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# NOTES ON THE ECOLOGY OF CORTICOLOUS EPIPHYTE DWELLERS

## 3. ORIBATIDA

BY H. M. ANDRÉ \*

ORIBATIDA,  
CORTICOLOUS,  
COMMUNITY

SUMMARY : Corticolous microarthropod communities have been analyzed in 3 sites located in Belgian Lorraine and related to their microhabitat (epiphytic cover), to phorophytes and sites. Oribatida represent *ca* 34 % of corticolous arthropods and 36 species were recorded out of a total of nearly 19000 oribatid mites. At the population level, six common species are studied in relation to seasons and habitats. At the community level, the structure and composition of oribatid taxocenoses are analyzed in relation to habitat and compared with the community properties observed by studying Arthropoda as a whole.

ORIBATIDA,  
CORTICICOLES,  
COMMUNAUTÉ

RÉSUMÉ : Les communautés de microarthropodes corticicoles ont été étudiées dans 3 sites de Lorraine belge et analysées en relation avec leur microhabitat (couvert épiphytique), les phorophytes et les sites. Les Oribates représentent quelques 34 % des Arthropodes ; près de 19000 individus répartis en 36 espèces ont été récoltés. Au niveau des populations, la distribution des 6 espèces les plus communes est décrite en fonction des saisons et de l'habitat. Au niveau des communautés, la structure et la composition des oribatocénoses sont analysées en relation avec l'habitat et comparées à celles de la communauté formée par l'ensemble des Arthropodes corticicoles.

### 1. INTRODUCTION.

As outlined in the previous paper (ANDRÉ, 1983), corticolous communities have been neglected by ecologists despite their relative simplicity and the peculiarity of their component populations. In addition, the few studies devoted to the description of corticolous communities deal with only one taxonomic order generally, for instance, with *Collembola* or *Oribatida*.

With respect to corticolous *Oribatida*, the only two detailed studies were carried out by TRAVÉ

(1963) who distinguished several synusiae, and by SUBIAS (1977). This paper reports further investigations on corticolous oribatid mites and extends the previous paper devoted to *Collembola* (ANDRÉ, 1983).

### 2. MATERIAL AND METHODS.

#### 2.1. Location of study sites.

The survey was undertaken in Belgian Lorraine (southern Belgium). Three sites located at the

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same altitude (235-285 m) on the north slope of the Bajocian-Bathonian cuesta were visited : from East to West, Ruelle, St-Mard A and St-Mard B (see map in ANDRÉ, 1983).

## 2.2. Experimental design.

Eighteen sets of 100 samples were sampled as detailed in appendix I. Each set is defined by a peculiar combination, site  $\times$  phorophyte species  $\times$  epiphyte species. Besides, each set is composed of 4 series of 25 examples taken during four successive seasons (March 1973-April 1974).

## 2.2. Sample collection and processing.

All samples were taken on trunks from 1 to 3 m above the soil level. As the efficiency of any method varies widely according to the substrate, samples were treated differently depending on the epiphytes and phorophytes :

- a) Sampling algae on hornbeam was done merely by brushing the bark (5  $\times$  5 cm) as described by ANDRÉ & LEBRUN (1979) ;
- b) adjacent cores of foliose lichens and other crustose epiphytes with the underlying bark constituted a sample (25 cm<sup>2</sup> or less) ; they were cut out with two punches (dia. 14 and 23 mm) and put into a plastic bag for transport to the laboratory ; epiphytes were brushed or peeled off in the laboratory before putting the cores (bark discs + epiphytes) on the Berlese-Tullgren ;
- c) fruticose lichen thalli were detached from bark with a knife, also put into a plastic bag for transport, weighed in the laboratory and directly submitted to the funnel extraction.

All sample handlings were performed over a large white sheet of paper to prevent animals (especially Collembola, spiders, *Orchestes* spp., etc.) from escaping unnoticed.

Funnels used for the extraction are described in

detail by ANDRÉ & LEBRUN (1979). In any case, the samples were smoked-out at the beginning of the extraction<sup>1</sup>, held in the funnels for about 8 days (but the light bulbs were used only after the 2nd day). Fruticose lichens were weighed a second time after the extraction (dry weight).

## 2.4. Sorting and identification.

Animals were sorted under a dissecting microscope (magnification 25 to 63  $\times$ ). Oribatid immatures and *Tectocephus* adults were all cleared with lactic acid, mounted in cavity slide and identified (species and stase) under a light microscope equipped with phase contrast. Most other adults were identified under the dissecting microscope.

## 2.5. Data analysis.

As explained previously (ANDRÉ, 1983), data were analyzed globally, *i.e.* data belonging to the same series are pooled together and form a relevé. For the community analysis, relevé abundances are expressed in pourcentages (relative abundances). The classification of the 72 relevés was yielded by the OSUCL4 program, a classification around variable centers algorithm (ANDRÉ, 1981). Similarity between different classifications was estimated by using the GOODM program (GOLDSTEIN & GRIGAL, 1972). As an ordination technique, detrended correspondence analysis was selected and the DECORANA program (HILL & GAUCH, 1980) used. Species diversity in figures 3 and 4 is estimated through HILL's (1973) index,  $N_2$ , which is the inverse of SIMPSON's index. Diversity charting in figure 3 was drawn by using the DAVAUD's (1975) algorithm.

## 3. RESULTS.

Oribatida represent 33.6 % of the arthropods collected and 36 species<sup>2</sup> were recorded out of a total of nearly 19000 oribatid mites. Six of them

1. Smoking out seems to be particularly efficient against Collembola which spring down into the alcohol and spiders which let themselves fall along their thread.

