

4.6 The oribatid mite communities and their reactions to different forestry factors

Within the scope of the doctoral thesis, 392 samples were analysed. 122 samples from one year from the Müritz NP and 270 samples from three years from Eberswalde were analysed. Altogether 155,450 oribatid mites were found in these samples. 61,904 of these were juvenile mites and Brachychthoniidae (39.8 %) (see chapter 2.3) that were ignored for the analysis on the species level. In the Müritz NP 69,431 oribatid mites (25,623 “juveniles”) were found while in Eberswalde 86,019 oribatid mites (36,281 “juveniles”) were found: 23,519 (8,537) in 2000, 34,946 (16,062) in 2001 and 27,554 (11,682) in 2002.

82 taxa have been found in both areas together, 66 in the Müritz NP and 74 in Eberswalde. 57 taxa were found in both areas, while 9 taxa were found only in the Müritz NP and 16 were found only in Eberswalde. All species that were restricted to one area occurred only in low abundances – in many cases only a single specimen was found – and in very few samples.

In the Müritz NP only 18 samples were taken per plot in one year (2001), while in Eberswalde in both years (200 and 2001) 33 samples were taken. However, the species-area curve (Fig. 107) shows that these 18 samples recover the majority of the species. Even doubling the number of samples only leads to a small number of additional species (Fig. 108).

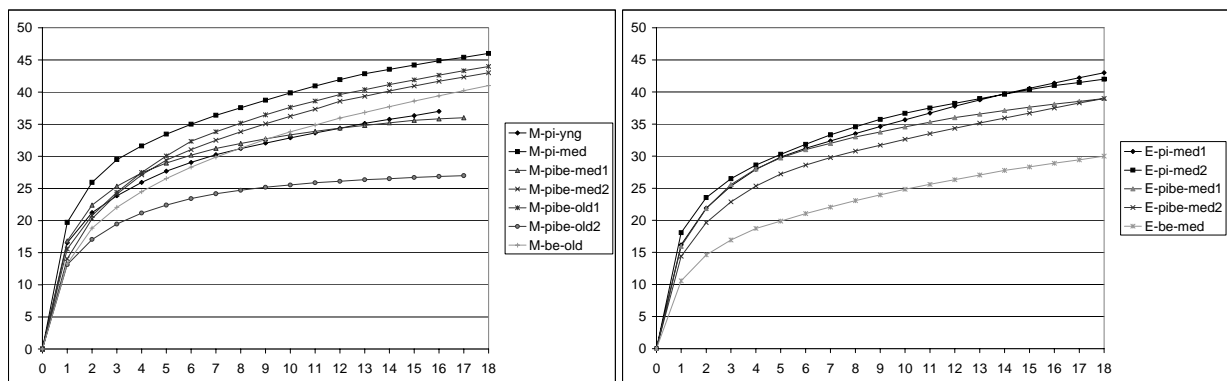


Fig. 107: Species-area curve for a) the Müritz NP and b) Eberswalde in 2001

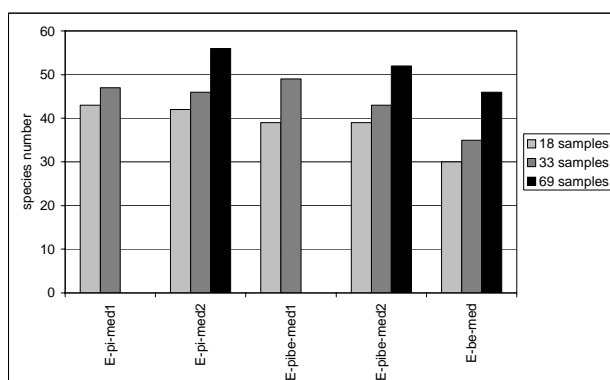


Fig. 108: Comparison of the species number for one year (2001: 18 samples), two years (2000 and 2001: 33 samples) and three years (2000-2002: 69 samples)

4.6.1 The dominance structure of the oribatid mite communities of each plot

4.6.1.1 The young pine stand

Plot M-pi-yng

In the young pine plot M-pi-yng 4,168 specimens were found in 16 samples. Of these, 1994 were adults that have been further identified. 37 taxa were recorded (Fig. 109).

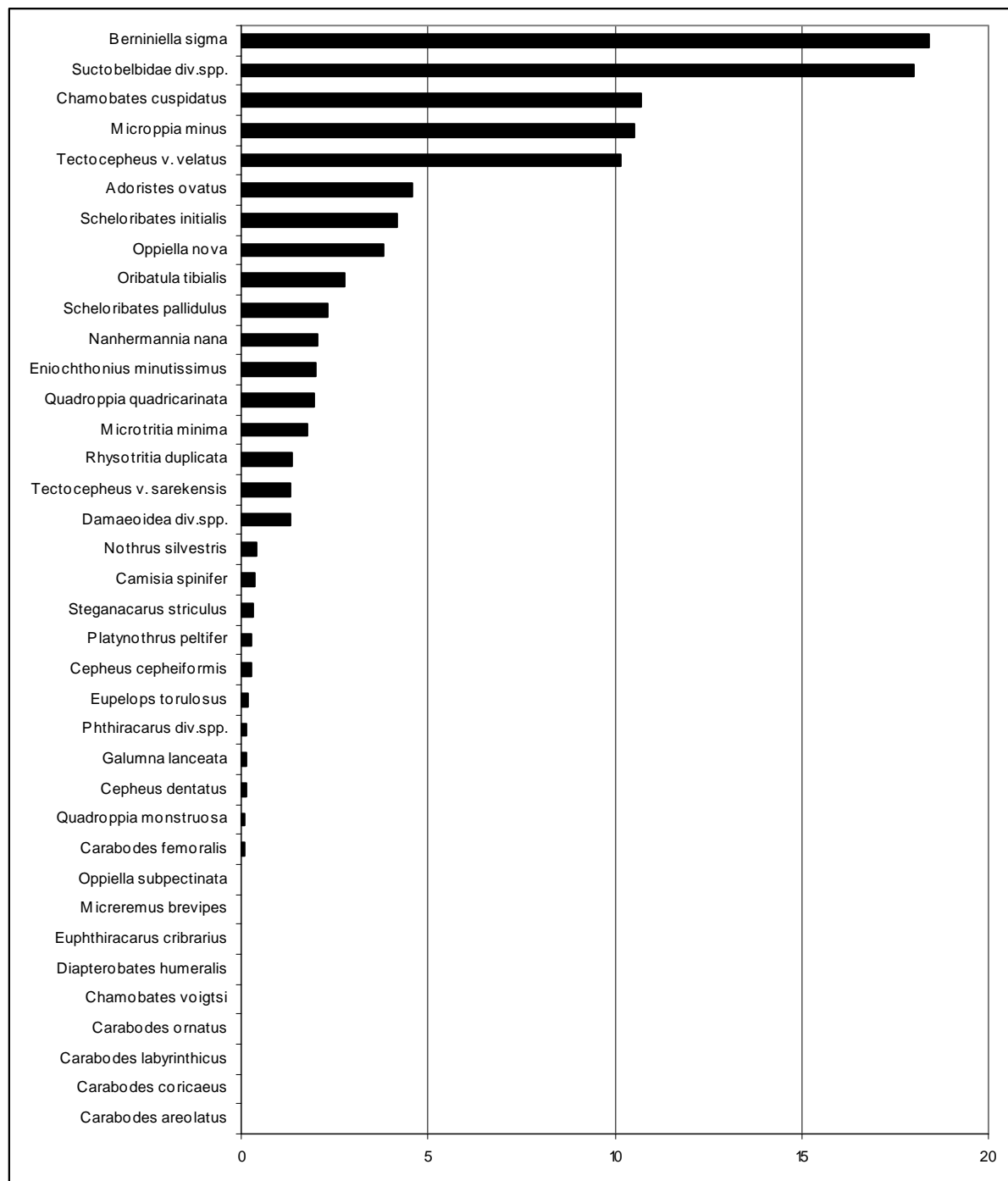


Fig. 109: Dominance structure of the oribatid mite community on plot M-pi-yng

The striking difference to the other plots is the relatively even distribution of the dominance values between the species and low dominance value of *Oppiella nova* and the high dominance of *Berniniella sigma*. Only on this plot was *B. sigma* the most abundant species.

4.6.1.2 The medium aged pine stands

Plot M-pi-med

11,751 specimens were extracted from 18 samples from plot M-pi-med. 7,389 of these were adult mites, that belonged to 46 taxa.

Oppiella nova occurred as the only eudominant species and 35 species only appeared subrecently (Fig. 110).

Plot E-pi-med1

15,241 specimens were found in plot E-pi-med1 in both years, 6,803 were found in 15 samples in 2000 and 8,438 were found in 18 samples in 2001. In 2000, 4273 adult oribatid mites belonged to 30 taxa and in 2001, 5271 adult oribatid mites belonged to 42 taxa. In both years combined 44 taxa were recorded. In 2000, the following species could not be found: *Achipteria coleoptrata*, *Acrogalumna longipluma*, *Carabodes coriaceus*, *C. ornatus*, *Chamobates cuspidatus*, *C. voigtsi*, *Eupelops plicatus*, *Ophidiotrichus tectus*, *Oppiella subpectinata*, *Phauloppia lucorum*, *Quadroppia monstrosa*, *Schelorbates initialis* and *S. pallidulus*. In 2001, *Carabodes areolatus* and *Cepheus latus* were not found. In both years, the Suctobelbidae were the only eudominant species, while *Dissorhina ornata* and *Oppiella nova* occurred as dominant species. *Microtritia minima* appeared as a subdominant species in 2000, but had a dominance value of only 1.2 % in 2001. Opposed to that, the Damaeioidea were much more dominant in 2000 (4.5 %) than in 2001 (1.6 %). The dominance values of the other species differed to a much smaller extent (Fig. 111).

Plot E-pi-med2

28,684 specimens were found in three years, 6,932 were extracted from 15 samples in 2000, 9,704 were found in 18 samples in 2001 and 12,048 were extracted from 36 samples in 2002. In all three years combined 54 taxa were recorded. In 2000, 4,768 adult oribatid mites belonged to 32 taxa, in 2001 5,652 adult oribatid mites from 41 taxa were recorded and in 2002 6,676 adult oribatid mites belonged to 42 taxa. Several species were only recorded with solitary specimens in one of the years: *Camisia biurus* and *Pilogramma crassiclava* were found only in 2000, *Carabodes coriaceus*, *C. subarcticus*, *Ceratoppia quadridentata*, *Ceratozetes*

minimus, *Euzetes globulus* and *Steganacarus magnus* were only found in 2001 and *Autogneta longilamellata*, *Chamobates cuspidatus*, *Cymbaeremaeus cymba*, *Nanhermannia elegantula*, *Steganacarus striculus* and *Xenillus clypeator* were only found in 2002. As in plot E-pi-med1 the Suctobelbidae were the most abundant taxon. In 2000 it was only dominant with about 28 %, while in 2001 and 2002 it appeared as the only eudominant taxon. *Oppiella nova* and *Dissorhina ornata* were dominant in all three years. The dominance values of most species differed more between the years than they did in plot E-pi-med1. This is most obvious for *Eniochthonius minutissima* and *Oribatula tibialis*. *E. minutissima* was the second most abundant species in 2001 and was dominant with 16 % in that year. In the other two years it was only subdominant with 5 to 8 %. *O. tibialis*, on the other side, was dominant with 11 % in 2000 and only recedent with 3 to 4 % in the other two years. Also the dominance values of the Damaeoidea and of *Oppiella subpectinata*, *Platynothrus peltifer* and *Scheloribates pallidulus* varied much between the years (Fig. 112).

All three plots have in common, that the dominance structure is very uneven with one eudominant and two dominant species, while the majority of species appears with less than 0.5 %.

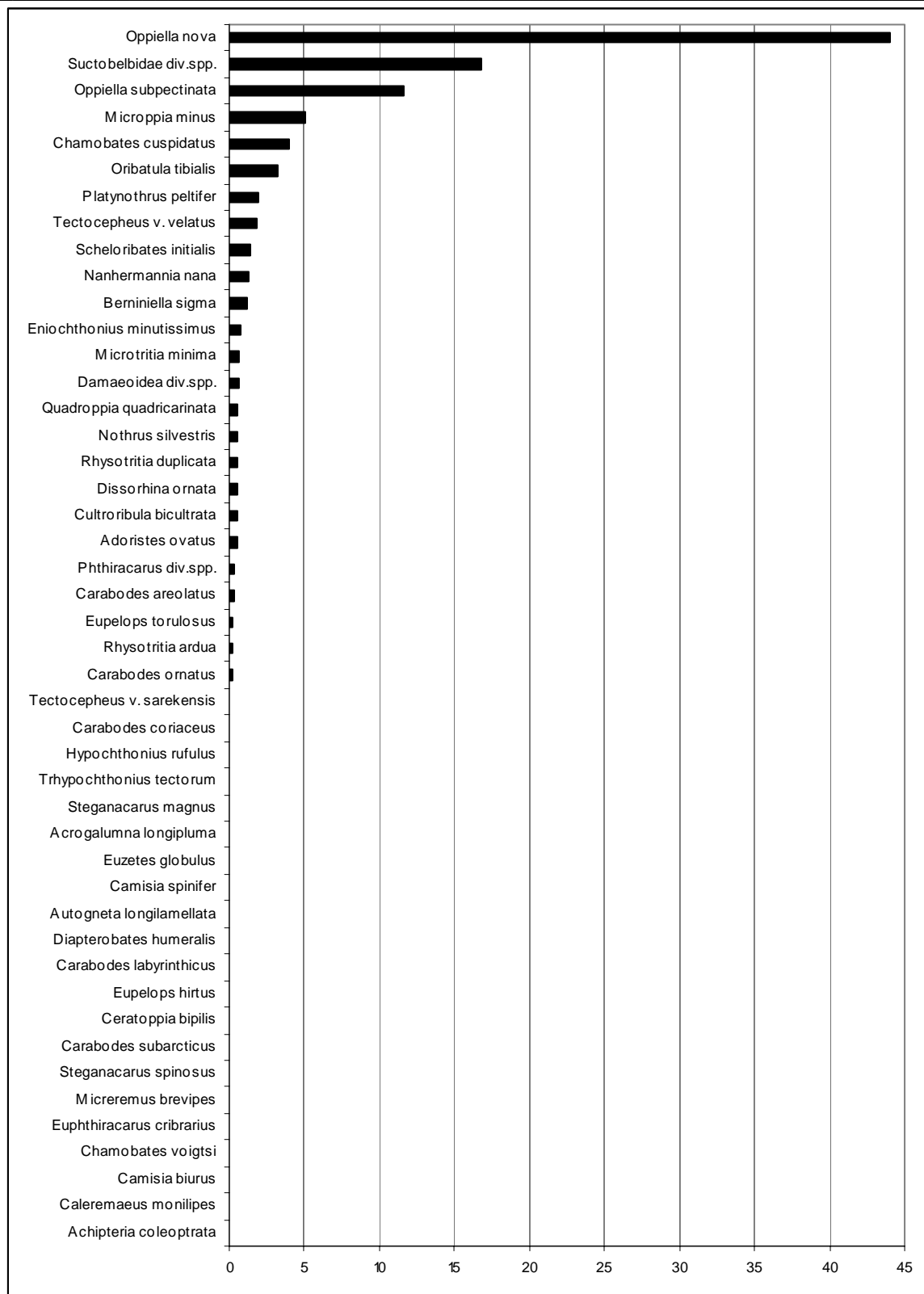


Fig. 110: Dominance structure of the oribatid mite community on plot M-pi-med

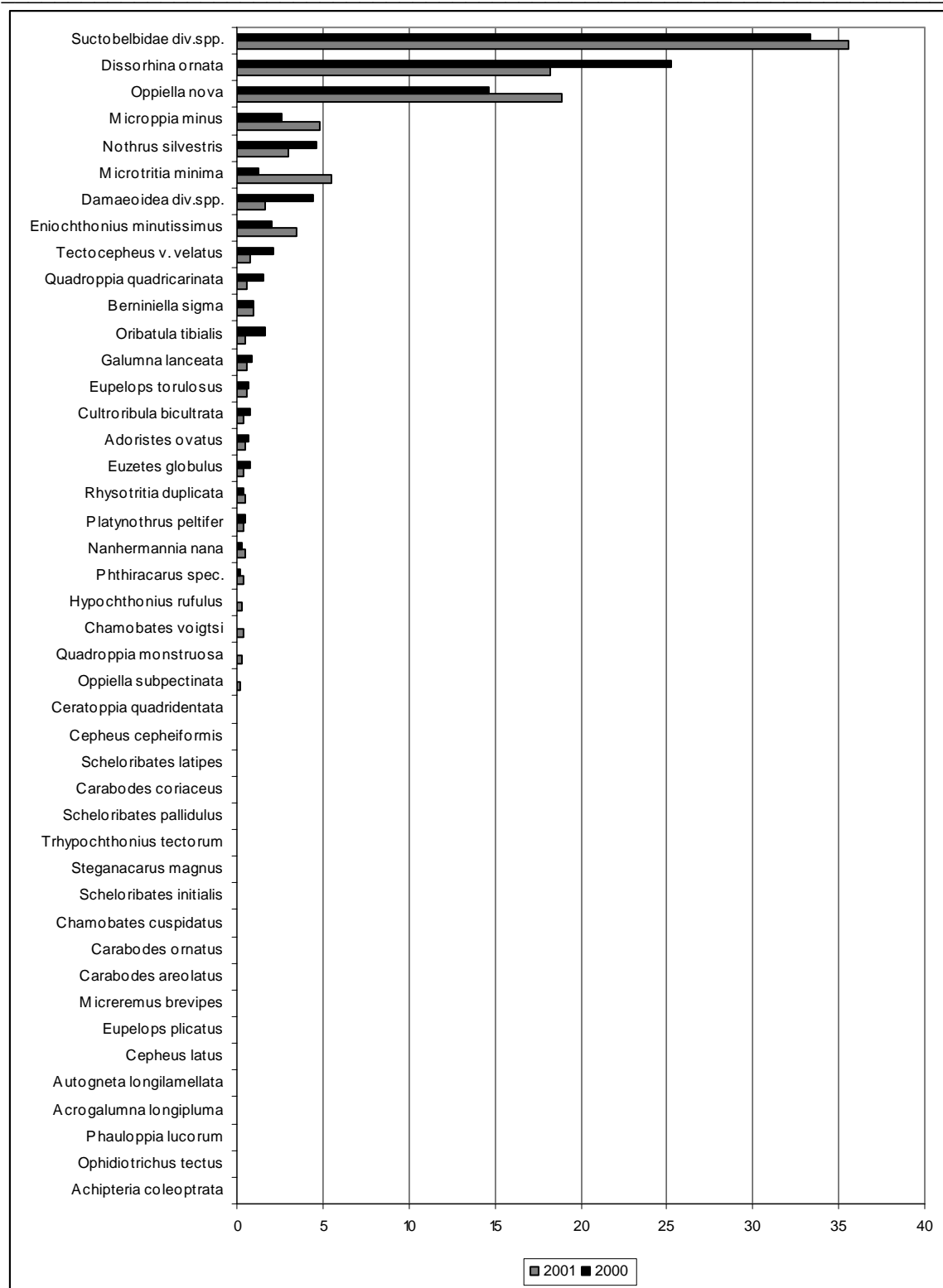


Fig. 111: Dominance structure of the oribatid mite community on plot E-pi-med1 sorted according to their average dominance over the entire sampling period

