Ber. nat.-med. Verein Innsbruck	Suppl. 10	S. 431 – 439	Innsbruck, April 1992

8th International Congress of Myriapodology, Innsbruck, Austria, July 15 - 20, 1990

Abundance and Species Composition of Pauropoda in Forest Soils of Western Austria (Vorarlberg, Tirol)

by

Erwin MEYER *) and Ulf SCHELLER **)
*) Institut für Zoologie, Technikerstraße 25, A-6020 Innsbruck
**) Häggboholm, Häggesled S-53194 JÄRPÅS

Abstract: During quantitative investigations on the soil fauna of forest habitats (480 - 1590 m a.s.l.) in western Austria (Vorarlberg, Tirol) 1170 Pauropoda were extracted from litter and soil samples. 17 species could be identified, 4 (*Allopauropus humilis, A. pectinatus, A. tenellus, Scleropauropus lyrifer*) are new to Austria, one of them (*Brachypauropus meyeri*) is also new to science. According to the distribution of the species in the investigated forest habitats the following pauropod associations become apparent: (1) Species living in Mullhumus in deciduous woods on calcareous soils with pH above 5 (*Allopauropus hessei, A. helophorus, Stylopauropus pubescens* and *A. helveticus*); (2) Species living mainly under the same conditions, but possibly more acid-tolerant (pH less than 5) and therefore also occuring in mull-like Moder in mixed deciduous forests on other than calcareous soils (*Allopauropus vulgaris, Brachypauropus hamiger*); (3) Species restricted to the lowland forests on sandy-silty soils with a thin cover of mull-like moder (*Allopauropus multiplex, Stylopauropus pedunculatus, A. pectinatus, Brachypauropus meyeri*); (4) Eurytopic species which occur over a wide range of deciduous to coniferous forests from pH = 3,0 to pH = 5,8 and over the whole altitudinal range (480 - 1570 m) (*Allopauropus gracilis, A. cuenoti, Pauropus huxleyi*).

1. Introduction:

Pauropoda are very small, fragile soil animals of low abundance. Therefore only few investigations on the soil fauna have paid attention to the ecology of these delicate arthropods (HUSSON 1938, STARLING 1944, TIEGS 1947, CHALUPSKY 1967, EDWARDS et al. 1967, HÜTHER 1974, 1985, MOORE 1982, SCHELLER 1988, LAGERLÖF & SCHELLER 1989, DUNGER 1989). According to SCHAEFER (1991) the only relevant quantitative study in mixed deciduous forests concerning Pauropoda was made by AXELSSON et al. (1984) in eastern central Sweden.

Previous records on Pauropoda from Austria are based on accicental hand collections from various habitats. The history of these investigations was summarized by IMHOF (1972), who listed 27 species. Since then *Allopauropus amaudruti* REMY and *A. cordieri* REMY have been combined with *A. gracilis* (HANSEN), and HASENHÜTL (1984, 1985, 1987) has recorded another five species. Up to now 30 pauropod species are known for Austria.

The analysis of a great number of specimens extracted from soil and litter samples from a wide range of woodland habitats in Vorarlberg and Tirol enables us to give further data on the distribution, and due to quantitative sampling also on the abundance of Pauropoda in forest soils. In this study we have tried to group the Pauropoda into associations on the basis of their habitat preference.

2. Material and Methods:

2.1. Site description:

The investigated forests are all located in Tirol and Vorarlberg (western Austria) between 480 m a.s.l. and 1570 m (Fig. 1). Two sites are riparian forests (LK, KU), four sites may be characterized as mixed deciduous forests (BT, RS, TH, ST) and three as coniferous forests (RA, KW, KO). The vegetation and the soil types of the sites in Vorarlberg have been described by GRABHERR & PETER (1989) and GLATZEL et al. (1989).

