ARTHROPOD CENOSIS OF THE LITTER STRATUM OF AN OAK FOREST.

By JÁNOS BALOGH and IMRE LOKSA.

(From the Hungarian Biological Research Institute, Tihany, Lake Balaton, and the Institute of Systematical Zoology of the Péter Pázmány University, Budapest.)

With 11 Tables in the text.

(Received for publication 18th December, 1947.)

In the following work we review briefly our quantitative investigation of the Arthropods living in the litter of dead leaves in a Hungarian oak forest. The territory is on the outskirts of Budapest, in the so-called "Vadaskert". According to ZÓLYOMI'S* analysis the oaks in question belong in the climatic climax community of the lower regions of the Magyar Középhegység (Central mountains of Hungary), in the consociation of the acidiphilous *Quercetum sessiles-cerridis pannonicus (= Querceto-Potentilletum albae pannonicum).* On the territory surveyed and in the immediate vicinity the canopy stratum is composed almost purely of *Quercus sessiliflora-petraea* (consociation), the shrub stratum (principally *Cornus sanguinea, Ligustrum vulgare, Evonymus verrucosa)* is richly developed, the field stratum in consequence being only very patchily covered, but none the less classifiable as of *Melica uniflora* type.

The *clayey loess* of the subsoil is deposited on *Kiscell clay* (according to the geological map). The A_0 horizont (leaf litter), is well developed on the area surveyed, the brownish, loose, humus-like A_1 horizont is moderately acidic, its pH at 0—5 cm is 5.5, while the lower, yellowish-red, clayey A_2 horizont is already distinctly acidic, with a pH of 4.3 at a depth of 10 cm (measured colorimetrically on freshly collected samples with a sala-indicator, KÜHN-SCHERF apparatus).

The purpose of our investigation was partly to establish the qualitative and quantitative composition of the cenoses living in this litter, partly to find suitable methods for the quantitative study of Arthropoda

* The plant sociological analysis was made by Dr. BÁLINT ZÓLYOMI, Private Docent. We take this occasion to thank him for his work.

fauna in such a habitat. For both purposes a relatively large area, 100 quadrate samples of 50x50 cm, was investigated, i. e., a territory of 25 m^2. In consequence of the relatively large size of the area and the large number of squares searched through, a huge number of Arthropods — several thousand — were worked upon. Partly for this reason, partly for lack of a suitable method, on this occasion animals of less than 2 mm were left out of account and only those Arthropods which were over 2—3 mm taken into consideration. We remark that in the meantime we have succeeded in working out a method for investigating these tiny creatures, but have not concluded it. It will therefore be dealt with in our next publication.

Our investigations were made essentially like those of an earlier work on a sandy area. In respect to ideas and methods we therefore refer the reader to our works appearing in this periodical (BALOGH & LOKSA 1948). In the oak forest now investigated we took a 5x5 m area which we divided into 100 squares of 50x50 cm. We took the litter from the different squares, quite down to the humus level, and put it into an insect-sieve, sifted it out, then emptied the debris which passed through into the sack of the sieve on to white paper and selected from it all the Arthropods to be found. This work was carried out on samples from 100 different squares, then the animals we removed were put into glass tubes numbered 1—100 to correspond with the series of 100 squares. Then the animals in each tube were identified and a list made of the contents of all 100 tubes, not only of the species to be found in the squares, but the number of individuals, degree of development and size. These 100 lists were the basis for further investigations, for with their help the fauna of a 5x5 m area could be reconstructed with complete exactitude and a true picture obtained of the Arthropods living there.

We set about working up the material in essentially the same way as mentioned earlier, in our previous work. In the first place we established the sociological characteristics of the more important species: the Constancy* (C), Abundancy (A), Production (P) and Dominancy (D). The equally important weight-dominancy, or Gravity (G) we could not give, as for that we should have had to establish the weight of all the species of Arthropods to be found on our area and this was impracticable in species of such small weight, occurring respectively in such small numbers. On the basis of the above four character-

* Most European botanists employ Frequency (F) instead of Constancy.

istics we chose the most important species of the area and from then on we analysed the cenoses largely concerning these. Finally, on all these points we tried to establish the structure of the cenosis existing in this litter.

