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# **The Beech Forests of Czechoslovakia.**

By *Karel Domin*, Praha.

The study of our beech forests from the sociological and ecological standpoints is not, as yet, finished even in rough outline. Therefore, I am endeavouring here to give, for the first time, a geobotanical synopsis of the Czechoslovakian beech forests based upon my own experiences gained in various parts of our Republic, and upon the synthetic works done by other authors. This paper is but a general survey, since a monographic treatment of these characteristic forest types would fill a thick volume.

## **I. Area covered by beech forests in Czechoslovakia.**

According to the latest statistics, of 1920, the forests in Czechoslovakia cover an area of 4,662.790 ha or 33.19% of the whole country's area. It is therefore quite evident that Czechoslovakia is a typical forest country. At the beginning of historic times, almost all of the Republic was covered by one continuous virgin forest, with the exception of some steppe areas in the Bohemian valley of the Labe (Elbe) River, in southern Moravia, in southern Slovakia, and in southern Subcarpathian Russia.

Striking to-day is the predominance of the coniferous forests in the Sudetic-Hercynian regions — in Bohemia 85,96% of the whole forest area is coniferous. However, in the Carpathian region, the deciduous forests cover a far greater area than do the coniferous forests. As we approach the deciduous and mixed forests, we notice their striking increase eastward. Deciduous and mixed forests occupy 14,24% of the entire forest area in Bohemia, 37,45% in Silesia, 39,98% in Moravia, 69,42% in Slovakia and 77,67% in Subcarpathian Russia.

Beech forests are most abundantly developed in Subcarpathian Russia where they take up 58,9% of the forest-covering while in Slovakia 32,1%, whereas in Silesia only 9,8%, in Moravia 8,2%, and

in Bohemia 2,0%. Therefore only 20,7% of the Republic's entire forest area is taken up by the beech forest.

As I once described in detail (<sup>1</sup>), Bohemia, with the exception of some parts of the Labe valley and the Středohoří Mts., at the beginning of historic times was covered by one continuous virgin forest interrupted here and there by swamps and peat bogs. Predominant in this forest almost everywhere were mixed forest growths, mostly with beech. Only in the highest zone of mountain forests the pure coniferous forest was present. However, the conifers have always had a marked significance in Bohemia, greater than in the Carpathians. Here in the Carpathian region the coniferous forests (mostly spruce) dominate only in the Central Carpathians from Orava to Eastern Beskydes, while the beech dominates in the broad band in the external Carpathian range from Bratislava on the Danube to the most eastern boundaries of Subcarpathian Russia. In the lower, inner range, mixed oak forests predominate, interrupted locally by the beech which sometimes comes down to the very edge of the lowlands.

Czechoslovakia is a classic land for the study of beech forests. Here they are richly developed in vast areas, found in the most diverse altitudinal zones, on all kinds of geological substrata, and under very different climatic conditions. Furthermore, they are most instructive in the Carpathians, especially in Subcarpathian Russia, where vast virgin forests have been preserved to this day together with forests but little disturbed by human influences.

## II. Altitudinal limits.

The lower limit of the beech forests is at about 200 meters, sometimes, as an exception, even lower. This is true at Onakovec in Subcarpathian Russia where a beech growth is found at 124 meters — absolute minimum. The beech alone, however, is sometimes found in other forest growths below the 200 meters limit, as for instance on the andesitic Kováčov hills on the Danube where it comes down to 130—120 meters, and in Subcarpathian Russia at Velké Lazy (district Užhorod) to 119 meters.

The upper limits of the beech and beech forest are quite clear in the Carpathians, but not always so clear in the Sudetic-Hercynian

region because here the original forest conditions have been greatly changed by forest culture. In the highest Sudetic mountains, Krkonoše (Riesengebirge), where it is impossible to-day to determine with much safety the original beech forest limits, we judge the beech forest, according to its remains, to have reached 950—1000 meters along the southern sides. On the southern slopes of the Jizera Mts. the beech forest extends to 950 meters and on a rich calcareous substratum of Mt. Buková to 1000 meters. In the Krkonoše Mts. themselves, we still find some well preserved beech growths at 950 meters. On Kiesberg the beech reaches 1000 meters on a limestone substratum. The highest point attained is on the southern slopes of the Krkonoše Mts. where small, shrub-like beech growths are found at 1185 meters — absolute upper limit. Upon the basis of this, Zlatník (1) divides the Krkonoše Mts. into the following altitudinal zones:

*Fagetum* to 950 meters (1185 meters)

*Picetum excelsae* (900 meters) 950—1350 meters (1000 meters)

*Mughetum* 1350—1480 meters

In the Šumava (Böhmerwald) Mts. the beech extends to 1200 meters on the southern slope of Mt. Javor (Arber), and in the Krušné Hory (Erzgebirge) Mts. to 1000 meters.

The altitudinal zonation of the beech and beech forests in our Carpathians has been worked out in detail by Fekete-Blattny (1); some of the data I presented in my own paper of 1923 (2). These authors give the following average upper limits for the Central Carpathians:

- a) upper limit of beech as the forest limit 1280 meters (max. 1376 meters).
- b) Upper limit of beech below the spruce zone 1230 meters (max. 1410 meters);
- c) beeches scattered in spruce forests 1260 meters (max. 1442 meters);
- d) upper limit of shrubby beeches 1350 meters (max. 1484 meters).

In the Tatra region, the beech never forms an upper forest limit. Its upper boundary here is 1140 meters (maximum 1308 meters) and in spruce forests 1220 meters (max. 1356 meters).

For the northeastern Carpathians, Fekete-Blattny give 1250 meters as the average upper limit of the beeches where they form

at the same time the forest limit; 1220 meters where the spruce zone is still above them; and 1340 meters for the shrubby beech. The average lower limit of sporadically scattered beeches is 250 meters, of beech growths 350 meters and as an exception beeches sometimes come down to 150 meters or less. Detailed statistics show that the width of the zone of tall-trunk beeches is about 1000 meters, of which 100 meters is of a sporadic growth and the lower 900 meters of a continuous growth. Further, the zone of shrubby beeches is 80 meters so that the entire beech zone, clear up to the forest limit, is about 1080 meters wide. However, where the beech does not form the upper forest and tree limit but extends only to the spruce zone, the beech forest zone has an average width of 1030 meters.

In the Tatra region, beech forests are very poorly developed and on southern slopes are entirely lacking due to the continental climate which favours the larch. On the limestone mountains of the Western Carpathians, the beech is richly developed, rising on Mt. Choč to 1359 meters. For the High Tatras, F e k e t e - B l a t t n y have given the following figures: average upper and, at the same time, the forest limit 1300 meters (1366 meters, max. limit), below the spruce zone 1260 meters (max. 1370 meters), highest ascent of beech in spruce forests 1290 meters (max. 1347 meters), and shrubby beeches to 1340 meters (max. 1404 meters). In the Low Tatras, the upper limit of the beech forests, and at the same time the forest limit, is at an average of 1290 meters (max. 1376 meters), below the spruce zone at 1250 meters (max. 1410 meters), beech in spruce forests at 1270 meters (max. 1443 meters), and shrubby beeches at 1390 meters (max. 1484 meters).

### III. Climatic Factors.

In this brief survey it is impossible to describe all the variations of the main climatic factors influencing our beech forests since we have beech forests in very diverse climates, from the typically dry continental climate of the Pannonian lowlands and hills to the damp, almost oceanic climate of the Eastern Carpathians. Beech forests are found in places with only 450 <sup>mm</sup> of yearly rainfall as well as in mountainous areas with a yearly rainfall of 1300 <sup>mm</sup>.

The following facts can be given in general:

a) In territories where the climate is sufficiently humid without any long, dry summer periods, that is a general climate favourable for beeches, the beech forest is spread on all exposures. In territories with a general climate less favourable or unfavourable for the beech, the conditions of the microclimate are the determining factor. Beech forests, located here on the colder, damper, northern and northwestern slopes, themselves help to create more favourable conditions by maintaining greater atmospheric humidity and a lower temperature. Measurements have shown that the evaporation from beech forests is markedly less than that of oak forests and that the thick leaf canopy helps to maintain a lower temperature. In the lower Carpathian range, we therefore frequently notice that oak forests (often *Quercetum lanuginosae*) and occasionally steppes (especially *Caricetum humilis*, sometimes *Festuceta*) occupy the southern slopes, whereas the northern slopes are covered to the ridge with beech forests. In narrow, wooded valleys this zonation is so modified that the beech forests are in the lower, narrow or broad zone of the southern slopes and the oak forests come in only above them, thus clearly reversing the situation.

b) The influence of exposure and wind manifests itself unequally in the altitudinal distribution of beech forests, although a clear correlation can usually be observed with the climatic and soil conditions. The beech, as a tree that loves a more humid and cooler climate, descends lower down the valley floor than on the slopes. In the beech forests of Subcarpathian Russia (see Fekete-Blatny) there is a marked lowering of the upper beech limit on the south and southwestern exposures, while on the southeastern exposures the beeches attain their greatest altitudes. Such is the case, for instance, on Mt. Plaj where the beech limit at the ridge is 1186 meters, on the southern side 1068 meters, southeastern and eastern 1132 meters, northeastern and northwestern 1200 meters, southwestern 1195 meters, northern 1169 meters, western 1144 meters. Similarly, on Mt. Menčul near Jasina, we have the beech limit at the ridge at 1165 meters, on the eastern slope at 1226 meters, north and northeastern 1252 meters, and western at 1185 meters. On the top of a ridge with a steep drop on one side and a gentle slope on the other, the effect of a mountain wind is shown by the presence

of a wider treeless zone at the crest on the side of the gentle slope, than on the steep side.

The upper limit of the tall-trunk beech forest in our Eastern Carpathians is, when it forms the forest limit, at an average of 1280 meters (max. 1376 meters), and of the shrubby beech forest at 1350 meters (max. 1484 meters). This limit is usually regarded as climatic, but detailed study in the Svidovec range has convinced me that very often it is a secondary forest limit. The formation of this shrubby beech zone is not a conclusive proof of the natural upper forest limit, since it can also arise after the artificial lowering of the forest limit due to deforestation. In some cases, the formation of the upper forest limit by the beeches is due to the fact that the mountain spruce zone, once lying directly above it, has been destroyed by grazing and is now covered, about half-way up, with grass or subalpine shrubby thickets (*Alnetum viridis*, *Juniperetum nanae*).

c) In conformity with the principles of substitution of ecological factors, beech forests may also develop in a climate unfavourable to them provided the soil conditions are favourable, such as a limestone substratum, or a high soil-water content.

#### IV. Soils.

Beech forests in Czechoslovakia develop on all types of rocks, be they limestone, dolomite, marly limestone, granit, gneiss, amphibolite, schists, sandstones, basalt, andesite, or other eruptive rocks, conglomerates, etc. This, and the different climatic conditions explain the great lack of uniformity in the character of the beech soils, in their reaction (soil acidity) and in their lime, nitrogen, and water contents. The production of humus depends not only on the rock strata, but also on the climatic conditions and often on the exposure of the slope. In a dry continental climate, the decay of the fallen leaves is delayed and the substratum is loamy to the surface, without humus, and covered with a thick layer of dried and slightly-decayed leaves. In a humid climate, leaf decay is much more intensive and often forms a very thick layer of humus. The acidity of the soil also varies greatly, although, even on siliceous soils, the beech itself aids in lowering the acidity. Typical beech forests have generally slightly acid to alkaline soils, while degraded

and spurious beech forests have decidedly acid soils. The higher the acidity, the more atypical the undergrowth becomes, until finally the herbaceous stratum of the beech forest takes on a spruce character. Zlatník (1) studied the soils of beech forests in the Krkonoše Mts. and found some considerable variations in their acidity, that is, from pH 4.2 to pH 6.65. But here, also, soils are in optimally developed beech forests, located even on a siliceous substratum, only slightly acid (pH 5.5—5.7), and on limestone with a pH 6.7. The most acid soils are found near the upper limit of the beech forests (pH 4.2—4.7) where on a distinctly podzolate soil in these beech forests we find undergrowth more properly belonging to spruce. Zlatník states that, on the whole, the soil acidity rises with the altitude, resp. with the humidity of the climate. This does not disagree with the phenomenon that soils of beech forests, in shaded and damp valleys, are comparatively more acid. Podzolation of the soil frequently corresponds to the degradation of the beech forest soil and to the effect of forest culture. The rhizospheres of the beech and the ground vegetation often show different acidities; but even in this respect, various modifications have been ascertained. According to Zlatník (1, 4), the profiles in lower situations show a regular increase in acidity as we go downward, whereas the fern types of the Krkonoše Mts. and of Subcarpathian Russia show the highest acidity in the podzolate layer.

Of extreme importance is the formation of mould which is favoured by a lime substratum. In the Carpathians, however, we know of beech forests with quite a typical ground vegetation though on a soil nearly devoid of humus; the loamy soil here, however, is not podzolate and shows a slightly acid to alkaline reaction. Of great importance, also, is the intensity of the nitrification process which depends upon the microbe vegetation. Humification in beech forests is aided by the mycorrhiza layer beneath the decayed leaves. However, this layer is not always equally developed in our beech forests, and can also be found beneath the leaves of *Acer pseudo-platanus* (Domin, 1, p. 40—41). Jar. Peklo (1, 2, 3) investigated, as did P. E. Müller in the Danish beech forests, forest mycorrhizas and the ecology of the beech forests soils and obtained some new interesting data. Peklo did his studies in some of the Bohemian beech forests, as for instance near Jevany (granit), near the Sázava

river between Vlkančice and Česká Skalice (gneiss) and between Drlatín and Radlice near Kourím (phyllit). He summarises the general results of his studies as follows: In all typical cases we find usually beneath the loose-leaf layer and beneath the thin layer of closely packed leaves, a thick *m y c o r r h i z a l a y e r* composed of smooth mycorrhizas, and of already — more or less — decayed and crumbled leaves. In this layer, the leaves have already disintegrated into humous matter. Beneath the mycorrhiza layer there is always present a more or less thick layer of mould in which mycorrhizas are already dying off, or are only very scarce. P e k l o, therefore, considers mycorrhizas as a leading pedological factor of the beech forests on certain geological substrata. In contrast to the mycorrhiza which covers macroscopically wide surfaces, the mould and bacteria seem to play an insignificant role. Mycorrhiza, however, have a decided effect on the nitrogen content in the soil.

In general, it is possible to say that the soils of our natural beech forests are in every respect favourable, that is they are either non podzolate or only slightly podzolate, slightly acid to alkaline, and have a good air capacity. However, spurious beech forests, particularly those with a spruce ground vegetation (viz. with *Vaccinium myrtillus* or with *Calamagrostis villosa*), show an acid reaction and usually are podzolated. Mixed forests with *Fagus*, *Acer*, *Abies*, *Tilia* and *Picea* show also advantageous soil conditions. I showed in my paper on the virgin forest of Boubín (<sup>3</sup>) that even on the archean siliceous soils of the Šumava Mts., the podzolation of forest profiles is comparatively slight and the acidity comparatively small, decidedly lower than in some other Hercynian districts in which forest culture resulted in far-reaching deterioration of soil conditions. Likewise, the investigations of W ł o d e k and S t r z e m i e n s k i (1925) show that the soil acidity in the *P i c e o - A b i e t e t u m a l - b a e* association in the Polish Tatras is considerably lower (pH 5.3—6.6) than in the *P i c e t u m m y r t i l l o s u m* (pH 3.4—3.9).

For the study of soil conditions, the Carpathian beech forests are of course most appropriate, partly because they occupy vast areas which have a large altitudinal zone, a great range of climatic conditions, and a variety of rocks on which they occur; and partly because many of them are virgin forests, as well as forests only slightly changed by forest culture. These virgin beech forests, also,

show the validity of the above mentioned facts. The vast virgin beech forests of Subcarpathian Russia have, in general, very advantageous soil conditions, though the geological substrata are formed here by sandstone and schists of the so-called Flysch formation. The soil reaction, according to Zlatník (4, pp. 411), shows here a wide range from pH 3.9 to 7.4, but the markedly acid soils are characteristic only for the «spruce» associations of the beech forests, especially those with *Vaccinium myrtillus*. Podzolation, even at high altitudes is only slight.

#### V. Regeneration of the beech within the forest.

The regeneration of the beech is good in natural beech growths, but not very uniform. Of special interest is the type without herbaceous undergrowth having instead, real thickets of a very rich natural growth of young beech. This type is to be found in the virgin forests of Subcarpathian Russia where imposing beeches, a hundred to three hundred years old, attain a height of 30 to 40 meters; these forests are not very dense. Pure virgin beech forests with only *Acer pseudoplatanus* interspersed, as well as mixed forests, are usually never densely developed. The thick layer of half-decayed beech leaves on the forest floor does not favour the growth or germinating beeches. In the Little Carpathians, I have seen mighty bare-floor beech forests with a dense undergrowth of beech-seedlings, but the thick layer of dry leaves checked their development so that only a few out of thousands could maintain themselves. In a loose *Cari-cetum pilosae* growth, the conditions for beech-seedlings already are somewhat more favourable. The shrubby beech colonies in old bare-floor beech forests arise in such manner that, under the protection of a young beech that has somewhat disturbed the dry-leaf carpet, new beech-seedlings take root and finally form these characteristic colonies.

#### VI. Dominance of the beech and mixture of other trees.

We know all possible intermediate stages of forests beginning with a 100 % dominance of the beech, to various types of coniferous and deciduous forests in which the beech is only scattered. Typical trees accompanying the beech in our beech forests are: deciduous *Acer pseudoplatanus*, *A. platanoides*, *Fraxinus excelsior*, *Ulmus*

*scabra*, *Tilia platyphylla*, *T. ulmifolia*, coniferous *Abies alba* and less often also *Picea excelsa*. Also other trees (*Acer campestre*, *Carpinus betulus*, *Quercus sessilis*, *Q. cerris*, even *Q. lanuginosa*, *Pinus silvestris*) may be interspersed but they cannot be considered as typically accompanying the beech.

A peculiar mixed beech forest sociation is found on ridges in our Carpathians, especially on talus in the mountain zone. The beech retreats here sometimes to such a degree that, locally, it may even disappear, but its typical ground vegetation remains. Interesting and frequent is the fact that talus, especially under the influence of the summit climate (and even at lower altitudes), shows a certain relation to an increasingly mixed beech forest, in which often, besides the dominant deciduous trees, conifers may also come in. I described this phenomenon, for instance, in the České Středohoří Mts. but it is even more typical in various parts of Slovakia.

#### VII. Transitions to other types of forest.

It is necessary that we distinguish the deciduous forests mixed with beech which are usually stable sociations, from the transitional types of beech forests to other forest communities.

I have shown in my book on the Brdy Mts. (<sup>1</sup>), that at the beginning of historic times, mixed forests of deciduous and coniferous trees predominated in Bohemia almost everywhere, and that these growths were most fit for maintaining favourable edaphic conditions. The percentage proportion of each type of individual trees fluctuated according to the habitat, or without any correlation to it, even in the natural mixed growths. This is, for instance, illustrated by the famous virgin forest of Boubín in the Šumava Mts. The chief trees forming the virgin forest are four in number, namely the fir (*Abies alba*), the beech (*Fagus sylvatica*), the spruce (*Picea excelsa*), and the maple (*Acer pseudoplatanus*), which last, however, plays a far smaller role than do the first three; the elm (*Ulmus montana*) is very rare. It is extremely difficult to determine accurately the proportionate percentage of each tree, because in different parts of the forest the percentage is different and also changes in the course of time. In many parts there is forty per cent of firs

and beeches, over fifteen per cent of spruces, and a smaller proportion of maples. There are also parts, however, (for example above the Lake of Boubín) where only conifers predominate, especially the spruce, and in places form pure coniferous growths. In other places, again, as for example in the lower part of the southern corner, the forest consists almost exclusively of beeches. Some authors, as for instance D r u d e, maintain that the spruce is constantly gaining ground, though this does not always hold true, for it is exactly the spruce that most often is uprooted, while we never see a freshly uprooted beech or maple, but only here and there an old trunk split by lightning or broken by a storm. The loss of deciduous trees is, on the whole, insignificant in comparison with that in the case of the spruce and fir.

Also, the magnificent virgin forest above the Hoverla creek in Subcarpathian Russia (D o m i n <sup>4</sup>), in reality a mixed virgin beech forest with the beech decidedly predominating, has huge spruces and firs as well as maples (*Acer pseudoplatanus*) abundantly interspersed. Many «pure» beech forests, as far as they are natural, have arisen by selective cutting of certain species, especially conifers.

Beech forests are sometimes sharply set off against neighbouring forest communities, but in places strips of mixed forest arise in which the ground vegetation is either determined by the beech with its accompanying woody plants, or by the spruce and occasionally by the oak. Sometimes, however, not only do the leading woody plants, of the two different forest sociations intermingle, but also, in the undergrowth fragments of the two respective sociations are mixed in such a manner, that an analysis shows a peculiar promiscuity which, in reality, is not a promiscuity but a mosaic of two distinct sociations. I have shown in another paper that decaying logs and stumps can be a place of support for the invasion of foreign elements into a beech forest (see also D o m i n <sup>5</sup>). The published analyses of such intermingled sociations (as well as of cultivated forests) s e e m i n g l y destroy the boundaries between the spruce and beech forests. Roads and paths, as well as forest cuttings and clearings, are also very important for the invasion of foreign elements into the beech forest region. In the virgin forest of Boubín in the Šumava Mts., I noted especially the following species growing chiefly on stumps, trunks, and roots of conifers and from them as-

sociating locally into small groups: *Homogyne alpina*, *Calamagrostis villosa*, *Listera cordata*, *Vaccinium myrtillus*, *Struthiopteris spicant*, *Lycopodium annotinum* and *L. selago*, hence only types quite foreign to typical beech forests.

Analogous examples are abundant. I described an especially interesting case (<sup>A</sup>, pp. 30—31) from Subcarpathian Russia. In a ravine on Mt. Kečírka in the Velký Trostinec valley there is a mixed virgin beech forest with a small strip dominated by spruce, which phenomenon alone suffices to cause a quite different type of ground vegetation. We find here *Calamagrostis arundinacea* ab. and *Vaccinium myrtillus*, abundantly to gregariously first taking root on mossy stumps or fallen trunks and persisting even after the latter have decomposed and finally seemingly disappeared. *Lycopodium annotinum* grows very greg. in this community, *Dryopteris spinulosa* is abundantly scattered while *Gentiana asclepiadea*, which species is almost entirely lacking in the beech forest region, is only scattered. The ground here is mossy. This community does not belong, of course, to the beech but is a fragment of an entirely different (spruce) sociation, here fairly well developed but in many other places difficult to distinguish and seemingly mixed with the beech forest undergrowth. There where the fir forms a small growth in the beech forests (with or without interspersed spruce) as for instance at the foot of the rocky shaded ridge on Mt. Kečírka, a mossy *Oxalis* type is developed with *Dryopteris pulchella* (v. scat.), *Valeriana tripteris* (only scat.), *Vaccinium myrtillus* and *Lonicera nigra* (v. sc.).

If the spruces here grow in a more humid ravine, a mossy type arises in which are also present growths of *Luzula silvatica*, *Carex silvatica*, a little of *Vaccinium myrtillus*, establishing itself chiefly on mossy trunks with gregarious *Lycopodium annotinum*. Other herbaceous plants may also appear, such as *Doronicum austriacum*, *Crepis paludosa* and shrubs, such as *Lonicera nigra*, in abundance, etc.

In such a manner foreign elements and fragments of spruce sociations penetrate into beech forests (even into virgin growths); in normal beech forests not even *Vaccinium myrtillus* can be found anywhere. Even in virgin beech forests without any human influ-

ence, small places arise by soil degradation where, for instance, *Struthiopteris spicant* and colonies of other spruce elements can establish themselves.

Transitional types of beech and spruce forests are quite frequent and in reality of two types:

a) in the mixed forest of deciduous and coniferous trees, one sociation dominates in the undergrowth, whereas the other is represented at least fragmentarily;

b) in the mixed forest, the undergrowth is determined either only by the beech or only by the spruce.

To the transitional beech-oak forests also belongs the *Poa nemoralis* type (with two subtypes, namely *Poa nemoralis* and *Poa nemoralis-Melica uniflora*), as was described by R. Mikyška (1) in the *Quercetum* and *Fagetum* in the Štiavnické Středohoří (Slovakia). In the tree stratum, in most cases, *Quercus robur* predominates, whereas the beech retreats. The forest is somewhat open as the growth is rather irregular due to the steep slopes. The rocks are eruptive rocks (andesites predominating) and the ground vegetation has the character of a community in a rather dry and sunny habitat with often shallow and stony ground. Some species as *Arabis arenosa*, *Cytisus nigricans*, *Genista tinctoria*, *Sedum maximum*, *Laserpitium latifolium* and others indicate a rather xerophytic character of this sociation. Mikyška characterises this type, first, by a great dominance of *Poa nemoralis* which is constant in all modifications of this type, further by the combination of *Fragaria elatior*, *Galium Schultesii*, *Quercus robur* as constant species, and the following differential species: *Arabis arenosa*, *Digitalis ambigua*, *Chrysanthemum corymbosum*, *Calamintha clinopodium*, *Laserpitium latifolium*, *Lampsana communis*, *Sedum maximum*, *Silene vulgaris*, *Vicia sepium*. Already from these remarks we see the relation of this forest to the oak forests.

Most remarkable are the transitions between beech forests and *Quercetum lanuginosae*, two sociations physiognomically, floristically and ecologically entirely contrasting. In the southwestern spurs of the Carpathians, these transitional types are fairly frequent. I became acquainted with them in the Tematín hills (dolomite) from where they were first described by Sillinger (1) and in the Mt. Rokoš group (also dolomite).

### VIII. Seasonal aspect of the ground vegetation (phenological spectrum).

The aspect of the undergrowth of the beech forest changes rather considerably during every vegetative period. Some of the early spring species as *Isopyrum thalictroides*, *Galanthus nivalis*, *Corydalis*, *Adoxa*, *Scilla bifolia* soon disappear completely while others are developed fully later in the summer. *Epipogon aphyllus* has also only a short life-duration.

As an example, I quote the three aspects distinguished by MIKYŠKA (1) in the undergrowth of the beech forests and of the oak forests mixed with beech in the Štiavnické Středohoří (Slovakia).

Early spring aspect (species flowering to about the middle of May): *Anemone ranunculoides*, *Corydalis cava*, *C. digitata*, *Daphne mezereum*, *Chrysosplenium alternifolium*, *Isopyrum thalictroides*, *Petasites albus* and *Scilla bifolia*. The optimal floral development falls into the period before the new leaf-canopy closes.

Late spring aspect (lasting to the latter half or eventually to the end of June): *Actaea spicata*, *Alliaria officinalis*, *Asperula odorata*, *Carex pilosa*, *Dentaria bulbifera*, *Euphorbia amygdaloides*, *Glechoma hirsuta*, *Melica nutans*, *M. uniflora*, *Melitis melisophyllum*, *Oxalis acetosella*, *Poa nemoralis*, *Polygonatum officinale*, *P. multiflorum*, *Primula elatior*, *Ranunculus auricomus*, *R. lanuginosus*, *Stellaria holostea*, *Symphytum tuberosum*, *Veronica chamaedrys*, *Viola Riviniana* and *V. silvatica*.

Summer aspect (less distinctive): to the species with a longer flowering period belong the following: *Ajuga reptans*, *Asperula odorata*, *Galium Schultesii*, *Geranium Robertianum*, *Hieracium murorum*, *Myosotis silvatica*, *Viola Riviniana* also *silvatica*. Species flowering only during the summer are not numerous: *Astrantia major*, *Campanula trachelium*, *Epilobium montanum*, *Galeopsis pubescens*, *Hypericum hirsutum*, *Chrysanthemum corymbosum*, *Impatiens noli tangere*, *Knautia silvatica*, *Lactuca muralis*, *Lilium martagon*, *Melampyrum nemorosum*, *Phyteuma spicatum*, *Prenanthes purpurea*, *Sanicula europaea*, *Scrophularia nodosa*, *Senecio Fuchsii*, *Stachys silvatica* and *Valeriana sambucifolia*.

I restrict myself to this one example, because it is impossible to

present phenological spectra of every sociation and every type, not to mention the fact that the spectrum varies according to the exposure, altitude, as well as to climatic regions, etc.

