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HIBERNATING MYRIAPODA IN COMPOST IN TAMPERE (FINLAND) (DIPLOPODA; CHILOPODA; SYMPHYLA)

by

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ABSTRACT

Seven myriapod species are recorded from 20 l samples taken from the upper and lower layers of two compost heaps of different ages in October and November, 1983, and February and April, 1984. The animals were extracted from the samples by hand. Data are given about the abundance of the species, sex ratio and seasonal distribution of different instars. Attention is paid to the ecological conditions of the compost heaps, which may be favourable places for hibernation of species sensitive to low winter temperatures.

INTRODUCTION

The aim of this study is to analyse the myriapod populations in two compost heaps of different age during the winter season. Special attention was paid to the ecological conditions prevailing in the compost and their possible influence on the myriapod populations.

Data on the distribution of Finnish myriapods have been recorded by Palmén (1949a, b), who also described the ecological distribution of the various species both in the wild and in winter-warm greenhouses. Lehtinen's (1962) paper includes such observations as well. Three unpublished studies (Salo, 1949; Roukka, 1964; Uotila, 1976) contain additional data on the distribution of Finnish myriapods.

THE STUDY SITE

The study site is located about 2 km from the centre of Tampere, 61°30′ N and 23°45′ E, about 150 m above sea level. The compost heaps studied are situated on the southern slope of Kalevankangas, a sandy ridge about 20-25 m above the level of a nearby lake. The place is sheltered from heavy northerly winds by an old pine and spruce wood (*Pinus sylvestris* (L.) and *Pices abies* (L.) Karsten). It receives a fair amount of sunshine in spring as the few birches and maples (*Betula pubescens* Ehrh. and *Acer platanoides* L.) on the southern slope get their leaves only in mid-May. In spring the sunshine and the moisture from the melting snow trigger the activity of the fauna and flora of this slope rather early.

The frost depth is generally measured from plots, where the snow has been removed. In Tampere the long-term mean value of frost depth is 137 cm, but in the rather mild winter of 1983-1984 the depth was only about half of this. The monthly mean temperatures during the study period fluctuated from +4.9°C to -6.3°C (fig. 1). During the winter in question the snow was very thick: in March the compost

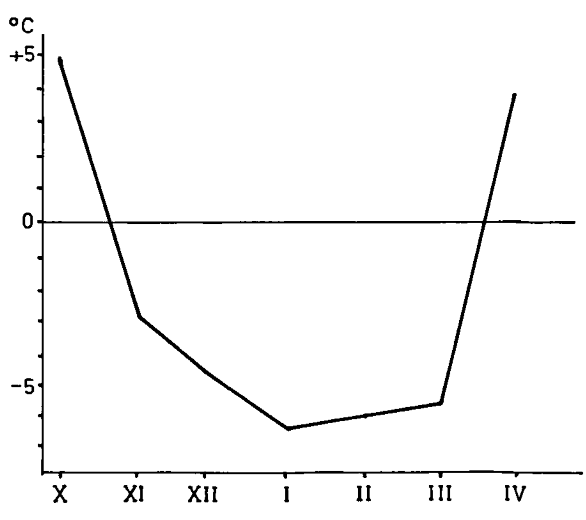

Fig. 1. Mean monthly temperatures at Tampere during the study period 1983-1984.

was covered by 50-60 cm of snow which melted in about mid-April.

Routine observations on temperature do not give an idea about the thermal conditions in compost heaps. The trees and other vegetation as well as the snow cover protect the compost from extreme temperatures. Measurements were made three times during October to April 1983-1984 from the compost, the soil under the compost and the air (fig. 2), always in the afternoon. In each case the temperature under the compost heaps was lower than inside the compost. In late autumn the temperature inside the compost was warmer, but in February and April it was colder than that of the air.

