

Centipedes (Chilopoda) of Some Forest Communities in Slovenia

Ivan KOS

Department of Biology, Biotechnical Faculty, Askerceva 2, 61000 Ljubljana, Slovenia

ABSTRACT

Centipede communities of seven forests in Slovenia were studied using the method of the quadrat sampling and extraction by modified Tullgren funnels. Three different forestal ecosystems were investigated in the southern part of Slovenia. This area is characterized by a small degree of pollution. On the three localities of *Abieti - Fagetum Dinaricum* 36 species of centipedes were found, estimated density per square meter was between 108 (± 53) and 579 (± 124). 18 species were found in *Luzulo albidiae - Fagetum*, estimated density varies between 354 (± 115) and 408 (± 94). In the *Asperulo - Carpinetum* 18 species were found, estimated density was between 136 (± 34) and 218 (± 88). In the northern part of Slovenia, around the town Velenje, three different forestal ecosystem types in five localities were investigated. There is a great emission of different pollutants by steam power station in this region of Slovenia. The species diversity was lower and the density was higher than in the non-polluted localities. In the *Querco - Luzulo - Fagetum* 23 species were identified and the estimated density ranged from 230 (± 137) to 655 (± 859), in the *Bazzanio - Abietetum* 16 species were found, the density was estimated between 195 (± 122) and 640 (± 137). In the *Vaccinio myrtilli - Pinetum* 12 species were found, the density was estimated between 165 (± 66) and 345 (± 345).

RÉSUMÉ

Chilopodes de quelques communautés forestières de Slovénie.

Les peuplements de chilopodes de sept forêts de Slovénie ont été échantillonnés par la méthode des quadrats suivi d'une extraction sélective à l'aide d'appareils de type Tullgren. Trois écosystèmes forestiers ont été étudiés dans le sud de la Slovénie, caractérisée par un faible degré de pollution. Dans trois sites à *Abieti - Fagetum Dinaricum*, 36 espèces de chilopodes ont été récoltées, la densité estimée par mètre carré varie de 108 (± 53) à 579 (± 124). 18 espèces ont été trouvées dans le *Luzulo albidiae - Fagetum* où la densité estimée varie de 354 (± 115) à 408 (± 94). Dans l'*Asperulo - Carpinetum*, 18 espèces ont été récoltées, dont la densité est estimée entre 136 (± 34) et 218 (± 88). Dans le nord de la Slovénie, aux environs de Velenje, trois types d'écosystèmes forestiers ont été étudiés dans cinq localités. Cette région est caractérisée par une forte émission de polluants due à l'activité d'une centrale thermique. La richesse spécifique est plus faible et la densité plus élevée que dans les sites non-pollués. Dans le *Querco - Luzulo - Fagetum*, 23 espèces ont été identifiées, la densité estimée variant de 230 (± 137) à 655 (± 859). Dans le *Bazzanio - Abietetum*, on a trouvé 16 espèces, dont la densité estimée varie de 195 (± 122) à 640 (± 137). Enfin, dans le *Vaccinio myrtilli - Pinetum*, 12 espèces ont été récoltées, leur densité estimée variant de 165 (± 66) à 345 (± 345).

INTRODUCTION

Very little is known about the communities of Centipedes (Chilopoda) from Slovenia; there are only a few records of them also from the northern part of the Balkan Peninsula. Only MATIC

(1966) and MATIC & TEODOREANU (1966) reported data about vegetation in localities. More information is available about centipedes in certain plant communities in Europe (e.g. ALBERT, 1979, 1982; DUNGER *et al.*, 1972; FRÜND, 1983, 1987; LOKSA, 1968, 1979; MEYER *et al.*, 1984; MINELLI & IOVANE, 1987; POSER, 1988; ZAPPAROLI, 1992; WYTWER, 1992). Comparing the region of our research with other places in Europe, we must emphasize that it has some specialities because of its' geographical site. It is important that here there are numerous mixed centipede species characteristic of different biogeographical areas (KOS, 1992). Populations of these species confirm many endemic and special communities. It is very important to research them and their basic characteristics for a better knowledge of the role of a single group of animals in the environment. In Slovenia, seven forest communities were studied at 11 different localities. The species composition, species diversity, density, and dominance were determined. Only the results of the method of quadrat of soil and litter sampling are represented here.

MATERIAL AND METHODS

The sampling sites

Centipede communities were studied in two regions in Slovenia. The first lies south of Ljubljana and is characterized by a small degree of pollution and well sustained forests. In the three localities near Kocevje (Rog, 900 m a.s.l., exposure SW) and Ribnica (Kot, 700 m a.s.l., exposure E; Mala gora, 850 m a.s.l., exposure SE) the sampling was done in the *Abieti - Fagetum Dinaricum*. The soil of these sites is shallow brown with underlying deep pockets in the limestone. On the surface, many stones are present and there are also stumps and decaying tree trunks. The fourth locality is near to Kocevje (Zeljne, 700 m a.s.l., flattened). Here the forest community is *Lamio orvule - Fagetum*. On the surface, there are few stones and the soil is similar to the previous ones. The forest of *Asperulo - Carpinetum* is near Ribnica (hamlet Seljan, 700 m a.s.l., exposure SW), the soil is shallow brown and lies on the geological joint through the limestone. *Luzulo albidae - Fagetum* is near Ribnica (Zrnovec, 600 m a.s.l., exposure SW). The soil is brown, with a thick layer of humus, the geological background is from Permian - Cretaceous silicate slate. The second research region was in the north of Slovenia surrounding the town Velenje. It is known for a great emission of different pollutants by steam powered electrical plant. Here we researched three plant communities. In the first two, two localities were selected which differed in the degree of pollution. Thus, in the *Quercu - Luzulo - Fagetum* the locality Veliki vrh (480 m a.s.l., exposure NE) the influence of the power station is greater than in Crnova (450 m a.s.l., exposure NW). In the *Bazzanio - Abietetum*, the less polluted locality Topolsica (450 a.s.l., exposure NW) was researched and Lajse (450 m a.s.l., exposure NW), which is more polluted. In the locality of Zavodnje *Vaccinio myrtilli - Pinetum* grows.

