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Investigation on lumbricid species (Oligochaeta, Annelida) at Síkfőkút Project^{*}

ABSTRACT - Changes in individual number, biomass, activity and juvenile:adult ratio of three common lumbricid species (*Dendrobaena rubida* SAVIGNY 1826, *Allolobophora rosea* SAVIGNY 1826, *Octolasion lacteum* ORLEY 1885) were studied in Quercetum petraeae-cerris forest at Síkfőkút (North-Hungary, Bükkalja) from September 1979 to October 1980. As the first step of the investigation the most appropriate sampling method was worked out. Relationships were found between the investigated characteristics of the species and the soil moisture, the soil temperature and the rainfall, respectively.

Introduction

There is no uniform, well worked sampling method to estimate the individual number and the biomass of lumbricid species. Therefore first it was necessary to determine the optimal monolith size and sample number so that we should not make larger error than $\pm 10\%$. Samples were taken monthly during a year in order to establish the changes in individual numbers, biomass, number of active and inactive individuals and juvenile:adult ratio. Three common species (*Dendrobaena rubida* SAVIGNY 1826, *Allolobophora rosea* SAVIGNY 1826, *Octolasion lacteum* ORLEY 1885) were investigated in the litter, the a_1 layer (from 5 to 10 cm) and the a_2 layer (to the depth of 40 cm). Relationships between the investigated characteristics of the species and the soil moisture, the soil temperature, rainfall were also studied to find out how these abiotic factors can influence quantitative and qualitative changes in the lumbricid fauna.

Characterization of the sampling site

The Síkfőkút Project is situated at Bükkalja in North-Hungary. The soil of the Quercetum petraeae-cerris forest (Papp, Jakucs 1976) is brown forest soil with clay illuviation (Papp 1985, Stefanovits 1985).

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During the period of the investigation the autumn rainfall lasted from the middle of October till the end of November in 1979. There was the first snow on 31 December and it remained till the middle of February without thawing. After the middling rainy spring June and July were very rich in rain. That time soil moisture as much as 60 percent could also be observed.

The soil temperature altered with great extremes in the depth of 1-5 cm. Here the temperature was around freezing-point from the middle of December till the end of February. In larger depths (5-50 cm) the fluctuations of the temperature were slight.

Determination of the size of the monolith

To establish the appropriate monolith size I worked with four different kinds of monolith (16x16, 32x32, 64x64 and 128x128 cm). Their depths were uniformly 40 cm so their volumes were 10.2, 40.8, 163.4 and 653.7 dm³. From each size 32 samples were taken. The places of samples were marked out with the random number table (Weber 1967) by means of a compass. One of the number pairs indicated the direction on the compass and the other did the steps to that direction. The soil lifted out was put on a nylon sheet and the animals were selected by hand.

Plot sizes used by several researches, for instance 1 m² (Nordström, Rundgren 1972), 0.5 m² (Nordström 1976), 0.25 m² (Zajonc 1970) were not applied since these would be appropriate if the dispersion was random (Greig-Smith 1964). In nature the random dispersion is rather rare but the non-random population can be thought random due to the wrong choice of the sampling unit (for instance in case of contagious dispersion the aggregates may be arranged in a random manner). The sampling strategy may depend on the type of dispersion.

Type of the dispersion was determined on the basis of the relationship between $\bar{x}$ and s^2 (Greig-Smith 1964). In case of random dispersion $\bar{x}=s^2$. In our case $\bar{x}$ is always smaller than s^2 which refers to the contagious dispersion (Table 1). The appropriate size of quadrat was established by determining the "efficiency" of each size (Précsényi, Máthé 1969). The quadrat of 32x32 cm proved to be the most effective.