As in most cenoses, in our investigation many species of Arthropods were to be found, but only a few of these play an important rôle in building up the cenosis. The number of individuals of these species is relatively very high, while that of the other species is less, even sometimes insignificant. It is characteristic of the species with large numbers of individuals that Abundancy, Dominancy, Constancy and even in most cases Production are also high, while in the other species of the cenosis all these values combined are never high. Hence on the basis of the four characteristics mentioned, the species playing an important part can be separated immediately from the others. On the area of our investigation the species with high characteristics were the following:

TABLE I.

Species with high characteristics (A, D, C, P) in the area surveyed.

Species	A* Ind./m²	D %	C 50×50 cm Q = 100	C 1×1 m Q = 25	P mg/m²
Hanseniella nivea Scop.	84.44	21.46	100	100	29.556
Lasius emarginatus Oliv.	62.68	15.93	33	60	37.620
Leptothorax unifasciata Latr.	49.08	12.47	97	100	26.940
Lithobius muticus Koch.	29.68	7.54	100	100	288.000
Campodea staphylinus Westr.	26.96	6.85	100	100	29.656
Monotarsobius austriacus, Verh.	18.84	4.78	88	100	41.680
Ophyiulus fallax Mein.	14.44	3.67	88	100	492.640
Myrmica ruginodis Nyl.	12.48	3.17	45	84	62.400
Protracheoniscus politus Koch.	11.80	2.99	80	100	188.800
Chelidura sp.	9.64	2.45	91	100	144.600
Total	320.04	81.34			1350.892

* see p. 265; Q = the number of spuares surveyed.

As we have already mentioned, the entire territory examined was 25 m², which we investigated by dividing it up into 100 samples of 50x50 cm. The total number of Arthropods found on this area was 9836, which calculated to 1 m^2 comes to 393.44 animals. Of the 10 species figuring in Table I. there were 8001; calculated to 1 m^2, 320.04. Hence these 10 species together repsesent 81.35% of the total number of Arthropods. The remaining 1835 specimens (73/m^2) belong to about 110 different Arthropods. Hence they play an inferior role in respect of numbers in building up the community and form altogether 18.66% of the entire Arthropod population.

In Table I. the above 10 species were ranged according to their decreasing A values (A = Abundancy, i. e., number of individuals occurring on 1 m^2). The D values of these species change parallel with the A value. But from the standpoint of the structure of the cenosis the C value is the most important, i. e., that characteristic which shows in what percent of the squares examined the species in question occurs. The ideal degree of value C is 100%, but in practice it is enough if we fix this limit at 80%. 8 species meet this condition in a square of 50x50 cm, 2 species, both of them species of ants, remain far below it. The explanation of this is that both these live in hills characterised by large numbers of individuals. Wherever an ant-hill occurred in the square investigated the numbers of individuals at once shot up, and on intervening areas sometimes dropped quite to zero. Hence the C value for ants is sometimes very low, though these Arthropods play an important part in the structure of the cenosis. In respect to the numbers of individuals of the 3 species of ants figuring in Table I., they form 31.6% of the whole Arthopod population. Ants have a very important role in the cenosis as carnivorous-necrophagous organisms. In the work cited above we have reviewed in detail the part they fill in the food-cycle of the cenosis, and have shown that in the *Festuca vaginata* sociation on sandy territories they are a characteristic element by virtue of their large numbers. Apparently in the litter of oak forests they also perform the same important activity and their relative numbers are also the greatest of all the life-forms there.