Sampling

From the forest soil a predetermined number of sampling units were taken (size 25x25x10 cm or 20x20x10 cm). The soil samples were taken randomly on the free surface between 8 and 12 a.m from areas, which are not covered with stones, stumps and tree trunks. Centipedes were extracted slowly on the modified Tullgren funnels, so that the extraction lasted 18- 21 days. The specimens were extracted in ethylene glycol and later transferred to 70% ethanol for the species determination after ATTEMS (1929, 1930), EASON (1982), KOREN (1986), MATIC (1966, 1972), VERHOEFF (1937) and others. The anamorph stages of Lithobiidae could not be determined and are labelled in the tables as *L. sp. juv.* Species *Si. n. sp.* is a new species for science, species *Si. non-microps* is determined after VERHOEFF (1937) as *Lithonnanus microps* Mein., but is another species (EASON, KOS, in prep.). The dates of sampling and the number of sampling units are listed in the tables. The estimated density was made after ELLIOT (1977), SEBER (1982) and KREBS (1989), but the type of the distributions was not taken into account. The 95% confidence limits of the mean was calculated as $\pm t \cdot SE$. The density is given for a m² of free forest surface. The Shannon - Weaver diversity index was also calculated.

RESULTS AND DISCUSSION

Species Composition

In the study of species composition we must take samples of suitable dimensions, about 20 sampling units in size 20x20x10 cm (KOS, 1988). Otherwise the species with small densities and the species with very aggregative distribution would not be included in the samples. It is also important to consider that some centipede species prefer some habitats (FRÜND, 1983, 1987; KOS, 1988). Because of this, species which live in tree trunks, in stumps, and under stones are not detected in their real number when using soil sampling methods. These must be considered in comparing different localities and communities. The largest number of species of

centipedes was found in *Abieti - Fagetum Dinaricum*, where 23 species were present in two localities and 22 species in one. This number is much larger than is reported from other parts of Europe (ALBERT, 1982; DUNGER *et al.*, 1972; FRÜND, 1983; LOKSA, 1968, 1979; MEYER *et al.*, 1984; WYTWER, 1992). The reason for this high number could be the biogeographical situation of these communities. An open question is the influence of the limestone substrate in the Karst, with its peculiar formations, on the number of species in these communities. Also, the influence of pollutants on the number of species is yet to be studied. In the *Asperulo - Carpinetum* and *Luzulo albidae - Fagetum*, 18 species were registered. Both localities are in southern Slovenia. Around the town Velenje, most of the species were present in *Quercus - Luzulo - Fagetum* (16 in one locality and 15 in another). In *Vaccinio myrtilli-Pinetum* we found 12 species, and the smallest number of species was found in *Bazzanio - Abietetum* (11 and 10 species). The results from communities mentioned are similar to those known from the middle of Europe (ALBERT, 1982; DUNGER *et al.*, 1972; FRÜND, 1983; LOKSA, 1968, 1979; MEYER *et al.*, 1984; WYTWER, 1992). The Shannon - Wieners diversity index shows the same situation; the highest is in *Abieti - Fagetum Dinaricum* (between 2.17 and 2.60). In other communities its value is lower (between 1.09 and 2.08).

Density

The density of centipedes was determined on the basis of sampling the "free" surface. The results, which present the number of animals per square meter of "free" surface are listed in the Tables 1-10. The number is probably underestimated because of the sampling methods and extraction. When sampling, we took only the upper 10 cm of soil, but some specimens also live deeper. And at slow extraction, some specimens remain in the soil (ALBERT, 1982; FRÜND, 1987). In comparing our density results to those of others we must take into account that they probably do not show the density of animals in the surface of the forest, but in the "free" surface, which is smaller. We suppose that other authors also estimated density in this way, but this was not always emphasized in their reports.

There is no data available about the density of centipedes in *Abieti - Fagetum*. The estimated number of centipedes varied between 108 (± 53) in one locality (Kot, on 8.5.1987, Table 2) and 579 (± 124) in the locality Rog (18.4.1990, Table 1). On the basis of our results we can conclude, that the density of centipedes in coniferous forest is smaller than in deciduous forest. It would be interesting to study the influence of litter on the density of centipedes. Taking into account the results of some authors who also researched centipedes in different communities (ALBERT, 1982; DUNGER *et al.*, 1972; FRÜND, 1983, 1987; WYTWER, 1992), we see that in spruce forests, the density of centipedes in studied communities in Slovenia is much bigger than in other parts of Europe. Further investigations of spruce forests in this region will probably give the explanation for such big differences in density. Similar as in spruce forests, also in beech forests of studied communities, the density of centipedes was much higher than is reported by some authors from the other parts of Europe (ALBERT, 1982; FRÜND, 1983, 1987; LOKSA, 1968; WYTWER, 1990).

On the basis of the shown results (Tables 1-10), we can see some specific interconnections between different populations of centipedes in individual localities. These interconnections are related to plant communities, but the reasons for these relations are probably not only due to the plants themselves, but to the conditions in the locality as well, such as microclimate, habitat and biogeography, which the plant community also defines.

The results confirmed our previous conclusions about the great number of specific communities in the area of the northern Balkans (KOS, 1992), a characteristic of its biogeographical situation, configuration and relative well sustained environment.

The specificity is presented in species composition and in the other characteristics of communities: density, dominance, distribution of specimens, and probably reproductive potentials.

