The beech woods of the Balkan Peninsula

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Objekttyp: **Article**

Zeitschrift: **Veröffentlichungen des Geobotanischen Institutes Rübel in Zürich**

Band (Jahr): **8 (1932)**

PDF erstellt am: **25.06.2024**

Persistenter Link: https://doi.org/10.5169/seals-307036

The beech woods of the Balkan Peninsula.

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Horizontal distribution.

Beech woods cover the slopes of a large number of mountains in the Balkan Peninsula. They are recorded from almost all its parts with the exception of its extreme south. The southern boundary of their distribution is in Middle Greece, on Prenzesi near Karoplesos in Acarnania, on the Mountains near Kravara in Aetolia and on the Mt. Oxya at about 38 45 N. lat. (15). According to J. Mattfeld (in a letter) the records from Parnassus are erroneous. In the eastern part of the Peninsula the beech reaches the Aegean Sea on the Peninsula of Athos, as well as the Marmara Sea on Mt. Tekir-Dagh.

In the western part of the Peninsula the beech woods are mostly discontinuous, a fact which may be explained by their limitation to mountains and by the orographic conditions of that part of the Peninsula. Nevertheless in Croatia, Bosnia, Hercegovina and Montenegro large beech woods are known. Also in Albania and Greece there are large beech woods, though they are chiefly scattered in the mountains. Large beech woods lie also in the eastern part of Yougoslavia, that is in Serbia.

According to Prof. Chenchine, Belgrad (in a letter), the best beech wood he has seen in Yougoslavia is that of the so-called University Valley at Maidanpek, in eastern Serbia. Large beech woods occur also, according to Adamovič, on such Serbian mountains as the Suva Planina, Besna Kobila, Strešer, Ostrozub and in all the mountains between Kopaonik and Osogovo (5).

The eastern part of the Peninsula is relatively poor in beech woods. The insignificant altitude of the mountains which are to be found in that part of the Peninsula does not allow a large extension of *Fagus silvatica* and only *Fagus orientalis* is widely spread there. The oriental beech however does not there form extensive and com-

pact forests, but is usually limited to damp valleys or to northern hill slopes. Only the central part of the Strandža range and especially the slopes of Mahiada bear more or less extensive woods of *Fagus orientalis* (27). The western part of Bulgaria is, on the contrary, rich in beech forests, which cover there the slopes of most mountains. They form a large belt on both sides of the Balkan range. This belt is divided into two parts by the valley of the river Isker. Its largest eastern part is about 250 km. long, extending from the slopes of the summit Mosha near the valley of Isker as far as a point near the place of the confluence of the two parts of the river Kamčia. This is probably the largest beech wood of the Balkan Peninsula. In some places the belt is interrupted, having been destroyed by man. Besides this, smaller beech belts occur in most mountains which occupy the western part of Bulgaria.

In most of the countries named the forests are considerably damaged by man, the best preserved beech woods being in Albania, which constrats in this respect with neighbouring countries (25).

Climatic conditions.

In the Peninsula the beech seems to be chiefly a mountain tree, although, according to Beck (7), its distribution in the valley of the Danube as well as in that of the Save is limited only by soil conditions. With this exception the beech areas of the Balkan Peninsula may usually be explained by the climatic preferences of the tree. It seems, that air moisture is the most important factor, the beech woods tending to occupy the dampest altitudinal zone of the mountains (42).

Their lower altitudinal limit seems to be determined by the summer air dryness, and the upper limit by the physiological dryness (in the sense of Schimper), caused by the low winter temperature. This is probably the cause why the beech has a wider distribution on the cool northern slopes of the mountains than on the sunny southern ones. In many mountains occurring in the southern part of the Peninsula, beech woods are found only on the northern slopes, thus for example on Mt. Oxya in Greece, and on Mt. Olympus. The beech prefers the eastern or the western mountain slopes, when the conditions of air humitidy are there more favourable. Thus the

beech grows only on the western more humid side of Mt. Athos; on the contrary it prefers the eastern slopes of the mountains in the Illyrian countries (according to Beck), the western being turned towards the Adriatic sea coast, which is characterised by Mediterranean climatic conditions, that is by a hot and dry summer (7).

