ON THE "LINEAL CENSUS" OF THE ARTHROPODS.

By János Balogh and Imre Loksa.

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

With 1 Figure in the text.

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In an earlier work (Balogh, 1947) a quantitative method for establishing the number of grasshoppers of an area was described. Later investigations show that with this method (called the "square-band method") the density of other Arthropods can equally well be established. From these investigations has developed another method we call "lineal census" and describe below. This is based upon the same principle as the "Linientaxierung" method (Palmgren) being a micro variety of it. We find that the "lineal census" is useful with almost every group of Arthropods.

Most of our investigations were made near Lake Balaton on a meadow near a brook. Many sorts of Arthropods live in this area (spiders, isopods, ants, etc.) in great numbers, so that it was particularly suitable for testing quantitative methods. The investigations were made as follows:

On a 1 m wooden rod divided off in 10 decimeters and 100 centimeters we fastened, at right-angles, a sliding 10 cm piece (Figure 1.).

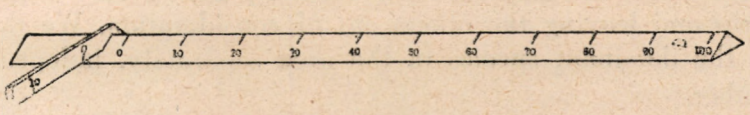

Figure 1. A simple instrument (first form) used in the "lineal census" method.

The sliding part was pushed to the 0 mark, the rod then deposited so that it and the right-angle piece lay on the ground or grass. The sliding piece was then gradually pushed from 0 to the 100 cm mark.

Where the right-angled pointer passed over an insect we noted the number the pointer touched on the rod. We thus got the distances at which there were any Arthopods within an area 1 m long and 10 cm wide during the examination. We made this count in several 10×100 cm strips, one after the other, totalled the results and calculated their average values, then computed the average value to the square meter, and thus of the Arthropod density per m^2.

Two disturbing circumstances arose in the course of the investigations. One was that on depositing the rod, part of the animals in the vicinity were frightened of this strange object and escaped. The other, rather a source of subjective error, was that to note all the Arthropods belonging to the different species and systematical groups demanded great attention and slowed up the work of counting.

To overcome the first difficulty we modified our calculating apparatus in the following way: Instead of a wooden rod we used a steel measuring tape which could be wound up. At its 0 point we attached a little 10 cm metal rod (pointer) with a piece of string about a meter long. The tape-measure, rolled up, was attached by its case to an iron peg (tent peg), and this was stuck into the ground. The Arthropods were then counted in the following way: One of us took the 10 cm pointer tied to the string in his hand and advanced slowly, keeping it about 1 cm above the surface of the ground. When it passed over an insect the advance of the pointer was stopped for an instant. The other of us, with note-book in hand, sat beside the peg stuck in the ground and noted down the point on the tape-measure at which the pointer had stopped. In this way we got the number of animals on a band 10×100 cm in the same way as before but without depositing the instruments on the ground and disturbing the insects.

The other defect, the possible confusion of the large numbers of different Arthropod species, was avoided by noting only 1 species in each strip and leaving the others out of consideration. We thus took each of the dominant species in the area separately, independent of one another.

To control the "lineal census" we also made "netted square" („Netzquadrat") tests on the same meadow at the same time on three dominant groups: on *Myrmica* ants, on Isopods, and on *Erigoneae* spiders. We investigated a total of 16 25×25 cm squares, i. e., altogether 1 m^2 with this method. The results of the two methods were as follows:

	Netted square	Lineal census
Myrmica sp.	232/m²	112/m²
Isopods	149/m²	247/m²
Erigoneae	91/m²	125/m²

We see then that the number of the very active, quickly moving *Myrmica* ants was greater reckoned by the first method; that of the slow-moving Isopods and the *Erigoneae* spiders, which are closely bound to their homes, was greater by the second method. This apparent contradiction proves that more accurate results can be reached by the "lineal census" method. We justify this statement as follows: There is no doubt that the subjective mistakes of the person counting are less by "lineal census" than with the other method, for it is easier to search thoroughly over an area of 10 cm than over one 25 cm wide. This explains how we got larger densities of both Isopods and *Erigoneae* spiders. Apparently in the 25×25 cm squares even in a thorough inspection about 25—30% of the animals remain unobserved. It is probable that the results obtained by the two methods would not in all cases differ so greatly from one another. But on the territory on which we made our investigation the density of the animals manifestly varied a little. It is possible that the squares taken for comparison were accidentally on areas of less density. The other supposition is that, as the netted square count was made after finishing the "lineal census", the area was examined with less attention due to the fatigue of several previous hours of work. If we take all this into consideration as sources of error it is probable that the results of the "netted square method" are about 10% less than those of the "lineal census". The question must be cleared up in the future on several biotops und by detailed investigation.

The *Myrmica* ants, on the other hand, run about rapidly on a relatively large area and in the course of investigating 25×25 cms more individuals get into the square. Indeed it is also possible that individuals counted once cross into the next square and are counted again, so that the results are much greater than the true values. This fault is much slighter in the "lineal census", in fact probably insignificant, for this method of counting is rapid and the person counting moves constantly away from the starting point.

The great advantage of the "lineal census" method is that Arthropod densities can be established with it on relatively large areas very

rapidly, in a short time compared with other quantitative methods. If the vegetation of the field is not very dense and the ground not irregular, not porous, then species of 3—10 mm length can easily be counted in a strip 10×100 cm in 1—2 minutes. If we take into consideration that on the area we investigated there are, for example, 3—4 dominant Arthropods occurring in greater densities, 3—4 hours are amply sufficient for counting them, even if we take 50—60 strips for each species. And this is quite sufficient for obtaining good average results.

With the "lineal census" a smaller biotop can be examined by putting the 1 or 2 meter strips irregularly here and there. In this case the average values probably approach most closely to the ideal. But if we examine longer, perhaps 10—12 m, parallel strips at a certain distance (1—2 m) from one another, we get a picture of greater area and of the density of the dominant species replacing or varying with one another.

This method is not suitable for counting the smaller Arthropods (of 1—2 mm), for it is hard to catch sight of such tiny animals on the ground. Neither is it good for less dense, rare species of larger size, for there are very few of them in a narrow, 10 cm band. For counting these experiments must be made with wider (20—25—50 cm) strips, though on such wide bands only the Arthropods of striking colours or larger size (10—20 mm) can be observed easily. We have not yet made such experiments thoroughly, but a few tests show that the "lineal census" method can be used successfully for these animals too.

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REFERENCES.

BALOGH, J. (1947): Arch. Biol. Hung. **17.** p. 48—50.
PALMGREN, P. (1930): Acta Zool. Fennica. **7.** pp. 219.