The millipedes and centipedes (Diplopoda, Chilopoda) of the river banks and the stream islands at the northern Upper-Rhine in Germany

PETER DECKER[1]* and MICHAEL T. MARX[2]

[1] Senckenberg Museum of Natural History, Am Museum 1, 02826 Görlitz, Germany, peter.decker@senckenberg.de

[2] Johannes Gutenberg-Universität Mainz, Becherweg 13, 55099 Mainz, Germany

* Corresponding author: Peter Decker

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Abstract. This work presents the fauna of millipedes and centipedes of a floodplain near Ingelheim at the Rhine in Germany to support the knowledge of the myriapod fauna in Central European floodplains and faunistic research of the Rhine-Main area, investigated by pitfall traps and tree eclectors. Structure of dominance, evenness and diversity is given. Seasonal activity on the ground and the lower stem region of the dominant species *Julus scandinavius* LATZEL, 1884 and *Polydesmus denticulatus* C. L. KOCH, 1847 were investigated which showed also high constancy at the lower stem region. Furthermore an overview of the Diplopoda and Chilopoda of various stream islands in the Rhine and river banks from pitfall traps during the years 2002 to 2005 are presented and discussed.

Zusammenfassung. Die Tausend- und Hundertfüßer (Diplopoda, Chilopoda) der Ufer und Rheininseln am nördlichen Oberrhein in Deutschland. Die vorliegende Arbeit gibt eine Zusammenstellung der Tausend- und Hundertfüßer aus Bodenfallen und Stammeklektoren in einem fragmentarischen Auwald bei Ingelheim am Rhein aus den Jahren 2003 bis 2005 als Beitrag zur Kenntnis der Myriapoden in mitteleuropäischen Auwäldern und zur Faunistik des Rhein-Main-Gebietes. Die Dominanzstruktur, Evenness und die Diversität wurden für den Boden und den unteren Stammbereich berechnet. Die Aktivitätsdichten der dominanten Arten *Julus scandinavius* LATZEL, 1884 und *Polydesmus denticulatus* C. L. KOCH, 1847 am Boden und im Stammbereich wurden näher untersucht. Es konnte eine hohe Konstanz beider Arten im unteren Stammbereich gezeigt werden. Des Weiteren wird eine Übersicht der durch Bodenfallen gefangenen Diplopoden und Chilopoden von verschiedenen Rheininseln und Uferstandorten aus den Jahren 2002 bis 2005 gegeben.

Keywords. Myriapoda, floodplain, Rhine, stem region, inundation

1. Introduction

Floodplain forests are characterised by an alternation of terrestrial and aquatic phases and thus constitute very dynamic ecosystems. The chilopods and diplopods of Central European lowland floodplains have been investigated by several authors (DUNGER 1958, HANDKE & HANDKE 1989, RIPPLINGER & ALBERTI 1993, TUF 2000, 2003, TUF & OŽANOVÁ 1999, STERZYŃSKA et al. 2015, TUFOVÁ 2003, TUFOVÁ & TUF 2005, WYTWER 1997, ZERM 1997a, 1997b, 1999, ZULKA 1990, 1991, 1992, 1996), the numerous floodplains of the northern Upper Rhine, however, having been overlooked until now. The aim of the following study was to investigate the composition of the millipede and centipede fauna of a fragmented hardwood floodplain near Ingelheim on the Rhine, Germany, and several floodplain forests of the Rhine islands and river banks. The following arthropod groups have been investigated so far in this floodplain forest near Ingelheim: Collembola (MARX 2005, 2007, 2011), Carabidae (LESSEL & EISENBEIS 2008), Opiliones (MARX & SCHÖNHOFER 2005), Pseudoscorpiones (MARX et al. 2008a) and Araneae (MARX et al. 2008b).

The diplopods of the Rhine-Main area have only been investigated by very few authors since HAACKER (1968a, 1968b), but especially the faunistic knowledge on the chilopods of this area is still very sketchy.

2. Material and Methods

2.1 Location and characterisation of the investigation sites

The floodplains study area „Heidenfahrt" (Fig. 1) is located in the Mainz Basin, approx. 7 km to the west of Mainz and 1.2 km from Heidenfahrt (Heidesheim on the Rhine) and is part of the nature reserve "Sandlache". It is a fragmented hardwood floodplain forest of the northern Upper Rhine area and is dominated in the tree layer by *Fraxinus excelsior*, *Quercus robur* and *Acer campestre*.

In the past, the floodplain forest has been flooded regularly for shorter periods of a few weeks. In recent years, such flood events have become increasingly rare due to lower precipitation. The last flooding across the whole area took place in March and April of 2002 with the floodplain forest almost completely underwater. The stream islands in the Rhine and the river banks were also largely flooded. During the investigation period, there was a flood in March and April of 2006. Primarily, the sinks of the floodplains forest were underwater in the following periods: 11 March to 15 March 2006, 31 March to 6 April 2006 and 13 April to 15 April 2006.