The *Hanseniella* represents the second life-form with a great number of individuals. But these animals are very tiny and because of their size are at the lower limit of the Arthropods considered in this investigation. If among the characteristics we consider the P value, i. e., the total weight in mgs of the *Hanseniella* on 1 m^2, we see that it is the smallest of almost any of the species. So we think that because of their small size their place should rather be among the Collembolae and Acarinae; as to their role, investigation of the micro-Arthropods now in progress will treat of it in detail.

Lithobius represents the third important life-form. The 2 dominant species, *Lithobius muticus* and *Monotarsobius austriacus,* together form more than 12% of the entire Arthropod fauna. But as the *Lithobius* is an animal of relatively large size, its P value well surpasses that of ants. As very active predaceous organisms they are among the most characteristic Arthropods of the litter.

These three life-forms together represent about 65% of the entire Arthropod population. In our work cited, analysing the *Festuca vaginata* sociation, we established that in the structure of the cenosis 2 life-forms („Grundform" DU REITZ) have an important part: that of the ants and of the Orthoptera. In other words, an "ants isoecium" *(isoecium*, GAMS) and a "grasshoppers isoecium" there give the cenosis its character. In the litter of the oak forest, on the other hand, the presence of an "ant isoecium" and a "*Lithobius* isoecium" is characteristic. Joined to this again are the life-forms with greater P value but smaller number of individuals. The most important among them is the group of detritiphagous Arthropods, the most important representatives of which are the *Ophyiulus fallax* and the *Protracheoniscus politus.* These together make 24.24% in A value, 6.66% in D value, while their P value is 681.44 mg/m², i. e., they form more than half the P value of the 10 dominant species together. It is probable that in some aspects of spring they get a leading rôle and as *"Diplopoda-Isopoda isoecium"* form the third characteristic component of the Arthropod cenosis in the litter .

Though the Arthropod cenosis of the litter in an oak forest forms a well-defined unity, it is convenient to treat it by separating it according to the more important systematic groups. In an earlier work (l. c.) we have shown that such an analysis is not artificial, as ecologicaly similar systematic groups really form one life-form. In our work cited we called these units *Partial sociations.* On the area investigated the following partial sociations can be distinguished:

TABLE II.

Structure of the partial sociation Leptothorax unifasciata-Lasius emarginatus-Myrmica ruginodis.

species	A Ind/m²	D %	C 50×50	C 1×1 m
Lasius emarginatus Oliv.	62.68	50.20	33	60
Leptothorax unifasciata Latr.	49.08	39.31	97	100
Myrmica ruginodis Nyl.	12.48	9.99	45	84
(3 other species)	0.60	0.50	—	—

As is shown in T a b l e II, the average number of ants found on the area per m^2 was 124.84. 124.24 of these belong to the 3 species mentioned, i. e., most of the population. The D value of the first three species together was 99.50. In respect to C value in a 50×50 cm square only the *Leptothorax* reached the 80% constancy value (C = 97); but on a square of 1 m^2 the *Myrmica* also (C = 84). These two species live in ant-hills containing relatively few individuals fairly evenly scattered over the area, while the *Lasius* lives in populous but widely-scattered hills. This explains how the *Lasius* with a relatively low C value shows a high D value and in respect to numbers of individuals is the most important component of the entire partial sociation. Though in our view a high C value is the most important criterion of the structure of any cenosis, in the case of the ants exception must be made. For that reason we also employ the *Lasius* in characterising the partial sociation.

TABLE III.

Structure of the partial sociation Lithobius muticus-Monotarsobius austriacus.

species	A Ind/m^2	D %	C 50×50 cm	C 1×1 m
Lithobius muticus C. Koch	29.68	57.47	100	100
Monotarsobius austriacus Verh.	18.84	36.48	88	100
(8 other species)	1.56	6.04	—	—

In T a b l e III. we summarize the centipedes belonging in the *Lithobiomorpha* and *Geophilomorpha* groups found on the territory examined, i. e., carnivorous Arthropods with a similar mode of life. The whole partial sociation is made up of 10 species, but in respect to number of individuals *Lithobius muticus* and *Monostarsobius* form 93.95% of all the specimens, the other 8 species representing altogether only 6.04%. Because of their low D value neither does the A value of these species reach 1, which in other words means that their density remains below 1 per m^2, i. e., typical accidental species. The 8 species are the following: *Lithobius mutabilis* L. Koch, *Lithobius dentatus* C. L. Koch, *Lithobius erythrocephalus* C. L. Koch, *Lithobius forficatus* L., *Geophilus insculptus* Att., *Geophilus longicornis* Leach, *Scolioplanes acuminatus* Leach, *Schendyla nemorensis* C. L. Koch.