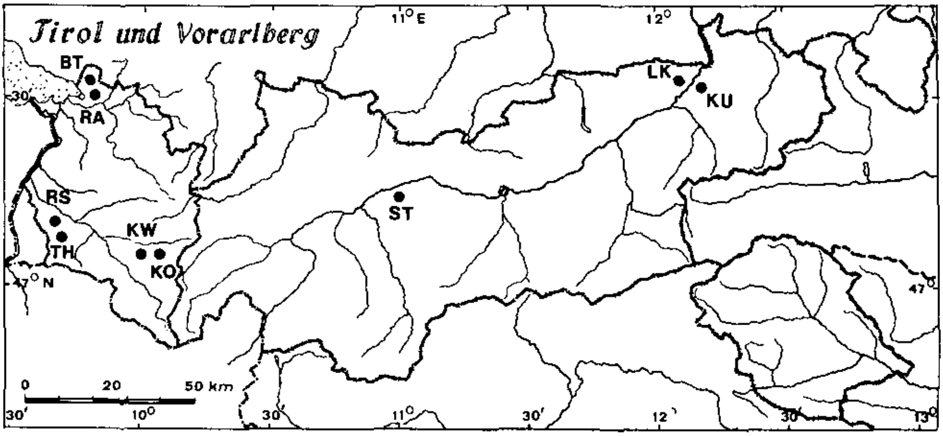

Fig. 1: Map of Tirol and Vorarlberg (western Austria) showing the localisation of the 9 forest habitats investigated.

– Light wood riparian forests
Langkampfen LK (Tirol): Poplar-willow-riverine forest (*Salici-Populetum* with *Salix alba*, *S. fragilis*, *Alnus incana*, *Populus nigra*) along the river Inn (480 m a.s.l.), sandy-silty Paternia with shallow mull-like Moder. At the annual high water mark, the Inn does not normally inundate the forest soil, annual (1989) precipitation 1040 mm, mean annual temperature 9,4° C, sampling dates: May 26, July 23 and Oct. 6 1988.

– Hard wood riparian forests
Kufstein KU (Tirol): riverine forest, *Salicetum fragilis* with *Quercus robur*, *Prunus padus*, *Fraxinus* and *Ulmus* (480 m a.s.l.), grey sandy-silty Paternia with mull-like Moder. Precipitation, temperature and sampling dates as in Langkampfen.

– Mixed deciduous forests
Nenzing-Rabenstein RS (Vorarlberg): Spruce-fir-beechwood, *Galio-Abietetum*, 590 m a.s.l., Pararendsina with Mull, pH = 5,6, mean annual precipitation 1250 mm, mean winter temperature 2° C, mean summer temperature 13,6° C, sampling dates: Aug. 17, Oct. 27 1987 and June 9 1988.
Nenzing-Trinahalda TH (Vorarlberg): Spruce-fir-beechwood, *Galio-Abietetum*, 870 m a.s.l., Pararendsina with moder-like Mull, pH = 5,8, mean annual precipitation 1350 m, mean winter temperature 0,2° C, mean summer temperature 11,8° C, sampling dates: Aug. 17, Oct. 27 1987 and June 24 1988.
Stams ST (Tirol): Mixed oak Wood, *Quercetum roboris*, 670 m a.s.l., shallow Ranker with moder-like Mull, pH = 5,1, mean annual precipitation 706 mm, mean annual temperature 7,9° C (1979), 7.4° C (1980), sampling dates: April 24, May 27, July 1, 31, Sept. 3 and Oct. 7 1987.
Möggers-Buchheimer Tobel BT (Vorarlberg): Spruce-fir-beechwood, *Galio-Abietetum*, 730 m a.s.l., Pseudogley with moder-like Mull, pH = 3,6, mean annual precipitation 1550 mm, mean winter temperature 2° C, mean summer temperature 12,4° C, sampling dates: Sept. 15, Nov. 11 1987 and June 9 1988.

– Coniferous forests
Kristberg-West KW (Vorarlberg): Subalpine spruce forest, *Homogyne-Piceetum*, 1540 m a.s.l., podsolic Brownearth with raw Humus or mull-like Moder, pH = 3,3, mean annual precipitation 1580 mm, mean winter temperature -0,5° C, mean summer temperature 8,2° C, sampling dates: Aug. 6, Oct. 10 1987 and June 24 1988.

