

## Soil mites in Belgium : A review

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### Summary

In this review we examine abundance and spatial organization patterns in mites, and more particularly in oribatid mites inhabiting soil organic horizons, from data gained in Belgium during the past thirty years. Several species show very weak abundances in all the sites sampled, whilst others can be regarded as the more abundant arthropods in terrestrial ecosystems. On the other hand, numerical analyses reveal close relationships between the species-composition of assemblages studied and the fertility of soils sampled that clearly reflect changes in physical structure of organic horizons, i.e. the categories of humus. Finally, future directions of research are indicated.

**Key-words :** Pedofauna, mites, spatial organization, Belgium.

### 1. Introduction

The first but fundamental stage of studies on systematics and distribution of invertebrates in Belgium, the LAMEERE's (1895) fauna reports on the presence of only 20 species of free-living mites belonging to Oribatida and Gamasida. At the beginning of the century, the number of mite species validly identified was approximately 5,000. Up to date, this number exceeds the amount of 100,000 and one assumes that half a million of species could inhabit the world-wide biosphere (see e.g. KRANTZ, 1978).

In Belgium, fifty years ago, the first investigations of terrestrial biotopes by COOREMAN (1941 a, b) and observations by LERUTH (1939) on cave habitats allowed the huge diversity and richness of mites to be foreseen. In 1955, under the impulse of Professor Hubert-Robert DEBAUCHE (Catholic University of Louvain), the first numerical analyses of soil mite assemblages were performed. Since that time, quantitative studies have been more and more numerous and covered several aspects of the biology *sensu lato* of mites.

Our review will try to present a synthesis of the data gained during the past years in order to show the great variety of mites found in Belgium, to draw up the contrasted features of the assemblages they create, and to dwell on the lack of our current knowledge.

### 2. Methods

The present review is intentionally limited to oribatid mites which create assemblages within the organic horizons of soils, mainly in forest ecosystems. Two major reasons explain this limitation : first, the existence of data on the space and time variability shown by assemblages of mites bounded to the soil; second, the availability of data on the environmental conditions that influence the sites inhabited by assemblages.

In this instance, we used only observations for which a quantitative sampling of oribatid assemblages and a straight description of the vegetation and soil of sites sampled had been carried out at the same time. On the whole, our review is then based on 105 observations that yield the species composition of assemblages and a quantitative information on population sizes, i.e. the mean annual abundance shown by species in each site sampled. As proposed by LEBRUN (1965, 1971), this parameter was studied using the following simple values that relate to increasing levels of relative abundance (RA) : 1, for  $RA \leq 0.1\%$  ; 2, for  $0.1\% < RA \leq 1\%$  ; 3, for  $1\% < RA \leq 5\%$  ; 4, for  $5\% < RA \leq 10\%$  ; 5, for  $RA > 10\%$ . Note that all things considered, our survey deals with the fabulous amount of approximately five million individuals recovered from the 105 sites.

In order to characterize the sites sampled, seven descriptors were studied: the geographic region (8 categories); the phytosociological series (10 categories), the degree of openness (4) and the type of vegetation (7); and, for the soil, the texture (5), the moisture level (6) and the type of humus (7). Hereafter, the number of assemblages sampled in each category is presented between brackets.

In Belgium, the geographic regions portray quite accurately macroclimates. Oceanic conditions are prevalent in the Atlantic province, i.e. in Flanders (2) and in the Picardy-Brabant Plateau (53). On the other hand, climates are more continental in the Condroz (6), the Calcareous Fagne (3), the Famenne (4), the Ardennes (26) and the Gaume (3), and even submountain in the High Ardennes (8).

Thirty-eight oligotrophic sites are oak forests relating to the *Quercion* series. On less acid soils, climax beach forests of the *Fagion* series occur, and two categories were identified: *Fagion Luzulo-Fagenion* (14) and *Fagion Asperulo-Fagenion* (4). Where substrates are too poor in nutrients, or too dry or too wet, the beech cannot take root, and a distinct vegetation belonging to the *Carpinion* series (36) is registered. Finally, two sites were studied in riparian ash forests (*Alno-Padion* series) and two others in peaty alder forests (*Alnion* series).

For all these wood sites, the degree of openness depends on sylvan practices and three major physiognomic categories were identified: high forests (31); coppices (15); and, coppices with standards (52).

On the other hand, the main types of vegetation are as follows: "natural" forests (79) which refer to sites not or weakly disturbed; substitution forests among which we distinguished deciduous plantations (7) from the coniferous ones (10); heathlands in which two contrasted series of vegetation were observed, i.e. the *Ericion* series of peaty soils (3) and the *Calluno-Genistion* series of dry soils (4); and, two grasslands, one for grazing (*Cynosurion* series) and the other for harvesting (*Arrhenaterion* series).

Where the soil texture is concerned, the three basic classes of sandy (14), silt (50) and clayey (13) soils were found, and we identified also two transitional categories (9 and 19 assemblages respectively). The levels of soil moisture are as follows: very dry (16); dry (18); balanced (29); wet (26); very wet (10); permanently wet (6).

In mull soils, there is no intermediate horizon between the dead organic matter and mineral substrates. Three categories of mull soils were considered: calcic mull (7); eutrophic mull (12); and, dystrophic mull soils (10) which are distinguishable from both others by a more marked acidity. In the other types of humus, intermediate organic horizons are developed, and their thickness increases substantially from mull-moder soils (11) to moder (38) and mor soils (22). Finally, peats (5) are developed in permanently wet soils where *Sphagnum* occurs.

### 3. Results

#### Faunistical aspects

A total of 284 species was recorded in the soils sampled (see a systematic list in the appendix). This number amounts to nearly 320 units when we consider the species found up to date in other biotopes such as tree canopies, bark and stone mosses, house dusts and cave habitats. Moreover, the other groups of soil mites have been much less intensively studied than oribatids. So were the uropodids (ATHIAS-BINCHE & MIGNOLET,

1974; ATHIAS-BINCHE, 1981), the other gamasids and the actinedids (COOREMAN, 1943 a & b; COVARRUBIAS, 1978), and the acaridids (FAIN & WAUTHY, 1979), for which 8, 43, 22 and 11 species respectively have been recorded. Therefore, in so far as more biotopes would be sampled and all the groups of Acari drawn up in inventory, we could reasonably assume that the amount of 450 species would be exceeded in Belgium.

Where the species abundances are concerned, considerable variations were registered, and there is a clear separation between the species.