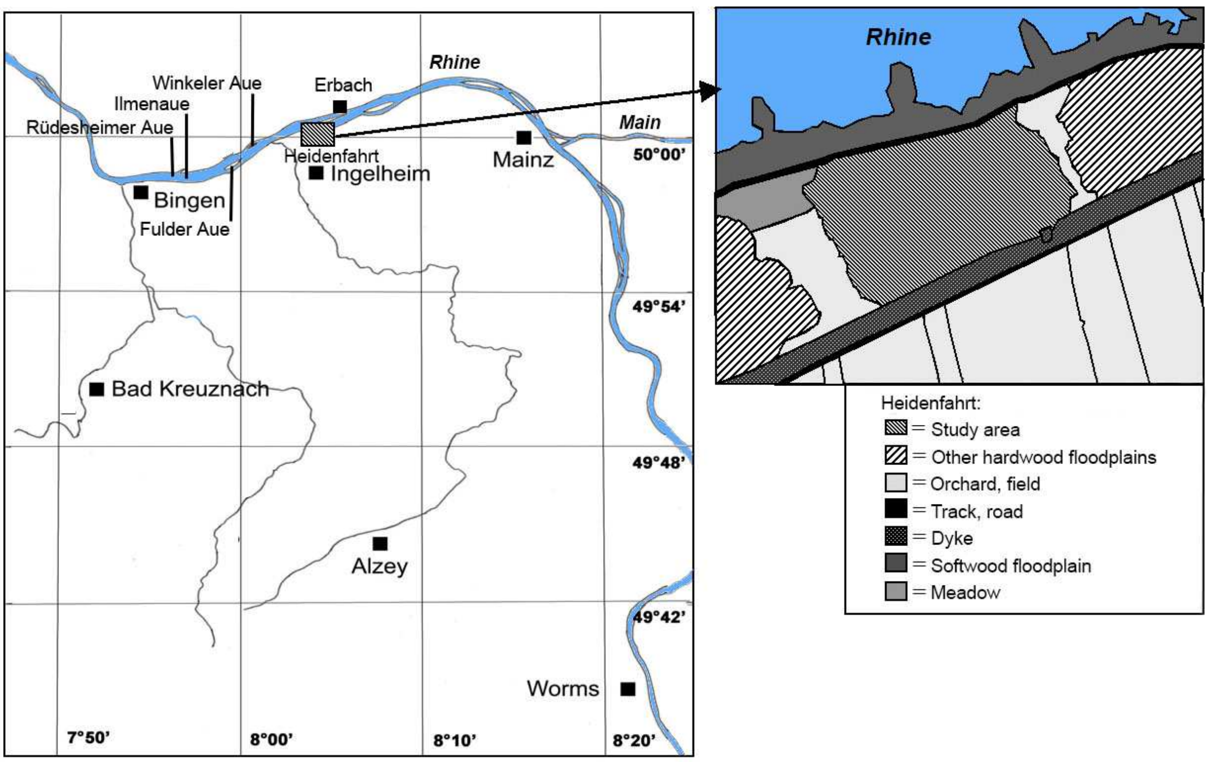

Figure 1: Map of the study area with investigations sites and outline of the investigation site „Heidenfahrt" (map modified after Marx & Schönhofer 2005).

Furthermore, the following islands in the Rhine were investigated (Fig. 1): Fulder Aue "West", Fulder Aue "East", Winkeler Aue, Rüdesheimer Aue and Ilmenaue. The Rhine islands near Mainz almost completely belong to the European nature reserve "Inselrhein" and offer very good living conditions for many migratory and passing birds. After the expansion measures of the Rhine, they are among the last few islands of the entire Upper-Rhine region and are therefore very important refuges for many animal and plant species.

In addition, the following river banks were investigated (Fig. 1): Erbach, Mainz-Mombach, Bingen-Gaulsheim, Ingelheim "Ufer" (Shore) and Ingelheim "Große Heide" (Great Heath).

At this point, the "extreme summer" of 2003 should be mentioned. A spring with low precipitation was followed by an extremely hot and dry summer. There was 40 % less rain (351.6 mm) in this year compared with the long-term average (585.8 mm per year).

In MARX (2011) you will find detailed information on the study area "Heidenfahrt", such as vegetation, soil geographic classification, climate and hydrology as well as information on the investigated Rhine islands and the river banks.

2.2 Collection and material

In the study area "Heidenfahrt" twelve pitfall traps and six tree eclectors were used on living trees (*Quercus robur*, *Tilia cordata*, *Acer campestre*, *Acer platanoides*) at a height of approx. 1.5-2.0 m. The traps were emptied at 14-day intervals. The pitfall trap (287 samples) and tree eclector (149 samples) catches over a period of one year from 19 May 2005 until 23 May 2006 were investigated. Additionally, the late autumn/early winter catches from pitfall traps from 14 October 2004 until 17 February 2005 (120 samples) were examined. A total of 11 samples from pitfall traps and 13 samples from tree eclectors could not be analysed due to sabotage and drying out of the traps.