2. These species are listed in appendix II.

were represented by more than 200 individuals and therefore will be studied at the population level.

### 3.1. Population distribution.

Figure 1 shows the distribution of the 6 most abundant species in the 3 study sites and the 3 types of epiphytes.

Three species are more abundant in foliose lichens than in other epiphytes : *Trichoribates trimaculatus* (Koch) which is abundant in St-Mard B and virtually absent in Ruelle, *Eueremaes oblongus* (Koch) which, conversely, is abundant in Ruelle but nearly absent in St-Mard B, and *Phaulloppia lucorum* (Koch) which is common in St-Mard A. Their frequencies observed in foliose lichens are, respectively, 32.8, 30.1 and 14.8 %. The 3 species are considered to be saxicolous/arboreicolous by TRAVÉ (1963). According to KUNST (1959), *Ph. lucorum* is a characteristic species of lichens growing on trees. High abundances of this mite have been recorded in foliose lichens such as *Parmelia saxatilis* (MACNEILL, 1966 ; COLOFF, 1983) or *Xanthoria parietina* (SEAWARD, 1974 ; GILBERT, 1976 ; COLOFF, 1983) but also in fruticose lichens such as *Cladonia* sp. (SEAWARD, 1974), *Anaptychia fusca* (COLOFF, 1983) or *Ramalina siliquosa* (GJELSTRUP & SØCHTING, 1984) and in crustose epilithes such as *Lecanora atra* and *Haematomma ochroleucum* (GJELSTRUP & SØCHTING, 1984). The last two authors even conclude that *Ph. lucorum* is relatively non-specific with respect to the lichen in which it lives. However, ANDRÉ (1976) already noticed it was more abundant in foliose than in crustose epiphytes. Some evidence does exist that *Ph. lucorum* is, at least in part, lichenophagous (MACNEILL, 1966 ; COLOFF, 1983). *T. trimaculatus* was also found more abundant in foliose than in crustose lichens growing on bark in orchards (ANDRÉ, 1976). On maritime rocks, this oribatid mite is also closely associated with foliose lichens, especially with *Xanthoria parietina* (GJELSTRUP & SØCHTING, 1984).

*Cymbaeremaes cymba* (Nicolet) is also a corticolous species, precisely a saxicolous arboreal one

(TRAVÉ, 1963 ; SUBIAS, 1977). It was found both in foliose and crustose epiphytes, particularly in St-Mard, but never in fruticose lichens.

*Carabodes labyrinthicus* (Michael) is a special case as this species is not confined to arboreal or similar habitats. Practically, it was found only in Ruelle, on birch where it is pretty abundant in *Lecanora conizaeoides* (21 individuals/dm<sup>2</sup> in spring) and on ash where it is common in foliose and fruticose lichens (7 individuals/dm<sup>2</sup> in winter). Only 4 individuals (out of 756) were found on poplar. Little specificity of *C. labyrinthicus* as to the lichens in which it lives is also noticed by GJELSTRUP & SØCHTING (1984).

*Domitorina plantivaga plantivaga* (Berlese) is an arboreal species (GRANDJEAN, 1951 ; TRAVÉ, 1963, 1969) and is obviously confined to crustose lichens as suggested by the results of TRAVÉ (1963) and ANDRÉ (1976). It is the most abundant and frequent arthropod in powdery surface epiphytes such as the algae (frequency 166/193 i.e. 86.0 %) and the lichen *Lecanora conizaeoides* covered with soredia (frequency 147/200 i.e. 73.5 %). In St-Mard A (in algae and *L. conizaeoides* on chestnut), its local density may exceed 1000 individuals/dm<sup>2</sup> or even reach 1500 individuals/dm<sup>2</sup>. Its abundance is much lower in crustose lichens with small thallus as *Lecanora chlorotera* or *Lecidea limitata* where, for instance its frequency drops to 29.7 % (89/300) and its spring density is ca 10 individuals/dm<sup>2</sup> ; it is however the only one constant inhabitant colonizing such small thalli. Recall that *D. plantivaga* feeds on lichens (GRANDJEAN 1951 ; TRAVÉ, 1963, 1969) and, specially, on *L. conizaeoides* (ANDRÉ, 1975). As crustose lichens supply the mite with "board and lodging", *D. plantivaga* could be considered as a parasite of lichens *sensu* MARSHALL (1981).

Figure 1 still prompts two comments. First, there is no seasonal variation in the oribatid mite density ; roughly, their density remains steady during the whole year. Second, for most species, larvae and the other immature stases were observed on the trunks, as well as teneral adults and gravid females. This suggests that species illustrated in figure 1 spend their whole life cycle on bark. However, results do not reveal any