(1) Many species showed very weak abundances in organic horizons of all the sites sampled. Among these species, four subsets can be identified as follows :

- The first subset refers to "accidental" species which normally are canopy, bark or stone dwellers. Their frequency and abundance in soil organic horizons are due to an aerial, relatively continuous drift. From data of LEBRUN (1971) and ANDRÉ (1985), these are : *Camisia segnis*, *Paradamaeus clavipes*, *Cepheus dentatus*, *Ceratoppia bipilis*, *Cymbaeremaeus cymba*, *Micrecremus brevipes*, *Licneremaeus licnophorus*, *Diapterobates humeralis*, *Humerobates rostroramellatus*, *Galumna alata* and *Zygoribatula exilis*.

- As the previous species, the ones of the second subset inhabit epigeic biotopes; but, their occurrence in litter is less frequent. These are : *Liodes theleproctus*, *Caleremaeus monilipes*, *Provertex sp.* and *Scutovertex sp.*

- The species of the third subset are true soil dwellers; but, their niche breadth is reduced. Either, because they are confined to deep soil horizons (hypogeic species) such as *Palaeacarus hystricinus*, *Atopochthonius artiodactylus*, *Brachychochthonius suecicus*, *Gehypochthonius sp.*, *Eulhomannia ribagai* and *Suctobelbella tuberculata*. Or, because they restrict their habitat occupancy to twigs and rotted wood debris found in litter (*Archiphthiracarus ligneus*, *Liacarus cf. xylicarum*, *Oppia splendens*, *Allosuctobelba grandis europaea*, *Thyrisoma lanceolata* and *Autogneta longilamellata*), or to lichens (*Domitorina plantivaga plantivaga* and, less commonly, *Carabodes labyrinthicus*) and mosses growing on the soil surface and on the lower parts of trunks (*Eueremaeus cf. oblongus*, *Eueremaeus silvestris*, *Parachipteria punctata* and *Oribatella calcarata*).

Note also the collecting, in only one site, of *Cosmochthonius lanatus* which is an usual component of house dust assemblages (GRIDELET & LEBRUN, 1973). At this point, a remark can be made: there is a lack of knowledge relating to those mites which would characterize the peculiar habitats created by aggregates of bacteria and fungi, and by dejections and nests of birds or mammals.

- Finally, the fourth subset refers to species which are at or near the limit of their geographic range. Among these species, there are three "meridional" species : *Autogneta penicillum* (only found on shallow calcareous soils), *Fosseremus quadripertitus* and *Joelia fiorii*.

(2) Several species showed quite the reverse of the previous ones since they exhibited very high levels of abundance. Two subsets can be identified:

- The first one refers to narrow ranging species which were collected in few sites (max. 4); but, always in great abundance ( $> 500$  individuals/m<sup>2</sup>). These are: *Nothrus cf. biciliatus*, *Nothrus pratensis*, *Trimalaconothrus foveolatus*, *Trimalaconothrus intermedius*, *Trimalaconothrus cf. novus*, *Ctenobelba pectinigera*, *Tectocephus knullei*, *Conchogneta dalearlica* and *Liebstadia similis ssp.1* (linked to grasslands).

- The second subset consists of 20 species (pointed out by an asterisk in the appendix) which are widely distributed (they occurred in at least 50 per cent of the sites sampled) and the most numerous arthropods in Belgium. Their abundance reached at least 3 per cent of the total number of oribatids found in each site they inhabited, and this corresponds to a density of more than 3,000 individuals/m<sup>2</sup>, on average.

These 20 species form a background-set featuring in all the microarthropod communities developed in soil organic horizons. Numerical analyses will now seek to clarify relationships between their populations and the ecological descriptors.

### Assemblage analysis

From the 105 observations at our disposal, the first question we ask is to know which identical environmental conditions bring about identical assemblage compositions, i.e. to establish those ecological descriptors we studied which have the greatest *predicting power* upon oribatid assemblages. A lot of techniques may be used (see GREIG-SMITH, 1980, for a review), and, at the present time, two techniques seem to prevail:

- Cluster analysis, and we used the divisive, "K-means" method of SPATH (1980) which, at each step of division, minimizes the within-groups variance and allows assemblage relocations between clusters to be achieved.

- Numerical ordination, the purpose of which is to range assemblages along axes, allowing these axes to be interpreted as "environmental gradients" that can be related to one or more ecological descriptors. Herein, we used correspondence analysis (CA) coupled with a graphical, 80% confidence ellipse method (see AUDA, 1983, for details) in order to depict assemblage separations in accordance with ecological descriptor's categories.

The dendrogram of classification revealed by cluster analysis shows seven groups of assemblages. These are:

- *Group 1* (33 assemblages). Association of assemblages developed in oligo- and mesotrophic soils with mor or moder horizons. The assemblages of all the oak-beech forests of the *Quercion* series sampled in the Atlantic province are related to this group.

- *Group 2* (12). Assemblages of eutrophic or calcic mull soils in oak-hornbeam forests of the *Carpinion* series

sampled in the Sub-Atlantic province.

- *Group 3* (10). Assemblages of peaty soils under vegetation belonging to the *Alnion* and *Ericion* series, to which the assemblages sampled in grassland are associated. Note that the three first groups are separated from the others within the dendrogram.

- *Group 4* (24). Assemblages of meso- or oligotrophic soils with mull or moder horizons in oak (*Quercion*) and oak-hornbeam (*Carpinion*) forests sampled in the Sub-Atlantic province.

- *Group 5* (10). Assemblages of oligotrophic, mor and moder soils in beech forests (*Fagion* and *Carpinion*) and dry heathlands of the Atlantic province.