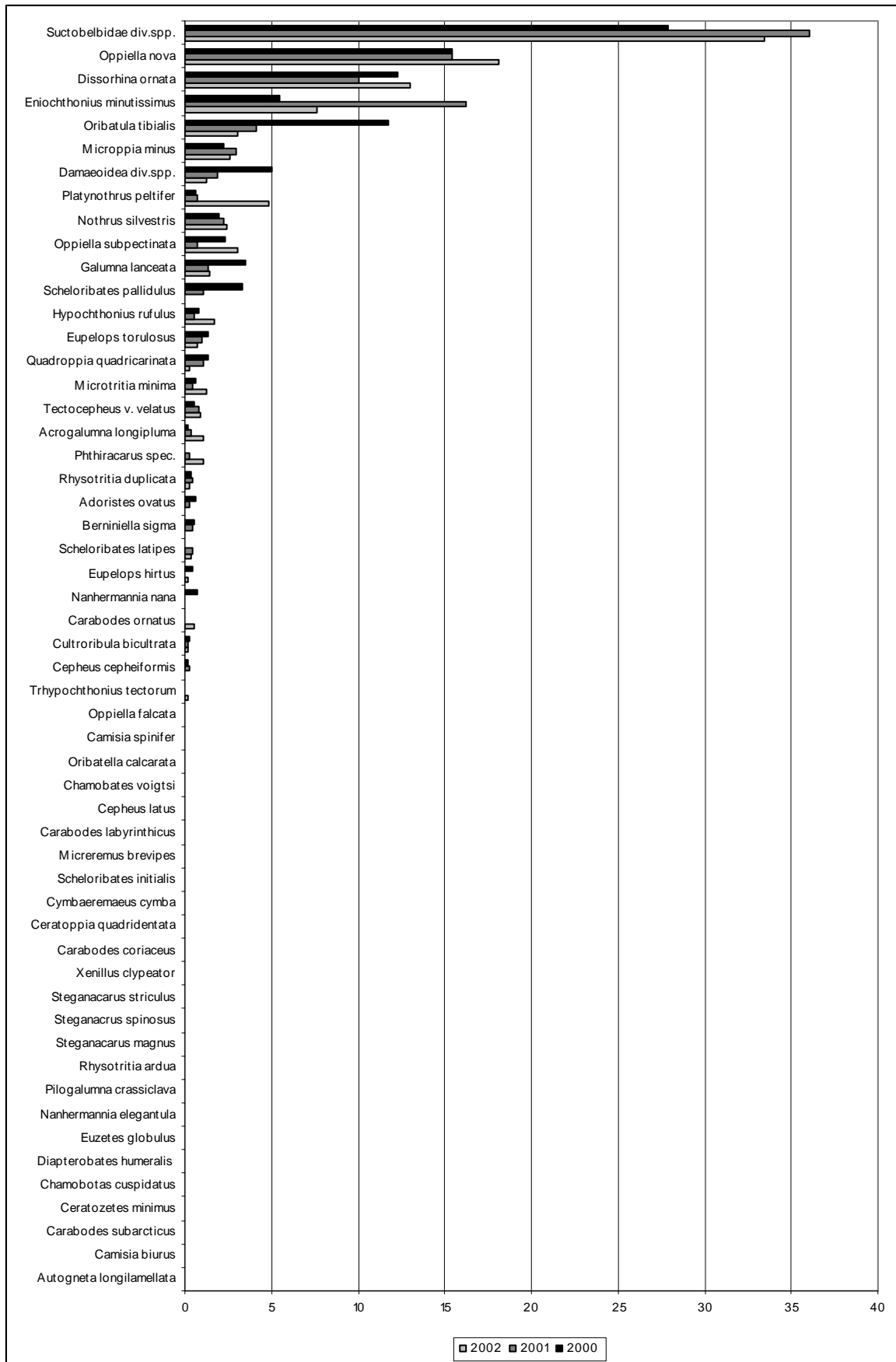


Fig. 112: Dominance structure of the oribatid mite community on plot E-pi-med2 sorted according to their average dominance over the entire sampling period

4.6.1.3 The medium aged mixed stands with young beech undergrowth

Plot M-pibe-med1

On plot M-pibe-med1 10,673 specimens were extracted from 17 samples. 5,939 of these were adult oribatid mites and belonged to 37 species. Almost 50 % of all adult oribatid mites belonged to *Oppiella nova*, which was the only eudominant species. The Suctobelbidae occurred as the only dominant taxon and *Micropoppia minus* as the only subdominant species (Fig. 113).

Plot E-pibe-med1

12,118 specimens were extracted in two years on plot E-pibe-med1; 4,419 in 15 samples in 2000 and 7,699 in 18 samples in 2001. In 2000 2,739 adult oribatid mites from 39 taxa were extracted, while in 2001 2,894 adult specimens from 38 taxa were found. Altogether, 46 taxa were recorded from this plot for both years. *Acrogalumna longipluma*, *Camisia spinifer*, *Carabodes areolatus*, *C. labyrinthicus*, *Cepheus latus*, *Ceratoppia quadridentata*, *Diapterobates humerata* and *Scheloriobates pallidulus* were only found in 2000, while *Camisia biurus*, *Carabodes coriaceus*, *C. subarcticus*, *Micreremus brevipes*, *Phauloppia rauschensis*, *Quadroppia monstruosa* and *Steganacarus magnus* were only found in 2001.

The Suctobelbidae were the most abundant taxon in both years, but only in 2001 it occurred as a eudominant taxon with about 30 %. *Oppiella nova* was dominant in both years, but *Dissorhina ornata* was dominant only in 2000. In 2001, its dominance value decreased to 8 %. In 2000, with *Chamobates cuspidatus* only one subdominant species was found; in 2001, with *Micropoppia minus* and *Microtritia minima* two further subdominant species besides *D. ornata* were found (Fig. 114).

The dominance structure of both plots shows still a relatively high concordance with that of the medium aged pine plots of the same area.

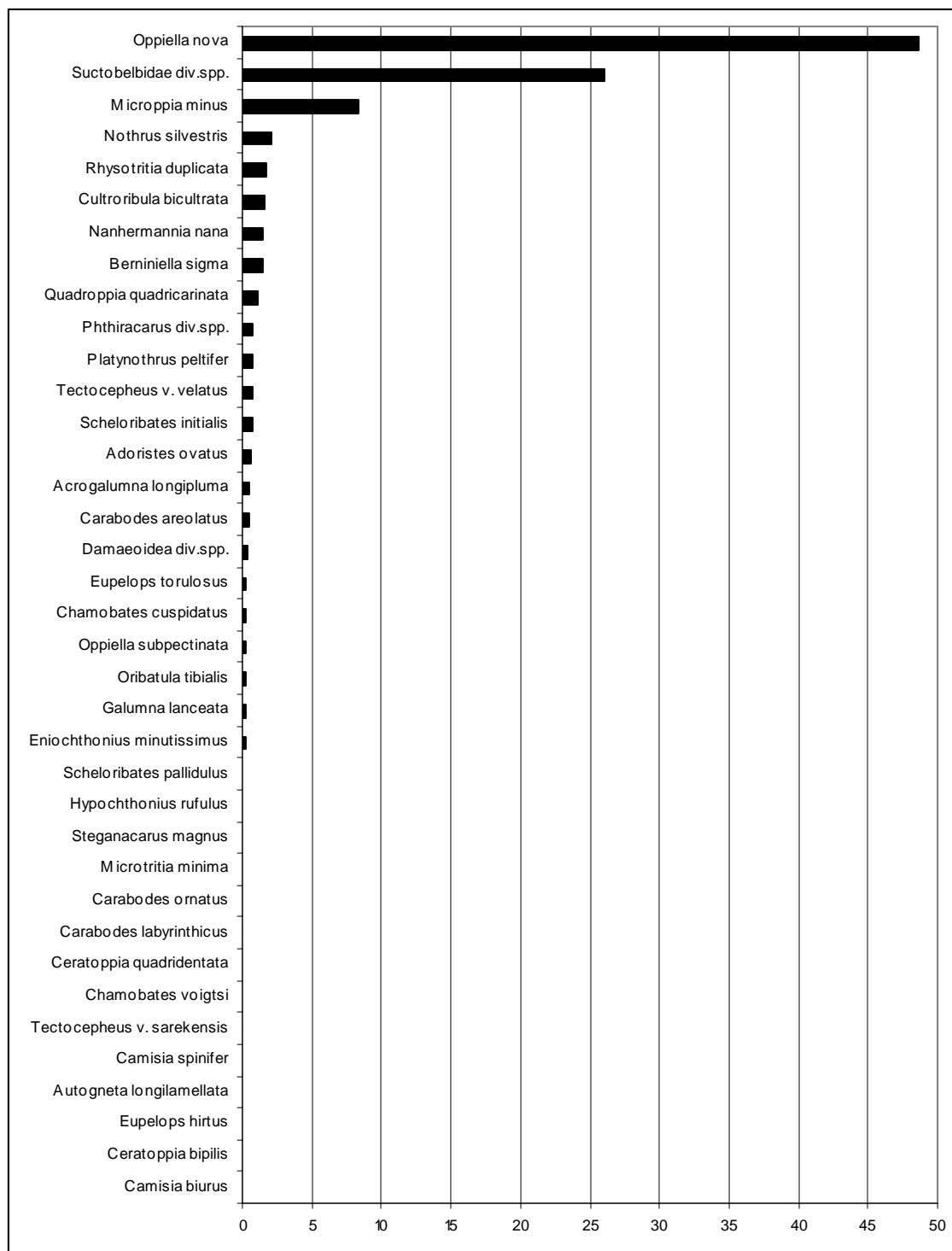


Fig. 113: Dominance structure of the oribatid mite community on plot M-pibe-med1

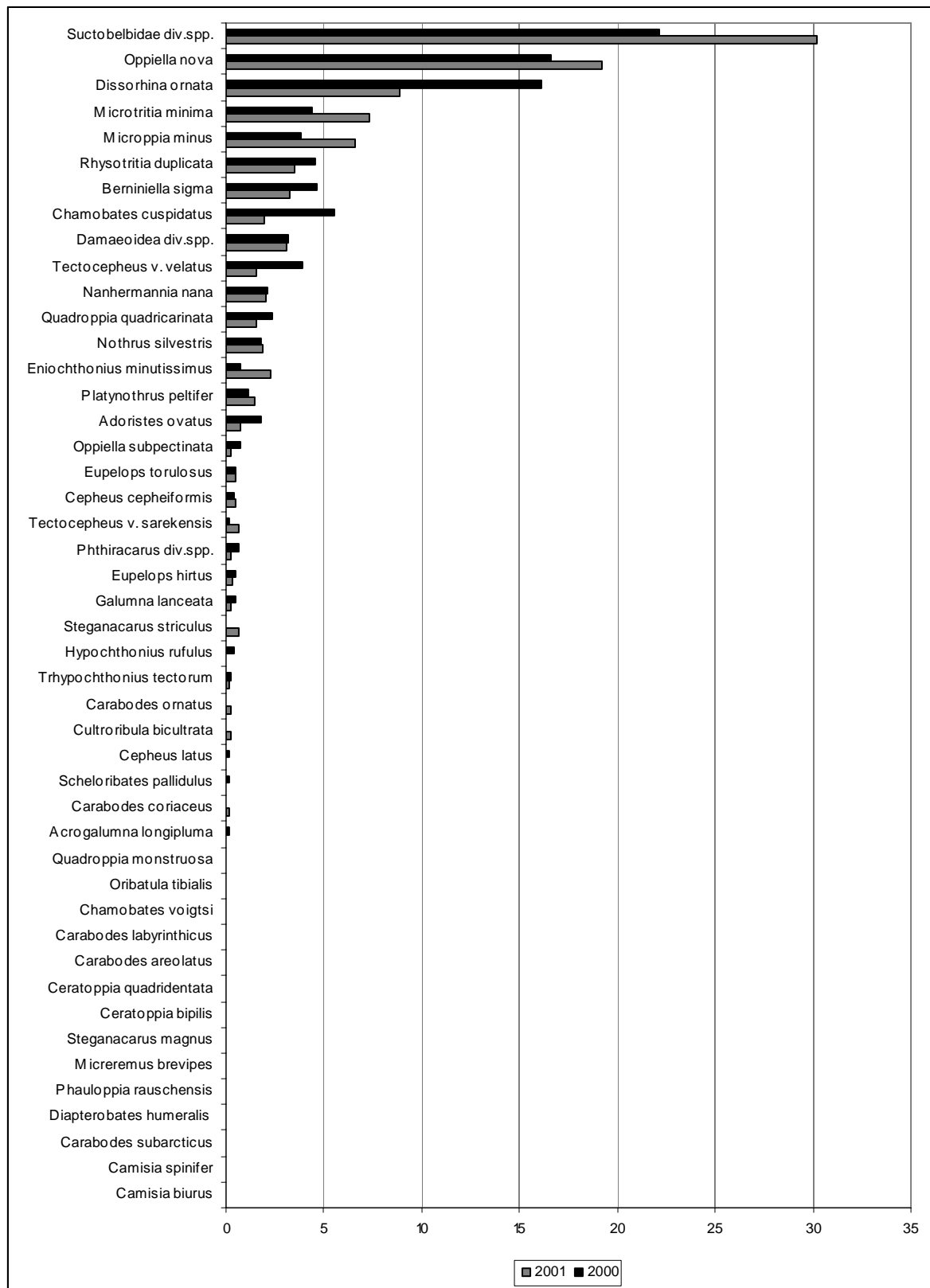


Fig. 114: Dominance structure of the oribatid mite community on plot E-pibe-med1 sorted according to their average dominance over the entire sampling period

4.6.1.4 The medium aged mixed stands with older beech undergrowth

Plot M-pibe-med2

On plot M-pibe-med2 6,264 specimens of oribatid mites were extracted from 18 samples. 3,532 of these were adult oribatid mites from 43 taxa. Again, as in the other plots in the Müritz NP, *Oppiella nova* is the most abundant species and reaches a dominance value of more than 45 %. The Suctobelbidae are the only dominant taxon with 22 % and *Micropia minus* and *Tectocephus v. velatus* are the only subdominant species. Further six species are recedent, while the majority of species is subrecedent (Fig. 115).

Plot E-pibe-med2

20,026 specimens belonging to 49 taxa were found on plot E-pibe-med2 in three years: 3,536 were found in 15 samples in 2000, 5549 were found in 18 samples in 2001 and 10,941 were found in 35 samples in 2002. In 2000 2,111 adult oribatid mites belonged to 30 taxa, in 2001 there were 3,196 adult oribatid mites from 39 taxa and in 2002 6,740 adult specimens belonging to 41 taxa were found. *Chamobates cuspidatus* and *Pilogalumna crassiclava* were found only in 2000, while *Acrogalumna longipluma*, *Camisia spinifer*, *Carabodes labyrinthicus*, *Nanhermannia nana*, *Oribatella calcarata*, *Tectocephus v. velatus* and *Trhypochthonius tectorum* were missing this year but found in the other two years. *Achipteria coleoptrata*, *Autogneta longilamellata*, *Galumna elimata* and *Zygoribatula cognata* were found only in 2001 and *Carabodes coriaceus*, *Cepheus latus*, *Galumna flagellata*, *Phauloppia lucorum*, *Quadroppia monstrosa* and *Zygoribatula propinqua* were found only in 2002. In 2002 *Steganacarus magnus* was not found. The Suctobelbidae were the eudominant taxon with 38 to 47 % in all three years. *Oppiella nova* was dominant with about 21 % in 2000 and 2002, but eudominant with about 32 % in 2001, while *Micropia minus* was subdominant in the entire sampling period. All other species were either recedent or subrecedent and their dominance values varied only to a small degree over the time (Fig. 116).