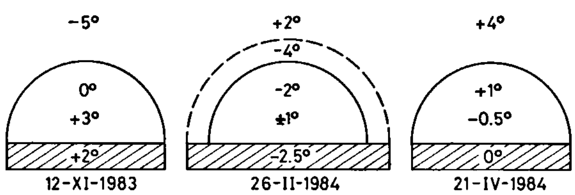

Fig. 2. Temperatures (°C) measured in the compost, the organomineral layer (hatched), the snow cover (26-II-1984 only), and the air.

The frost penetrated into the compost already in November before snowfall, but only into the top layer. The frozen layer was thickest, i.e. 20-25 cm, in February, and always somewhat thicker in the older compost than in the younger one. However, the irregular structure of the different components of the compost caused local differences.

COMPOSITION OF THE COMPOST

Both compost heaps were about 60 cm high and 2 m² in area, the younger (1-2 years old) had more litter and less decomposed humus, the older (4-5 years old) less litter and more nearly completely decomposed humus. Under both heaps there was a layer of organomineral material of about 20-25 cm, resting on the mineral bottom of sand (particle size 0.02-0.2 mm). The compost material consisted mostly of leaves and twigs of trees such as *Betula pubescens* and *Acer platanoides*, but also *Alnus incana* (L.) Moench, *Prunus cerasifera* Ehrh., *Larix russica* (Endl.) Sabine ex Trautv., etc., and among them also needles and cones of *Pinus* and *Picea* and seeds of *Prunus*. Some perennial plants such as *Urtica dioica* (L.), and a *Sorbaria sorbifolia* (L.) A. Braun bush grew through the older compost. In both heaps, particularly in the old, abundant mycelium of different mushrooms (*Agaricus* sp., *Melanoleuca* sp. and *Strobilurus stephanocystis* (Hora) Sing. were observed. The abundance of some invertebrates, such as annelids, enchytraeids, collembolans and Diptera (larvae) was remarkable. Microorganisms were not studied.

Compost heaps are rich in elements important for living organisms. The heaps studied contained 3800-3850 mg/l Ca, 440-490 mg/l K, 76-100 mg/l P and 540-600 mg/l Mg. In this respect no distinct differences were noticed between the two heaps. Under the heaps the quantities of Ca, P and Mg were clearly smaller and the quantity of K larger, about 725 mg/l. The amount of N was not studied but it is obviously high too. The pH was 6.4-6.6.

SAMPLING TECHNIQUE

Samples of 20 l were taken in October and November 1983, and February and April 1984, from two levels of both compost heaps, always in the afternoon. In order to prevent too rapid thawing of the frozen compost in winter, samples were stored at about 10°C before the study at room temperature of about 20°C. The myriapods were handpicked and preserved in 70% alcohol for identification.

THE SPECIES FOUND AND THEIR ABUNDANCE

Three species of Diplopoda, three of Chilopoda, and one of Symphyla were found in the compost samples (table I). All these species except *Choneiulus palmatus* (Němec) have also been found in the garden or in the wood close to the compost. *Geophilus proximus* C. L. Koch was represented by one individual only, although it is very common under stones and in mould around the compost. Some species (*Proteroiulus fuscus* (Am Stein), *Ommatoiulus sabulosus* (Linnaeus) and *Lithobius curtipes* C. L. Koch), not found in the compost, occur in the nearby garden or in the woodland.

Cylindroiulus britannicus (Verhoeff, 1894)

This julid was mentioned from Finland already by Schubart (1934) and Palmén (1949b), but only from winter-warm greenhouses in southern Finland. Lehtinen (1962) reported it to be common in greenhouses in S.W. Häme (only one find out-of-doors). According to

TABLE I

Numbers of myriapods found in the different samples from the young (Y) and old (O) compost.

	2-X-'83	5-X-'83	20-X-'83	12-XI-'83		19-II-'84	26-II-'84	21-IV-'84		
	40 liter	20 liter	20 liter	40 liter	40 liter	40 liter	40 liter	40 liter	40 liter	Total
	Y	O	O	Y	O	Y	O	Y	O	
C. britannicus	111	124	107	62	82	0	1	3	18	508
P. denticulatus	19	4	10	1	0	0	0	18	0	52
C. palmatus	0	24	0	0	3	0	0	0	1	28
L. microps	12	47	43	38	30	6	0	25	0	201
L. forficatus	16	12	5	4	2	6	0	5	0	50
G. proximus	0	0	0	0	0	1	0	0	0	1
Scutigerella sp.	6	13	12	4	4	0	0	3	2	44
Total	164	224	177	109	121	13	1	54	21	884

Uotila (1976) it is one of the commonest species in winter-warm greenhouses in the Helsinki area.

