Ber. nat.-med. Verein Innsbruck	Suppl. 10	S. 243 – 250	Innsbruck, April 1992

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

Diplopods and Chilopods of Conventional and Alternative (Biodynamic) Fields in Hesse (FRG)

by

Klaus KLINGER

Institut für Phytopathologie und Angewandte Zoologie [und Institut für Allgemeine und Spezielle Zoologie] der Universität Giessen, Ludwigstraße 23 [Stephanstraße 24] D-6300, Giessen FR Germany

Abstract: The myriapod fauna (diplopods and chilopods) of one alternatively and two conventionally managed farms was investigated on fields with sugar beets/turnips (1985) and of winter cereals (1986). The animals were collected by hand sorting and pitfall traps. Species spectrum, dominance structure and abundance are analysed. Altogether 16 diplopod species and six chilopod species could be found. Differences in species number and species composition concerning the different cultivated fields are tendentious but cannot be related with certainty only to the farming systems. The most important factors for the higher abundance, especially of diplopods, on the alternatively managed fields are considered to be a crop rotation which provides good food sources, and the fact that no pesticides are used.

1. Introduction:

The negative consequences of the industrialized conventional farming system, menacing man and environment, make the alternative farming system become more and more important. Beside the renunciation of pesticides and the use of organic fertilizers, there are further characteristics of the alternative agriculture like a special understanding of the farm as a nearly closed organism, a multifarious cropping system with great importance attached to legumes and the practising of underseeds.

Soil is doubtless a main factor in agricultural production and the existence and life activity of the edaphon are of decisive importance for soil quality (e.g. structure and fertility). As larger soil arthropods the saprophagous millipedes and the zoophagous centipedes play here an important part (DUNGER 1983). Soil invertebrates are on the other hand very dependent on their environment because of their poor mobility resp. homing and are therefore suitable as bioindicators for ecological investigations. Thus, it was necessary to include these animals in the investigations of a project on "Comparison and evaluation of ecological and economical characteristics of farming systems with different levels of intensity in Hesse" run by the University of Giessen.

2. Site Description and Methods:

The investigations took place at one biodynamic (BD, 12 crops) and two conventional farms (C I, 3 crops; C II, 6 crops). The three farms are located in close vicinity to each other north of Frankfurt/Main. In most cases the soils consisted of different luvisols. The investigations presented here concern the diplopod and chilopod fauna on fields with sugar beets resp. turnips (1985) and with winter cereals (1986). As the conventional beet and wheat fields investigated in 1985 and 1986 were identical, the alternative fields were different. Also the rye fields (C II, BD) were investigated only in 1986. The soil of BD 85 was silty loam (sand 7 %, silt 64 %, clay 29 %). Loamy silts were also present on C I 85/86 (6:70:24 %), C II 85/86 – wheat (6:70:24 %), BD 86 – wheat (23:66:11 %) and C II 86 – rye (4:75:21 %). The soil of field BD 86 – rye was a sandy loamy silt (25:60:15).

The myriapods were mostly collected by hand sorting (spade; 0.1 m^2, depth 30 cm). While the samples were evaluated as a whole in 1985, they were subdivided into top soil (0 - 15 cm) and subsoil (15 - 30 cm) in 1986. The sampling — up to 20 samples per field — took place from April to August. Catches of pitfall traps (BARBER 1931) gave further data. Plastic cups (0.3 l, r = 8 cm) with sodium benzoate solution (0.7 %) and a detergent were used. The control of the 10 traps per field was carried out from May to September in beets and from April resp. May to July in winter cereals.

For diplopod species determination the publications of SCHUBART (1934) and BLOWER (1985) and for chilopods those of VERHOEFF (1936), EASON (1964) and CROME (1986) were used.

3. Results:

3.1. Diplopods:

3.1.1. Species Spectrum:

Altogether 16 diplopod species (about 125 species occur in Germany) of six families were found in the study areas (Table 1). As expected, the polydesmid family was represented with many (six) species. While many diplopod species found in this study are described as eurytopic, synanthropic or typic on loamy arable land, species like *S. crinita, B. bradeae, M. palicola* and *O. albonanus* are not typical for arable land (Table 1). *P. testaceus* occurred only at the sites C I and C II. *S. crinita* and *O. albonanus* were only found at the site C II and *P. angustus, A. pallidus, B. guttulatus* and *B. pusillus* only on the alternatively managed farm. The conventionally cultivated field of the site C I showed with altogether nine species in the two years of investigation and a mean species number of 7.5 the lowest species occurrence. The site C II had the most species per field on the average (8.7).