#### IX. Shrub vegetation below canopy.

There are not, always, many strata in beech forests. The moss covering is nearly always lacking, the herbaceous undergrowth (in one or two layers) is more or less well developed but can also be suppressed (see *Fagetum nudum*), and the shrubby growth (young trees and true shrubs) is very unequally developed. As the most characteristic shrubs accompanying the beech, the following can be mentioned:

<i>Cornus sanguinea</i>	<i>Rosa pendulina</i>
<i>Corylus avellana</i>	<i>Rubus idaeus</i>
<i>Daphne mezereum</i>	<i>Sambucus racemosa</i>
<i>Lonicera nigra</i>	<i>Sorbus aria</i> (chiefly on limestone)
<i>Lonicera xylosteum</i>	<i>Sorbus torminalis</i>
<i>Ribes alpinum</i>	<i>Spiraea media</i> (only in Subcarpathian Russia)
<i>Ribes grossularia</i>	

Rather characteristic for some beech forests are also *Evonymus verrucosa*, *Ligustrum vulgare* (ab.), *Stachylea pinnata* and *Viburnum opulus*. Besides, a good many other shrubs (for instance *Cornus mas*, *Crataegus*, *Cotoneaster tomentosa* (Carpathians only), *Berberis vulgaris*, *Rhamnus cathartica*, *Viburnum lantana* and some *Rosa* and *Rubus* species are sometimes present in some beech forest sociations.

#### X. Ground vegetation.

The ground vegetation is the most reliable basis for a sociological classification of beech forests, because the general tree stratum is uniform and the small number of accompanying trees cannot be depended upon for establishing definite sociations. Since a sociological classification of beech forests is exceedingly difficult, many authors avoid a definite evaluation and distinguish simply «types», often characterised also ecologically. These types, however, are not identical with the well-known C a j a n d e r 's forest types, because these authors interpret the beech forest, including its tree

stratum, as one unit. This interpretation is without any doubt a correct one, because the influence of the tree layer on the ground vegetation is much more evident than in other forests. This is evident already from the fact that a normal beech forest has an influence upon the microclimate, upon the cyclic light intensity, as well as upon the formation of humus by leaf-decay, and upon the microbe vegetation. As I have already described above, a small spruce enclosure, measuring only a few square meters, causes, in a virgin beech forest, a radical change in the ground vegetation which points out quite clearly the dependance of the undergrowth upon the tree stratum.

On the basis of the ground vegetation, it is possible to distinguish beech forest sociations and their numerous variants. This classification, however, has many difficulties, as:

1. First of all, there are the antropical influences (forest culture, selective or clear cutting, grazing, etc.) which render it difficult to recognise the original beech forest sociations.

2. The evaluation of forest communities is and always will remain subjective and therefore one author can regard, as distinct sociations, such communities which in the opinion of another would be considered only as less important variants of one and the same sociation. According to the new terminology, introduced by G. Einar Du Riez (1929), *sociation* becomes a fundamental sociological unit, corresponding to association in the former sense of the Upsala ecological school. On the basis of this new conception, our beech forests consist of numerous sociations (small associations) and these sociations in turn form a *single consociation* (a group of association in the old sense) which consociation at the same time is an association of a single consociation.

3. For a correct evaluation of sociations, it is necessary that we know and compare growths of mature beech forests where the canopy has not been opened by selective felling. Besides that, it would be important to know every type of a beech forest in all stages of its development, that is, of virgin forests with natural openings and of cultivated forests with clearings. A change in light intensity, caused sometimes in virgin forests by the uprooting of old trees often brings about a complete change in the undergrowth.

4. The classification is further complicated by the fact that different types of beech forests are often made up of combinations of identical species so that we are compelled to accept the dominance of species as the determining character.

5. Some beech forest communities which appear to be distinct sociations are connected by various transitions.

6. Debatable is the question in what manner we ought to evaluate the floristic composition of the undergrowth and the dominance of the individual species. Sociation, in the narrower sense, should have constant dominants so that, for instance, analogous types of beech forests with *Asperula odorata* or *Mercurialis perennis* as dominants should be regarded as distinct sociations. Further, it is a question whether we can regard, as a single sociation, beech forests with abundant *Asperula odorata* and more or less abundant *Mercurialis perennis*, and whether we can add to this sociation as variants (resp. facies), communities, otherwise identical but differing by the presence or absence of mountain, calcareous, or geographically characteristic species. In reality only the correct recognition of these types is of importance, whereas their specification as sociations or variants and facies is a matter of subjective opinion in a similar manner as is the evaluation of species in taxonomy. From this point of view I do not emphasise, for the time being, the solving of the question, which phytocoenosis ought to be designated as a sociation and which as a variant of another sociation. These problems shall have to be solved by comparative studies in the future, after the studies of the European beech forests have been completed at least in rough outlines. How little our Czechoslovakian beech forests are known in world literature is best shown by L ä m m e r m a y r ' s book (1).

7. Of especial difficulty is the classification of those communities which I have called *F a g e t u m h e r b o s u m* and *a l t i h e r b o s u m*, because both types intermingle rather often, and the typical *F. h e r b o s u m*, when the canopy is loosened, takes on the character of the second group. Also *F. n u d u m* is, in reality, only a stage of this or that sociation with a latent herbaceous undergrowth.

8. Beech forests in optimal conditions and development appear frequently like mosaics of communities each of which, in other instances, has the character of distinct sociations.

9. It is sometimes very difficult to distinguish stable and transitional (resp. initial) stages as well as it is difficult to decide which types belong to the same sociation as the result of a chance or antropic change of the habitat. Thus I have described (<sup>4</sup>, p. 23—24) from Subcarpathian Russia beech forest types of an essentially different physiognomy but in reality brought about by the increase in light intensity. In the shade of an old, tall-trunk beech forest on a stony ground, we find the *Mercurialis-Phyllitis* type with very abundant *Urtica dioica*; in the lighter shade of more open forest places, the *Athyrium filix femina* type dominates; and on the still lighter places on coarse talus, a shrubby growth of *Rubus idaeus*, *Ribes grossularia* and *Lonicera nigra*, is to be found.

Besides, the same type (for instance *Carex pilosa*, *C. alba*, *Melica uniflora*) may be, in some instances, only a stage of another stable sociation or else a final stable community.

As a distinct sociation one cannot accept a growth which is characterised only by the fact that a single species of this or that sociation determines locally the aspect by its high dominance. A sociation must have its own sociological structure, a certain stability, and a certain geographical distribution. As I have already mentioned, it is a matter of personal opinion whether the geographical and edaphic variants ought to be evaluated as distinct sociations.

Sociations and variants of beech forests we characterise by the floristic composition and by the physiognomy of their tree, shrub and ground vegetation strata (also of the mossy layer, if present). In a broader sense, these principal sociations are complicated by other accompanying sociations, namely the epiphytic growths of bryophytes, lichens, algae, the mycoflora, and, of course, also the microbe vegetation of the soil.

#### XI. Sociations, variants and facies of Czechoslovakian beech forests.

As far as the beech forests of our state are concerned, it seems advisable to distinguish two sociologically and ecologically essentially different groups, namely the true beech forests (*F a g e t u m v e r u m*) and the spurious beech forests (*F. s p u r i u m*) to which latter may also be joined the degraded beech forests. The bare-floor beech

forests (*F. nudum*), entirely or almost without any herbaceous undergrowth, are widely distributed. It is, however, impossible to regard them as distinct sociations, since they are in reality only special stages of other sociations whose undergrowth became latent, but is potentially present.

The spurious beech forests have an undergrowth with dominants and other species foreign to the true beech forests and mostly belonging to the spruce (for instance *Vaccinium myrtillus*, *Calamagrostis villosa*, *Homogyne alpina*, *Lycopodium annotinum*, *Struthiopteris spicant*, *Gentiana asclepiadea*, Hercynians bryophytes, etc.), sometimes to the oak. The true beech forests always exclude, under favourable habitat conditions, all characteristic Hercynian elements such as *Deschampsia flexuosa*, *Vaccinium*, *Calluna*, etc., wherein they differ essentially from the usual spruce forest sociations.

In this chapter I shall try to give a short description of the main types characteristic of our true beech forests. This enumeration, however, is not complete but at least gives a general picture of our beech forests. These types I classify at present as follows:

A. *Fageta herbosa*.

1. *Asperula odorata* sociation.
  - a) *Sudetic-Hercynian* variants;
  - b) *Carpathian* variant;
  - c) *Mercurialis perennis* variant;
  - d) *Asperula odorata-Glechoma hirsuta* variant;
  - e) *Cephalanthera rubra-Epipactis microphylla*.
2. *Fagetum asperulacum mixtum* sociation.
  - a) *Hercynian* facies;
  - b) *Carpathian* facies.
3. *Asperula odorata-Polystichum Braunii* sociation.
  - a) *Tatra calcicole* facies;
  - b) *Eastern Carpathian Flysch* facies.
4. *Geranium Robertianum* sociation.
5. *Dentaria* sociation.
6. *Oxalis* sociation.
7. *Galeobdolon-Oxalis* sociation.
8. *Allium-ursinum* sociation.

- B. *Fageta altiherbosa*.
9. *Cortusa sociation*.
  10. *Pleurospermum-Cirsium erisithales sociation*.
  11. *Lunaria-Urtica sociation*.
    - a) *Phyllitis-Parietaria* variant;
    - b) Carpathian calcicole *Lunaria-Urtica* variant;
    - c) *Sudetic-Hercynian* facies;
    - d) *Urtica dioica* variant.
  12. *Senecio Fuchsii sociation*.
- C. *Fageta subhygrophila*.
13. *Petasites albus sociation*.
    - a) *Sudetic-Hercynian* facies;
    - b) *Western Carpathian* facies;
    - c) *Eastern Carpathian* facies;  
*non-mossy* variant;  
*mossy* variant.
  14. *Petasites albus-Mercurialis-Chaerophyllum hirsutum sociation*.
  15. *Impatiens noli tangere sociation*.
- D. *Fageta filicina*.
16. *Athyrium filix femina sociation*.
    - a) *Sudetic-Hercynian* facies;
    - b) *Eastern Carpathian non-mossy* facies;
    - c) *Eastern Carpathian mossy* facies.
  17. *Dryopteris Robertiana sociation*.
  18. *Eastern Carpathian Mercurialis-Phyllitis sociation*.
- E. *Fageta caricina*.
19. *Carex pilosa sociation*.
    - a) poor variant;
    - b) *Carex pilosa-Dentaria bulbiflora-Staphylea* variant;
    - c) *Carex pilosa-Hacquetia-Cephalanthera rubra* variant;
    - d) *Carex pilosa-Luzula nemorosa* variant.
  20. *Carex alba sociation*.
- F. *Fageta luzulina*.
21. *Luzula silvatica sociation*.
    - a) *Eastern Carpathian Flysch* facies;
    - b) *Western Carpathian limestone* facies.
  22. *Luzula nemorosa sociation*.

G. *Fageta graminosa*.

23. *Melica uniflora* sociation.
  - a) *Western Carpathian* calcicole facies;
  - b) *Western Carpathian* silicicole facies.
24. *Dactylis Aschersoniana* sociation.
25. *Sesleria calcaria* sociation.
26. *Festuca silvatica* sociation.
27. *Milium effusum* sociation.
28. *Brachypodium silvaticum* sociation.
29. *Poa nemoralis* sociation.
30. *Calamagrostis arundinacea* sociation.

Besides these, there are some sociations of degraded and spurious beech forests, as:

31. *Majanthemum bifolium* sociation.
32. *Festuca ovina-Luzula nemorosa* sociation.
33. *Myrtillus-Homogyne* sociation.
  - a) *Struthiopteris spicant* variant;
  - b) *Calamagrostis villosa* variant.
34. *Calamagrostis villosa* sociation.

A. *Fageta herbosa*.

1. *Asperula odorata* sociation. (*Fagetum asperulaceum odoratae*.)

It is questionable whether all the variants of the woodruff beech forests can be included into one sociation. They form, it is true, a certain natural unit but it seems that some of the types which I place provisionally into this sociation show a rather marked sociological character.

First, we may distinguish three geographical variants (facies), namely the Sudetic-Hercynian, the Western Carpathian, and the Eastern Carpathian, each of which can be further subdivided into silicicole and calcicole variants, and these again into submountain, mountain, respectively also supermountain variants. Thus the classification becomes very complicated but agrees with the communities found in nature. There are, of course, various transitions and frequently also transitions to other forest types. In the normal woodruff type, tall herbs and grasses are either missing, or only very scattered, or they may be more frequent but then weak and mostly sterile in-

dividuals and do not belong to the dominant species. If the canopy is artificially more or less opened, these herbs under certain habitat conditions may determine the aspect and thereby the undergrowth takes on the character of the second group (*Fagetum altherbosum*). To join both groups into one is not advisable, because types of both groups occur side by side under the same light conditions, and therefore cannot be considered as stages of one and the same sociation.

The Sudetic-Hercynian, woodruff beech forests are characterised chiefly by the absence of Carpathian species of which only a few penetrate into this region, where they are either very scarce or only locally abundant. Many of these beech forests have been described by our authors. These forests, occurring on humous and rather porous soils, show, however, more hygrophytic and xerophytic variants, connected by numerous intermediates. A moss-carpet on the floor is lacking, only the roots, stumps or stones may be mossy. Together with *Asperula odorata*, which is not only a constant species but also a dominant, the following species are usually found in this sociation (an asterisk designates species rare at low altitudes):

- |                            |                                  |
|----------------------------|----------------------------------|
| <i>Actaea spicata</i>      | * <i>Lonicera nigra</i>          |
| <i>Anemone nemorosa</i>    | <i>Melica nutans</i>             |
| <i>Asarum europaeum</i>    | <i>Mercurialis perennis</i>      |
| * <i>Bromus asper</i>      | <i>Oxalis acetosella</i>         |
| <i>Cardamine impatiens</i> | <i>Phyteuma spicatum</i>         |
| <i>Carex digitata</i>      | <i>Polygonatum multiflorum</i>   |
| <i>Carex silvatica</i>     | <i>Polygonatum verticillatum</i> |
| <i>Daphne mezereum</i>     | * <i>Prenanthes purpurea</i>     |
| <i>Dentaria bulbifera</i>  | <i>Pulmonaria obscura</i>        |
| <i>Epilobium montanum</i>  | * <i>Rosa pendulina</i>          |
| * <i>Festuca silvatica</i> | <i>Sanicula europaea</i>         |
| <i>Galium silvaticum</i>   | <i>Senecio Fuchsii</i>           |
| <i>Hedera helix</i>        | <i>Senecio nemorensis</i>        |
| <i>Hepatica triloba</i>    | * <i>Veronica montana</i>        |
| <i>Lactuca muralis</i>     | <i>Viola mirabilis</i>           |
| <i>Lamium luteum</i>       | <i>Viola Riviniana</i>           |
| <i>Lathyrus vernus</i>     | <i>Viola silvatica</i>           |
| <i>Lilium martagon</i>     |                                  |

In the Carpathian facies, all these species are present (only *Hepatica* and *Galium silvaticum* are mostly missing) and are joined by others, as for instance, *Galium Schultesii*, *Glechoma hirsuta*, *Hacquetia epipactis*, *Isopyrum thalictroides*, *Scrophularia Scopolii* etc., in the Eastern Carpathians also *Symphytum cordatum*, *Veronica urticifolia*.

The woodruff sociation under unfavourable conditions may be reduced to almost a *Fagetum nudum*. For instance in Slovakia on Mt. Trstje in the Rimava gneiss Mts., there are, in the lower zone of a rather steep slope on both sides of a creek, such beech forests almost without any herbaceous undergrowth, the floor covered only with a thick leaf-carpet. By analysis of an extensive area here, I was able to ascertain only the following species: *Asperula odorata*, *Mercurialis perennis*, *Carex digitata*, *Oxalis acetosella*, *Cardamine impatiens*, *Galium vernum*, *Dactylis Aschersoniana*, *Luzula nemorosa*, *Rosa pendulina*, all of them only sparsely scattered while *Glechoma hirsuta* grows rarely only in the higher parts.

The woodruff type, in its poorer to very poor variant, is widely distributed especially in the Sudetic-Hercynian region where the beech forests (with interspersed *Acer pseudoplatanus*, *Carpinus betulus* and *Fraxinus excelsior*, in the shrubby undergrowth also *Sambucus racemosa*) which Zlatník describes (<sup>3</sup>, p. 21) on the basaltic Bukový vrch in the České Středohoří Mts. (a somewhat stony slope, NE by E, 650 meters) also belong to this category. The growth is a fine, tall-trunked and almost pure beech forest with the following soil profile: leaf-carpet about 2 cm thick shows a reaction pH 5.94; beneath is a grey humous loam with a pH 6.15 and this stratum gradually merges (at about a depth of 20 cm) into an ochre-grey loam with a 10% fine skeleton and with an acidity pH 6.29 at 50 cm depth. In the undergrowth *Asperula odorata* has the highest dominance, then *Lactuca muralis* and *Senecio Fuchsii*; only scattered are *Carex silvatica*, *Elymus europaeus*, *Coronilla varia*, *Galeopsis grandiflora*, *Geranium Robertianum*, *Impatiens noli tangere*, *Veronica officinalis* and a few other species are solitary. Already this beech forest shows the penetration of some foreign elements. Other analyses which Zlatník gives from this district represent, however, mostly atypical growths, inappropriate as examples of sociologically well-defined types. Also the beech forests, described by Fírbaš (<sup>1</sup>, p. 141) on

Mt. Milešovka in the České Středohoří Mts., are mostly remains of this type with abundant *Asperula odorata* and *Mercurialis perennis*.

Of the numerous variants of the woodruff sociation, I give only the following few:

a) **Hercynian-Sudetic variants.**

These variants are widely distributed in this region, and according to local conditions, they may be floristically poor or even rich. H i l i t z e r (<sup>1</sup>, p. 70), for instance, described this type from the neighbourhood of Kdyně in the Český Les Mts. on amphibolite substratum. Floristically, this type is comparatively rich, the woodruff covers on the average 60 % to 85 % of the surface, but its low and not quite continuous growth does not prevent other accompanying species to come in. Constantly present is *Oxalis acetosella*, but only with small dominance, just as is true of *Lamium luteum*, *Geranium Robertianum* and *Viola silvatica*. Besides *Asperula odorata*, only *Mercurialis perennis* (always present) has a greater dominance. Of the species with only a slight dominance the following were ascertained in 3 analyses (out of 4): *Epilobium montanum*, *Fragaria vesca*, *Impatiens noli tangere*, *Milium effusum*, *Senecio Fuchsii* and *Urtica dioica*, in two analyses (out of 4): *Asarum europaeum*, *Bromus asper*, *Dryopteris filix mas*, *Festuca silvatica*, *Galeopsis grandiflora*, *Hypericum perforatum*, *Lactuca muralis*, *Lathyrus vernus*, *Melica nutans* and *Neottia nidus avis*. Other species were found only in a single analysis, among these were also *Dentaria bulbifera*, *D. enneaphyllos*, *Actaea spicata*, *Pulmonaria obscura*, *Hepatica triloba*, *Paris quadrifolia*, *Brachypodium silvaticum*, etc. In the tree stratum, *Fraxinus excelsior*, *Tilia platyphylla*, *Acer pseudoplatanus*, *A. platanoides*, *Ulmus scabra* and *Picea excelsa* also occur, but not in all instances; of the shrubs *Sambucus racemosa* and *Rubus idaeus* are the most frequent.

b) **Carpathian variant.**

R. M i k y š k a (<sup>1</sup>) describes from Štiavnické Středohoří Mts. (Slovakia) on tertiary eruptive rocks (mostly andesites) a type of pure or mixed beech forests which he considers to be a distinct association. He designates it as the *Asperula odorata* type and distinguishes the following 4 subtypes: 1. *Asperula odorata* subtype, 2. *Asperula odorata* — *Mercurialis perennis* subtype, 3. *Asperula odorata* — *Se-*

*Senecio Fuchsii* subtype, 4. *Asperula odorata* — *Impatiens noli tangere* subtype. Mikyška's first subtype belongs here, the second to the following variant, whereas the last is given in our classification as a distinct sociation. For this woodruff type, *Asperula odorata* as a dominant is most important and decreases in dominance only in those individuals where other species with a high sociability are present (*Glechoma hirsuta*, *Lamium luteum*, *Mercurialis perennis*, *Impatiens noli tangere*) and take up its layer, and thereby give rise finally to new types. The author designates as important the presence of the following constant species: *Dryopteris filix mas*, *Lamium luteum* and *Senecio Fuchsii* (not constant in other forest types of the same district), further *Pulmonaria officinalis*, *Viola Riviniana* and *silvatica* (only accessory in the bare-floor beech forest as well as in the *Poa nemoralis* type), then *Epilobium montanum* and *Geranium Robertianum* (inconstant in the bare-floor beech forest and in the *Carex pilosa* type); finally *Lactuca muralis* is a constant species, approaching in its occurrence and constancy the woodruff and *Dentaria bulbifera*.

Carpathian variants of the woodruff sociations are, of course, rather numerous. As an example, I give the following Western Carpathian mountain calcicole variant of the *Hacquetia* type. It is an old beech forest near the summit of Rokoš, on dolomite, at 1000 meters, NE by N slope. In the undergrowth shrubs are only scattered (*Rosa pendulina*, *Corylus avellana*, *Lonicera xylosteum*, *Sorbus aucuparia*, young *Fraxinus excelsior*, *Acer platanoides* and *pseudoplatanus*, the last species also solitarily as old trees). According to the dominants, we could designate this growth as a mixed *Asperula odorata* + *Mercurialis perennis* type; the woodruff is more conspicuous, though the dominance of both species is nearly equal. It is rather surprising that two species of such a high sociability as the two mentioned dominants maintain an approximately even balance. It can be explained by the peculiar habitat conditions of this dolomite district where there is no apparent surface water, and even at high altitudes the soil is hardly fresh and is covered by a dry leaf-carpet which prevents *Mercurialis* from taking possession of the ground. Floristically this growth is comparatively poor:

*Aconitum vulparia* only scat.

*Astrantia major* scat.

*Asarum europaeum* scat.

(*Campanula trachelium*)

(*Cirsium erisithales*)  
(*Convallaria majalis*)  
*Dentaria bulbifera* scat.  
*Hacquetia epipactis* scat.  
(*Lactuca muralis*)  
(*Lathyrus vernus*)

(*Melittis melisophyllum*)  
*Prenanthes purpurea* scat.  
(*Primula elatior*)  
*Senecio Fuchsii* scat.  
*Symphytum tuberosum* scat.

c) **Mercurialis perennis** variant.

The dominant of this type with its great capacity of vegetative propagation takes possession of the ground and forms dense growths, seemingly entirely pure but always having some species though frequently only very weak, of the woodruff sociation. This type is very abundant in many variations throughout the Czechoslovak region. Hilitz er, for instance, describes (<sup>1</sup>, p. 12—13) this variant from the neighbourhood of Kdyně in the Český Les Mts. and states that from the accompanying beech forest species only some very ombrophilous (for instance *Asperula odorata*, *Lamium luteum*) can maintain themselves, further some herbs of taller growth, while others are restricted to occasional gaps. It is therefore a very excluding type and thus acquires a characteristic physiognomy. It is up to the present disputable whether this beech forest type represents a distinct sociation or only a variant of the woodruff sociation with which this type agrees in its floristic composition and with which it is connected by various transitions. Especially there where the *Mercurialis* type is developed on old talus covered by humus, it is often very characteristic and has also the tree stratum more mixed than usual. It occurs, however, also on humous soils, loamy beneath. I have described (<sup>4</sup>, p. 8, 9) two typical growths from Subcarpathian Russia differing, as a geographical facies of the Eastern Carpathians, only by the presence of *Symphytum cordatum*. The first growth occurs on non-mossy humous soil on Mt. Kečírka in the Velký Trostinec valley (700 meters) in an old shaded virgin beech forest, interspersed with old firs and spruces, less frequently also *Acer pseudoplatanus*, *A. platanoides*, *Fraxinus excelsior*, *Ulmus scabra*, and is exceedingly dense and therefore to such a degree excluding that only *Circaea lutetiana*, *C. alpina* and *Geranium Robertianum* (ster.), are scattered, whereas other species are only solitary and also *Asperula odorata* forms only small colonies here and there.

The second growth in the same neighbourhood (730 meters) is characterised by extensive *Mercurialis* growths which are continuous, dense to very dense. On the rather humous, non-mossy ground covered by a decayed-leaf carpet, the shrubs *Lonicera nigra* and *Daphne mezereum* are scattered as well as a few young maples (*Acer pseudoplatanus*) and solitary *Sambucus racemosa*. The composition of the *Mercurialis* undergrowth is floristically richer, *Salvia glutinosa* is abundantly scattered, *Asperula odorata* is also fairly abundant and almost equally distributed, *Athyrium filix femina* (in a small form) and *Oxalis acetosella* are abundantly enough scattered, further *Sanicula europaea*, *Circaea lutetiana*, *Symphytum cordatum*, *Ranunculus lanuginosus*, *Chrysosplenium alternifolium*, *Carex silvatica* are scattered, *Lactuca muralis*, *Pulmonaria obscura* only scattered, less frequent are *Circaea alpina*, *Stachys silvatica*, *Geranium Robertianum*, *Impatiens noli tangere*, *Aegopodium podagraria* (ster.) and quite solitary is *Galeopsis grandiflora*. We see thus, that it is quite a typically developed growth of this type.

d) *Asperula odorata* — *Glechoma hirsuta* variant.

Into this category belong the characteristic Carpathian types which most likely represent a distinct sociation. As an example I cite, from my numerous analyses in various parts of the Carpathians, only the three following, rather essentially different, types:

a) The Eastern Carpathian facies without *Lamium luteum*. I described this type from Subcarpathian Russia (<sup>4</sup>, p. 7) in an old untouched, almost pure beech forest in the upper part of the Bilina creek valley on a rather steep SW slope, at an altitude of about 820 meters, on a Flysch substratum. The floor here is non-mossy, the soil covered by a thick layer of decaying leaves and beneath is a deep layer of slope loam with a fine gravel. Sparcely scattered are *Acer pseudoplatanus*, *Ulmus scabra* and *Fraxinus excelsior*; the undergrowth is fairly rich, herbaceous, but not continuous. *Asperula odorata* and *Glechoma hirsuta* are dominants in the undergrowth, accompanied by the abundantly scattered *Mercurialis perennis* and *Circaea lutetiana*; abundantly enough are scattered *Symphytum cordatum* and *Stellaria nemorum*, scattered *Salvia glutinosa*, *Epilobium montanum*, *Athyrium filix femina*, *Dryopteris filix mas*, *Asarum europaeum*, only scattered *Pulmonaria obscura*, *Actaea spicata*,

*Rubus* sp. and *Petasites albus* (small groups), and solitarily appear *Prenanthes purpurea*, *Doronicum austriacum*, *Dentaria bulbifera*, *Veronica urticifolia*, *Lactuca muralis*, *Stachys silvatica* (lighter places), *Senecio nemorensis*, *Solidago virga aurea* (ster.).

β) Western Carpathian mountain calcicole *Glechoma hirsuta* + *Galeobdolon* with *Hesperis nivea* facies.

This type is developed, for instance on Mt. Vysoká in the Little Carpathians, in a tall-trunk beech forest, located on a southern limestone slope at about 600 meters altitude; abundantly interspersed is *Acer campestre*, also *Ulmus scabra*, *Acer pseudoplatanus*, solitarily old and tall trees of *Carpinus betulus*. The undergrowth on its humous soil is luxuriant, entirely closed, *Glechoma hirsuta* and *Lamium luteum* are present as the two dominant elements; with them grow *Hesperis nivea* abundant even in whole growths as a higher layer, *Asperula odorata* (v. ab.), *Triticum caninum* and *Heracleum sphondylium* (v. scat.), *Salvia glutinosa*, *Impatiens noli tangere*, *Senecio Fuchsii*, *Pulmonaria officinalis* and *Chaerophyllum temulum* scat. *Lamium maculatum* and *Sisymbrium strictissimum* only scat., *Arabis turrita*, *Allium ursinum* and *Geranium phaeum* only rarely.