Table 1: Data for determination of appropriate plot size

size of quadrat	$\bar{x}$	s^2	V_a	V_e	V_e/V_a
16x16	1.78	7.5	7.5	7.5	-
32x32	5.53	28.5	28.5	30.0	1.052
64x64	17.59	195.9	195.9	120.0	0.6125
128x128	55.59	966.1	966.1	480.0	0.4968

Estimation of the sample size

The more monoliths of surface of 32x32 cm and of depth of 40 cm are taken, the more exact value can be obtained which is more characteristic of the area. For this reason it was necessary to determine by what percentage security the particular sample size could be used. Knowing the standard deviation of data, giving the permissible error of the estimation and the probability of error (P%) the sample number can be determined (Sváb 1973).

During the investigation I had to be satisfied with an error of 20% so all my data could include a deviation $\pm 10\%$. If I had decreased the percent of the error, length of time of one sampling would have increased to 8 or 9 days, that is a long period considering changes in flora, fauna and abiotic factors of the soil.

The total individual numbers were used to establish both the monolith size and the sample size.

Changes in number of individuals

In the litter the number of individuals was very low. *Allolobophora rosea* did not occur at all, *Octolasion lacteum* was found only on two occasions and only few individuals of *Dendrobaena rubida* were present (Fig. 1a). Although few data are available on the mortality of lumbricids (Horta 1978), birds feeding on them may also cause the considerably low individual number of this layer (Bengtson et al. 1976, 1978).

Individuals of every species investigated occurred in the a_1 layer (Fig. 1b). The individual number of *Dendrobaena rubida* was the lowest but a considerable increase could be seen in February and especially in July and August. Individual number of *Octolasion lacteum* fluctuated near a given value during the whole year. *Allolobophora rosea* showed the most significant variation. This species was present in this layer only in January. The maximum of its individual number had been found in June and then increased rapidly.

Individuals of *Dendrobaena rubida* were not found in the a_2 layer (Fig. 1c). In November only *Octolasion lacteum* occurred with comparatively many individuals. By December a decrease could be observed and *Allolobophora rosea* appeared. Individual number of *Octolasion lacteum* had decreased permanently till April and then it showed only a slow increase while the individual number of *Allolobophora rosea* had increased quickly till February and then it decreased to the minimum in May.

Studying the total individual numbers according to the layers it can be established that the litter was extremely poor in individuals (Fig. 1d). The tendency of changes in the a_1 and a_2 layers was the same from November till February but a decreasing tendency with a minimum in May could be seen in the a_2 layer. In the a_1 layer a significant increase was experienced till June, July and August. After the individual numbers had reached the maximum in the a_1 layer and the minimum in the a_2 layer, the total individual numbers of each layer came near to each other again. The high number of individuals observed in the a_1 layer in summer months