This dependence on air humidity is especially well seen in the continental central and eastern parts of the Peninsula. The air moisture is there most often a minimum factor, and therefore, accordingly to the modified law of Liebig, has an especially strong influence upon plant life.

Both species of beech, *Fagus silvatica* as well as *F. orientalis*, show the same preference for air moisture, occurring usually in the dampest districts and localities of the country. It seems however, that their temperature needs are not the same and that the oriental beech requires a higher temperature than the European. In this way may be explained the fact that *Fagus silvatica* usually occurs in the damp mountain zone, approximately at the altitude at which the winter clouds lie (42), and *F. orientalis* prefers lower altitudes, being not found at an altitude higher than 1100 meters above the sea level, and often reaching the sea shore. Under humid climatic conditions, thus for example on the main chain of Strandža, which is characterized by a rainfall not less than 900 mm, *Fagus orientalis* occurs on open slopes as much as on open plains (27). On the contrary, on the Strandža sea shore as well as in the lower parts of the Strandža range, and also on the low eastern part of the Balkan chain, *Fagus orientalis* occurs usually in deep and damp ravines and especially on their northern slopes, sometimes also on the northern slopes of the main chain, while the open places are occupied by heliophilous oak woods *(Quercus conferta* and *Q. cerris)* (35).

The altitudinal distribution.

The altitudinal limits of the European beech tree as well as those of the beech woods are not the same in different parts of the Peninsula. According to Beck, there is practically no lower limit of the beech woods in the north-western part of the Peninsula in the valleys of the Danube and Save. Only the edaphic conditions (sands and swampy soils) there stop the spread of the beech into the plain (7).

In all other parts of the Peninsula the beech belt has a definite lower limit.

Generally the zone of the beech forests lies lower in the northern part of the Peninsula than in the southern. The question if there is any regularity in the changes of the vertical position of the beech belt, which take place in the direction from west to east, remains unsettled. Thus for example, according to Beck (7), the beech zone of the Illyrian countries falls in the direction towards the interior of the Peninsula, while the observations of Markgraf in Albania are exactly the reverse (25). In Bulgaria one can observe a falling of the lower beech wood limits towards the east but this falling is only a result of the gradual ecological and morphological transition of *Fagus silvatica* into *Fagus orientalis*, which takes place in the eastern part of the country.

In all parts of the Peninsula the beech zone seems to be broader on the northern slopes of the mountains than on the southern. Mostly the zone lies higher on the southern side, but this difference is chiefly noticed at the lower altitudinal limit. The altitude of the upper limit may be different in different localities.

The difference in the situation of the lower limit on the sunny southern and the shady northern slopes extends in South Albania, to 300—400 m. (25), in South Croatia (7) to about 350 m., in Serbia (Chenchine in a letter) to 200—300 m., and in Macedonia to 200—400 m. (8; 14; 21; 22; 36). These differences seem to be rather larger in the continental interior of the eastern part of the Peninsula. On the Balkan range the approximate difference extends to 300—600 m.; the difference between both slopes of the Rhodope is nearly the same.

The difference between the lower beech wood limit on the western and on the eastern sides of the Illyrian mountains is, according to Beck, in South Croatia 400 m., on the Dinaric Alps and on Mt. Troglav 50 m., on Mt. Prenj 250 m., on Mt. Čvrstnica 450 m., and on Mt. Velez 100 m. (7, p. 318).

The upper limit of the beech woods is very unequal on different mountains, even in the same country. The beech belt only relatively seldom reaches the natural (climatic) upper limit. It is often suppressed by ecological or geologic-historical conditions, in several cases also by the activity of man.