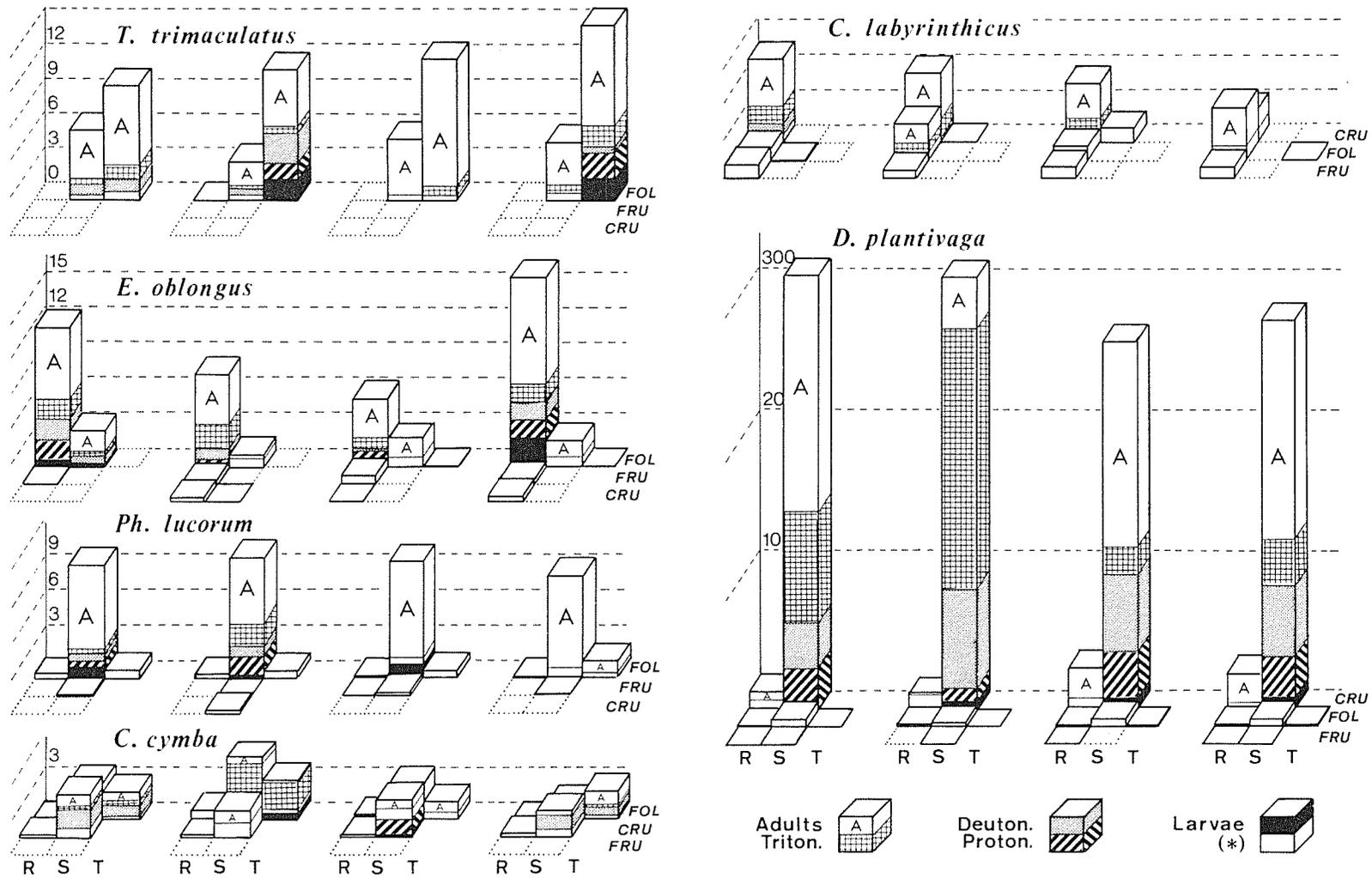


FIG. 1 : Distribution of 6 oribatid species in the 3 study sites (R : Ruette ; S : St-Mard A ; T : St-Mard B) and in the 3 types of epiphytes (Fol. : foliose ; Fru : fruticose ; Cru : crustose) during the 4 seasons (4 stereograms in line represent successively spring, summer, autumn and winter data). Densities are expressed either in number of individuals/dm<sup>2</sup> (foliose and crustose epiphytes) or in number of individuals/g of dried lichens (fructicose lichens). Note that the density scale relating to *D. plantivaga* differs from the others. (\*) : other stases than those indicated in the diagram.

clear life cycle, except for *D. plantivaga* and *C. cymba*. These two species spend the drought period, *i.e.* the summer, as immatures (83.4 % of immatures for *C. cymba*, 87.7 % for *D. plantivaga*).

### 3.2. Community structure and composition.

The clustering program applied to Oribatida (adults + immatures) leads to the construction of a dendrogram<sup>3</sup>. Partitionings into 3, 6 and 12 classes are illustrated in figure 2 which represents the DCA ordination of the same data.

Three major classes are clear-cut in figure 2. The major class at the right is characterized by the abundance of *T. trimaculatus* and comprises sample series from foliose and fruticose lichens in St-Mard. The middle class groups oribatocenoses dominated by *D. plantivaga* and observed in crustose epiphytes. The major class at the left is characterized by the abundance of *C. labyrinthicus* and *E. oblongus* and is composed of series taken in Ruelle. However at this partitioning level, classes are very heterogeneous<sup>4</sup>.

Partitioning into 6 clusters leads to the recognition of the 6 classes numbered in figure 2. The species composition of the 6 centroids is illustrated in figure 3. However, this partitioning does not yet allow the distinction of classes related to the epiphyte type as does the classification based on all the arthropods. To get such a classification, a partitioning into 12 classes is necessary as shown in figure 2A.

