RELATIONSHIP AMONG THE DRY MATTER PRODUCTION OF NATURAL PLANT COMMUNITIES AND WEATHER ELEMENTS

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Zusammenfassung: *(Zusammenhang zwischen der Trockenmaterialproduktion von natürlichen Pflanzengemeinschaften und den Wetterelementen)* Dieser Aufsatz befasst sich mit den Zusammenhängen, welche der Trockenmaterialproduktion von zwei Pflanzengemeinschaften *(Artemisietum* und *Peucedanetum)* und den Veränderungen gewisser meteorologischen Elemente (Monatsmitteltemperatur, monatliche Niederschlagsmenge, relative Feuchtigkeit, monatliche Globalstrahlung) bestehen.

Die Produktion von *Artemisietum* erweist eine kräftige positive Korrelation mit den Veränderungen der Monatsmitteltemperatur und der monatlichen Globalstrahlung. Nach den Ergebnissen einer Path Analysis werden die Veränderungen der Produktivität in erster Reihe durch die Veränderungen der monatlichen Mitteltemperatur beeinflusst.

Die Produktivität des *Peucedanetum* zeigt eine kräftige positive Korrelation mit der monatlichen Globalstrahlung. Unter den Koeffizienten der Path Analysis, die betreffend der Veränderungen der verschiedenen meteorologischen Elemente durchgeführt wurde, ist der Koeffizient für die monatliche Niederschlagsmenge eine negative, und die übrigen Koeffiziente sind alle positiv und einander fast gleich.

Summary: This paper is dealing with the relationship existing between the dry matter production of two plant communities (i. e. *Artemisietum* and *Peucedanetum)* and the variations of some meteorological elements (monthly mean temperature, monthly precipitation amount, relative humidity, monthly sums of global radiation).

The productivity of *Artemisietum* is exhibiting a strong positive correlation to the variations of monthly mean temperature and to the monthly sum of global radiation. According to the results of path analysis, the variations of productivity are primarily influenced by the variations of monthly mean temperature.

The productivity of *Peucedanetum* is exhibiting a strong positive correlation to the monthly sum of global radiation. From the path coefficients among the variations of the meteorological elements investigated, that for the variation of the monthly precipitation amount is negative, the remaining ones are positive ones having values being one close to the other.

The investigation of the dry matter production of natural plant communities is becoming still more important as a matter of theory and of practice. (IBP and MAB programs.) As compared to efforts concerning managed plant communities, very few attempts were made for evaluating the relationships existing among the dry matter productions of natural plant communities and the various weather elements.

There are several problems arising from an investigation on the relationship existing among the dry matter production of plant communities and the results of climatological measurements. Microclimatological measurements are mostly restricted to some shorter periods of the growing season. Such series of observations, although they are of a high importance, are barely utilizable ones in an immediate way for making evaluations in production studies, as production studies are extending to the whole of the growing season. If there were a possibility of extrapolating from the relatively short microclimatological series, or if the relationships existing among the macro-, meso- and micro-climates were known, there would be a possibility of using microclimatological data in the valuation of productivity studies. Further, the question is arising in connection to the utilization of microclimatological measurements, whether such data may be used for the whole of the plant community. Microclimatological influences may be consisting primarily in such factors which are exerting their effects on the populations or, respectively, on the individuals constituting the plant communities. This effect may be a variable one not only in the sense that some populations are reacting in a different way (e. g. their photosynthetic activities are different ones according to the phase of evolution of the population), but also in the sense of the pattern of microclimatological elements. The latter factor is, however, changing at every moment, which is followed only with a certain lag by the behaviour of plants. Microclimatological measurements have an important role primarily in studies on respiration and photosynthesis and they are connected through this feature to the productivity studies. Concerning these investigations, there exist still a number of unsolved problems (GATES 1968). The productions by plant communities as a whole are mainly influenced, in addition to environmental factors, by mesoclimatical conditions.

Plant communities are possessing various species compositions, the capability of producing dry materials of the various components being different ones, and it is changing also according to abiotic environmental conditions. It can be considered as a general feature in herbaceous communities of the temperate zone that the supraterranean dry mass in increasing from spring summer and it is decreasing from summer to autumn.

