoogeographical purposes.

Now, 355 species of springtails are known for the Ukrainian fauna. The Ukrainian Carpathians have been studied most completely (266 species) and for the rest of the area, including the Crimea, only 239 species of *Collembola* are known. The Roztocze region, with its great diversity of soils and vegetation, has been little studied. Only in the works of J. STACH (1947, 1963, 1964) some species recorded from this region are given. In particular, 9 species of *Collembola* are known for Central Roztocze (Roztocze Środkowe): *Xenylla maritima* TULLBERG, *Anurophorus laricis* NICOLET, *Isotoma hiemalis* SCHÖTT, *Isotomurus palustris* (MÜLLER), *Tomocerus vulgaris* (TULLBERG), *Orchesella flavescens* (BOURLET), *Entomobrya nivalis* (L.), *E. arborea* (TULLBERG), *Entomobrya corticalis* (NICOLET) (STACH 1964) and 3 species in all for South-Eastern Roztocze: *Neanura muscorum* (TEMPLETON), *Tetrodontophora bielaniensis* WAGA,

Folsomia quadrioculata (TULLBERG). 12 more species are known for the nearest environs of Lviv (Dubliany) (STACH 1947, 1949a, b, 1951, 1954).

The object of our work was to study species composition of springtails in some (mainly forest) habitats in Roztocze and to define clearly the biotopic preferences of different species.

I express my thanks to the management of the Roztocze National Park (Director Z. KOTUŁA) and to Dr. A. LIANA and Dr. W. MIKOŁAJCZYK (Institute of Zoology of PAS) for their help and assistance in my investigations in the Roztocze National Park.

MATERIAL AND METHODS

The material was collected between 1986 and 1990 within the framework of a systematic programme of scientific research of the State Museum of Natural History NASU; a total of 650 soil samples were collected and 23,350 springtail specimens were identified. The principal collections of *Collembola* were carried out in the south-eastern part of Roztocze, mainly in the Roztoczcza Reservation (Ukraine). Some material was collected in other habitats, e. g. in urban green of Lviv but mainly in meadows and pastures.

Within the framework of collaboration between the State Museum of Natural History NASU (Lviv) and the Institute of Zoology of the Polish Academy of Sciences (Warszawa) I also collected material in forest biotopes of the Roztocze National Park (Central Roztocze in Poland). A detailed description of the vegetation of the region investigated may be found in the works by IZDEBSKI et al. (1992) and by ZHYZHYN, KHAGALO and CHABAN (1988).

Soil samples of 250 cm³ volume were taken down to 10 cm, extracted in a Tullgren's apparatus for 5 days and preserved in 80% ethyl alcohol. Extensive material was also collected by the techniques of direct capturing.

The system of the genera and families is cited after the work "*Collembola* of USSR" (BABENKO et al. 1988) and separate works on systematics of *Collembola*.

LIST OF SELECTED HABITATS IN ROZTOCZE

Roztocze National Park (RPN)

Forests

1. Bukowa Góra, *Dentario glandulosae-Fagetum*, soil and litter
2. Bukowa Góra, *Abietetum polonicum*, soil and litter
3. Bukowa Góra, *Tilio-Carpinetum*, soil and litter
4. Zwierzyniec, *Betuleto-Alnetum*, soil and litter
5. Zwierzyniec, *Leucobryo-Pinetum*, soil and litter

Roztoczcza Reservation (RR)

6. Ivano-Frankove, ecological profile of Piasecky, *Fageto-Quercetum*, soil and litter
7. Ivano-Frankove, ecological profile of Piasecky, *Pineto-Fagetum*, soil and litter
8. Ivano-Frankove, ecological profile of Piasecky, *Carpineto-Quercetum*, soil and litter
9. Ivano-Frankove, ecological profile of Piasecky, *Querceto-Pinetum*, soil and litter

10. Ivano-Frankove, ecological profile of Piasecky, *Alnetum glutinosae*, soil and litter
11. Vereszycia near Ivano-Frankove, *Fagetum*, soil and litter
12. Vereszycia near Ivano-Frankove, *Fagetum*, under bark
13. Lelechivka near Ivano-Frankove, *Fageto-Pinetum*, soil and litter
14. Lelechivka near Ivano-Frankove, *Pinetum*, soil and litter

Bottomland sites of the Vereszycia River

15. Ivano-Frankove, locality "Zalyvky", *Salicetum cinerea purum*, soil and litter
16. Ivano-Frankove, locality "Zalyvky", *Molinietum caricosum (appropinquatae, rostratae, nigrae)*, soil and litter
17. Ivano-Frankove, locality "Zalyvky", *Betuleto (pubescentis)-betuletum (humilae) oxycoccosum (palustrae)*, soil and litter
18. Ivano-Frankove, locality "Zalyvky", *Betuletum pubescentis deschampsiosum*, soil and litter
19. Ivano-Frankove, locality "Zalyvky", *Betuleto (pubescentis)-Pinetum (frangulosum)*, soil and litter
20. Ivano-Frankove, locality "Zalyvky", *Betuleto (pubescentis) deschampsioso-moliniosum*, soil and litter
21. Ivano-Frankove, locality "Zalyvky", *Betuleto-Pinetum coryllosum*, soil and litter

Meadows

22. Stavky near Ivano-Frankove, pasture, soil and litter
23. Szklo, dry meadow, soil and litter, on grass
24. Hlynske near Zhovkva, wet meadow, on grass

Urban green of Lviv

25. Ivan Franko Park, soil and litter
26. Pohulianka Park, soil and litter
27. Orchard near the centre, soil and litter
28. Orchard near the centre, on grass, under bark of fruit trees.