γ) In the limestone mountains in the territory of the western Váh river, a somewhat different type is to be found which is in a certain sense an approach to the mixed beech forest types. For instance in the gorge-like valley near Mojtín, in the beech forests on the slopes, *Asperula odorata* is quite common, often forming large growths, and in its company we find *Glechoma hirsuta* (abundantly), *Lamium luteum* (scattered), further, *Aconitum vulparia* (abundantly enough), *Actaea spicata* (locally), *Arabis hirsuta* (v. scat.), *Asarum europaeum* (ab.), *Cardamine impatiens* (scat.), *Circaea lutetiana* (more humid places), *Cephalanthera rubra* (v. ab. scat.!), *Dentaria bulbifera* (scat.), *Epipactis latifolia* (sol.), *Galium Schultesii* (ab.), *Hedera helix* (rather ab.), *Lactuca muralis* (ab. scat.), *Lathyrus vernus* (ab. scat.), *Lilium martagon* (only scat.), *Melica nutans* (scat.), *Mercurialis perennis* (scat.), *Myosotis silvatica* (scat.), *Polygonatum multiflorum* (only scat.), *Pulmonaria obscura* (scat.), *Salvia glutinosa* (scat.), *Senecio Fuchsii* (only scat.), *Viola silvatica* (scat.), *Atropa belladonna* grows only solitarily in the shade of the forest, in one place, among mossy stones, grows gregariously enough *Phyllitis sco-*

*lopendrium*, and on a mossy beech root only rarely *Asplenium viride*.

e) **Cephalanthera rubra — Epipactis microphylla. variant.**

A mountain calcicole type frequent in the southwestern Carpathians, particularly on the slopes below the ridges. For instance on the ridge Kamenná Vrata near Trenčianské Teplice (Slovakia) we find, on the southern slope, wild and dense beech forests in which *Asperula odorata* is constantly present, very often *Melica uniflora*, *Melittis melisophyllum*, *Brachypodium silvaticum*, *Inula conyza*, and scattered *Epipactis microphylla*, *E. rubiginosa*, *E. latifolia*, *Cephalanthera rubra*, *C. alba*, *C. ensifolia* (the last species rarely), also *Arabis hirsuta*.

On Mt. Strážov (on the slope above 800 meters alt.), we find in a humous shady beech forest, with very abundant *Asperula odorata* and with numerous other ombrophilous species (also *Hacquetia epipactis*), *Epipactis microphylla* abundantly scattered besides *E. rubiginosa* as well as *E. latifolia*, only scattered *Cephalanthera alba* (the two other species of this genus are missing here), further *Lamium luteum* (ab.), *Dentaria bulbifera*, *Hedera helix*, *Galium Schultesii*, *Lathyrus vernus*, *Oxalis acetosella*, *Senecio Fuchsii*, etc., etc. In reality, it is a mixed woodruff type but with the above mentioned orchids.

Analogous types may arise also in the Western Carpathian beech forests in a loosened *Caricetum pilosae* or *Caricetum albae*.

In southern Bohemia there occurs, on limestone in the Strakonice-Sušice district in the region of the Hercynian vegetation (for instance on Mt. Čepičná) a parallel facies *Asperula odorata*—*Cephalanthera rubra* in which, in the company of the usual Hercynian beech forest elements, *Prenanthes purpurea* and *Vicia silvatica* are also to be found; *Epipactis rubiginosa* and *Cephalanthera alba* are here rather abundant but, of course, all Carpathian species, are lacking.

## 2. Sociation *Fagetum asperulaceum mixtum*.

Where the beech forests have very favourable habitat conditions for the full development of the tree stratum as well as of the

ground vegetation, the herbaceous undergrowth usually is copious and vigorous, and represents a mixture of various types, namely the herbaceous, tall herb, fern, grass, and hygrophilous types. The elements of these types, however, are intermingled in such a manner that it is hardly possible to keep the individual types apart. In places, it is true, the predominance of this or that species causes that the growth approaches some of the above named types, but in general, the growth is a mosaic which cannot be sociologically split into individual sociations and their variants. It is more likely that out of this mosaic, which unites elements of numerous types under special, in general, less favourable habitat conditions, single specialised types have been differentiated.

a) **Hercynian facies.**

As an example, I may give the beech forests of the basaltic Dou-pov Mts., which formally were the absolutely predominating forest communities in this district and even to-day have a rather wide distribution. For instance, I analysed, in the year 1914, on the slope of the Oedschloss-Berg (about 600 meters alt.) these splendid high-trunk beech forests with more or less interspersed spruces and with single maples (*Acer pseudoplatanus*). Everywhere on the humous soil on the slope (without flowing water), there is a continuous herbaceous undergrowth; the leading species either form extensive areas or pure or nearly pure growths or they are more or less intermingled. Nowhere is *Asperula odorata* absent, often grouped in large and nearly pure, very dense growths, elsewhere again overgrown by other, higher vegetation. *Senecio Fuchsii* is exceedingly abundant and often forms dense «woodlets» extending over an area of more than 100 m in length. *Impatiens noli tangere* is another leading plant, the enormous growths of which with their softness and glaucous green colour, form an agreeable contrast to the light green of *Asperula odorata* and the dark green of *Mercurialis perennis*, which grow always in more or less small groups. *Prenanthes purpurea* is abundant and in places rather high, *Ranunculus lanuginosus* is abundantly scattered, *Stellaria nemorum* very gregarious, *Oxalis acetosella* abundant, *Pulmonaria obscura* rather abundant, *Lamium luteum* scattered, *Actaea spicata* rather abundantly scattered, *Urtica dioica* abundant and in places forming quite extensive growths, *Pe-*

*tasites albus* often appears in groups, *Sanicula europaea* is rather abundantly scattered, *Geranium Robertianum* abundant and only locally missing, *Lactuca muralis* and *Viola silvatica* are scattered, *Neottia nidus avis* solitary, *Vicia silvatica* rather abundant, *Myosotis silvatica* only scattered, *Chrysosplenium alternifolium* scattered, *Astrantia major* along forest margin and *Chaerophyllum hirsutum* only in places. Of the grasses, *Bromus asper* is the most abundant, more or less abundant is *Poa nemoralis*, scattered *Melica nutans*, abundantly scattered *Milium effusum*, and only scattered *Festuca silvatica*. Ferns are also characteristic components, of which *Dryopteris filix mas* and *Athyrium filix femina* are very abundant and in places seem to dominate the whole aspect, especially the latter species; *D. pulchella* is scattered, appears, however, in places even in rather large groups.

This is the analysis of a single extensive individual; in another place, in a similarly mixed type, we also find *Elymus europaeus* (abundant in groups), scattered *Luzula pilosa*, *Carex silvatica*, *Polygonatum verticillatum* and *Rosa pendulina*.

This is a typical example of beech forests under very favourable conditions (basaltic substratum and sufficient humidity), which even in a light shade cause the formation of these luxuriant closed growths that one might consider as a mosaic of sociations, difficult to distinguish in the field.

It is interesting that even the very small but sturdy beech forest that still remains between Olešnice and Dreihäuselns has a typical, rather mixed undergrowth; *Asperula odorata* grows there gregariously in places, *Prenanthes purpurea* is the most abundant of all and usually dominates the undergrowth, then we find *Viola silvatica*, *Lamium luteum*, *Pulmonaria obscura*, *Actaea spicata* (ab.), *Impatiens noli tangere* (only locally gregarious), *Mercurialis perennis*, *Vicia silvatica*, *Sanicula europaea*, *Neottia nidus avis*, *Ranunculus auricomus*, *Majanthemum bifolium*, *Melica nutans*, *Poa nemoralis*, *Bromus asper* and *Equisetum silvaticum*. Considering the small area the mixed type here is not so richly developed but is, notwithstanding, rather characteristic. As another example, I have selected from the large number, I have at hand, the beech forests on Železné Hory Mts. in the Zlatý potok valley where it narrows down to a

picturesque gorge called «Peklo» (Hell) and in its continuation, the Hedvičino údolí. Here, mostly on the more humid northern slope, there are mixed to nearly pure beech forests (with interspersed *Acer pseudoplatanus*), partly spoiled by spruce culture. Also both *Tilias* (*Tilia platyphylla* and *T. ulmifolia*) are scattered and in the shrubby undergrowth we find *Rosa pendulina* (only locally), *Daphne mezereum* (rather seldom), *Lonicera xylosteum*, *Sambucus racemosa* and *S. nigra* only very scattered, *Rubus idaeus* not frequent. The herbaceous ground vegetation is not uniform, its differentiation is caused by local variations of humus and humidity as well as by the expansiveness and sociability of the respective species. Because of the numerous transitions it is, however, impossible to distinguish individual types. Along the forest creek, hygrophilous plants as *Crepis paludosa*, *Chaerophyllum hirsutum*, *Lychnis flos cuculi*, *Angelica silvestris*, *Myosotis palustris*, *Festuca gigantea* with *Alnus glutinosa* are grouped into a distinct sociation. The beech forest's herbaceous undergrowth starts on the slope above the creek and gradually becomes less luxuriant. Its composition is as follows:

<i>Actaea spicata</i> (rather ab. scat.)	<i>Lamium luteum</i> (very common!)
<i>Anemone nemorosa</i> (scat.)	<i>Mercurialis perennis</i> (locally
<i>Anthriscus nitida</i> (inabundantly)	greg.)
<i>Asarum europaeum</i> (rather ab.)	<i>Oxalis acetosella</i> (in humous loc-
<i>Asperula odorata</i> (only loc. greg.)	alities very greg.)
<i>Epilobium montanum</i> (ab. scat.)	<i>Paris quadrifolia</i> (rather sc.)
<i>Euphorbia dulcis</i> (scat.)	<i>Polygonatum verticillatum</i> (only
<i>Fragaria vesca</i> (scat.)	very locally)
<i>Galium silvaticum</i> (scat.)	<i>Sanicula europaea</i> (locally)
<i>Geranium Robertianum</i> (very	<i>Senecio nemoralis</i> (rather ab.
common and often greg.)	scat.)
<i>Impatiens noli tangere</i> (v. com-	<i>Stellaria nemorum</i> (scat.)
mon, greg. and even on slop-	<i>Urtica dioica</i> (ab. scat.)
es locally predominant)	<i>Viola Riviniana</i> (v. ab. scat.)
<i>Lactuca muralis</i> (common)	<i>Viola silvatica</i> (ab. scat.)

Of the grasses, *Festuca silvatica* (scarce), *Melica nutans* (scat.), *Poa nemoralis* (on the whole abundant), grow here, of the ferns are present *Athyrium filix femina* (abundantly scattered, locally even

very gregarious), *Dryopteris spinulosa* (rather abundant), *D. phegopteris* (scattered) and *D. pulchella* (in places rather gregarious).

Another type I have already described (°, p. 35) from the side valley near Jinčov in Central Bohemia. The beautiful high-trunk beech forest here has a very abundant and luxuriant undergrowth, consisting of herbs and grasses, attaining its highest development on light places but also, very rich, in the forest shade. *Luzula nemorosa* is only scattered, *L. pilosa* appears only locally, *Carex silvatica* is abundant especially near the creek. Of the ferns *Dryopteris pulchella* grows here locally. Besides, we find in the undergrowth:

<i>Aquilegia vulgaris</i> (ab.)	<i>Neottia nidus avis</i> (scat.)
<i>Asarum europaeum</i> (ab.)	<i>Oxalis acetosella</i> (scat.)
<i>Asperula odorata</i> (greg.)	<i>Paris quadrifolia</i> (rather ab. scat.)
<i>Astrantia major</i> (especially in the lower, more humid zone)	<i>Phyteuma spicatum</i> (ab.)
* <i>Chrysanthemum corymbosum</i> (only loc.)	<i>Polygonatum multiflorum</i> (loc. in the lower zone)
<i>Euphorbia dulcis</i> (ab. scat. e- specially in the more hum- id lower zone)	<i>Polygonatum verticillatum</i> (only scat.)
* <i>Galium rotundifolium</i> (loc.)	<i>Prenanthes purpurea</i> (only v. loc.)
<i>Galium silvaticum</i> (ab. scat.)	<i>Pulmonaria obscura</i> (ab.)
<i>Impatiens noli tangere</i> (loc. ab.)	<i>Ranunculus lanuginosus</i> (v. com- mon in the lower, more humid zone)
<i>Lathyrus niger</i> (ab.)	<i>Senecio Fuchsii</i> (ab.)
* <i>Lathyrus silvestris</i> (v. loc.)	<i>Senecio nemorensis</i> (ab.)
<i>Lathyrus vernus</i> (rather ab.)	<i>Stellaria holostea</i> (loc.)
<i>Lilium martagon</i> (ab.)	<i>Veronica chamaedrys</i> (ab. scat.)
<i>Majanthemum bifolium</i> (only in colonies)	<i>Vicia silvatica</i> (loc.)
<i>Mercurialis perennis</i> (ab.)	<i>Viola mirabilis</i> (rather ab. scat.)
	<i>Viola Riviniana</i> (ab. scat.)

This growth shows a certain differentiation in the more humid lower zone along the creek and higher up on the slope. Besides, there penetrate some species which have their principal distribution in the hornbeam-oak woods of the same region; they give to this community the aspect of a somewhat different type.

Another interesting type of beech forest of the same category,

I found on the Českomoravská Vysočina Mts. on the granite ridge north of the small ponds of Ransko. It is an old beech forest, with mossy boulders strewn here and there and with little or no undergrowth in its rather deep shade; only locally the herbaceous vegetation is somewhat richer. Ferns are almost completely missing, of shrubs are inabundant *Daphne mezereum* and *Rubus idaeus*. The composition of the undergrowth is as follows:

<i>Actaea spicata</i> (ab. scat.)	<i>Galium rotundifolium</i> (in ab. col.)
<i>Asperula odorata</i> (rather scat.)	<i>Impatiens noli tangere</i> (loc.)
( <i>Atropa belladonna</i> )	<i>Lactuca muralis</i> (scat.)
<i>Brachypodium silvaticum</i> (loc.)	<i>Lamium luteum</i> (scat.)
<i>Bromus asper</i> (loc.)	<i>Lathyrus vernus</i> (scat.)
<i>Cardamine trifolia</i> (v. ab.!)	<i>Moehringia trinervia</i> (ab. scat.)
<i>Carex silvatica</i> (v. common! in robust indiv.)	<i>Oxalis acetosella</i> (rather ab.)
<i>Circaea alpina</i> (col.)	<i>Polygonatum verticillatum</i> (scat.)
<i>Dentaria bulbifera</i> (rather ab.)	<i>Sanicula europaea</i> (v. ab.)
<i>Dentaria enneaphyllos</i> (scat.)	<i>Senecio Fuchsii</i> (loc. ab.)
<i>Epipogon aphyllus</i> (sol.)	<i>Valeriana sambucifolia</i> (scat. in shade only ster.)
<i>Festuca silvatica</i> (ab.)	<i>Veronica montana</i> (only scat.)

This type I have designated as the *Sanicula-Cardamine trifolia-Carex silvatica* type of the *Asperula* sociation. It will be necessary, however, to ascertain whether this type has a wider distribution.

#### b) Carpathian facies.

In the Carpathians some of the mixed herbaceous types are very interesting, especially those on limestone. As example I give the south western slope of Rokoš, dolomite, at 800 meters and more altitude. The ground is covered with half-decayed leaves, the layer of humus is only thin. Of woody plants, ash and maples (*Acer platanoides* and *A. pseudoplatanus*) are interspersed but they appear almost exclusively only as young individuals very scattered; in addition there are only scattered *Daphne mezereum* and *Lonicera xylosteum*, solitary *Sorbus aria*, *S. aucuparia* (only as shrub), *Corylus avellana*, *Populus tremula*, *Rhamnus cathartica*. The herbaceous undergrowth is rather rich; of grasses, *Brachypodium silvaticum* is scattered, *Bromus asper* and *Melica nutans* only scattered; *Carex di-*

*gitata* is only rare here. Of the ferns, we find only quite locally in-abundant *Pteridium aquilinum*. Besides:

<i>Aconitum vulparia</i> (ab. scat.)	<i>Galium Schulthesii</i> (scat.)
( <i>Ajuga reptans</i> )	<i>Hacquetia epipactis</i> (rather ab. scat.)
<i>Aquilegia longisepala</i> (scat.)	( <i>Arabis arenosa</i> )
( <i>Asarum europaeum</i> (scat.)	<i>Heracleum sphondylium</i> (scat.)
( <i>Astrantia major</i> )	<i>Hieracium murorum</i> (only scat.)
( <i>Calamintha clinopodium</i> )	( <i>Laserpitium latifolium</i> )
<i>Campanula rapunculoides</i> (scat.)	<i>Lathyrus vernus</i> (only scat.)
( <i>Centaurea mollis</i> )	<i>Lilium martagon</i> (only scat.)
<i>Cephalanthera alba</i> (only scat.)	<i>Melittis melisophyllum</i> (scat.)
( <i>Chrysanthemum corymbosum</i> )	<i>Mercurialis perennis</i> (only loc.)
<i>Cirsium erisithales</i> (scat.)	( <i>Neottia nidus avis</i> )
( <i>Clematis recta</i> )	<i>Prenanthes purpurea</i> (only scat.)
<i>Convallaria majalis</i> (scat.)	<i>Primula elatior</i> (ab.!)
<i>Dentaria bulbifera</i> (only scat.)	<i>Pulmonaria obscura</i> (only scat.)
( <i>Epipactis latifolia</i> )	<i>Pulmonaria mollissima</i> (only scat.)
<i>Euphorbia amygdaloides</i> (only scat.)	<i>Ranunculus nemorosus</i> (only scat.)
	<i>Rubus saxatilis</i> (only scat.)
	<i>Sanicula europaea</i> (only scat.)
<i>Euphorbia polychroma</i> (only scat.)	<i>Viola mirabilis</i> (scat.)

This type, which can be designated as the *Hacquetia-Aconitum vulparia* type of the mixed *Asperula* beech forests, is only an example of the Carpathian calcicole beech forests which also appears elsewhere in different variations.

### 3. The *Asperula odorata* — *Polystichium Braunii* sociation.

This sociation belongs to the mixed herbaceous types of mountain beech forests. As an example, I give the following two variants:

#### a) The calcicole Tatra facies.

An old beech forest, in parts with a more or less open canopy, on the slope of Mount Šotla in the Tatras of Biela. Of shrubs, the following are scattered in the undergrowth:

*Daphne mezereum*, *Lonicera nigra* and *Sambucus racemosa*. Of ferns *Polystichum Braunii* is very abundant, *P. lobatum* scattered, *Dryopteris filix mas* abundant, *D. austriaca* scattered, *D. spinulosa*

only scattered, *D. pulchella* loc. greg., *Athyrium filix femina* abundant scattered. Of grasses, we notice *Melica nutans* abundantly scattered, *Bromus asper* scattered (on clearings abundant), *Festuca gigantea* (only loc.), *Elymus europaeus* (locally), *Calamagrostis arundinacea* (very scattered), *Milium effusum* (scarce). Besides there grow *Luzula nemorosa* scattered and *Carex silvatica* scattered, mostly on light places. Otherwise the composition of the undergrowth is as follows:

<i>Actaea spicata</i> (ab. scat.)	<i>Moehringia trinervia</i> (ab. scat.)
<i>Ajuga reptans</i> (ab. scat.)	<i>Monesis grandiflora</i> (scat.)
<i>Anemone nemorosa</i> (ab.)	<i>Monotropa hypopitys</i> var. <i>hypophega</i> (only v. scat.)
<i>Asarum europaeum</i> (ab.)	<i>Myosotis silvatica</i> (scat.)
<i>Asperula odorata</i> (on more places very greg.)	<i>Oxalis acetosella</i> (v. ab. to greg.!)
<i>Cardamine impatiens</i> (ab.)	<i>Paris quadrifolia</i> (scat.)
<i>Circaea alpina</i> (often and greg.)	<i>Petasites albus</i> (only in scat col.)
<i>Dentaria bulbifera</i> (ab. scat.)	<i>Polygonatum verticillatum</i> (only scat.)
<i>Epilobium montanum</i> (ab. scat.)	<i>Prenanthes purpurea</i> (ab. scat.)
<i>Euphorbia amygdaloides</i> (ab. scat.)	<i>Primula carpatica</i> (loc.)
<i>Galium Schulthesii</i> (v. scat.)	<i>Pulmonaria obscura</i> (loc.)
<i>Impatiens noli tangere</i> (loc.)	<i>Salvia glutinosa</i> (only v. scat.)
<i>Isopyrum thalictroides</i> (scat.)	<i>Sanicula europaea</i> (v. com.!)
<i>Lactuca muralis</i> (ab. scat.)	<i>Senecio Fuchsii</i> (ab. scat.)
<i>Lamium luteum</i> (v. ab!)	<i>Stellaria nemorum</i> (loc. greg.)
<i>Lilium martagon</i> (only scat.)	<i>Veronica montana</i> (loc.)
( <i>Majanthemum bifolium</i> )	<i>Veronica officinalis</i> (ab. scat.)
<i>Mercurialis perennis</i> ( $\pm$ , loc. greg.)	<i>Vicia silvatica</i> (inab.)
	<i>Viola silvatica</i> (scat.)

To the dominants, besides the ferns, belong in the first place *Oxalis*, *Sanicula*, *Lamium luteum* and *Asperula odorata*.

#### b) Eastern Carpathian Flysch facies.

This variant I have described from Subcarpathian Russia (4, p. 9) as the *Glechoma hirsuta-Polystichum* type from about 1120 meters altitude on the southeast slope in the valley of the Gropjenec creek below the shepherd settlement Gropa. It is an old, not very

shady beech forest, of a virgin forest character, where the surface is strewn with stones and has a relatively deep layer of loam and rather thick humus. There are no mosses on the forest floor, no continuous leaf-carpet, and in places the ground is nearly bare. The beech forest is only slightly mixed, interspersed are *Acer pseudoplatanus* and *Abies*. In the shrubby stratum infrequently appear *Daphne mezereum* and *Sambucus racemosa*, scattered *Rubus* sp. The herbaceous undergrowth is abundant and we find also plenty of young beeches. Of ferns, *Polystichum Braunii* is abundantly scattered, *P. lobatum* and *P. Luerseii* scattered, *Athyrium filix femina* only scattered, *Dryopteris pulchella* seldom. Of grasses, there are none. *Luzula nemorosa* is only scattered. Besides these we find the following species:

<i>Anthriscus nitida</i> (only scat.)	( <i>Lamium luteum</i> v. scat., mostly
<i>Asperula odorata</i> (ab. scat.)	totally lacking)
<i>Chrysosplenium alternifolium</i>	<i>Oxalis acetosella</i> (rather ab.)
(loc. in col.)	<i>Ranunculus lanuginosus</i> (scat.)
<i>Circaea alpina</i> (loc. in col.)	<i>Ranunculus repens</i> (loc. ab.)
<i>Dryonicum austriacum</i> (scat.)	<i>Salvia glutinosa</i> (in rather ab.
<i>Euphorbia amygdaloides</i> (scat.)	scat. col.)
<i>Galeopsis grandiflora</i> (scat.)	<i>Scrophularia Scopolii</i> (only scat.)
<i>Geranium Robertianum</i> (scat.)	<i>Stachys alpina</i> (scat.)
<i>Glechoma hirsuta</i> (v. ab., often	<i>Stachys silvatica</i> (only scat.)
greg.)	( <i>Stellaria nemorum</i> only v. loc.)
<i>Impatiens noli tangere</i> (rather	<i>Symphytum cordatum</i> (scat.)
ab. scat.)	<i>Urtica dioica</i> (rather ab.)
<i>Lactuca muralis</i> (scat.)	<i>Verbascum lanatum</i> (only scat.)
	<i>Veronica montana</i> (only v. scat.)

#### 4. *Geranium Robertianum* sociation.

This plant community is characteristic for a stony ground and talus and appears here and there in our beech forests. It is sometimes only an evolutionary stage of the fern or the *Asperula* type; sometimes, however, it appears as a stable community. Its fern variant I have described (\*, p. 24—25) from Subcarpathian Russia from Svidovec (above Sterešora, at 1240 meters alt.). It is an old beech forest, interspersed with *Acer pseudoplatanus*, on a rough stony

ground where *Geranium Robertianum* is found growing abundantly, even gregariously so that it dominates the aspect. Of the ferns, there grow here *Polystichum lobatum* (abundantly scattered!), *P. Braunii* (scattered), *Dryopteris pulchella* (loc. scat.), *D. filix mas* (only scat.), *D. phegopteris* (scat.), *D. spinulosa* (scat.), *Athyrium filix femina* (scat.), besides there is *Lamium luteum* abundantly scattered!, *Oxalis acetosella* only scattered, to scattered, *Stellaria nemorum* and *Epilobium montanum* (scat.), *Rubus* sp. infrequent.

In the Hercynian region, *Geranium Robertianum* is sometimes associated with abundant *Urtica dioica*, which can, in places, even predominate.

#### 5. *Dentaria* sociation.

In shady humous beech forests, there appears, sometimes on larger areas, a type in which *Dentarias* are almost the only herbs in the undergrowth. So, for instance, in the Little Carpathians on the slope of Mt. Vysoká at an altitude of about 550 meters; above the zone of the bare-floor beech forest, but on limestone, we find in a beech forest with maple (*Acer pseudoplatanus*), *Dentaria enneaphyllos* growing very abundantly and *D. bulbifera* very abundantly scattered. Otherwise, however, nothing or next to nothing grows there, on the ground; I could only ascertain *Allium ursinum* infrequent and *Arum maculatum* scattered.

Whether this type belongs to some other sociation is for the present difficult to decide.

#### 6. *Oxalis* sociation.

The distribution of wood-sorrel in our beech forests is almost general, but there are beech forest districts where *Oxalis* does not grow at all because of the too-pronounced dryness, as for instance, in the Southwestern Carpathians on the dolomitic Tematin hills and also in the dolomitic Rokoš group (more than 1000 meters high), where *Oxalis* grows only very scarcely and quite locally. As the *Oxalis* type, in the true sense of the word, I designate such growths where *Oxalis* governs the whole aspect as the leading dominant and forms often more or less continuous carpets. Such types, however, are characteristic for spruce forests or mixed spruce forests, whereas in normal beech forests they hardly ever appear.

The next sociation, when poorly developed, may have spots where *Oxalis* is dominant, but here we can only speak of them as fragments of the sociation which I am next describing separately. J a r. Klika (1) writes that the greatest part of the beech forests in the region of the Velká Fatra Mts., which he has examined, belongs to the *Oxalis* type and that this type is characterised by deep soil, numerous herbs in the undergrowth, and abundant shrubs. But apparently Klika comprehends this type quite differently. His analysis from Koňská dolina (southeastern slope, 600 meters alt.) is meant apparently to be an example of this type. The plant community here, however, is quite atypical for beech forests. *Asperula odorata* is missing and among the species enumerated by Klika are *Galium silvaticum* (certainly *G. Schultesii*, since *G. silvaticum* does not grow in the Central Carpathians), also *Lactuca quercina*, *Lithospermum purpureocoeruleum*, *Carex alba*, *Cephalanthera rubra* and *Gentiana cruciata*, fairly abundant mosses and also rather numerous mountain beech forest species.

#### 7. Galeobdolon-Oxalis sociation.

My conception of this sociation is to be seen from my published analyses from Subcarpathian Russia (2, p. 16—17). I quote here the two following typical growths.

The Svidovec group, Mt. Kečírka in the Velký Trostinec valley about 730 meters alt.: an old mixed virgin beech forest with spruces abundantly interspersed and locally even predominant; maple (*Acer pseudoplatanus*) and fir are also scattered, solitarily elm and ash. The growth is developed in a flat saddle on a deeper loamy soil with little humus. The floor, with the exception of stumps, resp. rotten trunks, is only slightly mossy; on it grow only *Mnium rostratum* (of the mosses the most abundant), *Thuidium tamariscinum* and *Eurhynchium striatum*, on decomposed logs also *Sphagnum acufolium* and in it a little of *Vaccinium myrtillus*. Characteristic is the low herbaceous undergrowth which has *Oxalis acetosella* dominant and forming in places rather dense growths; also *Lamium luteum* is very abundant, *Lonicera nigra* is scattered and *Daphne mezereum* only scarce. In addition there appear:

*Anemone nemorosa* (only scat.) *Dryopteris spinulosa* (scat. to  
*Asperula odorata* (scat., loc. rather ab. scat.)  
rather ab.) *Lactuca muralis* (scat.)  
*Circaea alpina* (scat.)

Besides this the following species are scarce to solitary: *Athyrium filix femina* (small), *Carex silvatica*, *Dryopteris filix mas* (small), *Dentaria glandulosa*, *Epilobium montanum*, *Galeopsis grandiflora*, *Geranium Robertianum*, *Mercurialis perennis*, *Paris quadrifolia*, *Polygonatum verticillatum*, *Salvia glutinosa* (ster.), *Senecio nemorensis*, *Urtica dioica*.