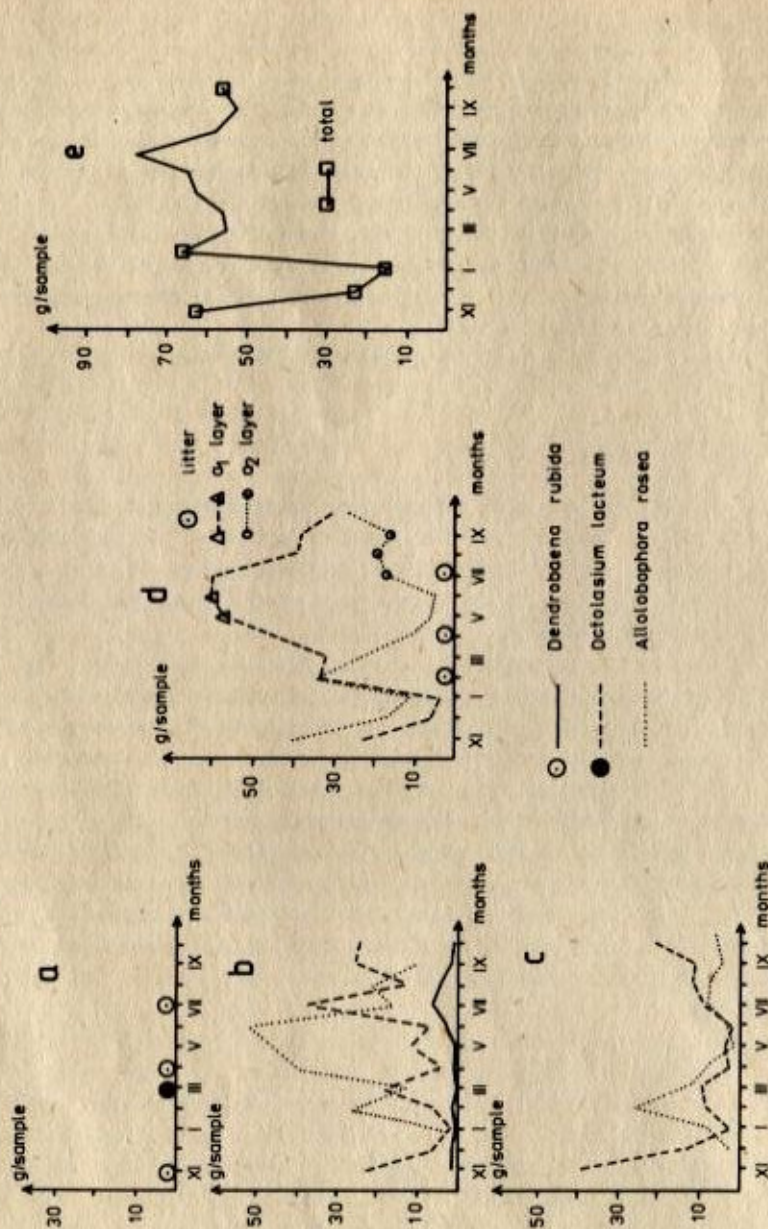


Fig. 1. Changes in number of individuals. a = litter, b = a₁ layer, c = a₂ layer, d = per layers, e = total

was conspicuous.

Considering the total individual number of the whole sample (Fig. 1e) its decrease could be seen from November till February and then it increased permanently to the maximum in June and July, after reaching the maximum it showed a decreasing tendency again. The trends of the change in total individual number coincided with those of the change in the soil temperature.

The total number of individuals per one hectare ranged from 68076 ($\pm 10\%$), 60292980 ($\pm 10\%$) (Table 2).

Table 2: Changes in the total number of individuals (number/ha) and the biomass (fresh weight, kg/ha)

year, month	number of individuals $\pm 10\%$	biomass $\pm 10\%$
1979		
November	174582	68.5
December	68076	25.4
1980		
January	72468	15.4
February	197640	73.0
March	215208	60.4
April	243040	59.6
May	237615	68.0
June	285355	70.1
July	292980	84.2
August	200725	62.8
September	181195	57.2
October	193130	59.6

Changes in biomass

The biomass was calculated on the basis of the fresh weight of individuals. Fig. 2a-e demonstrates the quantity of the biomass and its alteration within the individual layers, according to each layer and summing up. The tendencies of the monthly change are similar to those of the individual number so the detailed analysis can be omitted. Fig. 2e showing the change of the total biomass deserves attention. If we compare the Fig. 1e and Fig. 2e it appears that the degree of the biomass increase was not so significant as that of the number of individuals during the period lasting from February till July otherwise the number of

small individuals increased.

The total biomass per one hectare ranged from 15.4 kg ($\pm 10\%$) to 73.0 kg ($\pm 10\%$) (Table 2).

Changes in the active:inactive ratio

Lumbricids can become active during two periods: in winter due the low soil temperature and in summer due to the low precipitation (Zichi 1959). The inactive animals form a small cell and roll into a ball (Satchell 1967). During the investigation the summer inactivity was not observed in consequence of the much rainfall.

In the litter all animals were active (Fig. 3a).

In the a_1 layer the inactivity of *Octolasion lacteum* was the largest while *Dendrobaena rubida* was found only in active state (Fig. 3b).