GENERAL CHARACTERISTICS OF THE SPRINGTAIL FAUNA

The material collected in the region studied comprised 158 species of *Collembola* which belonged to 65 genera and 16 families (they constituted 43% of the Ukrainian collembolan fauna) (Table 1 – in the end of this paper). In the Polish part of Roztocze 51 species of springtails were found and in the Ukrainian part – 152 species in all. The largest number of species belonged to the families *Isotomidae* (31) and *Entomobryidae* (29), with a relative richness of *Onychiuridae* (19), *Neanuridae* (18), *Hypogastruridae* (19). Species of the families *Isotomidae* and *Onychiuridae* form the basis of the faunistic complex in arctic deserts and in boreal forests (KUZNETSOVA 1985, BABENKO 1993). Moving towards the south a gradual increase may be observed in species number in the families *Entomobryidae*, *Neanuridae*, *Odontellidae*, *Sminthuridae*, *Dicyrtomidae*. In the investigated habitats of Roztocze the proportion of the above-mentioned families is high – up to 40%, and may reach even 60% of the total species richness of the specific fauna in some tropical regions (DEHARVENG et al. 1989).

In the biotopes investigated a specific complex of springtails is formed on a common faunistic basis and it is very similar to the Central-European fauna. A comparison of faunistic spectra of *Collembola* in forest coenoses shows that

approximately half of the species belong to *Poduromorpha*. This is a peculiarity of a specific complex of communities in forests in the temperate and tropical climate (DEHARVENG et al. 1989).

In the majority of plant associations investigated the main body of the *Collembola* fauna is formed by euryplastic and polytopic species and species of forest complexes. Such species as *Folsomia manolachei*, *Isotomiella minor*, *Isotoma notabilis*, *Protaphorura armata*, *Folsomia quadrioculata*, *Lepidocyrtus lignorum*, *Lepidocyrtus lanuginosus*, *Friesea mirabilis*, *Isotoma tigrina*, *Pogonognathellus flavescens*, *Sminthurinus aureus*, *Pseudosinella zygophora*, *Megalothorax minimus*, *Sphaeridia pumilis*, *Tomocerus minor* are found very often.

In the region investigated special attention must be paid to some rare species which at present are known only from several localities in the world. They are: *Endonura tetraphthalma*, *Folsomia duodecimoculata*, *Karlstejnina annae*, *Odontella montemaceli*, *Folsomia strenzkei*, *Folsomia lawrensei*, *Orchesella sphagneticola*, *Lepidocyrtus nigrescens*, *Proisotoma armeriae*. In addition to those mentioned above the following species are recorded in single specimens: *Tetracanthella* sp. n. cf. *ksenemani*, *Deutonura stachi*, *Hypogastrura scotica*, *Neonaphorura adulta*, *Odontella lamellifera*, *Micranurida forsslundi*, *Sminthurides pseudoassimilis*, *Heteromurus bilineatus*.

The high species density and abundance of springtails are features characteristic of the forest fauna. The basis of the *Collembola* fauna in Roztocze forest is made by typical forest species (about 40% species diversity). In forest communities two groups of species typical of boreal and nemoral forests are distinguished. *Willemia anophthalma*, *W. denisi*, *Isotoma hiemalis*, *Anurophorus septentrionalis*, *Hypogastrura scotica* belong to the former group and *Endonura tetraphthalma*, *Pseudosinella zygophora*, *Neanura minuta*, *Lepidocyrtus paradoxus*, *Lipothrix lubbocki*, *Allacma fusca*, *Arrhopalites spinosus*, *Caprainea marginata*, *Pogonognathellus longicornis*, *Tomocerus minor*, *Thaumanura carolii* to the latter.

The corticophilous fauna is fairly specific and it is represented here by the following species: *Folsomia duodecimoculata*, *Entomobrya corticalis*, *E. arborescens*, *E. nivalis*, *Friesea clavisetata*, *Isotoma abella*, *Vertagopus cinereus*, *Xenylla boernerii*, *X. brevicauda*, *Willowsia buski*, *Odontella lamellifera*.

In open areas (bottomland meadow, pasture, wet meadow, dry meadow) we come across species which are rarely found under the forest cover or are absent there altogether. On one side these are hygro- and mesophilous species: *Hypogastrura mosquensis*, *Orchesella sphagneticola*, *Isotoma viridis*, *Willemia intermedia*, *Sphaeridia pumilis*, *Lepidocyrtus curvicollis*, *Deuterosminthurus bicinctus*, *Sminthurinus elegans*, *Protaphura campata*, *Brachystomella parvula*, *Sminthurus viridis*, *Spatulosminthurus flaviceps*, species of the genera *Sminthurides*, *Isotomurus* and on the other xerophilous species: *Metaphorura affinis*, *Stenaphorurella quadrispina*, *Hypogastrura succinea*, *Entomobrya multifasciata*, *E. quinquelineata*, *Folsomides parvulus*, *Isotomodes productus*, *Deuterosminthurus repandus*. The last two may be considered characteristic of the typical steppe fauna of *Collembola*.