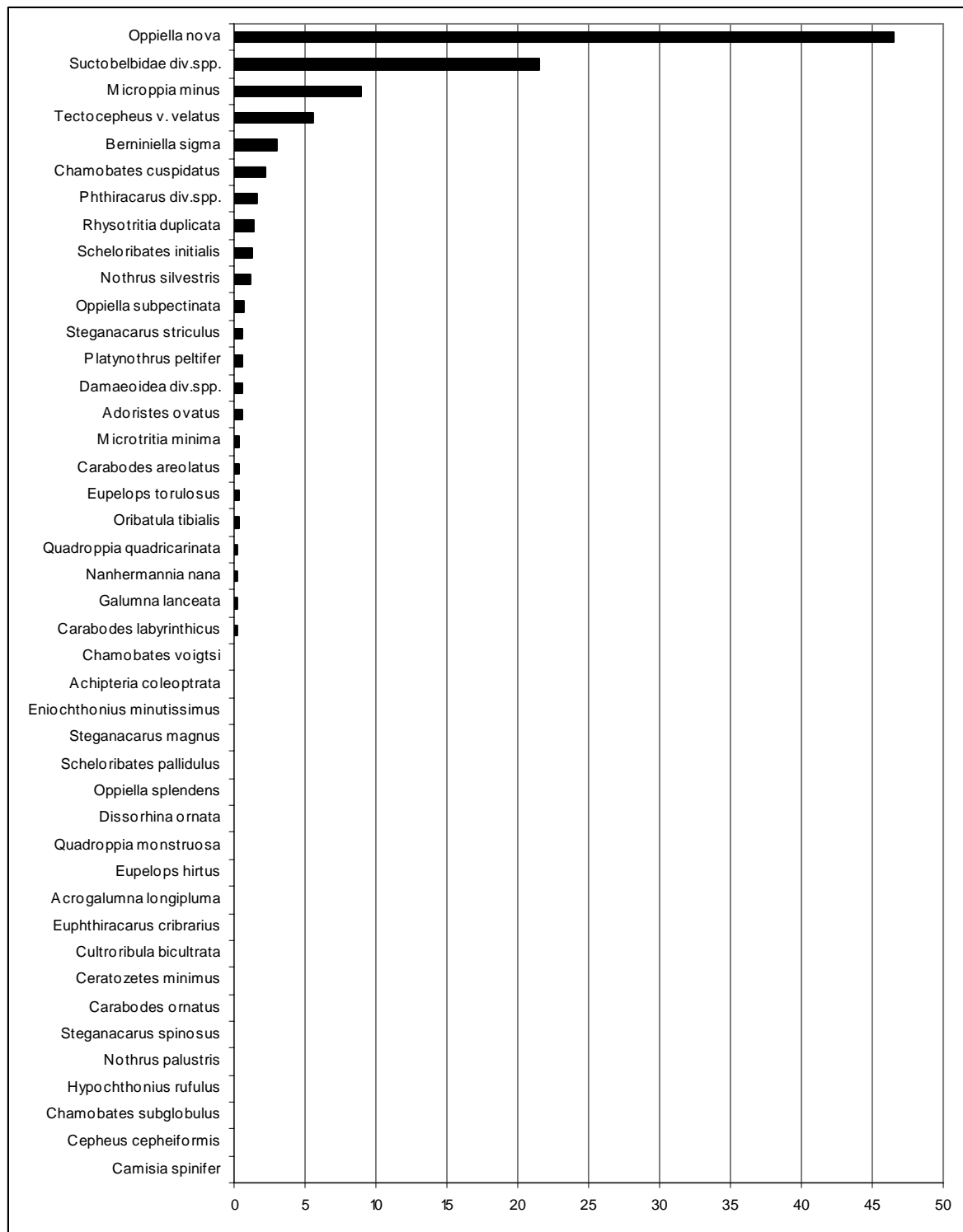


Fig. 115: Dominance structure of the oribatid mite community on plot M-pibe-med2

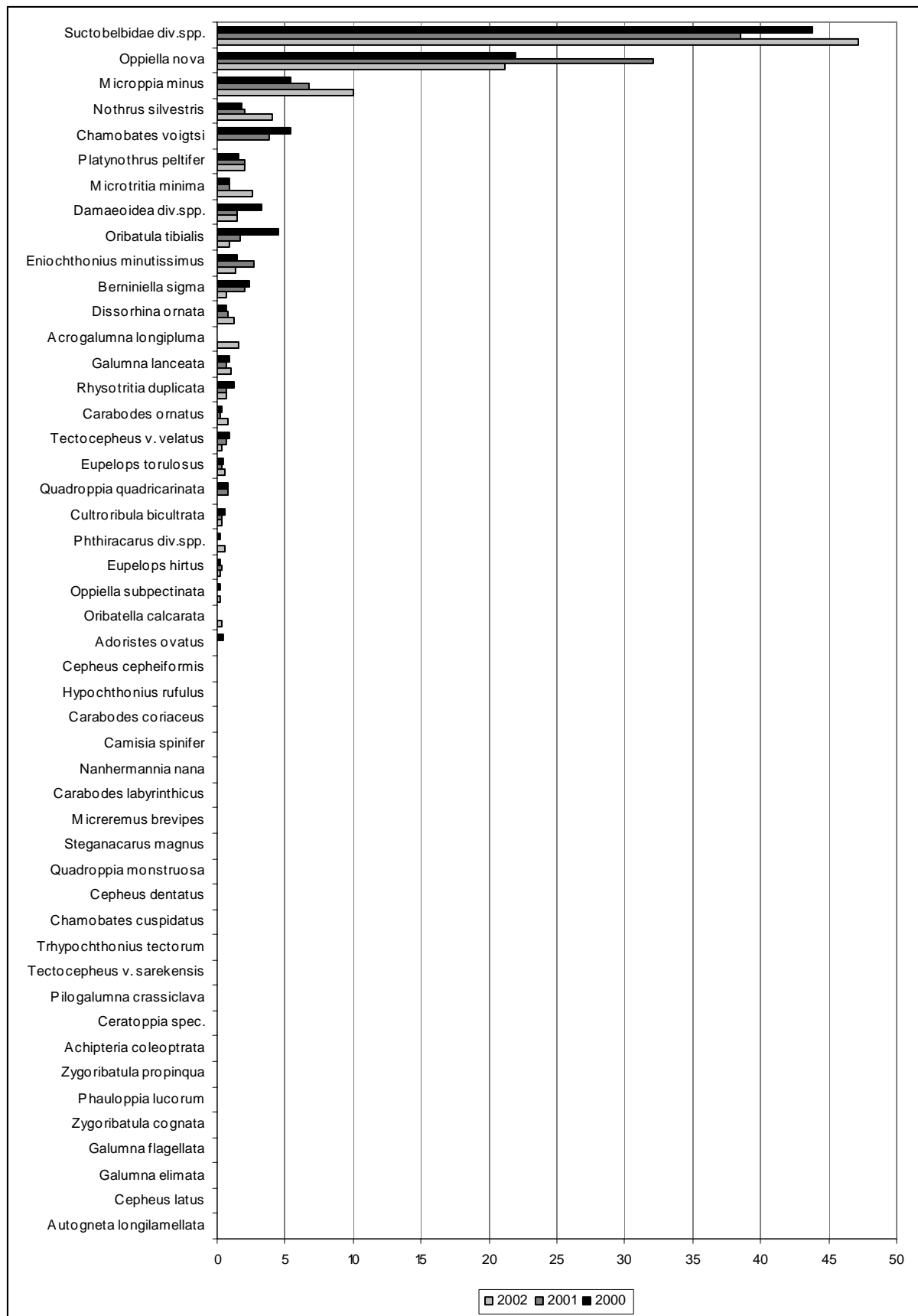


Fig. 116: Dominance structure of the oribatid mite community on plot E-pibe-med2 sorted according to their average dominance over the entire sampling period

4.6.1.5 The older mixed stands

Plot M-pibe-old1

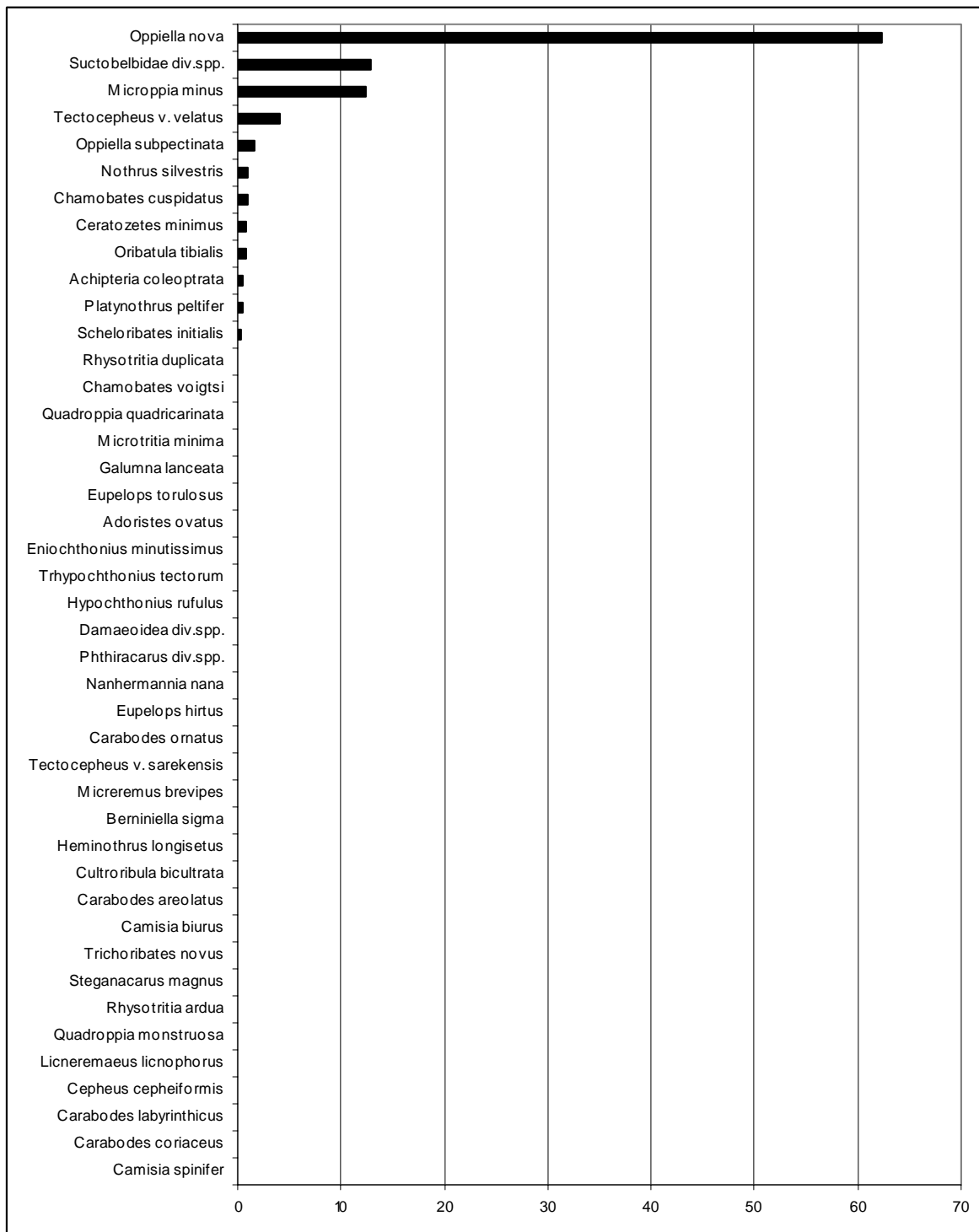


Fig. 117: Dominance structure of the oribatid mite community on plot M-pibe-old1

On plot M-pibe-old1, 18,047 specimens were found in 18 samples. 12,804 of these were adult oribatid mites and belonged to 43 species. *Oppiella nova* was the only eudominant species and reached a dominance value of 62 %. The Suctobelbidae and *Microppia minus* were domi-

nant with 13 and 12 % respectively, while *Tectocepheus v. velatus*, *Oppiella subpectinata* and *Nothrus silvestris* were recedent. The remaining species were all subrecedent (Fig. 117).

Plot M-pibe-old2

On this plot 13,832 specimens extracted from 17 samples. 9,665 of these were adult oribatid mites. 27 species were found. Here, too, *Oppiella nova* was the only eudominant species with almost 60 %. As in plot M-pibe-old1, the Suctobelbidae and *Micropoppia minus* were dominant species. Also in this plot only three recedent species were found: *Chamobates voigtsi*, *Oppiella subpectinata* and *Tectocepheus v. velatus* (Fig. 118).

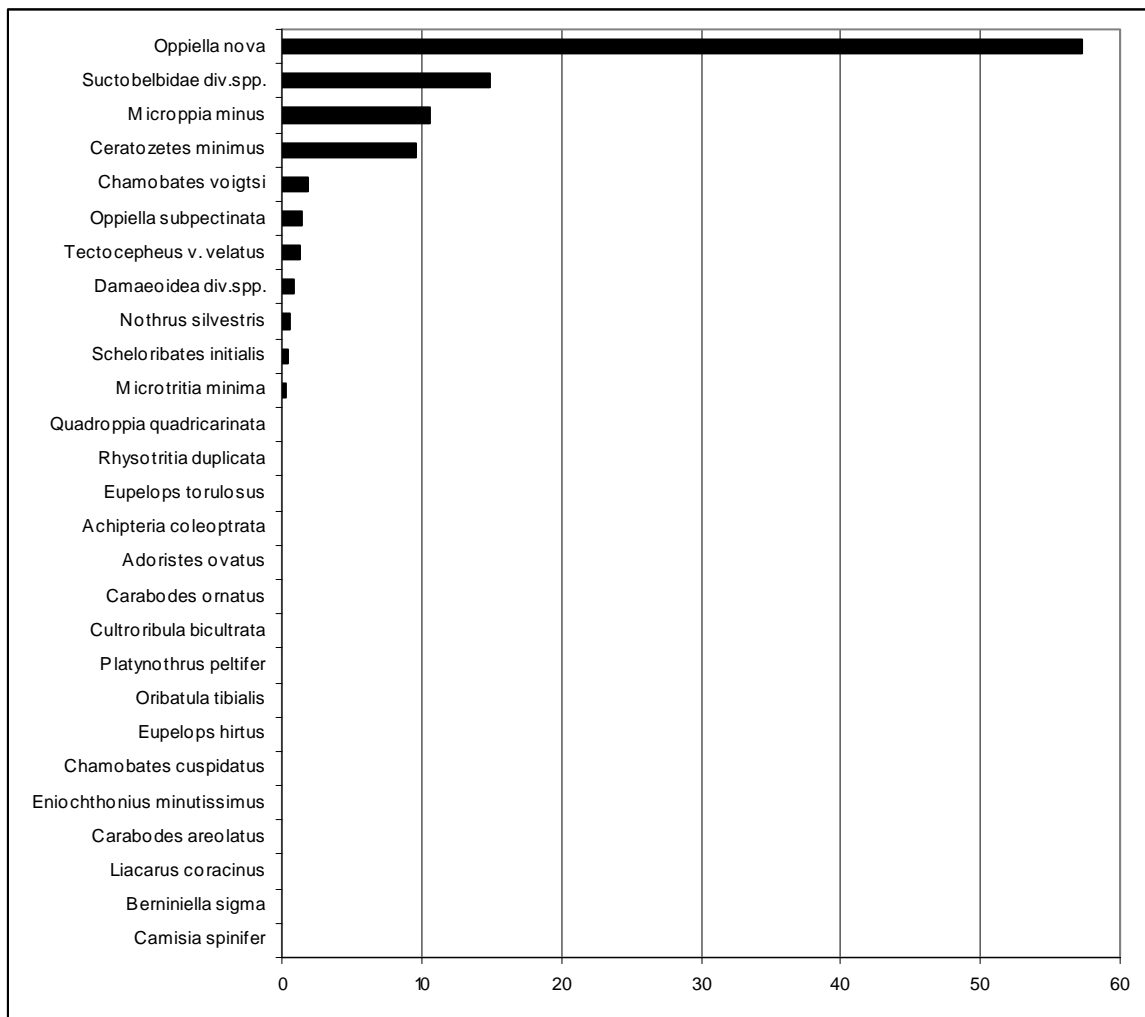


Fig. 118: Dominance structure of the oribatid mite community on plot M-pibe-old2

4.6.1.6 The beech stands

Plot M-be-old

On this plot 4,699 oribatid mites were extracted from 18 samples. 2,488 adult specimens were found that belonged to 41 taxa. The eudominant taxa were the Suctobelbidae and *Oppiella nova* with 37 and 35 % respectively. The only subdominant species was *O. subpectinata* with about 6 % (Fig. 119).

Plot E-be-med

9,919 oribatid mites from altogether 46 taxa were extracted from the samples from plot E-be-med in three years, 1,806 in 2000, 3,556 in 2001 and 4,557 in 2002. In 2000, 1,068 adult specimens from 24 taxa were found in 14 samples. *Ceratozetes minimus*, *Oppiella subpectinata* and *Scheloribates pallidulus* were only found this year, while *Carabodes subarcticus*, *Euphthiracarus cribrarius*, *Nanhermannia nana*, *Oribatella calcarata* and *Phthiracarus div.spp.* were missing this year, but found in the other two years. In 2001, 1,871 adult oribatid mites from 30 taxa were extracted from 18 samples. *Carabodes labyrinthicus*, *Cepheus cepheiformis*, *Eupelops torulosus* and *Scheloribates initialis* were found only in 2001, while *Carabodes ornatus* and *Chamobates cuspidatus* were missing this year. In 2002, 2,488 adult specimens from 39 taxa were found in 34 samples. Many species were only found this year: *Carabodes femoralis*, *Cepheus dentatus*, *Chamobates pusillus*, *C. subglobulus*, *Disorhina ornata*, *Eueremaes oblongus*, *Micreremus brevipes*, *Nanhermannia elegantula*, *Oppiella falcata*, *Platynothrus peltifer* and *Quadroppia monstrosa*.

The Suctobelbidae are the only eudominant taxon in this plot, but while its dominance value in 2000 is only 33 %, it increases to more than 50 % in 2001 and 2002. *Oppiella nova* is dominant in all three years, but its percentage decreases from 27 % in 2000 to 13 % in 2002. Also the dominance value of *Chamobates voigtsi*, *Oribatula tibialis*, *Quadroppia quadricarinata*, *Rhysotritia duplicata*, *Tectocephus v. velatus* and the Damaeioidea is much higher in 2000 than in the other years. *Berniniella sigma* and *Hypochthonius rufulus*, on the other side, are more dominant in 2001 than in the other years and *Galumna lanceata*, *Micropopia minus* and *Nothrus silvestris* have the highest dominance values in 2002. The dominance values of the remaining species differ less over time (Fig. 120).