Kristberg-Ost KO (Vorarlberg): Subalpine spruce forest, *Homogyne-Piceetum*, 1570 m a.s.l., Pseudogley-Podsol with hydromorphic raw Humus, pH = 3,4, precipitation, temperature and sampling dates as in Kristberg-West.

Möggers-Ramsach RA (Vorarlberg): Fir-spruce forest, *Bazzanio-Abietetum*, 870 m a.s.l., Stagnogley with hydromorphic Moder, pH = 3,0, mean annual precipitation 1700 mm, mean winter temperature 1,2° C, mean summer temperature 11,4° C, sampling dates as in Möggers-Buchheimer Tobel.

2.2. Methods:

The evaluation of the abundance is based on a total of 15 samples (à 707 cm^2, 15 cm deep) from each site, collected on 3 occasions (5 samples at each date) in 1987/88. A modified Kempson-Apparatus was employed for extraction. *Only in the mixed oak wood in Stams were a total of 7 x 42 samples (à 18 cm^2, 15 cm deep) collected on 6* occasions during 1987.

3. Results:

3.1. Distribution of the Species:

Alltogether 1170 Pauropoda have been extracted from all litter and soil samples. They belong to 17 species. The general and local distribution of the identified species and their total numbers collected are summarized in Table 1. One species (*Brachypauropus meyeri*) is new to science (SCHELLER 1991). Four species (*Allopauropus humilis, A. pectinatus, A. tenellus, Scleropauropus lyrifer*) are new for Austria, four species (*Allopauropus multiplex, Pauropus huxleyi, Stylopauropus neglectus, Brachypauropus hamiger*) are new for Tirol and two species (*Stylopauropus neglectus, S. pedunculatus*) are new for Vorarlberg. *B. hamiger* has already been collected in Vorarlberg in a snow coomb at 2200 m a.s.l. by JANETSCHEK (1961). Including the present investigation the number of pauropod species known for Austria is now 35, increasing the number of species recorded for Vorarlberg to 14, for Tirol to 12.

Four species (*Allopauropus cuenoti, A. gracilis, A. vulgaris, Pauropus huxleyi*) are present in high numbers. They are subcosmopolitan (*Stylopauropus pedunculatus* included) and all have a great capacity to adapt to various environmental factors and consequently where they occur they are usually abundant. A second group of species (7 spp.) is not known outside the West Palaearctic (*Allopauropus humilis, A. helophorus, A. hessei, A. pectinatus, Stylopauropus neglectus, S. pubescens*). The main part of these species has earlier been collected most often in deciduous forests. In general they are rare, exceptions are *S. pubescens* and to a lesser degree *B. hamiger. Allopauropus helveticus, A. multiplex, A. tenellus, Scleropauropus lyrifer* are West Palaearctic-Nearctic species. They, too, belong to deciduous forests. The first two are often met with.

3.2. Phenology and Sex Ratio:

Little information is available on the sex ratio for Pauropoda. When data for 13 species of Pauropoda (HÜTHER 1974, Tullgren extraction) are pooled, a ratio of 0,41 (143 ♂: 345 ♀) is obtained. The sex ratio obtained for our samples (17 species) is 0,48 (274 ♂: 576 ♀). For the most frequent species the values vary within a range of 0,25 (*A. gracilis*) to 0,79 (*A. vulgaris*) (Table 1). Only in *A. multiplex* (8 ♂/7 ♀) and *B. meyeri* (8 ♂/4 ♀) were more males than females extracted. In contrast, all 36 (subadult and adult) specimens of *A. helophorus* were females. All of these were collected at one date (Oct. 27) from several samples taken at the deciduous forests (RS, TH) on calcareous soils.

The high-gradient extraction method afforded the opportunity to obtain specimens with three (first instar), five (second instar) and six (third instar) pairs of legs, subadults with eight and adults with nine and ten pairs of legs. The phenology of the different developmental stages of the four most frequent species is indicated in Table 2. The first instars of *A. vulgaris* and *A. gracilis* were continuously present from April (May) to October. One may conclude that these two species have no

Table 1: List of the recorded species with comments to their general distribution and numbers collected during the present study. Juv.: Instars with 3, 5, 6 pairs of legs; ♂♀: subadult and adult males and females with 8, 9 and 10 pairs of legs.