In the urban green of Lviv there often are found synanthropic, compost and ruderal species which have not been recorded from natural forests. These are: *Folsomia candida*, *Isotoma anglicana*, *Heteromurus nitidus*, *Sinella caeca*, *Arrhopalites caecus*, *Cryptopygus bipunctatus*, *Folsomia fimetaria*, *Hypogastrura purpureascens*.

ZOOGEOGRAPHICAL ANALYSIS

For European species of springtails wide geographical ranges of distribution are typical. For example, according to different literature data (SZEPTYCKI 1967, WEINER 1981, POMORSKI 1992), widely distributed *Collembola* species (Cosmopolitan, Holarctic, Palaearctic, Euro-Siberian, Euro-North-American, Pan-European) constitute from 64.4% to 79.4% of their total number in particular faunas. In the Roztocze fauna only about 58% of species are widely distributed ones. This is indicative of high species specificity of the fauna of the region. Such character of the fauna first of all depends on the presence of boreal-montane, montane, and North- and South-European species of springtails.

A partly montane character of the Roztocze fauna depends on a fairly large proportion of boreal-montane and montane elements (9.6% of total species number) in a particular fauna. The boreal-montane element of the fauna is made by the six following species: *Xenylla brevicauda*, *Anurida granulata*, *Micranurida forsslundi*, *Folsomia inoculata*, *Vertagopus westerlundii*, *Tomocerus minutus*. Such species as *Tetrodontophora bielensis*, *Odontella montemaceli*, *O. pseudolamellifera*, *Hypogastrura luteospina*, *Thaumanura carolii*, *Folsomia multiseta*, *Plutomurus carpaticus*, *Orthonychiurus rectopapillatus*, *Deutonura stachi* can be included into the montane element. The last three species belong to the Carpathian endemics.

The majority of the boreal-montane and montane species are limited in their expansion to the plains of Roztocze and Podillia. Only some species of *Collembola* reach Polissia.

Four South-European species have been found in the region investigated. These are: *Neanura minuta*, *Entomobrya muscorum*, *E. quinquelineata*, *Hypogastrura luteospina*. The recording of the North-European species *Hypogastrura scotica*, *Anurophorus septentrionalis*, *Folsomia fimetarioides* in Roztocze is interesting.

The investigated collembolan fauna from Roztocze is rich in different chorologic elements. This may be explained by the fact that the region investigated occupied a special place in the historical events on the European continent at the end of the Tertiary and Quaternary periods.

REFERENCES

- BABENKO A. B. 1993. Temperatur preferendums of *Collembola* from Taimir arctic tundra. Zool. Zh., Moscow, 72, 4: 41-52.
- BABENKO A. B., KUZNETZOVA N. A., POTAPOV M. B., STEBAIEVA S. K., CHANISLAMOVA G. M., CHERNOVAN. M. 1988. *Collembola* of USSR. Moscow, 214 pp.

- DEHARVENG L., BEDOS A., LEKSAWASDI P. 1989. Diversity in tropical forest soil: The *Collembola* of Doi Inthanon (Thaailand). 3rd Intern. Semin. on *Apterygota*, ed. R. DALLAI. Siena, pp. 317–328.
- IZDEBSKI K., CZARNECKA B., GRADZIEL T., LORENS B., POPIOLEK Z. 1992. Zbiorowiska roślinne Roztoczańskiego Parku Narodowego na tle warunków siedliskowych. Lublin, 268 pp.
- KUZNETSOVA N. A. 1985. Types of collembolan population in coniferous forests of the European part of the USSR. In: *Microarthropods ecology in forest soil*. Moskov, pp. 24–52.
- POMORSKI R. 1992. Skoczogonki (*Collembola*) Śląży. *Acta univ. wratisl. Pr. zool.*, Wrocław, 1124, 23: 83–103.
- STACH J. 1947. The Apterygoten fauna of Poland in relation to the world fauna of this group of Insects. Family *Isotomidae*. *Acta monogr. Mus. Hist. Nat.*, Kraków, 488 pp.
- STACH J. 1949a. The Apterygoten fauna of Poland in relation to the world fauna of this group of Insects. Families: *Neogastruridae* and *Brachystomellidae*. *Acta monogr. Mus. Hist. Nat.*, Kraków, 341 pp.
- STACH J. 1949b. The Apterygoten fauna of Poland in relation to the world fauna of this group of Insects. Families: *Anuridae* and *Pseudacharutidae*. *Acta monogr. Mus. Hist. Nat.*, Kraków, 122 pp.
- STACH J. 1951. The Apterygoten fauna of Poland in relation to the world fauna of this group of Insects. Family *Bilobidae*. *Acta monogr. Mus. Hist. Nat.*, Kraków, 97 pp.
- STACH J. 1954. The Apterygoten fauna of Poland in relation to the world fauna of this group of Insects. Family: *Onychiuridae*. *Acta monogr. Mus. Hist. Nat.*, Kraków, 219 pp.
- STACH J. 1956. The Apterygoten fauna of Poland in relation to the world fauna of this group of Insects. Family: *Sminthuridae*. *Acta monogr. Mus. Hist. Nat.*, Kraków, 287 pp.
- STACH J. 1957. The Apterygoten fauna of Poland in relation to the world fauna of this group of Insects. *Neelidae* and *Dicyrtomidae*. *Acta monogr. Mus. Hist. Nat.*, Kraków, 113 pp.
- STACH J. 1960. The Apterygoten fauna of Poland in relation to the world fauna of this group of Insects. Tribe: *Orchesellini*. *Acta monogr. Mus. Hist. Nat.*, Kraków, 151 pp.
- STACH J. 1963. The Apterygoten fauna of Poland in relation to the world fauna of this group of Insects. Tribe: *Entomobryini*. *Acta monogr. Mus. Hist. Nat.*, Kraków, 140 pp.
- STACH J. 1964. Owady bezskrzydłe *Apterygota*. W: *Katalog fauny Polski*, 15. Warszawa, 103 pp.
- SZEPTYCKI A. 1967. Fauna of the springtails (*Collembola*) of the Ojców National Park in Poland. *Acta zool. crac.*, Kraków, 12: 219–280.
- WEINER W. M. 1981. *Collembola* of the Pieniny National Park. *Acta zool. crac.*, Kraków, 25: 417–500.
- ZHYZHYN M. P., KAGHALO O. O., CHABAN C. I. 1988. Greens of locality "Zalyvky" of Roztochchia Reservation. *Ukr. Bot. Zhurn.*, Kyiv, 45, 1: 68–73.