The other example of this type comes from an old, high beech forest, located above the shepherd settlement, Sterešora (Svidovec), at an altitude of about 1240 meters. The forest is shady, with abundantly scattered maples (*Acer pseudoplatanus*); in the undergrowth we find a number of young beeches, less of maples, solitarily scattered is *Daphne mezereum*, more abundantly scattered *Lonicera nigra* and rather scarce *Rubus idaeus*. The loamy, somewhat humous, non-mossy ground is covered with a rather thick carpet of decaying leaves and the vegetation covers only about one half of the surface. The composition of the undergrowth:

*Anemone nemorosa* (scat.) *Polypodium verticillatum* (ster.  
*Dryopteris pulchella* (rather ab. ab.)  
scat.) *Rubus* sp. (scat.)  
*Epilobium montanum* (only scat.) *Stellaria nemorum* (rather ab.  
*Lamium luteum* (ab.!) scat.)  
*Luzula silvatica* (scat.) *Vaccinium myrtillus* (scat.)  
*Oxalis acetosella* (v. ab.!)

In addition, the following species are very scattered to solitary: *Asperula odorata*, *Athyrium filix femina* (small), *Campanula abietina*, *Circaea alpina*, *Dentaria bulbifera*, *D. glandulosa*, *Polystichum lobatum*, *Veronica montana*.

Here we can notice, to a certain degree, the influence of the neighbouring spruce forest but already a few meters down the slope we find *Luzula silvatica* and *Vaccinium myrtillus* very scarce or missing, *Oxalis* and *Lamium luteum* gain in dominance, also there is a little more of woodruff, scattered are *Geranium Robertianum* and *Dryopteris phegopteris*, in scattered colonies grows *Lysimachia*

*nemorum*, only very scattered are *Scrophularia Scopolii*, *Galeopsis grandiflora*, *Lactuca muralis*, *Veronica officinalis* is scarce and *Ranunculus dentatus*, *Poa Chaixii*, *Soldanella hungarica* are locally scattered.

As a Hercynian-Sudetic facies we can add here also Zlatník's (1) *Lamium luteum* and *Asperula odorata* type from the Krkonoše Mts. in which with a constancy 5 are present *Lamium luteum*, *Oxalis acetosella*, *Athyrium filix femina* and *Picea excelsa*, with a constancy 4 *Asperula odorata*, *Circaea alpina*, *Impatiens noli tangere*, *Lysimachia nemorum*, *Dryopteris pulchella*, *Prenanthes purpurea*, *Senecio nemorensis* + *Fuchsii*.

These types are evidently already impoverished beech forest types.

#### 8. *Allium ursinum* sociation.

This *Allium* type is especially characteristic for mixed forests on mountain ridges. As an example, I give the mixed deciduous forest on the summit of Havrany (460 meters) near Piešťany with an undergrowth of dominant, and sometimes quite exclusive, *Allium ursinum*. In the tree stratum *Fagus silvatica* is scattered (locally even missing), *Ulmus scabra* and also *Fraxinus excelsior* are there abundant, *Acer pseudoplatanus* abundantly scattered, *A. campestre* only very scattered, then *Quercus sessilis* is interspersed, and in places *Carpinus betulus* and *Tilia platyphylla*. Of shrubs *Staphylea pinnata* is especially frequent and characteristic, scattered are *Corylus avellana*, *Evonymus verrucosa*, *Cornus sanguinea*. Of lianas, *Clematis vitalba* is abundant and along the ground *Hedera helix* is very scattered. In the undergrowth with the dominating *Allium*, of the grasses, there are *Bromus asper*, *Melica uniflora*, *Elymus europaeus* and *Dactylis Aschersoniana* more or less scattered, besides of sedges *Carex muricata*. In addition, the composition of the undergrowth is as follows:

<i>Asarum europaeum</i> (rather ab. scat.)	<i>Dentaria bulbiflora</i> (rather ab. scat.)
<i>Campanula rapunculoides</i> (scat.)	<i>Dentaria enneaphyllos</i> (loc. rather greg.)
( <i>Chrysanthemum corymbosum</i> )	
<i>Convallaria majalis</i> (loc.)	( <i>Galium aparine</i> )

( <i>Geranium Robertianum</i> )	<i>Mercurialis perennis</i> (here and there loose col.)
<i>Glechoma hirsuta</i> (loc. rather scat.)	<i>Polygonatum multiflorum</i> (scat.)
<i>Lathyrus vernus</i> (scat.)	<i>Pulmonaria officinalis</i> (scat.)
<i>Lilium martagon</i> (only scat.)	<i>Vicia dumetorum</i> (loc.)
<i>Lithospermum purpureoeruleum</i> (only col.)	<i>Vicia pisiformis</i> (loc.)
	( <i>Viola mirabilis</i> )

This is a general picture of this community which in its whole extent undergoes changes in two directions, either into dense and very excluding *Allium ursinum* growths in which only some of the above named species are present with but a small frequency, or into herbaceous or herb-grass types in which *Melica uniflora* is especially abundant. *Carex pilosa*, however, is always missing.

Also on the ridge of Mt. Vysoká in the Little Carpathians, we observe this type, for example in part of the high-trunk forest almost entirely of *Fraxinus* (only locally with interspersed beeches). *Allium ursinum* forms here an extensive continuous growth, very excluding and therefore poor floristically. *Parietaria officinalis* is very abundantly scattered, scattered are *Senecio Fuchsii*, *Impatiens noli tangere*, *Polygonatum multiflorum*, *Hesperis nivea*, *Symphytum tuberosum*, only scattered are *Lilium martagon* and *Geranium Robertianum*, whereas scarce are *Stachys silvatica*, *Poa nemoralis*, *Campanula latifolia*; in the *Allium* growth are also colonies of *Mercurialis perennis* and *Melica uniflora*.

J. K l i k a (2) describes this sociation from the Velká Fatra Mts. as characteristic for very moist beech forests, especially there where the underground water-level is near the surface. As an example, he gives a growth below the Mt. Lubochňa Klak (1220 meters, northern exposure), with *Oxalis acetosella*, *Crepis paludosa*, *Asperula odorata* and with a low frequency of *Ranunculus lanuginosus*, *Dryopteris phegopteris*, *D. filix mas*, *Athyrium filix femina*, *Asarum europaeum*, *Senecio Fuchsii*, *Glechoma hederaceum* (?), *Symphytum tuberosum*.

#### B. *F a g e t a a l t i h e r b o s a*.

There are no sharp limits between this and some other groups; the mixed herbaceous types, described above, already form a connecting link. The clearing stages of *F a g e t u m h e r b o s u m* usual-

ly have also the character of this group. Nevertheless the characteristic types with dominating tall herbs have their own peculiar physiognomy, consisting, of course, of various sociations differing in their floristic composition as well as in their dominant species. They are much better developed in the Carpathian beech forests than in the Sudetic-Hercynian and occur on limestone, where their floristic richness culminates, and on siliceous substrata. Spruce-fir mountain forests of the Central Carpathians often have on limestone very similar undergrowth but nevertheless there are some essential floristic differences. A definite classification of the sociations and variants is, at present, not possible, therefore I shall give only some of the especially characteristic communities of this group. A sufficient moisture and a half-shade favour a vigorous growth of the respective types.

#### 9. *Cortusa* sociation (*Fagetum carpaticum Cortusae*).

This is a distinct and a very remarkable sociation of the Western Carpathian limestone mountains which I described for the first time from Mt. Choč in Velká Fatra (Věda Přírodní, vol. III, 1922) and which I also mention in my textbook on Plant sociology (<sup>8</sup>, p. 308). K l i k a also describes this type from the Velká Fatra Mts.

As a new example, I give here the growths on Mt. Šíp in the Velká Fatra Mts. where there is, on the northern slope to the very crest, a low, almost shrubby beech forest with abundantly interspersed maples (*Acer pseudoplatanus*) and with an unusually luxuriant herbaceous and flowery undergrowth. Of shrubs *Daphne mezereum* and *Lonicera nigra* are scattered. The composition of the undergrowth is as follows:

<i>Aconitum firmum</i> (rather ab.)	<i>Astrantia major</i> (ab.)
<i>Aconitum vulparia</i> (rather ab.)	<i>Athyrium filix femina</i> (rather
<i>Actaea spicata</i> (rather ab. scat.)	ab.)
<i>Adenophora liliiflora</i> (only scat.)	<i>Bellidiastrum Michellii</i> (rather
<i>Ajuga genevensis</i> (scat.)	ab.)
<i>Asarum europaeum</i> (scat.)	<i>Centaurea mollis</i> (rather ab.
<i>Asperula odorata</i> (loc. rather	scat.)
greg.)	<i>Chaerophyllum aromaticum</i>
<i>Asplenium viride</i> (scat.)	(scat.)

<i>Chrysanthemum subcorymbosum</i> (r.)	<i>Melittis melisophyllum</i> (only scat.)
<i>Coeloglossum viride</i> (sol.)	<i>Mercurialis perennis</i> (v. ab.)
<i>Convallaria majalis</i> (rather ab.)	<i>Mulgedium alpinum</i> (ab.)
<i>Coralliorrhiza trifida</i> (scat.)	<i>Neottia nidus avis</i> (v. scat.)
<i>Cortusa Matthioli</i> (scat. to ab. scat.)	<i>Orchis maculata</i> (ab. scat.)
<i>Crepis paludosa</i> (ab.)	<i>Oxalis acetosella</i> (ab.)
<i>Cypripedium calceolus</i> (scat.)	<i>Paris quadrifolia</i> (ab.)
<i>Dryopteris filix mas</i> (rather ab.)	<i>Phyteuma orbiculare</i> (only scat.)
<i>Epipogon aphyllus</i> (r.)	<i>Phyteuma spicatum</i> (scat.)
<i>Euphorbia amygdaloides</i> (rather ab.)	<i>Pimpinella magna</i> (rather ab. scat.)
<i>Festuca silvatica</i> (scat.)	<i>Pirola secunda</i> (inab.)
<i>Galium Schultesii</i> (ab. scat.)	<i>Platanthera bifolia</i> (scat.)
<i>Geranium silvaticum</i> (ab.)	<i>Polygonatum verticillatum</i> (ab.)
<i>Gymnadenia albida</i> (scat.)	<i>Pclystichum lobatum</i> (ab.)
<i>Hacquetia epipactis</i> (loc. greg.)	<i>Pclystichum lonchitis</i> (ab.)
<i>Heracleum sphondylium</i> (scat.)	<i>Prenanthes purpurea</i> (ab. scat.)
<i>Homogyne alpina</i> (ab.)	<i>Primula elatior</i> (ab.)
<i>Isopyrum thalictroides</i> (ab. scat.)	<i>Ranunculus lanuginosus</i> (scat.)
<i>Knautia silvatica</i> (loc. greg.)	<i>Ranunculus platanifolius</i> (scat.)
<i>Lamium luteum</i> (ab.)	<i>Rubus saxatilis</i> (ab.)
<i>Listera ovata</i> (scat.)	<i>Sanicula europaea</i> (ab.)
<i>Lunaria rediviva</i> (inab.)	<i>Senecio Fuchsii</i> (scat.)
<i>Luzula silvatica</i> (loc.)	<i>Stellaria nemorum</i> (scat.)
<i>Majanthemum bifolium</i> (scat.)	<i>Tofieldia calyculata</i> (scat.)
<i>Melandryum silvestre</i> (scat.)	<i>Trollius europaeus</i> (scat.)
	<i>Viola mirabilis</i> (only scat.)

The *Cortusa* sociation is perhaps the most beautiful limestone forest sociation of our Western Carpathian forests and surely also endemic in this region.

#### 10. *Pleurospermum-Cirsium erisisthales* sociation.

A mountain calcicole sociation developed in various variants in the Western Carpathians. For instance, it is well developed in the Slovakian Karst in the saddle of Mt. Šejba above Tisovec, in a hu-

mous beech forest that is plentiful with shrubs (*Corylus avellana* ab., *Rosa pendulina* rather ab., *Daphne mezereum* scat., *Lonicera xylosteum* scat., *Rubus idaeus* rather ab., *Ribes grossularia* scat., *R. alpinum* only scat., *Cornus sanguinea* only scat.)

The composition of the undergrowth is as follows:

<i>Actaea spicata</i> (only scat.)	<i>Melampyrum silvaticum</i> (loc. greg.)
<i>Anthriscus nitida</i> (ab.)	
<i>Aruncus silvester</i> (scat.)	<i>Melandryum silvestre</i> (scat.)
<i>Asarum europaeum</i> (rather ab.)	<i>Melica nutans</i> (only v. scat.)
<i>Asplenium viride</i> (rather ab.)	<i>Melica uniflora</i> (inab.)
<i>Bromus asper</i> (loc.)	<i>Mercurialis perennis</i> (ab.!)
<i>Cardamine impatiens</i> (scat.)	<i>Monotropa hypopitys</i> (only v. scat.)
<i>Cephalanthera alba</i> (scat.)	
<i>Cirsium erisithales</i> (v. ab.!)	<i>Paris quadrifolia</i> (loc.)
<i>Dactylis Aschersoniana</i> (ab. scat.)	<i>Petasites albus</i> (loc.)
	<i>Phyteuma spicatum</i> (scat.)
<i>Dentaria bulbifera</i> (scat.)	<i>Pleurospermum austriacum</i> (ab. scat.)
<i>Dryopteris filix mas</i> (scat.)	
<i>Euphorbia amygdaloides</i> (ab. scat.)	<i>Polygonatum multiflorum</i> (ab.)
	<i>Polygonatum verticillatum</i> rather ab. scat.)
<i>Galium Schultesii</i> (ab. scat.)	<i>Polystichum lobatum</i> (scat.)
<i>Gentiana asclepiadea</i> (scat.)	<i>Prenanthes purpurea</i> (ab.)
<i>Geranium phaeum</i> (ab.)	<i>Primula elatior</i> (v. ab.)
<i>Hedera helix</i> (loc.)	<i>Pulmonaria obscura</i> (scat.)
<i>Lamium luteum</i> (ab.)	<i>Ranunculus lanuginosus</i> (ab. scat.)
<i>Lamium maculatum</i> (ab. scat.)	
<i>Lathyrus vernus</i> (scat.)	<i>Salvia glutinosa</i> (v. ab.)
<i>Lilium martagon</i> (scat.)	<i>Senecio nemorensis</i> (ab. scat.)
<i>Lunaria rediviva</i> (scat., loc. greg.)	<i>Thalictrum aquilegifolium</i>

Another interesting growth I analysed on the ridge called Šance, extending out from the Muráň castle ruins. On the northern slope, there is a beautiful beech forest interspersed with old maples (*Acer pseudoplatanus*); of shrubs there are mainly *Rosa pendulina*, *Lonicera xylosteum*, *Cotoneaster tomentosa*. Of grasses, *Calamagrostis arundinacea* is fairly abundant, *Poa nemoralis* and *Melica nutans*

scattered; also *Carex alba* grows gregariously in places. Otherwise the composition of the herbaceous undergrowth is as follows:

<i>Aconitum vulparia</i> (rather ab.)	<i>Galium Schultesii</i> (scat.)
<i>Adenophora liliiflora</i> (v. ab.)	<i>Gentiana asclepiadea</i> (ab. scat.)
<i>Aquilegia vulgaris</i> (rather ab. scat.)	<i>Heracleum sibiricum</i> (ab. scat.)
<i>Arabis turrata</i> (rather ab.)	<i>Knautia silvatica</i> (ab.)
<i>Asarum europaeum</i> (only loc.)	<i>Lactuca muralis</i> (scat.)
<i>Asperula odorata</i> (only loc.)	<i>Laserpitium latifolium</i> (scat.)
<i>Asplenium viride</i> (rather ab.)	<i>Lilium martagon</i> (ab. scat.)
<i>Aruncus silvester</i> (ab.)	<i>Majanthemum bifolium</i> (only scat.)
<i>Astrantia major</i> (loc.)	<i>Melittis melisophyllum</i> (rather ab. scat.)
<i>Campanula persicifolia</i> (only scat.)	<i>Mercurialis perennis</i> (rather ab.)
<i>Campanula trachelium</i> (ab.)	<i>Myosotis silvatica</i> (only scat.)
<i>Cephalanthera alba</i> (rather ab. scat.)	<i>Pimpinella magna</i> (rather ab.)
<i>Cephalanthera rubra</i> (rather ab. scat.)	<i>Platanthera bifolia</i> (only scat.)
<i>Chrysanthemum corymbosum</i> (v. ab.)	<i>Pleurospermum austriacum</i> (rather ab.)
<i>Cirsium ersithales</i> (ab.)	<i>Polygonatum multiflorum</i> (ab.)
<i>Coeloglossum viride</i> (sol.)	<i>Polygonatum verticillatum</i> (loc. ab.)
<i>Convallaria majalis</i> (loc.)	<i>Prenanthes purpurea</i> (v. ab.)
<i>Corallorrhiza trifida</i> (only loc. scat.)	<i>Primula elatior</i> (v. ab.)
<i>Cystopteris fragilis</i> (inab.)	<i>Pulmonaria obscura</i> (only v. scat.)
<i>Dentaria bulbifera</i> (rather ab. scat.)	<i>Rubus saxatilis</i> (scat.)
<i>Dryopteris filix mas.</i> (scat.)	<i>Salvia glutinosa</i> (v. ab.)
<i>Dryopteris Robertiana</i> (only loc.)	<i>Senecio Fuchsii</i> (rather ab.)
<i>Epipactis latifolia</i> (scat.)	<i>Silene vulgaris</i> (scat.)
<i>Euphorbia polychroma</i> (only scat.)	<i>Solidago virga aurea</i> (rather scat.)
	<i>Thalictrum minus</i> (scat.)
	<i>Valeriana tripteris</i> (ab.)

#### 11. *Lunaria-Urtica* sociation.

This sociation is characteristic for mountain beech forests of rather moist, humous soils, often also on talus, filled in and sometimes

even covered with a rich humus. It occurs scattered in the whole region of Czechoslovakia but it is more frequent in the Carpathians and best developed on limestone substratum. It consists of rather numerous variants, characteristic in its physiognomy because of the dominance of certain species. I present a few examples here:

a) **Phyllitis — Parietaria variant.**

This is a richly developed *Lunaria* type as we find it, for instance, on limestone of the slope of Mt. Žihlavník near Trenčianské Teplice (Slovakia) from 600 meters altitude upwards. Here, there are, on an old limestone humus-covered talus, splendid beech forests which have of the woody plants also *Acer pseudoplatanus*, *Fraxinus excelsior*, *Cornus sanguinea*, *Corylus avellana*, *Sambucus nigra*. In the undergrowth, *Phyllitis scolopendrium* is locally scattered but often very abundant and of other ferns, *Dryopteris filix mas* is very abundant, *Athyrium filix femina* scattered and *Polystichum lobatum* in beautiful vigorous clumps. The tall *Lunaria rediviva* is common and together with *Phyllitis* the principal leading plant, further *Arabis turrita* is abundant, *Asperula odorata* common and very gregarious, *Urtica dioica* (in a special variety) very abundant, *Parietaria officinalis* in great abundance, forming often closed groups or colonies, furthermore *Impatiens noli tangere* and *Mercurialis perennis* are very abundant, *Veronica montana* abundantly scattered, *Lamium luteum* abundant enough, scattered are *Melica nutans*, *Valeriana tripteris*, *Lathyrus vernus*, *Chrysosplenium alternifolium*, *Anthriscus nitida*, very abundantly scattered is *Dentaria bulbifera* together with *D. enneaphyllos*, only here and there appear *Actaea spicata*, *Pulmonaria obscura*, *Asarum europaeum* and *Polygonatum multiflorum*.

b) **The Carpathian calcicole Lunaria-Urtica variant.**

This type is, for instance, beautifully developed on Mt. Strážov in western Slovakia, at about 960 meters altitude, on a steep, humous, northern slope on limestone. It is an old, wild, virgin beech forest, rather thin but without opening; everywhere on the ground are strewn rotting trunks of fallen giants, mostly with plentiful *Poly-pori* and often covered with beautiful green moss carpets. On humous and rather moist soil, a splendid and characteristic vegetation of tall herbs, associated with smaller herbs in dense growths, is beautifully

developed. Of grasses only *Bromus asper* is abundant; the composition of the undergrowth is as follows:

<i>Ajuga genevensis</i> (scat.)	<i>Hesperis nivea</i> (loc. ab.)
<i>Arabis arenosa</i> (scat.)	<i>Impatiens noli tangere</i> (v. ab. and greg.)
<i>Arabis turrita</i> (loc. ab.)	<i>Isopyrum thalictroides</i> (scat.)
<i>Asperula odorata</i> (scat. to rather ab.)	<i>Lamium luteum</i> (ab.)
<i>Asplenium viride</i> (only scat. on mossy roots and trunks)	<i>Lunaria rediviva</i> (v. ab. and greg.)
<i>Athyrium filix femina</i> (rather ab. scat.)	<i>Melandryum silvestre</i> (v. ab. scat.)
<i>Campanula trachelium</i> (ab.)	<i>Mercurialis perennis</i> (v. ab. and greg.)
<i>Cardamine impatiens</i> (scat.)	<i>Paris quadrifolia</i> (loc.)
<i>Chrysosplenium alternifolium</i> (rather ab.)	<i>Phyteuma spicatum</i> (scat.)
<i>Circaea lutetiana</i> (ab. and greg.)	<i>Pleurospermum austriacum</i> (scat.)
<i>Dentaria bulbifera</i> (rather ab.)	<i>Polygonatum verticillatum</i> (only loc., very luxuriant)
<i>Dentaria enneaphyllos</i> (rather ab.)	<i>Polystichum lobatum</i> (v. ab.)
<i>Dryopteris filix mas</i> (v. ab.!)	<i>Prenanthes purpurea</i> (rather ab.)
<i>Epipactis latifolia</i> (scat.)	<i>Scrophularia Scopolii</i> (sol.)
<i>Galeopsis grandiflora</i> (only scat.)	<i>Stachys silvatica</i> (v. scat.)
<i>Galium Schultesii</i> (loc. rather ab.)	<i>Stellaria nemorum</i> (scat.)
<i>Glechoma hirsuta</i> (scat.)	<i>Urtica dioica</i> (on the whole ab.)

These two analyses are examples of two different, richly developed types of this sociation. Sometimes, however, we find variants variously impoverished, which are a sort of modification of these types, often with the predominance of only one or a few species. As for instance, in the shaded humous beech forest on the northern slope, below the Muráň castle ruins, in the Slovakian Karst district, are developed on extensive areas, dense and very excluding growths of *Lunaria rediviva*; *Parietaria* is also present here. In the dolomitic Tematín hills, there is, in the beech forests located at the foot of the rocks below the ruins of the Tematín castle, this community developed fragmentarily with *Lunaria rediviva* and *Dentaria enneaphyllos*.

*phyllos* (see also Sillinger<sup>2</sup>) and also with *Arabis turrita*. From the Velká Fatra Mts., Koňská dolina, ravine, 1200 meters alt., north-eastern exposure, Klika<sup>(2)</sup> describes a growth with dominant *Lunaria rediviva* and *Urtica dioica*, with rather abundant *Mercurialis perennis* and *Geranium Robertianum*, with scattered *Oxalis acetosella* and only infrequent *Melandryum silvestre*.

This community may be regarded as a very impoverished type of the second variant, even though not a single species indicates the Carpathian facies of the limestone substratum. Thereby this impoverished form merges seemingly into the silicicole Hercynian facies.

### c) Sudetic-Hercynian facies.

I described (Věda Přírodní, vol. IV, 1923) a fine growth from the Českomoravská vysočina Mts. in the Štírův důl valley near Krucemburk, in a ravine, on but slightly-limy marly limestone. In an extensive luxuriant growth we find here *Lunaria rediviva*, with it gregariously *Aconitum vulparia*, *Impatiens noli tangere* is common, *Actaea spicata* very abundant, *Urtica dioica* very gregarious, frequent are: *Polygonatum verticillatum*, *Petasites albus*, *Mercurialis perennis*, *Phyteuma spicatum*, *Oxalis acetosella*, *Asarum europaeum*, *Lamium luteum*, *Melica nutans*, *Festuca silvatica*, abundant are *Asperula odorata*, *Circaea lutetiana*, *Paris quadrifolia*, *Pulmonaria obscura*, *Geranium Robertianum* gregarious, scattered are *Aruncus silvester*, *Senecio Fuchsii*, *Dryopteris filix mas*, etc. (see Domin, l. c.). It is a more hygrophilous modification of this variant.

A. Hilitzer<sup>(1)</sup>, p. 12) described another modification from the beech forests in the Český Les Mts. in the neighbourhood of Kdyně. The tree stratum is more or less mixed, since there are interspersed *Acer pseudoplatanus*, sometimes also *A. platanoides*, *Fraxinus excelsior*, *Ulmus scabra* and *Picea excelsa*, in the shrubby undergrowth are scattered *Sambucus racemosa*, *Rubus idaeus*, *Sorbus aucuparia*. In the ground vegetation vigorous, often more than one meter high, *Lunaria rediviva* completely dominates and with it are associated some other tall herbs, such as *Urtica dioica*, *Senecio Fuchsii* and some ombrophilous beech forest elements, *Asperula odorata*, *Mercurialis perennis*, *Lamium luteum*, *Geranium Robertianum*, *Impatiens noli tangere*, *Asarum europaeum*, *Epilobium montanum*, sometimes also *Hedera helix* and *Actaea spicata* and of ferns *Dryopteris*

*filix mas*. Of grasses were ascertained *Milium effusum*, *Bromus asper*, *Elymus europaeus*, *Poa nemoralis* and *Festuca silvatica*, but only with a small abundance.

d) ***Urtica dioica* variant.**

Nettle growths in beech forests occur here and there in the whole region, especially on humous stony places. We may regard them as a variant of this sociation, characterised by the absence of some of the leading species (especially *Lunaria*). Klik a (2) describes this community from the Velká Fatra Mts. (a groove in the Žernovica valley, southern exposure, 610 meters alt.; *Urtica dioica* is dominant, *Senecio Fuchsii* rather abundant, in lesser abundance *Asperula odorata*, *Geranium Robertianum*, *Asarum europaeum*, *Lamium maculatum*, *Geranium silvaticum* and *Sambucus ebulus*.

12. ***Senecio Fuchsii* sociation.**

To the present it is somewhat problematic whether the *Senecio* growths represent a distinct sociation. *Senecio Fuchsii* (or sometimes *S. nemorensis*) is a common companion in beech forests but does not thrive — except on more humid places — in a deeper shade where it remains mostly sterile. On beech forest openings and clearings it often spreads and becomes dominant. The same phenomenon was observed of other rather numerous beech forest plants (see for instance D o m i n, 4, p. 26—30) but on this basis we cannot establish sociations. Sometimes *Senecio Fuchsii* is locally gregarious in mixed herbaceous beech forest types, but even here its complexes appear only as a part of the whole undergrowth. Similarly, other species with a high sociability occur in the undergrowth in close islets. Sometimes, however, *Senecio Fuchsii* appears very gregariously with other herbs in the undergrowth, especially in lighter beech forests and determines its general aspect. A good example of this type is described by P. Sillinger (1, p. 31) from the White Carpathians on the Kobylínek ridge above Lednice. *Senecio Fuchsii* dominates in dense growths, abundantly interspersed is *Elymus europaeus*, abundantly scattered are *Bromus asper*, *Stachys alpina* and *Campanula latifolia* and also ferns are rather abundantly scattered together with scattered colonies of *Asperula odorata*, *Oxalis acetosella*, *Impatiens noli tangere* and *Aegopodium podagraria*.

### C. *Fageta subhygrophila*.

Above already, we became acquainted with rather hygrophylous beech forest types, occurring chiefly on mountains and in more humid valleys. Into this category, however, I put only the particularly characteristic types, of which especially the *Petasites* type is fairly distributed and has its analogue in spruce and mixed coniferous forests. This type represents a well-defined sociation with some variants, whereas the *Impatiens* type, though physiognomically very marked, is not so very characteristic sociologically.

#### 13. *Petasites albus* sociation.

This sociation occurs chiefly on mountains or at lower altitudes in damp humous valleys and has several variants, some of which I shall give here.

