EFFECT OF THE ILLUMINATION IN DIFFERENT TYPES OF FORESTS

by

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It is a well known experience that the underwood of the beeches is extremely poor in species, nay rather poor. It is also an old intuition which was supported later by measurements that the light has in it a decisive importance, more exactly it is the deficiency of the light (V a l l i n in L u n d e g a r d h 1949). In course of light-ecological investigation of deciduous forests we also got the conclusion that there exists a close positive correlation between the herb layer covering of the beeches and the illumination (D r a s k o v i t s 1979).

We searched the answer how the effect of the light is realized in the closure and variability of the herb layer of the forests contrasted them to other factors, in case of the closed light-deficient beeches and of the much more opened, better illuminated hornbeamy-oaks. Could the light – in certain sense extent and in interaction with other factors – be a limiting factor of the quantitative relations of the underwood in beeches. Within the formation of the herb layer of forests beside some more important external abiotic factors (as for example the light) such interspecific relations have naturally definitive importance than the tolerance and the competition.

Further more we hoped from the investigation to answer the question whether the light from the point of view of the formation/development of the herb layer is a more essential factor in beeches than it is hornbeamy-oaks. Thus we adjusted such an experimental series which in both forest habitats – namely in the zonal horn-beamy-oaks *(Querco petraeae-Carpinetum)* and in the extrazonal *Melitti-Fagetum* – we watched paralelly at the same time more factors influencing on the closure of the herb layer. Beside the light, respectively the illumination we primarily draw into consideration such pedological factors which were considered essential in the aspect of the herb layer covering (i.e. pH value and the total humus content of the soil as well as the amount of roots of the herbaceous plants informing us on the supply of nutrients of the soil too).

In the two forest associations of differing physiognomy, structure and species-composition we investigated how the variability of the grass-level closure is influenced by some factors selected by us. The examined factors and their units were:

– illumination	lux
– amount of roots	g/dm³
– pH	
– humus	weight%
– covering of the herb layer	estimation%

Material and methods

The model area was designated in the Vöröskő-range of the Pilis-Hills situated located near to the village Tahi Hungary (geographical latitude 47° 46'; height above sea level 350 m).

The investigations were carried out as follows. In both forests (approximately 4 km far from each to other) we marked transsects of 16 squares in the size of by 2 meters. In the center of these not changing squares we measured the illumination using a JU 16 type luxmeter, (USSR), approximately 2–3 weekly in the noon-hours – possibly on days of similar weather circumstances. The cenological survey sampling of the squares was effected monthly. Soil-sampling was performed by lifting out monolites of 20×20×20 cm size from the center of the squares. We measured the humus content % by the method of Tyurin and Arinuskina (Arinuskina 1961) and the pH value in distilled water solution. To the root-saturation investigations we took the dry weight of all herbaceous plant roots having a cross-sectional diameter not exceeding 2 mm being found in the monolite. Corresponding to the vegetational rhythm of the underwood we investigated statistically the data series of the early spring sampling entirely come to leaf. In that period the average illumination in the beech wood is 800–1400 lux and in the hornbeamy-oak wood it is 3–5000 lux (see Table I). The effects of the given factors were analysed using principal component analysis as a multivariate statistical method (Hilary – L. Seal 1968, W. Jahn – H. Vahle 1974, Sváb 1979).

Discussion

On basis of our preliminary studies concerning the light regime of the forests we considered the light as a distincted factor. The simple correlation values convin cingly show the relation between the covering and illumination in the herb layer. While we started in the beech wood a rather closed positive correlation between the illumination and the covering of the herb layer ($r = 0.6862$), till then there is scarely a relation in the hornbeamy-oaks ($r = 0.1400$).

Table I

Data matrix

		X_1 illumination 10^3 lux	X_2 amount of roots gr	X_3 pH	X_4 humus %	Y covering %
Hornbeamy	1.	3.20	12.06	4.5	4.07	70
-Oak wood	2.	3.80	27.65	4.3	4.33	70
	3.	5.00	36.87	4.1	3.29	80
	4.	4.40	25.76	5.2	4.50	70
	5.	4.80	36.43	4.0	4.07	90
	6.	5.20	19.08	4.1	3.14	100
	7.	6.00	26.33	4.5	3.78	80
	8.	4.30	32.04	4.0	3.75	90
	9.	5.60	26.01	5.0	4.35	80
	10.	7.10	24.60	5.2	4.55	60
	11.	4.50	14.65	5.8	4.54	70
	12.	3.80	14.19	5.4	4.78	90
	13.	4.40	11.12	5.2	4.89	80
	14.	5.30	9.80	5.5	4.26	75
	15.	4.70	12.69	5.3	4.96	70
	16.	5.40	13.79	5.3	4.64	80
Beech	1.	2.80	1.60	5.0	3.04	75
wood	2.	2.90	3.90	4.9	3.14	80
	3.	2.00	3.26	4.9	3.41	70
	4.	1.70	1.29	5.0	3.45	70
	5.	1.40	2.32	4.6	3.90	30
	6.	1.90	9.26	4.1	2.60	60
	7.	2.10	4.95	4.9	3.35	55
	8.	3.10	6.78	4.8	3.60	70
	9.	1.80	4.34	4.3	3.71	40
	10.	1.50	2.32	4.6	3.74	40
	11.	1.45	7.52	4.2	3.72	50
	12.	1.70	7.19	5.2	3.53	25
	13.	0,95	2.14	4.4	3.24	10
	14.	1.20	4.26	4.5	3.25	30
	15.	1.40	3.34	4.8	3.22	75
	16.	1.75	2.95	4.3	2.87	90