The number of pitfall traps and the sampling period during the vegetation period (begin of May until end of October) of the Rhine islands and river banks can be found in Tables 4 and 5.

Further information on the applied methodology can be found in MARX (2011).

2.3 Determination

For the determination of the animals, the following literature was used.

Diplopoda: SCHUBART (1934) and BLOWER (1985); Chilopoda: EASON (1964, 1982) and KOREN (1986, 1992);

Non-determinable specimens (fragments and juveniles in early development stages, n = 35) were not further considered for this study.

2.4 Ecology

Classification of the dominance ratios (dominance values) and dominance classes was done according to ENGELMANN (1978), frequency (percentage of samples with species present to total number of samples), Shannon-Weaver-Index H_S (diversity) and species evenness E (distribution of individuals over species) according to MÜHLENBERG (1989). The calculation was based on the sampled millipedes and centipedes of one whole year from 19 May 2005 until 23 May 2006 in the study area "Heidenfahrt".

3. Results

3.1 The diplopod and chilopod fauna in the study area "Heidenfahrt"

A total of 4,133 animals, 3,800 diplopods and 333 chilopods, were determined. Eleven diplopod species (3 orders, 5 families) and 7 chilopod species (2 orders, 3 families) could be determined (Table 1). For the sake of completeness, the samples of *Archiboreoiulus pallidus* (BRADE-BIRKS, 1920) and *Schendyla nemorensis* (C. L. KOCH, 1836) from unpublished investigations within the study area (soil corer) from 2002, 2007 and 2008 are mentioned here. *Polydesmus angustus* (LATZEL 1884) was found by hand sampling (7 May 2008 and 24 May 2008, leg. P. Decker).

In the pitfall traps *P. denticulatus* (53 %) and *L. forficatus* (66 %) were the eudominant species, *J. scandinavius* (17 %), *P. superus* (12 %), *C. caeruleocinctus* (12 %), *S. crassipes* (15 %), and *L. microps* (15 %) were dominant (Table 2). In the stem eclectors *P. denticulatus* (61 %) and *L. forficatus* (86 %) were also eudominant and *J. scandinavius* (30 %) was dominant.

Diversity and Evenness were for both Chilopoda and Diplopoda higher on the ground than on the stem and generally higher in Diplopoda (Table 3).

P. denticulatus occurred with a frequency of 85 %, *J. scandinavius* with a frequency of 72 % in the lower stem region.

Table 1: Species spectrum and total number of individuals of the Diplopoda and Chilopoda at the investigation site „Heidenfahrt".

Species	Pitfall traps			Stem eclectors		
	♂♂	♀♀	Juveniles	♂♂	♀♀	Juveniles
Chilopoda						
Lithobius crassipes L. KOCH, 1862	–	–	–	–	7	–
Lithobius forficatus (LINNAEUS, 1758)	16	34	3	82	86	24
Lithobius melanops NEWPORT, 1845	1	–	–	9	10	3
Lithobius microps MEINERT, 1868	14	18	–	–	–	–
Lithobius tricuspis MEINERT, 1872	–	–	–	–	1	–
Geophilus flavus (DE GEER, 1778)	1	–	–	–	–	–
Strigamia crassipes (C. L. KOCH, 1835)	10	12	2	–	–	–
Diplopoda						
Proteroiulus fuscus (AM STEIN, 1857)	–	–	–	–	1	–
Nemasoma varicorne C. L. KOCH, 1847	–	3	–	4	10	1
Julus scandinavius LATZEL, 1884	141	138	187	35	52	298
Cylindroiulus caeruleocinctus (WOOD, 1864)	130	125	34	–	2	2
Cylindroiulus punctatus (LEACH, 1815)	4	5	6	31	25	42
Brachyiulus pusillus (LEACH, 1815)	55	32	5	–	–	–
Ommatoiulus sabulosus (LINNAEUS, 1758)	–	–	–	1	2	1
Melogona voigti (VERHOEFF, 1899)	16	9	3	–	–	–
Brachydesmus superus LATZEL, 1884	289	127	22	–	–	–
Polydesmus denticulatus C. L. KOCH, 1847	624	282	266	219	253	316
Propolydesmus testaceus (C. L. KOCH, 1847)	2	–	–	–	–	–

Table 2: Dominance ratios (in %) and dominance classes of the Diplopoda and Chilopoda on the ground and stem region in the investigation site „Heidenfahrt": (******) = eudominant, 32.0-100 %; (*****) = dominant, 10.0-31.9 %; (****) = subdominant, 3.2-9.9 %; (***) = recedent, 1.0-3.1 %; (**) = subrecedent 0.32-0.99 %; (*) = sporadic, <0.32 %.