The productivities of plant communities are given for units of area and units of time (weight · area $^{-1}$time^{-1}). This is essentially expressing the speed at which the plant communitiy in question is producing. The variation of weather elements can be expressed in a similar way (e. g. variation of temperature. day^{-1}). In this case, we are obtaining the speed of change for the various elements. In both cases, one is able of studying the sense and the average speed of the change. It may be presumed that such an expression of the variation of weather elements is suitable for an evaluation of productivity studies.

Plant communities investigated

In this paper, the productivities of two plant communities are investigated: *Artemisio-Festucetum speudovinae* (in the following shortly called *Artemisietum),* and *Peucedano-Galatelletum punctati* (in the following shortly called *Peucedanetum),* in connection to the variations of weather elements. Both communities were studied within the so-called ,,Tilos erdő'' (defended forest) nature conservancy area at Újszentmargita. A detailed description of these communities is to be found in the papers of MÁTHÉ—TALLÓS—ZÓLYOMI

(1967), MÁTHÉ—TALLÓS (1967), TALLÓS—TÓTH (1969). On the phenology of the dominant species of these communities MÁTHÉ (1967, 1968) and on their productivities PRÉCSÉNYI (1969) and ZÓLYOMI—PRÉCSÉNYI (1970) have reported.

The *Artemisietum* is consisting of small grasses and grass-like plants, the *Peucedanetum* consists of low and tall grasses and tall herbaceous plants. *Artemisietum* is found at alkaline soil spots, while *Peucedanteum* is found on forest clearings which are not alkaline.

Meteorological observations

On the sample area mentioned, the staff members ot he Meteorological Institute of the Kossuth L. University at Debrecen are conducting the observations. Observations are executed since 1967 during the whole year concerning temperature, precipitation, relative humidity, global radiation, number of insolation hours, etc. On the microclimatological conditions of the sample area, the paper of BERÉNYI—NAGY (1968), and concerning the radiation conditions within the forest from which the samples are taken, the paper of NAGY (1970) are yielding information.

Material and Method

As a basis of this paper, the following data were used: the variations in the dry weight of the green plant parts of both communities during the period 1967—1969 (Table 1); variations of the monthly mean temperature, the monthly precipitation amount, the relative humidity and the monthly sum of global radiation during the period in question (Table 2). The days of sampling are shown in Table 1. Sampling was carried out by using a harvest method, grass is harvested from an unit area, the living parts are separated from the non-living parts and after a drying at 105 centigrades their weight is determined. The continuous meteorological observations are carried out at the sampling area and on the neighbouring meteorological station.

In the course of the analysis, we made use of correlation calculus and of path analysis (SVÁB 1967, LE ROY 1960).

Results

The daily dry matter production of *Artemisietum* is exhibiting a close relationship to the variations of the monthly mean temperature and of the monthly sum of global radiation

Table 1

Productivity of the living subterranean parts of Artemisietum and Peucedanetum ($g \cdot m^{-2}\ day^{-1}$)

Day of sampling	*Artemisietum*	*Peucedanetum*
1967		
20.4		
20.6.	+4,0163	+6,8032
22.9.	−0,6043	−0,0891
1968		
18.4.		
19.6.	+2,9000	+2,2000
18.9.	−0,6043	−0,7362
1969		
18.4.		
19.6.	+2,9333	+5,9333
25.9.	−0,6632	−0,5000

Table 2
Variation of the weather elements

Year and month	a	b	c	d
1967				
4.				
6.	+0,134	+0,672	+0,016	+0,121
9.	−0,005	−0,086	0,000	−0,081
1968				
4.				
6.	+0,145	0,000	−0,200	+0,058
9.	−0,059	+0,538	+0,285	−0,089
1969				
4.				
6.	+0,145	+0,016	+0,016	+0,015
9.	−0,026	−0,326	0,000	−0,019

a = monthly mean temperature, centigrade
b = monthly precipitation amount (mm)
c = relative humidity
d = monthly sum of global radiation (cal . cm^{-2})