##### a) **Sudetic-Hercynian facies.**

Because beech forests of this region are frequently disturbed by antropical influences, principally by forest culture, this type is also often more or less changed. Nevertheless, even in spruce forests introduced by forest culture on the place of original beech forests, we can usually distinguish the *Petasites* type of the beech forests and that of the spruce forests according to their accompanying species. In the Bohemian Ohře River district, I analysed in 1914 the forest communities in the valley of the Krondorf creek. In places there are spruce forests, either pure or interspersed with beeches, in places, however, small beech forests are preserved as a relic of the original dominant beech forests, which we may recognise by the undergrowth of the cultivated spruce forests. On more humid places locally the *Petasites albus* type predominates, accompanied by *Mercurialis perennis*, *Impatiens noli tangere*, *Lamium luteum*, *Asperula odorata*, *Oxalis acetosella*, *Chrysosplenium alternifolium*, *Prenanthes purpurea*, *Senecio Fuchsii*, *Chaerophyllum hirsutum*, *Milium effusum* etc. In the Českomoravská vysočina Mts., in the neighbourhood of the so-called Ranská Jezírka, are humid forests chiefly spruce, in places also with rather abundant beeches which trees seem formerly to have had a wider distribution. There is a luxuriant hygrophilous undergrowth in which *Petasites albus* forms extensive

growths, with it is *Asarum europaeum* gregarious and locally the high *Bromus asper* is very gregarious. Also *Asperula odorata* is present, *Melica nutans*, *Actaea spicata*, and *Daphne mezereum* are frequent, *Euphorbia dulcis* is abundantly scattered, *Neottia nidus avis* and *Lathyrus vernus* are scattered. In the other places these *Petasites albus* growths are besides accompanied by *Athyrium filix femina*, *Circaea alpina*, *Oxalis acetosella*, *Prenanthes purpurea*, *Lactuca muralis*, *Paris quadrifolia*, *Lamium luteum*, *Senecio Fuchsii*, *Sanicula europaea*, *Carex silvatica*, *Impatiens noli tangere*, *Viola Riviniana*, *V. silvatica*, *Milium effusum*, etc.

Beautifully developed and on extensive areas is the *Petasites albus* sociation in the well-known virgin forest of the Boubínský Prales, in the Šumava Mts. (D o m i n <sup>3</sup>). Detailed analysis of this virgin forest, the tree stratum of which I have already described (p. 72), shows that the promiscuity of its undergrowth is only seeming and corresponds to the mosaic of habitat conditions. Disregarding the colonies of Hercynian species of acid soils, it is possible to distinguish three types here according to the degree of humidity, the first typical for marshes and swamps, the second for moist and damp places in the forest, and the third for places of medium humidity and of drier places. In this last type, *Petasites albus* does not grow, in the first it is common but not gregarious to such a degree as in the second type, which may rightly be designated as *Petasitetum albi* as far as the undergrowth is concerned. It is accompanied especially by the following species:

<i>Athyrium filix femina</i> (scat.)	<i>Polygonatum verticillatum</i> (v. scat. only loc. rather ab.)
<i>Festuca gigantea</i> (scat.)	
<i>Luzula silvatica</i> (ab. scat.)	<i>Ranunculus lanuginosus</i> (inab.)
<i>Lysimachia nemorum</i> (scat.)	<i>Ranunculus platanifolius</i> (inab.)
<i>Melandryum silvestre</i> (scat.)	<i>Soldanella montana</i> (scat.)
<i>Milium effusum</i> (scat.)	<i>Thalictrum aquilegifolium</i> (only loc.)
<i>Oxalis acetosella</i> (loc.)	
<i>Paris quadrifolia</i> (scat.)	

These species are joined by some elements of the two other types, the analyses of which I have published l. c.

b) **Western Carpathian facies.**

In the Western Carpathians, the *Petasites* type is rather frequent. It is interesting that it is locally developed even in the beech forests of the dolomitic Rokoš group, comparatively dry and without flowing water. My analysis was done on a rather steep, southwestern slope at an altitude of about 830 meters. The ground is non-mossy, covered by a dry beech-leaf carpet, the soil is only at the very surface slightly humous. Of the woody plants in the undergrowth are infrequent *Fraxinus excelsior*, *Acer pseudoplatanus*, *Corylus avellana*, *Rubus idaeus*, *Rosa pendulina*. The growth of *Petasites albus* governs the aspect, is fairly equally distributed, not grassy, mixed-herbaceous of the following composition:

<i>Aconitum vulparia</i> (scat.)	<i>Petasites albus</i> (v. ab.!!)
<i>Astrantia major</i> (v. ab.)	<i>Polygonatum verticillatum</i> (only scat.)
<i>Cirsium erisithales</i> (scat.)	<i>Prenanthes purpurea</i> (ab.)
<i>Dentaria bulbifera</i> (only scat.)	<i>Primula elatior</i> (scat.)
( <i>Epipactis latifolia</i> )	<i>Ranunculus nemorosus</i> (only scat.)
<i>Euphorbia amygdaloides</i> (v. ab.)	<i>Senecio Fuchsii</i> (rather ab. scat.)
<i>Hacquetia epipactis</i> (scat.)	<i>Symphytum tuberosum</i> (only scat.)
<i>Heracleum sphondylium</i> (only scat.)	<i>Valeriana tripteris</i> (only scat.)
<i>Listera ovata</i> (only scat.)	
<i>Melittis melisophyllum</i> (scat.)	
<i>Mercurialis perennis</i> (ab. scat.)	
<i>Orobanche flava</i> (rather ab. scat.)	

Higher up on Mt. Rokoš (at 970 meters altitude), on the northern slope on non-mossy, slightly humous soil, covered by a half-decayed leaf carpet, there occurs in an old, rather thin beech forest with the usual woody plants in the undergrowth, a somewhat different type which, according to its dominants, can be designated as a *Petasites albus-Asperula odorata-Hacquetia* type. This type is evidently less hygrophilous and forms a transition to the mixed herbaceous wood-ruff types. Its composition is as follows:

<i>Aconitum vulparia</i> (scat.)	<i>Asperula odorata</i> (ab. scat.!)
<i>Aquilegia longisepala</i> (only scat.)	<i>Astrantia major</i> (rather ab. scat.)
<i>Asarum europaeum</i> (only scat.)	

<i>Campanula rapunculoides</i> (rather ab. scat.)	( <i>Paris quadrifolia</i> )
<i>Cirsium erisithales</i> (only scat.)	<i>Petasites albus</i> (v. ab. scat.!)
<i>Dentaria bulbifera</i> (scat.)	( <i>Phyteuma spicatum</i> )
<i>Euphorbia amygdaloides</i> (scat.)	<i>Pleurospermum austriacum</i> (scat.)
<i>Festuca silvatica</i> (ab. scat.!)	<i>Polygonatum verticillatum</i> (v. ab.!)
<i>Hacquetia epipactis</i> (ab. scat.!) ( <i>Heracleum sphondylium</i> )	<i>Prenanthes purpurea</i> (rather ab. scat.)
<i>Lactuca muralis</i> (only scat.)	<i>Primula elatior</i> (rather ab. scat.)
<i>Laserpitium latifolium</i> (only scat.)	<i>Pulmonaria obscura</i> (only scat.)
<i>Melitis melisophyllum</i> (only scat.)	<i>Senecio Fuchsii</i> (scat.)
<i>Mercurialis perennis</i> (ab. scat.)	<i>Valeriana tripteris</i> (scat.)

c) **Eastern Carpathian facies.**

The beech forests with *Petasites albus*, which I described from Subcarpathian Russia (see <sup>4</sup>, p. 12, 13, 10), cannot be united in a single type. I distinguish principally a typical non-mossy and an atypical variant.

d) **Non-mossy variant.**

As an example, I cite an old virgin beech forest, only slightly mixed (maple, elm, ash) in the upper part of the Bilina valley (Svidovec), at an altitude of about 820 meters, on a southeastern slope above a gully-like cut. The forest is shady, the soil moderately moist, non-mossy, the undergrowth rich and herbaceous, and *Petasites albus* in a loose group dominating the aspect. In this herbaceous undergrowth grow:

<i>Aruncus silvester</i> (ab. scat.)	<i>Ranunculus lanuginosus</i> (only scat.)
<i>Circaea lutetiana</i> (scat.)	( <i>Rubus idaeus</i> )
<i>Dentaria bulbifera</i> (only scat.)	<i>Salvia glutinosa</i> (ab. scat.!)
<i>Doronicum austriacum</i> (ab. scat.!)	<i>Scrophularia nodosa</i> (only scat.)
<i>Epilobium montanum</i> (scat.)	<i>Senecio nemorensis</i> (ab. scat.!)
<i>Geranium Robertianum</i> (scat.)	<i>Solidago virga aurea</i> (ab. scat.)
<i>Impatiens noli tangere</i> (rather ab.!)	<i>Stachys silvatica</i> (scat.)
( <i>Paris quadrifolia</i> )	<i>Symphytum cordatum</i> (scat.)

e) **Mossy variant.**

The same locality as above on Flysch substratum, but on the opposite slope with a southwestern exposure (influence of the exposure is evident in the shady virgin forest with the same soil humidity).

The floor is rather mossy. Of bryophytes were ascertained: *Atrichum undulatum*, *Anomodon viticulosus*, *A. longifolius*, *Brachythecium laetum*, *Eurhynchium striatum*, *Fegatella conica*, *Homalothecium sericeum*, *Hypnum nemorosum*, *Isothecium myurum*, *Leskea polycarpa*, *Madotheca platyphylla*, *Metzgeria conjugata*, *Mnium punctatum*, *M. undulatum*, *Plagiothecium denticulatum*, *P. silvaticum*, *Pseudoleskea atrovirens* and *Pylaisia polyantha*.

The herbaceous growth is abundant, but unequal, locally of a *Petasites* aspect, in other places it could be designated as a *Lunaria-Impatiens* type; on light places *Urtica dioica* is frequent. The composition of the undergrowth is as follows:

<i>Asperula odorata</i> (scat.)	<i>Lunaria rediviva</i> (rather ab. scat., loc. greg.)
<i>Athyrium filix femina</i> (only scat.)	<i>Oxalis acetosella</i> (scat.)
<i>Chaerophyllum aromaticum</i> )	<i>Petasites albus</i> (only scat., loc. rather greg.)
<i>Chrysosplenium alternifolium</i> (rather ab.)	<i>Polystichum Braunii</i> (only scat.)
<i>Circaea alpina</i> (loc.)	<i>Polystichum lobatum</i> (only scat.)
<i>Circaea lutetiana</i> (loc.)	<i>Ranunculus lanuginosus</i> (scat.)
<i>Dryopteris filix mas</i> (scat.)	( <i>Rubus idaeus</i> )
( <i>Festuca gigantea</i> , more ab. only in the creek-cut)	( <i>Sambucus nigra</i> )
( <i>Galeopsis grandiflora</i> )	<i>Senecio nemorensis</i> (scat.)
<i>Geranium Robertianum</i> (scat.)	<i>Stellaria nemorum</i> (scat.)
<i>Impatiens noli tangere</i> (rather ab. to ab.)	<i>Symphytum cordatum</i> (only scat.)
<i>Lamium luteum</i> (rather ab. scat.!)	<i>Urtica dioica</i> (scat.)
	<i>Veronica urticifolia</i> (scat.)

**14. *Petasites albus-Mercurialis* — *Chaerophyllum hirsutum* sociation.**

Locality: Svidovec mountain group (Subcarpathian Russia), a side ravine joining the Velký Trostinec valley behind Mt. Kečírka, at

about 710 meters, on Flysch substratum, an old mixed beech forest interspersed with maple, ash, spruce and fir, with an open canopy at the bottom of the ravine. The herbaceous undergrowth is luxuriant and abundant, continuous towards the creek, *Mercurialis* and *Petasites* are dominants, shrubs are rather plentiful (especially *Lonicera nigra* and *Rosa pendulina*, less *Rubus idaeus*). On mossy boulders, ferns grow here and there — *Cystopteris sudetica*, *C. fragilis*, *Asplenium trichomanes*, *Polypodium vulgare*. The composition of the undergrowth is as follows:

<i>Caltha palustris</i> (ab.)	<i>Paris quadrifolia</i> (only scat.)
<i>Carex remota</i> (rather ab. scat.)	<i>Petasites albus</i> (ab.!)
<i>Carex silvatica</i> (scat.)	<i>Polystichum lobatum</i> (scat.)
<i>Chaerophyllum hirsutum</i> (ab.)	* <i>Pulmonaria Filarszkyana</i> (ab.)
<i>Cirsium oleraceum</i> (ab. scat.)	<i>Sanicula europaea</i> (only scat.)
<i>Crepis paludosa</i> (ab. scat.)	<i>Salvia glutinosa</i> (ab. scat.)
<i>Glechoma hirsuta</i> (ab.)	<i>Stachys silvatica</i> (ab. scat.)
* <i>Helleborus purpurascens</i> (rather ab. scat.)	* <i>Symphytum cordatum</i> (ab. scat.)
<i>Impatiens noli tangere</i> (rather ab., loc. ab.)	<i>Thalictrum aquilegifolium</i> (ab. scat.)
<i>Mercurialis perennis</i> (ab.!)	<i>Valeriana tripteris</i> (ab. scat.)
<i>Myosotis palustris</i> (ab. scat.)	* <i>Veronica urticifolia</i> (scat.)

This community (the Eastern Carpathian species are marked with an asterisk ) has a good many hygrophilous species accompanying usually creeks and swamps but mostly lacking in the forests of the *Petasites* type. As these growths repeat themselves elsewhere, also under similar habitat conditions, we may regard them as a distinct sociation.

#### 15. *Impatiens noli tangere* sociation.

*Impatiens noli tangere* is common in the somewhat humous and moist beech forests and forms, in its own way, islets and closed colonies. Under sufficient humidity, it can stand shade better than most of the other plants of the beech forest undergrowth. It forms, then, extensive dense growths, very excluding and in the summer aspect often seemingly pure, though a detailed analysis shows that some, to rather numerous, characteristic beech forest plants are present. If

we ascend, for instance, to the summit ridge of Žihlavník (limestone) near Trenčianské Teplice, we find in old beech forests a quite continuous, dense undergrowth. Vast growths are formed here by the light green, slightly glaucous *Impatiens* and into them, in places, penetrates abundantly *Mercurialis perennis*, which sometimes can predominate alone; as a third dominant *Urtica dioica* is associated and as a fourth *Aconitum vulparia*. Very abundant in this virgin beech forest is *Asperula odorata*; grasses, however, are missing, only *Elymus europaeus* grows in scattered groups. Further, more or less scattered are *Senecio Fuchsii*, *Asarum europaeum*, *Dentaria bulbifera*, *D. enneaphyllos*, *Stachys alpina* and *S. silvatica*, *Actaea spicata*, *Anthriscus nitida*, very abundant are *Circaea lutetiana* and *Glechoma hirsuta*, fairly abundant are *Galeopsis grandiflora*, *Geranium Robertianum*, *Lamium maculatum* and *L. luteum*, *Stellaria nemorum*, here and there appears *Arabis turrata*, only scattered *Polygonatum verticillatum* and infrequently *P. multiflorum*, locally *Circaea lutetiana* and *Heracleum sphondylium*, of ferns are scattered *Dryopteris filix mas*, *Athyrium filix femina*, *Polystichum lobatum*.

The fully developed *Impatiens* type corresponds, therefore, to the mixed herbaceous woodruff types with a striking dominance of *Impatiens*. Detailed analyses of beech forests with such undergrowth were described by P. Sillinger (<sup>1</sup>, p. 27—31), from the white Carpathians. Hercynian facies of the *Impatiens* type are floristically impoverished similarly as the respective woodruff types.

Under sufficient humidity, *Impatiens* growths may thrive (just as *Petasites* growths, see *Cirsieto-Petasitetum albi*, *Domín* <sup>4</sup>, p. 11) even on open places and independently of the forest. Such an open *Impatientetum* I described, for instance, from Subcarpathian Russia (<sup>4</sup>, p. 12) in the Svidovec group behind Mt. Kečírka (720 meters alt.), on a small meadow, with a creek, among beech forests. The soil is wet, in places even swampy, but non-mossy or only in places slightly mossy. *Impatiens* forms a very extensive and dense growth, composed of:

( <i>Athyrium filix femina</i> )	<i>Chaerophyllum hirsutum</i> (ab.!)
<i>Bupthalmum speciosum</i> )	<i>Chrysosplenium alternifolium</i>
<i>Caltha palustris</i> (loc. scat.)	(scat.)
<i>Cardamine amara</i> (scat.)	<i>Circaea lutetiana</i> (scat.)

<i>Cirsium oleraceum</i> (only v. scat.)	<i>Ranunculus lanuginosus</i> (only scat.)
<i>Crepis paludosa</i> (only scat.)	
<i>Festuca gigantea</i> (scat.)	<i>Ranunculus repens</i> (rather ab. scat.)
<i>Galeopsis grandiflora</i> (only scat.)	
<i>Geum urbanum</i> (only v. scat.)	<i>Rumex obtusifolius</i> (scat.)
<i>Glechoma hirsuta</i> (scat.)	<i>Salvia glutinosa</i> (rather ab. scat.)
( <i>Matteucia struthiopteris</i> )	
<i>Myosotis palustris</i> (ab.)	<i>Stachys silvatica</i> (ab. scat.)
( <i>Petasites albus</i> )	<i>Stellaria nemorum</i> (scat.)
( <i>Plantago major</i> )	<i>Symphytum cordatum</i> (scat.)
<i>Pulmonaria Filarszkyana</i> (scat.)	<i>Valeriana tripteris</i> (scat.)
<i>Pulmonaria obscura</i> (only scat.)	

Already from this analysis we see that this community comes closer of the preceding sociation, than to the normal *Impatiens* growths of the beech forests.

#### D. *Fageta filicina*.

Ferns rather often determine the aspect of the beech forests by their considerable dominance, especially on stony ground and talus, sometimes also on humous soils with a loamy subsoil. Various mixed fern types we have already seen above. In this category, I put only those sociations in which ferns have physiognomically a leading role.

#### 16. *Athyrium filix femina* (*Fagetum athyriosum*) sociation.

Here belongs the *Fagetum athyriosum filicis feminae* described by Zlatník (<sup>1</sup>), from the Krkonoše Mts. with the following constant species: *Athyrium filix femina*, *Lactuca muralis*, *Gentiana asclepiadea*, *Lamium luteum*, *Dryopteris pulchella*, *D. austriaca* + *spinulosa*, *D. filix mas*, *D. phegopteris*, *Oxalis acetosella*, *Prenanthes purpurea*, *Senecio nemorensis* + *Fuchsii*.

An allied variant ***Dryopteris pulchella-Oxalis*** from the same mountains which was described by Zlatník as *Fagetum nephrodiosum dryopteridis* shows an even closer approach to the spruce forests. With a constance 5 appear in it *Picea excelsa*, *Athyrium filix femina*, *Dryopteris pulchella*, *D. austriaca* + *spinulosa*, *Oxalis acetosella*, *Prenanthes purpurea*, with a constance 4 *Lac-*

*tuca muralis*, *Homogyne alpina*, *Dryopteris filix mas*, *D. phegopteris*, *Senecio nemorensis* + *Fuchsii*.

b) Non-mossy Eastern Carpathian variant.

Two interesting, non-mossy fern types I described (<sup>4</sup>, p. 14—16) from the Svidovec Mts. in Subcarpathian Russia on loamy and humous soils. The first locality is on the slope above the Koleček creek, at an altitude of 1000 meters. Here is an old, shady beech forest, not very dense, interspersed with spruce and with scattered fir; maple (*A. pseudoplatanus*) is, of course, present, but a shrubby undergrowth is missing. The floor — with the exception of stumps and trunks — is non-mossy, not stony, but mostly loamy with a moderately thick humus layer, only here and there stones are scattered; it is covered by a carpet of half-decayed beech (and maple) leaves. The herbaceous undergrowth is abundant though not entirely continuous, the ferns determine the aspect. The undergrowth consists of:

<i>Anemone nemorosa</i> (scat.)	<i>Geranium Robertianum</i> (ab.)
<i>Asperula odorata</i> (ab. to v. ab., does not form dense growths)	<i>Homogyne alpina</i> (only scat.)
<i>Athyrium filix femina</i> (v. ab.!) in vigorous clumps)	<i>Lactuca muralis</i> (rather ab. scat.)
<i>Chrysosplenium alternifolium</i> (loc.)	<i>Lamium luteum</i> (ab. to v. ab.!) <i>Oxalis acetosella</i> (v. ab.!) ( <i>Paris quadrifolia</i> )
<i>Circaea alpina</i> (only scat.)	<i>Polystichum Braunii</i> (rather ab. scat.)
<i>Dentaria bulbifera</i> (scat.) ( <i>Dryopteris austriaca</i> )	<i>Polystichum lobatum</i> (ab. scat., immense clumps)
<i>Dryopteris filix mas</i> (ab. scat.!) ( <i>Dryopteris pulchella</i> )	<i>Ranunculus dentatus</i> (scat.)
( <i>Epilobium montanum</i> )	<i>Rubus</i> sp. (rather ab. scat.)
( <i>Euphorbia carniolica</i> )	<i>Symphytum cordatum</i> (ab.!)

In the continuation of the extensive growth analysed, the following species were found in addition: *Adoxa moschatellina* (only scattered), *Prenanthes purpurea* (scattered), *Pulmonaria Filarzkyana* (loc.), *Stellaria nemorum*. Locally appear small insertions of *Luzula silvatica*, most often with spruce. Higher up on the slope (from 1100 meters upwards, N to NE by N exposure) is an old beech forest, almost pure, denser and therefore with a deeper shade. The soil is

loamy, with humus, non-mossy. *Athyrium* is again very abundant and ferns in general have a decided influence upon the aspect, although somewhat less so than in the lower, lighter beech forest. The undergrowth is, on the whole, similar, inabundantly appears *Daphne mezereum*, abundant are young beeches and scattered young maples. (*Acer pseudoplatanus*). The composition of the undergrowth is given in detail in my cited paper (<sup>3</sup>, p. 15).

c) **Eastern Carpathian mossy facies.**

I present an example of this type from the Svidovec Mts. (Mt. Kečírka in the Velký Trostinec valley, at about 720 meters alt., on Flysch). It is an old mixed beech forest, in more open places (half-shade) on coarse talus on a slope. The ground, really stony, is very mossy; the mossy carpet is formed by *Hylocomium splendens*, *H. Schreberi*, *Thuidium tamariscinum*, *Eurhynchium striatum*, *Lophozia barbata*.

The herbaceous undergrowth is abundant, ferns predominate, of these *Athyrium* is the most abundant in vigorous clumps. Of shrubs, *Ribes grossularia* is abundantly scattered, *Lonicera nigra* and *Rubus idaeus* scattered. The undergrowth is composed of:

<i>Athyrium filix femina</i> (v. ab.!, dominates)	<i>Dryopteris phegopteris</i> (only scat.)
<i>Chrysosplenium alternifolium</i> (rather ab. scat.)	<i>Glechoma hirsuta</i> (ab. scat.!) <i>Galeopsis grandiflora</i> (inab. scat.)
<i>Circaea alpina</i> (rather ab.)	<i>Geranium Robertianum</i> (scat.)
<i>Dryopteris austriaca</i> (rather ab. scat.)	<i>Impatiens noli tangere</i> (ab. scat.) <i>Oxalis acetosella</i> (only scat.)
<i>Dryopteris filix mas</i> (only v. scat., in vigorous clumps)	<i>Polystichum Braunii</i> (only inab. scat.) <i>Urtica dioica</i> (ab. scat.!)

In the neighbourhood where the forest thins out, on coarse talus in light places, shrubby loose to dense growths of *Rubus idaeus*, *Lonicera nigra* and *Ribes grossularia* predominate, accompanied by the above named species of the *Athyrium* type, growing here, however, with only a low frequency so that the aspect is governed by shrubs. This community is, therefore, only a stage of the described variant caused by the increased light intensity.

### 17. *Dryopteris Robertiana* sociation.

As an example, I give the Western Carpathian limestone facies from the slope of Mt. Žihlavník near Trenčianské Teplice. In the lower beech forest zone, on old talus, completely covered by humus, a mixed fern-woodruff type predominates; of ferns here grow *Dryopteris Robertiana* (v. ab.), *D. filix mas*, *Athyrium filix femina*, *Polystichum lobatum*, *Cystopteris fragilis*, *Asplenium trichomanes*, further *Asperula odorata*, *Asarum europaeum*, *Arabis hirsuta*, *A. arenosa*, *Cardamine impatiens*, *Circaea lutetiana* (v. ab.), *Cephalanthera rubra*, *Dentaria enneaphyllos* (ab.), *Epipactis latifolia*, *Galium Schultesii*, *Geranium Robertianum*, *Hedera helix*, *Hieracium murorum*, *Lactuca muralis*, *Oxalis acetosella*, *Prenanthes purpurea*, *Pirola secunda*, *Sanicula europaea*, *Senecio Fuchsii*, *Stachys silvatica*, *Torilis anthriscus*.

### 18. Eastern Carpathian *Mercurialis-Phyllitis* sociation.

The beech forest community which I described (4, p. 23) from Subcarpathian Russia as the *Mercurialis-Phyllitis* type, differs essentially from the Western Carpathian limestone types by the abundant *Phyllitis*, and can be more rightly classified as a fern type, although it shows certain affinities with the Carpathian woodruff types with abundant *Glechoma hirsuta*. It occurs, for instance, in the Svidovec Mts. on Mt. Kečirka in the Velký Trostinec valley (on Flysch, at about 720 meters alt.) on a coarse talus, filled in with humus, and with the bryophytes as enumerated under sociation no. 16 c. It is an old, shady virgin forest with abundant, locally even predominant maples (*Acer pseudoplatanus*), with scattered old elms, solitary also ash, *Acer platanoides*, spruce, fir and high-trunk hazel. The tree-stratum is therefore decidedly mixed. The undergrowth is rich; the abundantly scattered *Phyllitis* (together with the gregarious *Mercurialis* and the abundant *Urtica*) is its leading plant. It consists of:

<i>Asperula odorata</i> (only in scat. col., loc. lacking)	<i>Circaea lutetiana</i> (scat.)
<i>Athyrium filix femina</i> (scat.)	( <i>Daphne mezereum</i> )
<i>Cardamine impatiens</i> (loc. scat.)	<i>Dryopteris austriaca</i> (loc. scat.)
<i>Circaea alpina</i> (scat.)	<i>Dryopteris filix mas</i> (scat.)
	( <i>Epilobium montanum</i> )

<i>Geum urbanum</i> (scat.)	<i>Polystichum Braunii</i> (rather ab. scat.)
<i>Glechoma hirsuta</i> (ab.!)	
<i>Impatiens noli tangere</i> (ab.)	<i>Polystichum lobatum</i> (inab., vigorous clumps)
<i>Lactuca muralis</i> (only scat.)	
<i>Mercurialis perennis</i> (v. greg.!)	<i>Salvia glutinosa</i> (loc. col.)
( <i>Oxalis acetosella</i> )	<i>Urtica dioica</i> (v. ab.!)
<i>Phyllitis scolopendrium</i> (v. ab. scat..!)	

#### E. *Fageta caricina*.

Two characteristic sociations brought about by the gregarious *Carex pilosa* or *C. alba*, both Carpathian, belong to this group. Especially the former is widely distributed in many variants in our Carpathians. Sometimes *C. silvatica* — especially on more humid places — appears gregariously in beech forests, but it appears to me that its growths do not represent a distinct sociation.

#### 19. *Carex pilosa* sociation (*Fagetum carcinium pilosae*).

It is rather a group of allied sociations, distributed in the Carpathians, especially at lower mountain altitudes, on limestone as well as on various silicious rocks, in Subcarpathian Russia, on Flysch (the Eastern Carpathian facies with some regional species). Zlatník (<sup>4</sup>, p. 411) designates this type as the most widely spread in the beech forests of Subcarpathian Russia in the lower zone up to 600 meters altitude. It is interesting that this *Caricetum pilosae*, without *Asperula odorata*, but with a very similar sociological structure, penetrates even beyond the beech forest region to the lower and warmer Carpathian foothills where it occurs in mixed *Carpineta* and *Querceta* (as for instance in the andesitic Kováčov hills along the Danube at an altitude of only 120 meters).

P. Sillinger (<sup>4</sup>, p. 25) considers this *Carex pilosa* type as most characteristic for the beech forests of the White Carpathians where it is extensively spread from the lower hills to the mountain situations, on sandstone slopes with apparently rather nutritious soils of moderate humidity. *Carex pilosa* usually forms here a more or less equal, sometimes very dense to a seemingly quite closed growth into which other beech forest species penetrate in various abundance. On poorer and drier, less humous, soils (light-grey and yellow-grey soils)

the undergrowth has a characteristic sedge physiognomy and beech forest herbs and grasses are comparatively sparsely scattered among the dominating *Carex pilosa*. On apparently more humous and nutritious soils (greyish-brown to blackish-brown), as long as they are humid enough, we find, in company with *Carex pilosa*, a rich undergrowth with an abundance of beech forest elements. Thus, in the White Carpathians for instance, the undergrowth is usually a combination of *Carex pilosa-Hacquetia*, *Carex pilosa-Asperula odorata*, rarely *Carex pilosa* — *Allium ursinum*.