	General distribution and frequency	Total coll. this study		
		♂♂	♀♀	juv.
Pauropodidae				
Pauropodinae				
Allopauropus (A.) humilis REMY	West Palaearctic (Austria, Bulgaria, Greece), rare, probably a lowland species	1	2	-
A. (Decapauropus) cuenoti REMY	At least Holarctic, may be subcosmopolitan, frequent, up to 2300 m a.s.l.	115	235	86
A. (D.) gracilis (HANSEN)	May be subcosmopolitan, frequent, up to 2200 m	14	55	31
A. (D.) helophorus REMY	West Palaearctic (Belgium, Yugoslavia), rare, up to 1200 m	-	36	15
A. (D.) helveticus (HANSEN)	West Palaearctic - Nearctic, locally frequent, up to 1350 m	1	18	10
A. (D.) hessei REMY	West Palaearctic (France, Switzerland, Austria, Czechoslovakia, Roumania), rare up to 1400 m	9	12	-
A. (D.) multiplex REMY	West Palaearctic - Nearctic not very frequent, up to 2200 m	8	7	3
A. (D.) pectinatus (HANSEN)	West Palaearctic (Central and South Europe, North Africa) rare, lowlands ?	3	1	2
A. (D.) tenellus SCHELLER	West Palaearctic - Nearctic, rare, lowlands ?	-	-	1
A. (D.) vulgaris (HANSEN)	May be subcosmopolitan frequent, up to 2200 m	67	85	31
Pauropus huxleyi LUBBOCK	West Palaearctic (may have a wider range, has often been confused with *P. lanceolatus* locally frequent, up to 1600 m	36	71	106
Stylopauropus neglectus REMY	West Palaearctic (Central Europe), probably rare	1	-	1
S. pedunculatus (LUBBOCK)	May be subcosmopolitan, frequent, up to 1600 m	1	6	9
S. pubescens HANSEN	West Palaearctic (Great Britain, Roumania), fairly frequent, up to 1600 m	7	27	8
Scleropauropodinae				
Scleropauropus lyrifer REMY	West Palaearctic - Nearctic, rare, up to 1600 m	-	1	-
Brachypauropodidae				
Brachypauropus hamiger LATZEL	West Palaearctic, southern half of Europe, rare, up to 2200 m	3	8	13
B. meyeri SCHELLER	new species (SCHELLER 1991)	8	4	4

Table 2: Phenology of the four most abundant species. The total numbers for each developmental stage out of all samples from 9 forests are given. For juvenile, subadult and adult specimens the number of pairs of legs is indicated. In brackets: the total area (cm²) sampled in each month.

	developmental stage							
Allopauropus vulgaris	juvenile			subadult		adult		
	3	5	6	♂ 8	♀ 8	♂ 9	♀ 9	♀ 10
April (130 cm²)	3	2	5	2	4	14	20	-
May (7200)	1	1	-	-	-	3	3	1
June (21210)	-	2	2	2	4	19	24	-
July (7320)	1	-	1	1	-	2	4	-
August (14140)	-	-	-	-	-	-	1	-
September (7200)	1	1	-	-	-	1	1	-
October (21340)	1	-	6	1	4	12	8	1
November (7070)	-	2	2	7	1	3	9	-

Allopauropus cuenoti	juvenile			subadult		adult		
	3	5	6	♂ 8	♀ 8	♂ 9	♀ 9	♀ 10
April	-	-	-	-	-	-	-	1
May	3	-	-	-	1	-	1	1
June	3	20	41	12	25	34	58	3
July	-	-	-	-	-	1	-	-
August	-	-	1	-	1	-	1	-
September	-	2	5	12	12	12	10	1
October	-	1	1	-	1	-	6	-
November	-	1	8	10	15	34	85	13