TABLE IV.
Structure of the partial sociation Ophyiulus fallax-Protracheoniscus politus.

species	A Ind/m²	D %	C 50×50 cm	C 1×1 m
Ophyiulus fallax Mein.	14.44	45.06	88	100
Protracheoniscus politus Koch	11.80	36.82	80	100
(4 other species)	5.80	18.12	—	—

In Table IV. two groups taxonomically remote but related in respect to their life-forms are summarized: the Isopoda (Malacostraca) and the Diplopoda centipedes. Both groups have the common characteristic that they are detritiphagous, i. e., not carnivorous, Arthropods and that there is a great deal of calcareous matter deposited in their chitin shells. They usually occur together, where Isopods are found we nearly always find Diplopods too. 6 species live on our area: the *Ophyiulus* and *Protracheoniscus* figuring in our Table, and four species not yet named: *Orthometopon planum*, a *Julus* not more exactly identified, one *Glomeris* and one *Polydesmus* species. Among the 6 species figuring in the Table, two comprise 81.88% of the entire population, therefore the D value of these two species is much greater than of all the other four together. The C value of these species reaches 80% on a 50×50 cm square, so that in respect to constancy they also fulfill the criteria established. It is probable that in the litter of other types of forest this partial sociation is replaced by others; in a word, decidedly varied partial sociations represent the *Diplopoda-Isopoda* isoeciae.

Partial sociation of the *Coelotes longispina.*

The partial sociation of the spiders differs essentially from the groups thus far considered, for it is composed of relatively many species but of only low D value. For just this reason it is difficult to establish which among the many species has an important role in the construction of the partial sociation.

TABLE V.
Structure of the partial sociation Coelotes longispina.

species	A Ind/m²	D %	C 1×1 m	C 2×2 m
Harpactes cfr. rubicundus (C. L. Koch)	5.88	19.61	96	100
Coelotes longispina Kulcz.	3.96	13.21	92	100
Linyphia sp.	1.88	6.27	92	100
Lycosa ruricola (De Greer)	1.28	4.27	80	100
(about 26 other sp.)	16.36	56.64	—	—

As we see, of the 30 species comprising the partial sociation there are altogether four whose C value calculated to 50×50 cm reaches the 80% limit. These four species together represent 13 average A values on 1 m^2, their D value, i. e., number of individuals in relation to the other 26 species, is altogether 43.36%. Therefore here the number of the highly characteristic species altogether is much lower than that of the less characteristic, accidental species. This means, in other words, that the partial sociation of the spiders cannot be characterised by 2—3 species as in the case of the preceding groups. The cause for this is probably that many such species of spiders sometimes get into the litter of an oak forest but do not live there constantly in great numbers. These occasional species dilute the partial sociation and make the survey difficult. In such cases there is only one basis for analysing the cenosis: to take into consideration exclusively the species with high C value. But even with these we must make a selection among the species, for we must leave out of consideration 2 species with high C value, the *Harpactes* and the *Linyphia.* The *Harpactes* because they are represented only by very young specimens recently emerged from the egg, hence their presence in large numbers is of only transitory significance, the *Linyphia* because in reality they belong not to the litter cenosis but to the surface of the ground below it, and only got into the community through the technicalities of the investigation. In respect to the characteristics of the remaining two species, the *Coelotes* is the more important, while the *Lycosa,* because of its low A and D values, is only slightly different from a part of the 26 species not taken into the Table. It is probable that in the different seasons easily distinguishable aspects are formed and that in the different types of forest the spiders are represented by varying "spider-isoecia". These probable *partial sociations* are certainly characterised by one or another of those species which at the time of the investigation (autumn) derive from the ranks of the species with lower, 40—80% C value. These species are the following: (in parenthesis after the name we also give the C value calculated to 1×1 m). *Centromerus* sp. (C = 72%), *Pardosa lugubris* (Walck) (C = 68%), *Bathyphantes* sp. (C = 68%), *Apostenus fuscus* Westr. (C = 64%), *Scotina celans* (Blackw.) (C = 60%), *Drassodes* sp. (C = 56%), *Xysticus* sp. (C = 56%), *Robertus* sp. (C = 40%). The C value of the other, about 18, species is even much lower than these.