TABLE 1. — Estimated density of centipedes per square metre of free forest surface in *Abieti - Fagetum Dinaricum* in the locality Rog (near Kocevje, Slovenia) and Mala gora (near Ribnica, Slovenia). Estimated mean and 95% confidence limits are given. 8 sampling units (25x25x10 cm) were taken in Mala gora, and 6 sampling units (20x20x10 cm) in Rog. (Abbreviations, see Table 2).

species	Rog						Mala gora					
	18.4.1990			6.11.1990			19.5.1987			9.9.1987		
	avg/m ²	t*se	dom	avg/m ²	t*se	dom	avg/m ²	t*se	dom	avg/m ²	t*se	dom
<i>B. montana</i>	12.5	12.8	2.2	55.0	45.5	11.5	8.0	9.5	3.8	24.0	31.8	6.0
<i>C. abbreviatus</i>	12.5	28.5	2.2	10.0	24.8	2.1	0.0	0.0	0.0	0.0	0.0	0.0
<i>C. linearis</i>	0.0	0.0	0.0	0.0	0.0	0.0	12.0	19.9	5.7	3.2	4.6	0.8
<i>C. sp.</i>	8.3	12.0	1.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
<i>C. trebevicensis</i>	29.2	55.9	5.0	20.0	23.2	4.2	4.0	5.7	1.9	6.4	13.7	1.6
<i>Ch. scheerpeltzi</i>	0.0	0.0	0.0	0.0	0.0	0.0	4.0	5.7	1.9	0.0	0.0	0.0
<i>D. carniolensis</i>	0.0	0.0	0.0	5.0	12.4	1.0	9.9	9.2	4.8	0.0	0.0	0.0
<i>G. insculptus</i>	4.2	9.5	0.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
<i>G. oligopus</i> cf.	0.0	0.0	0.0	15.0	24.8	3.1	5.9	6.4	2.9	0.0	0.0	0.0
<i>G. promontorii</i>	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	8.0	9.3	2.0
<i>G. sp.</i>	4.2	9.5	0.7	10.0	24.8	2.1	0.0	0.0	0.0	0.0	0.0	0.0
<i>G. flavus</i>	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.6	3.4	0.4
<i>S. carniolensis</i>	0.0	0.0	0.0	10.0	24.8	2.1	0.0	0.0	0.0	1.6	3.4	0.4
<i>S. nemorensis</i>	0.0	0.0	0.0	5.0	12.4	1.0	0.0	0.0	0.0	0.0	0.0	0.0
<i>St. acuminata</i>	16.7	12.0	2.9	15.0	24.8	3.1	1.9	4.4	1.0	4.8	5.3	1.2
<i>St. transsylvanica</i>	8.3	19.0	1.4	15.0	24.8	3.1	9.9	9.2	4.8	14.4	15.7	3.6
<i>H. gottscheensis</i>	4.2	9.5	0.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
<i>L. castaneus</i>	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.2	4.6	0.8
<i>L. dentatus</i>	8.3	12.0	1.4	5.0	12.4	1.0	0.0	0.0	0.0	3.2	4.6	0.8
<i>L. forficatus</i>	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
<i>L. sp. juv.</i>	137.5	43.6	23.7	75.0	19.6	15.6	40.2	28.2	19.0	144.0	79.7	36.0
<i>L. lapidicola</i>	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.6	3.4	0.4
<i>L. latro</i>	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	17.6	12.9	4.4
<i>L. macilentus</i> cf.	66.7	54.5	11.5	65.0	57.4	13.5	35.8	20.6	17.1	108.8	81.4	27.2
<i>L. nodulipes</i>	4.2	9.5	0.7	0.0	0.0	0.0	3.8	4.4	1.9	0.0	0.0	0.0
<i>L. sp. pl2-3</i>	0.0	0.0	0.0	5.0	12.4	1.0	1.9	4.4	1.0	1.6	3.4	0.4
<i>Si. n.sp.</i>	8.3	19.0	1.4	0.0	0.0	0.0	24.0	24.0	11.4	6.4	7.5	1.6
<i>Si. non microps</i>	58.3	28.2	10.1	30.0	36.1	6.3	13.9	18.2	6.7	11.2	11.4	2.8
<i>Si. sp.</i>	0.0	0.0	0.0	5.0	12.4	1.0	0.0	0.0	0.0	0.0	0.0	0.0
<i>M. aeruginosus</i>	0.0	0.0	0.0	0.0	0.0	0.0	1.9	4.4	1.0	0.0	0.0	0.0
<i>Cry. croaticus</i>	0.0	0.0	0.0	5.0	12.4	1.0	0.0	0.0	0.0	0.0	0.0	0.0
<i>Cry. hortensis</i>	108.3	50.3	18.7	85.0	84.5	17.7	20.0	14.6	9.5	22.4	18.5	0.0
<i>Cry. parisi</i>	58.3	38.0	10.1	45.0	45.5	9.4	12.0	17.4	5.7	16.0	12.5	0.0
<i>Cry. rucneri</i> cf.	29.2	27.2	5.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
total density	579.2	123.6	100.0	480.0	245.7	100.0	197.9	82.0	100.0	400.0	146.0	100.0
total species	17			17			15			17		
Sha-W. div.	2.325			2.444			2.450			2.170		

TABLE 2. — Estimated density of centipedes per square metre of free forest surface in *Abieti - Fagetum Dinaricum* in the locality Kot (near Ribnica). Estimated mean and 95% confidence limits are given. The sampling was done on 8.5.1987 (12 sampling units), 21.7.1987 (16 sampling units), and on 6.11.1987 (14 sampling units). The size of a sampling unit was 25x25x10 cm. Abbreviations - B: *Brachyschendyla*; C: *Clinopodes*; Ch: *Chaetechelyne* or *Chalandea*; D: *Dicellogophilus*; G: *Geophilus*; S: *Schendyla*, St: *Strigamia*; E: *Eupolybothrus*, H: *Harpolithobius*; L: *Lithobius*; M: *Monotarsobius*; Si: *Sigibius*; Cry: *Cryptops*.