Taxon	Pitfall traps	Stem eclectors
Chilopoda		
Lithobius crassipes	–	3.2 (***)
Lithobius forficatus	66.7 (******)	86.5 (******)
Lithobius melanops	–	9.9 (****)
Lithobius microps	15.2 (*****)	–
Lithobius tricuspis	–	0.5 (**)
Geophilus flavus	1.5 (***)	–
Strigamia crassipes	16.7 (*****)	–
Diplopoda		
Proteroiulus fuscus	–	0.1 (*)
Nemasoma varicorne	0.1 (*)	1.2 (***)
Julus scandinavius	17.3 (*****)	29.7 (*****)
Cylindroiulus caeruleocinctus	12.9 (*****)	0.3 (**)
Cylindroiulus punctatus	0.5 (**)	7.6 (****)
Brachyiulus pusillus	3.1 (**)	–
Ommatoiulus sabulosus	–	0.3 (*)
Melogona voigti	0.6 (**)	–
Brachydesmus superus	12.5 (*****)	–
Polydesmus denticulatus	53.1 (******)	60.9 (******)

Table 3: Diversity (H_S) and Evenness (E) of the Diplopoda and Chilopoda on the ground and stem region in the investigation site „Heidenfahrt".

Taxon	Shannon-Weaver-Index		Evenness	
	Ground	Stem	Ground	Stem
Diplopoda	1.34	0.95	0.64	0.49
Chilopoda	0.58	0.49	0.42	0.35

The activity abundances of *J. scandinavius* on the ground were highest for adults from February to June, while juveniles were also very active in summer (Fig 2A). Ratio between males (141), females (138) and juveniles (187) was more or less balanced (Table 1). On the stem *J. scandinavius* adults were found throughout the year with slight peaks in spring and autumn, while juveniles showed very high activity abundances from September to November and in April (Fig. 2B). Females (52) were a bit more numerous on the stem than males (35), but juveniles were nearly 3.5 times more abundant than mature specimens (Table 1).

The activity abundances of *P. denticulatus* on the ground were highest from April to July, both in adults and juveniles (Fig. 3A). Males were two times more active (624) than females (282) or juveniles (266). On the stem *P. denticulatus* showed high activities from April to June and very high activities, especially of juveniles, in October and November (Fig. 3B). The ratio of males (219) and females (253) was balanced, but juveniles (316) were slightly more abundant (Table 1).