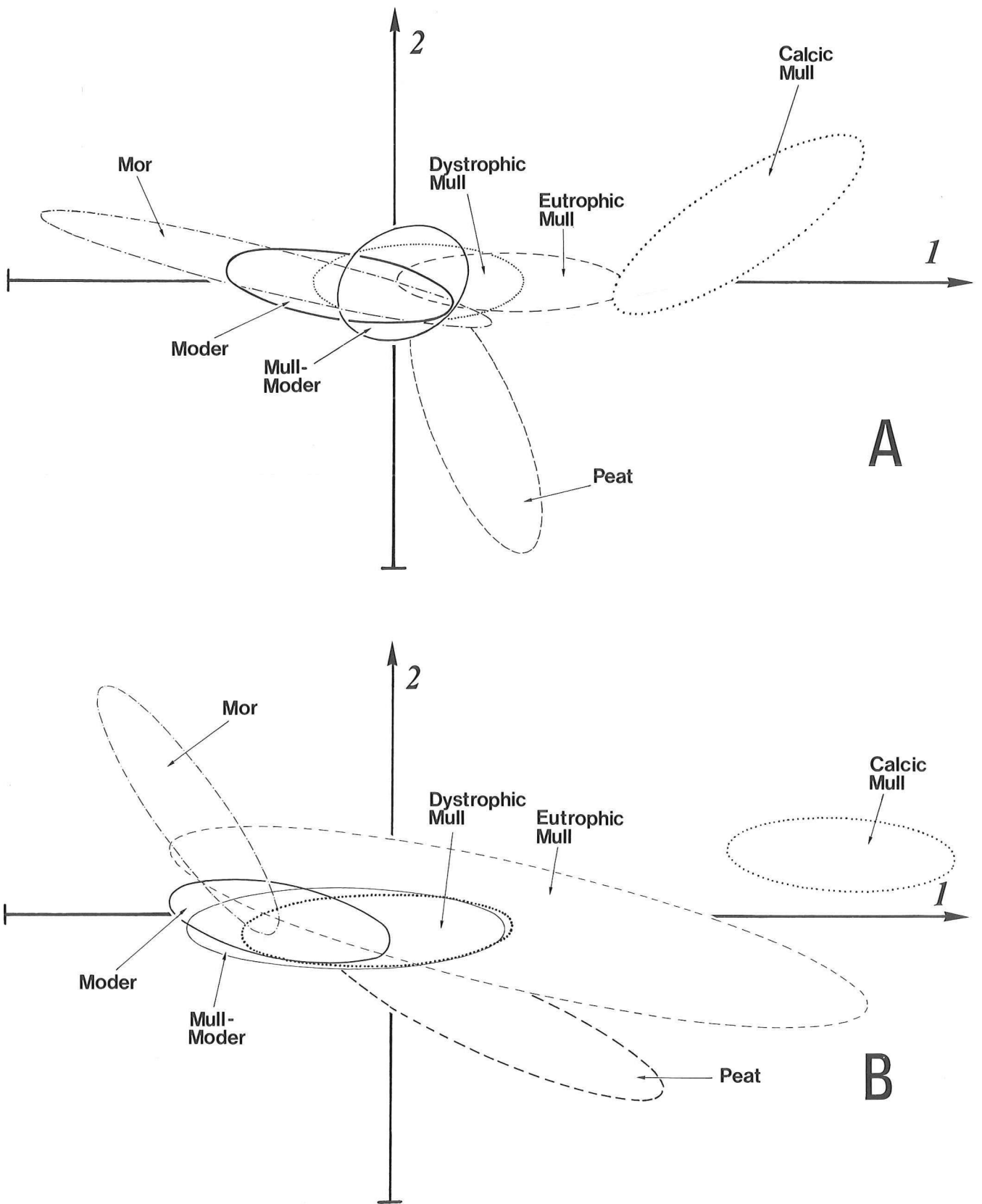
- *Group 6* (12). Assemblages of eutrophic and dystrophic mull soils in beech forests (*Fagion*) of the Ardenne and in riparian forests (*Alno-Padion*).

- *Group 7* (4). These assemblages were sampled in four stands of the same forest located in Grand-Leez. Their patent dissimilarity to all the other assemblages is due to the absence of several common species (e.g. *Nanhermannia nanus*, *Oppia bicarinata ssp. 1*, *Suctobelbella subtrigona*). To date, these absences are not clearly understood, but can presumably be related to non-equilibrium in local, emigration/immigration processes as discussed by WAUTHY *et al.* (in press).

Examination of the assemblage groupings suggests that the vegetation series are reliable criteria for classification of oribatid assemblages. However, to depict the pattern of assemblage similarities, vegetation series appear to be obscured by soil fertility to which the types of humus are strongly correlated.

This view was confirmed by the results of CA (Fig. 1A). The arrangement of assemblages along the first axis can undoubtedly be related to an increasing heterogeneity of the physical structure of organic horizons (i.e. thickness and number of organic layers) from calcic mull soils to the mor ones. Three assemblages developed in the former soils and one in the latter contribute the most to the creation of axis 1 (their relative contribution exceeds the value of 9%). Note: first, a noticeable similarity of the arrangement of assemblages along axis 1 when the four previous assemblages do not intervene in the analysis; second, an overlap more marked between assemblages originating from mor, moder and mull-moder soils than between the ones of mull soils. On the other hand, the assemblages of peaty soils contribute the most to the creation of axis 2 (the relative contribution of one of these assemblages exceeds the value of 45 %) and are clearly separated from all the others along the axis.

Furthermore, to assess the predicting power of ecological descriptors upon the species-composition of oribatid assemblages, we computed the mean "mutual information" (MI) between species and descriptor's categories (see DAGET & GODRON, 1982, for details). The value of 0.24 bits was registered in the case of the humus type, whilst all the other values were below 0.2 bits, i.e. : 0.19, for phytosociological series; 0.17, for



Correspondence analysis of 105 assemblages of oribatid mites inhabiting soil organic horizons in Belgium. Ordinations of assemblages along axis 1 and 2 are presented with pictorial interpretation using confidence ellipses of the seven humus categories to which organic horizons of sites sampled can be related. Note that several ellipses are not wholly outlined for simplicity. - A, assemblages created by all the species identified (284). - B, assemblages created by the 25 species which showed the highest values of "mutual information" towards the humus categories.

geographic regions; 0.17, for vegetation types; 0.14, for soil texture classes; 0.12, for moisture levels; 0.11, for vegetation openness categories.

Our current findings lend support to the hypothesis that the physical structure and chemical composition (e.g. pH, nitrogen content) of organic horizons are factors extremely important in determining the spatial organization of oribatid populations (ANDERSON, 1978; WAUTHY & LEBRUN, 1980; WAUTHY, 1982), presumably because they shape the assemblages of microorganisms on which oribatids feed directly or indirectly. The second question we ask is to know the *indicative power* of species with respect to the types of humus, i.e. to identify those species which show significant changes in population size within the humus categories identified.