species	8.5.1987			21.7.1987			6.11.1987		
	avg/m ²	t*se	dom	avg/m ²	t*se	dom	avg/m ²	t*se	dom
<i>B. montana</i>	4.0	4.6	3.7	5.9	8.7	2.0	17.1	9.9	7.1
<i>C. linearis</i>	0.0	0.0	0.00	5.0	6.7	1.7	8.0	7.9	3.3
<i>C. trebevicensis</i>	0.0	0.0	0.0	4.6	13.1	4.8	0.0	0.0	0.0
<i>Ch. scheerpeltzi</i>	0.0	0.0	0.0	5.5	6.2	2.8	0.0	0.0	0.0
<i>D. carniolensis</i>	9.3	9.2	8.6	4.2	3.4	1.1	4.6	3.4	1.9
<i>G. carpophagus</i>	0.0	0.0	0.0	3.8	2.1	0.3	0.0	0.0	0.0
<i>G. pygmaeus</i>	0.0	0.0	0.0	3.3	2.1	0.3	0.0	0.0	0.0
<i>G. flavus</i>	1.3	2.9	1.2	2.9	6.9	3.1	1.1	2.5	0.5
<i>S. carniolensis</i>	0.0	0.0	0.0	2.0	2.1	0.3	3.4	5.4	1.4
<i>St. acuminata</i>	1.3	2.9	1.2	2.5	5.3	2.0	3.4	3.9	1.4
<i>St. transsilvanica</i>	2.7	4.0	2.5	1.6	5.1	1.7	8.0	6.0	3.3
<i>E. tridentinus</i>	1.3	2.9	1.2	1.0	2.1	0.3	0.0	0.0	0.0
<i>H. anodus</i>	0.0	0.0	0.0	1.0	2.1	0.3	1.1	2.5	0.5
<i>L. agilis</i>	0.0	0.0	0.0	1.0	2.1	0.3	0.0	0.00	0.00
<i>L. dentatus</i>	5.3	6.6	4.9	1.9	4.3	0.7	0.0	0.0	0.0
<i>L. sp. juv.</i>	30.7	26.5	28.4	119.0	55.9	41.1	107.4	56.7	44.3
<i>L. lapidicola</i>	2.7	4.0	2.5	12.0	8.5	4.1	5.8	6.8	2.4
<i>L. latro</i>	2.7	4.0	2.5	5.9	6.9	2.0	5.8	5.8	2.4
<i>L. macilentus</i> cf.	5.3	5.0	4.9	32.0	16.8	11.0	24.0	24.2	9.9
<i>L. nodulipes</i>	0.0	0.0	0.0	3.0	3.4	1.1	0.0	0.00	0.00
<i>L. sp.</i>	1.3	2.9	1.2	0.0	0.0	0.0	0.0	0.0	0.0
<i>M. aeruginosus</i>	9.3	9.2	8.6	21.9	9.8	7.6	10.2	10.6	4.3
<i>Si. n.sp.</i>	1.3	2.9	1.2	5.0	6.7	1.7	0.0	0.0	0.0
<i>Si. non microps</i>	0.0	0.0	0.0	15.0	11.4	5.2	16.0	14.5	6.6
<i>Cry. parisi</i>	29.3	19.8	27.1	13.9	6.1	4.8	26.2	13.4	10.9
total density	108.0	52.7	100.0	289.9	91.7	100.0	242.2	95.6	100.0
total species	14			22			14		
Sha-W. div.	2.090			2.600			2.320		

TABLE 3. — Estimated density of centipedes per square metre of free forest surface in *Lamio-ovulae-Fagetum* in the locality Zeljne (near Kocevje). Estimated mean and 95% confidence limits are given. 6 sampling units (20x20x10 cm) were taken. (Abbreviations, see Table 2).

species	18.4.1990			6.11.1990		
	avg/m ²	t*se	dom	avg/m ²	t*se	dom
<i>B. montana</i>	33.3	28.2	10.1	62.5	52.6	11.2
<i>C. abbreviatus</i>	8.3	19.0	2.5	16.7	24.1	3.0
<i>D. carniolensis</i>	0.0	0.0	0.0	12.5	12.8	2.3
<i>S. carniolensis</i>	0.0	0.0	0.0	8.3	19.0	1.5
<i>St. acuminata</i>	0.0	0.0	0.0	8.3	12.0	1.5
<i>St. transsilvanica</i>	4.2	9.5	1.3	16.7	28.2	3.0
<i>H. anodus</i>	12.5	28.5	3.8	0.0	0.0	0.0
<i>L. agilis</i>	0.0	0.0	0.0	4.2	9.5	0.8
<i>L. sp. juv.</i>	91.7	74.6	27.9	145.8	78.5	26.2
<i>L. macilentus</i> cf.	75.0	76.6	22.8	62.5	43.6	11.2
<i>L. melanops</i>	0.0	0.0	0.0	8.3	12.0	1.5
<i>L. pygmaeus</i>	25.0	20.8	7.6	0.0	0.0	0.0
<i>M. aeruginosus</i>	50.0	48.9	15.2	179.2	124.5	32.2
<i>M. sp.</i>	0.0	0.0	0.0	4.2	9.5	0.8
<i>Si. non microps</i>	29.2	37.3	8.9	0.0	0.0	0.0
<i>Cry. hortensis</i>	4.2	9.5	1.3	0.0	0.0	0.0
<i>Cry. parisi</i>	12.5	19.5	3.8	37.5	35.3	6.7
total density	329.2	207.5	100.0	556.7	238.3	100.0
total species	10			12		
Sha-W. div.	1.970			1.470		

TABLE 4. — Estimated density of centipedes per square metre of free forest surface in *Asperulo - Carpinetum* in the locality Seljan (near Ribnica). Estimated mean and 95% confidence limits are given. 8 sampling units (25x25x10 cm) were taken. (Abbreviations, see Table 2).