Classes 1, 2 and 3 are observed in foliose and fruticose lichens in St-Mard and characterized by the abundance of *T. trimaculatus*. In class 1, *Ph. lucorum* is the dominant species (54.2 %  $\pm$  4.0); this class comprises the 4 series sampled in *P. sulcata* on *Populus* in St-Mard A. It is roughly similar to the *Phauloppia lucorum*-*Ameronothrus maculatus* association found on rocks by GILBERT (1976) and COLOFF (1983) and to the *Ph. lucorum*-*Tectocephus sarekensis* association

observed in foliose lichens in orchards by ANDRÉ (1976). Class 2 is characterized by the dominance of *T. trimaculatus* (57.0 %  $\pm$  10.2). Subclass 2a is an outlier (*Physcia pulverulenta* on *Populus* in St-Mard B in spring) with 3 dominant species; subclass 2b comprises all the other series collected in foliose lichens on *Populus* in St-Mard B and dominated by *T. trimaculatus* (61.7 %  $\pm$  6.2) with *C. cymba* as subdominant (12.0 %  $\pm$  6.8); subclass 2c consists of the 4 series of fruticose lichens sampled in St-Mard A with *T. trimaculatus* as dominant Oribatida (51.3 %  $\pm$  4.9) and *Ph. lucorum* as subdominant (31.7 %  $\pm$  12.0). Class 3 is composed of the 4 series of *P. sulcata* collected on *Aesculus* in St-Mard A; *T. trimaculatus* (23.3 %  $\pm$  3.9) and *D. plantivaga* (26.4 %  $\pm$  5.4) are both dominant; the abundance of the latter species is explained by a phytocenosis largely dominated by *L. conizaeoides* and *P. viridis* following to the constant peeling of the chestnut bark.

Class 4 is characterized by the high dominance of *D. plantivaga* (88.0 %  $\pm$  11.8) and groups all the series sampled in crustose lichens except those collected on birch. It corresponds to the *D. plantivaga* oribatocenosis already described by TRAVÉ (1963) and ANDRÉ & LEBRUN (1979). Subclass 4a differs by the abundance of *E. oblongus* (16.5 %) and was observed twice in Ruelle in *L. chlarofera*.

Classes 5 and 6 are very close in figure 2 and the similarity of their composition is well displayed in figure 3. Roughly, class 5 corresponds to a *C. labyrinthicus* (63.7 %  $\pm$  16.9) oribatocenosis found in crustose and fruticose lichens while class 6, characterized by *E. oblongus* (65.3 %  $\pm$  13.1), is observed in foliose lichens. Both classes are confined to Ruelle. Subclass 5a and 5b are observed in fruticose lichens and dominated by *C. labyrinthicus* and *E. oblongus*. Subclass 5b, recorded on ash, is also characterized by the abundance of *Oribatella quadricornuta* and *Tectocephus sarekensis*. Subclass 5c is a *C. labyrinthi-*

3. Contrary to other clustering programs, the output of OSUCL4 is not necessarily a hierarchical dendrogram (ANDRÉ, 1981).

4. This is easily verified by analyzing the centroid composition and comparing the mean abundance of dominant species to their variance. Those results are detailed in the OSUCL4 output.