Such an investigation requires at first to eliminate species which exhibit either too weak overall abundances or too marked preferences for one category of humus. Then, to identify the more "indicative" species among the remaining ones, several methods mainly referring to discriminant analysis can be used. In this instance, however, we applied an alternative, "step by step" method as follows : CA was performed for the 50 species which showed the highest values of MI towards humus categories ( $> 0.16$  bits); then, from the previous set, we removed successively the five species, the 10, and so on, which showed the lowest MI values; and, at each step, CA was performed. Up to the fifth step, CA results were quite similar to the ones gained with the raw data matrix (Fig. 1B). At the next step (not figured), obvious changes occurred in the arrangement of assemblages along axis 1 since a graphical distinction between the assemblages originating from mor soils and the other ones was no more apparent.

This reveals that the 25 species with the highest values

of MI towards humus categories ( $> 0.24$  bits) are also basic components of oribatid assemblages since they induce assemblages to exhibit their pattern of coadjustment to the changes in structure shown by soil organic horizons (these species are underlined in the appendix). The sub-assemblages they create can then be regarded as the major building blocks (in ORIAN'S meaning, 1980) of soil micro-arthropod communities, and constitute a reliable ecological model of terrestrial, saprophagous system.

#### 4. Conclusions

Our conclusions will focus on the gaps brought to light by the present review in current knowledge of free-living mites in Belgium.

1. Where the 25 species we regarded as the more "indicative" towards humus categories are concerned, data on their population dynamics, on the mechanisms structuring their assemblages (e.g. competition, predation), and on the factors governing their distribution are almost completely lacking.

2. Too many biotopes were the subject of sporadic and quite limited surveys: not only, the cave habitats, the deep soil horizons, the dejections of vertebrates and the house habitats as stated above, but also, the dune substrates, the calcareous lawns, the peculiar associations of lichens and mosses, and the nests of birds and mammals.

3. Finally, the present review emphasizes the need to document on other groups of soil mites (gamasids, acaridids and actinedids) in order to study their patterns of richness, composition, population dynamics and trophic structure, and to compare these assemblage metrics to the ones of oribatids.

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## Appendix

List of oribatid mites found in Belgium according to taxonomic order

Centesimal frequencies shown by species in the organic horizons of the seven humus categories are presented (1st column : calcic mull ; 2nd : eutrophic mull ; 3rd : dystrophic mull ; 4th : mull-moder ; 5th : moder ; 6th : mor ; 7th : peat). Data are converted into six increasing frequency (F) classes, with following simple values : 0, if the species is absent ; 1, for  $0\% < F \leq 20\%$  ; 2, for  $20\% < F \leq 40\%$  ; 3, for  $40\% < F \leq 60\%$  ; 4, for  $60\% < F \leq 80\%$  ; 5, for  $80\% < F \leq 100\%$ .

The term "div." is used for systematic units which consist of two or more identified taxa not retained in the numerical analyses we performed.

### I. PALAEOSOMATA

#### Palaeacaridae

1. *Palaeacarus hystericinus* Trägårdh, 1932 0 0 1 1 2 2 0

### II. ENARTHRONOTA

#### Hypochthoniidae

2. *Hypochthonius luteus* Oudemans, 1917 3 1 1 0 0 0 0

3. *H. rufulus* Koch, 1836 (\*) 1 5 5 5 5 4 5

#### Eniochthoniidae

4. *Eniochthonius minutissimus* (Berlese, 1904) (\*) 1 3 5 5 5 5 1

#### Cosmochthoniidae

5. *Cosmochthonius lanatus* (Michael, 1885) 0 1 0 0 0 0 0

#### Brachychthoniidae

6. *Brachychthonius berlesei* Willmann, 1928 (\*) 2 4 3 4 4 3 3

7. *B. bimaculatus* Willmann, 1936 0 0 0 0 0 1 0

8. *B. impressus* Moritz, 1976 0 1 2 1 1 1 0

9. *Brachyochthonius cricoides* Weis-Fogh, 1948 0 1 2 1 2 2 0

10. *B. formosus* (Cooreman, 1947) 1 0 0 0 0 0 0

11. *B. honestus* Moritz, 1976 0 2 3 2 2 0 1

12. *B. immaculatus* Forsslund, 1942 3 1 1 0 1 1 0

13. *B. rostratus* (Jacot, 1936) 0 1 0 0 0 0 0

14. *B. suecicus* Forsslund, 1942 0 0 1 1 2 1 0

15. *B. zelawaiensis* (Sellnick, 1928) 0 0 3 1 2 2 0

16. *B. sp. 1* 1 0 0 0 1 0 0

17. *Eobrachychthonius latior* (Berlese, 1910) 0 0 0 0 0 0 1

18. *Liochthonius alpestris* (Forsslund, 1958) 0 1 0 0 1 0 2

19. *L. brevis* (Michael, 1888) (\*) 2 1 5 2 3 2 3

20. *L. evansi* (Forsslund, 1958) 0 0 1 0 3 2 0

21. *L. horridus* (Sellnick, 1928) 0 0 1 0 0 0 0

22. *L. hystericinus* (Forsslund, 1942) 3 2 1 1 1 0 0

23. *L. muscorum* Forsslund, 1964 5 1 3 0 1 0 0

24. *L. perfusorius* Moritz, 1976 0 0 1 0 1 0 2

25. *L. propinquus* Niedbala, 1972 1 0 0 0 0 0 0

26. *L. sellnicki* (Thor, 1930) 0 0 0 0 0 0 1

27. *L. simplex* (Forsslund, 1942) 1 1 3 2 4 2 0

28. *L. strenzkei* Forsslund, 1963 5 2 2 1 0 0 0

29. *L. sp. 1* 0 1 0 0 0 0 0

30. *L. sp. 2* 0 1 0 0 0 0 0

31. *L. sp. 3* 0 0 0 0 0 1 0

32. *Mixochthonius pilosetosus* (Forsslund, 1942) 0 0 0 0 1 1 1

33. *Neobrachychthonius marginatus* (Forsslund, 1942) 1 1 0 0 0 0 0

34. *Paraliochthonius globuliferus* (Strenzke, 1951) 0 1 1 0 1 0 0

35. *P. piluliferus* (Forsslund, 1942) 0 0 0 0 1 2 0

36. *Poecilochthonius italicus* (Berlese, 1910) 2 0 3 2 1 0 0

37. *Verachthonius cf. laticeps* (Strenzke, 1951) 0 0 0 0 0 1 0

#### Atopochthoniidae

38. *Atopochthonius artiodactylus* Grandjean, 1948 0 0 1 0 0 0 0

## III. PARHYPOCHTHONOIDEA

Gehypochthoniidae	
39. <i>Gehypochthonius</i> sp.	0 0 0 0 1 0 0

## IV. MIXONOMATA

Eulhomanniidae	
40. <i>Eulhomannia ribagai</i> (Berlese, 1910)	2 1 2 1 1 1 0

Euphthiracaridae	
41. <i>Euphthiracarus cribrarius</i> (Berlese, 1904)	0 0 1 0 1 0 0
42. <i>Microtritia minima</i> (Berlese, 1904)	0 1 0 1 2 4 0
43. <i>Rhysotritia ardua</i> (Koch, 1841)	2 0 0 0 0 0 2
44. <i>R. duplicata</i> (Grandjean, 1953) (*)	0 3 5 5 5 5 1