species	19.5.1987			9.9.1987		
	avg/m ²	t*se	dom	avg/m ²	t*se	dom
<i>B. montana</i>	24.0	13.4	11.0	8.0	7.7	5.9
<i>C. flavidus</i>	5.9	9.2	2.8	0.0	0.0	0.0
<i>C. linearis</i>	4.0	5.7	1.8	1.6	3.4	1.2
<i>C. trebevicensis</i>	13.9	18.6	6.4	1.6	3.4	1.2
<i>D. carniolensis</i>	8.0	9.5	3.7	4.8	5.3	3.5
<i>G. flavus</i>	45.9	40.3	21.1	33.6	22.5	24.7
<i>S. carniolensis</i>	1.9	4.4	0.9	0.0	0.0	0.0
<i>St. crassipes</i>	1.9	4.4	0.9	1.6	3.4	1.2
<i>St. transsilvanica</i>	1.9	4.4	0.9	3.2	6.9	2.4
<i>L. sp. juv.</i>	41.9	25.0	19.3	32.0	26.5	23.5
<i>L. lapidicola</i>	1.9	4.4	0.9	0.0	0.0	0.0
<i>L. nodulipes</i>	0.0	0.0	0.0	1.6	3.4	1.2
<i>L. macilentus cf.</i>	16.0	13.3	7.3	20.8	15.3	15.3
<i>L. tricuspis</i>	1.9	4.4	0.9	0.0	0.0	0.0
<i>M. aeruginosus</i>	21.9	25.8	10.1	6.4	13.7	4.7
<i>Si. n.sp.</i>	4.0	5.7	1.8	3.2	4.6	2.4
<i>Si. non microps</i>	8.0	9.5	3.7	14.4	13.9	10.6
<i>Cry. hortensis</i>	0.0	0.0	0.0	1.6	3.4	1.2
<i>Cry. parisi</i>	20.0	25.6	9.2	1.6	3.4	1.2
total density	217.9	88.2	100.0	136.0	33.6	100.0
total species	16			14		
Sha-W. div.	2.085			1.737		

TABLE 5. — Estimated density of centipedes per square metre of free forest surface in *Luzulo albidae* - *Fagetum* in the locality Zrnovec (near Ribnica). Estimated mean and 95% confidence limits are given. 6 sampling units (25x25x10 cm) were taken. (Abbreviations, see Table 2).

	19.5.1987			11.9.1987		
	avg/m ²	t*se	dom	avg/m ²	t*se	dom
<i>B. montana</i>	88.0	53.1	24.9	53.9	29.8	13.2
<i>C. trebevicensis</i>	53.9	41.2	15.2	61.9	34.4	15.2
<i>Ch. illyriaca</i>	0.0	0.0	0.0	1.9	4.4	0.5
<i>D. carniolensis</i>	9.9	6.4	2.8	9.9	6.4	2.4
<i>G. oligopus</i>	1.9	4.4	0.5	0.0	0.0	0.0
<i>St. acuminata</i>	0.0	0.0	0.0	8.0	9.5	2.0
<i>St. transsilvanica</i>	1.9	4.4	0.5	0.0	0.0	0.0
<i>L. castaneus</i>	1.9	4.4	0.5	0.0	0.0	0.0
<i>L. forficatus</i>	1.9	4.4	0.5	1.9	4.4	0.5
<i>L. sp. juv.</i>	33.9	30.2	9.6	65.9	31.7	16.2
<i>L. lapidicola</i>	4.0	5.7	1.1	17.9	10.4	4.4
<i>L. latro</i>	1.9	4.4	0.5	0.0	0.0	0.0
<i>L. macilentus cf.</i>	64.0	34.2	18.1	88.0	55.1	21.6
<i>L. melanops</i>	1.9	4.4	0.5	0.0	0.0	0.0
<i>L. pygmaeus</i>	1.9	4.4	0.5	0.0	0.0	0.0
<i>Si. non microps</i>	24.0	23.1	6.8	12.0	8.8	2.9
<i>M. aeruginosus</i>	33.9	22.6	9.6	53.9	25.8	13.2
<i>Cry. hortensis</i>	8.0	13.4	2.3	5.9	13.2	1.4
<i>Cry. parisi</i>	20.0	14.6	5.6	25.9	21.1	6.3
total density	354.0	115.3	100.0	408.0	94.3	100.0
total species	16			12		
Sha-W. div.	2.055			2.030		

TABLE 6. — Estimated density of centipedes per square metre of free forest surface in *Vaccinio myrtilli*-*Pinetum* in the locality Zavodnje (near Velenje). Estimated mean and 95% confidence limits are given. 6 sampling units (20x20x10 cm) were taken. (Abbreviations, see Table 2).

species	22.6.1990			23.10.1990			21.3.1991		
	avg/m ²	t*se	dom	avg/m ²	t*se	dom	avg/m ²	t*se	dom
<i>B. montana</i>	0.0	0.0	0.0	50.0	41.5	14.5	20.0	21.9	12.1
<i>C. abbreviatus</i>	5.0	11.7	1.8	0.0	0.0	0.0	0.0	0.0	0.0
<i>C. trebevicensis</i>	140.0	115.2	50.9	20.0	34.2	5.8	5.0	11.7	3.0
<i>S. nemorensis</i>	0.0	0.0	0.0	25.0	37.1	7.2	25.0	37.1	15.2
<i>S. carniolensis</i>	0.0	0.0	0.0	25.0	45.4	7.2	15.0	23.5	9.1
<i>St. acuminata</i>	5.0	11.7	1.8	0.0	0.0	0.0	0.0	0.0	0.0
<i>L. macilentus</i>	35.0	35.2	12.7	85.0	133.2	24.6	65.0	54.4	39.4
<i>L. latro</i>	0.0	0.0	0.0	20.0	11.7	5.8	5.0	11.7	3.0
<i>L. tenebrosus</i>	15.0	23.5	5.5	15.0	35.2	4.3	0.0	0.0	0.0
<i>L. sp. juv.</i>	20.0	21.9	7.3	75.0	132.5	21.7	10.0	23.5	6.1
<i>M. aeruginosus</i>	25.0	18.5	9.1	20.0	34.2	5.8	10.0	23.5	6.1
<i>Cry. hortensis</i>	30.0	34.2	10.9	10.0	14.4	2.9	10.0	14.4	6.1
<i>Cry. parisi</i>	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
total density	275.0	143.64	100.0	345.0	344.7	100.0	165.0	65.8	100.0
total species	7			9			8		
Sha-W. div.	1.402			1.978			1.613		