Pauropus huxleyi	juvenile			subadult		adult		
	3	5	6	♂ 8	♀ 8	♂ 9	♀ 9	♀ 10
April	-	-	-	-	-	-	-	-
May	-	-	-	-	-	-	-	-
June	47	41	10	2	10	12	18	-
July	-	-	-	-	1	-	-	-
August	-	1	-	2	1	1	7	-
September	-	-	1	-	1	2	4	-
October	-	-	3	3	4	1	11	-
November	-	-	3	-	-	13	14	-

Allopauropus gracilis	juvenile			subadult		adult		
	3	5	6	♂ 8	♀ 8	♂ 9	♀ 9	♀ 10
April	-	-	1	-	-	-	1	-
May	1	1	1	-	-	1	12	4
June	-	-	1	-	2	4	9	-
July	4	2	2	-	-	4	4	1
August	-	-	-	-	1	2	-	-
September	-	-	-	-	1	-	1	-
October	5	5	7	2	2	1	11	2
November	-	1	-	-	-	-	2	2

particular breeding period during the year. The first instars of a *A. cuenoti* and *P. huxleyi* could only be collected in May/June. One may speculate that these two species are possibly spring breeders. Unfortunately the seasonal pattern of the phenology of the other stages allows no further interpretation about a possible life cycle of any species. But there is a tendency for the highest abundance of adults to occur in spring and late autumn. The low numbers in July, August and September may be connected with susceptibility to drought.

3.2. Abundance and Vertical Distribution (Table 3):

Table 3: Seasonal abundance [ind. per m^2] and vertical distribution [total ind. collected] of the Pauropoda at the forest habitats investigated. 5 samples (à 707 cm^2) at each date and each site, in Stams (ST) 7 samples (à 18 cm^2) at each date.

Site	abundance [ind./m^2]						vertical distribution 0 - 7 cm	vertical distribution 8 - 15 cm
RS	1987, Aug 17		Oct 10		1988, June 9			
	22,6		**257,5**		**254,6**		**158**	31
TH	1987, Aug 17		Oct 27		1988, June 24			
	16,9		**101,9**		45,3		**41**	17
ST	1987, Apr 24	May 27	July 1	July 31	Sep 3	Oct 7		
	4263	1421	1184	1026	276,3	789,5	**94**	19
BT	1987, Sep 15		Nov 11		1988, June 9			
	172,6		**483,8**		198,1		**247**	55
	1987, May 26		July 23		Oct 6			
KU	50,9		5,7		**121,7**		**34**	29
LK	**101,9**		8,5		8,5		**21**	**21**
	1987, Aug 6		Oct 10		1988, June 24			
KW	28,3		59,4		**107,5**		**66**	3
KO	11,3		5,7		**25,5**		**10**	5
RA	1987, Sep 15		Nov 11		1988, June 9			
	8,5		200,9		**690,4**		**304**	14

The highest density estimate for all Pauropoda was obtained in the mixed oak wood (4263 ind. m^2, mean: 1493). But, because it is calculated from small (à 18 cm^2) samples, this value may be an overestimate. All other values are derived from large samples (à 707 cm^2). Apart from this, Pauropoda are in any case most abundant at Ramsach (RA, 300 ind. m^2) and Buchheimer Tobel (BT, 285 ind. m^2), two neighbouring forests each with high annual precipitation and relatively high summer temperatures, but differing as to plant association, soil pH and Humus type. The lowest density was obtained at the subalpine spruce forest (Kristberg KO 1570 m a.s.l., 14 ind. m^2) with hydromorphic raw Humus. The abundance at the mixed deciduous forests (RS 178 ind. m^2, TH 55 ind. m^2) on calcareous soils are intermediate. The seasonal abundance is highest either in May/June (RA, LA, ST, KW, KO) or in October/November (BT, RS, TH, KU). In conclusion there is no obvious relationship between the abundance of Pauropoda and plant association (deciduous or coniferous), soil pH or Humus type. A positive correlation may probably exist between the abundance of Pauropoda and the availability of sufficient humidity (precipitation) and moderate summer temperature.

Species richness, a further important ecological parameter, seems certainly to depend on the soil-pH and Humus type (Table 4). The highest diversity (8 - 11 species) is found in the deciduous forests with Mull-Humus on calcareous soil (pH 5,6 - 5,8), the poorest community (2 species) in the

Table 4: Pauropod species, their phenology and total numbers collected in 9 forest habitats, grouped into 4 associations on the basis of their habitat preferences.