With the help of the principal component analysis we may emphasize the primarily responsible factors. The method has a great advantage that can decrease the number of the variables by forming new orthogonal artificial factors. Thus the number of the dimensionless principal components is less (eventually essentially less) than that of the observed variables.

In our experiment we reduce the observed 5 variables on basis of

their correlation to fewer principal components. In our investigation we can reduce the original 5 observed components to two principal components.

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Table II

Eigen values of the principal components in beech wood

Principal component	Eigen value	Eigen value %	Cumulated eigen value procent
$\lambda 1$	1.94	38.9	38.9
$\lambda 2$	1.38	27.7	66.5
$\lambda 3$	0.93	18.6	85.1
$\lambda 4$	0.47	9.5	94.8
$\lambda 5$	0.24	4.8	100.0

Table III

Principal component weights of the investigated properties in beech wood
Principal component weights, Matrix A

Factors	Principal component I	Principal component II
illumination	0.858	0.074
root	0.005	0.660
pH	0.469	0.732
humus	0.481	0.624
covering	0.869	0.129
effeet of the factor	38.9%	27.7%

It is a generally accepted procedure that only those principal components are taken in to consideration which have eigen values greater than unity. The eigen value data are expressed as a percentage of the number of variables too. The cumulated eigen value percent of the principal components I and II means that the artificial variables interpreted together explain 66.5% of cenologically traceable variability of the herb layer.

In beech wood the high values (0.858 and 0.869) of the principal component I mean the connection between the illumination and herb layer covering system. Beside these there are of less value yet the two pedological facotrs, the pH and the humus. In the principal component II the effect of the pedological components can be interpreted.

The principal component analysis concerning the hornbeamy-oak wood brought the following results.

In this case it is also just enough to stady only the first two principal components because the third one already has an eigen value less than unity.

In the hornbeamy-oak wood in contrary to the beech wood in the first principal component there is a great role of the pedological factors

Table IV

Eigen values of the principal components in hornbeamy-oak wood

Principal component	Eigen value	Eigen value percent	Cumulated eigen value percent
$\lambda 1$	2.67	53.4	53.4
$\lambda 2$	1.16	23.1	76.6
$\lambda 3$	0.67	13.4	90.0
$\lambda 4$	0.38	7.6	97.5
$\lambda 5$	0.12	2.4	100.0

Table V

Matrix A of the principal components in hornbeamy-oak wood

Factors	Principal components	
	I	II
illumination	0.010	0.923
root	0.770	0.349
pH	−0.937	0.084
humus	−0.879	−0.078
covering	0.653	−0.411
Effect of the facror	53.4%	23.1%

and the effect of light can be shown only in the second principal component. It is evident that while in the beech wood the variability of the herb layer covering is in the closest connection with the illumination which is interpreted by the principal component I and in the hornbeamy-oak wood all the other components are presented in principal component I, the illumination is thus not significant in the above connection system. The Figure shows the observed variables in the two-dimensional system of the first two principal component axis.

Concerning the beech wood the illumination and the herb layer covering are allocated very closed to each other on both sides of the principal component I axis; the ensemble of the two form a cluster. The other observed variables are in this system not significant.

Concerning the hornbeamy-oak wood close to the principal component I axis also forming a cluster the soil-system consisting of pH – humus factors is allocated which is mostly definitive to the variability of the herb layer.

Hence we may state that the variability of the herb layer in summer in beech wood is primarily determined by the light intensity, till then in hornbeamy-oak wood the effect of some soil factors come into prominence and the illumination cannot be considered as an ecological factor.

Our basic hypothesis got confirmed by this and we may say that the light (deficiency) is primarily responsible for the variability of the herb layer of the beech wood even then if we consider also the effect of other abiotic and biotic factors (as soil humidity, root concurrence etc) not investigated by us.

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