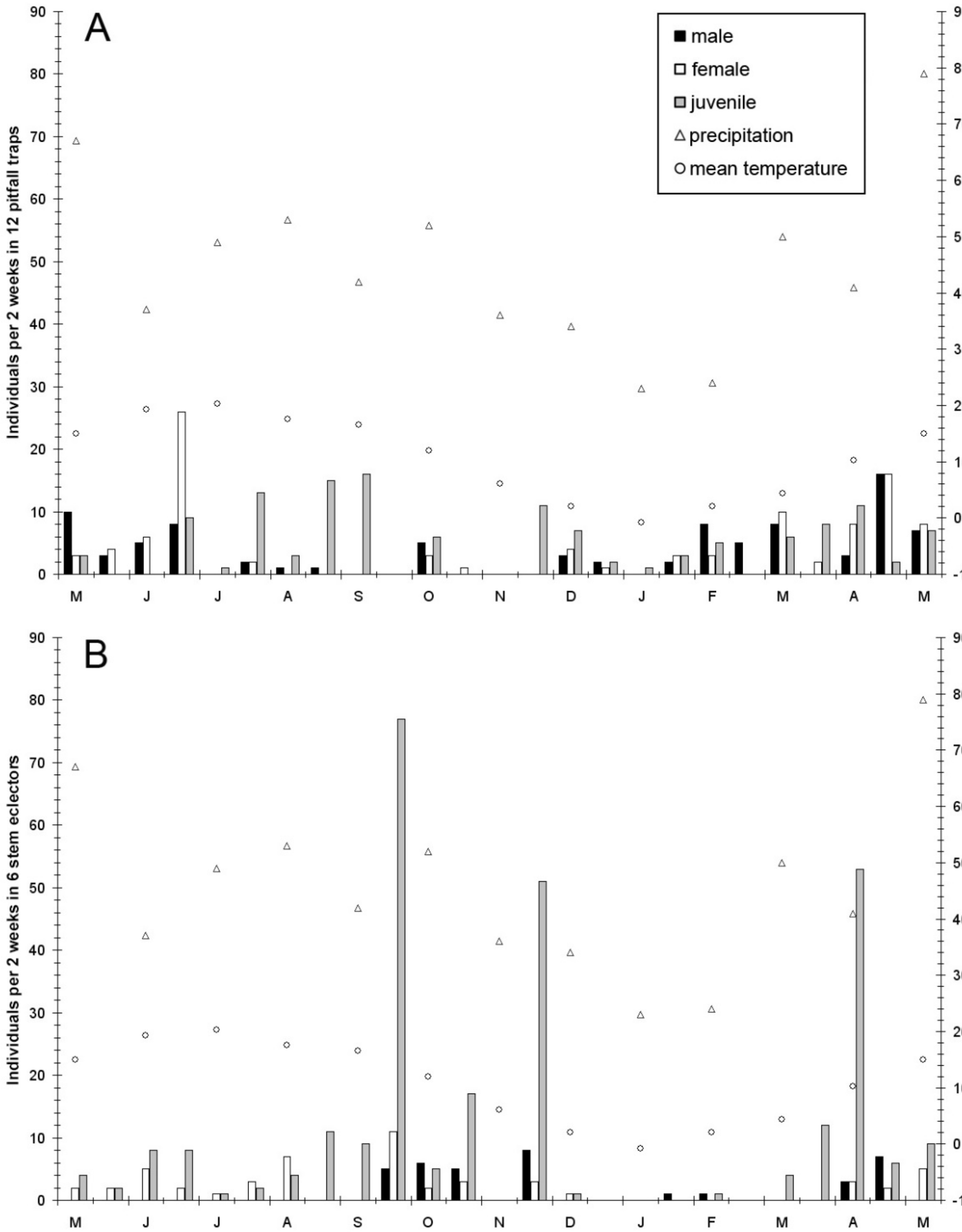

Figure 2: Activity abundance of *Julus scandinavius* in pitfall traps (A) und stem eclectors (B) for the period 19 May 2005 to 23 May 2006 in the investigation site „Heidenfahrt" and meteorological data from the weather station Heidesheim. Source: Agrarmeteorologie Rheinland-Pfalz.