	RS	TH	ST	BT	KU	LK	KW	KO	RA	Total	Phenology
Scleropauropus lyrifer	1	-	-	-	-	-	-	-	-	1	VI
Allopauropus hessei	21	-	-	-	-	-	-	-	-	21	VI
A. helophorus	50	1	-	-	-	-	-	-	-	51	VI,X
Stylopauropus pubescens	35	2	-	5	-	-	-	-	-	42	VI,VIII,X,XI
Allopauropus helveticus	13	11	-	-	5	-	-	-	-	29	V,VI,X
A. humilis	-	3	-	-	-	-	-	-	-	3	VIII
A. tenellus	-	-	1	-	-	-	-	-	-	1	X
A. vulgaris	29	30	74	50	-	-	-	-	-	183	
Brachypauropus hamiger	11	-	2	11	-	-	-	-	-	24	IV,VI,VIII,X,XI
Allopauropus multiplex	3	-	-	1	4	10	-	-	-	18	V,VIII,X,XI
Stylopauropus pedunculatus	-	-	1	5	10	-	-	-	-	16	V,VII,X,XI
Allopauropus pectinatus	-	-	-	-	6	-	-	-	-	6	VI,X
Brachypauropus meyeri	-	-	-	-	-	24	-	-	-	24	V,VII
Stylopauropus neglectus	-	1	-	-	-	1	-	-	-	2	V,VIII
Allopauropus gracilis	19	1	32	8	32	7	1	-	-	100	
A. cuenoti	2	9	3	184	6	-	26	3	203	436	
Pauropus huxleyi	5	-	1	38	-	-	42	12	115	213	
Total	*189*	*58*	*114*	*302*	*63*	*42*	*69*	*15*	*318*	*1170*	
No of species	11	8	7	8	6	4	3	2	2	17	
Ind./m²	178	55	1493	285	60	40	65	14	300		
area sampled [cm² x 1000]	10,6	10,6	0,8	10,6	10,6	10,6	10,6	10,6	10,6		
mean summertemp. [°C]	13,6	11,8	13,7	12,4	-	-	8,2	8,2	11,4		
annual precipitation [mm]	1250	1350	706	1550	1040	1040	1580	1580	1700		
altitude [m a.s.l.]	590	870	670	730	480	480	1540	1570	870		
pH	5,6	5,8	5,1	3,6	-	-	3,3	3,3	3,0		
Humus *)	Mull	Mull	Mull	Mull	Mod	Mod	Mod	Raw	Raw		

*) **Mod** .. Moder

fir-spruce forest with hydromorphic Moder and the lowest pH (3,0). As mentioned earlier the latter species have obviously a great capacity to adapt to various environmental factors and are obviously often abundant whereever they occur.

Each of the soil cores has been divided into two layers: 0 - 7 cm and 8 - 15 cm. On the whole, Pauropoda were concentrated in the upper part of the sample (Table 3). In the coniferous forests (KW, RA) with raw Humus or Moder more than 95 % of the animals were extracted from the 0 - 7 cm layer. At the sites with Mull-Humus (RS, TH, ST, BT) the upper layer still contains 70 - 80 %. Only in the riparian forests (LK, KU) on sandy-silty soils is the vertical distribution nearly even.

3.3. The Pauropod Assosiations:

In Table 4 the species are arranged according to their occurrence at the 9 habitats investigated. Some additional lines give information on the total number of specimens collected per site, the species number, the calculated total abundance (ind./m^2), mean summer temperature, mean annual precipitation, altitude and pH of the soil.

