CONNECTIONS OF EFFECTS OF EXPOSURE RELATIONS OF SLOPES AND DIFFERENT DENUDATIVE MICROFORMS

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The conception has developed in the Department of Natural Geography in Szeged that in the future one of the fundamental tasks of geomorphology will be to provide a comprehensive regional evaluation of the state of our environment, of its spontaneous developmental tendencies, and of its regional dynamics, striving towards full complexity even in a morphogenetic sense. However, our scientific efforts can hope to achieve the approximate complexity of regional evaluation only when the form-analyzing examinations are extended to the analysis of microregional processes. As established by L. JAKUCS (1971) in a generalization of karstic features, the process of denudation of the surface in a zone can be conceived as the average of the "denudation events" of the microregions comprising the zone. The form types observed in the macroregions and the complex interactions of the natural geographical processes giving rise to these can thus be interpreted simply as the statistical sum of the characteristically manifested microregional effect-connections. For this reason the denudation events fundamentally determining the morphological aspect of a region, or a regional type, can themselves be expressed in an exact manner only on the basis of the examination and synthesis of the microregional processes.

In the present paper an account is given of a part-question of the above general topic: the results of studies aimed at revealing the relations between the slope exposures and the various microregional forms.

The substrata of the microregions, in which the denudation processes take place, are equivalent if the base rock aud the Soil Covering it are of the same quality, thickness and stratification, and if the vegetation on it is the same (as regards its formation and density too). In microregions of the same type and the same climate, the developing microforms too are the same if the exposures of the microspaces to be compared are also the same.

The most important primary factor in the bringing about of the differences in dynamism of the microregional denudation processes is the microclimate. Depending on their structures, water contents, colours and exposures, the various rocks and soils heat up and cool down in different ways. This has a direct effect on the processes of comminution, wearing-away and corrosion, but it also acts on the development and composition of the vegetation by changing the structure, and possibly the texture, of the soil covering the rock.

The temperature and moisture conditions of the soil influence the vital conditions of the microorganisms living in the soil. An important indicator of the qualitative features of soilsis the humus content. Humus is formed from organic matter as a result of the destructive activity of microorganisms. The life functions of the microorganisms involve the liberation of carbon dioxide, which, in the case of carbonate rocks, acts directly on the processes of denudation of the base rock by increasing the dissolving power of the rainwater seeping through. The vital activity of the microfauna and microflora thus has a considerable influence on the corrosion activitiy in soils.

Both earlier and more recent investigations (BECK 1968, FEHÉR 1954) indicate that, in addition to the temperature of the soil, one of the factors having a great effect on the vital activity of the soil bacteria is the moisture content of the soil. The quantity of CO_2 produced by the microorganisms differs from soil to soil depending on the moisture content. The seasonal fluctuation in the number of microorganisms too is a function of the water content and temperature level of the soil. The change of the water content is most often inversely proportional to the temperature change, and directly proportional to the amount of rainfall. The local soil moisture concentrating in the rhizosphere of the individual plant species also frequently acts on the quantitative development of bacterium populations of certain species.

On the above basis, therefore, the soil life, as a function of the microclimate of the soil, exerts a considerable influence on the rate and development of the denudation of the rock surface covered by the soil, and hence on the quality of the resulting microforms.

The differences in the micromorphological types of the microregions are thus functions of the interactions of multiple factors, the study of which requires comprehensive orientation. Of these factors, the effect of the exposure will now be examined, and the important role of this factor in the denudation processes will be pointed out.

In a study of the close disposition of the microclimates at Hosszúbérc in the Bükk Hills, WAGNER (1955) observed that the substratum in the E-exposure within the dolines represents a characteristic morphological structure. However, since the aim of his research was to differentiate microlimates of different orders of magnitude, he investigated the morphological structure only as a factor affecting the microclimate. Nevertheless, he did point out that the rapid heating-up of the slopes of E-exposure has a direct effect on the processes of comminution by insolation. Similar results were found by the present author (BÁRÁNY 1967) in a microclimate study relating to N and S-exposures. It was established that the various slopes within the closed microclimatic region of the doline exhibit extremes of heating-up in accordance with the exposure. In the period of cooling-down, the effect of the exposure diminishes.