3.1.2. Dominance Structure:

Comprehending, no diplopod species was eudominant (Fig. 1). About 80 % of the specimens collected were among the first five most abundant species with dominances between 21.8 and 8.3 %. *B. guttulatus*, often cited as a potential pest and occurring in great numbers on arable land (BLOWER 1955, BIERNAUX & BAURANT 1964, BAKER 1971), reached a dominance of only 0.6 %.

Comparing the different cultivated fields, in the beet fields always one species was eudominant in contrast to the winter cereal fields (Table 2). Though only four species were found on the biodynamic turnip field, the sugar beet field of the site C I had the most pronounced dominance structure because of the low total number of individuals at six species. At the conventional site C II and particularly on the biodynamic field the millipedes showed a more balanced dominance structure in

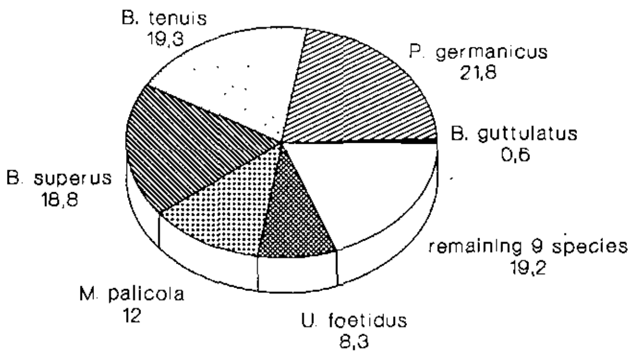

Fig. 1: Total dominance of diplopods (n = 1895) in % at all three sites in 1985 and 1986 (hand sorting).

winter wheat due to higher species numbers (Table 2). On the rye fields a more balanced situation was found at the site C II with ten to seven (BD) species and a relatively low total number of individuals.

3.1.3. Abundance:

The results of the hand sorting are shown in Fig. 2. The highest mean abundances of diplopods were found in all crops on the biodynamic fields. A very high density of individuals (446 ind. m^{-2}) was reached on rye. On conventional fields the abundance had its maximum also in rye with 147 ind.m^{-2} (C II).

Table 1: Diplopod species found (+) resp. not found (–) on the three farms in 1985 and 1986 (hand sorting and pitfall trapping); **C I:** conventional I, **C II:** conventional II, **BD:** biodynamic, **B** Beets, **W** Wheat, **R** Rye.

	C I		C II			BD		
	B 85	W 86	B 85	W 86	R 86	B 85	W 86	R 86
Glomeridae								
Stygioglomeris crinita BROLEMANN	-	-	-	-	+	-	-	-
Brachychaeteumidae								
Brachychaeteuma bradeae BROLEMANN & BRADE-BIRKS	-	-	-	-	+	-	+	+
Polydesmidae								
Brachydesmus superus LATZEL	+	+	+	+	+	+	+	+
Polydesmus angustus LATZEL	-	-	-	-	-	-	+	-
P. denticulatus C.L. KOCH	-	+	+	+	+	-	+	+
P. germanicus VERHOEFF	+	+	+	+	+	-	+	+
P. inconstans LATZEL	-	+	-	+	-	-	+	-
P. testaceus C.L. KOCH	+	+	-	-	+	-	-	-
Strongylosomidae								
Macrosternodesmus palicola BROLEMANN	+	+	-	+	+	-	+	+
Ophiodesmus albonanus (LATZEL)	-	-	+	+	+	-	-	-
Blaniulidae								
Archiboreoiulus pallidus (BRADE-BIRKS)	-	-	-	-	-	-	+	-
Blaniulus guttulatus (F.)	-	-	-	-	-	-	+	-
Boreoiulus tenuis (BIGLER)	+	+	+	+	+	+	+	+
Iulidae								
Brachyiulus pusillus LEACH	-	-	-	-	-	+	-	+
Cylindroiulus caeruleocinctus (WOOD)	-	+	+	+	+	-	+	+
Unciger foetidus (C.L. KOCH)	+	+	+	+	+	+	+	+
Number of species per field	6	9	7	9	11	4	12	9
Number of species per site	9		12			13		
Mean number of species per field	7,5		9,0			8,3		

Table 2: Dominance structure (%) of diplopods on conventional and biodynamic fields in 1985 and 1986 (hand sorting); for abbreviations of sites and of species see Table 1, e.g. Bs = *B. superus.*

