

THE VEGETATIVE INVERSION ON THE EXAMPLE OF THE MORAVIAN KARST

Vegetační inverze na příkladu Moravského krasu. — Vegetační inverze vzniká jako důsledek dlouhodobé inverze tam, kde chlad, vlhko a stín během celého roku převládá nad teplem, suchem a slunečním svitem. V důsledku rozmanitého utváření reliéfu zasahují inverzní vlivy v oblasti Moravského krasu do různých výšek. Směrem ode dna ubývá chladné a vlhké složky inverze a přibývá složky suché a teplé, která dosahuje maxima na hranách horních okrajů skalních stěn. V místech exponovaných k severu zasahují inverzní vlivy až k hranám skalních stěn a ještě výše, vliv inverze při této expozici je zastřen. Inverze se velmi zřetelně projevuje v nástupu fenofázi. Dalším projevem inverze je bohatá fruktifikace mechů, zajímavý je v Moravském krasu výskyt prealpinských a dealpinských prvků a horských druhů. Moravský kras tvoří samostatné květenné území kryté svéráznou vegetací, jevíci vztahy k vápencovým obvodům Karpat bohatým zastoupením rostlinných prvků horské povahy.

The vegetable associations influence very considerably the character of the landscape and they use often to be one of the decisive factors for the distinction of various areas. It is first of all necessary to pay attention to the soil base — which uses to be the decisive factor — as to one of the factors conditioning the occurrence of the individual vegetable associations or of certain kinds of plants. A very rich flora covers the territories with the base of limestone character and therefore they are a very grateful topic of the biogeographic observations. The limestone areas form expressive karst regions, many of which occur even on the European continent. Recently even the detailed biogeographic investigation of one of the karst areas of Czechoslovakia, of the Moravian Karst, is carried out. The first results of observations showed some characteristic and very interesting factors having an important influence on the vegetation cover in this area.

This paper treats of one of these factors, of the vegetative inversion.

It is necessary first of all to devote some words to the position and to the relief of the investigated area. The territory of the Moravian Karst lies northward of the town Brno, on the south and SW of the Dražanská vrchovina Highland, roughly among the towns Boskovice, Blansko, and Brno. It occupies the area of about 74,6 square kilometres. The geological base of the investigated karst area is formed by Upper Devonian limestones.

Into the apparently monotonous landscape the canyons Pustý žleb and

Suchý žleb are cut, reaching the average depth of 150 m. The further canyon called Pustý or Syrový žleb is flown through in some sections by the river Punkva sinking in many places into underground spaces and emerging in other places. The Suchý žleb is waterless. The most known place of the Moravian Karst is the Macocha-chasm, 138,4 m in depth. Approximately on the half of its bottom and walls the sun does not shine the whole year, similarly like on other places in the canyons. There is a constant shade and cold there. On the contrary on the sunny valley spurs numerous thermophile kinds seized forming isolated islets in the middle of extensive beech-fir woods. We meet here on small distances with vegetative contrasts — in the valleys with numerous kinds of mountain character, on the sunny spurs with thermophile elements of steppe character. This inverted stratification is called inversion.

Besides the relief and warmth inversion, which can be divided into the short-range and long-range one, we know the inversion of the vegetative zones, which can be found as the consequence of the long range warmth inversion on places, where the cold, the dampness and the shade are predominating during the whole year over the warmth, the dryness and the sunshine.

Owing to the various forming of the relief (rock-steps, rock walls, debris), to the different width of the canyon valleys, to the differences in exposure, to the declivity and depth of the canyons, the influences of the inversion reach different altitudes. It may be said on the whole that upwards from the bottom the cold and humid component of the inversion decreases and the dry and warm one increases, reaching its maximum on the edges of the upper margin of the rock walls. Higher, on the surface of levelling, the vegetation is developed in harmony with the height above sea level of the surface of levelling. These are beech-fir covers, which are today, especially in their northern part, considerably changed by human intervention into fir and pine-tree monocultures.

On the bottom of the canyons and of the chasm the associations of mountain character can be found, some sorts of which are growing in Carpathians, e.g. *Cortusa sibirica*, *Phyllitis scolopendrium* and others. On the contrary on the upper margins of the rock walls thermophile associations are prevailing, some sorts of which reach in the Moravian Karst locally their northern boundaries of occurrence, e.g. *Cornus mas*, *Anemone silvestris*, *Prunus fruticosa*, *Stipa joannis*, *Stipa stenophylla*, *Lithospermum purpureo-coeruleum* and others.

On places facing north the influences of inversion reach the edges of the rock walls and still higher. At this exposure the influence of the inversion is screened. It appears in the vegetation covers which are searching for cold, dampness and shade, in strongly mossy associations of the type *Seslerietum muscosum*.

On the bottom of the Pustý žleb the river Punkva flows in the narrowed sections, or only a road leads there, in the larger ones there is a narrow stripe of a river flat. On some places the plantcovers of the *Petasitetum albi*, elsewhere

the fragments of the humider facies of the yoke-elm wood with mountain elements occupied smaller or larger areas. The extremely shaded lower parts of the rock walls are covered by the greyish-blue dustlike covers of the leprous stages of the lichens and by the ochreous lichen *Blastenia ochracea*. The shaded rocks belong in their lower parts to the moss associations of the societies *Neckerion*, *Thamnion* and *Seligerion*. Above these the spurs and rock steps are occupied by the association *Seslerietum muscosum*, passing over upwards into a beech-fir wood (*Abieto-Fagetum*). Inasmuch as debris are reaching the bottoms of the canyons, they are either not overgrown or covered by forest and rock moss with the prevailing kinds *Hylocomium splendens* and *Rhytidiadelphus triquetrus*. In the further stage of stabilisation the debris are covered by the association *Seslerietum muscosum*. The debris use sometimes to be overgrown with woods, which belong to the association *Acereto-Fraxinetum* with several facies according to the prevailing sorts: *urticetosum*, *lunarietosum*, *asperuletosum*, *festucetosum silvaticae*. The vegetable aspect appears to us in this manner at the exposure towards north.