STRESZCZENIE

[Tytuł: Fauna *Collembola* wybranych środowisk Roztocza]

W wybranych zbiorowiskach roślinnych ukraińskiej i polskiej części Roztocza stwierdzono występowanie 158 gatunków *Collembola* (tab. I – na końcu pracy). Materiały były zbierane w latach 1986–1990, głównie na obszarze rezerwatu Roztocze w okolicy Iwano Frankowa i Lwowa (Ukraina) oraz w Roztoczańskim Parku Narodowym (Polska). Najliczniej w zebranych materiałach reprezentowane są rodziny: *Isotomidae* (31 gatunków) oraz *Entomobryidae* (29 gatunków).

Trzon zgrupowań *Collembola* jest charakterystyczny dla fauny Europy Środkowej. Tworzą go głównie eury- i politopowe gatunki takie jak: *Isotomiella minor*, *Isotoma notabilis*, *I. tigrina*, *Folsomia quadrioculata*, *F. manolachei*,

Sminthurinus aureus, *Friesea mirabilis*, *Pseudosinella zygophora* i wiele innych. W środowiskach leśnych Roztocza 40% fauny Collembola stanowią gatunki typowo leśne reprezentujące dwie grupy: borealną i nemoralną. Do pierwszej można zaliczyć takie gatunki jak: *Willemia anophthalma*, *W. denisi*, *Isotoma hiemalis*, *Anurophorus septentrionalis*, *Hypogastrura scotica*; do drugiej: *Endonura tetrophthalma*, *Pseudosinella zygophora*, *Neanura minuta*, *Lepidocyrtus paradoxus*, *Lipothrix lubbocki*, *Allacma fusca*, *Arrhopalites spinosus*, *Caprainea marginata*, *Pogonognathellus longicornis*, *Tomocerus minor*, *Thaumanura carolii*.

Bardzo specyficzna jest fauna podkorowych Collembola (kortykofilna), na Roztoczu reprezentowana przez: *Folsomia duodecimoculata*, *Entomobrya corticalis*, *E. arborea*, *E. nivalis*, *Friesea claviseta*, *Isotoma abella*, *Vertagopus cinereus*, *Xenylla boernerii*, *X. brevicauda*, *Willowsia buski*, *Odontella lamellifera*.

Ze środowiskami otwartymi związane są z jednej strony gatunki hygromefilne, jak na przykład: *Hypogastrura mosquensis*, *Orchesella sphagneticolla*, *Willemia intermedia*, *Isotoma viridis*, *Sminthurinus elegans*, *Protaphura campata*, *Brachystomella parvula*, *Sphaeridia pumilis*, *Sminthurus viridis*, *Spatulosminthurus flaviceps*, *Deuterosminthurus bicinctus*; z drugiej gatunki kserotermofilne, jak: *Metaphorura affinis*, *Stenaphorurella quadrispina*, *Hypogastrura succinea*, *Entomobrya multifasciata*, *E. quinquelineata*, *Folsomides parvulus*, *Isotomodes productus*, *Deuterosminthurus repandus*.

Na szczególną uwagę zasługuje występowanie na Roztoczu gatunków znanych dotychczas z niewielu stanowisk na świecie. Są to: *Endonura tetrophthalma*, *Folsomia duodecimoculata*, *Karlstejnina annae*, *Odontella montemaceli*, *Folsomia strenzkei*, *Orchesella sphagneticolla*, *Proisotoma armeriae*, *Folsomia lawrensei*.

Tylko w środowisku zieleni miejskiej Lwowa znaleziono synantropijne i ruderalne skoczogonki: *Folsomia candida*, *Isotoma anglicana*, *Heteromurus nitidus*, *Sinella caeca*, *Arrhopalites caecus*, *Cryptopygus bipunctatus*, *Hypogastrura purpurescens*.

Spośród gatunków Collembola wykazanych z Roztocza stosunkowo mniej niż w innych regionach, bo około 58%, ma szerokie zasięgi (kosmopolityczne, palearktyczne, euroszyberyjskie, europejsko-północnoamerykańskie). Stosunkowo duży natomiast jest odsetek gatunków borealno-górskich, górskich, borealnych i południowoeuropejskich.