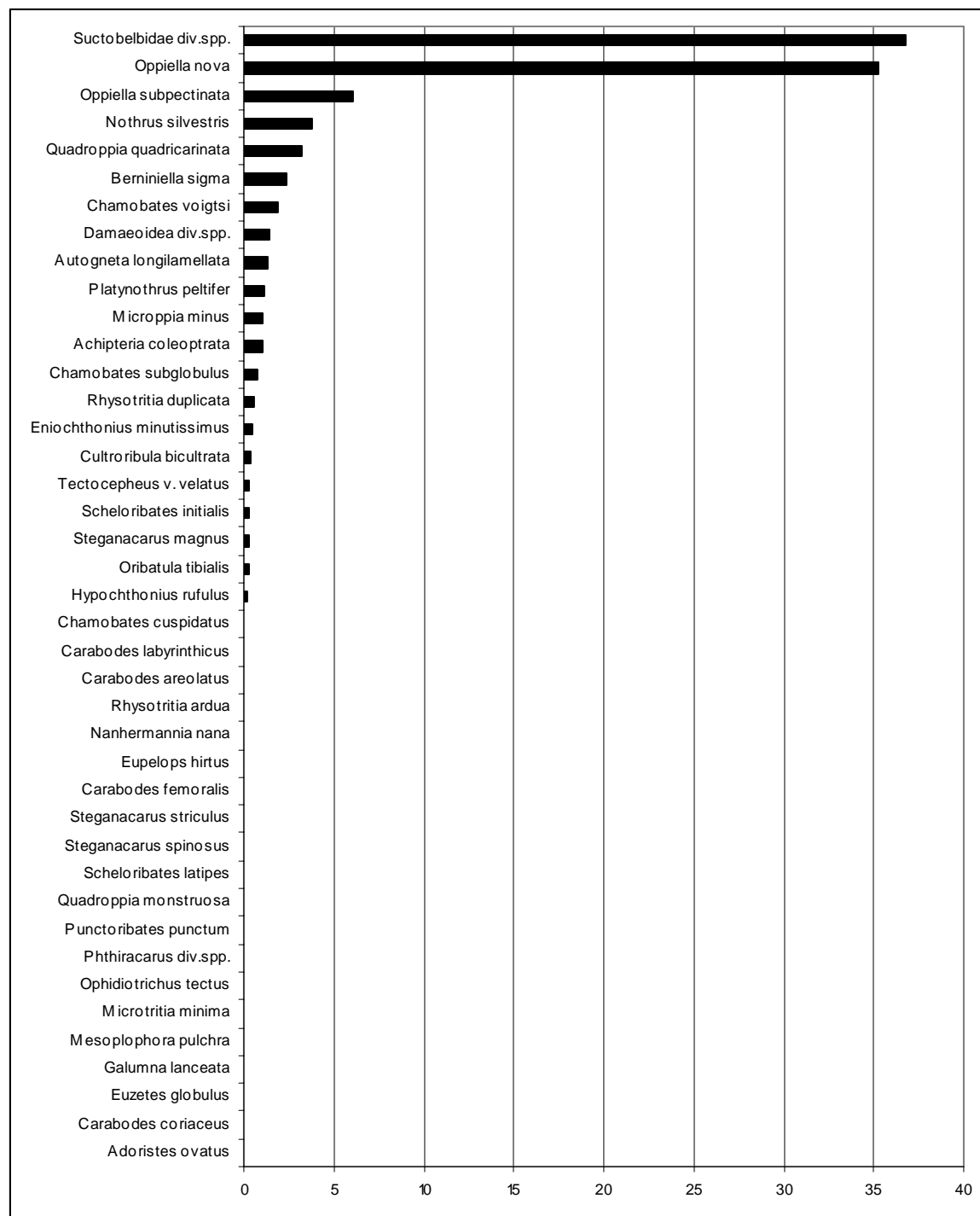


Fig. 119: Dominance structure of the oribatid mite community on plot M-be-old

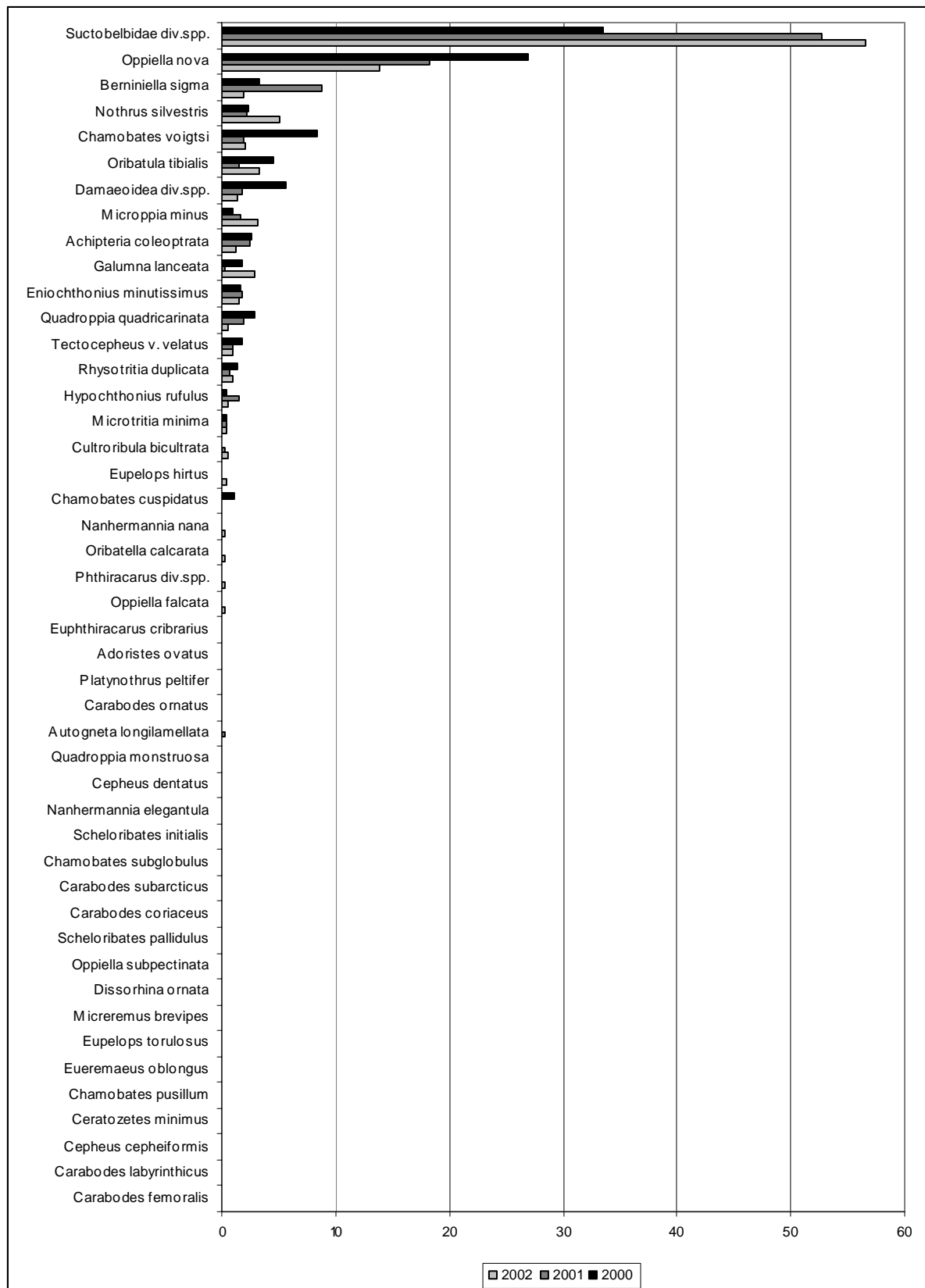


Fig. 120: Dominance structure of the oribatid mite community on plot E-be-med sorted according to their average dominance over the entire sampling period

4.6.1.7 Discussion

When looking at the dominance structure of the oribatid mites in the different plots, it is striking that the most even dominance structure is found in the young pine plot in the Müritz NP with 5 dominant taxa. This is the only plot, in which the most dominant taxon is not *Oppiella nova* or the Suctobelbidae. SENICZAK et al. (1997) also found a relatively even dominance structure in a 20-year old, unpolluted pine forest.

The dominance structure of most other plots is dominated by one eudominant taxon, usually *O. nova* in the Müritz NP (except on the beech plot) and the Suctobelbidae in Eberswalde, respectively. In the Müritz NP, *O. nova* reached dominance values of 40 – 50 % in the medium aged plots and of more than 60 % in the old plots. Since *O. nova* is a fungivorous species, it probably benefits from the thick raw layer that covers the soil in the old plots, because this raw humus layer is highly interspersed with fungi. On the beech plot, the Suctobelbidae are slightly more abundant than *O. nova*, but both taxa reach dominance values of about 35 %. In the pine plots in Eberswalde, the Suctobelbidae are the only eudominant taxon with dominance values of 30 to 36 %. In mixed stand with the young beech undergrowth, the Suctobelbidae only reach 30 % in 2001, while in 2000 they reach only about 23 %. In the mixed stand with the older beech undergrowth, however, the Suctobelbidae reach dominance values of well over 35 %. In the beech plot in Eberswalde, the Suctobelbidae are eudominant with even more than 50 %.

Since *O. nova* as well as the Suctobelbidae are considered to be fungivore, the differences between the two sampling areas might be explained by different climatic conditions. The climate in the Müritz NP is much drier than in Eberswalde and *O. nova* might be better adapted to the drier conditions than the Suctobelbidae are.

Species that have their main distribution in beech forest, like *Achipteria coleoptrata*, *Autogneta longilamellata*, *Chamobates subglobulus* and *C. voigtsi* are found with dominance value of more than 1 % only in the beech stands, though *C. voigtsi* is also found with 4 – 5 % in the medium aged mixed stand with the older beech undergrowth.

4.6.2 Forest conversion

4.6.2.1 Results

For this part of the investigation, the medium aged pine and mixed plots (with the exception of the plots with the high nutrient content in Eberswalde) and the beech plots in the Müritz NP and Eberswalde were considered (Tab. 1).

Altogether 67 taxa from 42 genera were found (App. Tab. 1). Of those, 8 species were only recorded in Eberswalde while there were 12 species found only in the Müritz NP.

All detected taxa are sorted according to their presumed preference using abundance and frequency. 9 species are considered to have a preference for beech forests, 15 species were mainly found in mixed forests and 25 taxa were mainly found in pine forests. Another 12 taxa can be classified as ubiquitous forest species and for 6 species no obvious preference was found.

The species numbers in Eberswalde are lower in 2000 than in 2001, while the species density is the same (Fig. 121). In the Müritz NP the species number and density is slightly higher than in Eberswalde. Only for the beech stands the species number is much higher in the Müritz NP than in Eberswalde. In both areas, the species number and density is higher in the pure pine plots than in the beech plots, while in the mixed stands intermediate values were found. Only in the plot M-pibe-med1 the number of species is lower than in the other plots in the Müritz NP.

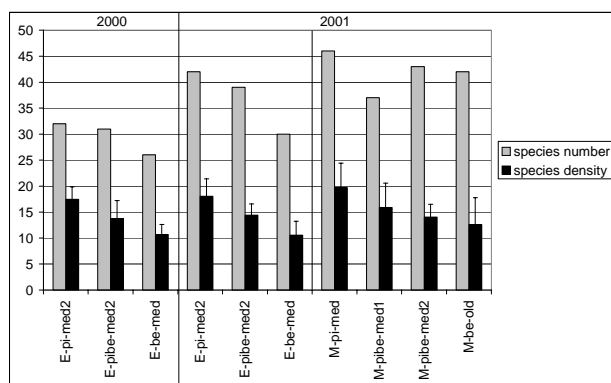


Fig. 121: Species number and species density of the oribatid mites for each plot

In the Müritz NP, the species composition of oribatid assemblages differs between the stands in a far more obvious way than it does in Eberswalde. For instance, *Nanhermannia nana* only shows up in the plots M-pi-med and M-pibe-med1 which are either a pure pine stand (M-pi-med) or a stand with a very young beech undergrowth (M-pibe-med1). *Autogneta longilamel-*

lata, *Chamobates voigtsi* and the Damaeioidea are only found in the pure beech stand and *Phthiracarus* div.spp. and *Rhysotritia duplicata* were only observed in the mixed stands.

The similarities of species composition between the oribatid assemblages of different plots vary between 0.50 and 0.73 in 2001 (Fig. 122). The beech stands on the plots M-be-old and E-be-med show a low species similarity to the other plots, but also between both beech plots a low Jaccard index was found. The highest similarity was found between the plots M-pibe-med and M-pibe-med1 with a value of 0.73. The pure pine plot and the mixed plot in Eberswalde and the pure pine plot and the mixed plots in the Müritz NP form one cluster respectively.

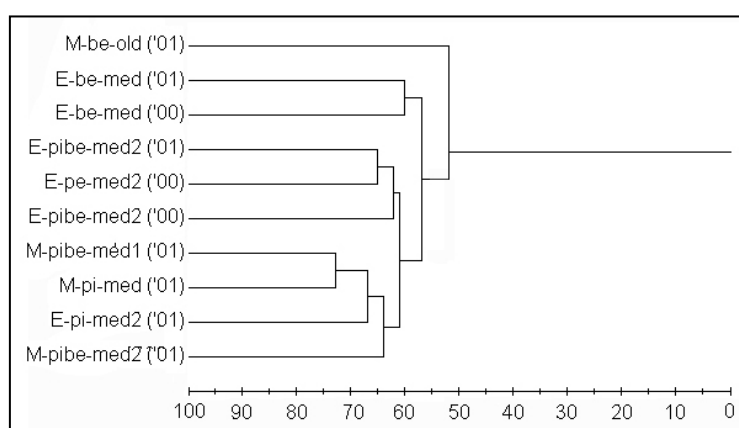


Fig. 122: Cluster diagram of similarities for oribatid mites assemblages of study plots, based on the Jaccard index

Altogether 64,505 oribatid mites were found in the samples, 33,399 in the Müritz NP in 2001, and 31,106 in Eberswalde in both years. Here, 12,297 were found in the year 2000 and 18,809 in the year 2001. Of those 64,505 oribatid mites 26,456 were juvenile stages and Brachychthoniidae.

year	plot	adults	juveniles	total
2000	E-be-med	22,609 ± 9,959	15,294 ± 15,610	37,903 ± 20,628
	E-pibe-med2	43,747 ± 26,700	29,531 ± 34,930	73,278 ± 50,628
	E-pi-med2	98,809 ± 29,761	44,845 ± 22,156	143,654 ± 40,630
2001	E-be-med	32,311 ± 17,384	29,099 ± 29,222	61,410 ± 37,851
	E-pibe-med2	55,193 ± 24,331	40,635 ± 32,907	95,828 ± 48,527
	E-pi-med2	97,003 ± 36,580	70,435 ± 40,587	167,582 ± 71,129
	M-be-old	42,966 ± 28,000	38,183 ± 33,183	81,149 ± 52,473
	M-pibe-med2	60,996* ± 32,341	47,180 ± 48,579	108,176* ± 72,927
	M-pibe-med1	108,596 ± 46,923	86,562 ± 57,248	195,159 ± 86,897
	M-pi-med	127,604 ± 36,527	75,329 ± 34,881	202,933 ± 56,503

Tab. 33: Abundances of the oribatid mites [ind./m²], with standard error; * significant difference to all other plots

In the pine plots, higher abundances of mites have been found than in the beech plots (Tab. 33). In 2001 in Eberswalde and in the Müritz NP, this difference is significant ($p < 0.5$). The abundance in the mixed stand is of intermediate value. Furthermore, the ratio of adults : juveniles shifts towards a higher percentage of adults in the pine plots.

It can be observed that the abundance of oribatid mites is higher in the Müritz NP than in Eberswalde and there it is higher in 2001 than in 2000, though these differences were not significant.

The abundant species are common to both areas whereas species with low abundances often are only found in one of the areas (App. Tab. 1).

Members of the family Cepheidae, which had been found in Eberswalde with three different species, were not found in the Müritz NP with the exception of one single specimen in the plot M-pibe-med2. Also members of the families Eniochthoniidae, Galumnidae, Hypochthoniidae, Oribatulidae and Phenopelopidae were more abundant in Eberswalde than in the Müritz NP.

Opposed to that the Astegistidae, Autognetidae, Ceratoppiidae, Euzetidae, Nanhermanniidae, Phthiracaridae and Tectocephidae were more abundant in the Müritz NP. The same applies to the Carabodidae and Oppiidae, though not for all species within these families. Within the Carabodidae no differences could be found for the abundance of the species *Carabodes ornatus* and *C. subarcticus*. Within the Oppiidae *Microppia minus*, *Berniniella sigma* and *Quadroppia quadricarinata* appeared in both areas with similar abundances, whereas *D. ornata* was far more abundant in Eberswalde.

The Scheloribatidae as a family showed no differences in their abundance between the two areas, but in Eberswalde it was due to the appearance of the *Scheloribates pallidulus* and *S. latipes* while in the Müritz NP it was based upon the occurrence of *S. initialis*. Also the Chamobatidae were found with similar abundances in both areas, but in the Müritz NP *Chamobates cuspidatus* and *C. subglobulus* were more common, while in Eberswalde *C. voigtsi* was the more common species.

In all study plots the Suctobelbidae and *Oppiella nova* are the dominant or even eudominant taxa (Figs. 110, 112-113, 115-116, 119-120). A striking difference between both areas is the fact that in Eberswalde the Suctobelbidae are the most abundant taxon while in the Müritz NP *O. nova* is eudominant in all plots, caused by the significantly higher abundance of *O. nova* in the Müritz NP than in Eberswalde. Only in the beech stand the dominance of the Suctobelbidae is still slightly higher.

The dominance structure differs only to a small degree between the plots and the years in Eberswalde (Figs. 112, 116 & 120). The majority of the ten most dominant species occurs in all plots. *Dissorhina ornata* is the only dominant species in the plot E-pi that cannot be found in the other two plots with significant numbers. *Chamobates voigtsi* occurs as a subdominant or recedent species in both stands with beeches and is missing among the abundant species in the pure pine stand. *Achipteria coleoptrata* can only be found in the pure beech stand as a recedent species. In the other plots, it only occurs with solitary specimens.

On one hand, in the Müritz NP a number of species occurs among the most dominant taxa that have not been found in Eberswalde in equally high numbers such as *Autogneta longilamelata*, *Chamobates cuspidatus*, *Cultroribula bicultrata*, *Scheloribates initialis*, *Nanhermannia nana*, *Phthiracarus* div.spp. and *Rhysotritia duplicata*. On the other hand, a few species such as *Achipteria coleoptrata*, *Eniochthonius minutissimus*, *Galumna lanceata*, *Dissorhina ornata* and *Scheloribates pallidulus* are missing in the Müritz NP among the most dominant species (Fig. 110, 113, 115 & 119).

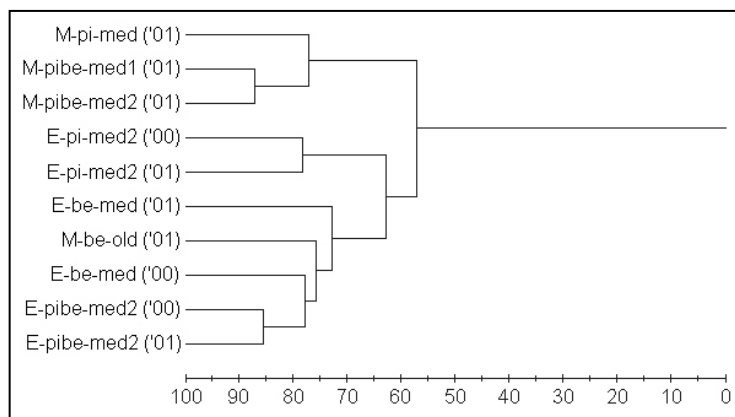


Fig. 123: Cluster diagram of similarities for oribatid mite assemblages of study plots, based on the Renkonen index

The similarity of mite assemblages as measured by the Renkonen index shows slightly different results than the cluster analysis for the Jaccard index. The pine plots and the mixed plots in the Müritz NP form a cluster that is well separated from the other plots (Fig. 123). The dominance identity of the mixed plot as well as of the pine plot in Eberswalde is quite high, when both years are compared. The dominance structure of the mixed plot in Eberswalde is closer to the beech plots than to the pine plot in Eberswalde.

The species diversity was higher in the pine stands than in the mixed and the beech stands (Fig. 124). In Eberswalde the values of the diversity and evenness were higher in 2000 than in 2001. Especially the diversity of the beech stand was very low. In 2001 the replicated plots in Eberswalde and the Müritz NP exhibited similar values of diversity. The evenness is follow-

ing the same trend as the species diversity. The lowest values for both indices were found in the plot M-pibe1.

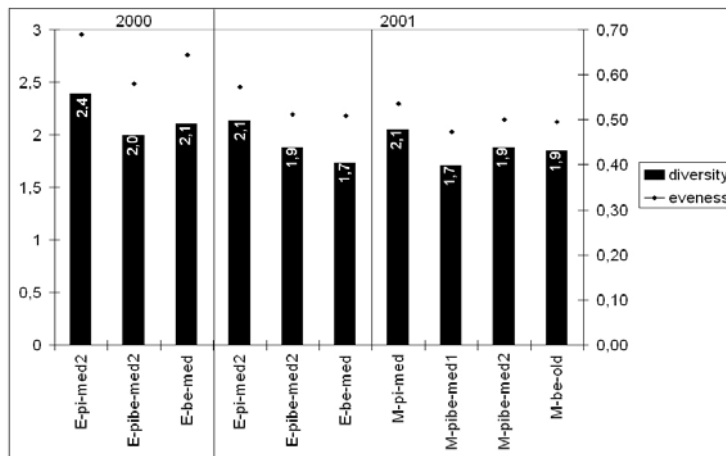


Fig. 124: Species diversity and evenness of the oribatid mites for each plot

4.6.2.2 Discussion

In the soil of temperate forests oribatid mites occur in huge numbers, but their number varies depending on humus type, thickness of the humus layer and other factors (REHFUESS 1981, DUNGER 1983, NORTON 1990). In general, the density of oribatid mites is higher in coniferous forests than in deciduous forests. Most authors report 15,000 to 50,000 ind./m² in deciduous forests (e.g. AOKI, 1967; ATHIAS-HENRIOT & CANCELA DA FONSECA, 1976; LUXTON, 1981a; KANEKO & TAKEDA, 1984; SCHÄFER & SCHAUERMANN, 1990; WUNDERLE, 1992; SKUBALA, 1999; DUNGER et al., 2001), whereas abundances of 100,000 Ind./m² are reported less frequently (HARDING, 1969). The number of oribatid mites recorded from coniferous forests is usually higher (e.g. KARPINEN, 1958a; HUHTA & KOSKENNIEMI, 1975; SYLWESTROWICZ-MALISZEWSKA et al., 1993; SENICZAK et al., 1994, 1998; DUNGER et al., 2001) and reach values up to 425,000 Ind./m² (WALLWORK, 1983).