In the a_2 layer the inactivity of *Octolasion lacteum* was also the largest (Fig. 3c).

Considering the active:inactive ratio within the layers it appears that there are no considerable differences among the layers in summer, but during the winter months the a_2 layer rises above the others with its high inactive proportion (Fig. 3d).

Examining the active and inactive stadia of the three populations it can be established that there was a considerable inactive proportion only during the winter period (Fig. 3e). From April the majority of the animals were active.

The adult:juvenile ratio

The juvenile animals are still not on the level of body development which would make their reproduction possible (Nordström 1976, Zajonc 1970). During the investigation the juvenile:adult ratios of active and inactive animals were studied separately.

In all cases the number of juvenile individuals of active animals was much larger than that of adult ones (Fig. 4b). The number of juvenile individuals was especially high during the summer months proving that the considerable increase of individual number (Fig. 1e) was not followed closely by the increase of the biomass (Fig. 2e), because the increase of the total individual number is caused by the enormous appearance of the small juvenile individuals. Furthermore, it is remarkable how few adult animals were in inactive state during the period (Fig. 4b).

Summary

The author investigated three common lumbricid species (*Dendrobaena rubida*, *Octolasion lacteum*, *Allolobophora rosea*) on the area of the Sikkökút Project (*Quercetum petraeae-cerris* forest, North-Hungary) in 1979 and 1980. The samples were taken monthly. In the first part of the investigation the optimum sampling size and monolith size were determined, knowing the