Okolo 9,6% wszystkich roztoczańskich Collembola stanowią gatunki borealno-górskie i górskie. Do pierwszej z wymienionych grup można zaliczyć: *Xenylla brevicauda*, *Anurida granulata*, *Micranurida forsslundi*, *Folsomia inoculata*, *Vertagopus westerlundi*, *Tomocerus minutus*. Spośród wymienionych poniżej gatunków górskich trzy ostatnie należą do endemitów karpaccyckich: *Tetrodontophora bielansensis*, *Odontella montemaceli*, *O. pseudolamellifera*, *Hypogastrura luteospina*, *Thaumanura carolii*, *Folsomia multiseta*, *Plutomurus carpaticus*, *Ortonychiurus rectopapillatus*, *Deutonura stachi*.

Na Roztoczu znaleziono cztery południowoeuropejskie gatunki Collembola: *Neanura minuta*, *Entomobrya muscorum*, *E. quinquelineata*, *Hypogastrura*

luteospina. Do gatunków borealnych natomiast można zaliczyć: *Hypogastrura scotica*, *Anurophorus septentrionalis*, *Folsomia fimetarioides*.

Tak interesujący skład chorologiczny *Collembola* Roztocza ma ścisły związek z rolą jaką omawiany region odegrał w historii fauny środkowoeuropejskiej w końcu trzeciorzędu i w czwartorzędzie.

Table I. List of springtails (*Collembola*) of the studied habitats in Roztocze. Explanations: RNP – Roztocze National Park (Poland). RR – Roztoczcza Reservation (Ukraine)

N.	Species	RPN	RR		Meadows	Urban greens of Lviv	Habitats
		Forests	Forests	Bottom-land sites			
1	2	3	4	5	6	7	8
	<i>Hypogastruridae</i>						
1.	<i>Hypogastrura (Ceratophysella) armata</i> (NICOLET)	+	+	-	-	-	1, 13
2.	<i>Hypogastrura (Ceratophysella) mosquensis</i> (BECKER)	-	-	+	+	-	6, 16-20, 22
3.	<i>Hypogastrura (Ceratophysella) silvatica</i> RUSEK	-	+	-	-	+	6, 9-11, 13, 26, 27
4.	<i>Hypogastrura (Ceratophysella) succinea</i> GISIN	-	-	-	+	-	23
5.	<i>Hypogastrura (Ceratophysella) denticulata</i> (BAGNALI)	+	+	-	+	+	1, 3, 13, 22, 23, 25-27
6.	<i>Hypogastrura (Ceratophysella) scotica</i> (CARPENTER EVANS)	-	-	+	-	-	17
7.	<i>Hypogastrura (Ceratophysella) bengtssowi</i> ÅGREN	-	-	-	-	+	27
8.	<i>Hypogastrura (Ceratophysella) luteospina</i> STACH	-	+	-	-	-	9
9.	<i>Hypogastrura (Hypogastrura) vernalis</i> (CARL)	-	-	-	-	+	27
10.	<i>Hypogastrura (Hypogastrura) socialis</i> (ÜZEL)	-	-	+	-	-	17-20
11.	<i>Hypogastrura (Hypogastrura) viatica</i> TULLBERG	-	-	-	+	+	22, 27
12.	<i>Hypogastrura (Hypogastrura) manubrialis</i> (TULLBERG)	-	+	-	-	-	14
13.	<i>Hypogastrura (Hypogastrura) purpurescens</i> LUBBOCK	-	-	-	-	+	27
14.	<i>Willemia anophthalma</i> BÖRNER	+	+	-	-	+	5, 8-10, 25-27
15.	<i>Willemia denisi</i> MILLS	+	+	-	-	+	5, 9, 10, 14, 27
16.	<i>Willemia intermedia</i> MILLS sensu HÜTHER	-	-	-	+	-	22
17.	<i>Xenylla brevicauda</i> TULLBERG	-	+	-	-	-	12
18.	<i>Xenylla maritima</i> TULLBERG sensu STACH	+	-	-	+	+	5, 22, 23, 28
19.	<i>Xenylla boernerii</i> AXELSON	+	+	-	-	+	3, 6, 26, 28
	<i>Poduridae</i>						
20.	<i>Podura aquatica</i> L.	-	-	+	-	-	15
	<i>Odontellidae</i>						
21.	<i>Odontella montemaceli</i> WEINER	+	-	-	-	-	3