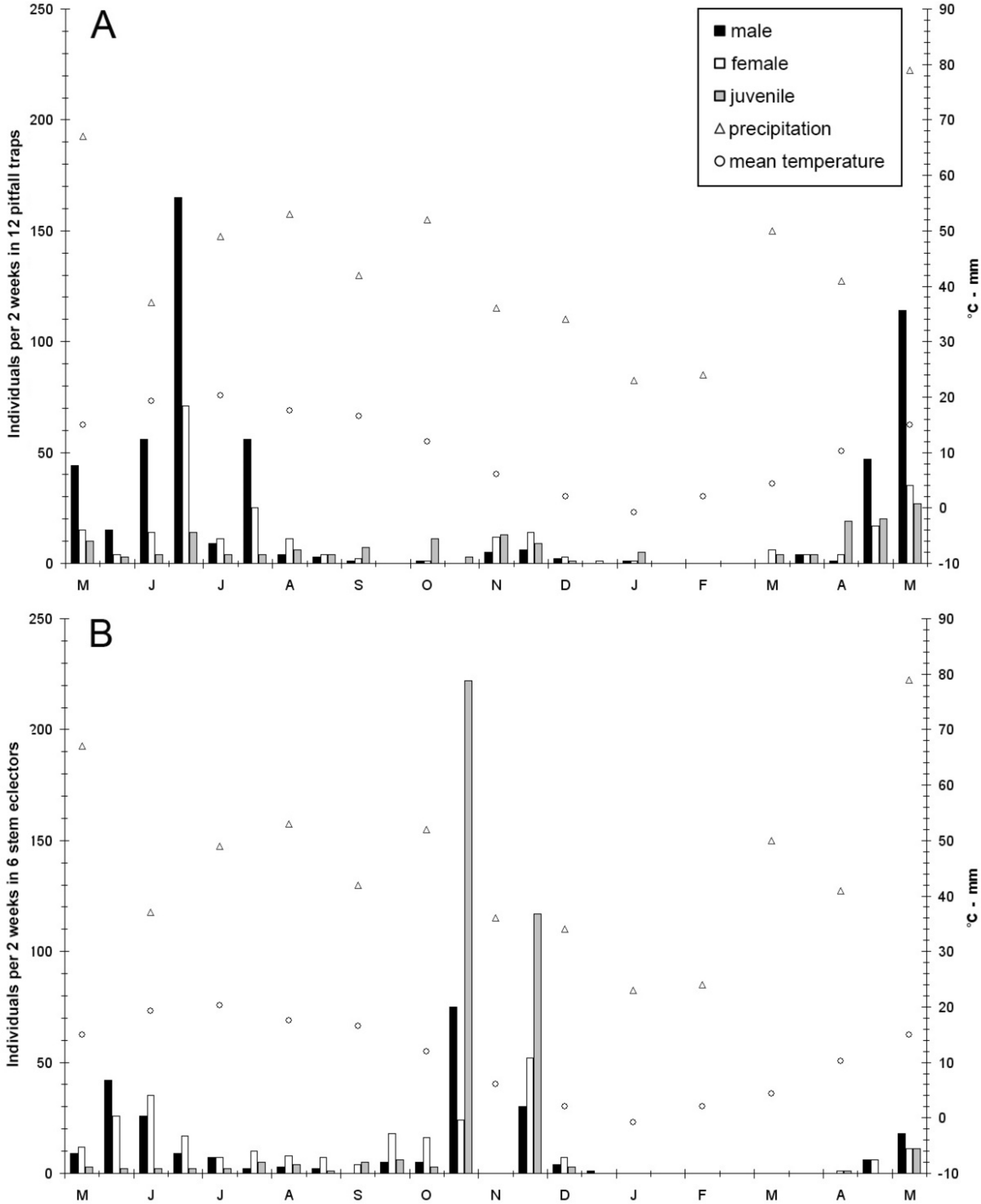

Figure 3: Activity abundance of *Polydesmus denticulatus* in pitfall traps (A) und stem eclectors (B) for the period 19 May 2005 to 23 May 2006 in the investigation site „Heidenfahrt“ and meteorological data from the weather station Heidesheim. Source: Agrarmeteorologie Rheinland-Pfalz.

3.2 The diplopod and chilopod fauna of the Rhine islands and the river banks

A total of 5,398 animals were determined, 5,047 diplopods (11 species) and 351 chilopods (6 species) (Tables 4, 5).

In contrast to the investigated floodplain forest near Heidesheim, in some sites the species *Craspedosoma rawlinsi* Leach, 1815, *Lamyctes emarginatus* (Newport, 1844) and *Pachymerium ferrugineum* (C. L. Koch, 1835) were also recorded. *P. denticulatus* was by far the most frequent millipede with 3,691 individuals, followed by *J. scandinavius* (881 individuals). The most frequent centipede was *L. forficatus* with a total of 315 specimens.

4. Discussion

4.1 The millipedes and centipedes in the study area "Heidenfahrt"

The diplopod fauna mainly consists of euryoecious species. It was found that the composition of species on the ground and the lower stem region shows significant differences. The diversity and evenness of diplopods on the ground was more than twice as high as in the lower stem region (Table 3). On the ground as well as on the stem, there is a clear dominance of *P. denticulatus*, followed by *J. scandinavius*.

While *P. denticulatus* is classified as a hygrobiont wood species of very damp sites, the latter species is classified as an euryoecious species of very dry to very damp habitats (VOIGTLÄNDER 2011). RIPPLINGER & ALBERTI (1993) could show a high dominance of *P. denticulatus* in a floodplain forest (*Populus canescens*) and this species is also known from other floodplain areas (DUNGER 1958, HANDKE & HANDKE 1989, SCHUBART 1934, SPELDA 1999c, TUF & OŽANOVÁ 1999, ZULKA 1991).

So far, only very little is known about the stem region as activity area of millipedes in Central Europe, especially since stem eclectors are only rarely used (BRONEWSKI 1991, POSER 1991, SPELDA 1999a, 1999b) and the stem region is only rarely investigated comprehensively (FRÜND 1987).

The high frequencies of *P. denticulatus* (85 %) and *J. scandinavius* (72 %) in the study area "Heidenfahrt" very clearly show that the lower stem region is an integral part of the activity area of both species. For *P. denticulatus*, there is so far no information about the colonisation of the stem region and it seems to be differing from other native species of the family Polydesmidae by a high climbing activity.

The results of *J. scandinavius* on the ground in the study area "Heidenfahrt" are consistent with the literature references (SCHALLNASS et al. 1992, SCHUBART 1934, SPELDA 1993). However, it was shown that the juveniles were significantly more active in the lower stem region than the adults.

SCHUBART (1934), BLOWER (1985) and THIELE (1968) also observed a high activity of *P. denticulatus* during the summer months. In Brandenburg, however, their peak activity was in May and October (SCHUBART 1957). THIELE (1968) observed peaks in May/June and August for field shrubs in Asbruch near Velbert-Nerviges. An interruption of activity in the investigated floodplain forest was observed in early June which is most likely due to that month's low precipitation. VERHOEFF (1929) and ZULKA (1991) also suspected drought to be the cause for the summer break. After observing the juvenile stages, it is to be assumed

Table 4: Species spectrum and activity abundance (individuals per 2 weeks per trap) of the Diplopoda and Chilopoda of the stream islands of the northern Upper-Rhine with short characterization of the investigation sites and methods.