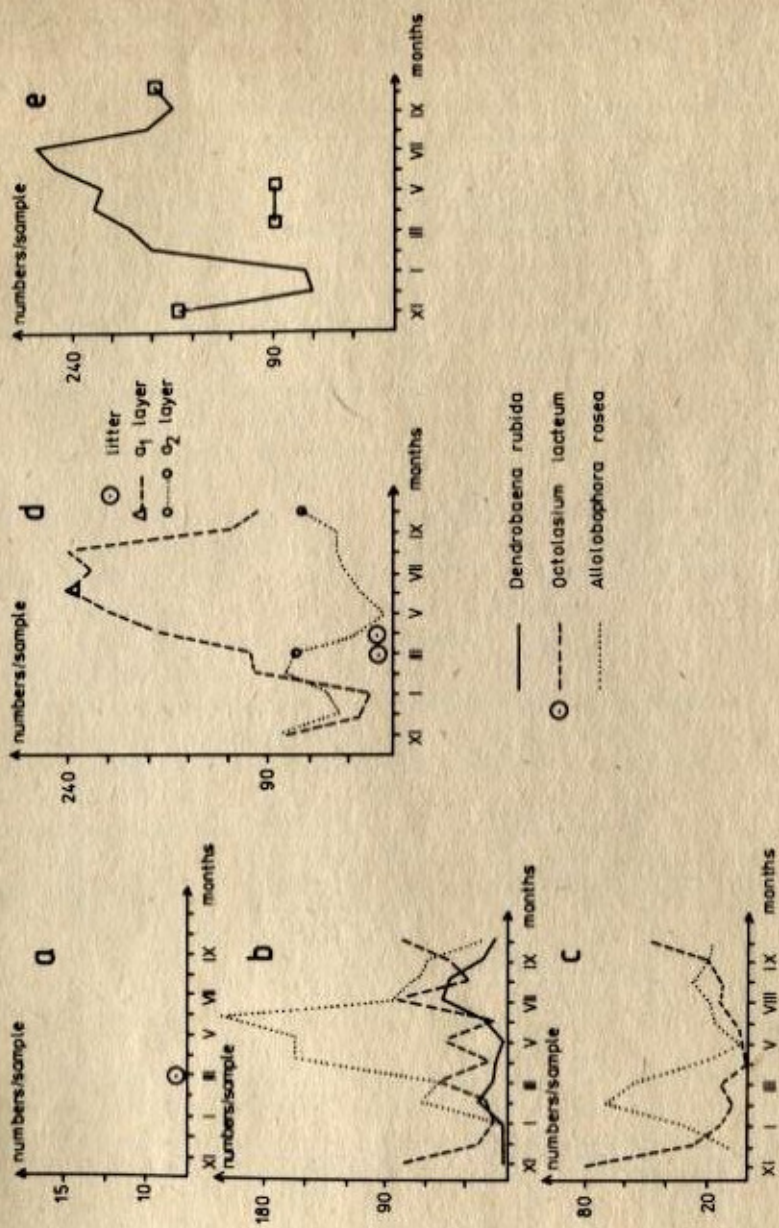


Fig. 2. Changes of biomass. a = litter, b = a₁ layer, c = a₂ layer, d = per layers, e = total

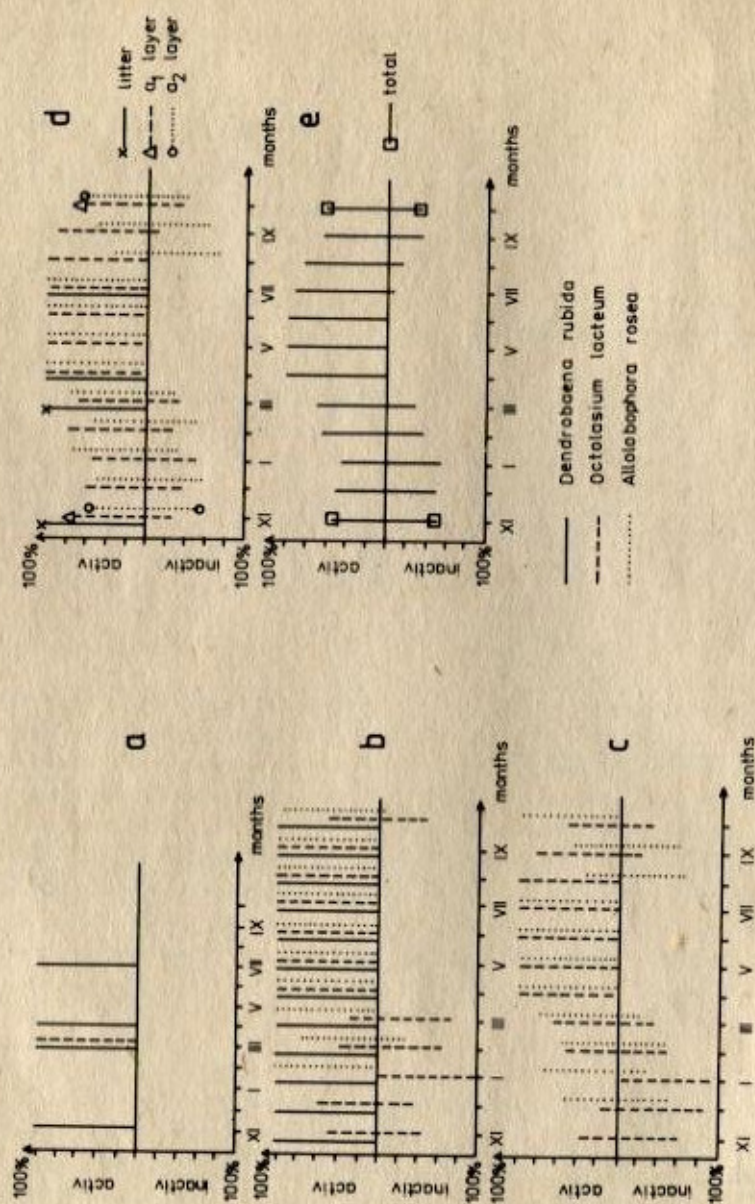


Fig. 3. Changes in the percentage active and inactive stages. a = litter, b = a_1 layer, c = a_2 layer, d = per layers, e = total.

error of estimation.