As examples, I present some variants: \*

a) The Strážné valley near Pieštany, at 285 meters alt., N. E. slope, has a mixed high-trunk beech forest, rather thin, with abundant hornbeam (*Carpinus betulus*) and scattered maple (*Acer pseudoplatanus*). The forest floor is without mosses, open spots are always covered by a carpet of decaying leaves. *Carex pilosa* forms a continuous and dense, therefore very excluding growth in which beech seedlings show the highest dominance. The soil is loamy to a great depth and humous on the surface. Here and there are maple seedlings and solitarily also oak (*Quercus sessilis*) seedlings, otherwise the floristic composition is very poor. *Lathyrus vernus* is abundant, *Pulmonaria officinalis* and *Viola silvatica* are scattered, only sparsely scattered are *Oxalis acetosella*, *Hedera helix*, *Melica uniflora*, also a little of *Asperula odorata*, solitarily appear *Dactylis Aschersoniana* and *Campanula trachelium*, quite isolated are *Epilobium montanum* and *Luzula nemorosa*.

b) As an illustration of an impoverished type, I mention a high-trunk beech forest from the lower part of the Strážné valley near Moravany in the Pieštany hills on a N. to NE. by N. exposure. The non-mossy soil is covered by a thick layer of beech leaves, on it grow very abundantly young beeches, and *Carex pilosa* forms a very loose, rather evenly distributed undergrowth. Grasses are entirely lacking, solitarily appear oak seedlings (*Quercus sessilis*); the floristic composition is very poor: scattered is *Lathyrus vernus*, only scattered *Pulmonaria officinalis* and *Oxalis acetosella* (here and there in small colonies), very little of *Asperula odorata*, only quite solitary appear: *Lactuca muralis* (ster.), *Melittis melisophyllum*, *Symphytum tuberosum*, *Lamium luteum*, *Dryopteris filix mas*, *Ajuga*

*genevensis*, *Impatiens noli tangere*, *Luzula nemorosa* (only along the margin).

It seems that the undergrowth is held back by the leaf carpet so that in places the beech forest has the aspect of a half-bare-floor forest; the shade here is also rather deep.

c) *Carex pilosa* — *Dentaria bulbifera*-*Staphylea* variant.

On the Plešina ridge in the Pieštany hills, at an altitude of 430 meters on rather level land, there is a younger, mixed, very dense beech forest with a non-mossy soil, covered by a thick leaf carpet. The *Carex pilosa* undergrowth is equally distributed but loose. The composition of the tree stratum is somewhat irregular, in fact, in places the beech does not dominate. It is in reality a type peculiar to the mixed forests on ridges, in which are scattered *Fraxinus excelsior*, *Ulmus scabra* (abundantly enough scattered), *Acer platanoides* (chiefly young trees in the undergrowth), less so *A. campestre*, *A. pseudoplatanus*, *Quercus sessilis*. Tall hazels (*Corylus avellana*) are rather abundantly scattered, of shrubs, besides young trees, are mainly *Staphylea pinnata* and *Evonymus verrucosa* abundantly enough scattered, less so *Cornus sanguinea*, solitary is *Sorbus aria* (also in tree form). *Carex pilosa* is accompanied by very abundant *Dentaria bulbifera*, further *Isopyrum thalictroides* (very abundantly scattered), *Mercurialis perennis* (locally in loose colonies), abundant enough are *Asarum europaeum* and *Pulmonaria officinalis*, and only very scattered *Hedera helix*, *Viola mirabilis*, *Galium aparine*, *Orchis pallens*, *Bromus asper*, *Melica uniflora*, solitary *Lamium luteum*, *Lathyrus vernus*, *Viola silvatica*, *Geum urbanum*.

d) *Carex pilosa*-*Hacquetia* — *Cephalanthera rubra* variant.

In the dolomitic Rokoš group on the Janko hill above Uhrovec on the northern slope in the zone from 350 to 500 meters altitude are younger, continuous, shady beech forests which can be considered, according to their physiognomy, as *Fagetum subnudum* because the herbaceous undergrowth is very thin to almost none. The loamy, rather dry soil has no distinct humus layer and is covered everywhere by a thick layer of very slowly-decaying leaves. Here and there are scattered hornbeams (*Carpinus betulus*) or oaks (*Quercus sessilis*, *Quercus cerris*), scattered *Sorbus torminalis* and soli-

tary also *S. aria*, *Corylus avellana*, *Fraxinus excelsior*, but shrubby beeches are mostly lacking. Sociologically, we may characterise these beech forests by *Carex pilosa* which sometimes grows quite alone in extensive areas, of course only scattered among the dryleaf carpet and never forming dense growths. In addition, there are:

<i>Arabis hirsuta</i> (scat.)	<i>Hacquetia epipactis</i> (inab.)
<i>Asarum europaeum</i> (rather ab.)	<i>Hedera helix</i> (ab. scat.)
<i>Asperula odorata</i> (rarely, in scat. col.)	<i>Hypericum montanum</i> (only scat.)
<i>Brachypodium silvaticum</i> (only scat.)	<i>Lactuca muralis</i> (only scat.)
	<i>Lathyrus niger</i> (inab.)
	<i>Lathyrus vernus</i> (scat.)
<i>Carex digitata</i> (only scat.)	<i>Melica uniflora</i> (scat. in small. col.)
<i>Carex pilosa</i> (v. ab. scat.)	
<i>Carex silvatica</i> (loc.)	<i>Neottia nidus avis</i> (sol.)
<i>Cephalanthera alba</i> (scat.)	<i>Oryzopsis virescens</i> (only quite loc.)
<i>Chrysanthemum corymbosum</i> (only scat.)	<i>Paris quadrifolia</i> (quite loc.)
<i>Clematis vitalba</i> (only scat.)	<i>Pulmonaria officinalis</i> (only scat.)
<i>Dactylis Aschersoniana</i> (only scat.)	<i>Sanicula europaea</i> (quite loc.)
<i>Epipactis latifolia</i> (inab.)	<i>Senecio Fuchsii</i> (only scat.)
<i>Epipactis microphylla</i> (only loc. scat.)	<i>Symphytum tuberosum</i> (only scat.)
	<i>Vincetoxicum officinalis</i> (scat.)
<i>Galium Schulthesii</i> (scat.)	

This, of course, is not a usual sociological analysis, but rather a list of species found in this beech forest in a vertical zone of 150 meters width.

e) *Carex pilosa* — *Luzula nemorosa* variant.

This type is characteristic for drier habitats, usually in the neighbourhood of oak forests, not seldom in beech forests interspersed with oak. It is chiefly spread on the eruptive rocks of middle Slovakia. As an example I mention a beech forest on the southern slope of Mt. Bílá Skála, above Nová Báně on the Hron River (trachyte). The beech forest spreads here above the oak-forest zone and is, in its lower part, rather abundantly interspersed with hornbeam (*Carpinus betulus*) and solitarily oaks (*Quercus cerris*). The soil is humous, non-mossy, and covered with decayed leaves. An analysis at an altitude of about 550 meters shows a predominance of *Carex*

*pilosa* in the undergrowth, abundant enough is *Luzula nemorosa*, abundantly scattered is *Carex digitata*, here and there are colonies of *Asperula odorata*, scattered are *Dactylis Aschersoniana* and *Poa nemoralis*, otherwise inabundant are *Cephalanthera rubra*, *Epilobium montanum*, *Galium Schultesii*, *Hieracium sabaudum*, *Lactuca muralis*, *Lathyrus niger*, *L. vernus*, *Melittis melisophyllum*. In general the undergrowth is very poor floristically.

R. M i k y š k a <sup>(1)</sup>, in his paper on the forest types in the Štiavnické Středohoří Mts., describes in beech and oak forests the *Carex pilosa* type with two subtypes, namely *Carex pilosa* proper and *Carex pilosa* — *Luzula nemorosa*, which belongs here. In general, he designates beech (and oak) forests with dominant *Carex pilosa* as a hemixerophytic type, physiognomically uniform by its sedge undergrowth in which species, otherwise with a great sociability (for instance *Asperula odorata*, *Galium Schultesii*), grow more or less isolated. The cause of this he sees in the great expansibility of both dominants (*Carex pilosa*, *Luzula nemorosa*). Notwithstanding that the vegetation covers an average of 80% of the surface, of the species more abundant in the woodruff type especially the following decrease: *Melica uniflora*, *Paris quadrifolia*, *Geranium Robertianum*, *Mercurialis perennis*, *Primula elatior*, and *Sanicula europaea*. Both named dominants are constant species in this territory just as *Dentaria bulbifera* and *Asperula odorata*; *Melica nutans* is the only differential species with regard to the other beech forest types. *Carex pilosa* type occurs in the Štiavnické Středohoří Mts. on comparatively drier soils and is customary mainly in somewhat cut-out forests. The tree stratum is rather uniform, composed of beech, more rarely of oak (*Quercus robur*).

This *Luzula* variant is, in a certain sense, an already degraded type of our sociation, caused by a drier soil (especially on eruptive rocks) and by a mixing-in of oak.

## 20. *Carex alba* sociation (*Fagetum caricinum albae*).

This type, occurring in the Carpathians (especially in the southwestern), is, however, nowhere in its continuity as widely distributed as the preceding one. Very often I have seen in beech forests only small local growths of *Carex alba*, and I have the impression, that

rarely — if at all — it is possible to consider this type as a permanent community. Many of its accompanying species differ according to the habitat conditions and according to the vegetation of the neighbouring beech forests. An interesting type is to be found, for instance, in the dolomitic Rokoš group on the northern slope of the rocky ridge Malé Zrubisko, near the crest, at an altitude of 590 meters (analyses done by P. Sillinger). It is a thin beech forest where the woody plants besides the absolutely dominant beech, are: *Acer pseudoplatanus*, *Fraxinus excelsior*, *Daphne mezereum*, *Cornus mas*, *Sorbus aria*, *Frangula alnus*, *Berberis vulgaris*, *Lonicera xylosteum*, *Viburnum opulus*, *Cotoneaster tometosa*. The undergrowth consists of:

<i>Ajuga reptans</i> (scat.)	<i>Hedera helix</i> (scat.)
<i>Allium ochroleucum</i> (rar.)	<i>Hieracium murorum</i> (scat.)
<i>Aquilegia longisejala</i> (scat.)	<i>Hypericum montanum</i> (scat.)
<i>Asarum europaeum</i> (rather ab. scat.)	<i>Laserpitium latifolium</i> (rather ab. scat.)
<i>Asperula tinctoria</i> (ab. scat.)	<i>Lilium martagon</i> (scat.)
<i>Brachypodium pinnatum</i> (scat.)	<i>Melittis melisophyllum</i> (scat.)
<i>Calamagrostis varia</i> (ab. scat.)	<i>Mercurialis perennis</i> (scat.)
<i>Campanula rapunculoides</i> (scat.)	<i>Origanum vulgare</i> (rather ab. scat.)
<i>Campanula rotundifolia</i> var. (scat.)	<i>Phyteuma orbiculare</i> (scat.)
<i>Carex alba</i> (v. ab.)	<i>Pimpinella magna</i> (scat.)
<i>Carex humilis</i> (sol.)	<i>Pirola secunda</i> (sol.)
<i>Chrysanthemum corymbosum</i> (scat.)	<i>Platanthera bifolia</i> (only scat.)
<i>Cirsium erisithales</i> (scat.)	<i>Prenanthes purpurea</i> (scat.)
<i>Convallaria majalis</i> (sc.)	<i>Primula officinalis</i> var. <i>canescens</i> (scat.)
<i>Dentaria bulbifera</i> (scat.)	<i>Pulmonaria officinalis</i> (scat.)
<i>Dryopteris Robertiana</i> (scat.)	<i>Ranunculus nemorosus</i> (scat.)
<i>Epipactis rubiginosa</i> (scat.)	<i>Sesleria calcaria</i> (rather ab. scat.)
<i>Euphorbia amygdaloides</i> (rather ab. scat.)	<i>Solidago virga aurea</i> (scat.)
<i>Galium Schultesii</i> (rather ab. scat.)	<i>Teucrium chamaedrys</i> (ab. scat.)
<i>Hacquetia epipactis</i> (scat.)	<i>Valeriana tripteris</i> (rather ab. scat.)
	<i>Vincetoxicum officinalis</i> (scat.)
	<i>Viola mirabilis</i> (scat.)

I recorded this community with the dominant *Carex alba* as the first example, even though it is sociologically very atypical, because this heterogeneity, as shown in the above list, often characterises the more extensive growths of this sociation. If we know the vegetation of the territory where the analysis is done, we recognise in it elements of various neighbouring sociations, partly from the normal beech forests (these, however, are not numerous and even *Asperula odorata* is missing), partly from oak forests, and especially from the *Seslerieta* and *Cariceta humilis*, here customary. Although this community shows a certain stability, its elements form a mixture in which the local habitat conditions permitted the dominance of *Caricetum albae*. This dominance, likely to last a longer time, will, however, not be permanent.

In the deep shade of the beech forest, these foreign elements disappear and only the beech forest species remain. In the same region on the ridge above the Studená studňa valley towards Mt. Kanišová skála, I analysed a beech forest on the northwestern slope at about 600 meters altitude. Along the ridge is a strip of an old, half-bare-floor beech forest and below it, on a comparatively large area, is a rather continuous *Caricetum albae*, in the growth of which is a large quantity of decayed leaves, while mosses are missing. The composition of the undergrowth because of the excluding habit of *Carex alba* is floristically poor.

( <i>Arabis hirsuta</i> )	<i>Dentaria bulbifera</i> (scat.)
<i>Asarum europaeum</i> (ab. scat.)	( <i>Epipactis latifolia</i> )
<i>Asperula odorata</i> (v. little)	( <i>Epilobium montanum</i> )
( <i>Campanula rapunculoïdes</i> )	( <i>Lactuca muralis</i> )
<i>Cephalanthera alba</i> (only scat.)	( <i>Viola silvatica</i> )
<i>Cephalanthera rubra</i> (ab. scat.)	

In the beech forest only young shrubs of *Fraxinus excelsior*, *Acer platanoides*, *A. pseudoplatanus*, *Sorbus aria* are present, of the true shrubs *Rubus idaeus* and *Lonicera xylosteum* are rare; in places, however, there is a shrubby, dense, and rather tall young-beech growth, but here *Carex alba* does not penetrate and the floor is covered only by dry leaves.

This type of beech forest with *Carex alba* is more uniform and normal, since it is not mixed with foreign elements, and we cannot

assume that it would undergo a change in the future, provided the succession is not disturbed.

*Carex alba* is remarkable because of its plasticity, since it grows, as already the above examples show, in rather deep shaded as well as in light thin forests. Its growths are of a more xerophytic nature than the normal *Carex pilosa* type and therefore they occupy often the upper drier zone (especially below ridges) and this even on a shallow soil. We observe this, for instance, on the northern slope of Mt. Klepáč above Trenčianské Teplice where *Carex alba* forms, in the upper zone, whole growths and with it we find sometimes some of the species belonging to the lower zone, also *Cephalanthera rubra* and *Epipactis microphylla*. Rather often *Carex alba* penetrates even into secondary forests, as for instance into somewhat dry spruce forests (on limestone) where the *Carex alba* growth, because of the lowered competition, spreads with great intensity (thus for instance on the foot of Mt. Strážov in the valley of Bjeli potok).

J. K l i k a (2) writes about the *Carex alba* type in the Velká Fatra and he considers it as typical of thinned forest growths on limestone, chiefly at lower situations but attaining sometimes an altitude of 1000 meters, and there especially where the stony, often more or less taluslike substratum, with only a thin layer of humus, shows its influence.

#### F. *Fageta luzulina*.

Types of our beech forests with dominating *Luzula nemorosa* in the undergrowth belong usually to the impoverished (degraded) types or appear as stages of antropic succession. On the other hand, *Fagetum luzulinum* is a natural mountain type of a restricted distribution in our beech forests; *Luzuletum silvaticae* as an undergrowth of mountain spruce forests on acid humous soils is much more widespread but differs in its accompanying species.

#### 21. *Luzula silvatica* sociation (*Fagetum luzulinum silvaticae*).

As an example of this sociation I give the two following strikingly different variants from our Carpathians.

##### a) Eastern Carpathian Flysch facies.

I described a typical example from Subcarpathian Russia, Svido-

vec Mts., Bilina potok valley (820 meters alt.), in an old, shady, virgin beech forest which is but slightly mixed, without a shrubby undergrowth, only on places with rather abundant young beeches. The ground is non-mossy, the soil scantily humous, a fine talus, with only slightly infiltrated loam, penetrates to the surface which is covered by only a small amount of dry leaves since most of them were washed away by water. The very luxuriant *Luzula silvatica* completely dominates the aspect and forms, on an extensive area, a continuous undergrowth, or sometimes is divided into large, closely grouped complexes. The boundaries between this and the neighbouring types are absolutely sharp. The composition of this *Luzuletum* is rather poor, because of the very excluding habit of the dominant:

<i>Asperula odorata</i> (scat.)	<i>Galeopsis grandiflora</i> (only v. scat.)
<i>Athyrium filix femina</i> (only scat.)	<i>Lamium luteum</i> (v. ab. scat.!)
<i>Carex silvatica</i> (only loc. scat.)	<i>Oxalis acetosella</i> (only scat. in small. col.)
<i>Doronicum austriacum</i> (rather ab. scat.!)	<i>Salvia glutinosa</i> (scat.)
<i>Dryopteris filix mas</i> (only scat.)	<i>Senecio nemorensis</i> (scat.)
<i>Dryopteris phegopteris</i> (only scat.)	<i>Solidago virga aurea</i> (ab. scat.!)
<i>Epilobium montanum</i> (only v. scat.)	<i>Stachys silvatica</i> (only scat.)
	<i>Veronica urticifolia</i> (ab. scat.)

On some mossy stones, settled colonies of *Circaea alpina* are present.

#### b) Western Carpathian limestone facies.

In the Western Carpathians sometimes there is developed a quite different mountain calcicole variant (*F. luzulinum silvaticae calcicolum*) which approaches the limestone mountain calcicole beech forests of the Western Carpathians but differs by the high dominance of *L. silvatica*. Here must be added «*Fagion carpaticum Cortusae facie* with *Luzula maxima*», which KLIKA (2) describes from the Velká Fatra Mts. in a thin mixed beech forest (with spruce and *Ribes grossularia* infrequent in the shrubby stratum) in a mountain kettle on the slope of Smrekovice near Močidlo (1100 meters alt.). The great dominance of *L. silvatica*, forming a whole growth, is said by the author to be due to the long-lying snow

cover, to the thinned forest, and to the high humidity. Mostly, but with a slight dominance, there grow in this community: *Adenostyles alliariae*, *Anemone ranunculoides*, *Aquilegia vulgaris*, *Chrysosplenium alternifolium*, *Dentaria bulbifera*, *D. enneaphyllos*, *Isopyrum thalictroides*, *Mercurialis perennis*, *Oxalis acetosella*, *Paris quadrifolia*, *Petasites albus*, *Polystichum lonchitis*, *Primula elatior*, *Rumex arifolius*, *Thalictrum aquilegifolium*, *Veratrum Lobelianum*.

22. *Luzula nemorosa* sociation (*Fagetum luzulinum nemorosae*).

Beech forests with abundant *Luzula nemorosa* in the undergrowth frequently belong to the degraded types and arise particularly in the Sudetic-Hercynian region as a consequence of forest culture. Sometimes, however, *Luzula nemorosa* may penetrate even into typical beech forests, especially in the neighbourhood of Hercynian spruce or oak forests on siliceous substrata. Sillinger (<sup>4</sup>, p. 25) also mentions this type from the beech forests in the more northern part of the White Carpathians on drier and more acid soils. From Subcarpathian Russia, I described (<sup>4</sup>, p. 17—18) the *Luzula nemorosa* type in the virgin beech forests of the Gropjenec creek valley below the shepherd settlement Gropa, S. E. slope at about 1120 meters alt. It is an interesting phenomenon that these local *Luzula* growths repeat themselves fairly regularly under old spruces interspersed in the beech forest, whereas they are not present under beeches. I analysed, for instance, such a fairly extensive *Luzuletum nemorosae* under two old spacious spruces where the floor, in as far as it was free, was covered by a dry leaf carpet, without mosses. The composition was as follows:

( <i>Anemone nemorosa</i> )	<i>Lactuca muralis</i> (scat.)
<i>Aposeris foetida</i> (scat.)	<i>Lamium luteum</i> (scat.)
( <i>Asperula odorata</i> )	( <i>Lilium martagon</i> , ster.)
( <i>Campanula abietina</i> )	<i>Oxalis acetosella</i> (scat.)
( <i>Epilobium montanum</i> )	<i>Rubus</i> sp. (scat.)
<i>Galium vernum</i> (scat.)	( <i>Salvia glutinosa</i> , ster.)
<i>Geranium Robertianum</i> )	<i>Valeriana tripteris</i> (ab. scat.!)
( <i>Glechoma hirsuta</i> )	( <i>Veronica urticifolia</i> , ster.)

The influence of the spruce is evident here.

### *G. Fageta graminosa.*

In thinned beech forests and on beech clearings a luxuriant vegetation usually comes in, sometimes shrubby, as for instance raspberry (*Rubus idaeus*) clearings, and sometimes herbaceous, or mixed (grassy-herbaceous). Under a sufficient humidity some grasses can spread, especially *Bromus asper*, *Elymus europaeus*, *Festuca silvatica*, sometimes also *Brachypodium silvaticum* or on drier soil *Poa nemoralis*, whereas the ombrophilous *Melica uniflora* does not tolerate a direct light well without the protection of shrubs. Here we are concerned only with types with grasses dominating in the beech forest itself. There are some such types but their distribution in our beech forests is not very great since herbaceous, respectively fern or sedge types, evidently predominate. Of special interest are the following types:

#### 23. *Melica uniflora* sociation.

This sociation is the most abundant of the grassy types of our beech forests. The leading grass is very abundant also in the woodruff and other types but can so increase that finally it forms continuous dense growths, decidedly excluding. I cite here two variants of this sociation, much more abundant in the Carpathian region than in the Hercynian, one calcicole and the other silicicole.

##### a) Western Carpathian calcicole variant.

On Mt. Vysoká in the Little Carpathians, there is, below the first rocky group on the ridge (on limestone, at about 650 meters altitude, western slope), a thinned beech forest the undergrowth of which is mostly a continuous *Melicetum uniflorae* of the following composition:

<i>Arabis turrata</i> (ab. scat.)	<i>Glechoma hirsuta</i> (ab. scat.)
<i>Asperula odorata</i> (rather greg.)	<i>Hesperis nivea</i> (ab. scat.)
<i>Campanula trachelium</i> (scat.)	<i>Mercurialis perennis</i> (v. scat. col.)
<i>Dactylis Aschersoniana</i> (scat.)	<i>Poa nemoralis</i> (scattered)
<i>Geranium Robertianum</i> (ab. scat.)	<i>Parietaria officinalis</i> (rather ab.)
	<i>Sisymbrium strictissimum</i> (ab.!)
<i>Geum urbanum</i> (scat.)	

On light places locally are colonies of *Lithospermum purpureo-coeruleum*.

#### b) Western Carpathian silicicole variant.

On Mt. Zlatý vrch near Piešťany on a steep eastern slope on Permian quartzites, there is a broad zone of a mixed oak forest (*Quercetum sessilis* with abundantly scattered *Carpinus betulus*), below which beeches increase and mixed beech forests are formed. A vast and quite close *Melicetum uniflora* is characteristic for the oak forest but penetrates also into the beech forest. Abundantly scattered everywhere is *Asperula odorata*, scattered are *Symphytum tuberosum*, *Hieracium sabaudum*, only scattered *Melittis melisophyllum*, locally *Galium Schultesii*, very rarely *Lactuca muralis*, *Pulmonaria officinalis*, *Solidago virga aurea*, *Lathyrus vernus*, *Cephalanthera ensifolia*, *C. alba*, *Polygonatum multiflorum*, *Poa nemoralis*, *Bromus asper*, *Dactylis Aschersoniana*. A shrubby undergrowth is lacking, sparsely only appear *Ligustrum vulgare* and *Acer campestre*.

*Melica uniflora* sociation can combine itself also with either *Asperula odorata* or *Carex pilosa* sociations (for instance in the White Carpathians, Sillinger<sup>1</sup>, p. 25).

R. Mikyška<sup>(1)</sup>, describes from the Štiavnické Středohoří Mts. the *Poa nemoralis* — *Melica uniflora* subtype of his *Poa nemoralis* type which shows evident affinities with oak forests into which *Melicetum uniflora* penetrates, just as in the mixed *Carpineta* outside of the beech forest region.

In general, we may say that the *Melica uniflora* sociation is not a climax type but often only a stage of woodruff types in thinned beech forests. Quite correctly Sillinger<sup>(2)</sup> writes that this sociation, widely distributed in the Western Carpathians, develops chiefly on drier habitats with a higher light intensity and that it only represents, in part, stages of the succession, the spread of which is greatly aided by forest culture. It is interesting that this sociation, just as the *Carex pilosa* sociation, spreads out beyond the beech forest limit into mixed oak, and hornbeam forests.

#### 24. *Dactylis Aschersoniana* sociation.

*Dactylis Aschersoniana*, clearly one of the leading plants of our beech forests, is but scattered to abundantly scattered in the undergrowth and usually does not dominate the aspect in the forest shade. In the Little Carpathians on the foot of Mt. Vysoká, beginning along

the forest road leading to the hunting-seat Vývrat, I analysed a somewhat thinned but shady, tall-trunk beech forest of the *Dactylis Aschersoniana* — *Melampyrum nemorosum* type with the following composition: *D. Aschersoniana* forms a nearly continuous and dense undergrowth and *Melampyrum nemorosum* is quite common as a lower layer and abundant; otherwise, of grasses, *Poa nemoralis* is rather abundant but is lost in the aspect by the dominance of *Dactylis*; *Melica nutans* is scattered, while others are:

( <i>Ajuga reptans</i> )	<i>Lathyrus niger</i> (rather ab. scat.)
<i>Asperula odorata</i> (loc. in col.)	<i>Lathyrus vernus</i> (scat.)
( <i>Astragalus glycyphyllus</i> )	( <i>Lilium martagon</i> )
<i>Campanula persicifolia</i> (scat.)	<i>Melittis melisophyllum</i> (only
<i>Campanula trachelium</i> (scat.)	scat.)
<i>Convallaria majalis</i> (scat.)	( <i>Myosotis silvatica</i> )
( <i>Daphne mezereum</i> )	<i>Pimpinella magna</i> (only scat.)
<i>Euphorbia amygdaloides</i> (rather	<i>Pulmonaria officinalis</i> (scat.)
ab. scat.)	<i>Salvia glutinosa</i> (scat.)
( <i>Genista tinctoria</i> )	<i>Sanicula europaea</i> (rather scat.)
<i>Heracleum sphondylium</i> (only	<i>Solidago virga aurea</i> (only scat.)
scat.)	<i>Veronica chamaedrys</i> (ab. scat.)
<i>Hieracium barbatum</i> (only scat.)	<i>Veronica officinalis</i> (scat.)
<i>Hieracium murorum</i> (only scat.)	<i>Viola silvatica</i> (only scat.)

This type also cannot be regarded as a climax community; it appears to me, that the influences of oak and, perhaps also, of forest culture manifest themselves here.

## 25. *Sesleria calcaria* sociation (*Fagetum sesleriosum*).

I know this type only from the limestone Western Carpathians where it occurs in places in the zone just below the ridges, normally on the northern slopes. Open *Seslerieta calcariae* here in the beech forest region are frequent on the northern slopes, even in the foothills of the southwestern Carpathians, and penetrate not seldom also into thin beech forests. We find, however, loosened *Seslerieta*, mixed with elements of woodruff and mixed herbaceous beech forest types, in a narrow strip, below the ridges, as for instance in the dolomitic Tematín hills and the Rokoš group. Also *Festuca amethystina* is often scattered here.