Investigation site	**Fulder Aue "West"**				**Fulder Aue "East"**				**Winkeler Aue**				**Rüdesheimer Aue**	**Ilmenaue**
German federal state	Rhineland-Palatinate				Rhineland-Palatinate				Hesse				Hesse	Rhineland-Palatinate
Biotope	Softwood floodplain forest				Hardwood floodplain forest				Softwood floodplain forest				Softwood flood. for.	Softwood flood. for.
Dominating trees	*Ulmus*, *Salix*				*Ulmus*, *Salix*				*Ulmus*, *Salix*				*Ulmus*, *Salix*	*Ulmus*, *Salix*
Number of pitfall traps	4	3	3	3	4	3	3	3	4	3	3	3	4	4
Trap exposition per year (days)	169	85	135	169	169	85	135	169	169	85	135	169	169	169
Year	2002	2003	2004	2005	2002	2003	2004	2005	2002	2003	2004	2005	2002	2002
Diplopoda														
Julus scandinavius	0.35	–	0.55	0.99	–	–	0.03	0.22	0.50	0.33	0.42	1.80	0.21	2.50
Cylindroiulus caeruleocinctus	–	–	–	–	–	0.05	0.03	–	–	–	–	–	0.14	0.81
Cylindroiulus punctatus	–	–	–	–	–	–	–	–	–	–	–	–	0.06	0.04
Brachyiulus pusillus	0.04	–	0.10	0.03	–	–	0.07	0.03	0.02	0.44	0.14	0.17	–	0.08
Ommatoiulus sabulosus	–	–	0.07	–	–	–	–	–	–	–	–	–	–	–
Craspedosoma rawlinsi	–	–	–	–	–	0.11	0.03	0.06	–	–	–	–	–	0.02
Brachydesmus superus	–	–	–	–	–	–	–	0.08	–	–	–	0.08	0.02	0.02
Polydesmus denticulatus	3.23	0.16	1.04	8.95	–	–	0.14	0.14	1.14	0.05	0.42	1.19	0.08	0.74
Chilopoda														
Lamyctes emarginatus	–	0.05	–	–	–	–	–	–	0.10	0.05	–	–	–	–
Lithobius forficatus	0.29	0.22	0.24	0.03	–	0.43	0.28	0.14	0.87	0.93	0.90	1.19	1.26	0.43
Lithobius microps	–	–	–	0.03	–	–	0.03	–	–	–	–	–	0.04	0.02
Geophilus flavus	–	–	–	–	–	–	–	–	–	–	–	0.06	–	–
Pachymerium ferrugineum	–	–	0.03	–	–	–	–	–	–	–	–	–	–	–
Σ Individuals per year and site	189	8	53	363	–	11	18	24	127	33	54	139	88	226

Table 5: Species spectrum and activity abundance (individuals per 2 weeks per trap) of the Diplopoda and Chilopoda of the river bank sites of the northern Upper-Rhine with short characterization of the investigation sites and method.

Investigation site	**Mainz-Mombach**				**Bingen-Gaulsheim**				**Ingelheim "Shore"**				**Ingelheim "Große Heide"**				**Erbach**
German federal state	Rhineland-Palatinate				Rhineland-Palatinate				Rhineland-Palatinate				Rhineland-Palatinate				Hesse
Biotope	Softwood floodplain forest				Softwood floodplain forest				Softwood floodplain forest				Softwood floodplain forest				Hardwood fl. for.
Dominating trees	*Populus*, *Salix*				*Populus*				*Populus*, *Salix*				*Populus*-planting				*Ulmus*, *Tilia*
Number of pitfall traps	4	3	3	3	4	3	3	3	4	3	3	3	4	3	3	3	4
Trap exposition per year (days)	128	85	141	167	165	85	141	167	167	85	141	167	165	85	141	167	169
Year	2002	2003	2004	2005	2002	2003	2004	2005	2002	2003	2004	2005	2002	2003	2004	2002	2002
Diplopoda																	
Proteroiulus fuscus	–	–	–	–	–	–	–	–	–	–	–	–	–	–	0.03	–	–
Julus scandinavius	0.55	0.05	0.50	0.12	0.04	–	–	0.11	0.04	–	0.10	1.57	0.21	–	0.96	10.29	0.37
Cylindroiulus caeruleocinctus	–	–	–	–	0.06	–	–	0.06	–	–	–	–	–	–	–	–	0.12
Cylindroiulus punctatus	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	0.02
Brachyiulus pusillus	–	–	1.62	0.70	0.76	0.05	0.13	0.56	–	–	0.07	0.08	–	–	0.03	0.25	0.19
Ommatoiulus sabulosus	–	–	–	–	–	–	–	–	–	–	0.03	–	–	–	–	–	–
Craspedosoma rawlinsi	–	–	0.03	0.08	–	–	–	–	–	–	0.03	0.03	–	–	0.03	–	–
Brachydesmus superus	–	–	–	–	–	–	–	0.25	–	–	–	–	–	–	0.03	–	0.06
Polydesmus angustus	–	–	–	–	–	–	–	–	–	–	0.03	0.36	–	–	–	–	0.70
Polydesmus denticulatus	1.58	0.16	0.89	6.82	1.72	–	0.20	4.75	0.34	0.11	6.26	35.58	0.13	–	2.68	24.06	0.02
Propolydesmus testaceus	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	0.17	2.63
Chilopoda																	
Lamyctes emarginatus	–	–	–	–	0.06	–	–	–	0.13	–	–	–	0.08	–	–	–	–
Lithobius crassipes	–	–	–	–	–	–	–	–	–	–	–	0.03	–	–	–	–	–
Lithobius forficatus	0.22	0.38	0.73	0.42	0.11	0.22	–	0.08	0.04	0.05	0.30	0.14	–	–	0.03	–	0.06
Lithobius microps	0.03	–	–	–	0.02	–	–	–	–	–	–	–	–	–	0.03	–	0.04
Geophilus flavus	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	0.02
Pachymerium ferrugineum	–	–	–	–	0.02	–	–	–	–	–	–	–	–	–	–	–	–
Σ Individuals per year and site	86	7	114	330	130	5	10	208	26	3	206	1,352	20	–	115	1,244	202