The litter, the a_1 layer (5-10 cm) and the a_2 layer were treated separately. Depth of the samples was 40 cm in all cases.

The total number of individuals increased heavily from the lowest value of December and January till July but by October it decreased again reaching the value obtained in November of the previous year. During the year the highest number of individuals was observed in the a_1 layer while very few animals could be found in the litter. The total number of individuals per one hectare ranged from 68000 to 290000 ($\pm 10\%$). *Dendrobaena rubida* had the smallest proportion of the total individual number. This species occurred only in the litter and the a_1 layer. *Allolobophora rosea* had the largest individual number and the largest fluctuation of it. It reached its highest individual number in the a_1 layer, but it could not be found in the litter. The fluctuations of the individual number of *Octolasion lacteum* were not significant and this species was present in all layers.

The quantitative changes in the biomass followed the changes in individual number, but during the period lasting from February till August the increase in individual number was stronger. The total biomass ranged from 15 to 84 kg ($\pm 10\%$) per hectare. The animals did not become inactive in summer; it was due to the precipitation. *Dendrobaena rubida* was found only in active state. During the summer months all animals were active. In winter *Octolasion lacteum* become inactive with a smaller percent in the a_1 layer and a larger percent in the a_2 layer. *Allolobophora rosea* could scarcely be found in the a_1 layer during the winter months and that time it was inactive to a small degree. In the a_2 layer it already appeared and was active to a great degree.

As regard the juvenile:adult ratio it can be said that the number of juvenile animals was always larger than that of adults. Considering the active animals it was remarkable how high the number of juveniles was during the summer months. It may explain that the degree of increase in individual number is not followed by the same degree of increase in biomass during this period, as the number of small juveniles is higher.

From the high individual numbers and biomass it can be stated that lumbricids play important role in the life of the soil of the *Quercetum petraeae-cerris* forest.

NAGY SÁNDOR

Lumbricida fajok (Oligochaeta, Annelida) vizsgálata a Síkfőkút Projecten

ÖSSZEFOGLALÁS - A szerző a Síkfőkút Project (*Quercetum petraeae-cerris* erdő Észak-Magyarországon, a Bükkalja területén) három gyakori Lumbricida fajtát (*Dendrobaena rubida*, *Octolasion lacteum*, *Allolobophora rosea*) vizsgálta 1979-80-ban havi mintavétellel. Munkájának első részében megállapította, milyen kvadrát nagyságú és milyen számú mintát kell venni ahhoz, hogy ismert hibaszázalékkal legyenek megbízható adatok. A mintákban elkülönítette az avart, az 5-10 cm mélység között változó a_1 szintet és az a_2 szintet. A minták mélysége