Members of the partical sociation *Hanseniella nivea — Compodea* *staphylinus* are small creatures which because of their size belong partly to the micro-Arthropods (Collembola, Acari, etc.). They are nevertheless briefly mentioned here because of their large numbers.

TABLE VI.

Structure of the partial sociation Hanseniella nivea-Campodea staphylinus.

species	A ind/m²	D %	C 50×50 m	C 1×1 m
Hanseniella nivea Scop.	84.44	75.23	100	100
Campodea staphylinus Westw.	26.96	24.01	100	100
Japix	0.84	0.75	15	52

Three species represent the whole partial sociation. The C value of the first two species per 50×50 cm is 100%, their united D value 99.24%, their A value 111.40, calculated to 1×1 m. In spite of the high characteristics of the two species their weight is very slight, so that they give a low P value. This partial sociation, as we have already said, in reality belongs to the micro-Arthropods' cenosis, investigation of which is now in progress.

*

* *

The partial sociations so far discussed include more than 80% of the number of Arthropods found on the area surveyed. We have not spoken separately of the *Chelidura* species figuring in the summarizing Table (Table I), which we intentionally did not include in our partial sociation. The remaining Arthropods all have low C values, but their other characteristics are also low, so that they do not form very typical units. The Coleoptera form an exception, perhaps, with a united A value of 8.72, approaching that of the *Chelidura*. But their composition is exceptionally heterogeneous and only one species, a *Medon* species, reaches the 80% constancy value on an area of 1×1 m (C = 84%). Among the species of higher C value we can still mention a *Cryptophagus* (C = 68%), and an *Othius* species (C = 60%); the other species do not even reach a 60% value.

Worthy of mention among the other Arthropod groups is a Lygaeidae (Heteroptera) found only in its larval form, of which the average density was 6.28/m² and the C value/m² 72%: a few Coleoptera — and other larvae of which there were altogether 6 specimens per squaremeter (but of heterogeneous species); and, finally, the Pseudo-scorpionidea group, the average density of which was 6.50/m², but these species because of their small size belong rather to the micro-Arthropods.

As appears from the summarizing Table (Table I), the 10 most important Arthropods living in the litter in an oak forest present a *biomass* of an average 1350.892 mg weight per m², that is, the average weight of the Arthropods investigated was 1.35 g per m². It is probable that this value would rise still more with the inclusion of accidental species of large proportions, but as the density of these species is low it could affect the result of 1.35 g only to a small extent. We can therefore state that in the litter of the oak forest surveyed there are about 1.35 g Arthropods per m². This value corresponds to 13.5 kg production calculated to 1 hectare, meaning 3,200.000 individuals. Hence the Arthropods represent a very important quantity of organic material in the litter stratum.

As appears from Table I, the partial sociation of the *Ophyiulus fallax* — *Protracheoniscus politus* produces 50% of the total weight of the most important species, the partial sociation of the carnivorous *Lithobius muticus* — *Monotarsobius austriacus* a further 25%, the *Chelidura* 10%, and finally the partial sociation of the *Leptothorax unifasciata* — *Lasius emarginatus* — *Myrmica ruginodis*, or the "ants-sociation" 9%. Hence except for the Arthropod species of low characteristics these cenoses take the most important part in Arthropod production.