Those investigations that compared deciduous and coniferous forests under similar geographical and climatic conditions showed that the density of oribatid mites is higher in stands with a higher percentage of coniferous trees (MORITZ, 1965; SKUBALA, 1999b). The same trend can be observed in this investigation in Eberswalde as well as in the Müritz NP. It cannot be explained by thickness of humus. In both areas the humus changes from a mull in the beech stands toward a moder or a mor in the pine stands. In the Müritz NP the F-mull in the beech stand is 2.5 cm thick, while the mor in the pine stand is about 7 cm thick. In

Eberswalde on the other side there is no difference in the thickness of the humus layer. Nevertheless the number of oribatid mites is higher in stands with a higher number of pines.

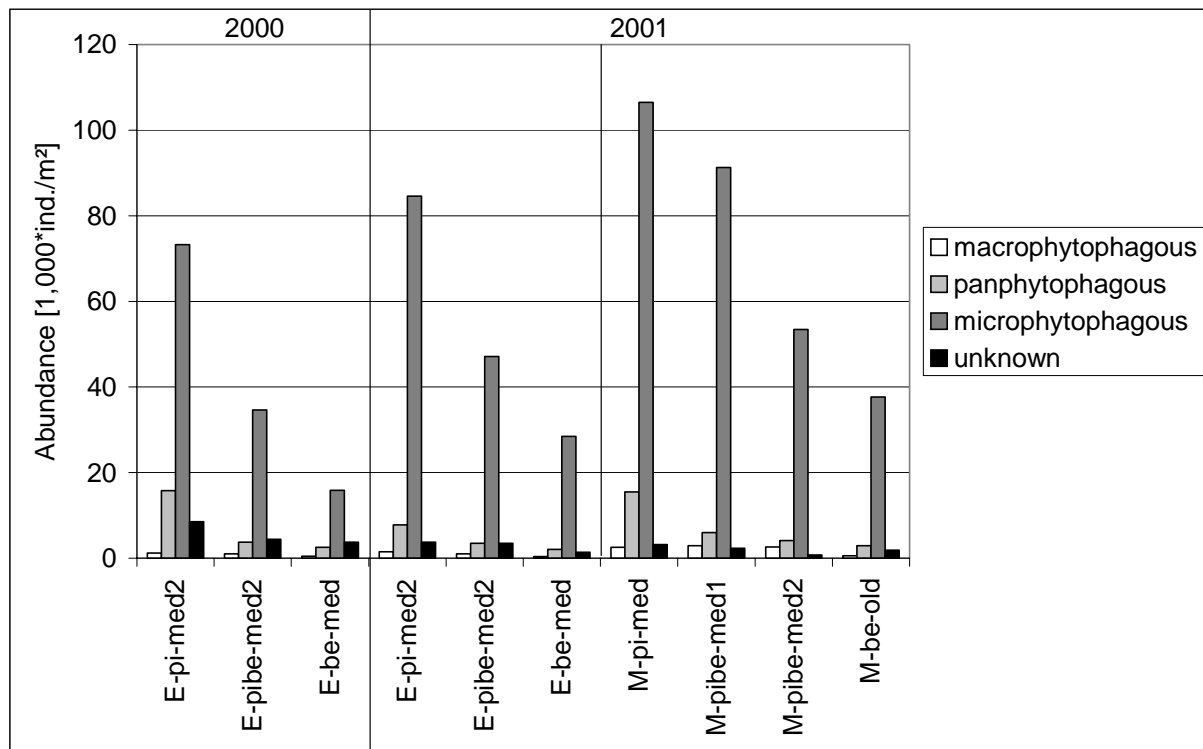


Fig. 125: Abundance of oribatid mites according to the main food source

Another reason for the growing number of oribatid mites in moder or mor might be the availability of food. Especially in a mor the major part of the decomposition is accomplished by fungi and bacteria. Since many oribatid mites feed on fungi (SCHUSTER, 1956; LUXTON, 1972; PANDE & BERTHET, 1973; BECK, 1983; KANEKO, 1988; MARAUN et al., 1998), the better availability of food may be responsible for the higher number of oribatid mites. This phenomenon is also observed in the present study. In the study plots the majority of the oribatid mites prefers microphytophagous food sources (App. Tab. 2, Fig. 125). And though the number of oribatid mites of all feeding habits rises as the humus layer develops toward a mor, this trend is most obvious among the microphytophagous mites. Unfortunately, there is still a number of species with unknown feeding habits, but the abundance of these mites is so low that their influence on the overall result is negligible.

The numbers of oribatid species found in the different stands are typical for the temperate forests in the northern hemisphere. In the beech forests in Eberswalde and the Müritz NP between 26 and 42 species were detected on one sampling plot. The species numbers in the mixed stands were slightly higher and varied between 31 and 43 and in the pine stands 37 to

47 species were accounted for. MORITZ found in mixed deciduous forest dominated by beech in this region between 46 (MORITZ, 1965) and 74 (MORITZ, 1963) species and between 47 and 64 species in mixed forests. Considering that in our investigation Brachychthoniidae, Damaeioidea and Suctobelbidae have not been separated on the species level the species number probably reaches the same dimension. Other authors report similar species number of oribatid mites for beech forests: LUXTON (1981a) 66 species, ALBERTI et al. (1996) 54 species and SCHEU & SCHULZ (1996) 67 species. FABIAN (1997) found 21 to 40 species in beech forests and 43 species in a mixed forest, while MELAMUD (1998) reported between 50 and 57 species from mixed forests. In pine stands in Poland SENICZAK & DĄBROWSKI (1993) and SENICZAK et al. (1995, 1998) detected between 40 and 44 species and SYLWESTROWICZ-MALISZEWSKA et al. (1993) found between 30 and 56 species. SKUBALA (1999b), who also compared coniferous, mixed and deciduous forests, detected 77 species in the beech forest, 80 species in the mixed forest and 86 species in the spruce forest. So he could also observe the trend of increasing species numbers with increasing percentage of coniferous trees.

All species found in the present investigation, as far as they are mentioned in their paper, WEIGMANN & KRATZ (1981) specified as species that mainly occur in acid deciduous or coniferous forests or in mesophilic deciduous forests. This, of course, is only a rough characterisation, since most species occupy smaller niches within these forest types. To this date, it is not completely clarified to which factors single species react. So some species seem to be either directly or indirectly dependent on a certain form of litter or humus, while other species rather seem to react to the humidity or chemical factors of their environment or a combination of several factors. *Achipteria coleoptrata*, *Chamobates voigtsi*, *C. subglobulus* and *Autogneta longilamellata* for instance were found with higher abundances in stands in which the beeches were dominating. These species are found mainly in deciduous forests or mixed forests (MORITZ, 1963, 1965; LUXTON, 1981a; WUNDERLE, 1992; IVAN, 1995; ALBERTI et al., 1996; FABIAN, 1997; MELAMUD, 1998; SKUBALA, 1999b), but they are missing in pure coniferous forests (e.g. KARPINEN, 1958a; SYLWESTROWICZ-MALISZEWSKA et al., 1993; SENICZAK & DĄBROWSKI, 1993; SENICZAK et al., 1995, 1998). WALLWORK (1976) on the other hand noted, that species like *Achipteria coleoptrata* are rare or absent in localities where ground vegetation is poorly developed, because they often move between the litter and the vegetation. The current study does not support this observation, since this species occurs only in stands with no or with a poorly developed ground vegetation.

The species that in our investigation showed a preference for pine and mixed forests are found in a wide range of forest types (e.g. STRENZKE, 1952; RAJSKI, 1961; WEIGMANN & KRATZ,

1981). So these species probably react rather to other factors than the litter type. Therefore, it may be that the species that showed a preference for mixed or for pine forests in this area have a wider ecological tolerance than those that have a preference for pure beech forests.

The diversity of the oribatid mites is higher in the pine stands than in the other stands. This was to be expected, because oribatid mites are most numerous in coniferous forests. Here, they also appear with the highest species numbers. In both pine stands the ground vegetation is well developed, whereas in the beech stands there was literally no ground vegetation. KARPINEN (1958a) and ITO & AOKI (1999) found that the soil mites fauna is more varied under forest stands having a rich ground vegetation, since the presence of ground vegetation increases the diversity of microhabitats available to soil animals (WALLWORK, 1976). ANDERSON (1978), too, showed that there is a positive correlation between the habitat structure and the species diversity. He also showed, that the microhabitat diversity decreases from mull toward mor soil, which could explain the results obtained in this investigation.

At the current study the similarity of oribatid assemblages from any two plots, measured by Jaccard index was at least 50 %. These are mainly ubiquitous taxa as the Oppiidae, the Suctobelbidae or *Nothrus silvestris* that appear in all plots. The Renkonen index tends to underestimate rare species while dominant species are overestimated. In this case, the ubiquitous *Oppiella nova* and the Suctobelbidae combined reach a dominance identity of at least 42 % as in the pine stand in Eberswalde. In the other plots both taxa even reach a dominance identity between 50 and 80 %. The other species contribute only to relatively small amount to this index, so that it reveals little information about the likeness between the plots.

The cluster diagrams of oribatid assemblage similarity show that the differences between the two areas overweigh the differences between the plots of an area, despite the similar soil substrate, tree stocking and soil quality. The reason for these differences may lay in the climatic differences, in particular in the different annual amount of rainfall. This indicates that oribatid mites do react strongly to differences in humidity as several authors suggested (MADGE, 1964; TARMAN, 1967; METZ, 1971; RUBCOVA, 1973). Furthermore, it can be seen that the similarity between oribatid assemblages of the same plot when both years are compared does not exceed 55 %. This means that the mite populations of the soil vary between the years. This, too, can be a climatic effect. But these differences are still smaller than the differences to the other plots, so that the influence of the different tree stocking is more important than the climatic influence in the same area.

In summary it can be ascertained, that despite the differences between the two areas the conversion of the forests causes the oribatid mite community to change dramatically. Most obvious is the decrease of abundances that occur when pines are replaced by beeches. Also the species number is reduced during this process. The composition of the oribatid mite community also changes, but in a less obvious way. As the beeches are introduced and grow older some species like *Dissorhina ornata*, *Adoristes ovatus* and *Eupelops torulosus* disappear, while others like *Achipteria coleoptrata*, *Chamobates voigtsi* and *C. subglobulus* immigrate.

It is still difficult to deduce consequences for the forestry management from these data without further investigations. The knowledge of soil mites, though significantly increasing, is still scarce, especially with regard to the autecology of most species. Reports on autecological observations are often insufficient or contradictory. This applies particularly to the feeding preference of many species. Most authors state only a general feeding preference as macrophytophagy, microphytophagy or panphytophagy. It is generally acknowledged that oribatid mites are generalists with regard to their feeding preference, at least within the three feeding habits (SCHUSTER, 1956; LUXTON, 1972; BEHAN & HILL, 1978; MARAUN et al., 1998). And though many oribatid mites may be considered as “choosy generalists” (SCHNEIDER & MARAUN, 2005) further knowledge is needed about the feeding preferences of oribatid mites under field conditions. This knowledge is necessary to draw conclusions with regard to the current state of a certain soil or humus form and a possible development.

4.6.3 The influence of the age of different forest stands

4.6.3.1 Results

For this part of the investigation, all plots in the Müritz NP except for the beech plot have been considered (Tab. 1).

Altogether 64,394 oribatid mites were found in the samples. Of those oribatid mites 23,222 were juveniles and Brachychthoniidae. A complete list of all taxa is given in the appendix (App. Tab. 3).

As can be seen in Tab. 34 the abundance of oribatid mites was lowest in the youngest stands and highest in the oldest stands. An exception was the plot M-pibe-med2, where the abundance is far lower than in the other stands of medium age, though this difference is not significant. Furthermore, the ratio of adults : juveniles shifts towards a higher percentage of adults as the mean age of the stand rises.

	M-pi-yng	M-pi-med	M-pibe-med1	M-pibe-med2	M-pibe-old1	M-pibe-old2
adults	38,317	127,604	115,383	68,620	176,617	234,125
juveniles	42,545	75,329	91,973	51,737	76,195	95,870
sum	80,862	202,933	207,356	120,357	252,812	329,994
% juveniles	53	37	44	43	30	29
species no.	37	46	37	43	28	44
sp. density	17.1	19.7	17.9	14.6	13.1	15.9
diversity	2.57	2.04	1.71	1.88	1.43	1.37
evenness	0.71	0.53	0.47	0.50	0.43	0.36

Tab. 34: Abundances [ind./m²], species numbers and diversity indices (diversity according to Shannon-Weaver) for each plot

Altogether 60 species from 38 genera and two families that have not been further separated were found. Neither species numbers nor species density were influenced by the age of the stands (Tab. 34). The species numbers varied between 37 and 46, except on plot M-pibe-old1, where the species number was very low with a value of 28. The diversity and evenness is decreasing with the increasing age of the stands.

Species richness, diversity and evenness were higher in the medium aged pure stand than in both mixed of medium age as could be expected (SKUBALA, 1999a).

The dominance structure of the oribatid mite community of the different stands is given in chapter 4.6.1. It can be clearly seen that the dominance structure was shifted toward an uneven distribution with growing age by an increasing percentage of *O. nova* already indicated by the evenness. The Suctobelbidae were the second most abundant taxon and were dominant in all plots. *M. minus* was dominant in the young pine stand on plot M-pi-yng (Fig. 109) and the old mixed stands on plots M-pibe-old1 (Fig. 117) and M-pibe-old2 (Fig. 118), but subdominant in the stands of medium age on the plots M-pi-med (Fig. 110), M-pibe-med1 (Fig. 113) and M-pibe-med2 (Fig. 115). The abundant species are common to all plots (App. Tab. 3).

The Wainstein index as displayed in Fig. 126 shows that the age of the pine trees had a strong influence. The mixed stands of medium age (M-pibe-med1 and M-pibe-med2) had an identity of almost 60 %. The similarity to the pure pine stand of medium age was still 50 %. The mixed stands of old age (M-pibe-old1 and M-pibe-old2) also formed a cluster and had a similarity of 50 %. The pure pine stand of young age (M-pi-yng) on the other side was clearly separated from the older stands.

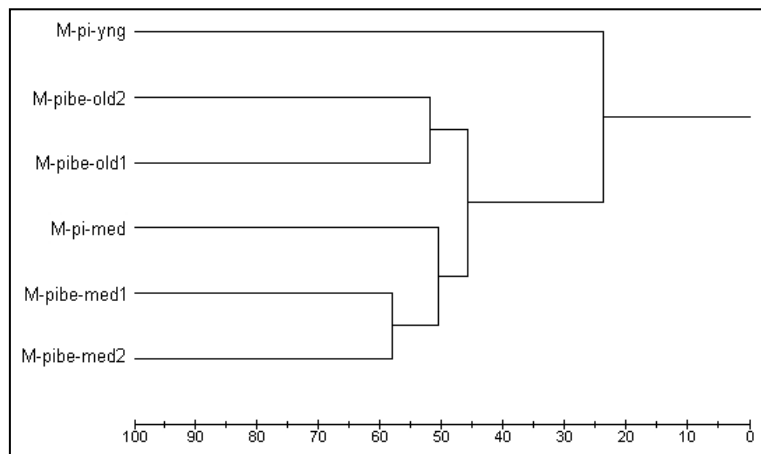


Fig. 126: Cluster diagram for the Wainstein index

4.6.3.2 Discussion

The abundances in these stands were higher than those reported by most other authors for coniferous forests (e.g. DUNGER et al., 2001; HUHTA & KOSKENNIEMI, 1975; WALLWORK, 1983; SYLWESTROWICZ-MALISZEWSKA et al., 1993; SENICZAK et al., 1994, 1998), but unfortunately the age of the investigated stands is often not recorded in the papers. Those authors who mentioned the age of the stands only investigated pure pine stands of young age and medium age. SENICZAK et al. (1994) found in a 20-year-old pure pine stand ca. 150,000 ind./m², while in ca. 80-year-old pine stands between 80,000 Ind./m² (SENICZAK et al., 1994) and 110.000 ind./m² (SENICZAK et al., 1995a) were recorded. SYLWESTROWICZ-MALISZEWSKA et al. (1993) got their material from pure pine stands or mixed stands in which the pine dominated, that were between 90 and 110 years old and found between 65,000 and 120,000 ind./m². Unfortunately data from old stands are not available.

Comparing the mixed stands of medium and old age a striking difference is the time when the beeches were introduced to the pine stands. In the younger stands the beeches were introduced when the pines were about 40 years old. In the stand M-pibe-med1 the beeches are only 8 years old and therefore no significant changes regarding the oribatid community could be found so far compared to the pure pine stands. In the stand M-pibe-med2 on the other side the introduction of the beeches 40 years ago showed first results. The higher quality of the beech litter (C/N ration of beech ca. 40, C/N ratio of pine ca. 50; GISI et al., 1990; SCHEFFER & SCHACHTSCHNABEL, 1982) probably caused the humus form to change back into a moder of a thickness of only 5 cm. In this humus form the fungi play a less important role in the decomposition process than in raw humus (DUNGER, 1983; GISI et al., 1990; SCHEFFER & SCHACHTSCHNABEL, 1982). This can explain the lower abundance of oribatid mites, though also in the samples from this plot the fungivore oribatids such as *Oppiella nova* or the Sucto-

belbidae are the dominant taxa. But these taxa were less abundant here than in the stands with mor as humus form.

In the older stands the beech trees were not introduced to the stands before the pines were 105 years (M-pibe-old1) or even 145 years (M-pibe-old2) old. Therefore the low quality pine litter could accumulate over a period of more than a hundred years and form a thick layer of raw humus. Two scenarios for the further development of the humus are possible. In the first scenario the beech litter is quickly decomposed in these stands leading to an improved humus quality. This could open new ecological niches for the other members of the decomposer fauna who may increase the decomposition rate in these stands. In the other scenario the low quality of the existing humus may prohibit other decomposers than those already present. In this case the beech litter will probably be quickly decomposed while the pine litter can further accumulate without any improvement of the humus form as a whole unless the pines are eliminated from these stands. Which scenario comes true may be depending on the climatic conditions as well as the substrate, but for more specific proposition more data are needed. But under the acid and sandy conditions in the Müritz NP the second scenario seems to be more likely.

The dominance structure in these old stands is typical for a mor. There are many fungivore species, mainly oppiid and suctobelbid mites. Especially *Oppiella nova* benefits from these conditions and appears in huge numbers. But the input of beech litter also increases the opportunities for other species such as *Achipteria coleoptrata* or *Chamobates voigtsi* that seem to prefer litter from deciduous trees (MORITZ, 1963, 1965; LUXTON, 1981; WUNDERLE, 1992; IVAN, 1995; ALBERTI et al., 1996; FABIAN, 1997; MELAMUD, 1998; SKUBALA, 1999b).