At the southern aspect the associations are developed differently. The lowest parts of the rock walls in the narrowed sections of the canyons, in semi-shade, are overgrown with the dry association belonging to the society *Neckerion*, with the association *Camptothecium philippeanum*, *Anomodon viticulosus*. To this association the vegetation cover of the whole surface of the walls belongs. The rock-steps and terraces are covered by the association *Seslerio-Festucetum duriusculae*. On the upper edges of the rock walls influenced extremely by the insolation the previous association passes over into the association of the thermophile bushy cover of *Corneto-Quercetum* and on free surfaces into the association *Brachypodietum pinnati*. Higher the debris forest (*Querceto-Carpinetum melicetosum uniflorae*) links on to. The vertical rock walls exposed fully to the sun, are overgrown with thermophile moss and lichens of the society *Grimmion tergestinae*. The rock walls watered by the soaking water, are covered by dark stripes of aerophytic *Cyanophiceae*. The spurs sprinkled by the water dripping from the rock-shelters, on which birds are reposing and enriching it with nitrogenous matter, are covered with orange-yellow lichens of the species *Caloplaca*. They form typical nitrophilous associations, striking by the orange-yellow covers.

The inversion can be observed very well in the setting in of the phenophases. In the cold, dampness and shade of the canyon valleys the individual phenophases are setting in with a considerable delay. So for instance we observed on the bottom of the Suchý žleb the *Carpinus betulus* with rolled up leaves, while it was in full bloom above on the sunny spurs. It was similarly even with the other woody plants. The delay was observed even in the setting in and in the beginning of the flowering, in the ripening of the fruits, etc.

A further expression of the inversion the rich fructification of mosses is,

even of those, which use to be sterile. The extreme dampness and the cold lasting the greater part of the vegetative period, cause the fertility of the following sorts: *Ditrichum flexicaule*, *Ctenidium molluscum*, *Hylocomium splendens*, *Rhytidiadelphus triquetrus*. More often the fruitful sorts of *Neckera crispa*, *Anomodon viticulosus*, *Camptothecium philippeanum* can be found.

The occurrence of the praealpine and dealpine elements, both having their origin in the limestone foot-hills of the European high mountains is very interesting in the Moravian Karst. The praealpini are at home on the warm and dry limestone foot-hills of the Alps and Carpathians, the dealpini on the contrary on the cold and humid positions of the subalpine and alpine zone. They got to the lower positions and consequently even to the Moravian Karst with the proceeding glacier. After the deglaciation they conformed to the life conditions in lower positions, the praealpini in the dry ones, the dealpini in the humid and cold ones.

Of the praealpini of the Moravian Karst *Allium montanum*, *Alyssum saxatile*, *Berberis vulgaris*, *Biscutella laevigata*, *Cirsium eriophorum*, *Cyclamen europaeum*, *Libanotis pyreneica* etc. can be found.

To the important dealpini of the Moravian Karst *Asplenium viride*, *Cimicifuga europaea*, *Cortusa sibirica*, *Saxifraga aizoon*, *Sesleria calcarea*, *Phyllitis scolopendrium* and a whole series of mosses and lichens belong.

A further speciality of the flora of the Moravian Karst is the abundant occurrence of the mountain kinds, which are at home in the higher positions of the *Českomoravská vysočina* Highland and of the *Jeseníky* Mts. They have there suitable life conditions in the inverse positions, in the deeply cut canyons. The occurrence of the mountain sorts in lower positions is specified as the demountain phenomenon, the plants then as demountain elements. The occurrence of two sorts, *Athyrium distentifolium* and *Lycopodium selago*, which are at home in the *Jeseníky* Mts. in the park-like forest above 1250 m and in the *Tatra* Mts. in the stunted-fir zone in 1500—1800 m was established in the Moravian Karst too. Of the sorts being at home in the mountain pine-tree woods (1000—1250 m) *Chaerophyllum hirsutum*, *Ribes alpinum*, *Sambucus racemosa* and some others occur in the investigated area.

A very numerous group is formed by the sorts belonging to the zone of the beech-fir forests and being at home in the altitudes of 700—1000 m: *Bromus ramosus* ssp. *benekenii*, *Circaea alpina*, *Corallorhiza trifida*, *Dentaria bulbifera*, *Polystichum lobatum* etc.

The Moravian Karst forms an independent area of flora covered by a characteristic vegetation, showing relations to the limestone areas of Carpathians by the rich representation of the vegetable elements of mountain character; the flora differs here substantially from the flora of the *Drahanská vrchovina* Highland and from the area of the coherent occurrence of the thermophile plants, which are ceasing to appear most typically on the southern border of

the Moravian Karst, on the southern slopes of the Hády near Brno and near the mouth of the river Svitava near Obřany. In the proper Moravian Karst the thermophile elements are forming only islets on exposed limestone rocks. For the sake of its great natural-scientific significance (the karst phenomenon, the flora, the fauna), the territory of the Moravian Karst has been declared in 1930 already a protected landscape area.