The circumstance that the material of a great number of squares was worked up also offered an occasion for investigating the usefulness of the quadrate method from a statistical standpoint. With the exception of the two ants, *Lasius* and *Myrmica*, all the 10 species figuring in the summarizing Table achieve an 80% value, that is, the 8 species could be found in 80—100% of the 50×50 cm squares investigated. In other words, this means that in practice it would be enough to examine a single 50×50 cm square to find all the constant species. We therefore get a satisfactory picture of the qualitative composition of the Arthropod cenosis of the litter of an oak forest by investigating 1 50×50 cm square. In the words of DU RIETZ this square is the "constans-minimi area" of the cenosis, that is, the smallest area on which all the constants occur. If we increase this square (by four) to 1 m², then with the exception of the two ant species mentioned all the species figuring in the Table reach absolute constancy, i. e., can always be found in all the squares. A square 1 m² is therefore unquestionably sufficient for us to find all the constant species of the cenosis with complete certainty. Hence the 1 m² square can in any case serve as a certain starting point in investigating the Arthropod cenosis living in the litter of a forest.

A more difficult problem is how big a square is necessary to get a picture corresponding to the quantitative composition of the litter's Arthropod cenosis. As we have already mentioned, in the above investigation we examined an area of 25 m², in 100 50×50 cm sample squares. There can be no doubt that after searching through such a large area we get good average values of the density of the more important Arthropod species, but the careful investigation of 100 squares uses up a great deal of time and is such minute work that it would deter a good many ecologists. We ourselves chose such a large area so that after the analysis of the cenosis we could establish how big a square, smaller than 25 m² (if possible decidedly smaller!) would still lead to acceptable quantitative results. To establish this we calculated the A and D values of the 10 species figuring in the Table, first to 16 50×50 cm squares, then also to four 1×1 m squares. There was no selection among the squares in our calculations, but from one of the corners of the area surveyed we took a square 2×2 m, and give below the data concerning it.

TABLE VII.

The A values for the 16 50×50 cm squares.

	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12	Q13	Q14	Q15	Q16
Hanseniella	19	15	15	29	16	13	21	15	23	27	22	19	14	15	22	11
Lasius	76	205	7	315	21	—	23	116	—	—	—	—	—	5	—	—
Leptothorax	6	10	11	48	25	57	16	7	13	7	13	11	4	3	10	—
Lithobius	1	10	9	2	11	5	5	3	5	9	14	9	6	2	6	5
Campodea	6	14	7	3	8	2	4	3	8	10	6	4	5	4	7	2
Monotarsobius	1	—	—	3	—	6	8	6	10	8	3	10	1	3	1	—
Ophyiulus	2	—	1	1	6	5	4	5	8	1	4	4	3	1	3	—
Myrmica	—	—	1	—	1	1	3	10	—	—	1	2	1	7	1	—
Protracheoniscus	1	—	—	4	6	3	1	7	5	3	8	3	1	—	—	1
Forficula	—	1	1	1	3	3	3	4	4	5	3	6	1	2	2	1

TABLE VIII.

The D value calculated to the same squares in the same order as the foregoing.