Phthiracaridae	
45. <i>Archiphthiracarus anonymum</i> (Grandjean, 1934)	2 4 5 5 4 4 2
46. <i>A. ligneus</i> (Willmann, 1931)	0 0 0 0 0 0 1
47. <i>A. cf. peristomaticus</i> (Willmann, 1954)	1 1 0 1 1 0 0
48. <i>A. rectisetosus</i> (Parry, 1979)	0 0 1 0 0 1 1
49. <i>A. sp. 1</i>	0 1 0 0 0 0 0
50. <i>Phthiracarus affinis</i> (Hull, 1914)	0 1 0 0 0 0 0
51. <i>P. cf. globosus</i> (Koch, 1841)	0 0 0 1 0 1 0
52. <i>P. laevigatus</i> (Koch, 1841)	5 2 2 0 1 0 2
53. <i>P. nitens</i> (Nicolet, 1855)	5 5 5 4 3 0
54. <i>P. serrulatus</i> Parry, 1979	3 3 1 1 0 0 1
55. <i>P. tardus</i> Forsslund, 1956	4 2 4 1 1 0 0
56. <i>P. sp. 1</i>	2 1 1 1 1 0 0
57. <i>P. sp. 2</i>	0 1 0 0 1 0 1
58. <i>P. sp. 3</i>	0 0 0 1 0 0 0
59. <i>P. sp. 4</i>	0 0 0 1 0 0 0
60. <i>P. sp. 5</i>	0 0 0 1 1 0 0
61. <i>P. sp. 6</i>	0 0 0 1 1 0 0
62. <i>P. sp. 7</i>	0 1 0 0 0 0 0
63. <i>Steganacarus magnus anomalus</i> (Berlese, 1883)	5 3 3 2 1 1 0
64. <i>S. magnus magnus</i> (Nicolet, 1855)	2 2 3 2 3 2 1
65. <i>S. spinosus</i> (Sellnick, 1920)	3 1 0 0 1 0 0
66. <i>S. striculus</i> (Koch, 1836)	3 2 1 1 1 1 0
67. <i>S. striculus</i> (Koch, 1836) ssp. 1	2 1 0 0 1 0 2

## V. NOTHROIDEA

Hermanniidae	
68. <i>Hermannia cf. convexa</i> (Koch, 1840)	0 0 0 0 1 1 0
69. <i>H. gibba</i> (Koch, 1839) (*)	5 4 4 3 4 3 3

Nothridae	
70. <i>Nothrus anauniensis</i> Canestrini & Fanzago, 1877	2 0 0 0 0 0 0
71. <i>N. cf. biciliatus</i> Koch, 1841	0 1 0 0 0 0 0
72. <i>N. cf. borussicus</i> Sellnick, 1929	0 2 4 3 3 0 0
73. <i>N. palustris</i> Koch, 1839	1 5 3 3 3 2 2
74. <i>N. pratensis</i> Sellnick, 1928	0 0 0 0 1 0 3
75. <i>N. silvestris</i> Nicolet, 1855 (*)	1 3 5 5 5 5 2

Camisiidae	
76. <i>Camisia exuvialis</i> Grandjean, 1939	0 0 0 0 0 1 0
77. <i>C. segnis</i> (Hermann, 1804)	0 0 0 0 0 2 2
78. <i>C. spinifer</i> (Koch, 1836)	0 1 2 2 2 5 2
79. <i>Heminothrus targionii</i> (Berlese, 1885)	2 0 0 0 0 0 0
80. <i>Platynothenrus capillatus</i> (Berlese, 1914)	0 0 1 0 0 0 0
81. <i>P. peltifer</i> (Koch, 1839) (*)	3 5 5 5 5 5 3

Nanhermanniidae	
82. <i>Nanhermannia coronata</i> Berlese, 1913	0 0 2 1 2 0 2
83. <i>N. elegantula</i> Berlese, 1913	0 1 1 1 2 0 2
84. <i>N. nanus</i> (Nicolet, 1855) (*)	2 4 3 5 4 3 3
85. <i>N. pectinata</i> Strenzke, 1953	0 0 2 0 1 0 0

Malaconothridae	
86. <i>Malaconothrus gracilis</i> v. d. Hammen, 1952	1 2 3 2 2 1 2
87. <i>M. sp. 1</i>	0 0 0 1 0 0 0
88. <i>M. sp. 2</i>	0 0 0 1 1 0 0
89. <i>M. sp. 3</i>	0 0 0 1 1 1 0
90. <i>M. sp. 4</i>	0 1 0 0 0 0 0
91. <i>Trimalaconothrus foveolatus</i> Willmann, 1931	0 0 0 0 0 0 1
92. <i>T. intermedius</i> Cooreman, 1941	0 0 0 0 0 0 1
93. <i>T. cf. novus</i> (Sellnick, 1921)	0 0 0 0 0 0 2
94. <i>T. sp. 1</i>	0 0 0 0 0 0 2

Varia	
95. <i>Thrypochthoniellus excavatus</i> (Willmann, 1919)	0 0 0 1 1 0 0

## VI. CIRCUMDEHISCENTIAE

OPSIOPHEREDERMA	
Hermanniellidae	
96. <i>Hermanniella granulata</i> (Nicolet, 1855)	3 0 3 3 3 2 1
97. <i>H. punctulata</i> Berlese, 1908	0 0 0 1 0 0 1