		B 1985			W 1986			R 1986	
Dominance class		C I	C II	BD	C I	C II	BD	C II	BD
Eudominant	> 40 %	73,1 Bs	41,5 Pg	62,9 Bs	-	-	-	-	-
Dominant	20 - 40 %	-	33,1 Bs	25,1 Bt	38,9 Pg	28,4 Uf	26,2 Cc	28,6 Mp	36,1 Bt
		-	-	-	-	24,6 Mp	23,1 Pg	21,8 Bt	30,3 Pg
		-	-	-	-	-	-	20,4 Pg	-
Subdominant	10 - 20 %	16,1 Pg	-	10,8 Bp	18,3 Bt	17,2 Oa	18,2 Uf	-	17,3 Mp
		-	-	-	16,0 Pd	11,9 Pd	15,4 Mp	-	-
		-	-	-	12,6 Bs	-	-	-	-
Recedent	0 - 10 %	5,4 Bt	10,0 Uf	1,2 Uf	9,1 Uf	9,7 Pg	8,6 Bt	8,2 Pd	6,0 Pd
		3,2 Pt	6,1 Bt	-	5,1 Mp	3,7 Cc	2,8 Bg	8,2 Oa	5,6 Cc
		1,1 Mp	5,4 Pd	-	-	3,0 Bt	2,3 Bb	4,8 Bs	4,5 Bb
		1,1 Uf	2,3 Oa	-	-	0,7 Bs	1,9 Pd	4,1 Uf	0,2 Uf
		-	1,1 Cc	-	-	0,7 Pi	1,2 Ap	1,4 Bb	-
		-	-	-	-	-	0,2 Bs	1,4 Cc	-
		-	-	-	-	-	-	1,4 Bp	-
Total number of species		6	7	4	6	9	10	10	7
Total number of individuals		93	130	342	175	134	428	147	446

While only 26 (C I) resp. 21 % (C II) of the diplopods on the conventional wheat fields lived in the subsoil, on the biodynamic field it was 51 % in the subdivided samples from 1986. In rye the total of specimens found in C II was comparably low (only 33 % of the abundance in BD, Fig. 2). Here (C II), the diplopods occurred mainly in the subsoil (63 %) as only 33 % were found in the subsoil in BD.

3.2. Chilopods:

3.2.1. Species Spectrum:

Six chilopod species (about 45 species occur in Germany) were found on the three sites (Table 3). Some species are typical for arable land (*N. flavus, L. microps, L. fulvicornis*), others like *Striga-*

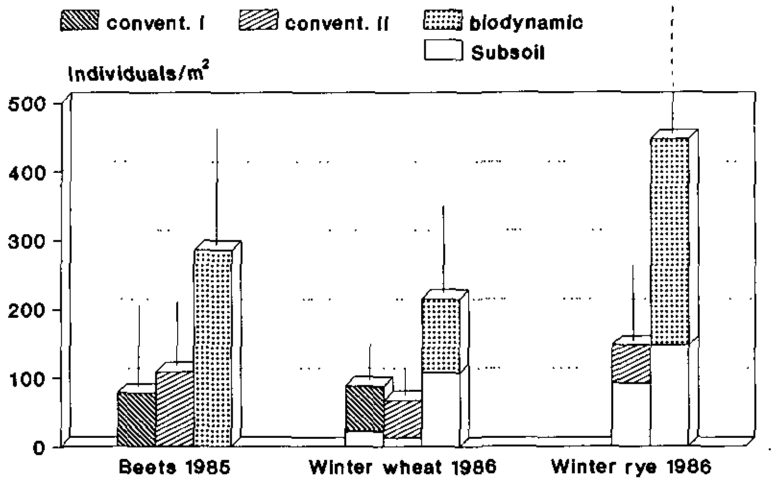

Fig. 2: Diplopod mean abundance (with standard deviation) on conventional and biodynamic fields in 1985 and 1986 (hand sorting).

Table 3: Chilopod species found (+) resp. not found (−) on the three farms in 1985 and 1986 (hand sorting and pitfall trapping); abbreviations see Table 1.

	C I		C II			BD		
	B 85	W 86	B 85	W 86	R 86	B 85	W 86	R 86
Lithobiidae								
Lithobius microps MEINERT	-	+	-	+	-	-	-	+
Henicopidae								
Lamyctes fulvicornis MEINERT	-	+	+	+	+	+	+	+
Geophilidae								
Clinopodes linearis (C.L. KOCH)	+	+	+	+	+	-	+	+
Necrophloeophagus flavus (DE GEER)	+	+	+	+	+	+	+	+
Strigamia crassipes (C.L. KOCH)	-	-	-	+	+	-	-	-
S. transsilvanica VERHOEFF	-	-	+	+	-	-	-	-
Number of species per field	2	4	4	6	4	2	3	4
Number of species per site	4			6			4	
Mean number of species per field	3,0			4,7			3,0	

mia spp. are rarely found. Both *Strigamia* species occurred at the site C II only. The site C II had the highest number of species and the highest mean number of species per field.