In summary the age structure of a stand had significant effects on the oribatid community inhabiting the humus layer. The point of time for the introduction of beeches into a pine stands seems to be very important regarding the development of the humus layer and its inhabiting fauna. The results indicate that an early introduction of beeches to pine stands is favourable.

4.6.4 The influence of the nutrient content of the soil in different forest stands

4.6.4.1 Results

All plot from Eberswalde with the exception of the beech plot have been considered under this aspect (Tab. 1).

Altogether 54,250 oribatid mites were found in the samples, 22,990 in the year 2000 and 31,260 in the year 2001. 22,176 mites in both years combined were juvenile stages and Brachychthoniidae.

The abundances tend to be higher in the pure pine stands than in the mixed stands, though these differences are not statistically significant (Tab. 35). Between the different treatments there is no difference detectable.

	E-pi-med1	E-pi-med2	E-pibe-med1	E-pibe-med2
adults	100,922	98,153	53,061	49,990
juveniles	53,664	58,553	61,087	35,587
total	154,586	156,706	114,148	85,578
deviation	107,251	58,296	74,755	50,025
% juveniles	35	37	54	42
species no.	47	47	46	44
sp. density	15.9	17.8	16.8	14.1
diversity	2.2	2.3	2.5	1.9
evenness	0.4	0.4	0.5	0.4

Tab. 35: Abundance [ind./m²], species numbers and diversity (according to Shannon-Weaver) of the oribatid mites of each plot

61 taxa were found (App. Tab. 4). With regard to species number, species density, diversity and evenness no clear trend can be observed. The mixed plot E-pibe-med2 has the lowest values for species numbers and density as well as for the diversity and evenness, while those values vary only to small degree between the other three plots.

The dominance structure of all four plots shows many similarities (Fig. 111-112, 114 & 116). On all plots the Suctobelbidae are the most abundant taxon with dominances between 26 % and 41 %. *Oppiella nova* is the second most abundant species and dominant in all plots except for plot E-pi-med1 where it comes in third place. Also *Dissorhina ornata* is dominant in all plots except for plot E-pibe-med2 where it is missing among the most abundant species. Remarkable is the high dominance of *Eniochthonius minutissimus* on plot E-pi-med2 and *Quadroppia quadricarinata* on plot E-pi-med1. The dominance structure on plot E-pibe-med2 shows a very uneven distribution with only one eudominant taxon and one dominant species.

The dominance identity according to Renkonen also proves that there are only small differences between the plots (Fig. 127). The highest value with about 75 % was found between the two pine plots. Even the mixed plot E-pibe-med2 with the least accordance to the other plots still has a dominance identity of about 60 % with the other plots.

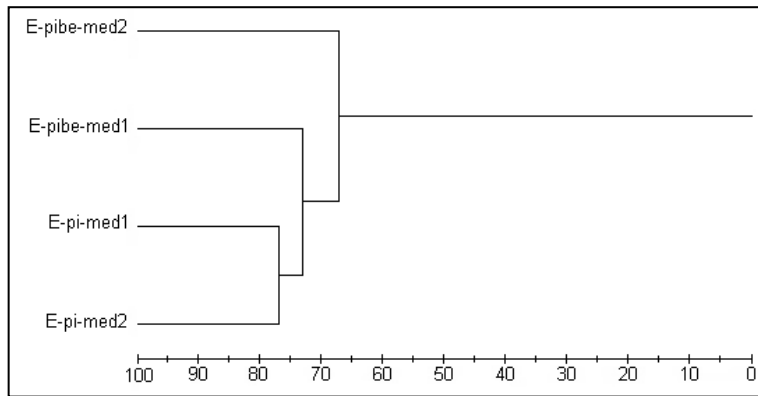


Fig. 127: Cluster diagram for the Renkonen index

4.6.4.2 Discussion

It was suspected that there is a clear distinction between the plots with a medium nutrient content and those with a high nutrient content regarding the oribatid mite community. The idea behind this thought was that the higher nutrient content of the soil should lead to an increased plant growth and therefore to a higher input of litter. Furthermore the higher nutrient content causes a slightly different undergrowth in these plots which leads to litter of a different quality.

However, no changes between the different treatments could be detected in the pure pine stands, neither with regard to abundance, species numbers and diversity nor with regard to the dominance structure. The abundance in the pure pine stands is nearly the same on both plots, only the deviation is significantly higher on the plot with the higher nutrient content. The reason for the high accordance of both plots may be the almost identical undergrowth in both plots; only *Rubus ideaus* was less abundant in the E-pi-med1.

The differences between the different treatments of the mixed stands are more evident. The abundance of the E-pibe-med2 (medium nutrient content) is lower than that of the E-pibe-med1 (high nutrient content), though also here the differences are not significant. In plot E-pibe-med2 the diversity index and the evenness have also been lower. But these differences are probably not caused by the different nutrient content, but the different plant composition and age structure of the stands. In plot E-pibe-med1 the beeches are only 5 years old and there is an undergrowth of grass present. In plot E-pibe-med2 on the other side the beeches are already 30 years old and there was no undergrowth to speak of. In plot E-pibe-med1 the introduction of the beeches happened such a short while ago, that no significant changes of the soil and humus could take place in that time. Therefore the oribatid mite community probably still resembles the state before the introduction of the beeches, while in the mixed stand the oribatid mite community had enough time to adapt to the new conditions (compare with re-

sults in chapters 5.2 and 5.3. On the plot E-pibe-med2 *Chamobates voigtsi* appeared in relatively high numbers and was one of the subdominant species. This species usually occurs only in stands with a relatively high percentage of beeches (MORITZ, 1963, 1965; LUXTON, 1981; SKUBALA, 1999b).

Hence, it is evident that in the study sites the influence of the tree composition and age structure on the oribatid mite community is much higher than the nutrient content of the soil.

5 Concluding discussion

Europe belongs to the vegetation zone of deciduous and mixed forests (ODUM, 1999). Under natural conditions, most parts of the land would be covered by forests. These forests in Central Europe would be dominated by beech (*Fagus sylvatica*) and oak (*Quercus robur* and *Q. petraea*) and would be mixed with maple, elm, linden, ash and aspen. Pines would be found only under dry conditions. Due to abiotic conditions, the northeastern lowlands are an area that could be almost completely covered by forests, with different types of beech forests being the dominant form of natural forest. Today, 1.1 million hectares, 37 % of the state area of Brandenburg, are wooded, which is well above the average in Germany with 30 %, while in Mecklenburg-Vorpommern the wooded area adds up to 504,000 hectares, which are only about 21.7 % of the state area and well below the German average. In both states, however, the forests are dominated by Scots pine (*Pinus sylvestris*). In Brandenburg 82 % (WALDZUSTANDSBERICHT BRANDENBURG 2003) and in Mecklenburg-Vorpommern 50 % (WALDZUSTANDSBERICHT MECKLENBURG-VORPOMMERN 2003) of the wooded area are covered by artificial pine forests.

Beech forests are an important source of the local and regional biodiversity. But they are also important on a global scale, because beech forests are a vegetation form that is more or less limited to Central Europe. According to TISCHLER (1984), the beech forests contribute to the regional biodiversity in Germany by about 20 %. Here, about 4,000 species of plants and about 7,000 species of animals can be found. However, beech forests and artificial pine forests of the same area can harbour equal species numbers (MÜLLER, 1984), though both forest types are usually inhabited by different species.

The investigation of different forest types of different ages proved that the oribatid mites do react to the conversion of the forests from pure pine forests to mixed and pure deciduous forests by a decrease of the abundance and a change of the species composition. One aim was the establishment of species or species groups that can be used as indicators of the success of forest measures. In the case of this project, there are two possible groups of oribatid mites that could be used:

1. Species that are correlated with the stocking and prefer either pure beech stands or stands with a high percentage of beeches as indicators that the fauna in the stands develops toward the desired direction.

2. Species that are correlated with the humus form and prefer moder or mull. The development toward these humus forms is desired because they are connected with a higher soil-biological activity. The higher activity leads to an expedited mineralization (ANDERS et al., 2004) and therefore a quicker availability of nutrients.

One method to find species with a value as indicators is the establishment of isovalent species groups. The isovalent species groups should be established from data in the literature. For this reason, the stocking was considered as an influencing factor; because most papers give only insufficient abiotic data and the humus form is hardly ever mentioned. This however is quite problematic, because most oribatid mites occur in a wide range of forest types and, though many of them show preferences for either deciduous or coniferous forests, generally they can be found frequently in both forest types.

The reason for this is that the stocking is not the dominating factor causing the distribution of many species. As the correlation analysis in chapter 4.5 proved, the distribution of many species is only weakly correlated with the stocking. Often, the humus form, soil water content, pH value, C/N ratio or a combination of several of these factors are more important. Of course, all these factors are interdependent, but they also depend on further factors such as the physical property of the bedrock and the climate.

With regard to the geological and climatic properties, the northeastern lowlands offer some special conditions. Here, base poor, sandy soils with a low capacity to store water are situated in an area with a mild climate and relatively low precipitation. Hence, the soil is quite acidic and dry, unless a well developed organic layer is present that improves the soil capacity to store water.

Special geographical, geological and climatic conditions will cause animals to adapt their behaviour to these conditions. Hence, many species can occupy different ecological niches in different localities (MÜLLER, 1984; TISCHLER, 1984). The autecology of most oribatid species is not at all or only insufficiently known. Most conclusions with regard to the autecology can only be drawn from faunistic investigations and their presence or absence in certain habitats. However, publications often lack important data of the sampling locality as vegetation and/or physical data. This makes it very difficult to determine the precise factor or combination of factors that regulate the distribution of many species.

Another problem is that many oribatid mites found in forests can be found in a huge geographical region. Only 11 species from this investigation are considered to have a distribution limited to Europe, while the majority of species has a Palearctic or Holarctic distribution.

Many of these species can be found from the Northern Europe and Asia southwards to Northern Africa and Central Asia, from the lowlands into the mountainous regions.

Many of these species are indeed regarded as ubiquitous, but others seem to have different demands or at least different preferences under varying geographic and climatic conditions. It is known from insects that many of them perform a biotope change in different areas of their geographic range (MÜLLER, 1984; TISCHLER, 1984). It is conceivable that mites react in similar ways to the different conditions within their range. To ensure that the isovalent groups represent the actual conditions of the northeastern lowlands, data from former investigations in that area were used whenever possible. Therefore, the main references are the papers of MORITZ (1963, 1965) for deciduous and mixed forests, GRAUF (2004) for deciduous and coniferous forests, and investigations from the lowlands in Poland with comparable geographic and climatic conditions (e.g. SYLWESTROWICZ-MALISZEWSKA et al., 1993; SENICZAK et al., 1994, 1995a, 1997b) for coniferous forests. Also the works of STRENZKE (1952), RAJSKI (1961) and WEIGMANN (1991) were considered, while the remaining publications were only considered to a small degree.

According to the data from the literature, only a small number of species has a clear preference for a certain forest type, while the majority of species is rather euryoecious in this respect.

According to the data from the literature, the following species have a strong preference for deciduous forests: *Achipteria coleoptrata*, *Chamobates subglobulus*, *C. voigtsi*, *Euzetes globulus* and *Steganacarus magnus*. *Autogneta longilamellata*, *Berniniella sigma*, and *Rhysotritia ardua* can be regarded as secondary species of deciduous forests, because their preference for this forest type is less distinct. However, *Euzetes globulus* showed a strong preference for the pine forests in this investigation, while for *Berniniella sigma*, *Rhysotritia ardua* and *Steganacarus magnus* were rather euryoecious with respect to the forest type.

Adoristes ovatus, *Camisia spinifer*, *Carabodes ornatus*, *Cepheus cepheiformis*, *Ceratozetes minimus*, *Eupelops torulosus* and *Microtritia minima* can be regarded as primary species of coniferous forests, while *Chamobates cuspidatus*, *Dissorhina ornata*, *Scheloribates latipes*, *S. pallidulus* and *Tectocephus v. sarekensis* can be regarded as secondary species of coniferous forests. All species had indeed a preference for the pine and mixed stands, though *Ceratozetes minimus* was only found frequently in the older mixed stands. Also *Trhypochthonius tectorum* showed a preference for the coniferous stands, but in this case no data were available about preferences for a certain forest type.

The following species are considered to be euryoecious with regard to the forest type: *Acrogalumna longipluma*, *Carabodes areolatus*, *Cultroribula bicultrata*, *Eniochthonius minutissimus*, *Eupelops hirtus*, *Galumna lanceata*, *Hypochthonius rufulus*, *Microppia minus*, *Nanhermannia nana*, *Nothrus silvestris*, *Oppiella nova*, *O. subpectinata*, *Oribatula tibialis*, *Platynothrus peltifer*, *Quadroppia quadricarinata*, *Rhysotritia duplicata*, *Schelorbitates initialis*, *Steganacarus striculus* and *Tectocephus v. velatus*. Also in this investigation, these species were euryoecious. Furthermore, *Phthiracarus* div. spp., the Damaeoidea and the Suctobelbidae were found in all plots. Of the remaining species, too few specimens were found to give clear indication of their preferences. Therefore, they were not considered for this part of the analysis.

In Tab. 36, the species mentioned above were sorted according to their preferences. The data from this investigation formed the base for this table. In general, the data from literature are confirmed with a few exceptions that are highlighted in grey.

The generation of isovalent species groups according to KNÜLLE (1957) and WEIGMANN (1997) with regard to the forest type is difficult for the reasons mentioned above. However, many species do have a preference for a certain forest type (Tab. 36, Fig. 128). In terms of the main question of the project, those species that have a strong preference for deciduous forests can be used as indicators to measure the success of the forests conversion.

The abundance of all four species from this investigation that have a preference for beech forests are not only strongly correlated with the stocking, but also with other factors such as the humus form, the soil water content, the pH value and the C/N ration. This indicates that these species depend on the particular conditions found in deciduous forests. However, *Achipteria coleoptrata* and *Chamobates voigtsi* are obviously more tolerant towards less favourable conditions and appear in early stages of the forest conversion. *Autogneta longilamellata* and especially *Chamobates subglobulus* seem to occupy narrower niches and are mainly found in the pure beech forests. It is striking that both species are completely missing from the older mixed stands, whereas at least solitary specimens were found in the medium mixed plots. These species are also more abundant in the older, nature-like, unmanaged beech forest in the Müritz NP than in the managed forest in Eberswalde.

Tab. 36 (next page): Common species sorted according to their preferences for a certain forest type: I) beech; II) older mixed stands; III) pine; IV) euryoecious species; D: dominance (+: dominance < 0.5 %), F: frequency categories according to SCHWERDTFEGER (1: very rare; 2: rare; 3: common; 4: frequent; 5: very frequent); highlighted in grey: preference differing from data in literature

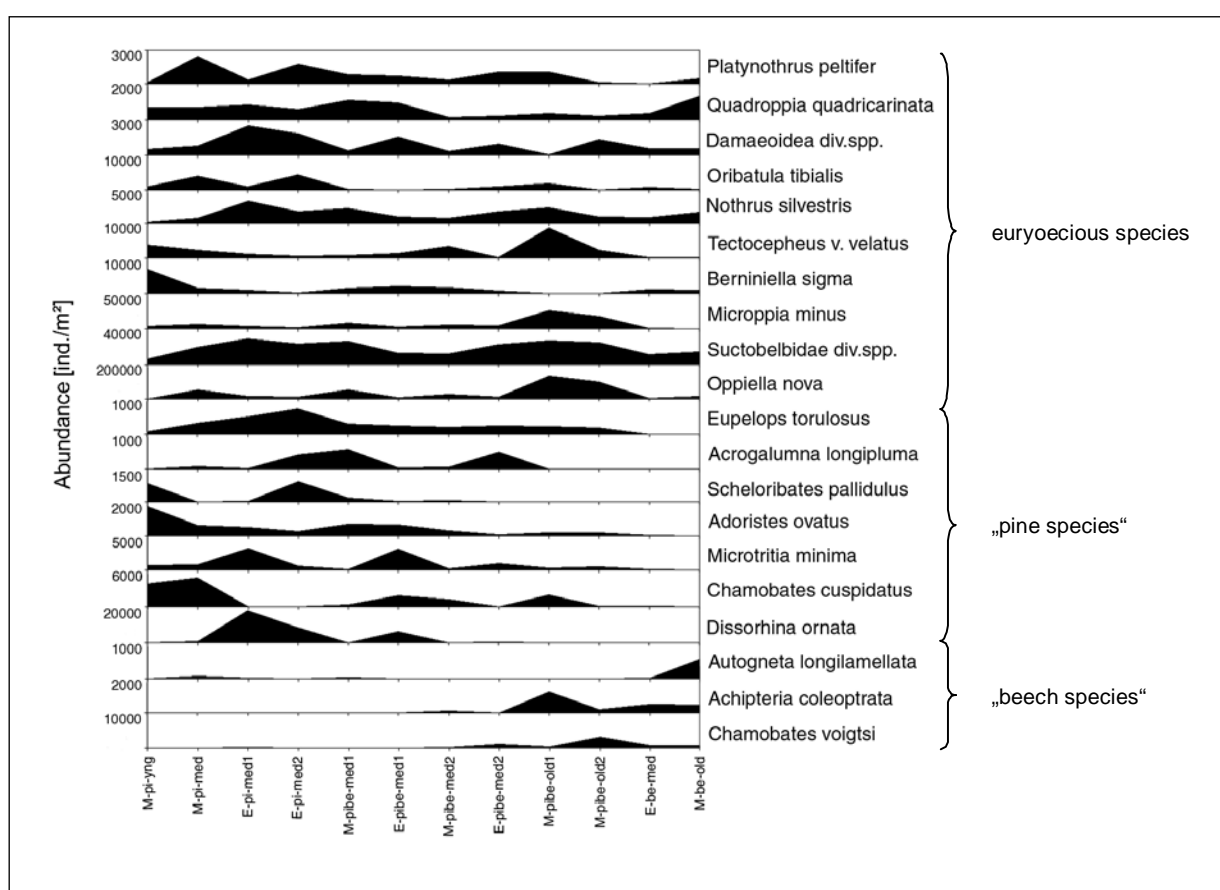


Fig. 128: Distribution of selected species between the plots

Also the results from the CCA (Fig. 129) show, that all measured factors have a big influence on the distribution. In the Müritz NP the age of the stands seemed to be the most important factor, though soil water content, stocking and C/N value were also important. The pH value had the smallest influence on the distribution. That means that species that were rather associated with old stands with many beeches point towards the left, while species that prefer younger stands with a high percentage of pines point toward the right. Here, in the Müritz NP, the species with a preference for beech stands (*Autogneta longilamellata*, *Achipteria coleoptrata* and *Chamobates voigtsi*) are rather found on the right side, while the majority of the remaining species points more toward the right side. However, in the Müritz NP, the “beech species” are not as clearly separated from the remaining species as in Eberswalde.

In Eberswalde, the distribution of the species was obviously influenced by different factors. In this diagram, species with a preference for a high nutrient content are found on the right; species with a preference for a medium content are found on the left; the “beech species” point toward the top, while the euryoecious species and the “pine species” point more toward the bottom. In this case, both “beech species” are clearly separated from the remaining species.