Continuing with conclusions on the theory of microclimates, the question had be turned from the viewpoint of natural geography. What is the effect of the microclimate on the development of the various forms of the microregions?

The investigations of L. JAKUCS (1971) on the example of karstic terrains indicate that the different heating and cooling relations, and the differences in soil processes on the slopes of N and S-exposures entail changes in the soils covering the surface and in the vegetation living on them, and hence give rise to large quantitative differences, even within a small locality, in the biogenous carbonic acid and organic acid productions of the soils. Investigation of this topic with regard to the morphogenetics of the forms of non-karstic rocks has not yet been carried out, either by Hungarian or foreign research workers. Accordingly, it is definitely desirable to extend the pioneering investigations initiated by L. JAKUCS to include more distant areas of rock-morphology, taken in the broader sense, utilizing results relating to climatology (WAGNER 1956, 1960, BOROS 1971), soil science (FEHÉR 1954, BECK 1968), biology (BACSÓ—ZÓLYOMI 1934, P. JAKUCS 1956, 1962) and soil-geography (GÓCZÁN 1968).

However, the length of the present paper does not permit a detailed account to be given of every topic now under examination in order to attain the above aim. For a start, therefore, and as an introduction of the methodology, let us analyze as an example the characteristic features of a karst doline in the Bükk Hills, where a study was made of the daily fluctuations in the moisture and in the air-temperature in a 10 cm air-layer above the surface. This 10 cm layer represents the air-layer approximately in contact with the surface in various association types on mountain meadows. Since the short waves of the solar rays change into thermal energy on the surface of the soil, this layer plays an important part in the regulation of the thermal changes in the soil and the higher air-layers. The course of the temperature is different on overcast, cloudy and bright days, and the various exposures result in further differences within this. In general the data for the bright days are suitable for the deducing of regularities in the microclimate, but as regards the surface development the overcast and cloudy days can not be left out of consideration either. In the Bükk Hills, for instance, the sky is 55% overcast on a yearly average. The number of overcast days is 100, and ef bright days 70. In the menth ef August the sky is 40% overcast. The total annual precipitation is 750—800 mm. May and June are very raintymonths. At any event, therefore, it is justified to investigate the climatic features of the exposures on cloudy and evercast dyas too.

On a bright day the maximum and minimum values of the air-temperature are higher on the E and S-exposures on every slope section. The exposure difference is also marked on a cloudy day, between both the E-W and the S-N exposures. However, while 80% cloud-cover does not cause a significant temperature decline in the S-N and W-exposures, the E-exposure reacts rapidly to a fall in temperature. This is due to the extreme heating -up compared to the lother slopes.

The temperature difference of nearly 5°C occurring in a short time (during about 1 hour) with the large daily amplitude accelerates the comminution processes in the fibrous rock (see Fig. 1.)

The slope culmination on the E-exposure occurs at about 10 a. m., while up to this time the radiation arrives on the W and N-exposures at a low angle. On the cloudy days too high temperatures (25—27°C) promote the establishment of the xerothermous vegetation. The favourable situation of the E-exposure is related with the fact that both in the air and in the soil the temperature maxima can be observed earlier, in the morning, while on the other slopes the maxima are attained only in the early afternoon hours. On bright, cloudy and overcast days the maximum is higher on the E and S-exposures. On the other hand, the minimum attains the lowest value on the W-exposure. As a consequence of the early self-shading in the case of the E-exposure, with decreasing temperature the humidity saturation value of the air is reached sooner; this leads to precipitation, and this results in a heat excess here compared with the W-exposure.