Sillinger (2) gave, for the first time, a detailed description and explanation of these *Sesleria* beech forests often with scattered to rather abundant *Quercus sessilis*. I am convinced that these mixed *Sesleria* beech forests, in a narrow strip below the ridges, are a climax community, since the habitat conditions often prevent any further succession here. There, where these beech forests developed as a succession stage of an open *Seslerietum* (respectively of the sociation *Calamagrostidetum variae* or *Calamagrostideto — Festucetum amethystinae*), it is, of course, possible that they will lead in the final succession to some of the usual beech forest types. Often, however, the character of the habitat is of such a kind that we have to consider these *Sesleria* beech forests as stable communities. Sillinger (2) correctly emphasises their sociological individuality which I, myself, can confirm as regards the dolomitic districts of Tematín hills and Rokoš. *Sesleria calcaria* dominates and often forms dense to almost continuous undergrowth with numerous herbs which represent a mixture of *Seslerietum* (resp. of *Calamagrostideta variae*) elements and of beech forest elements. *Festuca amethystina* is a characteristic species of the highest degree. Sillinger records further, as fairly characteristic for the Tematín hills, also *Laserpitium latifolium*, *Chrysanthemum leucanthemum*, *Pimpinella magna*, *Aquilegia longisepala*, *Digitalis ambigua*, to some degree *Epipactis rubiginosa*, and of dealpines *Bupleurum longifolium* and *Pleurospermum austriacum*, whereas the other species (such as *Brachypodium pinnatum*, *Melampyrum cristatum*, *Primula officinalis* var. *canescens*, *Cytisus nigricans*, *Chrysanthemum corymbosum*, *Asperula tinctoria*) this sociation has in common with the *Quercetum lanuginosae* of the southern slopes. The beech forest species are not numerous, with a greater constancy appear *Asarum europaeum*, *Melittis melisophyllum*, *Lathyrus vernus*, *Lilium martagon*, less so *Mercurialis perennis* and *Symphytum tuberosum*.

Regarding the biological spectrum of this sociation, as well as further details, I refer to Sillinger's paper (2).

#### 26. *Festuca silvatica* sociation.

A mountain type, present here and there, chiefly on talus filled in with humus. In a deeper shade, *Festuca silvatica* is usually only

abundantly scattered but reaches a higher dominance in thinned beech forests and on clearings just as *Bromus asper* and *Elymus europaeus*.

The usual mountain type with abundant or abundantly scattered *F. silvatica* can be better joined to the mountain beech forests with abundant tall herbs. Hilitz er (1, p. 19) records it as a distinct type from the beech forests in the neighbourhood of Kdyně in the Český Les Mts., on summits or on southwestern slopes, often in a very thin forest mixed with spruces and maples (*Acer pseudoplatanus*). *Festuca silvatica* is dominant, *Dryopteris filix mas* and *Mercurialis perennis* show a considerable dominance, whereas other species play a minor role (*Asarum europaeum*, *Asperula odorata*, *Bromus asper*, *Cardamine impatiens*, *Epilobium montanum*, *E. angustifolium*, *Geranium Robertianum*, *Hepatica triloba*, *Majanthemum bifolium*, *Oxalis acetosella*, *Poa nemoralis*, *Polygonatum multiflorum*, *Senecio Fuchsii* etc.) Also in the highest zone of Čerchov (Český Les) *Festuca silvatica* is very gregarious.

#### 27, 28. *Milium effusum* and *Brachypodium silvaticum* sociations.

These two types, although physiognomically very characteristic, are sociologically distinct. From the Šumava Mts. I know dense to almost closed growths of *Milium* which, however, can better be considered as variants with local dominance of this grass, than as a well-marked type. Hilitz er (1, p. 15) records the *Milium effusum* type from the beech forests in the neighbourhood of Kdyně (Český Les) on summits with higher light intensity, and states that this type is parallel to the *Festuca silvatica* type but differing in the leading grass. Floristically this type does not essentially differ from the herbaceous beech forest types, the quantitative and physiognomical differences, however, are striking. Beech forest species (*Asarum europaeum*, *Asperula odorata*, *Melica nutans*, *Mercurialis perennis*, *Oxalis acetosella*, *Senecio Fuchsii* etc.) are often present, the *Milium* growth is never completely closed.

The *Brachypodium silvaticum* type occurs only very scattered but combines mostly with some of the above mentioned types (in the Carpathians also with the *Carex pilosa*).

### 29. *Poa nemoralis* sociation.

This type belongs mostly to the transitional oak-beech forest types, sometimes also to the beech-hornbeam forests, may, however, also occur in drier and lighter beech forests (see p. 75).

### 30. *Calamagrostis arundinacea* sociation.

I know this type chiefly from degraded beech forests. Zlatník (<sup>1</sup>, p. 411) records it as characteristic for beech forests of the higher zone of Subcarpathian Russia, on drier places. The *Calamagrostis arundinacea* — *Dryopteris filix mas* type, which Zlatník (<sup>2</sup>) described from the České Středohoří Hills, belongs to basaltic talus, but occurs not only in beech forests but also in a mixed *Quercus-Tilia* forest.

## XII. Bare-floor beech forests (*Fagetum nudum* and *subnudum*).

Beech forests with a non-mossy soil, covered by a thick layer of decaying leaves, without herbaceous undergrowth or with an undergrowth so thin that it is lost in the general aspect, are certainly an interesting ecological problem. The shrubby undergrowth in the bare-floor beech forests is also usually missing or only very scarce, sometimes, however, there is a rich shrubby growth of naturally seeded young beeches. Bare-floor and half-bare-floor beech forests occur very frequently, they even predominate in some of our areas, but in my opinion they cannot be considered as due to a single ecological factor. Sociologically, these bare-floor beech forests are not a distinct sociation, but only a stage of some other sociation or variant, for some reason impoverished in such a manner that the beech remained practically alone. My own experiences seem to favour the idea that the suppression of the herbaceous undergrowth corresponds above all to the thick layer of dry beech-leaves especially when slowly decomposing. This, of course, does not yet explain why this layer remains preserved. Dry and not nutritious (acid) soils as well as shade are also of consequence but in a very unequal manner. The layer of fallen leaves, every season enriched by a new contribution, is a hindrance to the germination of seeds and of spores of bryophytes and to the occasional young seedlings; only fungi can grow here. Bare-

floor beech forests create less favourable edaphic conditions which manifest themselves sometimes by the fact that Hercynian (spruce) elements sometimes take a foothold on the bare-floor and form isolated colonies. In some cases I was able to ascertain the absence of the mycorrhiza layer but this question must yet be worked upon. *Fagetum nudum* is to be found as on limestone so on silicious substrata, on humous and loamy soils. It occurs also in virgin beech forests in a very humid climate and, therefore, deserves special attention.

For the understanding of bare-floor beech forests, I give some examples with explanatory remarks.

1. It is very easy to explain a bare-floor beech forest when the beech is introduced by forest culture (especially on originally spruce areas), or when the shade is very deep in a certain evolutionary stage of a forest where the trees are still young and very dense. On a drier locality, the absence of herbaceous undergrowth is not surprising.

2. I found an interesting and extensive *Fagetum nudum* in the Little Carpathians on Mt. Vysoká, above the hunting-seat Vývrat, on a rather steep slope, at an altitude from about 350 to 550 meters. It is an old, tall-trunk beech forest interspersed with abundant *Acer platanoides* and *A. pseudoplatanus*. In the broad vertical zone, 200 meters wide, there is not a single herb in the undergrowth, but instead there is such an abundance of beech seedlings and of both maples and scattered ash, that this vast number of seedlings imitates a low, green, herbaceous undergrowth. A shrubby undergrowth is missing, even young beeches and maples are scarce, so that it is apparent that the seedlings of these trees, smothered by the thick leaf-carpet, die off yearly. The explanation of this bare-floor beech forest may be looked for mainly in the substrata. That is, here we have a limestone region, where quartzite protrudes, and by its disintegration forms a yellowish brown loam. In one place, higher up on the slope where there is a smaller part of a younger beech forest (old stumps indicate that here also there originally was a high-trunk beech forest) an undergrowth is developed under more favourable light conditions. This undergrowth shows that it is a distinct beech forest sociation and quite different from the usual beech forest types on limestone, and represents a degraded type. The floor is very mossy (*Polytrichum* predominating), the undergrowth is mainly a loose *Luzuletum*

nemorosae with very abundant *Festuca ovina* (*euovina*) so that, in places, it may more properly be designated as a *Festuceto-Luzuletum*. Floristically, this undergrowth is extremely poor, scattered grow here *Deschampsia flexuosa*, *Calamagrostis arundinacea*, *Hieracium murorum*, *H. pilosella*, *Genista pilosa*, *Galium asperum*, only scattered *Poa nemoralis*, *Vaccinium myrtillus*, infrequently *Carex montana*, locally *Antennaria dioica*, and solitary *Platanthera bifolia*. This is, therefore, a typical undergrowth of Hercynian coniferous forests on acid soils and not a single typical beech forest plant is present. We may then observe here a certain analogy to the Hercynian deciduous woods as I have defined them from Central Bohemia. Also, in another part of the same district of the Little Carpathians, I have found, on quartzite, a local growth, belonging to *Fagetum nudum*, having in its upper lighter zone an undergrowth of a low *Myrtilletum* with very abundant *Polytrichum* and again *Festucetum euovinae* with *Luzula nemorosa*, but floristically even poorer.

In these cases the origin of the bare-floor beech forests is clear since we are concerned here with a special sociation brought about edaphically, the elements of which cannot tolerate complete shade and so disappear in old forest growths. Not even mosses can maintain themselves in the thick leaf carpet.

3. In the southwestern foothills of the Carpathians in the Piešťany hills as well as in the dolomitic Tematín hills, beech forests predominate and occupy especially all the northern slopes to the highest ridges. These beech forests belong to several sociations (*Carex pilosa* — *Asperula odorata* predominates), but we often meet here also *Fagetum subnudum*. In this case we cannot explain the latter by the geological substratum nor by the shade, but primarily by the dryness of the soil and by the general climate of a continental character with a low yearly rainfall and a long, warm, dry summer. The dry beech leaves decompose slowly and so form a thick leaf carpet. This very thick layer of half-decayed leaves suppresses the herbaceous undergrowth, the composition of which corresponds to the usual calcicole beech forests at lower altitudes in the Western Carpathians.

4. Even more striking is this phenomenon in the Rokoš group, in the limestone Váh River district of western Slovakia. These dolo-

mitic mountains, reaching beyond 1000 meters alt., are waterless even in the wooded valleys; the fallen leaves do not decay and form a thick leaf carpet, the soil is loamy, non humous, and the bare-floor and half-bare-floor beech forests are widely distributed, representing an impoverished calcicole type (see p. 96). Only in the highest zone of Rokoš and at the bottom of some valleys (for instance between Malé and Kamenné Zrubisko) the soil water conditions are more favourable and support the evolution of a richer herbaceous undergrowth, even of the *Petasites* (see p. 115) and fern types.

5. Especially interesting are the bare-floor beech forests in Subcarpathian Russia where they appear even in old virgin beech forests. An instructive example of such a virgin forest I described in detail (<sup>4</sup>, p. 18—20) from the head of the Velký Trostinec valley, on the slope of Mt. Rivni (730—1000 meters alt.). The virgin forest here is without firs and spruces, only huge maples (*Acer pseudoplatanus*) are rather abundantly scattered. The virgin forest is not very dense, since windfalls and lightning provide for its thinning and old giants, with internally rotten trunks, at times break and fall. Strewn everywhere on the ground are fallen trunks of trees, centuries old; they quickly decompose under the continuous green moss carpet, and finally disappear, merging into the forest soil. The beech (and maple) leaf carpet covers the floor continuously, there are neither mosses nor lichens, only trunks and stumps are more or less overgrown with mosses. On vast areas of this virgin forest, in spite of the very humid climate, there is not a single herb, in other places again we find only a sparse undergrowth. *Lamium luteum* is the most abundant and the leading plant of the undergrowth, when the latter is developed at all. Besides there is a little of *Oxalis acetosella*, only rarely appear *Circaea alpina*, *Epilobium montanum*, *Athyrium filix femina* (in a small form), *Scrophularia nodosa*, but that usually is all. When a little of *Asperula odorata* occurs locally, it is already an approach to a richer type. In places, the scattered *Oxalis* is more abundant than *Lamium luteum* and rarely present are *Dryopteris pulchella* (small colonies), *Anemone nemorosa*, *Dentaria glandulosa*, in the higher zone also *Dentaria bulbifera*, *Viola silvatica*, and especially the characteristic *Ranunculus dentatus*.

The insufficient herbaceous undergrowth and mostly its total absence cannot be explained by the too deep shade, since the shade

on the one hand is not so very deep (the virgin forest is rather thin and in the spring bare), and on the other hand even in the openings we see only naturally seeded young beeches and with them a very sparse to almost no herbaceous undergrowth. Similarly the insufficiency of soil moisture is not the cause explaining the absence of an undergrowth, since we observe that the stumps and logs disappear rapidly and, further, I have found a furrow with a creek, certainly permanent, and yet even in this more humid furrow the higher moisture did not produce a more copious herbaceous growth; only a strip of a blackened leaf carpet indicated the edges of the creek and nearby grew only scattered *Lamium luteum*! In this case, the thick leaf carpet prevents a growth of herbs even in the humid climate (I would estimate the yearly rainfall at 1200 mm at least) and in such a manner an impoverished *Oxalis-Galeobdolon* type arises, decreasing to a complete suppression of any herbaceous undergrowth.

I described (<sup>4</sup>, p. 20—22) also other instances of bare-floor and half-bare floor virgin beech forests from Subcarpathian Russia which seem to confirm the above explanation. There is, for instance above the head of the Bilina potok valley at an altitude of 1000 meters, such a virgin forest, in parts without any undergrowth and in other parts developed as a *Fagetum nudum* of the *Asperula-Galeobdolon-Oxalis* type; *Asperula odorata* is more abundant here than the two other leading species of approximately the same dominance. Of course, bare places, covered by a beech-leaf carpet, predominate; ground mosses are lacking, in the undergrowth young beeches and maples (*Acer pseudoplatanus* and *A. platanoides*) are scattered, together with rare *Sorbus aucuparia*, *Daphne mezereum* and *Rubus* sp. Besides, there are:

( <i>Actaea spicata</i> )	<i>Epilobium montanum</i> (only scat.)
<i>Adoxa moschatellina</i> (only loc.)	<i>Euphorbia carniolica</i> (only scat.)
<i>Anemone nemorosa</i> (only scat.)	( <i>Lactuca muralis</i> )
<i>Athyrium filix femina</i> (rather ab. scat.)	( <i>Paris quadrifolia</i> )
( <i>Doronicum austriacum</i> )	( <i>Polygonatum verticillatum</i> )
( <i>Dryopteris filix mas</i> )	( <i>Polystichum lobatum</i> )
<i>Dryopteris phegopteris</i> (loc.)	( <i>Pulmonaria obscura</i> )
<i>Dryopteris pulchella</i> (loc. scat.)	<i>Ranunculus dentatus</i> (loc. scat.)

(*Salvia glutinosa*, only in scat.     *Stellaria nemorum* (scat.)

col.)

*Symphytum cordatum* (scat.)

6. There, where in a bare-floor beech forest a shrubby growth of young beeches is developed in larger or smaller groups, the continuous thick leaf carpet becomes disturbed and under the protection of these thickets a somewhat richer herbaceous undergrowth is formed. Some such instances I described from Subcarpathian Russia. For example, above the shepherd settlement, Stereša, at an altitude of about 1240 meters, I observed in these beech thickets usually the following species: *Asperula odorata* (rather abundantly scattered), *Anthriscus nitida* (scattered), *Euphorbia carniolica*, *Lamium luteum* (rather abundantly scattered), (*Lilium martagon*), *Oxalis acetosella* (rather abundantly scattered), *Paris quadrifolia* (only scattered), *Polygonatum verticillatum* (only scattered), *Pulmonaria Filarszkyana* (col.), *Rubus* sp. (scattered), (*Rumex arifolius*), *Stellaria nemorum* (scattered), *Symphytum cordatum* (scattered) and *Thalictrum aquilegifolium* (abundantly scattered).

In the virgin beech forest of Mt. Rivni (see p. 142) we find in the young beech thickets, besides *Oxalis acetosella*, *Lamium luteum* and *Dryopteris pulchella*, also *Anemone nemorosa*, *Ranunculus dentatus*, *R. lanuginosus*, *Rubus* sp., *Salvia glutinosa*, *Symphytum cordatum*, and rarely *Actaea spicata* and *Paris quadrifolia*.

In the shrubby beech growth, loose to rather dense, in a half-bare-floor virgin beech forest above the head of the Bilina potok valley at an altitude of about 1000 meters, the following species were present: (*Actaea spicata*), *Anemone nemorosa* (scattered), *Asperula odorata* (scattered), *Athyrium filix femina* (scattered in a small form), (*Circaea alpina*), (*Doronicum austriacum*), *Dryopteris filix mas* (scattered), *D. phegopteris* (scattered), *D. pulchella* (scattered), *Epilobium montanum* and *Lamium luteum* (scattered), *Oxalis acetosella* (scattered), *Polygonatum verticillatum* (scattered), *Polystichum Braunii* (only scattered), *Prenanthes purpurea* (scattered), *Rubus idaeus* (scattered), (*Rubus* sp.), (*Senecio nemorensis*), *Stellaria nemorum* (scattered), *Veronica urticifolia* (scattered), only scattered is young *Acer pseudoplatanus*.

7. On the Mt. Velký Trábec near Nitra, from the 635 meters point up to the summit (829 meters alt.), pure beech forests, exceedingly poor and mostly without any ground vegetation, everywhere predomi-

nate. The causes for the absence of the herbaceous undergrowth are — not to speak of the leaf carpet — sundry: a) poor soil with but a little humus, b) great dryness of the slope, c) a rather deep shade, and d) game destroying the undergrowth. Fungi are abundant, often present are *Strobilomyces*, *Craterellus*, *Hydnum repandum* and many others; on dead trunks *Polyporus fomentarius* grows in great abundance. The herbaceous undergrowth mostly is entirely lacking; I came across some green vegetation only in one lighter place, close to some uprooted trunks, full of *Polipori*. *Sambucus nigra* grows here as well as *Stachys alpina*, *S. silvatica*, *Impatiens noli tangere*, *Senecio Fuchsii*, *Paris quadrifolia*, *Monotropa hypopitys* var. *hypophegea*, rarely *Asperula odorata*, scattered *Dentaria bulbifera*, but further in the dense beech forest we see again only a bare leaf carpet, only in the highest beech forest zone the ground vegetation increases but consists mainly only of *Mercurialis perennis* which occurs here very gregariously, and scattered are *Calamagrostis arundinacea* and *Glechoma hirsuta*.

We recognise this bare-floor beech forest, therefore, as a very impoverished stage of the woodruff sociation.

8. Also on the eruptive, comparatively dry soils of middle Slovakia, bare-floor or half-bare-floor beech forests are very frequent. R. M i k y š k a (1) describes them from the Štiavnické Středohoří Mts. and states that, on an average, more than 90% of the floor is devoid of any ground vegetation. Many species grow here with a diminished prosperity and occur usually isolated, only exceptionally in small clans (*Asperula odorata*, *Asarum europaeum*, *Mercurialis perennis*, *Oxalis acetosella*). The individuals of these bare-floor beech forests usually occupy large areas in this territory; they occur mostly on sloping grounds covered by a thicker continuous leaf carpet, and on drier soils; but exceptions are not very rare. Even though the floristic composition seems to be more or less casual, it is evident that they are only impoverished types of beech forests common in the Štiavnické Středohoří Mts.

### XIII. Degraded and spurious beech forests.

A detailed study of the beech forests in various parts of our state shows that normal beech forests under favourable conditions, even

though they do show far-reaching differences in their undergrowth, agree in that they exclude Hercynian spruce forest elements, especially those of the heath character. Whenever these elements are present, it is usually due to the influence of forest culture, to other antropical agents, to the penetration onto roads and paths, openings and clearings, or sometimes to the quite special habitat conditions, that is to the degradation of the soil, its podzolation and increase in acidity. This degradation, it is true mostly secondary and antropical, may, however, also be natural. Especially near the upper forest limit this phenomenon is sometimes evident, but even here it is often brought about not only by the humid climate but also by the penetration of the spruce; in such a manner a mosaic of two entirely different consociations may arise which is not rarely incorrectly combined into one sociation. *Vaccinium* species always avoid the true beech forests and in the beech forest areas are usually entirely lacking. Their occasional presence may be due to a siliceous substratum forming an acid soil. Thus I noticed, in the Pieštany hills, a mossy *Myrtillum* only in one place on Permian quartzites, whereas in the neighbouring dolomitic Tematin hills, *Vaccinium myrtillus* (of course also *V. vitis idaea*) is entirely missing; in the dolomitic Rokoš group, I discovered *V. myrtillus* only quite locally in the Striebornica valley near Uhrovec on a loamy, non-limy layer, etc. By soil degradation, caused by forest culture, a succession is often produced, leading to these Hercynian types. Since all these types are foreign to true beech forests, I designate the respective beech forests as spurious (*Fagetum spurium*), as a distinct group of sociations, or as degraded (*Fag. degradatum*), inasmuch as there is an evident correlation to the deterioration of soil, eventually also, the bioclimatic conditions.

Already the three first types described by Hilitzer (1, p. 5—7) from the Český Les Mts. in the neighbourhood of Kdyně, belong to impoverished atypical beech forests, brought about by dryness and likely also by antropical influences. They are of the *Majanthemum* type, which in the first case is developed as a *Fagetum nudum* only with very solitarily scattered *Majanthemum bifolium*, *Hieracium murorum*, *H. vulgatum*, *Veronica officinalis*, *Poa nemoralis*. The second case pertains to a thinned beech forest in which solitarily occur also *Calamagrostis epigeios*, *Polygonatum verticillatum*, *Epipactis latifolia* and *Pirola secunda*. The third table, the result of 10 analyses

on the ridge below Koráb (at about 730 meters altitude) and one on Mt. Herštý, represents best this *Majanthemum* type in which the leading species shows the greatest dominance; it is constantly accompanied by *Hieracium murorum*, sometimes by *Poa nemoralis* and occasionally by some other species, mostly of the beech forests.

Also the *Oxalis Majanthemum* type, described by Klika (1, p. 49) from the Velká Fatra Mts., is already a rather impoverished beech forest type of more xerophytic character and floristically poor. Of grasses, *Poa nemoralis* is characteristic, sometimes even *Vaccinium myrtillus* is present, indicating less favourable soil conditions.

Another type of beech forests from the Velká Fatra Mts. which Klika (1 c.) quotes under Cajander's name «*Oxalis-myrtillus-nigra*» corresponds already to acid raw humus. Analysis no. 7 from an altitude of 950 meters (with *Petasites albus* and *Impatiens noli tangere*) indicates, of course, a mixed herbaceous type; analysis no. 10. from an altitude of 1000 meters is more typical, in it occur also *Majanthemum*, *Calamagrostis villosa* and *Festuca silvatica*.

From the Krkonoše Mts. Zlatník (2) described the following three types which clearly belong to spurious beech forests. They are:

**Struthiopteris spicant — Homogyne type** («Fagetum blechnosum spicant» (in which grow with a constancy 5 *Vaccinium myrtillus*, *Struthiopteris spicant*, *Homogyne alpina*, *Dryopteris spinulosa* + *austriaca*, *Oxalis acetosella*, with a constancy 4 *Picea excelsa*, *Athyrium filix femina*, *Calamagrostis villosa*, *Gentiana asclepiadea*, *Hieracium murorum*, *Majanthemum bifolium*, *Dryopteris phegopteris*, *D. Pulchella*, *Polygonatum verticillatum*, *Prenanthes purpurea*, *Senecio nemorensis* — *Fuchsii*, *Polytrichum formosum*).

The **Calamagrostis villosa type** (Fagetum calamagrostidetum villosae), in which occur with a constancy 5 *Picea excelsa*, *Athyrium filix femina*, *Calamagrostis villosa*, *Dryopteris austriaca* + *spinulosa*, *Oxalis acetosella*, *Prenanthes purpurea*, with a constancy 4 *Sorbus aucuparia*, *Vaccinium myrtillus*, *Gentiana asclepiadea*, *Homogyne alpina*.

The **Vaccinium myrtillus — Calamagrostis villosa type** (Fagetum myrtillosum cum Calamagrostis villosa), in which grow with a constancy 5 *Picea excelsa*, *Vaccinium myrtillus*, *Athyrium filix femina*, *Homogyne alpina*, *Majanthemum bifolium*,

*Dryopteris austriaca* + *spinulosa*, *Oxalis acetosella*, *Calamagrostis villosa* (with a constancy 4), *Dryopteris pulchella*, *Lycopodium annotinum*, *Polygonatum verticillatum*, *Prenanthes purpurea*.

Also Zlatník's third type, *Dryopteris pulchella* — *Oxalis* (see also p. 120), belongs to atypical beech forest types approaching the spruce forests.

The woodruff type, common in our beech forests in very numerous variants, goes over sometimes into the impoverished *Galeobdolon-Oxalis* type. Two variants from Subcarpathian Russia I have described above (p. 101). Also the *Luzula nemorosa* type (see p. 133) belongs to the impoverished types; it is not, however, of wide distribution in our beech forests. The *Myrtillus* type always belongs into this category and cannot be added to the *Fagetum verum*. *Vaccinium myrtillus* penetrates into beech forests on acid humous soils, often using stumps and decomposing logs as a starting point (Domin<sup>5</sup>). Usually it takes foothold only on isolated spots as we may observe, for instance in the virgin beech forests of Subcarpathian Russia, where locally even small *Myrtillaeta* occur with their accompanying species; among these we sometimes find also two typical Eastern Carpathian spruce forest elements, *Hieracium transsilvaticum* and *Aposeris foetida* incorrectly attributed by some authors to the beech forests. If the beech forest is interspersed with spruces, the origin of such colonies is sometimes favoured by the acid spruce humus. If the spruces are more abundant and aggregated into groups or even small growths, two sociations, beech and spruce, sometimes intermingle in the undergrowth. From the sociological as well as the ecological standpoints, we must strictly distinguish these two sociations even when they are intermixed. Such analyses which combine elements of both sociations, misrepresent, of course, the true character of the beech forest undergrowth.

To the spurious beech forests I count also mixed deciduous forests with predominating oaks (respectively hornbeam) in which beeches are more or less scattered, but their influence is to be seen in the composition of the undergrowth. With such forests, which are in reality only in their ground vegetation of a beech forest character, I am familiar, for instance, from the dolomitic Tematín hills and the Mt. Rokoš, where such a forest is developed as

a *Quercetum lanuginosae* (with scattered *Fagus*, *Quercus cerris*, *Quercus sessilis*). Analogous examples Mikyška gives from the eruptive rocks (mostly andesites) in the Štiavnické Středohoří Mts. where, however, *Quercus robur* is the dominant tree.

From a sociological standpoint, we may distinguish in this category besides the sociations already described (as for instance *Oxalis-Galeobdolon*, *Luzula nemorosa* sociations) especially the following:

1. *Majanthemum* sociation.

2. *Festuca ovina* — *Luzula nemorosa* sociation (see p. 141).

3. *Myrtillus-Homogyne* sociation, to the Sudetic-Hercynian facies of which two variants belong, namely *Struthiopteris spicant* and *Calamagrostis villosa* described by Zlatník from the Krkonoše Mts. and besides also Western Carpathian and Eastern Carpathian facies, regionally specific species of the latter are *Aposeris foetida*, *Hieracium transsilvanicum*, *Campanula abietina*.

4. *Calamagrostis villosa* sociation, as for instance described from the Krkonoše Mts. by Zlatník.

#### XIV. Spore plants.

In typical beech forests, the ground is wholly or practically destitute of mosses. We find them, however, on the roots, trunks, and stumps of beeches and not seldom even on stones where the soil is stony. Likewise the humid to damp beech communities are sometimes mossy (see p. 117) as may also be the «spruce» types of spurious beech forests. The epiphytic vegetation of mosses, lichens, and algae however, is usually very interesting and has been in some regions of Bohemia thoroughly studied by A. Hilitzer (2) who deals in great detail also with the ecological factors and distinguishes many sociations, some of which are specific for the beech. As far as the local distribution of these sociations on the trunk itself is concerned, we find on the beech usually on the trunk base the sociations *Pyrenula nitida*, *Thelotrema lepadinum* or *Pertusaria amara*, in the middle part of the trunk *Parmelia saxatilis* sociation, and on the upper part the *Evernia prunastri* sociation. Sometimes we notice on the base a differentiation of moss and lichen sociations, for instance on beech roots the sociation *Isothecium myurum* or *Pteriginandrum filiforme*, on the trunk base *Thelotrema lepadinum* or

*Graphis scripta* sociation, in the middle part of the trunk *Parmelia saxatilis* or *Cetraria glauca* sociation, in the upper part *Alectoria jubata* sociation.