In the compost heaps *C. britannicus* seems to occur at every level. In October both adult and young specimens were abundant in the wet upper layer of the young compost. In the more decomposed humus layer mostly adults were found. In November many specimens were also found in the powder-like section of twigs and between the scales of partly decomposed cones. *C. britannicus* was very abundant particularly in the old compost in October and November, but in the upper part of both compost heaps many dead individuals were found as well. The only specimen found alive in February was an adult female from the humus of the lower level of the old compost. The 18 specimens found in April, mostly from the old compost, came from both layers.

In the samples studied, the sex ratio of *C. britannicus* over the whole period was 38 (120 ♂♂ : 315 ♀♀).

The instars of *C. britannicus* were distinguished on the basis of the defence gland method (Peitsalmi, 1981; Blower, pers. comm.). The larval instars I-V of this species were in general more common in the young compost than in the old (fig. 3). The instars I-III (with 0, 1 or 6 gland pairs) were found only in October and mostly between the damp leaves. Instar IV (mostly with 12-13 gland pairs) and instar V (mostly with 18 gland pairs) occurred in both heaps in October and were still found, though not very frequently, in November. Instars VI, VII and VIII (mostly 23-24, 29-30 and 32-34 gland pairs) were found abundantly in October and November. In the young compost instar VIII was the most common of all stadia in November, while all three stadia were the main representatives of *C. britannicus* in the old compost in November and April. Individuals of later instars were present in this material too.

In Britain the males of *C. britannicus* achieve maturity at instar VII, the females at instar VIII; there are few females at instar IX and very few at later stadia (Blower, pers. comm.). In Finnish material specimens with the highest numbers of gland pairs are rare too. The percentage of individuals with 36-37 gland pairs is 4.5 (23 specimens), and they were found in every sample. Actually, in the samples from April only individuals with 36 gland pairs occurred. Only 2.6% (13 individuals) of all samples together were specimens with 38-40 gland pairs; all of them came from the first autumn sample. The males seemed to be common up to instar VII, but were rare among later stadia. Among the "giants" with 38-40 gland pairs there was only one male. It may be worth while to study the reason for the great dif-