## EUPHEREDERMA

Liodidae	
98. <i>Liods theleproctus</i> (Hermann, 1804)	0 0 0 0 1 0 0

Belbidae	
99. <i>Belba corynopus</i> (Hermann, 1804)	3 2 1 1 1 0 1
100. <i>B. sp. 1</i>	0 0 0 0 0 1 0
101. <i>Damaeobelba minutissima</i> (Sellnick, 1920)	1 1 4 5 5 3 1
102. <i>Damaeus onustus</i> Koch, 1841	5 3 3 4 3 2 1
103. <i>D. sp. 1</i>	0 0 1 0 0 0 0
104. <i>Hypodamaeus auritus</i> (Koch, 1836)	0 1 1 3 2 4 0
105. <i>H. cf. crispatus</i> (Kulczynski, 1902)	0 0 1 0 0 0 0
106. <i>H. riparius</i> (Nicolet, 1855)	3 0 1 1 0 0 0
107. <i>Metabelba cf. cremersi</i> v. d. Hammen, 1952	0 0 0 0 0 1 0
108. <i>M. papillipes</i> (Nicolet, 1855)	2 1 1 1 2 1 0
109. <i>M. pulverosa</i> Strenzke, 1953	0 0 0 0 0 1 0
110. <i>M. sp. 1</i>	0 0 0 0 0 1 0
111. <i>Paradamaeus clavipes</i> (Hermann, 1804)	3 2 4 3 2 1 2
112. <i>Parobelba spinosa</i> (Sellnick, 1920)	0 0 1 2 0 0 0
113. <i>Spotiobdamaeus verticillipes</i> (Nicolet, 1855)	0 0 0 0 1 0 0

Cepheidae	
114. <i>Cepheus cepheiformis</i> (Nicolet, 1855)	0 1 2 2 2 4 2
115. <i>C. dentatus</i> (Michael, 1888)	1 1 3 2 2 1 1
116. <i>C. latus</i> Koch, 1836	0 0 0 1 1 1 0
117. <i>Tritegeus bisulcatus</i> Grandjean, 1953	2 1 0 1 1 0 0

Microzetidae	
118. <i>Nellacarus cf. septentrionalis</i> Kunst, 1963	2 0 0 0 1 0 0

Gustaviidae	
119. <i>Gustavia microcephala</i> (Nicolet, 1855)	0 2 0 1 1 0 0

Caleremaeidae	
120. <i>Caleremaeus monilipes</i> (Michael, 1882)	0 0 0 1 0 0 0

Eremaeidae	
121. <i>Eremaeus sp.</i>	0 0 0 1 0 0 0
122. <i>Eueremaeus cf. oblongus</i> Koch, 1836	0 1 0 0 0 0 0
123. <i>E. silvestris</i> Forsslund, 1956	0 0 0 1 1 0 0
124. <i>E. cf. valkanovi</i> Kunst, 1957	3 0 0 1 0 0 0

Ctenobelbidae	
125. <i>Ctenobelba pectiniger</i> (Berlese, 1908)	2 0 0 0 0 0 0

Damaeolidae	
126. <i>Fosseremus quadripertitus</i> Grandjean, 1965	3 0 1 1 0 0 0

Ameridae	
127. <i>Amerus cf. polonicus</i> Kulczynski, 1902	1 0 2 1 1 1 0

Varia	
128. <i>Eremuloidea sp.</i>	3 0 1 0 0 0 0

## APHEREDERMA PYCNONOTICAE

Ceratoppiidae	
129. <i>Ceratoppia bipilis</i> (Hermann, 1804)	3 1 3 1 3 3 4
130. <i>C. quadridentata</i> (Haller, 1884)	0 0 0 0 0 0 3
131. <i>C. sexpilosa</i> Willmann, 1938	0 0 0 0 1 0 5

Liacaridae	
132. <i>Adoristes poppei</i> (Oudemans, 1906)	3 4 4 4 2 3 1
133. <i>Li acarus coracinus</i> (Koch, 1841)	0 2 0 3 2 2 0
134. <i>L. cf. cuspidatus</i> Mihelcic, 1954	1 2 2 1 1 1 0
135. <i>L. nitens</i> (Gervais, 1844)	5 1 2 2 0 0 0
136. <i>L. cf. subterraneus</i> (Koch, 1841)	1 1 2 2 2 0 1
137. <i>L. cf. xylariae</i> (Schrank, 1803)	0 0 0 1 0 0 0
138. <i>Xenillus tegeocranus</i> (Hermann, 1804)	5 4 2 4 2 2 0

Carabodidae	
139. <i>Carabodes areolatus</i> Berlese, 1916	0 0 0 1 1 0 0
140. <i>C. coriaceus</i> Koch, 1836	1 2 3 3 3 5 0
141. <i>C. femoralis</i> (Nicolet, 1855)	1 1 2 3 3 4 1
142. <i>C. forsslundi</i> Sellnick, 1953	0 0 1 0 0 0 0
143. <i>C. labyrinthicus</i> (Michael, 1879)	2 3 5 4 5 4 2
144. <i>C. marginatus</i> (Michael, 1884)	0 1 1 1 1 2 1
145. <i>C. minusculus</i> Berlese, 1923	0 0 0 1 1 2 0
146. <i>C. reticulatus</i> Berlese, 1913	0 0 1 0 1 0 0
147. <i>Odontocephus elongatus</i> (Michael, 1879)	0 0 0 0 2 2 0

Oppiidae	
148. <i>Ctenoppiella fallax</i> (Paoli, 1908)	1 0 1 1 1 1 0
149. <i>C. obsoleta</i> (Paoli, 1908)	3 3 3 2 3 3 0
150. <i>C. subpectinata</i> (Oudemans, 1901) (*)	5 3 5 5 5 4 2
151. <i>Hypogeoppia sigma</i> Strenzke, 1951	0 2 4 2 3 1 1
152. <i>H. sigma conjuncta</i> Strenzke, 1951	0 0 2 2 1 0 0
153. <i>Micropoppia minus</i> (Paoli, 1908)	0 3 4 3 3 4 0
154. <i>Oppia bicarinata</i> (Paoli, 1908) ssp. 1 (*)	0 1 1 3 3 2 0
155. <i>O. bicarinata</i> (Paoli, 1908) ssp. 2	0 0 1 1 1 0 0