Table 3
Correlation coefficients between the variations of meteorological elements and among these variations and the productivity of plant communities

	b	c	d	x	y
a	0,132	−0,656	0,843**	0,923***	0,751*
b	—	0,498	0,293	0,264	0,414
c		—	−0,557	−0,526	−0,257
d			—	0,961***	0,831**

The meaning of the symbols a, b, c and d are the same as in Table 2.

x = productivity of *Artemisietum*
y = productivity of *Peucedanetum*
* = singnificant on the confidence level of 10%
** = significant on the confidence level of 5%
*** = significant on the confidence level of 1%

(Table 3). Peucedanetum is exhibiting a similar behaviour, however, the relationship is this time not so a strong one as in the case of *Artemisietum*. Concerning the variation of monthly precipitation amount, the productions of both communities are showing a positive (not reliable) and with the variation of relative humidity a negative (notreliable) correlation.

According to the results of path analysis, the dry matter production of

Table 4

Table of results of path analysis

1. path coefficients

2. percentual participation of various factors

1.	P_a	P_b	P_c	P_d	P_E
Artemisietum	0,829	0,106	0,029	0,117	0,353
Peucedanetum	0,499	—0,209	0,634	0,824	0,436

1. Influences	Direct P_a	P_b	P_c	P_o	Indirect	Other P_E	Total
Artemisietum	68,8	1,1	0,1	1,4	16,1	12,5	100%
Peucedanetum	24,9	4,4	40,2	67,9	56,4	19,0	100%

P_a, P_b, etc. = path coefficient between the variation of the correspondent weather element and the productivity of the correspondent plant community; meaning of the symbols a, b, c and d as given in Table 2; P_E = error path coefficient.

Artemisietum is primarily influenced by the variation of the monthly mean temperature (Table 4). The influences of the factors not evaluated is considerably greater than that of the other factors, with the exception of monthly mean temperature.

In the case of *Peucedanetum,* the results are not as homogeneous ones. In this case, the variations of global radiation and relative humidity are yielding path values very close one to the other, and not by much smaller are the path values concerning the variation of monthly mean temperature and of the error (Table 4). While, in the case of *Artemisietum,* not one of the path values had been negative, in this case we have between the variations of the monthly precipitation amount and of the dry matter production a negative path coefficient, though its absolute value is not a large one. The importance of the variations in relative humidity has not been demonstrated by the correlation calculus, it is made evident only by the path analysis (the correlation coefficient between relative humidity and the productivity is a negative one, while the corresponding path coefficient is a positive one).

It is worth to notice that, among the immediate influences, for both plant communities, the values for monthly mean temperatures and for global radiation are the positive ones.

The following table is showing the path coefficients for both plant communities according to their order:

Factor	a	b	c	d	other
Artemisietum	1	4	5	3	2
Peucedanetum	3	5	2	1	4

The meanings of the symbols a, b, c and d are given in Table 2.

Here it is shown in a conspicuous way how different are the influences exerted by the same variations of the weather conditions on the two kinds of plant communities.

To the results of this analysis, the following remarks could be made:

a) The meteorological observations were carried out not within the plant communities mentioned, but on the meteorological station (the problem of the usability of observations made not immediately within the crop has been discussed by ZÓLYOMI—PRÉCSÉNYI 1971);

b) The results seem to be, in spite of the low number of elements ($n = 6$) rather reliable ones. Actually, *Peucedanetum* is located on the forest clearings or between the skirts of the forest and *Artemisietum*. The soil of *Artemisietum* is from early summer dry, only the water originating from precipitation is occasionally accumulating in its surface. The soil of *Peucedanetum* is wet during almost the whole of the growing season, its microclimate is moist, damp, humid, which, is a consequence of its location. Moreover, as a consequence of horizont limitation, radiation does not reach it continually, in contrast to *Artemisietum* (BERÉNYI—NAGY, 1968). At the same time, within *Artemisietum*, which has a ,,lesser shielded" location, a strong irradiation may be assumed.

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