Table I. continued

1	2	3	4	5	6	7	8
22.	<i>Odontella lamellifera</i> AXELSON	-	+	+	-	-	12, 13, 16
23.	<i>Odontella pseudolamellifera</i> STACH	-	+	-	-	-	11
	<i>Neanuridae</i>						
24.	<i>Frisea mirabilis</i> (TULLBERG)	+	+	+	+	+	5, 8, 9-12, 14-18, 20-22, 25, 26
25.	<i>Frisea claviseta</i> AXELSON	-	-	-	-	+	25, 28
26.	<i>Brachystomella parvula</i> (SCHÄFFER)	-	+	-	+	-	6, 9, 10, 22
27.	<i>Pseudacherutes parvulus</i> BÖRNER	+	+	-	-	+	1, 5, 6, 8, 14, 28
28.	<i>Pseudacherutes dubius</i> KRAUSBAUER	+	+	+	-	-	3, 8, 9, 11, 16, 21
29.	<i>Pseudacherutes subcrassus</i> TULLBERG	+	+	-	+	-	5, 6, 10, 11, 23
30.	<i>Pseudacherutes corticolus</i> (SCHÄFFER)	-	+	-	-	+	6, 9, 14, 25
31.	<i>Micranurida pygmaea</i> BÖRNER	-	-	-	+	-	22
32.	<i>Micranurida forsslundi</i> GISIN	+	+	-	-	-	1, 11
33.	<i>Anurida granulata</i> AGRELL	+	+	-	-	-	2, 5, 6, 11
34.	<i>Anurida</i> . sp. n. cf. <i>brunsvigiensis</i> HÜTHER	+	+	-	-	-	2, 5, 8, 9, 11
35.	<i>Anurida tullbergi</i> SCHÖTT	-	-	+	-	-	15
36.	<i>Thaumanura carolii</i> (STACH)	+	+	-	-	-	4, 6, 11
37.	<i>Neanura muscorum</i> (TEMPLETON)	+	+	+	-	+	4-8, 10, 11, 14, 15, 20, 23, 27, 28
38.	<i>Neanura minuta</i> GISIN	+	+	-	-	-	1, 12
39.	<i>Deutonura stachi</i> GISIN	+	-	-	-	-	2
40.	<i>Deutonura albella</i> (STACH)	+	+	+	-	-	1, 2, 5, 6, 9-12, 17-19, 21
41.	<i>Endonura tetrophthalma</i> STACH	-	-	+	-	-	15
	<i>Onychiuridae</i>						
42.	<i>Tetradontophora bielaniensis</i> WAGA	+	+	+	-	-	2, 4, 6-11, 13, 21
43.	<i>Micraphorura absoloni</i> (BÖRNER)	+	+	-	-	+	4-6, 8-11, 13, 27
44.	<i>Hymenaphorura polonica</i> POMORSKI	+	+	-	-	-	3, 8, 10
45.	<i>Protaphorura armata</i> (TULLBERG)	+	+	+	+	+	1-4, 6-11, 13, 14, 16-22, 25-27
46.	<i>Protaphorura campata</i> (GISIN)	+	-	+	+	+	1, 18-20, 22, 26
47.	<i>Protaphorura pseudocellata</i> NAGLITSCH	-	+	-	-	+	6-8, 11, 25, 26
48.	<i>Protaphorura aurantiaca</i> (RIEDLE)	-	+	-	-	-	8
49.	<i>Protaphorura subuliginata</i> GISIN	+	+	-	+	-	2, 3, 6, 8, 10, 11, 13, 22

Table I. continued

1	2	3	4	5	6	7	8
50.	<i>Orthonychiurus rectopapillatus</i> STACH	+	+	+	-	-	1-3, 5, 11, 12, 19, 21
51.	<i>Deuteraphorura insubrarica</i> GISIN	-	-	-	-	+	27
52.	<i>Onychiurus ambulans</i> (L.) sensu STACH	-	-	-	-	+	27
53.	<i>Mesaphorura krausbaueri</i> (BÖRNER)	-	-	-	+	+	22, 23, 26, 27
54.	<i>Mesaphorura italica</i> RUSEK	+	+	-	-	-	3, 5, 6, 8
55.	<i>Mesaphorura macrochaeta</i> (RUSEK)	-	-	-	+	+	23, 27
56.	<i>Mesaphorura sylvatica</i> RUSEK	-	+	+	-	-	6, 18, 20, 21
57.	<i>Neonaphorura adulta</i> GISIN	-	-	-	-	+	28
58.	<i>Metaphorura affinis</i> (BÖRNER)	-	-	-	+	+	23, 25
59.	<i>Stenaphorurella quadrispina</i> (BÖRNER)	-	-	-	+	+	23, 25
60.	<i>Karlstejnia annae</i> RUSEK	-	+	-	-	-	9
	<i>Isotomidae</i>						
61.	<i>Tetracanthella</i> sp. n. cf. <i>ksenemani</i> NOSEK	-	+	-	-	-	13
62.	<i>Anurophorus septentrionalis</i> PALISSA	+	-	-	-	-	5
63.	<i>Isotomodes productus</i> (AXELSON)	-	-	-	+	-	23
64.	<i>Folsomides parvulus</i> STACH	-	-	-	+	+	23, 26
65.	<i>Folsomia manolachei</i> (BAGNAL) sensu DEHARVENG	+	+	+	+	+	1-4, 6-14, 16-22, 25-27
66.	<i>Folsomia quadrioculata</i> (TULLBERG)	+	+	+	+	+	1, 4, 6, 8-11, 13, 15-21, 24, 26
67.	<i>Folsomia multisetata</i> STACH	-	+	+	+	+	7, 11, 15, 18, 22, 27
68.	<i>Folsomia inoculata</i> STACH	-	+	-	-	-	9
69.	<i>Folsomia lawrensei</i> RUSEK	-	+	-	+	-	6, 7, 22
70.	<i>Folsomia duodecimoculata</i> MARTYNOVA	-	+	-	-	-	12
71.	<i>Folsomia candida</i> WILLEM	-	-	-	-	+	26, 27
72.	<i>Folsomia fimetarioides</i> (AXELSON)	-	+	-	-	-	9
73.	<i>Folsomia strenzkei</i> NOSEK	-	-	-	-	+	26
74.	<i>Folsomia fimetaria</i> (L.)	-	-	-	+	+	22, 27
75.	<i>Cryptopygus bipunctatus</i> (AXELSON)	-	-	-	-	+	26
76.	<i>Proisotoma minima</i> (ABSOLON)	-	+	+	+	+	9, 19, 22, 26
77.	<i>Proisotoma minuta</i> (TULLBERG)	-	-	-	-	+	25, 26
78.	<i>Proisotoma armeriae</i> FJELLBERG	-	+	+	+	-	6, 9, 15-18, 22
79.	<i>Isotomiella minor</i> (SCHÄFFER)	+	+	+	+	+	1-4, 6-11, 13-22, 26, 27
80.	<i>Isotomiella</i> sp. n. cf. <i>muscorum</i> (SCHÄFFER)	-	-	+	-	-	15, 16, 18