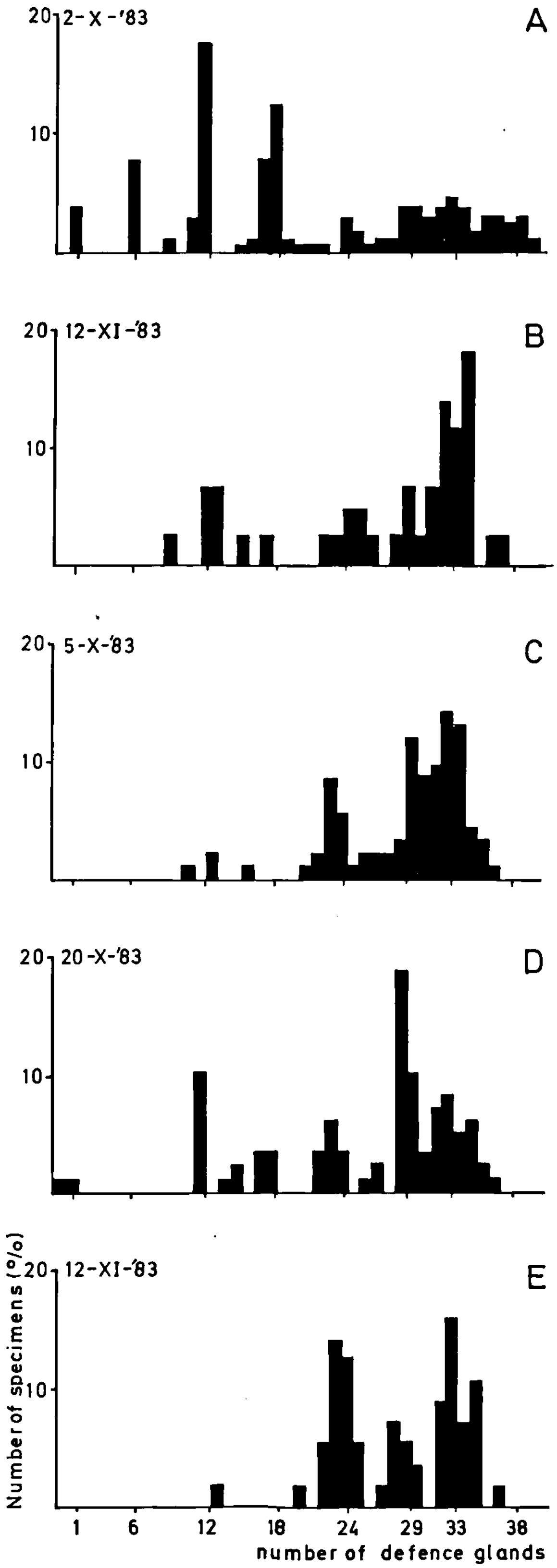

Fig. 3. Distribution of the numbers of defence glands in the populations of *Cylindroiulus britannicus* from the 1983 samples: A, B, young compost; C, D and E, old compost; A, 111 individuals from 40 l sample; B, 62 individuals from 40 l sample; C, 124 individuals from 20 l sample; D, 107 individuals from 20 l sample; E, 82 individuals from 40 l sample.

ference in frequency of males and females, particularly at instar VIII.

Polydesmus denticulatus C. L. Koch, 1847

This species is common in South Finland (Schubart, 1934; Palmén, 1949b; Lehtinen, 1962). Uotila (1976) found it in both winter-cold and winter-warm greenhouses.

P. denticulatus occurred mainly in the young compost (table I). It was collected in most cases from the upper level of the compost in autumn. In April only three specimens were taken from the lower level and two from the organomineral layer; at the same time the upper level sample included 13 individuals. The sex ratio in this sample was 125 (10 ♂♂ : 8 ♀♀). There were no immatures in this sample, but rather many in others.

Choneiulus palmatus (Němec, 1895)

According to Schubart (1934) and Palmén (1949b) *C. palmatus* is probably not able to live out-of-doors in Finland permanently. Accordingly, Uotila (1976) found it only in winter-warm greenhouses.

C. palmatus was rather rare in the compost. All finds were from the old compost and mostly from the lower level. Remarkably no males were found. It is interesting to note that the only specimen found in April was encountered at -0.5°C.

Lithobius microps Meinert, 1868

About this species there is very little information from the whole of Fennoscandia. It was reported from South Finland by Palmén (1949a), Lehtinen (1962) and Uotila (1976) from winter-warm and even winter-cold commercial greenhouses, by Palmén also from two localities close to human settlements.