TABLE 7. — Estimated density of centipedes per square metre of free forest surface in *Bazzanio* - *Abietetum* in the locality Topolsica (near Velenje). Estimated mean and 95% confidence limits are given. 6 sampling units (20x20x10 cm) were taken. (Abbreviations, see Table 2).

species	22.6.1990			23.10.1990			21.3.1991		
	avg/m ²	t*se	dom	avg/m ²	t*se	dom	avg/m ²	t*se	dom
<i>B. montana</i>	0.0	0.0	0.0	5.0	11.7	1.6	15.0	23.5	7.7
<i>G. insculptus</i>	43.8	78.6	11.3	75.0	41.5	23.4	10.0	14.4	5.1
<i>G. oligopus</i> cf.	12.5	25.4	3.2	0.0	0.0	0.0	0.0	0.0	0.0
<i>S. nemorensis</i>	0.0	0.0	0.0	25.0	45.4	7.8	5.0	11.7	2.6
<i>S. carniolensis</i>	0.0	0.0	0.0	5.0	11.7	1.6	25.0	18.5	12.8
<i>L. forficatus</i>	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
<i>L. sp. juv.</i>	18.8	38.1	4.8	30.0	43.1	9.4	5.0	11.7	2.6
<i>L. macilentus</i>	18.8	24.3	4.8	25.0	32.1	7.8	20.0	46.9	10.3
<i>M. aeruginosus</i>	50.0	68.8	12.9	15.0	35.2	4.7	30.0	43.1	15.4
<i>Cry. hortensis</i>	137.5	44.0	35.5	140.0	73.2	43.8	85.0	75.5	43.6
<i>Cry. parisi</i>	6.2	12.7	1.6	0.0	0.0	0.0	0.0	0.0	0.0
total density	387.5	86.7	100.0	320.0	179.2	100.0	195.0	122.2	100.0
total species	6			7			7		
Sha-W. div.	1.367			1.417			1.506		

TABLE 8. — Estimated density of centipedes per square metre of free forest surface in *Bazzanio - Abietetum* in the locality Lajse (near Velenje). Estimated mean and 95% confidence limits are given. 6 sampling units (20x20x10 cm) were taken. (Abbreviations, see Table 2).

species	22.6.1990			23.10.1990			17.6.1991		
	avg/m ²	t*se	dom	avg/m ²	t*se	dom	avg/m ²	t*se	dom
<i>C. flavidus</i>	5.0	11.7	1.1	0.0	0.0	0.0	0.0	0.0	0.0
<i>C. trebevicensis</i>	75.0	61.5	15.8	50.0	26.2	7.8	95.0	78.4	17.6
<i>D. carniolensis</i>	0.0	0.0	0.0	5.0	11.7	0.8	0.0	0.0	0.0
<i>S. carniolensis</i>	0.0	0.0	0.0	75.0	37.1	11.7	0.0	0.0	0.0
<i>S. nemorensis</i>	0.0	0.0	0.0	60.0	68.4	9.4	0.0	0.0	0.0
<i>St. acuminata</i>	5.0	11.7	1.1	0.0	0.0	0.0	0.0	0.0	0.0
<i>L. dentatus</i>	5.0	11.7	1.1	0.0	0.0	0.0	0.0	0.0	0.0
<i>L. sp. juv.</i>	90.0	93.8	18.9	130.0	77.4	20.3	60.0	57.5	11.1
<i>L. macilentus</i>	70.0	65.3	14.7	105.0	98.8	16.4	65.0	104.9	12.0
<i>M. aeruginosus</i>	130.0	70.4	27.4	80.0	65.3	12.5	200.0	193.0	37.0
<i>Cry. hortensis</i>	85.0	77.8	17.9	120.0	56.9	18.8	110.0	92.9	20.4
<i>Cry. parisi</i>	10.0	14.4	2.1	15.0	14.4	2.3	10.0	30.8	1.8
total density	475.0	252.2	100.0	640.0	137.0	100.0	540.0	160.6	100.0
total species	8			8			5		
Sha-W. div.	1.223			1.226			1.867		

TABLE 9. — Estimated density of centipedes per square metre of free forest surface in *Quercus - Luzulo - Fagetum* in the locality Veliki vrh (near Velenje). Estimated mean and 95% confidence limits are given. 6 sampling units (20x20x10 cm) were taken. (Abbreviations, see TABLE 2).