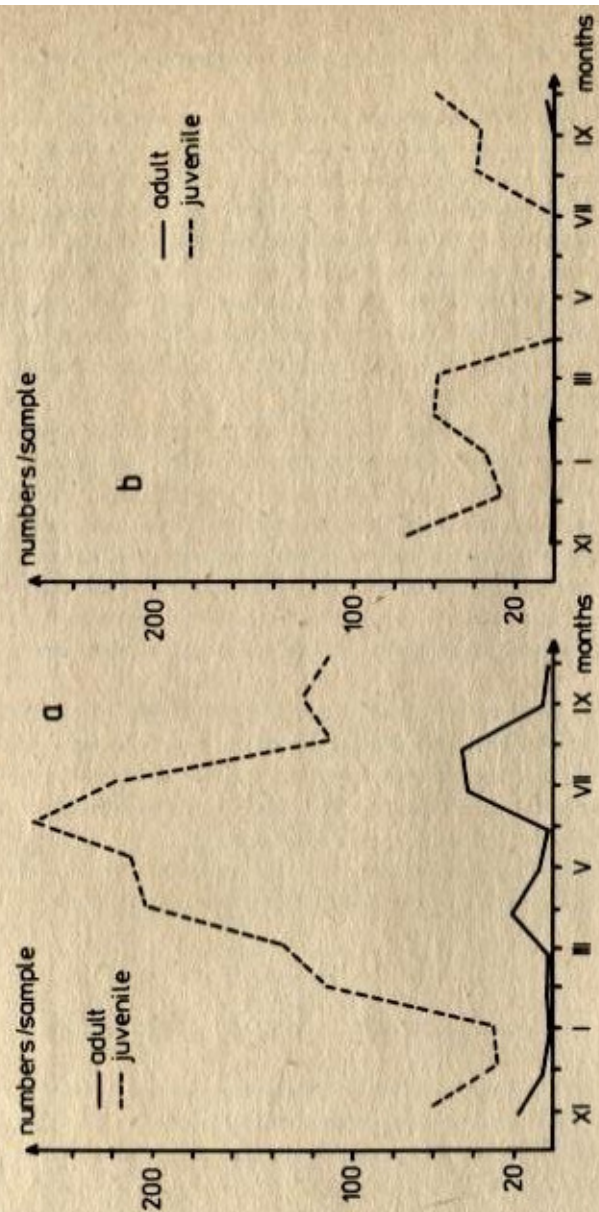


Fig. 4. Changes of the adult:juvenile ratio. a = actives, b = inactives

minden esetben 40 cm volt.

Megállapította, hogy az összegyedszám a december-januári mélyponttól júliusig erőteljesen növekszik, de októberre csaknem az előző év novemberi mennyiségére csökken vissza. Az év során a legnagyobb egyedszám az a_1 szintben mutatkozott, míg az avarban rendkívül kevés állat fordult elő. Az összegyedszám: 68000-290000 ($\pm 10\%$) db/ha között változott. Az összegyedszámból legkisebb aránnyal részesedett a *Dendrobaena rubida*. Ez a faj csak az avarból és az a_1 szintből került elő. Legnagyobb egyedszámmal és egyedszám-ingadozással az *Allolobophora rosea* bírt. Legmagasabb egyedszámát az a_1 szintben érte el, az avarban viszont egyszer sem volt található. Az *Octolasion lacteum* egyedszám-ingadozásai nem voltak nagyok és minden szintben meg lehetett találni.

A biotassza mennyiségi változásai követik az egyedszámváltozásokat. A februártól augusztusig terjedő időszakban azonban az egyedszám növekedése erőteljesebb. Az összbiotassza 15-84 ($\pm 10\%$) kg/ha között változott.

Az aktív-inaktív viszonyokat vizsgálva a legfeltűnőbb az volt, hogy az állatok nyáron nem kerültek inaktív állapotba. Ez a csapadékos nyárnak köszönhető. A *Dendrobaena rubida* csak aktív állapotban volt található. A nyári hónapokban minden faj aktív. Az *Octolasion lacteum* a téli hónapokban az a_1 szintben kisebb, az a_2 szintben nagyobb százalékban került inaktív állapotba. Az *Allolobophora rosea* a téli hónapokban az a_1 szintben alig fordult elő és akkor is kis részben inaktívan. Az a_2 szintben már volt (nagyobb részt aktív) téli előfordulása.

A juvenilis/adult arányt vizsgálva megállapítható, hogy mindig több juvenilis állat fordult elő, mint adult. Az aktív állatokon belül vizsgálva ezt a kérdést, feltűnő volt a nyári hónapok magas juvenilis aránya. Ez a magyarázata annak, hogy ebben az időszakban az egyedszám növekedési ütemét nem követi a biotassza ugyanolyan mértékű növekedése, hiszen a kisebb testsúlyú fiatal egyedek vannak többségben.

A Lumbricida populáció magas egyedszáma és biotassza értékei arra engednek következtetni, hogy ezeknek az állatoknak jelentős szerepe van a *Quercetum petraeae-cerris* erdő talajának életében.

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