It is observed in Macedonia (22) as much as in Bulgaria, that the belt reaches its natural upper limits chiefly on relatively narrow and steep mountain ranges, if only their uppermost part is not built of vertical rocky walls. In Bulgaria the beech attains its natural upper limit on several parts of the Balkan range, reaching 1700—1900 (2000 m.; in Macedonia, on Belasica (1600—1800 m.), Galičica (1800 m.), Jablanica (2000 m.) etc.

In all these the beech forms the upper limit of forests. In low mountains, which do not reach the height of the natural upper beech limit, the forest only in exceptional cases occupies the mountain crest. The upper mountain zone usually remains woodless. This is chiefly due to the shallow soils and the physiological dryness (in the sense of S c h i m p e r), caused especially by winter winds. In such cases the upper limit of the beech belt may be at a relatively low altitude, thus on Mt. Lulin at about 1200 m. etc.

The upper limit of beech forests may be suppressed by an intense development of rocky formations on the upper parts of the mountains, as on Mt. Korab in Macedonia, where, according to Košanin, the situation of the upper beech limit varies between 1200 and 1900 m.

Especial conditions exist often on large mountainous massives, such as the Rila and the Rhodope in Bulgaria, Pirin, Perister, and Šar in Macedonia, and Kopaonik in Serbia. The central (upper) part of these massives is occupied by coniferous woods, the beech belt being limited to the lower part of the mountain and thus suppressed or ever interrupted. In such a manner the upper limit of the beech belt may be reduced to a relatively low altitude, far from corresponding to its natural upper limit. Thus the upper beech limit in different parts of the Rhodope corresponding to the more or less extensive development of coniferous woods lies at Chvojna and Pavelsko between 700 and 800 m. (the lower limit at about 400 m.), at Jasa-Korija at about 1200 m. (the lower limit at 800 m.) at Bela Crkva about 1500 m. (the lower limit at 1000 m.).

In the Rila on the southern slope of the summit Eleni the upper limit of beech woods lies at about 1500 m. (the lower limit in the valley of the river Rilska at about 800 m.). In some other localities on the same mountain however, where the coniferous woods were

felled, the beech community has extended on that account and nearly reaches its normal upper altitudinal limit, about 1800 m. (28).

On the eastern slopes of Pirin in Bulgarian Macedonia, above the valley of Rezlog, the beech belt is lacking being suppressed by an intense development of coniferous woods, which there reach to the foot of the mountain (about 900 m.).

The difference between the upper limit of the beech woods on the north and the south side of the mountains seems to be not always of the same character. According to A d a m o v i č (5) this limit lies higher on the south side of Kapaonik, than on its north side (N. 1600 m.; S. W., 1650 m.); the same occurs on Kopren, on the west part of the Balkan chain (N. 1700 m.; S. 1750 m.). The same relations exist, according to B e c k (7), in Bosnia on Matorač and in Hercegovina on Prenj.

On the contrary, this limit lies higher on the northern side of Strešer (N. 1850 m.; S. W. 1800 m.) and of Golema Čuka (N. E. 1800 m.; S. 1750 m.) in the western part of the Balkan chain. Similar relations exist also, according to Beck, on the Velebit, in South Croatia (N. E. 1500 m.; S. W. 1200 m.). In Bulgaria the upper beech limit lies often higher on the northern side than on the southern. Such relations can be observed especially clearly in the upper part of some mountain rivers, running in a latitudinal direction (W. to E. or reverse). The upper part of the valley of the river Elešnica on Osogovo Mt. represents such an example. The northern slope is covered there by a beech wood, which extends to the altitude of about 1800 m. while the opposite southern side represents an alpine meadow, and the limit of the beech forest lies there at about 100—150 m. lower. Similar relations may be observed on Belasica, Rila and elsewhere. The difference is probably due to the greater air humidity, proper to the northern slopes.

Examples of lower beech limits (in meters) as given in the titerature.