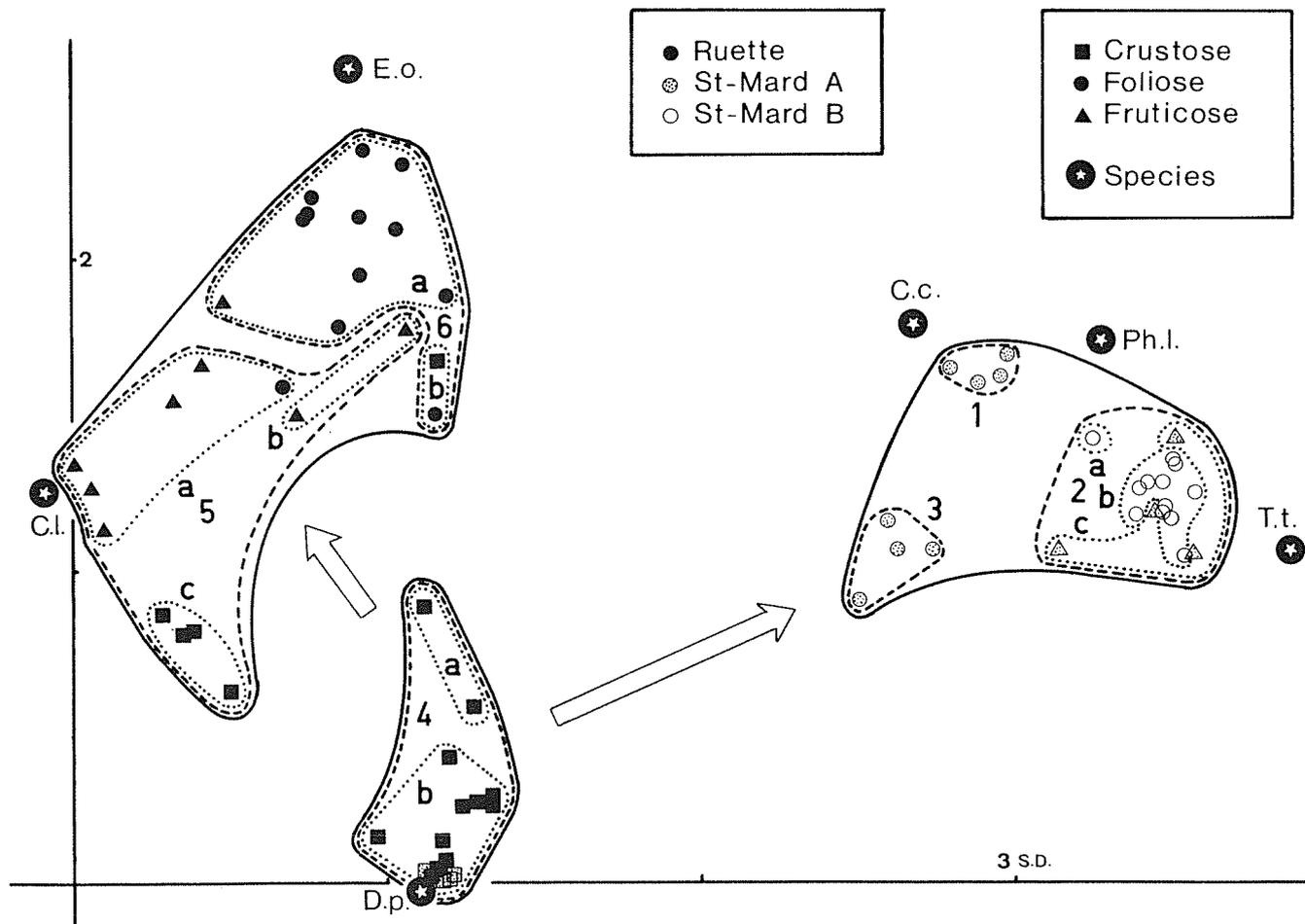


FIG. 2 : DCA ordination of oribatid species and the 72 relevés. The 3 major classes, classes and subclasses distinguished by OSUCL4 are delineated respectively by full, broken and dotted lines and designated by an alphanumeric ID code (C.l. : *C. labyrinthicus* ; C.c. : *C. cyba* ; D.p. : *D. plantivaga* ; E.o. : *E. oblongus* ; Ph.l. : *Ph. lucorum* ; T.t. : *T. trimaculus*).

*cus/D. plantivaga* oribatocenosis observed in *L. conizaeoides* on birch in Ruelle<sup>5</sup>. Class 6, specially subclass 6a, is peculiar to foliose lichens in Ruelle : *E. oblongus* is highly dominant (68.3 %  $\pm$  11.9 in subclass 6a) with *C. labyrinthicus* and *D. plantivaga* as associate species. Subclass 6b is a seasonal facies observed only twice in summer.

#### 4. DISCUSSION.

During this survey, 36 oribatid species have been recorded and are listed in appendix II. This number of oribatid species is not so much different from the species richness observed in various forest soils (see table II in WALLWORK, 1983).

5. This oribatocenosis could be widely distributed. It has also been observed in *L. conizaeoides* on beech and hornbeam in the neighborhood of Louvain-la-Neuve (Lauzelle wood, middle Belgium). GJELSTRUP (1979) points out a similar oribatocenosis (80 % *C. labyrinthicus* + 20 % *C. cyba*) in crustose lichens on beech.

