Quantitative Investigation of Xerothermophilous Lichens of Sandy Soil

by K. P.-VERSEGHY, Budapest

Abstract — The xerothermophil lichen vegetation on the sandy areas of the Great Hungarian Plain was investigated with special regard to lichen phytomass seasonal changes and environmental conditions. Sequence of important factor was established by path-analysis. With 3 figures and 1 table.

Typical xerothermophil lichen vegetation is formed on some undisturbed areas of Bugac, Hortobágy, and near the village of Csévharaszt. Our patterns were studied on the Nature Conservation Area near Csévharaszt. The studied area is not too rich in lichen species but their quantity is often high surpassing the phytomass of the phanerogamous plants (Verseghy & Láng 1971). On basic sandy soil: Cladonia magyarica VAIN., Cl. furcata var. palamaea (ACH.) NYL., var. subrangiformis (SANDST.) ABBAYES, Cl. rangiformis HOFFM. Cl. convoluta (LAM.) COUT., Parmelia pokornyi (KÖRB.) SZAT., P. vagans NYL., Diploschistes scruposus var. arenaria (SCHAER.) MÜLL. ARG., Toninia coeruleonigricans var. argilacea (WALLR.) ZAHLL., Collema coccophorum TUCK., C. tenax (Sw.) ACH. Two species were collected under Juniperus trees: Cladonia subulata (L.) WIGG. and Cl. fimbriata (L.) SANDST.

Within the framework of the IBP and the MAB programmes, we have investigated the productivity and its seasonal changes (VERSEGHY & LÁNG 1971, Verseghy in press) as well as the mineral cycle of the xerothermophilous lichens living in great quantities in the grassland communities of sandy soil in the Great Hungarian Plain (LÁNG & VERSEGHY 1974, VERSEGHY & LÁNG 1975). We have analyzed the role of environmental factors. BESCHEL (1954, 1955) considered the climatic factors to be of great significance. The growth of lichens shows proportionality to active lifespan taken in one day. Life activity is regulated by moisture and air temperature. In a dry state, life activity is latent. On these bases we sought interconnecting factors between the productivity of lichens and the climatic effects. The several relationships, which may arise were determined by using path-analysis (cf. LeROY 1960).

Material and method

The productivity of xerophitic lichens of sandy soil has been investigated in two sandy grass associations, namely, in a one-year-old Brometum tectorum secaletosum and in the perennial, open calciphilous grassland community, i. e. in Festucetum vaginatae danubiale.

The dominant species in Brometum is Cladonia furcata, while Cl. magyarica and Cl. convoluta are less common. In Festucetum vaginatae, there is about the same ratio of Cl. magyarica and Cl. furcata, while there is a smaller quantity of CI. convoluta, Parmelia pokornyi and Diploschistes scruposus var. arenaria.

The description of the sampling method and detailed contributions are given in VERSEGHY & LÁNG, 1971, VERSEGHY (in press).

The productivity of lichens was counted by growth-analysis (cf. Kvët, Ondok, Nečas & Jarvis 1971) and by path-analyses according to LeROY (1960). Path-analysis is suitable for the examination of those systems in which the relationship between the variables is not mutual, but unidirectional in course (cf. O’SVÁTH 1961, 1965).

We sought the interconnecting factors between 1. radiation minimum, 2. humidity, 3. precipitation, 4. global radiation on the one hand, and the productivity of lichens, on the other. We have determined the order of relevance among these factors by using path-analysis to trace the changes in the total productivity of certain lichen associations as well as in the case of two dominant species (Cladonia magyarica and Cl. furcata).

Climatic effects

The area investigated lies in the Danube—Tisza Interfluve, on some sand dunes, 110–120 metres a.s.l., 40 kilometres from Budapest. The climate is continental. The annual mean precipitation is 515 mm, during the investigations (1968 and 1971) it was less (460 and 342 mm, respectively), while in 1970 and 1972 it was more (583 and 561 mm). The Walter climatogramm well characterizes the respective years. In each year there was a semi-arid period (Fig. 1.).