In the intensive heating-up and cooling-down stages the W-exposure comes into a more favourable situation. This arises from the fact that a considerable amount of heat is used in the early-morning hours on the E-exposure for the drying-up of the dew, and only at around 8—9 a. m. does the air temperature exceed the temperature values on the other exposures, where the dew is dried up only later, when the sun is higher. All this also plays an important rôle in the development of the soil temperature.

In the afternoon the E-exposure gradually comes into the shade, and the air temperatures are again higher on the W-exposure. At night the E and S-exposures are in

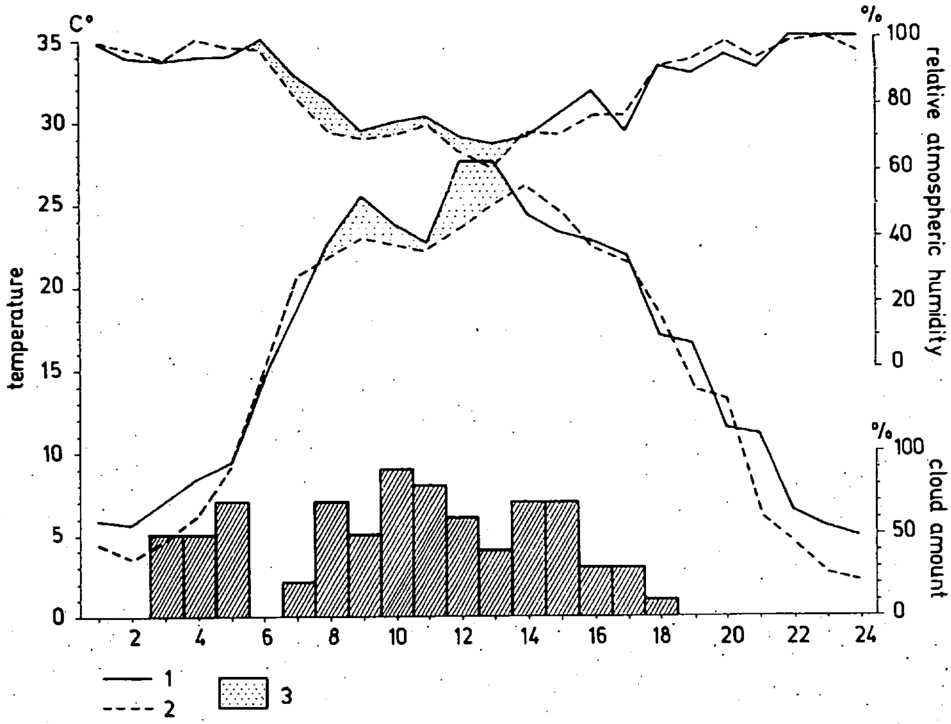

Figure 1. Daily course of the air temperature and humidity 10 cm above the soil in a Bükk doline on a typically cloudy day (2 August 1960). 1 = E-exposure; 2 = W-exposure; 3 = temperature and humidity eycess of E-exposure

more favourable situations in all types of weather, for these two cool slopes down more slowly in the eradiation period because of the strong heating-up in the daytime. In the intensive heating-up and cooling-down stages on the N and S-exposures an almost isothermal air state results, and the features of these stages according to exposure can be recognized only with difficulty.

In the case of the fibrous rock the strong heating in the daytime has a direct effect on the comminution of the rock, but in the main on the evaporation from the soil covering the rock, on the transpiration of the vegetation, and on the multiplication of the soil microorganisms and the acceleration of their vital rhytms.

The connection between the exposure and the air temperature can thus be demonstrated unambiguously. However, only few research workers have dealt with the question of how the humidity of air above the soil varies (P. JAKUCS—MAROSI—SZILÁRD, 1967). On the basis of the humidity of the air, information can be derived on the transpiration ability of the vegetation and indirectly on the change with time of the soil moisture too.