L i b u r n i a n K a r s t (7): (284) 584; S o u t h C r o a t i a : Plješivica: 916; Velebits. S. W. (7); 1000; N. E.: 570 (600); Velebit (Koch): 250. T h e D i n a r i c c h a i n : Dinara, S. S. W.: 900; Troglav, N. E.: 900. W e s t B o s n i a : Osječenica and Klekovaca: 700; Činčer: 1200; Vlasic: 900. M i d d l e B o s n i a : Matorač, N. N. W.: 900. S o u t h

Bosnia: Trebovic: 1000; Bjelašnica: 550; Treskavica: 900; Visočica: 1240; Magliš and Volujak: (600) 700. Hercegovina: Čvrstnica and Čabolja, N.: 350: S. 800; Prenj, N. E. (750) 900; S.: 1000; Velež: (900) 1300; Crvanj: 900; Bjelasica: 1500; Orjen: (700) 1000; Hercegovina in general (Koch): 1000; Hercegovina in general (Ascherson u. Graebner): (100). Montenegro: Durmitor: 800; Kom: ? 1400 (7); Zijovo: 1300; Maglič: 600. N. Albania in general (7): 909; (25): 700—900; N. Albania: Michaina: 600 (21); Herukava: 800 (19); Topalja: 600—700 (19); Munela: 900 (25); Krabi: 700 (25); Kruma: 800 (25). Middle Albania: Mal: 1000—1200 (25); Zanlin: 1200 (25); S. Albania: Qarisht: 1200 (25). Macedonia in general (14): 1200; Macedonia in general, N. slopes (Chenchine): 600—700; S. slopes (Chenchine): 800—1000; Macedonia: Šar (8): 500; (14): 2850; Belasica: 700—900; Golešnica: 800; Drenska: 800; Dudica: (680); Nidge: 3000 (18, 22, 36). Greece in general (15): 800; Greece: Pindus (Koch): 1400; Olymp (18): 1000; (Handel-Mazzetti 18): (600) 1200—1350; The mediterranean part of the Peninsula in general (42): 1000.

Serbia, in general (according to Chenchine): N. slopes: 400; S. slopes: 700—800. Serbia: at Vranja etc. (1; 5): 300; Stara Pl., Suva Pl. etc. (7): 1100.

Bulgaria: Rila: 800—900; Vitoša: N. side (700) 800—900, S. side: 1000; Osogovo, W. side: 1200, N. side: 800 (600—900); Pirin, W. side: 700—800; Sredna Gora, N.: 500; The Balkan range, W. part, N. side: 600 (300—800); S. side: 1000 (700—1300); E. part, N. side: (400) 500; S. side: (600—1000); Rhodope, N. side: 700 (400—800).

Thrace: Rhodope, S. slopes (10): 900; (26): 1050—1100.

Examples of upper beech limits:

Liburnian Karst (7): 1327 (1350); S. Croatia: Plješivica: 1500 (1620); Velebit, S. S. W.: 1200 (1500); N. E. 1500 (1300—1650). Dinaric Alps: Dinara, S. S. W.: 1636: W.: 1572; Troglav: 1650. West Bosnia: Osečnica and Klekavača: 1000 (1700); Činčer: 1620; Vlasič: 1300. Middle Bosnia: Matorač, N. N. W.: 1600; S. E.: 1750. South Bosnia: Trebovic: 1590; Bjelašnica: 1650 (1750); Treskavica: 1700; Visočcica: 1700; Lolja and Dumoš: 1700—(1750); Magliš and Volujak: 1700 (1750). Hercegovina: Čvrstnica