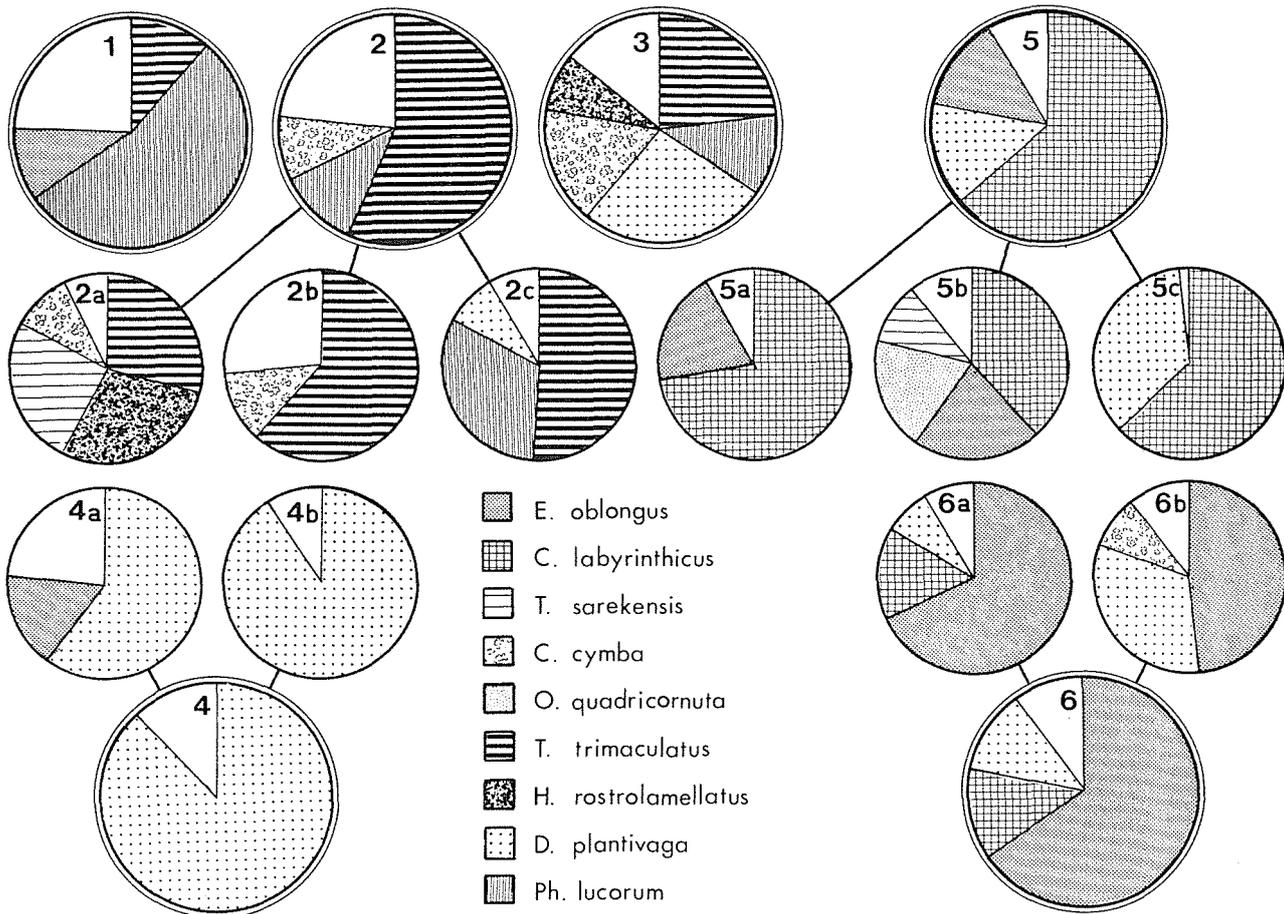


FIG. 3 : Centroid composition of the classes and subclasses delineated in figure 2, with the same ID code.

The mean density of oribatid mites observed in crustose and foliose lichens (as a whole) and integrated over all the year is *ca* 53 individuals/dm<sup>2</sup>. This is much lower than densities recorded in various forest soils (see table I in WALLWORK, 1983). Actually, this gap between the densities on bark and in forest soils comes to very little if the litter is considered as a real 3-dimensional structure in opposition to epiphytes, especially crustose lichens, which are virtually 2-dimensional habitats.

Among the Oribatida, the most frequent and abundant species is *D. plantivaga plantivaga* although it is confined to crustose epiphytes. *C. cymba* is also common in crustose epiphytes but is as abundant in foliose lichens. *T. trimaculatus*, *E. oblongus* and *Ph. lucorum* are the most abun-

dant in foliose lichens. These results support the hypothesis that oribatid mite distribution is *clearly related to the epiphytic cover*, particularly the morphological type (crustose vs. foliose vs. fruticose). Superimposed onto the microdistribution, *Oribatida* reveal a *macrodistribution pattern clearly related to sites*. In particular, if three species are abundant in foliose lichens, they do not really coexist in so far as each of them is more or less confined to a particular site, i.e. to a continental island. Lastly, the results suggest that most Oribatida, except *Carabodes labyrinthicus* which is an ubiquitous species, avoid typical fruticose lichens such as *Evernia* or *Ramalina*, at least on bark. Although this conclusion should not be generalized (see for instance GJELSRUP & SØCHTING, 1979), it would be worthwhile making new

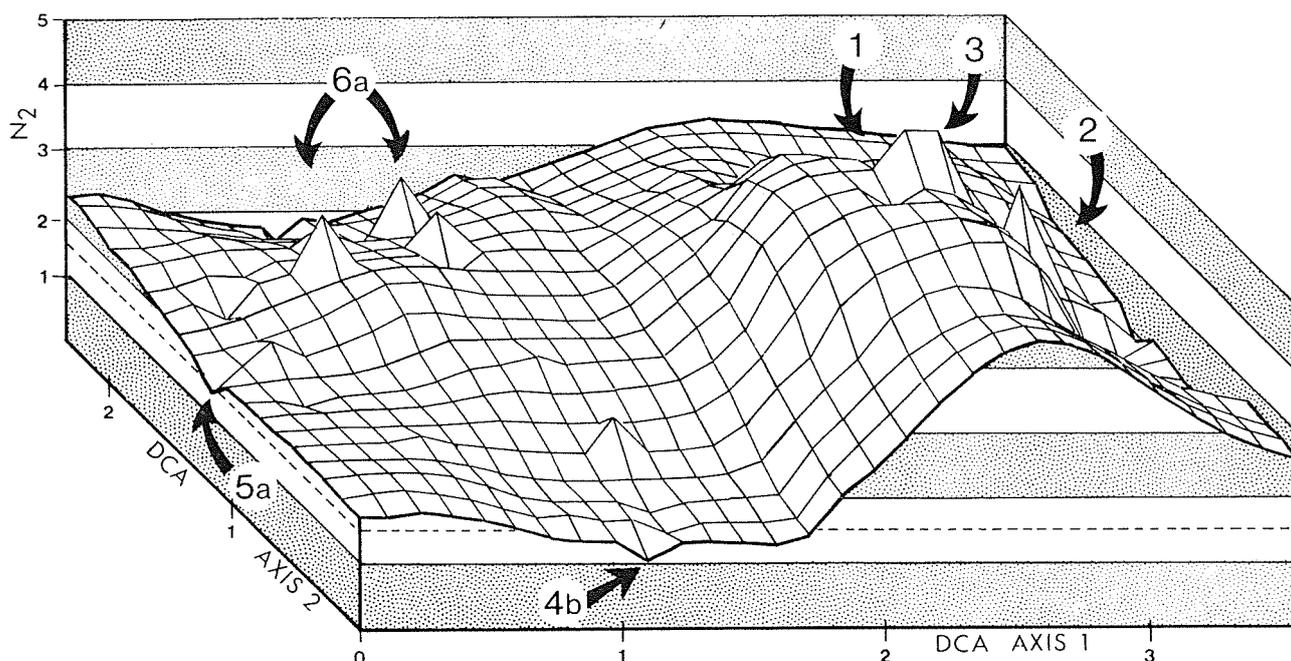


FIG. 4 : Three dimensional diagram showing the oribatid species diversity (estimated through  $N_2$ ) in the 72 series superimposed onto the DCA plane of figure 2. Locations of main classes are indicated by arrows with their ID code. The diagram clearly displays one valley corresponding to low diversities observed in the pioneer oribatocenoses (class 4) and bordered by two massifs corresponding to high diversities encountered in derived seral stages (classes 3, 6).

observations to confirm and possibly explain such a distribution pattern.