Table 1. continued

1	2	3	4	5	6	7	8
81.	<i>Isotoma notabilis</i> SCHÄFFER	+	+	+	+	+	1-14, 16-23, 25-27
82.	<i>Isotoma tigrina</i> (NICOLET)	+	+	+	+	+	1, 3, 4, 6, 8-10, 17, 18, 22, 27
83.	<i>Isotoma hiemalis</i> SCHÖTT	-	+	-	-	-	14
84.	<i>Isotoma nivea</i> (SCHÄFFER)	-	+	-	-	-	9
85.	<i>Isotoma anglicana</i> LUBBOCK	-	-	-	-	+	27
86.	<i>Isotoma violacea</i> TULLBERG	+	-	-	-	-	2
87.	<i>Isotoma viridis</i> BOURLET	-	+	+	+	+	6, 16, 22, 23, 25, 27
88.	<i>Isotomurus plumosus</i> BAGNALL	-	+	-	-	-	10
89.	<i>Isotomurus</i> gr. <i>palustris</i> (MÜLLER)	-	+	+	+	+	10, 15-19, 22, 26, 27
90.	<i>Vertagopus westerlundii</i> (REUTER)	-	+	+	-	-	10, 20
91.	<i>Vertagopus cinereus</i> (NICOLET)	-	+	-	-	+	6, 8, 12, 28
	<i>Cyphoderidae</i>						
92.	<i>Cyphoderus albinus</i> NICOLET	-	+	+	-	-	14, 18
	<i>Tomoceridae</i>						
93.	<i>Tomocerus minor</i> (LUBBOCK)	+	+	+	-	+	2, 4-10, 14, 21, 25-27
94.	<i>Tomocerus minutus</i> (TULLBERG)	+	-	-	-	-	1
95.	<i>Tomocerus vulgaris</i> (TULLBERG)	-	+	-	+	+	9, 23, 27
96.	<i>Plutomurus carpaticus</i> RUSEK et WEINER	+	+	-	-	-	1, 11
97.	<i>Pogonognathellus flavescens</i> (TULLBERG)	+	+	+	+	+	1, 2, 4-11, 13, 14, 16-21, 23, 24, 27
98.	<i>Pogonognathellus longicornis</i> (MÜLLER)	-	+	-	-	-	6, 13
	<i>Entomobryidae</i>						
99.	<i>Orchesella flavescens</i> (BOURLET)	+	+	-	+	+	5, 8, 13, 24, 28
100.	<i>Orchesella xerothermica</i> STACH	-	-	-	-	+	28
101.	<i>Orchesella bifasciata</i> NICOLET	-	-	-	-	+	26, 27
102.	<i>Orchesella spectabilis</i> TULLBERG	-	+	-	+	+	9, 12, 14, 24, 28
103.	<i>Orchesella pseudobifasciata</i> STACH	+	-	-	-	+	1, 2, 5, 28
104.	<i>Orchesella cincta</i> (L.)	-	-	-	-	+	28
105.	<i>Orchesella sphagnicola</i> STACH	-	-	+	-	-	16
106.	<i>Entomobrya nivalis</i> (L.)	-	+	-	-	+	14, 28
107.	<i>Entomobrya marginata</i> (TULLBERG)	-	-	-	+	-	23
108.	<i>Entomobrya muscorum</i> (NICOLET)	-	+	-	-	-	6, 8