and Čabolja, N.: 1200; S.: 1760; Prenj, N. E.: 1400; S.: 1600; Velež: 1600 (1650); Crvanj: 1620; Bjelašica: 1680; Orjen: 1580 (1600); Hercegovina in general (Koch): 1700; (Ascherson u. Graebner): 1750 (1900). Montenegro: Durmitor: 1610 (1960); Sinjavina: 1650 (1750); Kom: 1600 (1800); Žijovo: 1600 (1750); Maglič: 1650. North Albania: in general (7): 1670 (2000); (25): 1800 (2000); N. Albania: Herukava: 2000; Koritnik: 1500; Middle Albania: Maja Shebenikut: 1900; Mal: 1800; Kaptin: 1800; Jablanica: 1900; Gur i Topit: 2000; Serbia: Kopaonik: 1500—1600; Suva Planina (5): 1700—1800; (7): 1660—1690); Stara Planina (5): 1700—1800; (7): 1660 (1690). Macedonia: Šar (8): 1500—1700; (22): 1800—1850; Jablanica: 2000; Korab: 1200—1900; Galičica: 1800; Nidge (14): 4400 feet; (22): 1800; Belasica: 1700 (1600—1800); Golesnica 1600; Drenska 1200; Macedonia in general (14): 5540 feet. Greece: Olympus: 1900. Bulgaria: Osogovo; W.: 1500; N.: 1800; Rila, S.: 1500 (1800); Rila, N. (5): 1500; N. W. 1550; Vitoša, N.: 1400—1500 (1700); S.: 1400 (1500); Pirin, W.: 1500—1800; Sredna Gora, N.: 1500; Balkan range, N.: 1700—1800 (2000); S.: 1600—1700 (2000); Rhodope, N.: (800) 1100—1600.

Soil Conditions.

The beech of the Balkan Peninsula seems to be comparatively indifferent to soil conditions, and may therefore be observed on all kinds of soil which occur in the mountains of this part of Europe. It grows thus on silicate and on limestone rocks, on igneous rocks and on schists.

The development of the beech is, however, not always the same upon different kinds of soil. In the western part of the Peninsula, for example in Istria and in Dalmatia, the beech seems to show a certain preference to limestone soils, as it frequently does in north and west Europe (7). Also, according to Markgraf, (25, p. 74), the beech woods in Albania grow higher and closer on limestone than on serpentine and have besides this a richer rejuvenation. The conditions seem to be different in the eastern part of the Peninsula, and especially in Bulgaria. Investigations in forestry as well as direct observations show that there the beech usually grows better developed on silicate rocks than on the limestone. It is stated that lime-

stone rocks mostly produce soils which are relatively rich in humus and remain humid in the spring but very dry in the summer. Such conditions are but little suited for the existence of a mesophilous tree like the beech under a continental climate. The best qualities of beech, from a forestry point of view (qualities 1 to 3), occur on the Balkan range, as the results of taxation show, on deep and fresh silicate soils; the lowest qualities (4 to 5) on shallow limestone soils

In some localities in Bulgaria, as well as in Bulgarian Macedonia, the beech seems to avoid the limestone and to be chiefly spread on silicate soils. Thus of two neighbouring and approximately equally high mountains in Bulgarian Macedonia, Ali Botuš and Belasica, the first, consisting chiefly of limestone rocks, is largely covered by coniferous woods, the few beech forests being nearly limited to an area of silicate rocks on the N. W. side of the mountain (36; 42). The slopes of Belasica which consists of silicate rocks are on the contrary covered exclusively by large and well developed beech woods. The same conditions can be observed on Pirin. The north-eastern limestone part of this mountain is covered by coniferous woods, while the silicate south-western part bears beech woods.

The relatively fresh and cool silicate soil and the warm and dry limestone one, have here probably the significance of complementary factors to the climatic conditions.

According to forestry studies in different parts of the Balkan range, beech forests grow especially well upon deep schistous soils, which usually contain a certain quantity of clay and which are fresh and not too compact. Old igneous rocks break up into stones sand and clay. On sloping places they often form deep and fresh soils. Such soils have usually an acid reaction and are rich in humus, but poor in lime. Such soils usually bear well developed beech woods, wich show a tendency to merge into grass communities (as a result of a permanent water table?). Sandstone usually produces poor and shallow soils little suited to the development of beech woods.

The beech evidently avoids too moist and swampy soils as much as sandy ones. Thus in the valleys of the Danube and Save, according to Beck, swampy and sandy soils stop the extension of the beech into the bottom of the valleys. In the eastern part of the Peninsula both species of beech *(Fagus silvatica* and *F. orientalis)* never occur

on permanently moist soils nor on soils with a permanent water layer in the subsoil. The subsoil usually consists of rocks or stony conglomerates.