Based on the occurrence of the species in the investigated forests we have arranged and indicated by frames the following pauropod associations:

(1) Species preferably living in Mull-Humus in deciduous woods on calcareous soils with pH above 5: *Allopauropus hessei, A. helophorus, Stylopauropus pubescens* and *A. helveticus.*

(2) Species living mainly under the same conditions, but possibly more acid tolerant (pH less than 5) and also occuring in mull-like Moder in mixed deciduous forests on non-calcareous soils: *Allopauropus vulgaris, Brachypauropus hamiger.*

(3) Species restricted to the lowland forests on sandy-silty soils with a thin cover of mull-like Moder: *Allopauropus multiplex, Stylopauropus pedunculatus, A. pectinatus, Brachypauropus meyeri.*

(4) Eurytopic species occuring over a wide range from deciduous to coniferous forests from pH = 3,0 to pH = 5,8 and over the whole altitudinal range (480 - 1570 m): *Allopauropus gracilis, A cuenoti, Pauropus huxleyi.*

4. Discussion:

High-gradient soil extraction seems to be a suitable technique for obtaining reasonable abundance values for Pauropoda. This is well documented in studies made by AXELSSON et al. (1984) in a deciduous forest in eastern central Sweden, or by LAGERLÖF & SCHELLER (1989) in agricultural soils in south central Sweden. Compared with other arthropods of corresponding size the population densities of Pauropoda are very low. During the present study the highest density was obtained in a mixed oak wood (4260 ind. m^2). Since no obvious relationship between the quantitative occurrence of Pauropoda and the forest type (deciduous or coniferous) could be detected it is permissible to average all values thus obtaining a density of 300 ind. m^2 for the investigated forest soils. This is twice as much as that given by AXELSSON et al. (1984) for a deciduous forest in Sweden (140 ind. m^2) and only one third of that noted by PETERSEN & LUXTON (1982) for a *Liriodendron* forest in Tennessee (920 - 2900 ind. m^2). In agricultural soils pauropod densities seem to be just as high (1900 ind. m^2, LAGERLÖF & SCHELLER 1989). The vertical distribution of Pauropoda seems to be strongly dependent on the habitat and soil type. In forest soils they are concentrated in the uppermost layer of the profile. This is most pronounced in coniferous forests with raw Humus. Only in the light sandy soil under the riparian forest can they move to deeper zones. In open cultivated soils, also, they live deeper in the soil (HÜTHER 1974, LAGERLÖF & SCHELLER 1989).

Nearly 80 % of all Pauropoda collected belong to only four species. Three of them (*A. gracilis, A. cuenoti, P. huxleyi*) show no habitat preference, and are ubiquists, occuring in deciduous and coniferous woodland soils even under extremely acid conditions, as well as in cultivated soils (LAGERLÖF & SCHELLER 1989) and in open areas and vineyards (HÜTHER 1974). Another four species (*A. hessei, A. helophorus, S. pubescens, A. helveticus*) are frequent enough to characterize them as species which, in the West Palaearctic, are restricted to deciduous woodlands on base rich soils with Mull-Humus. *A. multiplex, S. pedunculatus,* and the newly described species *A. meyeri* may only live in light sandy-silty soils. It is known that Pauropoda feed on Humus, decaying plant and animal material as well as on microscopic animals (STARLING 1944). DUNGER (1983) suggested that *A. gracilis* is a specialized fungal feeder. Our study indicated that, unlike Oribatid mites and Collembolans, Pauropoda are not generally favoured by the high amount of fungal biomass in Moder or raw Humus soils. Apart from the eurytopic species pauropods are obviously more abundant in Mull soils where they may utilize the rich bacterial and microfaunal populations.

5. Acknowledgements:

Field work was supported by the government of Vorarlberg and the Tyrolean Hydraulic Power Company (TIWAG). We are grateful to Joy Wieser who revised the English text.

6. Literature:

AXELSSON, B., U. LOHM & T. PERSSON (1984): Enchytraeids, lumbricids and soil arthropods in a northern deciduous woodland – a quantitative study. – Holarctic Ecology **7**: 91 - 103.

CHALUPSKY, J. (1967): Bohemian Pauropoda III. – Acta Soc. zool. Bohemoslov. ***31****: 121 - 132.*

DUNGER, W. (1983): Tiere im Boden. – Die Neue Brehm-Bücherei, A. Ziemsen, Wittenberg Lutherstadt, 280 pp.