However, the micro-climatic effects are more important for lichens than are the macro-climatic ones. It is micro-climatic effects that show best the extreme nature of the environment. In July and August the temperature of the air near the surface of the sand reached 55–66 °C around noon; as a result, the temperature of lichen thallus was similar if not higher. Relative humidity reached 100% at dawn and decreased to 35–35% around noon in both communities (GALLÉ 1972–73).

Results

The production of lichens shows seasonal changes, affected by environmental factors. We have noticed a smaller maximum in the spring and a greater one in the autumn (Fig. 2, 3). The total production of lichens (monthly average) was 1520 kg/ha in the case of Festucetum vaginatae and 1700 kg/ha in Brometum; i.e. it is decreasing with the closing of the garssland (VERSEGHY, in press).

It is worth mentioning that the change in the phytomass of the very same species of lichen is different in various associations. The cause of the changes in
the phytomass is quite evident within a single growing season, however the seasonal changes of the phytomass of the slow-growing dwarf lichens are all the more difficult to explain.

On the basis of path-analysis summer and winter are clearly distinct in their effect in both associations. In winter and during autumn and early spring productivity is positive. The sequence of importance of the primary active factors in the case of Festucetum vaginatae is global radiation, humidity, precipitation and radiation minimum. In contradistinction the "other" factors not examined by us are the most important in the summer period, and this may be in connection with the growth of flowering plants and their effects upon lichens. Precipitation has a positive, while humidity has a negative influence.

In the course of three summer investigations, from the total productivity values of twelve months, eight were negative, indicating that it is during this period that the deterioration, disintegration process is dominant over the reproductive one in lichens.

In the case of the one-year-old, open Brometum the "other" factors are primary during the winter period, while in summer they come fourth. In winter the lichens have unrestricted dominance over grassland; the factors primarily affecting their productivity have not been examined by us (the so-called "other" factors) and are, therefore, unknown to us. The radiation minimum ranks first in summer and second in winter as a determinent; global radiation is second in summer and third in winter. It is an interesting phenomenon that humidity, considered to be crucial in the case of lichens, comes either fourth or fifth in place throughout the year in these grasslands (Table 1).

If we are to rank the climatic factors, the order of their relevance to the two dominant species of lichens (Cladonia magyarica and Cl. furcata) of the two associations is as follows:

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*Fig. 3. Total production of lichens in Brometum tectorum association in g/m².*
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In the case of Cl. furcata, the order of the factors in both associations is the same in winter, but different in summer. In winter, radiation minimum and humidity are followed by the “other” factors. In summer, in the case of Brometum, the radiation minimum, while in the case of Festucetum vaginatae, the energy of the global radiation enhances the productivity of Cl. furcata.

As for Cl. magyarica, we have only examined it in the Festucetum vaginatae association. In winter, the “other” factors are primary, while in summer, global radiation takes the first place. Humidity ranks second throughout the year, and precipitation is last.

In summarizing, we may say that:
1. The role of environmental factors is different in the case of the total productivity of lichens in the grasslands from the case of the total productivity of various species.
2. The one-year-old Brometum and the perennial open Festucetum vaginatae association are sharply differentiated in terms of relationship concerning productivity and the environmental factors.
3. The order of importance of the environmental factors is different in the winter and in the summer months.
4. Regarding the direction within the effects of these factors, we have determined that the “other” factors are positive throughout the year; the radiation minimum factor is positive in summer in the cases of all associations, the total productivity of lichens and of various species. The influence of the other factors is variable.

The seasonal changes in the phytomass of the lichens cannot be explained away only by environmental factors. The anatomic (i.e. internal morphological) changes of the individual and the development of certain phenophases, fructification, senescence, and the dynamism of growth within a population are all related to productivity.

References

Author’s address: Dr. KLÁRA P.—VERSEGHY
Botanical Department
Hungarian Natural History Museum
H-1146 Budapest, Vajdahunyadvár
Hungary