On the other hand, the foregoing data and subsequent conclusions sometimes seem to be inconsistent with other observations published in the literature. These seeming discrepancies might make the reader puzzled, especially if he refers to a recent review on the association of oribatid mites with lichens by SEYD & SEAWARD (1984). This masterly review consists of a comprehensive compilation of the literature but, in a way, might be misleading. For instance, *Dometorina plantivaga* is classed in group A, *i.e.* among species that are restricted to lichens as a biotope. But only 11 references giving records from lichens are listed vs 13 for records from non-lichen biotopes. Conversely, *Phauloppia lucorum* is classed in group B, *i.e.* with species also found living and feeding in other biotopes than lichens and 31 records from lichens are listed vs 20 from non-lichen biotopes. Yet, *Ph. lucorum* reaches densities up to 2300 individuals/dm<sup>2</sup> in some lichens

(SEAWARD, 1974), a level never observed elsewhere and the same is true for *D. plantivaga* (up to 1.500 individuals/dm<sup>2</sup>; see above). Problems arise because the literature almost exclusively consists of data gleaned by chance from here and there and generally does not refer to any abundance estimate (density, frequency, etc.). This clearly means that most discrepancies are more a reflection of the meager state of knowledge in this field than a real inadequacy of the review by SEYD & SEAWARD (1984). In fact, this review highlights the distressing lack of real ecological data based on a rigorous sampling design.

A comparison of Oribatida with corticolous Collembola (ANDRÉ, 1983) prompts two comments. First, there is no seasonal variation in the oribatid mite density similar to the summer trough observed in Collembola. Second contrary to Collembola, most corticolous oribatid species recorded in this study spend their entire life cycle on bark. These species, such as *Trichoribates trimaculatus*, *Eueremaeus oblongus*, *Phauloppia luco-*

rum, *Cybaeremaes cyba* and *Domitorina plantivaga* are thus "phloioibiotic" whereas Collembola are merely phloiophilous. In other words, bark constitutes a *permanent habitat* for those oribatid species while it is just a temporary substrate for Collembola <sup>6</sup>.

At the community level, three major classes can be distinguished. The arrows drawn in figure 2 suggest the following succession. The *D. plantivaga* oribatocenosis (class 4 in figure 2A) would constitute the pioneer community associated with pioneer crustose epiphytes colonizing the trunks. As shown in figure 4, this pioneer oribatocenosis is very poor, specially class 4a where the expected number of species is close to one following the high dominance by *D. plantivaga*. From this pioneer oribatocenosis different seral stages as suggested by arrows in figure 2 would be derived. These derived oribatocenoses are much more diverse <sup>7</sup> as clearly outlined in figure 4 and are related to macrohabitat factors, *i.e.* the sites interpreted as "continental" islands.

At a finer scale, six classes have been distinguished. Five of them are characterized by a highly dominant species, *i.e.* *Phauloppia lucorum* (class 1), *Trichoribates trimaculatus* (class 2), *Domitorina plantivaga* (class 4), *Carabodes labyrinthicus* (class 5) and *Eueremaes oblongus* (class 6) oribatocenoses. As suggested by figure 2, these classes are more or less related to the epiphytic cover; for instance, class 4 is definitely associated with crustose epiphytes. Surprisingly, these 6 classes are not mentioned or precisely described in the literature, except the *D. plantivaga* oribatocenosis. Paradoxically, the oribatocenosis the most often cited, *i.e.* the *Zygoribatula exilis* oribatocenosis (PSCHORN-WALCHER & GUNHOLD, 1957; TRAVÉ, 1963; LEBRUN, 1971; GJELSTRUP, 1979) was not observed in either study sites. Such an absence is however easily explained, for this oribatocenosis colonizes mosses, liverworts and foliose lichens in shady area (underwood) with a constant high humidity (TRAVÉ, 1963). This

means that most classes defined in this study would be characteristic of open space lands.

However, the relationships oribatocenosis-epiphytic cover suggested in figure 2 are not as well outlined as those defined between the arthropod communities and the epiphytes (ANDRÉ, 1984). The question arises as to whether the oribatocenosis composition and structure are a good indicator of the corticolous arthropod community properties. Table I summarizes the results yielded by a comparison between classifications based on different taxa. It turns out that 1. classifications based on Collembola and Oribatida are little similar; 2. the classification based on Oribatida is closer to the arthropod community classification than that based on Collembola; 3. the classification based on adults only is not too different from that based on all the oribatid stages. Another method of comparing arthropod communities to oribatid taxocenoses consists in analyzing their respective species diversities. The correlation between both species diversities measured through Hill's index,  $N_2$ , is rather poor as the correlation coefficient is only 0.28.

TABLE I : Similarity between classifications based on different taxa (upper triangular matrix : partition into 6 classes ; lower matrix : partition into 9 classes).