species	22.6.1990			23.10.1990			21.3.1991			17.6.1991		
	avg/m ²	t*se	dom	avg/m ²	t*se	dom	avg/m ²	t*se	dom	avg/m ²	t*se	dom
<i>B. montana</i>	0.0	0.0	0.0	10.0	14.4	2.9	10.0	14.4	3.9	0.0	0.0	0.0
<i>C. abbreviatus</i>	0.0	0.0	0.0	25.0	58.6	7.1	10.0	14.4	3.9	0.0	0.0	0.0
<i>C. flavidus</i>	5.0	11.7	2.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
<i>C. linearis</i>	0.0	0.0	0.0	5.0	11.7	1.4	5.0	11.7	2.0	5.0	11.7	1.0
<i>C. trebevicensis</i>	10.0	14.4	4.3	10.0	14.4	2.9	5.0	11.7	2.0	35.0	35.2	7.1
<i>D. carniolensis</i>	5.0	11.7	2.2	5.0	11.7	1.4	0.0	0.0	0.0	0.0	0.0	0.0
<i>G. oligopus</i> cf.	10.0	23.5	4.3	5.0	11.7	1.4	20.0	21.9	7.8	15.0	23.5	3.0
<i>St. transsilvanica</i>	0.0	0.0	0.0	5.0	11.7	1.4	0.0	0.0	0.0	0.0	0.0	0.0
<i>E. tridentinus</i>	0.0	0.0	0.0	5.0	11.7	1.4	0.0	0.0	0.0	0.0	0.0	0.0
<i>L. dentatus</i>	0.0	0.0	0.0	5.0	11.7	1.4	10.0	23.5	3.9	0.0	0.0	0.0
<i>L. forficatus</i>	0.0	0.0	0.0	5.0	11.7	1.4	0.0	0.0	0.0	0.0	0.0	0.0
<i>L. sp. juv.</i>	25.0	45.4	10.9	85.0	104.2	24.3	85.0	122.4	33.3	220.0	261.2	44.4
<i>L. lapidicola</i>	0.0	0.0	0.0	5.0	11.7	1.4	0.0	0.0	0.0	0.0	0.0	0.0
<i>L. lusitanus</i>	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5.0	11.7	1.0
<i>L. macilentus</i>	165.0	113.7	71.7	160.0	118.2	45.7	100.0	92.7	39.2	195.0	113.4	39.4
<i>M. aeruginosus</i>	5.0	11.7	2.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
<i>Cry. parisi</i>	5.0	11.7	2.2	20.0	21.9	5.7	10.0	14.4	3.9	20.0	21.9	4.0
total density	230.0	136.8	100.0	350.0	194.5	100.0	255.0	241.4	100.0	495.0	344.1	100.0
total species	7			13			8			6		
Sha-W. div.	0.831			1.569			1.348			1.000		

TABLE 10. — Estimated density of centipedes per square metre of free forest surface in *Quercus - Luzulo - Fagetum* in the locality Crnova (near Velenje). Estimated mean and 95% confidence limits are given. 6 sampling units (20x20x10 cm) were taken. (Abbreviations, see Table 2).

species	22.6.1990			21.3.1990			21.3.1991			17.6.1991		
	avg/m ²	t*se	dom	avg/m ²	t*se	dom	avg/m ²	t*se	dom	avg/m ²	t*se	dom
<i>B. montana</i>	0.0	0.0	0.0	40.0	52.4	14.0	25.0	32.8	3.8	0.0	0.0	0.0
<i>C. abbreviatus</i>	0.0	0.0	0.0	5.0	6.6	1.8	5.0	6.6	0.8	0.0	0.0	0.0
<i>C. trebevicensis</i>	15.0	19.7	4.3	10.0	13.1	3.5	0.0	0.0	0.0	0.0	0.0	0.0
<i>D. carniolensis</i>	0.0	0.0	0.0	5.0	6.6	1.8	5.0	6.6	0.8	5.0	6.6	1.1
<i>G. insculptus</i>	75.0	98.3	21.7	30.0	39.3	10.5	30.0	39.3	4.6	205.0	268.8	43.6
<i>G. flavus</i>	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5.0	6.6	1.1
<i>S. nemorensis</i>	0.0	0.0	0.0	0.0	0.0	0.0	10.0	13.1	1.5	0.0	0.0	0.0
<i>St. acuminata</i>	5.0	6.6	1.4	0.0	0.0	0.0	10.0	13.1	1.5	5.0	6.6	1.1
<i>L. dentatus</i>	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
<i>L. forficatus</i>	5.0	6.6	1.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
<i>L. lusitanus</i>	5.0	6.6	1.4	0.0	0.0	0.0	10.0	13.1	1.5	20.0	26.2	4.3
<i>L. macilentus</i>	100.0	131.1	29.0	55.0	72.1	19.3	150.0	196.7	22.9	110.0	144.2	23.4
<i>L. nodulipes</i>	0.0	0.0	0.0	0.0	0.0	0.0	25.0	32.8	3.8	0.0	0.0	0.0
<i>L. validus</i>	10.0	13.1	2.9	5.0	6.6	1.8	0.0	0.0	0.0	10.0	13.1	2.1
<i>L. sp. juv.</i>	70.0	91.8	20.3	45.0	59.0	15.8	265.0	347.5	40.5	65.0	85.2	13.8
<i>L. sp.</i>	5.0	6.6	1.4	0.0	0.0	0.0	10.0	13.1	1.5	0.0	0.0	0.0
<i>H. sp.</i>	0.0	0.0	0.0	0.0	0.0	0.0	5.0	6.6	0.8	0.0	0.0	0.0
<i>Cry. hortensis</i>	55.0	72.1	15.9	90.0	118.0	31.6	105.0	137.7	16.0	45.0	59.0	9.6
total density	345.0	452.4	100.0	285.0	373.7	100.0	655.0	858.9	100.0	470.0	616.3	100.0
total species	9			8			12			8		
Sha-W. div.	1.615			1.638			1.864			1.345		