Furthermore, the CCA shows that the nutrient content does indeed have an influence on the distribution of the species with regard to their abundances, even though this does not significantly affect the dominance structure as shown in chapter 4.6.4.

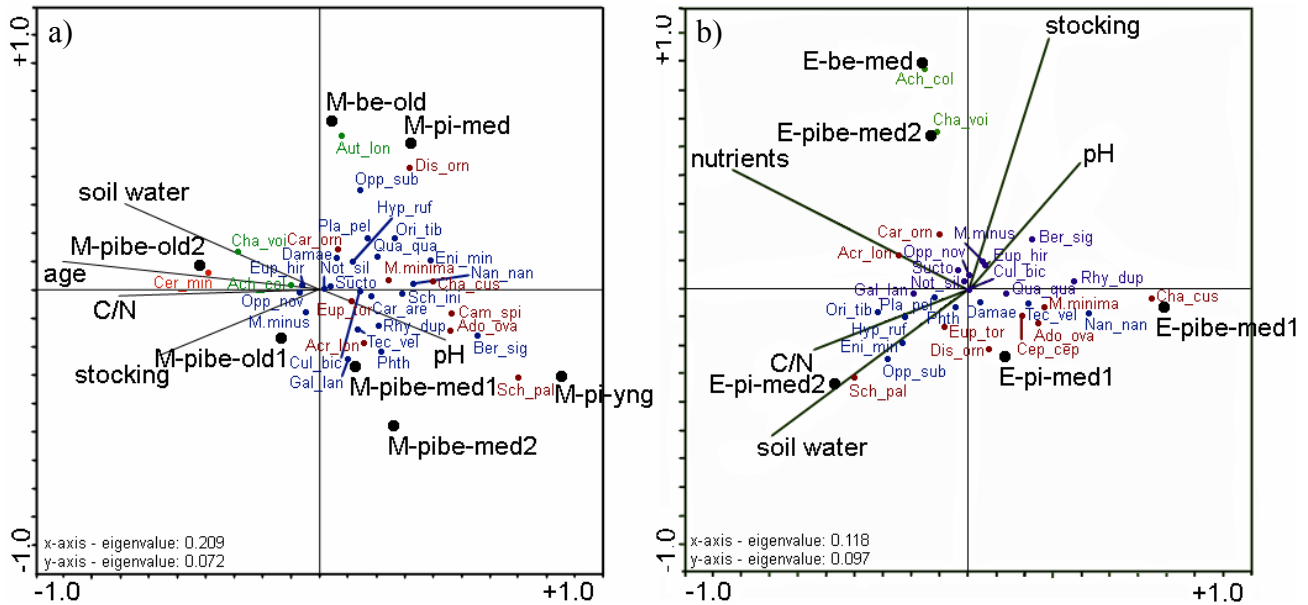


Fig. 129: Biplot diagram of the CCA, a) MNP, b) Eberswalde; Date used from 2001, green – “beech species”, red – species of the old mixed plots, brown – “pine species”, blue - euryoecious species, abbreviations of species names in App. Tab. 5

This investigation showed that despite some general trends such as the decreasing abundance from coniferous forests towards deciduous forests the reactions to the forest conversion are much differentiated, especially on the species level. Each species reacts to a different set of factors or is at least correlated to different factors. The evaluation, which factor or combination of factors eventually influences the distribution of each species, is still problematic without further knowledge on their autecology. Here, further experiments in the laboratories and the fields are needed.

In the course of this investigation, it was attempted to identify factors that influence the small scale distribution by taking a large number of samples in a selected area in a defined pattern. In this case, a raster with a grid size of 1 m was used. This method proved to be successful though the grid size was too large for a precise analysis. Considering that the plots were very heterogeneous, a smaller grid size would have been desirable.

In conclusion, it should be pointed out, that some general developments of the oribatid mite community were recorded. The abundance of oribatid mites increases as the percentage of pines in a stand increases. Furthermore, old mixed stands show much higher abundances of

oribatid mites than medium aged mixed stands. In fact, here the highest abundances of all were recorded. The increasing abundance can in most cases be attributed to the increasing abundance of small fungivore oppiid and suctobelbid mites, while the abundance of the remaining species varies less intensely.

The investigation of the ecological behaviour of the species - with respect to stocking, humus form and abiotic factors that each species reacts to – shows that it changes in its own way and is correlated to distinct factors or combination of factors. But so far, the knowledge of the autecology of most species is too scarce to draw definite conclusions with regard to the important factors. But the correlation analysis as presented in chapter 4.5 can give some important hints about these factors. In order to prove or disprove relations and dependencies of the mites to certain factors, experiments under controlled condition could be carried out as a next step.

Nevertheless, a group of four species could be established, that can be used as indicators for the success of the forest conversion towards more nature-like deciduous forests: *Achipteria coleoptrata*, *Autogneta longilamellata*, *Chamobates subglobulus* and *C. voigtsi*.

6 Summary

Under natural conditions, most parts of northeastern Germany would be covered by forests that would be dominated by beech (*Fagus sylvatica*) and oak (*Quercus robur* and *Q. petraea*). However, today most of the wooded area is covered by artificial monocultures of pine forests. This form of cultivation was recognised to be the cause of instability against calamities of pests as well as severe storms therefore in the early eighties of the last century this knowledge was used to start the conversion of the forests towards more nature-like stands. The ecological effects of the forest conversion on the soil, the fauna and the flora have been investigated in a nation-wide project supported by the Federal Ministry of Education and Research (Bundesministerium für Bildung und Forschung - BMBF) in the project “Future-oriented forest management”.

The present work has been accomplished within the scope of this project and is concerned about the effects that different aspects of forest conversion have on oribatid mites. The present work shall serve to answer a number of questions about the distribution of oribatid mites and their reaction to environmental changes.

The investigation was carried out on 12 plots in two sampling areas. 7 plots were chosen in the Müritz NP and 5 in Eberswalde. In both areas plots were chosen that resemble the different stages of forest conversion: one medium aged pine plot in each area, two medium aged mixed plots with pines and beeches in the Müritz NP and one mixed plot in Eberswalde as well as one beech plot in each area. Furthermore, in the Müritz NP the chance arose to investigate the effects of different age stages of the stands on the oribatid mites. Therefore, an additional young pine plot and two old mixed plots have been sampled. In Eberswalde, on the other hand, another emphasis was laid on the effects of a different nutrient content in the soil. Here, an additional pine plot and mixed plot, respectively, of a higher trophotic level was sampled. In Eberswalde, an additional sampling was done in three plots (a beech plot, a mixed plot and a pine plot) to investigate the horizontal distribution of the oribatid mites in these habitats. The data were used along with others to ecologically characterise the different species. The sampling took place from 2000 to 2002.

Within the scope of the doctoral thesis, 392 samples were analysed. 122 samples from one year from the Müritz NP and 270 samples from three years from Eberswalde were analysed. Altogether 155,450 oribatid mites from 82 taxa were found in these samples.

The ecological characterisation of the species revealed that the various species react quite differently to the investigated factors. Most species occur with different abundances in different forest types, but their abundance often varies also in comparable stands of both sampling areas. This indicates that they react to climatic effects as well as to biotic and abiotic factors.

The forest conversion from pine forests to beech forests causes the abundance of oribatid mites to decrease, probably due to the change of the humus form from mor or mor-like moder in pine forests to mull in beech forests, that is accompanied by a decrease of the abundance of fungi, the main food source for most oribatid mites. Furthermore, the species composition changed. Species like *Camisia spinifer*, *Adoristes ovatus* or *Acrogalumna longipluma* that are typical for pine forests disappeared, while other species like *Achipteria coleoptrata* or *Chamobates voigtsi* immigrated in mixed stands after the introduction of beeches.

The age of the stands proved to be another important factor. The overall abundance of oribatid mites was higher in the older stands than in the younger stands, while the percentage of juvenile oribatids decreased towards the older stands. Furthermore, the dominance structure became more uneven and shifted toward a higher percentage of fungivorous oppiid and suctobelbid mites. Especially on the old mixed plots, *Oppiella nova* reaches a dominance value of about 60 %.

The nutrient content of the soil seems to be a relatively unimportant factor on the community level as no significant differences with regard to overall abundance and the dominance structure could be recorded. However, the Canonical Correspondence Analysis showed that the nutrient content of the soil does influence the distribution of species, at least with regard to their individual abundance.

In summary, it can be said that the distribution of the oribatid species is influenced by many factors, and the stocking is only one of these factors. Nevertheless, a group of four species could be established, that can be used as indicators for the success of the forest conversion towards more nature-like deciduous forests: *Achipteria coleoptrata*, *Autogneta longilamelata*, *Chamobates subglobulus* and *C. voigtsi*.

Zusammenfassung

Unter natürlichen Bedingungen wäre der größte Teil des nordostdeutschen Tieflandes mit Buchen- und Eichenmischwäldern (*Fagus sylvatica*, *Quercus robur*, *Q. petraea*) bedeckt. Heute jedoch besteht ein Großteil des Waldes aus künstlichen Kiefern-Monokulturen. Diese Form der Bewirtschaftung wurde bald als Ursache der Instabilität dieser Bestände gegenüber Ungezieferkalamitäten und schweren Stürmen erkannt und so begann man in den achtziger Jahren des letzten Jahrhunderts, die Kiefern-Monokulturen in naturnähere Misch- und später Laubwaldbestände umzuwandeln. Im Rahmen des vom Bundesministerium für Bildung und Forschung (BMBF) geförderten Projektes „Zukunftsorientierte Waldwirtschaft“ wurden die ökologischen Auswirkungen des Waldumbaus auf den Boden sowie die Fauna und Flora untersucht.

Die vorliegende Arbeit wurde im Rahmen dieses Projektes durchgeführt und beschäftigt sich mit der Wirkung verschiedener Aspekte des Waldumbaus auf die Oribatiden (Hornmilben). Diese Arbeit soll helfen verschiedene Fragen in Bezug auf die Verbreitung der Oribatiden und deren Reaktion auf Umweltveränderungen zu klären.

Die Untersuchung wurde auf 12 Flächen in zwei Untersuchungsgebieten durchgeführt. Sieben Flächen wurden im Müritz NP beprobt und fünf weitere in einem Wald bei Eberswalde. In beiden Gebieten wurden Flächen ausgesucht, die die verschiedene Umbaustadien widerspiegeln: jeweils eine Kiefernfläche mittleren Alters, zwei Mischflächen mittleren Alters im Müritz NP sowie eine solche Fläche in Eberswalde und jeweils eine Buchenfläche. Des Weiteren ergab sich im Müritz NP die Gelegenheit, den Einfluss unterschiedlicher Alterstadien der verschiedenen Bestände auf die Oribatidengemeinschaft zu untersuchen. Zu diesem Zweck, wurden hier zusätzlich eine junge Kiefernfläche und zwei alte Mischbestände untersucht. Im Gegensatz dazu, wurde in Eberswalde ein zweiter Schwerpunkt auf die Effekte unterschiedlicher Nährkraftstufen des Bodens gelegt. Entsprechend wurden hier eine weitere Kiefernfläche und eine weitere Mischfläche auf Böden mit einer höheren Nährkraftstufe ausgewählt. Zusätzlich wurde in Eberswalde die horizontale Verteilung der Oribatiden in drei Beständen (in einem Buchenwald, einem Mischwald und einem Kiefernwald) untersucht. Diese Daten wurden zusammen mit anderen zur ökologischen Charakterisierung der Arten genutzt. Die Probennahme fand in den Jahren 2000 bis 2002 statt.

Im Rahmen der Doktorarbeit wurden 392 Proben analysiert. 122 Proben stammten aus dem Müritz NP und weitere 270 Proben aus Eberswalde. Insgesamt wurden 155.450 Oribatiden aus 82 Taxa in den Proben gefunden.

Die ökologische Untersuchung der Arten ergab, dass die einzelnen Arten sehr differenziert auf die unterschiedlichen Umweltfaktoren reagieren. Die meisten Arten waren nicht nur unterschiedlich häufig in den verschiedenen Waldtypen vertreten, sondern zeigten auch unterschiedliche Abundanzen in vergleichbaren Beständen der beiden Untersuchungsgebiete. Die Ergebnisse deuten darauf hin, dass diese Tiere nicht nur auf biotische und abiotische Faktoren im Boden sondern auch auf klimatische Effekte reagieren.

Der Waldumbau von reinen Kiefernbeständen hin zu Buchenbeständen führt zu einer Abnahme der Individuenzahl der Oribatiden, die vermutlich auf eine Veränderung der Humusform von Rohhumus bzw. rohhumusartigem Moder in Kiefernwäldern hin zu Mull in Buchenwäldern zurückgeht. Diese Veränderung geht einher mit der Abnahme der Pilzbestände im Boden, die die Hauptnahrung der meisten Oribatiden darstellen. Außerdem ändert sich die Artzusammensetzung der Oribatidengemeinschaft im Lauf dieser Entwicklung. Typische Kiefernwaldarten wie *Camisia spinifer*, *Adoristes ovatus* oder *Acrogalumna longipluma* verschwinden, während typische Laubwaldarten wie *Achipteria coleoprata* und *Chamobates voigtsi* langsam in die Mischbestände einwandern.

Ein weiterer wichtiger Faktor ist das Bestandsalter. Auf den untersuchten Flächen war die Gesamtabundanz der Oribatiden in älteren Beständen höher als in den jüngeren Beständen. Außerdem wurde die Dominanzstruktur mit zunehmendem Alter unausgeglichener zugunsten der fungivoren Oppiiden und Suctobelbiden. Besonders in den alten Mischbeständen erreicht *Oppiella nova* Dominanzwerte von ungefähr 60 %.

Die Nährkraftstufe des Bodens hingegen scheint nur wenig Einfluss auf die Zusammensetzung der Oribatidengemeinschaft zu haben. Es konnten weder in Bezug auf die Gesamtabundanz noch in Bezug auf die Artzusammensetzung signifikante Unterschiede zwischen Böden der verschiedenen Nährkraftstufen festgestellt werden. Allerdings zeigt die Canonische Korrespondenzanalyse, dass die Nährkraftstufen durchaus einen Einfluss auf die Abundanz einzelne Arten haben können.

Zusammenfassend lässt sich sagen, dass die Verteilung der Oribatiden durch eine Vielzahl von Faktoren beeinflusst wird. Trotzdem konnte eine Gruppe von vier Oribatidenarten etabliert werden, die typisch für Laubwald- und insbesondere Buchenbestände ist, und somit als Indikator für den Erfolg des Waldumbaus hin zu naturnäheren Beständen genutzt werden kann: *Achipteria coleoprata*, *Autogneta longilamellata*, *Chamobates subglobulus* und *C. voigtsi*.

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8 Appendix

	plot	E-be-med	E-pibe-med2	E-pi-med2	M-be-old	M-pibe-med2	M-pibe-med1	M-pi-med							
preference for beech	<i>Achipteria coleoprata</i> *	720	85	17	3	449	78	104	22	17	6				
	<i>Chamobates voigtsi</i> *	1357	79	2224	52	19	6	794	83	104	22	55	18	17	6
	<i>Autogneta longilamellata</i> *	35	6	9	3	587	61	37	6	69	11				
	<i>Chamobates subglobulus</i> *	328	61	17	6										
	<i>Carabodes femoralis</i>	35	11												
	<i>Mesoplophora pulchra</i>	17	6												
	<i>Ophidiotrichus tectus</i>	17	6												
	<i>Punctoribates punctum</i>	17	6												
	<i>Oribatella calcarata</i>	9	3												
	<i>Quadropia monstruosa</i>	17	6	52	6										
preference for mixed stands	<i>Steganacarus striculus</i>	17	6	345	33										
	<i>Cultroribula bicultrata</i>	54	9	212	33	218	30	155	22	35	6	1701	76	691	56
	<i>Carabodes ornatus</i>	17	6	123	27	35	9	17	6	91	12	259	22		
	<i>Acrogalumna longipluma</i>	9	3	254	36	52	11	585	76	86	22				
	<i>Carabodes areolatus</i>	52	11	225	33	494	53	363	39						
	<i>Cepheus dentatus</i>	28	6												
	<i>Galumna elimata</i>	9	3												
	<i>Pilogalumna tenuiclava</i>	21	6												
	<i>Oribatella quadricornuta</i>	9	3												
	<i>Zygoribatula cognata</i>	9	3												
	<i>Trhypochthonius tectorum</i>	9	3	59	15	86	11								
	<i>Tectocephus velatus sarekensis</i>	9	3	37	12	155	11								
	<i>Oppiella splendens</i>	69	6												
	<i>Nothrus palustris</i>	17	6												
	preference for pine	<i>Dissorhina ornata</i>	371	42	10968	100	69	11	691	50					
<i>Oribatula tibialis</i>		760	64	1459	88	7852	88	104	22	190	33	274	24	4110	100
<i>Eniochthonius minutissimus</i>		471	55	1062	70	10593	73	207	33	86	22	219	18	950	67
<i>Microppia minus</i>		371	30	3065	82	2542	82	449	56	5440	78	9051	88	6459	94
<i>Platynothis peltifer</i>		912	76	677	70	484	56	328	22	841	47	2435	83		
<i>Tectocephus velatus velatus</i>		352	30	378	58	629	64	138	22	3437	89	805	59	2400	72
<i>Microtritia minima</i>		111	24	437	48	528	58	17	6	225	17	91	12	812	67
<i>Rhysotritia duplicata</i>		259	45	449	55	380	52	225	39	863	61	1865	65	725	67
<i>Phthiracarus div.spp.</i>		9	3	59	18	190	42	17	6	967	89	859	88	380	56
<i>Eupelops hirtus</i>		19	6	128	24	269	27	35	11	52	17	18	6	35	11
<i>Carabodes coriaceus</i>		17	6	17	6	155	6								
<i>Galumna lanceata</i>		231	39	389	64	2387	79	17	6	121	28	238	29		
<i>Scheloribates pallidulus</i>		10	3	2136	76	69	6	183	29						
<i>Cepheus cepheiformis</i>		9	3	47	15	231	36	17	6						
<i>Cepheus latus</i>		21	6												
<i>Ceratoppia spec.</i>		17	6	91	18	35	6								
<i>Diapterobates humeralis</i>		9	3	52	11										
<i>Euzetes globulosus</i>		9	3	17	6	69	17								
<i>Camisia biurus</i>		10	3	18	6	17	6								
<i>Micrereemus brevipes</i>		21	6	9	3	17	6								
<i>Chamobates cuspidatus</i>		124	6	31	6	52	11	1330	83	311	65	5146	94		
<i>Calaremaeus monilipes</i>		17	6												
<i>Adoristes ovatus</i> *		36	6	136	27	478	45	17	6	328	50	713	59	639	61
<i>Eupelops torulosus</i> *		9	3	199	36	1166	82	207	39	311	59	328	44		
<i>Scheloribates initialis</i> *		17	3	10	3	9	3	138	33	812	78	786	82	2141	89
ubiquitous species	<i>Oppiella nova</i>	5927	97	13665	100	15156	100	15163	100	28287	100	52808	100	56229	100
	<i>Suctobelbidae div.spp.</i>	12232	97	20205	100	31379	100	15784	100	13142	100	28306	100	21397	100
	<i>Nothrus silvestris</i>	625	76	957	79	2067	97	1623	94	743	33	2267	100	743	83
	<i>Damaeioidea div.spp.</i>	907	82	1245	91	3385	91	604	72	328	72	421	53	812	67
	<i>Berniniella sigma</i>	1787	76	1098	70	478	55	1002	56	1813	67	1591	71	1485	56
	<i>Quadropia quadricarinata</i>	623	61	373	55	1197	79	1399	72	155	44	1152	71	743	56
	<i>Hypochthonius rufulus</i>	275	30	29	9	651	55	86	22	17	6	165	24	121	22
	<i>Oppiella subpectinata</i>	10	3	69	9	1521	45	2625	78	414	17	293	18	14834	100
	<i>Nanhermannia nana</i>	36	12	26	3	357	15	35	11	155	22	1664	71	1641	83
	<i>Carabodes labyrinthicus</i>	19	6	17	6	17	6	52	17	86	17	91	29	52	17
	<i>Camisia spinifer</i>	10	3	35	12	36	9	17	6	37	12	69	22		
	<i>Steganacarus magnus</i>	19	6	9	3	86	17	69	11	73	18	69	22		
	no obvious preference	<i>Carabodes subarcticus</i>	9	3	9	3	35	6							
<i>Ceratozetes minimus</i>		10	3	9	3	35	6								
<i>Euphthiracarus cribrarius</i>		9	3	35	6	17	6								
<i>Rhysotritia ardua</i>		35	6	276	33										
<i>Scheloribates latipes</i>		207	9	17	6										
<i>Steganacarus spinosus</i>	9	3	17	6	17	6									