3.2.2. Dominance Structure:

The euedaphic Geophilomorpha with the genera *Necrophloeophagus* (89.5 %), *Clinopodes* (24 %) and *Strigamia* (2.3 %) dominated by far the hemiedaphic Lithobiomorpha (8.2 %) (Fig. 3). In nearly all fields the dominance structure was ruled by only one eudominant species (*N. flavus*) (Table 4), predominantly visible on the biodynamic beet field with only two chilopod species. On

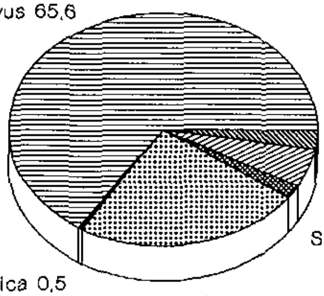

Fig. 3: Total dominance of chilopods (n = 1502) in % at all three sites in 1985 and 1986 (hand sorting).

Table 4: Dominance structure (%) of chilopods on conventional and biodynamic fields in 1985 and 1986 (hand sorting); abbreviations of sites and of species see Table 1 and Table 3 resp, e.g. Cl = *C. linearis.*

		B 1985			W 1986			R 1986	
Dominance class		C I	C II	BD	C I	C II	BD	C II	BD
Eudominant	> 40 %	80,0 Nf	50,0 Nf	87,1 Nf	86,9 Nf	60,5 Nf	66,5 Nf	81,5 Nf	-
Dominant	20 - 40 %	-	41,3 Cl	-	-	31,3 Cl	32,7 Cl	-	38,1 Nf
		-	-	-	-	-	-	-	30,7 Cl
		-	-	-	-	-	-	-	29,9 Lm
Subdominant	10 - 20 %	20,0 Cl	-	12,9 Lf	-	-	-	16,7 Cl	-
Recedent	0 - 10 %	-	4,3 St	-	9,6 Lm	6,1 Sc	2,8 Lf	0,9 Sc	1,3 Lf
		-	4,3 Sc	-	1,7 Cl	1,4 St	-	0,9 Lf	-
		-	-	-	1,7 Lf	0,5 Lf	-	-	-
		-	-	-	-	0,2 Lm	-	-	-
Total number of species		2	4	2	4	6	3	4	4
Total number of individuals		10	46	218	115	425	349	108	231

wheat, site C II and the alternatively cultivated field showed again similar dominance structures. The most balanced situation was found on the biodynamic rye field.

3.2.3. Abundance:

The centipedes showed a similar situation to the millipedes (Fig. 4). On the alternatively cultivated beet field and in rye again high abundances were found. These differences could not be seen in

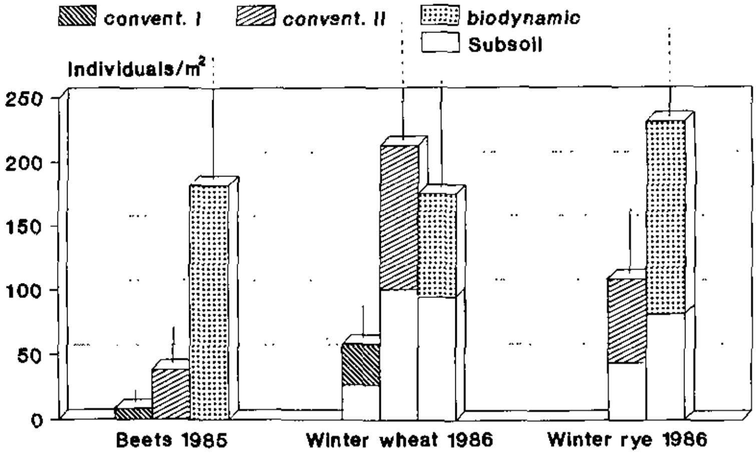

Fig. 4: Chilopod mean abundance (with standard deviation) on conventional and biodynamic fields in 1985 and 1986 (hand sorting).

winter wheat. On the site C II all six chilopod species occurred and two of them (*N. flavus, C. linearis*) with high densities. The beet field C I had an extremely low abundance (8.3 ind. m^{-2}). Only in the biodynamic wheat field was the density of individuals in the subsoil higher (54 %) than in the top soil. In the other fields the percentage in the subsoil varied from 47 % to 35 %.