In the most simple case, there is on the trunk only one epiphytic sociation and that of indifferent sociations *Parmelia physodes* or *Protococcus viridis*, of sociations characteristic for the beech *Lecanora subfusca* + *Phlyctis* or *Parmelia saxatilis*. Sometimes the epiphytic vegetation is restricted to only one side of the trunk, in other instances it is on both sides, in which case at the same height the following differentiation may be observed.

*Fagus*

Exposed side: sociation	Protected side: sociation
<i>Parmelia physodes</i>	<i>Algae</i>
<i>Parmelia saxatilis</i>	<i>Lecidea parasema</i>
<i>Cetraria glauca</i>	<i>Lecanora subfusca</i>
<i>Lobaria pulmonaria</i>	<i>Parmelia sulcata</i>
<i>Pyrenula nitida</i>	<i>Trentepohlia</i> .

As examples of differentiation of the epiphytic sociations on beech Hilitzer gives the following:

1. *Beeches in the virgin forest of Boubin in the Šumava Mts.*  
 base: *Isothecium myurum* sociation;  
 lower part of trunk and protected side of the middle part: *Thelotrema lepadinum* sociation;  
 middle part of trunk, exposed side: *Lobaria pulmonaria* sociation;  
 upper part of trunk: *Parmelia saxatilis* sociation;  
 branches: *Alectoria jubata* sociation.
2. *Beeches in an old beech forest near Kdyně in Český Les Mts.*  
 base: *Dicranum longifolium* sociation;  
 lower part of trunk: *Pyrenula nitida* sociation;  
 upper part of trunk, exposed side: *Parmelia saxatilis* sociation;  
 upper part of trunk, protected side: *Lecanora subfusca*.

As a typical succession of the epiphytic sociations in the pure beech forests, Hilitzer gives this scheme:

Base	Exposed side	Protected side
<i>Parmeliopsis ambigua</i> mosses	<i>Lecanora subfusca</i> <i>Phlyctis</i> <i>Parmelia saxatilis</i> mosses and <i>Lobaria</i>	<i>Lecanora-Phlyctis</i> <i>Parmelia saxatilis</i>

In his paper on the beech forests in the neighbourhood of Kdyně, Hilitzer (4) describes in detail the epiphytic vegetation of mosses and lichens and distinguishes 21 sociations as accompanying sociations of beech forests.

Very characteristic and different from that of the spruce forests is the mycoflora of the beech forests, especially as regards *Hymenomycetinae*. Numerous contributions on the fungi of our beech forests have been published, but notwithstanding, it is not possible at present to make a sociological analysis of the beech forest mycoflora of the whole state.

#### XV. Exclusive species of beech forests.

Beech forests are one of the rather exceptional communities in which we may perhaps distinguish faithful (exclusive) species, although even here the number of the absolutely exclusive species is insignificant when taking the whole Czechoslovak republic into consideration. Under special conditions, many beech forest species go over also into other sociations, however, avoid spruce forests with acid soils; many are at home in mixed spruce forests with fir, maple, and beech. Many species, and even whole communities, especially *Caricetum pilosae* and *Melicetum uniflorae*, penetrate beyond the limits of beech forests into mixed oak and hornbeam forests. Nevertheless, a rather great number of species is more or less confined to beech forests and these species may by therefore designated as beech forest species. With regard to the whole territory of our state, we can classify these species into three categories according to their more or less frequent occurrence outside of the beech forests. The exclusive species of the beech forests are given in the first group.

##### A. Especially characteristic beech forest species.

*Asperula odorata* (generally in our beech forests, on all kinds of geological substrata, from foothills up to the mountain region).

*Arabis turrata* (a calcicole Carpathian species).  
*Atropa belladonna* (in the whole region).  
*Cynoglossum montanum* (a calciphilous Carpathian species).  
*Dactylis Aschersoniana* (generally, most abundant in the Western Carpathians).  
*Elymus europaeus* (in the whole region).  
*Fraxinus excelsior* (mainly in the Carpathians).  
*Hacquetia epipactis* (a Carpathian species).  
*Hesperis nivea* (a Carpathian species).  
*Phyllitis scolopendrium* (a calciphilous Carpathian species, also on Flysch in Subcarpathian Russia).  
*Polystichum Braunii* (chiefly in the Carpathians).  
*Polystichum Luerksenii* (Eastern Carpathians).  
*Scopolia atropoides* (Eastern Carpathians, also Pienines.).

**B. Rather characteristic beech forest species.**

*Acer platanoides* (in the whole region).  
*Acer pseudoplatanus* (in the whole region).  
*Aconitum vulparia* (generally, with preference on limestone soils).  
*Actaea spicata* (in the whole region).  
*Allium ursinum* (in the Carpathians more frequent than in the Sudetic-Hercynian region).  
*Anthriscus nitida* (in the whole region, more frequent in the Carpathians).  
*Aquilegia longisepala* (in the Western Carpathians, otherwise in the whole region the closely allied *A. vulgaris* (scattered)).  
*Arabis pauciflora* (only here and there).  
*Arum maculatum* (more frequent in the Carpathian region).  
*Bromus asper* (in the whole region).  
*Cardamine trifolia* (from southern Bohemia to Slovakia).  
*Carex alba* (Carpathians).  
*Carex digitata* (common in the whole region).  
*Carex pilosa* (Carpathians, penetrates, however, as far as Central Bohemia).  
*Cephalanthera ensifolia* (in the whole region scattered).  
*Cephalanthera rubra* (in the whole region, most abundant on limestone in the Western Carpathians).

- Cyclamen europaeum* (rarely in the Western Carpathians and in Moravia).
- Cypripedium calceolus* (only scattered in the whole region).
- Daphne mezereum* (in the whole region).
- Dentaria bulbifera* (in the whole region).
- Dentaria glandulosa* (Carpathians, westwards towards Olomouc).
- Dentaria enneaphyllos* (in the whole region, more frequent westwards).
- Epipactis microphylla* (a Western Carpathian type).
- Epipogon aphyllus* (rare except the Carpathian region).
- Erythronium dens canis* (Eastern Carpathians, also Medník on Sázava in Bohemia).
- Euphorbia amygdaloides* (rare except the Carpathian region).
- Euphorbia carniolica* (An Eastern Carpathian species, but here also in the polonines).
- Festuca silvatica* (in the whole region).
- Galanthus nivalis* (in beech forests chiefly in the Carpathian region).
- Geranium phaeum* (becoming rare towards the West).
- Geum aleppicum* (Carpathians, penetrates westwards to the Českomoravská vysočina Mts.).
- Glechoma hirsuta* (a Carpathian species, westwards to Jihlava).
- Hedera helix* (in the whole region).
- Helleborus purpurascens* (Eastern Carpathians).
- Isopyrum thalictroides* (common in the Carpathians, becoming rare in the Sudetic-Hercynian region).
- Lamium luteum* (common in the whole region).
- Lonicera nigra* (in the whole region, abundant at higher altitudes).
- Lunaria rediviva* (in the whole region).
- Melica uniflora* (in the whole region, more frequent in the Carpathian part).
- Mercurialis perennis* (common in the whole region).
- Milium effusum* (in the whole region frequent).
- Oryzopsis virescens* (southwestern Carpathians).
- Parietaria officinalis* (in beech forests, in the Western Carpathians).
- Petasites albus* (in the whole region frequent).
- Polistichum lobatum* (in the whole region).
- Primula vulgaris* (Carpathians).

*Pulmonaria Filarszkyana* (Eastern Carpathians).  
*Ranunculus cassubicus* (abundant in the whole region).  
*Ranunculus dentatus* (An Eastern Carpathian species, but here also  
in the polonines).  
*Sanicula europaea* (in the whole region abundant).  
*Symphytum cordatum* (an Eastern Carpathian species, penetrating  
westwards into the Pieniny Mts. and the Tatras of Biela).  
*Ulmus scabra* (in the whole region).  
*Valeriana sambucifolia* (in the whole region).  
*Verbascum lanatum* (Eastern Carpathians).  
*Veronica montana* (in the whole region).  
*Veronica urticifolia* (Eastern Carpathians).  
*Vinca minor* (only scattered in the whole region).  
*Viola mirabilis* (in the whole region).

**C. Less characteristic beech forest species.**

*Aconitum moldavicum* (Carpathians).  
*Adoxa moschattelina* (in the whole region).  
*Anemone nemorosa* (in the whole region).  
*Brachypodium silvaticum* (in the whole region).  
*Bupleurum longifolium* (in the whole region, chiefly on limestone).  
*Campanula latifolia* (very scattered).  
*Cardamine impatiens* (abundant in the whole region).  
*Carex silvatica* (frequent in the whole region).  
*Cephalanthera alba* (in the whole region).  
*Circaea alpina* (in the whole region).  
*Circaea lutetiana* (in the whole region).  
*Coralliorrhiza trifida* (in the whole region, in the Carpathians, how-  
ever, often in spruce forests).  
*Cortusa Matthiolii* (a Carpathian limestone type with an isolated lo-  
cality in the Moravian Karst district).  
*Dipsacus pilosus* (very scattered, more frequent in the Carpathian  
region).  
*Epilobium montanum* (common in the whole region).  
*Galeopsis grandiflora* (in the whole region).  
*Galium Schultesii* (rare with exception of the Carpathian region).  
*Geranium Robertianum* (common in the whole region).

*Hepatica triloba* (more frequent in the Sudetic-Hercynian part).  
*Knautia silvatica* (scattered in the whole region).  
*Lactuca muralis* (common in the whole region).  
*Lilium martagon* (abundantly scattered in the whole region).  
*Mulgedium alpinum* (in the whole region at higher altitudes).  
*Orobanche flava* (Carpathians, upon *Petasites albus*).  
*Polygonatum verticillatum* (in the whole region, especially in mountains).  
*Polystichum lonchitis* (in the beech forests, only on limestone in the Carpathians rather frequent).  
*Prenanthes purpurea* (in the whole region).  
*Rubus idaeus* (common in the whole region).  
*Rubus saxatilis* (scattered in the whole region, in the Western Carpathians very abundant).  
*Salvia glutinosa* (mainly in the Carpathians, besides in southern Bohemia in the Vltava River valley).  
*Scrophularia Scopolii* (in the Carpathians and in Jeseníky).  
*Senecio Fuchsii* and *S. nemorensis* (abundant in the whole region).  
*Spiraea media* (a Carpathian species, in beech forests only in Subcarpathian Russia).  
*Staphylea pinnata* (scattered, chiefly in the Carpathians).  
*Symphytum tuberosum* (abundant in the whole region).  
*Urtica dioica* (common in the whole region).  
*Viola silvatica* (abundant in the whole region).

#### XVI. Mixed forests with beech.

Beech forests, themselves, may be more or less mixed, in which case evidently the fir and the maple (*Acer pseudoplatanus*) agree with the beech better than the spruce, as the latter sometimes influences the undergrowth, even in small groups, and can even give rise to fragments of various spruce types: Solitarily scattered spruces, however, do not disturb the sociological character of the beech forest.

In estimating mixed forests where the beech is only interspersed, great care must be exercised because of the influence of forest culture. It is, however, quite doubtless that there exist, in our country, mixed forests with beech not only as transitional types but also as distinct sociations. Mountain spruce forests (as well as spruce — fir

forests) with interspersed beech and maple (*A. pseudoplatanus*) are known in calcicole (for instance in the Tatras of Biela and in the Fatra) as well as in silicicole sociations. To the latter type belongs, for instance, as an Eastern Carpathian facies the *Piceetum* sociation *Mercurialis — Petasites albus*, which I described from Subcarpathian Russia (<sup>4</sup>, p. 31).

In this general study we cannot deal with the question of which beech forest species grow in these coniferous forests because this would lead to a long discussion on the distribution of beech forest species in other sociations. The number of species that are not confined to beech forests alone is very great and many of them pass also over into the *Mugheta* (especially so into the *Mughetum calcicolum* sociations).

A very interesting sociation, where the beech sometimes dominates, sometimes again appears only interspersed or locally, or even disappears, are the mixed ridge forests (*Fagetum fraxineum mixtum*) that are best developed on the limestone ridges of the southwestern Carpathians. In them *Fraxinus excelsior* is native (sometimes even dominant), of other trees especially *Ulmus scabra*, *Tilia platyphylla*, *Acer pseudoplatanus*, *A. platanoides*, also *A. campestre* and *Carpinus betulus*. Their undergrowth is mostly the same as in the beech forests, but there are also some special species.

Another distinct sociation is represented by mixed deciduous forests that form a sort of continuation and projection of the beech forests proper into the lower and warmer hill country, where they occupy the cooler and more humid northern slopes. In these forests, rather numerous mountain elements penetrate into very low altitudes. In Bohemia, these mixed deciduous woods containing mountain elements spread from the region of the Berounka River and Karlštejn, where locally also beech forests are developed, in the direction, and almost to, Praha. I described them in detail from the Radotín valley (<sup>7</sup>, p. 15—18). They are composed of *Fagus*, *Tilia platyphylla*, *Acer pseudoplatanus*, *A. platanoides*, *Carpinus betulus*; interspersed is also oak (*Quercus sessilis* and *Q. robur*), in the shrubby stratum appear *Daphne mezereum*, *Sorbus torminalis*, *S. aria*, *Corylus avellana*, *Cornus mas*, *Berberis vulgaris*, *Viburnum opulus*. Of constant species are especially noteworthy *Arabis pauciflora*, *Aconitum vulparia*, *Bromus asper*, *Bupleurum longifolium*, *Dactylis Aschersonia-*

na, *Lilium martagon*, *Viola mirabilis*. A high constancy (of 4—10) show, besides, the following species: *Anemone nemorosa*, *Arabis hirsuta*, *Astragalus glycyphyllos*, *Asarum europaeum*, *Campanula persicifolia*, *C. trachelium*, *Carex digitata*, *Cephalanthera alba*, *Chrysanthemum corymbosum*, *Convallaria majalis*, *Galium silvaticum*, *Hepatica triloba*, *Hypericum hirsutum*, *Lamium luteum*, *Melampyrum nemorosum*, *Melica nutans*, *Mercurialis perennis*, *Poa nemoralis*, *Primula officinalis*, *Pulmonaria obscura*, and *Stellaria holostea*. Many other beech elements (*Actaea spicata*, *Dentaria bulbifera*, *Impatiens noli tangere*, *Symphytum tuberosum*, etc.) are occasional, *Asperula odorata*, the most faithful beech species, however, is missing, wherein there is a very important distinction from the beech forests proper.

Also, the mixed oak forests and hornbeam woods of the most southern Slovakia, where we usually find sociations very similar to those of the beech forests (even *Caricetum pilosae*), are destitute of *Asperula odorata*.

#### XVII. Exploitation of the beech forest and effects of grazing in the forest.

The far-reaching influence of forest culture on habitat and growth, I described in detail elsewhere (1). In the historical countries of our republic its influence is far more prominent than in the Carpathian region, since in the former, the original forest growths went through a radical change due to forest culture, whereby beech and mixed forests, especially, were involved.

Clear felling and regular culture of young trees of the same age have a bad influence on undergrowth and on natural regeneration even if the original tree species were retained. By the effects of forest culture, light and soil conditions were changed and we often observe a deterioration of soil inasmuch as the mould is gradually changing into acid raw humus and the podzolization of the soil is steadily progressing. Artificial coniferous forests, of course, destroy the beech undergrowth much more than any other factor.

In the Carpathian beech forests, we often have to reckon with grazing in the forest as a further destructive factor. Its effects vary according to circumstances; often it causes deterioration of soil, decrease of beech elements and invasion of foreign species into the

beech undergrowth. A classic example of this kind I have published (4, p. 22) from Subcarpathian Russia, where there exists along the upper forest limit a strip of forest protected by law but where grazing is permitted. These uppermost beech forests possess normally a very rich and typical undergrowth that can be, however, completely destroyed by cattle grazing. So we find, for instance, near the creek Svidovec between Sterešora and the shepherd settlement, Dragobrat, at an altitude of 1200 meters, on the northern side, a pure beech forest where on the ground stamped by cattle, the following species are growing:

<i>Anemone nemorosa</i> (scat.)	* <i>Fragaria vesca</i> (scat.)
* <i>Aposeris foetida</i> (v. ab.!)	<i>Luzula silvatica</i> (only scat.)
* <i>Brunella vulgaris</i> (scat.)	* <i>Myosotis palustris</i> (scat.)
* <i>Caltha laeta</i> (scat.)	<i>Oxalis acetosella</i> (scat.)
<i>Carex silvatica</i> (rather ab., loc. also greg.)	* <i>Parnassia palustris</i> (scat.)
<i>Daphne mezereum</i> (scat.)	* <i>Poa annua</i> (ab. scat.)
<i>Dentaria bulbifera</i> (scat.)	<i>Polystichum Braunii</i> (rarely)
<i>Dryopteris pulchella</i> (loc.)	<i>Rubus idaeus</i> (rarely)
<i>Epilobium montanum</i> (only scat.)	<i>Senecio nemorensis</i> (scat.)
	* <i>Vaccinium myrtyllus</i> (scat.)
	* <i>Veronica officinalis</i> (scat.)

It is obvious that the beech undergrowth underwent a radical change, the most faithful species accompanying the adjoining beech forests are missing, whereas a good many new species (marked with an asterick) made their appearance, among which there is an increasing number of hygrophylous species. This remarkable fact can be explained by the loamy soil, trodden on and trampled by cattle and thus deprived of humus and of a leaf carpet, and consequently becoming considerably more humid.

### XVIII. Succession.

As a climax forest community, the beech forests do not undergo, at present, a further succession and I do not know of a single case in which a beech forest gave way, without human influence, to a spruce forest or on the contrary a spruce forest yielded to a beech forest. It is true, that in forests where beech and coniferous trees are mixed, the mutual relation of woody plants during a few gene-

rations may undergo changes which certainly make themselves apparent also in the undergrowth; but here it is more or less only a question of oscillation which does not lead to the ultimate extinction of the beech forest. Transitional types between beech forests and other forests cannot be regarded as stages of succession, because as far as these are not the product of forest culture, they correspond to the habitat. Under *optimal* climatic conditions, the beech forest thrives, without regard to the exposure, all over the mountains from the foot to the tree limit or to the narrow strip of mountain spruce forest forming the forest limit. But there are regions where only special habitats agree with the beech and where beech forests are in close contact with other forest communities. I draw attention to the southwestern foothills of the Carpathians, where beech forests cover the southern slopes to the ridges and oak forests (mostly *Quercetum lanuginosae*) with steppe plant communities (in the first place *Caricetum humilis*, but even small *Stipeta* are not missing), take possession of the southern slopes to the ridges. Here, then, the decision lies in the microclimatic conditions and we are compelled to acknowledge two climaxes, represented by two ecologically and floristically antagonistic forest communities.

Geomorphological formation of the terrain, however, gives rise to habitats of an intermediate character which enables the two forest types, with their accompanying plant communities, to intermingle. These mixed oak — beech forests can be stable, sometimes, however, they lead, in the following succession, to the predominance of one of the communities. But even in this case it is not a question of a succession in a certain direction. The decrease of beech forests from South to Central Bohemia is due to climatic factors.

In mountainous South Bohemia, where the climate is rougher and more humid, beech forests appear on places of various exposure, in the southern part of Central Bohemia they are to be found nearly without exception only in localities with a more or less northern exposure, while towards Praha, on foothills with a warm and dry climate, beech forests disappear, and on the northern slopes they are replaced by mixed deciduous forests with beech and with rather numerous mountain elements in the undergrowth.

On limestone or dolomite in western Slovakia, there originates, in open places of beech forests, rather often *Calamagrosti-*

*detum variae* and also, especially along ridges and at the foot of rocks, *Seslerietum calcariae*. The first of these communities arise also on clearings created without human influence, but in the next succession the beech regains its footing and the characteristic grassy sociation disappears. In a thin beech forest, replacing a one time *Calamagrostidetum variae*, sometimes the leading grass is still abundantly scattered, disappears, however, completely in the next succession. *Seslerieta*, likewise, can be overgrown by beeches and then they either vanish or they combine with beech elements and form the above described characteristic sociation.

Of less interest is the succession brought about by antropical influences. In our Sudetic-Hercynian region especially, forest culture decimated the original beech forests as well as the mixed forests containing beech and substituted for them mostly cultivated spruce or pine forests. In my book on the Brdy Mts. (1), I gathered data on the change which the forests in Bohemia underwent from historic times to the present. Subfossil findings in Bohemian travertines prove, likewise, the correctness of my deductions, based on historical and geobotanical data.

As a special method for the determination of the original forest types, I have emphasised the study of relic localities and of the remains of beech undergrowth, since this method has proved to be of utmost importance for the reconstruction of the plant covering modified by antropical influences. In cultivated forests, these locally (very often in small clans) preserved species represent the best and often the only indication of the original forest growth. The great significance of even small colonies, as a consequence of the deterioration of the habitat conditions, I have shown by concrete examples. Rather considerable changes occurred in the Hercynian Brdy Mts. in the course of thirty years.

The original undergrowth of beech or mixed forests practically vanished, until at last, in some cases, the Hercynian spruce undergrowth took complete possession of the ground. We have here, therefore, in the forest undergrowth, the following succession due to antropical influence:

Fagetum asperulaceum herbosum (original plant community). Further stages are:

- a) The beech undergrowth is getting poorer, the number of indifferent forest species increases.
- b) Of the beech undergrowth, there remains exceedingly little, newcomers are *Calamagrostis arundinacea*, *Luzula nemorosa* and others, *Vaccinia*, *Deschampsia flexuosa* are still lacking.
- c) In the further succession, there arises a *Luzula nemorosa* or *Calamagrostis arundinacea* type, or *Vaccinium myrtillus*, *Deschampsia flexuosa*, and *Festuca ovina* appear, and a spruce undergrowth is finally established. Beech species vanish either completely or are preserved as locally restricted relics. The original rich humus is gradually reduced to acid raw humus, the soil is strongly podzolated, occasionally even an ortstein layer is formed.

Sometimes in cultivated coniferous forests, the beech undergrowth holds its ground for a long period. Thus, I ascertained near Strakonice, on a limestone ridge near Tisovník, in a humous tall-trunk coniferous (mostly spruce) forest, this undergrowth: of beech forest species (and that of deciduous woods), *Cornus sanguinea* (scattered), *Cephalanthera rubra* (v. ab!), *C. alba* (only scattered), *Monotropa hypopitys* (only scattered), *Epilobium montanum* (scattered), *Mercurialis perennis* (abundant!), *Epipactis rubiginosa* (rather scattered), *Hedera helix* (rather scattered), *Aquilegia vulgaris* (only scattered), *Melica nutans* (only scattered), *Athyrium filix femina* (scattered), *Convallaria majalis* (scattered), but also there grow *Luzula nemorosa* (inabundant), *Juniperus communis*, *Scabiosa columbaria*, *Pirola secunda* (abundant), *Polygonatum officinale* (only scattered), *Veronica teucrium* (scattered), and *Calamintha clinopodium*.

On Mt. Svát near Sušice there are, on archaean substratum, pure or practically pure, very humous and shady, rather humid, fir forests, which doubtlessly stand in place of the original beech forest. Beeches are only quite solitary, spruce is interspersed but forms, in places, even growths. In the shrubby undergrowth *Daphne mezereum* grows very rarely, *Sambucus ebulus* very locally, *S. racemosa* on light places. The undergrowth is composed as follows:

<i>Actaea spicata</i> (ab. scat.)	<i>Melica nutans</i> (rather ab.)
<i>Anemone nemorosa</i> (scat.)	<i>Mercurialis perennis</i> (ab.)
<i>Arabis arenosa</i> (ab. scat.)	<i>Moehringia trinervia</i> (scat.)
<i>Asperula odorata</i> (on more places greg., but with diminished prosperity)	<i>Neottia nidus avis</i> (only v. scat.)
<i>Asplenium trichomanes</i> (v. scat.)	<i>Oxalis acetosella</i> (only loc. but greg.)
<i>Dryopteris filix mas</i> (ab.)	<i>Pirola secunda</i> (scat.)
<i>Hedera helix</i> (only loc.)	<i>Pulmonaria obscura</i> (scat.)
<i>Hepatica triloba</i> (scat.)	<i>Veronica chamaedrys</i> (scat.)
<i>Lactuca muralis</i> (scat.)	<i>Vicia pisiformis</i> (v. scat.)
<i>Lathyrus vernus</i> (ab. scat.)	<i>Vicia sepium</i> (scat.)
<i>Luzula pilosa</i> (loc. rather ab.)	<i>Vicia silvatica</i> (very ab.)

We notice that in this case the undergrowth of the coniferous forest is the same as in beech forests. When we find, in the coniferous (spruce) forest (in places abundantly interspersed with hornbeam) at the beginning of the Kamenické údolí valley opposite Klášterec in the district of the Sázava river, a plant community containing *Asperula odorata* (ab.), *Actaea spicata*, *Asarum europaeum*, *Epilobium montanum*, *Hepatica triloba*, *Lactuca muralis*, *Lamium luteum*, *Luzula pilosa*, *L. nemorosa*, *Melica nutans*, *Neottia nidus avis*, *Oxalis acetosella*, *Pulmonaria obscura*, *Viola silvatica*, it is a sure sign that here the original tree was the beech.

It is clear that not all of the above enumerated sociations of our beech forests are climaxes, though the beech forest itself is, in every case, a climax or subclimax.

I have already <sup>(2)</sup> expressed my opinion on the relations between the Carpathian and Sudetic-Hercynian beech forests. It may, therefore, suffice to say that the latter represent an only floristically impoverished type of the Carpathian beech forests, even if some species (for instance *Galium silvaticum*, *Hepatica triloba*) have their main distribution in the first named region.

### Additional remarks.

In May 1931 I had opportunity to analyse many beech wood types in southern Subcarpathian Russia. Of utmost interest are some beech woods at very low altitudes; so there are, for instance, near Chust, above the river Tisa, hills covered with natural beech woods which, at an altitude of 165 meters, show distinctly mountainous character. Thus, on the foot of Kobyla (615 m), at an altitude of 165 m, I found close to the river Tisa an old virgin beech forest, mixed with *Fraxinus excelsior*, *Ulmus montana*, *Acer campestre*, *A. pseudoplatanus*, *A. platanoides*, *Tilia ulmifolia*, *T. platyphylla*, *Corylus avellana* (in tree form). In a ravine near the river the soil is wet, and covered with a continuous luxuriant herbaceous undergrowth of the following composition:

<i>Aegopodium podagraria</i> scat.	<i>Impatiens noli tangere</i> very ab.
<i>Aruncus silvester</i> ab.	<i>Lamium luteum</i> ab.
<i>Asarum europaeum</i> ab. scat.	<i>Lunaria rediviva</i> ab.
<i>Asperula odorata</i> ab.	<i>Melandryum silvestre</i> scat.
<i>Carex silvatica</i> scat.	<i>Mercurialis perennis</i> ab. scat.
<i>Cerastium silvaticum</i> scat.	<i>Milium effusum</i> ab. scat.
<i>Chaerophyllum aromaticum</i> scat.	<i>Myosotis palustris</i> scat.
<i>Chelidonium majus</i> only scat.	<i>Oxalis acetosella</i> only scat. in
<i>Chrysosplenium alternifolium</i>	small col.
scat.	<i>Phyllitis scolopendrium</i> scat.
<i>Circaea lutetiana</i> scat.	<i>Polygonatum multiflorum</i> ab. scat.
<i>Corydalis fabacea</i> scat.	<i>Polystichum lobatum</i> scat.
<i>Dentaria glandulosa</i> ab. scat.	<i>Polystichum Braunii</i> scat.
<i>Dentaria bulbifera</i> scat.	<i>Salvia glutinosa</i> scat.
<i>Dipsacus pilosus</i> loc. in col.	<i>Scopolia carniolica</i> greg.
<i>Doronicum austriacum</i> ab.	<i>Stachys silvatica</i> scat.
<i>Dryopteris filix mas</i> scat.	<i>Stellaria nemorum</i> scat.
<i>Epilobium montanum</i> only scat.	<i>Symphytum cordatum</i> very ab.
<i>Ficaria verna</i> in col.	<i>Symphytum tuberosum</i> only scat.
<i>Galium Schultesii</i> ab. enough	<i>Symphytum cordatum</i> × <i>tubero-</i>
<i>Geranium Robertianum</i> only	sum scat.
scat.	<i>Veronica urticifolia</i> ab. scat.
<i>Glechoma hirsuta</i> ab. enough	

On a northern slope of a low range between Berehovo and Čop there is near Zapsoň a natural beech wood descending to about 110 meters altitude.

In our Eastern Carpathians beech forests with dominant *Aposeris foetida* are scattered. They seem to indicate a more acid soil and occur either in damp humous soil or on rather drier, degraded soils.

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