156. <i>O. bicarinata</i> (Paoli, 1908) ssp. 3	0 0 1 0 0 0 0		
157. <i>O. clauvipectinata</i> (Michael, 1885)	0 1 0 0 1 1 0		
158. <i>O. fasciata</i> (Paoli, 1908)	0 1 1 0 1 1 0		
159. <i>O. maritima</i> (Willmann, 1929)	0 1 0 1 2 3 0		
160. <i>O. ornata</i> (Oudemans, 1900) (*)	5 5 5 5 5 5 3		
161. <i>O. cf. quadrimaculata</i> Evans, 1952	0 1 0 0 1 0 0		
162. <i>O. serrata</i> Mihelcic, 1956	1 0 1 0 1 1 0		
163. <i>O. splendens</i> (Koch, 1841)	0 0 0 1 1 1 0		
164. <i>O. translamellata</i> (Willmann, 1923)	0 0 0 1 1 2 0		
165. <i>O. unicarinata</i> (Paoli, 1908)	1 0 0 0 1 1 0		
166. <i>O. ssp. 1</i>	0 0 0 1 0 0 0		
167. <i>O. ssp. 2</i>	0 0 0 0 0 1 0		
168. <i>Oppiella neerlandica</i> (Oudemans, 1900)	1 0 1 1 1 1 3		
169. <i>O. nova</i> (Oudemans, 1902) (*)	5 4 5 5 5 5 1		
170. <i>O. nova</i> (Oudemans, 1902) ssp. 1	0 0 1 0 0 1 0		
171. <i>O. nova</i> (Oudemans, 1902) ssp. 2	1 1 1 0 1 0 2		
172. <i>Quadropia quadricarinata</i> (Michael, 1885) div.	4 4 5 5 5 5 2		
Suctobelbidae			
173. <i>Allosuctobelba grandis europaea</i> (Willmann, 1933)	0 0 0 1 0 0 0		
174. <i>Suctobelba granulata</i> v. d. Hammen, 1952	0 0 1 1 1 0 0		
175. <i>S. lapidaria</i> Moritz, 1970	0 1 2 0 2 0 0		
176. <i>S. regia</i> Moritz, 1970	3 2 1 0 1 0 0		
177. <i>S. sorrentensis</i> Hammer, 1961	0 0 1 0 1 0 0		
178. <i>S. trigona</i> (Michael, 1888)	1 2 3 2 3 4 1		
179. <i>S. sp. 1</i>	0 0 0 1 0 0 0		
180. <i>Suctobelbella acutidens</i> (Forsslund, 1941)	0 1 1 1 2 1 1		
181. <i>S. alboenasuta</i> Moritz, 1971	3 0 1 0 0 0 0		
182. <i>S. baloghi</i> (Forsslund, 1958)	3 0 0 0 0 0 0		
183. <i>S. carcharodon</i> (Moritz, 1966)	1 0 0 0 0 0 0		
184. <i>S. duplex</i> (Strenzke, 1950)	0 1 1 1 0 0 0		
185. <i>S. falcata</i> (Forsslund, 1941)	0 1 1 2 3 2 2		
186. <i>S. forsslundi</i> (Strenzke, 1950)	4 1 0 0 0 0 0		
187. <i>S. hamata</i> Moritz, 1970	0 0 1 0 1 2 0		
188. <i>S. longirostris</i> (Forsslund, 1941)	0 0 0 0 1 0 0		
189. <i>S. nasalis</i> (Forsslund, 1941)	3 4 4 3 3 1 1		
190. <i>S. perforata</i> (Strenzke, 1950)	0 1 3 0 1 0 1		
191. <i>S. sarekensis</i> (Forsslund, 1941) (*)	5 5 5 4 5 3 2		
192. <i>S. similis</i> (Forsslund, 1941)	0 2 2 2 2 2 2		
193. <i>S. subcornigera</i> (Forsslund, 1941) (*)	4 4 5 5 5 3 2		
194. <i>S. subcornigera</i> (Forsslund, 1941) ssp. 1	0 0 0 0 1 1 1		
195. <i>S. subtrigona</i> (Oudemans, 1916)	3 4 4 4 5 5 2		
196. <i>S. tuberculata</i> (Strenzke, 1950)	0 0 0 0 1 0 1		
Thyrisomidae			
197. <i>Thyrisoma lanceolata</i> (Michael, 1885)	0 2 0 1 2 2 1		
Tectocephidae			
198. <i>Tectocephus knullei</i> Vanek, 1960	0 0 1 0 1 0 0		
199. <i>T. minor</i> Berlese, 1903 (*)	3 3 5 3 4 1 0		
200. <i>T. sarekensis</i> Trägårdh, 1910 (*)	4 5 4 2 3 2 0		
201. <i>T. velatus</i> (Michael, 1880) (*)	4 4 4 5 5 5 5		
Autognetidae			
202. <i>Autogmeta longilamellata</i> (Michael, 1885)	3 0 1 1 1 1 0		
203. <i>A. penicillum</i> Grandjean, 1960	1 0 0 0 0 0 0		
204. <i>A. willmanni</i> (Dyrdowska, 1929)	0 0 0 2 1 0 0		
205. <i>Conchogneta dalecarlica</i> (Forsslund, 1947)	0 0 1 0 1 0 0		
Cymbaeremaeidae			
206. <i>Cymbaeremaeus cymba</i> (Nicolet, 1855)	0 1 0 1 1 1 0		
Micreremidae			
207. <i>Micreremus brevipes</i> (Michael, 1888)	5 2 1 1 1 1 0		
Varia			
208. <i>Cultroribula bicultrata</i> (Berlese, 1904)	1 1 2 3 4 4 1		
209. <i>C. sp. 1</i>	0 0 0 0 1 1 0		
210. <i>Machuelia draconis</i> Hammer, 1961	3 1 2 0 1 0 0		
211. <i>Pantelozetes paolii</i> (Oudemans, 1913)	1 1 1 1 0 0 0		
212. <i>P. pectinata</i> (Michael, 1885)	0 1 0 2 0 0 0		
213. <i>P. sp. 1</i>	0 0 0 0 1 0 0		
APHEREDERMA PORONOTICAE			
Licneremaeidae			
214. <i>Licneremaeus licnophorus</i> (Michael, 1882)	0 0 0 1 1 1 0		
Scutovertexidae			
215. <i>Provertex sp.</i>	0 0 0 0 1 0 0		
216. <i>Scutovertex sp.</i>	0 1 0 0 0 0 0		
Achipteridae			
217. <i>Achipteria coleoprata</i> (Linnaeus, 1758)	1 3 3 4 3 3 0		
218. <i>A. nitens</i> (Nicolet, 1855)	1 0 1 1 0 0 0		
219. <i>Parachipteria punctata</i> (Nicolet, 1855)	4 1 1 1 1 2 4		