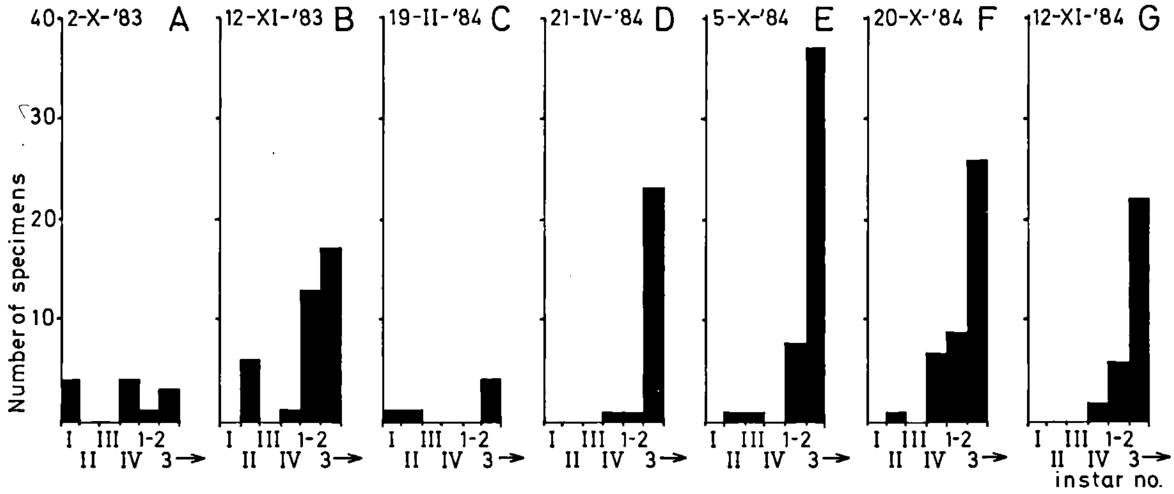

Fig. 4. Larval (I-IV) and postlarval (1-2, 3→) instars of *Lithobius microps* collected from young (A-D) and old (E-G) compost during 1983-1984. Samples A-D and G 40 l, samples E and F 20 l. Sample C was taken from the organomineral layer.

Lithobius microps, the commonest chilopod in the compost, preferred the upper level of the young compost, but not its twiggy parts. In February a few individuals were found, but only from the bottom layer of the young compost, where the temperature was + 1°C.

According to Roberts, cited by Lewis (1981), *L. microps* does not feed if kept at + 2 ± 1°C for 24 hours; furthermore, *L. microps* could not tolerate more than 2 hours at -1°C. In the present study young adults of *L. microps* were found near that temperature (-0.5° to ±0°C) in April, together with young *L. forficatus*.

The chemical composition of the compost studied may be advantageous to *L. microps*, particularly the quantity of Ca (Dunger, 1966; Fairhurst et al., 1978). *L. microps* shows a 2:1 ratio in favour of calcareous areas in England. Perhaps this might be one of the reasons for the abundance of *C. britannicus* too, which like *L. microps* is rare outside the compost and which needs plenty of Ca to build its integument.

The sex ratio of *L. microps* in all samples together was 106 (57 ♂♂ : 53 ♀♀). Fig. 4 shows that throughout the study period few larval instars were found. Stadium I occurred in October, but mostly the larvae were at instar IV. The ratio of larva/postlarva : immature/postlarva : mature was 31 : 38 : 132, i.e. there were 65.7% matures in all samples together. Only in the young compost in October more immatures than matures were found.

Lithobius forficatus (Linnaeus, 1758)

This is one of the commonest chilopods in Finland.

L. forficatus was not as common as *L. microps* in the compost. It seemed generally to prefer the top parts of the young compost, even twiggy places, but in February it was found only in the organomineral layer.

The sex ratio of *L. forficatus* in this study was 167 (10 ♂♂ : 6 ♀♀). The larval instars were more common in October than later on. The commonest larval instar of the autumn samples was the oldest, IV. The ratio larva : postlarva/immature : postlarva/mature was 26 : 9 : 16, i.e. immatures were in the majority (35 out of 51 individuals). No matures had reached the last or postlarva 10 stadium and only two were in the postlarva 8 instar, although these two instars were very common elsewhere.

Scutigerella sp.

This symphylid was first mentioned from Finland by Lehtinen (1962). Collections in the Zoological Museum of the University of

Helsinki and the present author's observations indicate that this species is rather common in southern Finland.

Scutigerella sp. was found in all layers, but it seemed to prefer the rich humus layer. In winter it was also found in organomineral soil outside the compost at 40-60 cm depth, together with *L. microps*.

HIBERNATION

The number of myriapod specimens during October-November was much higher than during February-April, the ratio being 795 : 89.

At least part of all species found were able to hibernate under the conditions studied of the winter 1983-1984. It is too early to say anything about the possible mortality during hibernation or about the main hibernating places of the myriapods studied.

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