On bright, cloudy and overcast days the relative humidity of the air layers above the soil in the S, N and W-exposures (in the sense of the macroclimate regularity) decreases on the rise of temperature, and vice versa. On the E-exposure, however, clearly as a result of the strong irradiation, from 6 a. m. until 11—12 a. m. the relative humidity values do not vary in accordance with this regularity. The temperature here is higher, and thus the relative humidity values should be lower than on the W-exposure. Examinations for several days, however, show the relative humidity in the morning hours to be higher in the E-exposure than in the W-exposure (see Fig. 2). The strong irradiation following the period of calm at night accelerates the processes of metabolism of the vegetation, and hence the amount of humidlty resulting from the transpiration is higher here. On the E-exposure, therefore, the state of the soil and the vegetation is related with the characteristic course of the humidity.

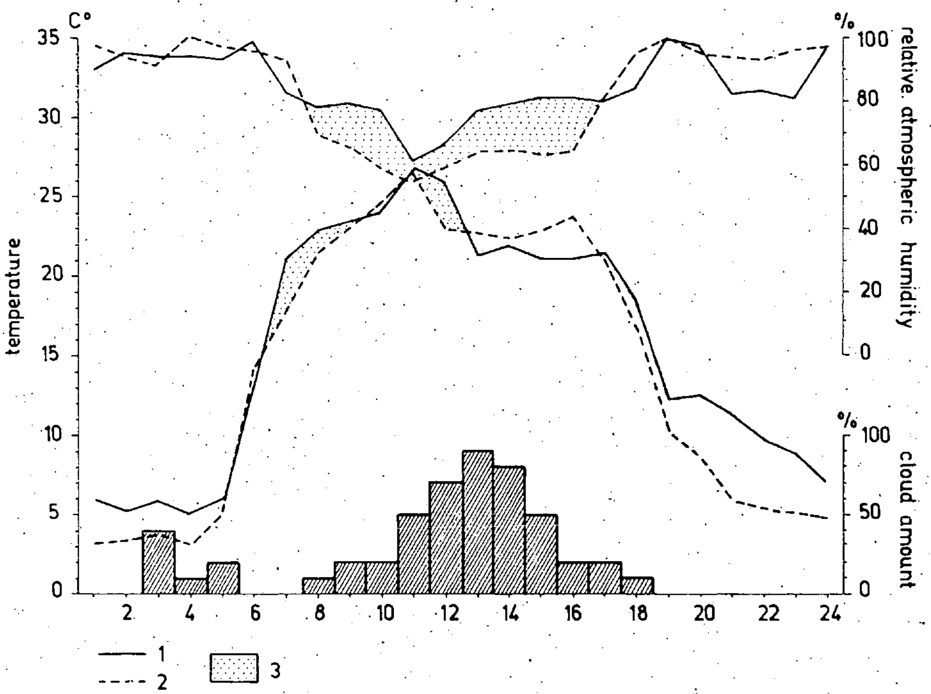

Figure 2. Daily course of the air temperature and humidity 10 cm above the soil in a Bükk doline on an overcast day (1 August 1960).
1 = E-exposure; 2 = W-exposure; 3 = temperature and humidity excess of E-exposure

To summarize, it may be stated that the temperature and humidity conditions of the air-layer just above and in contact with the soil indicate that of the four exposures the E-exposure distinguishes itself by strong heating-up in the morning and by intensive evaporation in the afternoon. This fact results in the creation of local differences in denudation dynamisn, leading to peculiarities of the micromorphological picture, primarly by acceleration of comminution by insolation, variation of the soil moisture, and hence enhancement of the biogenous carbonic acid production.

The microclimatic characteristics depending on the exposures are naturally only part-factors in the extremely complex problem. The above account was intended merely to indicate the tendencies of the investigations now under way. In the future it is hoped to extend these primarily to the temperature changes and moisture conditions of the soil, to the composition of the vegetation, and to the effects of these factors in the regulation of denudation.

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