Table I. continued

1	2	3	4	5	6	7	8
109.	<i>Entomobrya corticalis</i> (NICOLET)	+	+	+	+	-	5-7, 10-13, 15, 23
110.	<i>Entomobrya lanuginosa</i> (NICOLET)	-	+	+	+	-	6, 16-19, 21, 22
111.	<i>Entomobrya quinquelineata</i> (BÖRNER)	-	+	-	-	-	6
112.	<i>Entomobrya multifasciata</i> (TULLBERG)	-	-	-	-	+	28
113.	<i>Entomobrya puncteola</i> UZEL	-	-	-	-	+	28
114.	<i>Entomobrya arborea</i> (TULLBERG)	-	-	-	-	+	28
115.	<i>Lepidocyrtus lignorum</i> (FABRICIUS)	+	+	+	+	+	1-11, 13-21, 23-28
116.	<i>Lepidocyrtus lanuginosus</i> (GMELIN)	+	+	+	+	+	3-5, 8-10, 19, 20, 22, 26, 27
117.	<i>Lepidocyrtus cyaneus</i> TULLBERG	-	-	+	+	+	20, 23-25, 28
118.	<i>Lepidocyrtus violaceus</i> (GEOFFROY)	-	+	+	+	+	7, 17, 22, 27
119.	<i>Lepidocyrtus curvicollis</i> (BOURLET)	-	+	-	+	+	10, 24, 28
120.	<i>Lepidocyrtus paradoxus</i> UZEL	-	-	-	+	+	24, 28
121.	<i>Lepidocyrtus nigrescens</i> SZEPTYCKI	-	+	-	-	-	9
122.	<i>Pseudosinella zygophora</i> (SCHILLÉ)	+	+	+	-	+	1-11, 15-19, 21, 25, 26
123.	<i>Pseudosinella alba</i> (PACKARI)	-	-	-	+	+	25, 27
124.	<i>Sinella caeca</i> (SCHÖTT)	-	-	-	-	+	27
125.	<i>Heteromurus nitidus</i> (TEMPELTON)	-	-	-	-	+	25, 27
126.	<i>Willowsia nigromaculata</i> (LUBBOCK)	-	+	-	-	-	6, 10
127.	<i>Willowsia buski</i> (LUBBOCK)	-	+	+	-	+	10, 18-21, 28
	<i>Neelidae</i>						
128.	<i>Megalothorax minimus</i> WILLEM	+	+	+	+	+	1, 2, 5, 8, 9, 14, 16-21, 25-27
129.	<i>Neelides minutus</i> FOLSOM	-	+	+	+	-	7, 18, 22
	<i>Arrhopallitidae</i>						
130.	<i>Arrhopalites secundarius</i> GISIN	-	+	-	-	-	6, 7, 8, 11
131.	<i>Arrhopalites terricola</i> GISIN	-	+	-	-	-	6, 8
132.	<i>Arrhopalites principalis</i> STACH	-	-	+	-	-	15-19, 21
133.	<i>Arrhopalites spinosus</i> RUSEK	+	+	-	-	-	1, 6, 10
134.	<i>Arrhopalites caecus</i> (TULLBERG)	-	-	-	-	+	27
135.	<i>Arrhopalites</i> sp. n. cf. <i>canzianus</i> STACH	+	+	-	-	-	4, 6
136.	<i>Arrhopalites</i> sp. n. cf. <i>ornatus</i> STACH	-	+	-	-	-	9

Table 1. continued

1	2	3	4	5	6	7	8
	<i>Sminthurididae</i>						
137.	<i>Sphaeridia pumilis</i> (KRAUSBAUE)†	+	+	+	+	+	1, 2, 4, 6, 8, 10, 15–22, 24, 26, 28
138.	<i>Sminthurides malmgreni</i> (TULLBERG)	–	–	+	–	–	15, 16
139.	<i>Sminthurides aquaticus</i> (BOURLET)†	–	–	+	–	–	15, 16
140.	<i>Sminthurides schoetti</i> (AXELSON)	–	–	+	–	–	16–18
141.	<i>Sminthurides pseudoassimilis</i> STACH	–	–	+	–	–	15
142.	<i>Sminthurides parvulus</i> (KRAUSBAUE)†	–	–	+	–	–	15–17
	<i>Katiannidae</i>						
143.	<i>Sminthurinus aureus</i> (LUBBOCK)†	+	+	+	+	+	3, 5, 6, 8, 15–20, 24, 26–28
144.	<i>Sminthurinus elegans</i> (FITCH)†	–	–	–	+	+	23, 28
	<i>Bourletiellidae</i>						
145.	<i>Deuterostminthurus repandus</i> (ÅGREN)	–	–	–	+	+	23, 28
146.	<i>Deuterostminthurus bicinctus</i> (KOCH)†	–	–	–	+	+	23, 28
147.	<i>Heterostminthurus bilineatus</i> (BOURLET)†	–	–	+	–	–	18
	<i>Sminthuridae</i>						
148.	<i>Caprainea marginata</i> (SCHÖTT)†	+	+	+	–	–	5, 8, 10, 13, 15, 18, 19, 21
149.	<i>Lipotrix lubbocki</i> (TULLBERG)	+	+	+	–	+	2, 4–6, 10, 11, 19, 21, 26, 27
150.	<i>Allacma fusca</i> (L.)	–	+	+	–	–	9, 11, 12, 18, 19, 21
151.	<i>Sminthurus viridis</i> (L.)	–	–	+	+	+	16, 18, 24, 28
152.	<i>Spatulosminthurus flaviceps</i> TULLBERG	–	–	–	+	–	24
	<i>Dicyrtomidae</i>						
153.	<i>Dicyrtomina ornata</i> (NICOLE)†	–	+	–	–	+	9, 28
154.	<i>Dicyrtomina minuta</i> (FABRICIUS)	–	–	+	–	+	15, 28
155.	<i>Dicyrtoma fusca</i> (LUCAS)	–	–	+	–	+	15, 28
156.	<i>Ptenothrix setosa</i> (KRAUSBAUE)†	–	+	–	–	–	8, 10
157.	<i>Ptenothrix atra</i> (L.)	–	+	–	–	–	8, 10
158.	<i>Ptenothrix ciliata</i> STACH	–	+	–	–	–	9
	Total species	51	91	57	53	79	