220. <i>P. willmanni</i> v. d. Hammen, 1952	0 0 0 1 1 2 2		
Pelopsidae			
221. <i>Eupelops acromios</i> (Hermann, 1804)		1 1 0 1 1 0 1	
222. <i>E. cf. curtipilus</i> (Berlese, 1916)		0 0 0 0 1 0 0	
223. <i>E. cf. occultus</i> (Koch, 1836)		2 1 0 1 1 2 0	
224. <i>E. plicatus</i> (Koch, 1836)		1 2 2 1 2 0 2	
225. <i>E. cf. ureaceus</i> (Koch, 1840)		0 0 0 1 1 1 0	
226. <i>E. sp. 1</i>		0 0 0 0 1 0 0	
227. <i>E. sp. 2</i>		0 1 0 0 0 0 0	
228. <i>E. sp. 3</i>		0 0 0 0 1 0 0	
229. <i>E. sp. 4</i>		0 1 0 0 0 0 0	
230. <i>Peloptulus phaeonotus</i> (Koch, 1841)		0 0 0 0 0 0 1	
Oribatellidae			
231. <i>Joelia fiorii</i> (Goggi, 1898)		0 0 0 0 1 0 0	
232. <i>Ophidiotrichus cf. tectus</i> (Michael, 1884)		1 2 5 4 5 3 0	
233. <i>Oribatella calcarata</i> (Koch, 1836)		3 3 2 3 3 1 1	
234. <i>O. quadricornuta</i> (Michael, 1884)		2 3 2 2 2 3 0	
235. <i>O. reticulata</i> Berlese, 1916		0 0 0 1 0 1 0	
Ceratozetidae			
236. <i>Ceratozetes gracilis</i> (Michael, 1884)		3 3 4 3 2 1 1	
237. <i>C. mediocris</i> Berlese, 1908		0 1 0 1 1 1 0	
238. <i>C. cf. minimus</i> Sellnick, 1928		0 0 0 1 0 0 0	
239. <i>C. peritus</i> Grandjean, 1951		1 2 3 1 1 0 0	
240. <i>Diapterobates humeralis</i> (Hermann, 1804)		2 0 1 1 1 0 0	
241. <i>Eduardozetes edwardsi</i> (Nicolet, 1853)		5 1 0 1 1 1 4	
242. <i>Fuscozetes fuscipes</i> (Koch, 1841)		1 0 1 1 0 0 3	
243. <i>Latilamellobates incisellus</i> (Kramer, 1897)		0 1 0 0 1 0 0	
244. <i>Melanozetes meridianus</i> Sellnick, 1928		0 0 0 0 0 1 0	
245. <i>M. mollicornus</i> (Koch, 1839)		0 0 1 1 1 2 1	
246. <i>Trichoribates novus</i> (Sellnick, 1928)		0 0 0 1 0 1 0	
247. <i>T. trimaculatus</i> (Koch, 1836)		0 0 0 0 0 0 1	
248. <i>T. sp. 1</i>		0 0 1 1 0 0 0	
Humerobatidae			
249. <i>Humerobates rostrilamellatus</i> Grandjean, 1936		0 1 0 1 1 1 0	
Euzetidae			
250. <i>Euzetes globulus</i> (Nicolet, 1855)		3 5 4 3 3 1 2	
Mycobatidae			
251. <i>Mycobates tridactylus</i> Willmann, 1929		0 0 0 0 0 1 0	
252. <i>Minuthozetes pseudofusiger</i> (Schweizer, 1922)		2 0 1 0 1 0 0	
253. <i>M. semirufus</i> (Koch, 1841)		3 4 3 5 3 4 2	
254. <i>Punctoribates punctum</i> (Koch, 1839)		3 3 1 1 1 1 1	
255. <i>P. sellnicki</i> Willmann, 1928		0 0 0 0 0 0 1	
Chamobatidae			
256. <i>Chamobates cf. borealis</i> (Trägårdh, 1902) div.		3 4 3 2 3 3 0	
257. <i>C. cf. cuspidatus</i> (Michael, 1884)		2 3 3 3 4 5 0	
258. <i>C. cf. pusillus</i> (Berlese, 1895)		0 0 0 1 1 2 0	
259. <i>C. cf. schützi</i> (Oudemans, 1902)		2 1 1 0 1 0 0	
260. <i>C. sp. 1</i>		0 1 0 0 0 0 0	
Galumnidae			
261. <i>Acrogalumna longiplumum</i> (Berlese, 1904)		0 1 0 0 1 0 0	
262. <i>Allogalumna sp. 1</i>		0 1 0 0 0 0 0	
263. <i>A. sp. 2</i>		0 0 0 1 1 0 0	
264. <i>Galumna alata</i> (Hermann, 1804)		3 1 0 1 1 0 0	
265. <i>Galumna laevis</i> (Oudemans, 1900)		3 3 4 5 4 1 1	
266. <i>Pergalumna nervosus</i> (Berlese, 1915)		1 0 1 0 1 0 2	
267. <i>Pilogalumna allifera</i> (Oudemans, 1915)		0 0 0 1 0 0 0	
268. <i>P. tenuiclavus</i> (Berlese, 1908)		0 2 0 1 1 0 0	
Haplozetidae			
269. <i>Haplozetes sp.</i>		0 0 1 1 0 0 0	
270. <i>Protoribates cf. badensis</i> Sellnick, 1928		0 0 0 0 0 1 0	
271. <i>P. cf. capucinus</i> Berlese, 1908		1 0 0 1 1 1 0	
272. <i>P. cf. lagenulus</i> (Berlese, 1904)		0 0 0 0 1 1 0	
273. <i>P. sp. 1</i>		1 0 0 0 0 0 0	
274. <i>P. sp. 2</i>		0 0 0 0 1 0 0	
Scheloribatidae			
275. <i>Domatorina plantivaga plantivaga</i> (Berlese, 1895)		5 3 2 2 0 0 0	
276. <i>Hemileius initialis</i> (Berlese, 1908)		3 2 3 3 3 1 2	
277. <i>Liebstadia humerata</i> Sellnick, 1928		1 1 0 1 0 0 1	
278. <i>L. similis</i> (Michael, 1888)		0 1 1 1 1 3 3	
279. <i>L. similis</i> (Michael, 1888) ssp. 1		0 1 0 0 0 0 0	
280. <i>Schelorbitates laevigatus</i> (Koch, 1836)		0 2 1 1 1 0 3	
281. <i>S. latipes</i> (Koch, 1844) div.		0 1 1 1 1 0 1	
282. <i>S. pallidulus</i> (Koch, 1841)		0 1 1 1 0 0 3	
Oribatulidae			
283. <i>Oribatula tibialis</i> (Nicolet, 1855) div.		2 3 4 5 4 3 1	
284. <i>Zygoribatula exilis</i> (Nicolet, 1855)		1 1 0 1 1 1 0	