	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12	Q13	Q14	Q15	Q16
Hanseniella	16.5	5.7	25.0	6.9	14.1	11.4	19.6	8.8	18.5	26.7	21 1	21.	30.4	28.3	32.8	36.6
Lasius	66 0	78.2	11.6	75.7	18.5	—	21.5	57.1	—	—	—	—	—	9.4	—	—
Leptothorax	5.2	3.8	18.3	11.5	22.1	50.0	14.9	3.4	10.4	6.9	12.5	12.5	8.7	5.6	14.9	—
Lithobius	0.8	3.8	15 0	0.4	9.7	4.3	4.6	1.4	4.0	8.9	13.4	10.2	13.0	3.7	8.9	16.6
Campodea	5 2	5.3	11.6	0.7	7.0	1.7	3.7	1.4	6.4	9.9	[illegible].7	4.5	10.8	7.5	10.4	6.6
Monotarsobius	0.8	—	—	0.7	—	5.2	7.4	2.9	8.0	7.9	2.8	11.3	2.1	5 6	1.5	—
Ophyiulus	1.7	—	1.6	0.2	5.3	4.3	3.7	2 4	6.4	0.9	3.8	4 5	6.5	1.8	4.4	—
Myrmica	—	—	1.6	—	0.8	0.8	2 8	4.9	—	—	0.9	2.2	2.1	13.2	1.5	—
Protracheoniscus	0.8	—	—	0.9	5.3	2.6	0.9	3.4	4.0	2.9	7.6	3.4	2.1	—	—	3.3
Forficula	—	0.3	1.6	0.2	2.6	2.6	2.8	1.9	3.2	4.0	2.8	6.8	2.1	3.7	2.9	3.3

If we total up the Arthropods found in the above 16 small squares we get the results shown in Table IX.

TABLE IX.

A, S and D data on 16 50×50 cm squares.

	A.	S.	D.
Q. 1 =	112	115	97.39
Q. 2 =	255	262	97.32
Q. 3 =	52	60	86.66
Q. 4 =	406	416	97.59
Q. 5 =	97	113	85.84
Q. 6 =	95	114	83.33
Q. 7 =	88	107	82.24
Q. 8 =	179	203	88.17
Q. 9 =	76	124	61.29
Q.10 =	70	101	69.30
Q.11 =	74	104	71.05
Q.12 =	68	88	77.27
Q.13 =	36	46	78.26
Q.14 =	42	30	79.24
Q.15 =	52	53	78.65
Q.16 =	20	67	66.66

(A = the number of individuals of the 10 species figuring in Tables VII—VIII; S = the number of individuals of all the Arthropods found in the square in question; D = the percentual ratio of the 10 species in the Table in relation to the Arthropods found in all the squares; Q1—Q16 = the numbers of the squares investigated.)

In T a b l e X. the data on the above 16 squares are united in 4 squares of 1 m² (QI—QIV) and their A—D values calculated.

TABLE X.

United A and D values for the 4 squares according to species.

	A.				D.			
	QI	QII	QIII	QIV	QI	QII	QIII	QIV
Hanseniella	78	68	91	62	9.1	12.6	21.8	31.6
Lasius	603	160	—	5	70.6	29.7	—	2.5
Leptothorax	75	105	44	17	8.7	19.5	10.5	8.6
Lithobius	22	24	37	19	2.5	4.4	8.8	9.6
Campodea	30	17	28	18	3.5	3.1	6.7	9.1
Monotarsobius	4	20	31	5	0.4	3.7	7.4	2.5
Ophyiulus	4	20	17	7	0.4	3.7	4.0	3.5
Myrmica	1	15	3	9	0.1	2.7	7.1	4.5
Protracheoniscus	5	17	19	2	0.5	3.1	4.5	1.0
Forficula	3	13	18	6	0.3	2.4	4.3	3.0

The united values of the four squares patterned on the foregoing T a b l e are shown in T a b l e XI.

TABLE XI.

	A.	S.	D.
Q. I =	825	853	96.71
Q. II =	150	537	85.86
Q.III =	288	417	69.06
Q.IV =	459	196	76.53

If we compare the data on the different-sized squares we find that with the increased size of the area the variations in the statistics are levelled out to a relatively small extent. Comparison of the different characteristics of the 1×1 squares shows almost the same differences as the data for the 50×50 cm squares. In other words this means that neither an area of ¼ m² or 1 m² is sufficient to give an ideal value of the Arthropods on it. But one thing is beyond doubt: after comparing the data on a few ¼ m² squares, species with the highest D values can immediately and easily be distinguished; that is, those numbers of a cenosis which participate in its structure in the greatest individual numbers. If, for example, we look at the first four columns of Table X (which corresponds to 4 50×50 cm squares, i. e., to 1 m²), the supremacy of the first 5 species is immediately apparent. Hence in order to express the dominancy of the 5 species over the others investigation of one of these squares would have been sufficient.