REFERENCES

- ALBERT, A. M., 1979. — Chilopoda as part of the predatory macroarthropod Fauna in forests: Abundance, Life-cycle, Biomass, and Metabolism. In: M. CAMATINI, *Myriapod Biology*. London, Academic Press : 215-231.
- ALBERT, A. M., 1982. — Species spectrum and dispersion patterns of Chilopods in Solling habitats. *Pedobiologia*, **23** : 337-347.
- ATTEMS, C., 1929. — Myriapoda. I. Geophilomorpha. *Das Tierreich*, **52** : 1-388.
- ATTEMS, C., 1930. — Myriapoda II. Scolopendromorpha. *Das Tierreich*, **54** : 1-308.
- DUNGER, W., ENGELMANN, I. & SCHNEIDER R., 1972. — Untersuchungen zur Langzeitwirkung von Industrie - Emissionen auf Böden, Vegetation und Bodenfauna des Neitzetales bei Ostitz/Oberlausitz. *Abh. Ber. Natur. Görlitz*, **47** : 1-40.
- EASON, E. H., 1982. — A review of the North-West Lithobiomorpha with a revised key to their identification. *Zool. J. Linn. Soc.*, **74** : 9-33.
- ELLIOT, J. M., 1977. — Some methods for the Statistical Analysis of samples of Benthic Invertebrates. *Freshwater Biological Association Sci. Publication*, **25** : 1-157.
- FRÜND, H. C., 1983. — Untersuchungen zur Koexistenz verschiedener Chilopodenarten im Waldboden. Dissertation, Würzburg, 164 pp.
- FRÜND, H. C., 1987. — Räumliche Verteilung und Koexistenz der Chilopoden in einem Buchen-Altbestand. *Pedobiologia*, **30** : 19-29.
- KOREN, A., 1986. — Die Chilopoden-Fauna von Kärnten und Osttirol, Teil 1, Geophilomorpha, Scolopendromorpha. Verlag des Naturwiss. Vereins für Kärnten, Klagenfurt, 87 pp.
- KOS, I., 1988. — The problems of quality and quantity sampling of centipedes (Chilopoda). Ljubljana, University of Ljubljana, Biotech. Faculty, Department of Biology, 85 pp. (in Slovene).

- KOS, I., 1992. — A Review of Taxonomy, Geographical Distribution and Ecology of the Centipedes of Yugoslavia (Myriapoda, Chilopoda). [In: E. Meyer, K. Thaler, W. Schedl, Advances in Myriapodology.] *Ber. nat.-med. Verein Innsbruck*, suppl. 10 : 353-360.
- KREBS, J. R., 1989. — *Ecological methodology*. New-York, Harper Collins Publishers, 654 pp.
- LOKSA, I., 1968. — Quantitative Makrofauna-Untersuchungen in den Waldboden des Bükkgebirges (Ungarn). *Ann. Univ. Sci. Budapest*, 9-10 : 265-289.
- LOKSA, I., 1979. — Quantitative Untersuchungen über die Makrofauna der Laubstreu in Zerreichen- und Hainsimeneichen Beständen des Bükkgebirges. *Opusc. Zool. Budapest*, 16: 87-96.
- MATIC, Z., 1966. — Clasa Chilopoda, Subclasa Anamorpha. *Fauna Republicii socialiste Romania*, 6 : 1-272.
- MATIC, Z., 1972. — Clasa Chilopoda, Subclasa Epimorpha. *Fauna Republicii socialiste Romania*, 6 : 1-224.
- MATIC, Z. & TEODOREANU, M., 1966. — Contribution à la connaissance des Lithobiides (Chilopoda-Lithobiidae) de Croatie. *Biol. Glasnik*, 19 : 19-26.
- MEYER, E., SCHWARZENBERGER, I., STARK, G. & WECHSELBERGER, G., 1984. — Bestand und jahreszeitliche Dynamik der Bodenmakrofauna in einem inneralpinen Eichenmischwald (Tirol, Österreich). *Pedobiologia*, 27 : 115-132.
- MINELLI, A. & IOVANE, E., 1987. — Preferences and taxocenoses of Italian centipedes (Chilopoda). *Boll. Mus. civ. St. nat. Venezia*, 37 : 7-34.
- POSER, T., 1988. — Chilopoden als Prädatoren in einem Laubwald. *Pedobiologia*, 31 : 261-281.
- SEBER, G. A. F., 1982. — *The Estimation of Animal Abundance and related Parameters*. London, Charles Griffin & Company Ltd., 654 pp.
- VERHOEFF, K. W., 1937. — Chilopoden-Studien. Zur Kenntnis der Lithobiiden. *Archiv für Naturgeschichte*, 6 : 171-257.
- WYTWER, J., 1990. — Centipedes (Chilopoda) of linden - oak - hornbeam forests (*Tilio - Carpinetum*) and the thermophilous oak forests (*Potentillo albae - Quercetum*) of Mazovian Lowland. *Fragm. Faun.*, 32 : 73-94.
- WYTWER, J., 1992. — Chilopoda Communities of the Fresh Pine Forests of Poland. [In: E. MEYER, K. THALER, W. SCHEDL, *Advances in Myriapodology*.] *Ber. nat.-med. Verein Innsbruck*, suppl. 10 : 205-211.
- ZAPPAROLI, M., 1992. — Preliminary Data on Centipede Communities of *Quercetea ilicis* and *Fagetalia sylvaticae* in Central Italy. [In: E. MEYER, K. THALER, W. Schedl, *Advances in Myriapodology*] *Ber. nat.-med. Verein Innsbruck*, suppl. 10 : 197-204.



Kos, Ivan. 1996. "Centipedes (Chilopoda) of some forest communities in Slovenia." *Mémoires du Muséum national d'histoire naturelle* 169, 635–646.

View This Item Online: <https://www.biodiversitylibrary.org/item/272291>

Permalink: <https://www.biodiversitylibrary.org/partpdf/288138>

Holding Institution

Muséum national d'Histoire naturelle

Sponsored by

Muséum national d'Histoire naturelle

Copyright & Reuse

Copyright Status: In copyright. Digitized with the permission of the rights holder.

Rights Holder: Muséum national d'Histoire naturelle

License: <http://creativecommons.org/licenses/by-nc-sa/4.0/>

Rights: <http://biodiversitylibrary.org/permissions>

This document was created from content at the **Biodiversity Heritage Library**, the world's largest open access digital library for biodiversity literature and archives. Visit BHL at <https://www.biodiversitylibrary.org>.