that this species only produces one generation per year in the study area, that the development is possible within a period of one year and that the species hibernates as adults or subadults. This is also assumed by ZULKA (1991) for the March area in Austria. In the lower stem region, *P. denticulatus* had reached its activity peak not during the summer months, but in autumn. In a floodplain forest near Leipzig, *P. denticulatus* and *P. inconstans* (LATZEL, 1884) also had a peak in autumn, whereas there was no noticeable activity peak in the summer (DUNGER 1958).

The high ♂♂/♀♀ ratio (624:282) on the ground has already been determined by BLOWER (1985) for a forest in Cheshire, England. By contrast, the ♂♂/♀♀ ratio in the lower stem region was almost 1:1 (219:253) and there was a high number of subadult animals which presumably reach maturity not until the next year.

The species *B. pusillus*, *M. voigti* and *B. superus* seem to colonise the stem region above 1.5 to 2 m only to a lesser extent. By contrast, *N. varicorne* and *C. punctatus* are more active on the stem which is due to living under bark and especially the latter species living in the wood (SPELDA 1999c, HAACKER 1968a). There was only one specimen of *P. fuscus* in the lower stem region which is usually found under bark (SPELDA 1999c). In subsequent traps and square samplings, further specimens of this species were found.

The findings of *O. sabulosus* in the tree eclectors are not surprising, as this species is known for high climbing activity (BLOWER 1985, KÖPPEL & SPELDA 1994, SCHUBART 1934).

For the chilopods, diversity was higher on the ground than in the lower stem region, evenness was, by contrast, only slightly higher on the ground (Table 3). *L. forficatus* was eudominant on the ground as well as in the lower stem region. TUF (2003) stated that *L. forficatus* and *Lithobius mutabilis* (L. KOCH, 1862) were dominant in not regularly flooded floodplain forests in the Czech Republic. The high dominance values of this species also reflect the low equal distribution values (E) for the chilopods. *Strigamia crassipes* occurred dominantly in the pitfall traps. The species is an inhabitant of the litter layer (SPELDA 1999c), but does not seem to colonise the stem region in the study area, in contrast to *Strigamia acuminata* (LEACH, 1814), which was also found in the stem region (SPELDA 1999a). On the ground, *L. microps* occurred dominantly, which is found in the litter layer and the topmost layer of soil (DUNGER 1989), and which is seen only rarely above the surface (BARBER 1992). In the lower stem region *L. melanops* occurred subdominantly which, according to BARBER (1992), prefers to colonise the stem region. *L. crassipes* occurred only recedently in the stem region and not at all on the ground. This species is found in the litter layer, on the surface as well as above the ground floor (BARBER 1992). The small amounts of geophilids are due to the fact that they rarely get into the pitfall traps (SPELDA 1999b) and, therefore, cannot be collected adequately with the trapping methods used for this study.

4.2 The millipedes and centipedes of the Rhine islands and the river banks

The range of species of the different Rhine islands and river banks is mainly dominated by the three species *P. denticulatus*, *J. scandinavius* and *L. forficatus* with the range of species of the islands and river banks showing no significant differences. The four species *Proteroiulus fuscus*, *Polydesmus angustus*, *P. testaceus* and *Lithobius crassipes* could not be found on the Rhine islands which might be explained by a low tolerance against flooding.

There are strikingly low activity abundances in the year of the flooding 2002 and the extreme summer of 2003, the number of captured specimens slightly increasing in 2004, and abruptly rising in 2005, especially for *L. forficatus*, *J. scandinavius* and *P. denticulatus*. This shows very clearly that centipede and millipede populations can recover from such extreme events within just a few years. The pioneer species *Lamyctes emarginatus*, which was recorded e.g. in the regularly flooded Oder regions (ZERM 1997a, 1997b, 1999), occurred in this study only shortly after the flooding in the pitfall traps, presumably as a result of the quick population growth. The same is true of *Pachymerium ferrugineum* which only occurs in dry biotopes and habitats characterised by water, such as peatland, floodplain forests, river banks and alder swamps (DECKER et al. 2009). SPELDA (1999c) assumes that the strictly local occurrence in such habitat types (exposed to disturbances) may be due to a lack of competition from other predatory arthropods.

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