The same is expressed in the data in Table IX. This Table gives the combined D values of the 10 dominant species appearing in the 16 50×50 cm squares. As we see, these figures fluctuate within a fairly small range between 70 and 85%, with the exception of the data for the 1st, 2nd, 4th, 9th and 16th squares. In the first, second and fourth squares there were also ant-hills which raised the value of the ants, i. e., of one of the largest D-value Arthropod groups, to an abnormal degree. In squares 9 and 16, on the contrary, there were relatively few Arthropods, so that the D values based on the low number of individuals remained far below the average value.

From the foregoing it can be concluded that an area of about 1 m² of litter in an oak forest is sufficient to distinguish the species of the cenosis having high C and D values from the accidental species less characteristic. But a square of this size is usually not enough to give us a satisfactory A value for the different dominant species (that is, of the average number of a given species occurring on 1×1 m). In other words, the „Netzquadrat Methode" of DU RIETZ, which we have also employed, gives a picture answering to the structure of the cenosis, but is apparently not suitable for solving problems of production. DU RIETZ himself calls attention to this, in attempting to make a sharp distinction between the conceptions of constancy and frequency.

And here we reach one the most important problems of method in field biocenology, namely, when we examine the structure of a cenosis we take the animals of a relatively small area under intensive investigation. If, however, we wish to establish the average production of a more extensive biocenosis then the delicate methods used for investigating the structure are not suitable. Such extensive investigations are to a certain extent in antagonism with exact "sociological" investigations and require other methods suitable to them. In this antagonism we see the essential of the whole problem of method. We believe that we are not wrong if we say that for establishing production averages it is better to use many small squares fairly remote from one another rather than one single, larger square.

SUMMARY.

The authors investigated the Arthropods in the litter of an oak forest from bio-sociological and production-biological standpoints.

On the basis of the Arthropods surveyed in an area of 100 50×50 cm squares the following results were obtained:

1. The 9836 specimens of Arthropods found in the 100 squares belong to altogether about 120 species. The average number of specimens occurring in 1 m^2 was 393. Most of the Arthropods living in the area (8001 specimens, 81% of the total number) belong to 10 species, the other 110 species being represented by only the remaining 1835 specimens, 18%. Hence in the structure of the cenosis only 9% of the species living there play an important rôle; the other 91% are of subordinate significance.

2. The total weight of the above 10 species corresponds to a production of 13.5 kg calculated in average value per 1 ha area.

3. The two important life-forms of the species of the cenosis are:

a) the "ants-isoecium", represented by 3 species of ants, comprising 31.6% of the Arthropod individuals.

b) the "*Lithobius*-isoecium", represented by 1 species of *Lithobius* and 1 of *Monotarsobius*, comprising 12% of the Arthropods.

These two isoecia are characteristic for the Arthropod cenosis of the area surveyed.

In respect to P value the "Diplopoda-Isopoda isoecium" also plays an important rôle, its P value amounting to more than half that of all the 10 species mentioned.

4. In the litter of an oak forest an area of about 1 m^2 is sufficient for distinguishing the species with high C and D values from the accidental species. The same sized square is not enough to give a

satisfactory picture of the A values of the dominant species, i. e., of the average number of individuals in 1 m^2.

Grateful acknowledgment is made to Mrs. J. THOMPSON VASS for the English translation.

REFERENCES.

BALOGH, J. (1946). *All. Közl.* **43.** 1.
BALOGH, J. LOKSA, I. (1948) *Arch. Biol. Hung.* **18.** 65—100.
PALMGREN, P. (1930). *Acta Zool. Fenn.* **7.** 209.
DU RIETZ, E. (1921). *Zur methodologischen Grundlage der modernen Pflanzensoziologie. Wien.*