Tab 1: Mean abundance [ind./m²] and frequency of each species for each plot for the treatment “forest conversion” sorted according to their presumed habitat preference; white background: abundance, grey background: frequency; bold: * strong preference

Species	Feeding preference	reference
<i>Achipteria coleoprata</i>	panphytophagous	Noordam & Vlieger, 1943; Riha, 1951; Schuster, 1956
<i>Acrogalumna longipluma</i>	panphytophagous	Sengbusch, 1954
<i>Adoristes ovatus</i>	panphytophagous	Forsslund, 1939; Schuster, 1956; Luxton, 1972, Pande & Berthet, 1973
<i>Camisia spinifer</i>	panphytophagous	Schuster, 1956; Hartenstein, 1962a
<i>Carabodes areolatus</i>	panphytophagous	Schuster, 1956, Borcard, 1992b
<i>Carabodes coriaceus</i>	macrophytophagous	Noordam & Vlieger, 1943
<i>Carabodes femoralis</i>	microphytophagous	Riha, 1951
<i>Carabodes labyrinthicus</i>	macrophytophagous	Borcard, 1992b
<i>Cepheus cepheiformis</i>	macrophytophagous	Borcard, 1992a
<i>Cepheus latus</i>	macrophytophagous	Wallwork, 1958; Borcard, 1992a
<i>Ceratoppia spec.</i>	panphytophagous	Schuster, 1956; Luxton, 1972; Kaneko, 1988
<i>Chamobates cuspidatus</i>	panphytophagous	Luxton, 1972
<i>Cultroribula bicultrata</i>	microphytophagous	Behan & Hill, 1978; Kaneko, 1988
<i>Eniochthonius minutissimus</i>	microphytophagous	Wallwork, 1967; Pande & Berthet, 1973
<i>Eupelops hirtus</i>	microphytophagous	Schuster, 1956
<i>Eupelops torulosus</i>	microphytophagous	Schuster, 1956
<i>Euphthiracarus cribrarius</i>	macrophytophagous	Schuster, 1956
<i>Enphthiracarus monodactylus</i>	macrophytophagous	Schuster, 1956
<i>Schelorbates initialis</i>	panphytophagous	Forsslund, 1939; Luxton, 1972; Borcard, 1994
<i>Galumna elimata</i>	microphytophagous	Hartenstein, 1962a
<i>Hypochthonius rufulus</i>	microphytophagous	Hartenstein, 1962a; Farahat, 1966; Luxton, 1972, Pande & Berthet, 1973
<i>Mesoplophora pulchra</i>	macrophytophagous	Wallwork, 1958
<i>Micreremus brevipes</i>	microphytophagous	Borcard, 1994
<i>Microtritia minima</i>	macrophytophagous	Pande & Berthet, 1973; Kaneko, 1988
<i>Nanhermannia nana</i>	panphytophagous	e.g. Schuster, 1956; Hartenstein, 1962a; Pande & Berthet, 1973
<i>Nothrus palustris</i>	panphytophagous	Schuster, 1956; Luxton, 1972
<i>Nothrus silvestris</i>	panphytophagous	Sengbusch, 1954; Schuster, 1956; Pande & Berthet, 1973
<i>Oppiella nova</i>	microphytophagous	Hartenstein, 1962a; Luxton, 1972
<i>Micropoppia minus</i>	microphytophagous	Luxton, 1972
<i>Dissorhina ornata</i>	microphytophagous	Luxton, 1972
<i>Berniniella sigma</i>	microphytophagous	Luxton, 1972
<i>Oppiella splendens</i>	microphytophagous	Luxton, 1972
<i>Oppiella subpectinata</i>	microphytophagous	Schuster, 1956; Luxton, 1972
<i>Oribatella quadricornuta</i>	microphytophagous	Behan-Pelletier & Hill, 1983
<i>Oribatula tibialis</i>	panphytophagous	Schuster, 1956; Luxton, 1972; Borcard, 1994
<i>Phthiracarus div. spp.</i>	macrophytophagous	e.g. Jacot, 1939; Schuster, 1956; Wallwork, 1958; Hayes, 1963; Pande & Berthet, 1973
<i>Platynothis peltifer</i>	panphytophagous	Schuster, 1956; Hartenstein, 1962a; Pande & Berthet, 1973
<i>Quadroppia monstrosa</i>	microphytophagous	Luxton, 1972
<i>Quadroppia quadricarinata</i>	microphytophagous	Luxton, 1972
<i>Rhysotritia ardua</i>	macrophytophagous	Schuster, 1956; Hartenstein, 1962a
<i>Rhysotritia duplicata</i>	macrophytophagous	Pande & Berthet, 1973
<i>Schelorbates pallidulus</i>	microphytophagous	Hartenstein, 1962a
<i>Steganacarus magnus</i>	macrophytophagous	Luxton, 1972
<i>Steganacarus spinosus</i>	macrophytophagous	Luxton, 1972
<i>Steganacarus striculus</i>	macrophytophagous	Luxton, 1972
<i>Suctobelbidae div. spp.</i>	microphytophagous	Luxton, 1972
<i>Tectocephus velatus velatus</i>	microphytophagous	Riha, 1951; Kühnelt, 1961; Behan & Hill, 1978

Tab 2: Feeding preference of the oribatid mites

species	M-pi-yng		M-pi-med		M-pibe-med1		M-pibe-med2		M-pibe-old1		M-pibe-old2	
<i>Achipteria coleoptrata</i>			17	6			104	22	1261	50	190	41
<i>Acrogalumna longipluma</i>			86	22	553	76	52	11				
<i>Adoristes ovatus</i>	1520	88	639	61	674	59	328	50	207	44	173	35
<i>Autogneta longilamellata</i>			69	11	35	6						
<i>Berniniella sigma</i>	5975	94	1485	56	1502	71	1813	67	35	11	17	6
<i>Caleremaeus monilipes</i>			17									
<i>Camisia biurus</i>			17	6	17	6			35	11		
<i>Camisia spinifer</i>	121	31	69	22	35	12	17	6	17	6	17	6
<i>Carabodes areolatus</i>	17	6	363	39	466	53	225	33	35	11	52	18
<i>Carabodes coriaceus</i>	17	6	155	6					17		6	
<i>Carabodes femoralis</i>	35	6										
<i>Carabodes labyrinthicus</i>	17	6	52	17	86	29	121	22	17	6		
<i>Carabodes ornatus</i>	17	6	259	22	86	12	35	11	69	11	155	29
<i>Carabodes subarcticus</i>			35	6								
<i>Cepheus cepheiformis</i>	86	19					17	6	17	6		
<i>Cepheus dentatus</i>	52	6										
<i>Ceratoppia spec.</i>			35	6	86	18						
<i>Ceratozetes minimus</i>							35	6	1951	28	15974	100
<i>Chamobates cuspidatus</i>	3523	100	5146	94	294	65	1330	83	2090	78	86	24
<i>Chamobates subglobulus</i>							17	6				
<i>Chamobates voigtsi</i>	17	6	17	6	52	18	104	22	397	22	3039	100
<i>Cultroribula bicultrata</i>			691	56	1606	76	35	6	35	11	104	24
<i>Damaeoides div.spp.</i>	449	63	812	67	397	53	328	72	86	22	1243	65
<i>Diapterobates humeralis</i>	17	6	52	11								
<i>Dissorhina ornata</i>			691	50			69	11				
<i>Eniochthonius minutissimus</i>	674	75	950	67	207	18	86	22	173	33	69	18
<i>Eupelops hirtus</i>			35	11	17	6	52	17	69	22	86	18
<i>Eupelops torulosus</i>	69	19	328	44	294	59	207	39	225	44	190	47
<i>Euphthiracarus cribrarius</i>	17	6	17	6			35	6				
<i>Euzetes globulus</i>			69	17								
<i>Galumna lanceata</i>	52	13			225	29	121	28	294	56		
<i>Heminothrus longisetus</i>									35	6		
<i>Hypochthonius rufulus</i>			121	22	155	24	17	6	86	11		
<i>Liacarus coracinus</i>											35	12
<i>Licneremaeus lincophorus</i>									17	6		
<i>Micreremus brevipes</i>	17	6	17	6					52	17		
<i>Micropopia minus</i>	3281	88	6459	94	8548	88	5440	78	27389	100	17615	100
<i>Microtritia minima</i>	570	69	812	67	86	12	225	17	294	39	484	59
<i>Nanhermannia nana</i>	708	81	1641	83	1572	71	155	22	69	17	17	6
<i>Nothrus palustris</i>							17	6				
<i>Nothrus silvestris</i>	138	31	743	83	2141	100	743	33	2314	94	933	76
<i>Oppiella nova</i>	1226	88	56229	100	49874	100	28339	100	137914	100	95603	100
<i>Oppiella splendens</i>							69	6				
<i>Oppiella subpectinata</i>	17	6	14834	100	276	18	414	17	3627	100	2331	71
<i>Oribatula tibialis</i>	915	94	4110	100	529	24	190	33	1882	89	86	18
<i>Phthiracarus div.spp.</i>	52	19	380	56	812	88	967	89	69	17		
<i>Platynothrus peltifer</i>	86	25	2435	83	794	47	328	22	1071	67	86	24
<i>Quadroppia monstrosa</i>	35	13					52	6	17	6		
<i>Quadroppia quadricarinata</i>	622	69	743	56	1088	71	155	44	380	17	207	35
<i>Rhysotritia ardua</i>			276	33					17	6		
<i>Rhysotritia duplicata</i>	449	69	725	67	1761	65	863	61	397	56	190	35
<i>Schelorbates initialis</i>	1226	100	1831	89	743	82	812	78	622	83	656	71
<i>Schelorbates pallidulus</i>	777	75			173	29	69	6				
<i>Steganacarus magnus</i>			86	22	121	18	69	11	17	6		
<i>Steganacarus spinosus</i>			17	6			17	6	17	6		
<i>Steganacarus striculus</i>	86	19					345	33				
<i>Suctobelbidae div.spp.</i>	5872	100	21397	100	26733	100	13142	100	28546	100	24972	100
<i>Tectocephus v. sarekensis</i>	432	50	155	11	35	12			52	6		
<i>Tectocephus v. velatus</i>	2746	94	2400	72	760	59	3437	89	9032	100	2193	76
<i>Trhypochthonius tectorum</i>			86	11					155	28		
<i>Trichoribates novus</i>									17	6		

Tab. 3: Mean abundance (white background) [ind./m²] and frequency (grey background) for each species and each plot for the treatment “age”

species	E-pi-med1		E-pi-med2		E-pibe-med1		E-pibe-med2	
<i>Achipteria coleoprata</i>	9	3					19	3
<i>Acrogalumna longipluma</i>	19	3	264	36	38	3	9	3
<i>Adoristes ovatus</i>	518	67	462	45	650	58	132	27
<i>Autogneta longilamellata</i>	19	6					9	3
<i>Berniniella sigma</i>	895	48	471	55	2101	79	1102	70
<i>Camisia biurus</i>			9	3	9	3		
<i>Camisia spinifer</i>			38	9	9	3	38	12
<i>Carabodes areolatus</i>	28	6			28	6		
<i>Carabodes coriaceus</i>	66	15	19	6	38	12		
<i>Carabodes femoralis</i>			9	3				
<i>Carabodes labyrinthicus</i>			9	3	57	12	19	6
<i>Carabodes ornatus</i>	28	9	38	9	57	18	122	27
<i>Carabodes subarcticus</i>			9	3	9	3		
<i>Cepheus cepheiformis</i>	75	21	235	36	235	30	47	15
<i>Cepheus dentatus</i>							28	6
<i>Cepheus latus</i>	19	3	19	6	47	9		
<i>Ceratoppia spec.</i>	75	18	19	6	38	9		
<i>Ceratozetes minimus</i>			9	3				
<i>Chamobates cuspidatus</i>	28	3			1931	79	66	9
<i>Chamobates voigtsi</i>	207	6	19	6	57	9	2176	48
<i>Cultroribula bicultrata</i>	518	42	217	30	66	18	207	33
<i>Damaeioidea div.spp.</i>	2600	88	3240	91	1658	85	1093	88
<i>Diapterobates humeralis</i>	9	3	9	3	9	3		
<i>Dissorhina ornata</i>	19197	97	10861	100	6584	97	377	42
<i>Eniochthonius minutissimus</i>	2543	61	11068	73	829	24	1102	70
<i>Eupelops hirtus</i>			254	27	207	45	132	24
<i>Eupelops plicatus</i>	19	3					9	3
<i>Eupelops torulosus</i>	528	48	1149	82	254	42	188	33
<i>Euzetes globulus</i>	480	61	9	3				
<i>Galumna elimatus</i>							9	3
<i>Galumna lanceata</i>	622	61	2289	79	198	39	386	64
<i>Hypochthonius rufulus</i>	217	27	641	55	122	15	28	9
<i>Micreremus brevipes</i>	19	6	9	3	9	3	19	6
<i>Micropoppia minus</i>	3429	79	2572	82	2779	76	3127	82
<i>Microtritia minima</i>	3240	91	509	55	3146	85	443	48
<i>Nanhermannia nana</i>	339	33	339	18	1102	64	28	3
<i>Nothrus silvestris</i>	3344	100	2082	97	980	88	970	79
<i>Ophidiotrichus tectus</i>	9	3						
<i>Oppiella nova</i>	15279	97	15147	100	9514	97	14035	100
<i>Oppiella subpectinata</i>	75	3	1319	42	254	24	66	9
<i>Oribatella calcarata</i>			132	3			9	3
<i>Oribatula tibialis</i>	876	64	7507	88	28	6	1413	88
<i>Phauloppia lucorum</i>	9	3						
<i>Phauloppia rauschensis</i>					9	3		
<i>Phthiracarus div.spp.</i>	245	58	198	42	217	42	57	18
<i>Pilogalumna crassiclava</i>			9	3			19	6
<i>Platynothrus peltifer</i>	330	39	678	70	697	82	933	76
<i>Quadropoppia monstrosa</i>	122	6			28	9		
<i>Quadropoppia quadricarinata</i>	13103	73	1187	79	1027	76	377	55
<i>Rhysotritia duplicata</i>	386	52	386	52	2129	73	443	55
<i>Scheloribates initialis</i>	28	3	9	3			9	3
<i>Scheloribates pallidulus</i>	47	3	2035	76	38	12		
<i>Scheloribates latipes</i>	66	6	226	9				
<i>Steganacarus magnus</i>	28	6	9	3	9	3	38	6
<i>Steganacarus spinosus</i>			9	3				
<i>Steganacarus striculus</i>					188	18		
<i>Suctobelbidae div.spp.</i>	29964	100	31725	100	13932	100	20299	100
<i>Tectocepheus v. sarekensis</i>					217	24	9	3
<i>Tectocepheus v. velatus</i>	1225	73	641	64	1432	79	377	58
<i>Trhypochthonius tectorum</i>	38	6	57	15	94	18	9	3
<i>Zygoribatula cognata</i>							9	3

Tab. 4: Mean abundance (white background) [ind./m²] and frequency (grey background) for each species and each plot for the treatment “nutrient content of the soil”

abbreviation	species
Ach_col	<i>Achipteria coleoptrata</i>
Acr_lon	<i>Acrogalumna longipluma</i>
Ado_ova	<i>Adoristes ovatus</i>
Aut_lon	<i>Autogneta longilamellata</i>
Ber_sig	<i>Berniniella sigma</i>
Cam_spi	<i>Camisia spinifer</i>
Car_are	<i>Carabodes areolatus</i>
Car_orn	<i>Carabodes ornatus</i>
Cep_cep	<i>Cepheus cepheiformis</i>
Cer_min	<i>Ceratozetes minima</i>
Cha_cus	<i>Chamobates cuspidatus</i>
Cha_voi	<i>Chamobates voigtsi</i>
Cul_bic	<i>Cultroribula bicultrata</i>
Damae	<i>Damaeoidea div.spp.</i>
Dis_orn	<i>Dissorhina ornata</i>
Eni_min	<i>Eniochthonius minutissimus</i>
Eup_hir	<i>Eupelops hirtus</i>
Eup_tor	<i>Eupelops torulosus</i>
Gal_lan	<i>Galumna lanceata</i>
Hyp_ruf	<i>Hypochthonius rufulus</i>
M.minima	<i>Microtritia minima</i>
M.minus	<i>Micropia minus</i>
Nan_nan	<i>Nanhermannia nana</i>
Not_sil	<i>Nothrus silvestris</i>
Opp_nov	<i>Oppiella nova</i>
Opp_sub	<i>Oppiella subpectinata</i>
Ori_tib	<i>Oribatula tibialis</i>
Phth	<i>Phthiracarus div.spp.</i>
Pla_pel	<i>Platynothrus peltifer</i>
Qua_qua	<i>Quadroppia quadricarinata</i>
Rhy_dup	<i>Rhysotritia duplicata</i>
Sch_ini	<i>Scheloribates initialis</i>
Sch_pal	<i>Scheloribates pallidulus</i>
Sucto	<i>Suctobelbidae div.spp.</i>
Tec_vel	<i>Tectocepheus velatus velatus</i>

Tab. 5: Abbreviations of the species used in Fig. 129

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Eidesstattliche Erklärung

Hiermit erkläre ich, dass diese Arbeit bisher von mir weder an der Mathematisch-Naturwissenschaftlichen Fakultät der Ernst-Moritz-Arndt-Universität Greifswald noch einer anderen wissenschaftlichen Einrichtung zum Zwecke der Promotion eingereicht wurde.

Ferner erkläre ich, dass ich diese Arbeit selbständig verfasst und keine anderen als die darin angegebenen Hilfsmittel benutzt habe.