4. Discussion:

With altogether 16 diplopod and six chilopod species the myriapods showed a rich spectrum on the studied arable land. The differences concerning species composition and number of species on the different cultivated fields show a tendency but cannot be related to the farming systems exclusively. Site factors like soil class which really has a decisive influence on soil moisture are surely of great importance. The occurrence of hygrophilus species like *B. pusillus* and *L. fulvicornis* on the alternatively cultivated beet field in 1985 was certainly favoured by the location of this field in a river loop.

The species association of *B. guttulatus* and *A. pallidus* described in literature (BAURANT 1964, BLOWER 1985) — these species were only found on the alternative wheat field in 1986 — was confirmed.

Pitfall trap catches only, without the data of the hand sorting, lead to a completely different evaluation concerning the occurrence and the dominance of species. Pitfall trap catches reflect mainly the epigaeic stratocoenosis and include species with a mainly edaphic mode of life only insufficiently. On the other hand *P. angustus* is lacking in Fig. 1 because it was only caught — as a unique specimen — by the pitfall traps. Thus, pitfall trap catches are a good supplementation to hand sorting.

Considering the large numbers of myriapod species and individuals on the site C II compared with the site C I the higher number of crops, a more manifold structured landscape in combination with a lower mean field size (1.3 : 5.7 ha) and site factors are possible explanations. Small differences in the use of biocides are not considered to be decisive. High abundances of myriapods on the alternative fields are certainly caused not only by the missing continuous strain of pesticides. Especially concerning the saprophagous diplopods there are additional factors. The biodynamic beet field 1985 had received 100 dt/ha more stable manure than the conventional ones, showed a rank weed flora and the content of organic matter in the soil was higher. Moreover, soil specific factors — this field was the only one with a pseudogley — might have had positive effects. The two previous years of lucerne — in contrast to sugar beet as preceeding crop — were doubtless of high importance on the wheat field. This means a long period of soil dormancy and the provision of sufficient amounts of decaying plant material. The effects of this period of recuperation became obvious even in the subsoil. For the rye field also positive factors are the use of stable manure and a rich weed flora. Especially regarding manifold nutritive resources and more favourable microclimatic conditions (weed flora) the centipedes likewise might have found better life conditions on the alternatively cultivated fields.

4. Literature:

BAKER, J.G. (1971): Rothamsted Experimental Station. — Report for 1970: 248 - 250.

BARBER, H. (1931): Traps for cave-inhabiting insects. — J. Elisha Mitchell Sci. Soc. **46:** 259 - 266.

BAURANT, R. (1964): Les degats d'Iules mouchetes sur jeunes betteraves. — Bull. Inst. Agron. et Stat. Rech. Gembloux **32:** 3 - 11.

BIERNAUX, J. & R. BAURANT (1964): Au sujet de la presence de *Blaniulus guttulatus* BOSC. et d'*Archiboreoiulus pallidus* BR.-BK. (Myriapodes, Diplopodes) dans les couches superieures du sol, au moment des semis de betteraves. — Meded. Landb. Hoogesch. Opzoek Stns. Gent **29:** 1063 - 1070.

BLOWER, J.G. (1955): Millipedes and Centipedes as soil animals. — In: KEVAN, D.E. (ed.): Soil zoology, London (Butterworth): 138 - 151.

— (1985): Millipedes. Keys and notes for the identification of the species. — Synopses of the British Fauna (E.J. Brill, Dr. W. Backhuys, London .. København) NS **35:** viii, 1 - 242.

CROME, W. (1986): Myriapoda — Tausendfüsser. — In: STRESEMANN, E. (Hrsg.): Exkursionsfauna für die Gebiete der DDR und der BRD. Wirbellose I. Berlin (Volk und Wissen): 370 - 393.

DUNGER, W. (1983): Tiere im Boden. — Neue Brehm Bücherei **327:** 1 - 280. Wittenberg Lutherstadt (A. Ziemsen).

EASON, E.H. (1964): Centipedes of the British Isles. — London (F. Warne & Co LTD), x, 1 - 294.

SCHUBART, O. (1934): Tausendfüßler oder Myriapoda I: Diplopoda. — In: DAHL, F. (Hrsg.): Die Tierwelt Deutschlands **28:** viii, 1 - 318. Jena (Fischer).

VERHOEFF, K.W. (1936): Hundertfüßler, Chilopoda. — In: BROHMER, P., P. EHRMANN, G. ULMER (Hrsg.): Die Tierwelt Mitteleuropas **2** (3): 91 - 117. Leipzig (Quelle & Meyer).