– (1989): The return of soil fauna to coal mined areas in the German Democratic Republic. – In: MAJER J.D. (ed.): Animals in Primary succession – The Role of Fauna in Reclaimed Lands: 307 - 337. Cambridge University Press.

EDWARDS, C.A., A.R. THOMPSON & J.R. LOFTY (1967): Changes in soil invertebrate populations caused by some organophosphorus insecticides. – Proc. 4th Br. Insect. Fungic. Cong. *1967*: 48 - 55.

GLATZEL, G., K. KATZENSTEINER & M. SIEGHARDT (1989): Waldforschung – Waldbodensanierung 3. Forstökologie. – In: Amt. d. Vlbg. Landesregierung, Lebensraum Vorarlberg, Bd. 3 Waldforschung *in Vorarlberg*: 117 - 141, Bregenz.

GRABHERR, G. & C. PETER (1989): Waldökosystemforschung – Waldbodensanierung 4. Pflanzensoziologie. – In: Amt d. Vlbg. Landesregierung, Lebensraum Vorarlberg, Bd. 3 Waldforschung in Vorarlberg: 143 - 147, Bregenz.

HASENHÜTL, K. (1984): Neue Zwergtausendfüßler aus der Steiermark und angrenzenden Gebieten (Myriapoda, Pauropoda). – Mitt. naturwiss. Ver. Steiermark **114**: 272 - 301.

– (1985): Die Eurypauropodidenfauna der Steiermark und angrenzender Gebiete in zoogeographischer Sicht (Myriapoda, Pauropoda). – Mitt. naturwiss. Ver. Steiermark **115**: *105 - 114.*

– (1987): Neue Zwergtausendfüßer aus Kärnten (Myriapoda, Pauropoda). – Carinthia **II**, 45. Sonderheft: 17 - 75.

HUSSON, R. (1938): La faune des galeries de mines de l'est de la France. – C. R. 1[er] Congr. Lorr. Soc. sav. l'est Fr. 1938: 1 - 6.

HÜTHER, W. (1974): Zur Bionomie mitteleuropäischer Pauropoden. – Symp. zool. Soc. London **32**: 411 - 421.

– (1985): Verbreitung und Vorkommen einiger Pauropodenarten im Brasilianischen Amazonas-Gebiet. – Bidr. Dierk. **55** (1): 95 - 99.

IMHOF, G. (1972): Pauropoda. – In: Catalogus Faunae Austriae, **XIa**: 20 - 23. Österr. Akad. d. Wissenschaften (ed.), Springer, Wien.

JANETSCHEK, H. (1961): Die Tierwelt. – In: K. ILG (Hrsg.), Landes- und Volkskunde, Geschichte, Wirtschaft und Kunst Vorarlbergs: 173 - 240, Wagner, Innsbruck.

LAGERLÖF, J. & U. SCHELLER (1989): Abundance and activity of Pauropoda and Symphyla (Myriapoda) in four cropping systems. – Pedobiologia **33**: 315 - 321.

MOORE, F.R. (1982): Ecology of the Pauropoda from a coal shale heap in Lancashire, England. – Pedobiologia **24**: 309 - 317.

PETERSEN, H. & M. LUXTON (1982): A comparative analysis of soil fauna populations and their role in decomposition processes. – Oikos **39**: 287 - 388.

SCHAEFER, M. (1991): Fauna of the European temperate deciduous forests. – In: RÖHRIG, E. & B. ULRICH (eds.): Ecosystems of the world 7, Temperate deciduous forests: 503 - 525. Elsevier, Amsterdam.

SCHELLER, U. (1988): The Pauropoda (Myriapoda) of the Savannah River Plant, Aiken, South Carolina. – Savanna River Plant & National Environmental Research Park Program **17**: 1 - 99.

– (1991): A new species of Pauropoda from Austria. – Rev. suisse Zool. **98**: 77 - 82.

STARLING, J.H. (1944): Ecological studies of the Pauropoda of the Duke Forest. – Ecol. Monogr. **14**: 291 - 310.

TIEGS, O.W. (1947): The development and affinities of the Pauropoda, based on a study of *Pauropus silvaticus*. – Q. Jl. microsc. Sci. **88**: 165 - 267.