	Arthrop.	Oribat.	Or. ad.	Collemb.
1. Arthropoda	1.00	0.54	0.48	0.31
2. Oribatida	0.55	1.00	0.80	0.24
3. Oribatida adults	0.57	0.85	1.00	0.24
4. Collembola	0.34	0.27	0.25	1.00

## 5. CONCLUSIONS.

The oribatid mite distribution pattern is clearly related to the epiphytic cover (crustose vs. foliose vs. fruticose epiphytes) on one hand, and to the study sites (conceived as continental islands) on the other hand. Most corticolous Oribatida could

6. Even a corticolous species as *Entomobrya nivalis* returns down to the soil for ovoposition (ALLMEN & ZETTEL, 1982).

7. An exception is offered by few series sampled in fruticose lichens on *Fraxinus* (subclass 5a) whose expected number of species drops below 1.5.

be considered as phloibiontic species as they spend the entire life cycle on bark which constitutes for them a permanent habitat.

However, in spite of these interesting properties and even if Oribatida are a major component of the corticolous fauna, their study in isolation to other arthropod groups can not lead to a real understanding of the corticolous microcommunities. In particular, the oribatocenosis structure is a bad indicator of the whole arthropod community structure and diversity which are greatly affected by migrations of phloiphilous species.

#### ACKNOWLEDGEMENTS

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#### APPENDIX I

Characteristics of the 18 sets of 100 samples  
(epiphyte × phorophyte × site)

##### Crustose epiphytes :

- 1) *Protococcus viridis* on *Carpinus betulus* in Ruelle,
- 2) *P. viridis* on *Aesculus hippocastaneum* in St-Mard A,
- 3) *Lecidea limatata* on *Populus × canadensis* in Ruelle,
- 4) *Lecanora chlorotera* on *Fraxinus excelsior* in Ruelle,
- 5) *L. chlorotera* on *P. × canadensis* in Ruelle,
- 6) *L. conizaeoides* on *Betula pendula* in Ruelle,
- 7) *L. conizaeoides* on *A. hippocastaneum* in St-Mard A ;

##### Foliose lichens :

- 8) *Xanthoria parietina* on *P. × canadensis* in St-Mard B,
- 9) *Physcia pulverulenta* on *P. × canadensis* in St-Mard B,
- 10) *Parmelia acetabulum* on *P. × canadensis* in St-Mard B,
- 11) *P. acetabulum* on *F. excelsior* in Ruelle,
- 12) *P. sulcata* on *F. excelsior* in Ruelle,
- 13) *P. sulcata* on *P. × canadensis* in Ruelle,
- 14) *P. sulcata* on *P. × canadensis* in Ruelle,
- 15) *P. sulcata* on *A. hippocastaneum* in St-Mard A ;

##### Fruticose lichens :

- 16) *Evernia prunastri* on *P. × canadensis* in St-Mard A,
- 17) *E. prunastri* on *F. excelsior* in Ruelle,
- 18) *Ramalina farinacea* on *F. excelsior* in Ruelle.

#### APPENDIX II : List of species

Oribatid species are ranked by decreasing order of abundance. Names are followed by the number of individuals recorded and the site where species were collected (R : Ruelle ; S : St-Mard A ; T : St-Mard B).

1. *Dometorina plantivaga* (Berlense) (14896 - R, S, T)
2. *Trichoribates trimaculatus* (Koch) (1026 - R, S, T)
3. *Eueremaeus oblongus* (Koch) (919 - R, S, T)
4. *Carabodes labyrinthicus* (Michael) (756 - R, S, T)
5. *Phauloppia lucorum* (Koch) (535 - R, S, T)
6. *Cymbaeremaeus cymba* (Michael) (466 - R, S, T)
7. *Humerobates rostromellatus*  
Grandjean (189 - R, S, T)
8. *Tectocephus sarekensis* Trägårdh (162 - R, S, T)
9. *Camisia segnis* (Hermann) (107 - R, S, T)
10. *Camisia horrida* (Hermann) (52 - R, S, T)
11. *Micreremus brevipes* (Michael) (31 - R, S, T)
12. *Oribatella quadricornuta* (Michael) (23 - R, S, T)
13. *Liebstadia humerata* (Sellnick) (20 - S, T)
14. *Eupelops acromios* (Hermann) (19 - S, T)
15. *Phauloppia coineai* Travé (19 - S)
16. *Scheloribates cf. latipes* (Koch) (10 - S)
17. *Ceratoppia bipilis* (Hermann) (4 - S)
18. *Mycobates parmeliae* (Michael) (4 - S)
19. *Chamobates incisus* Hammen (3 - S)
20. *Oppia* spp. (3 - S)
21. *Quadroppia quadricarinata* (Michael) (3 - R)
22. *Zygoribatula exilis* (Nicolet) (3 - R, S)
23. *Belbidae* (undetermined) (2 - R)
24. *Galumnidae* (undetermined) (2 - S)
25. *Oribatida* undetermined (2 - R, S)
26. *Phthiracaridae* (undetermined) (2 - R)
27. *Suctobelba* spp. (2 - R)
28. *Brachychthonius* sp. (1 - S)
29. *Eueremaeus* sp. 2 (1 - T)
30. *Eupelops cf. oculatus* (1 - R)
31. *Liochthonius* sp. (1 - S)
32. *Platynothrus peltifer* (Koch) (1 - R)
33. *Punctoribates* sp. (1 - R)
34. *Sphaerobates cf. tricuspidatus*  
Willmann (1 - T)
35. *Tectocephus velatus* (Michael) (1 - T)
36. *Xenyllus clypeator* Rob.-Des, (1 - T)

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