The beech woods of the Balkan range and these of the Rila are usually well developed on slopes, which are not steeper than 50°. The results of taxation on the beech woods of the Petrochan Pass (in the western part of the Balkan range) show, that the beech trees, 100years old, reach there a mean size of 32 meters, if growing upon slightly sloping places, 25 m. on moderate steep places and only 12 m. on very steep ones. A deep layer of dead leaves is observed in most beech woods, with the exception of those growing on very steep slopes; this layer attains in Rila a depth of 20—30 cm. Beneath it lies a thin layer of humus, which extends to a thickness of 5 to 10 cm.

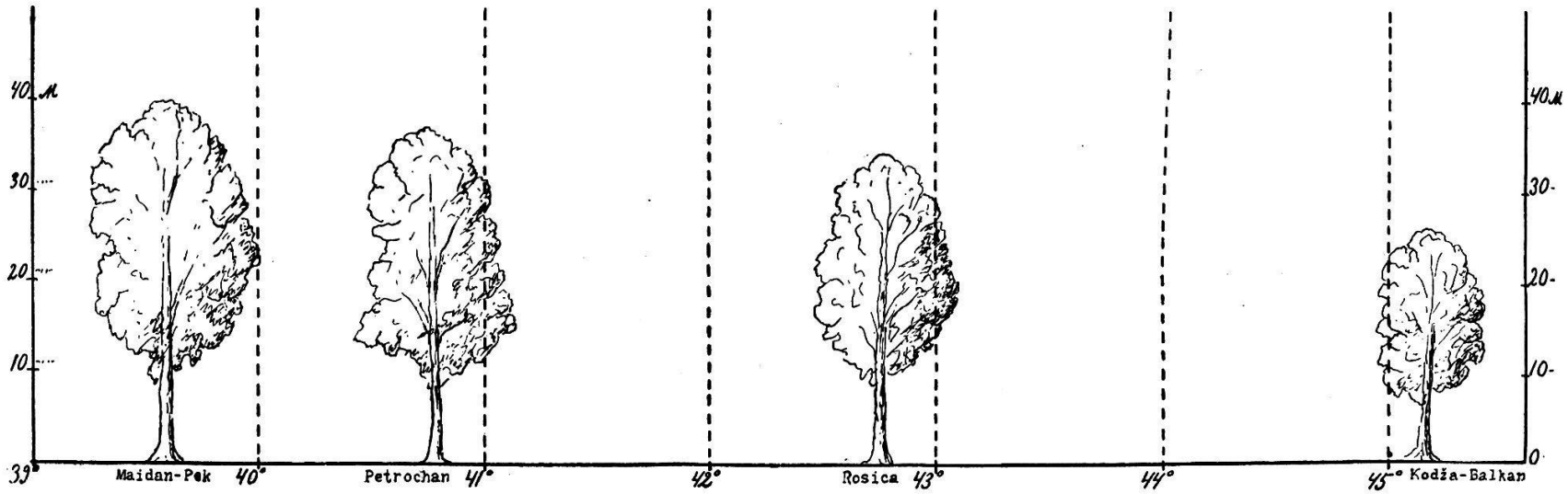
Biology.

Really primitive beech woods in Bulgaria, and, according to Markgraf, also in Albania, are not uniform in regard to the age of the trees. Uniform beech woods, in which all trees are approximately of the same age, are recorded from Rila by Müller (28). Such woods occur also in the Balkan range and elsewhere, but a carefully examination usually shows that such woods bear traces of a formerly destruction, and a later regeneration by shoots, which probably took place in historic time. Some of the best beech woods of the Balkan range, have this character, thus for example that of the Petrochan Pass.

Results of taxation show, that the beech trees are poorly developed in the eastern parts of the country than in its western parts.

In the beech woods of Petrochan (40° 46' E. of F.), the 140 years old trees (which form about 3% of all trees in the first quality woods) attain in the woods of the first quality an average height of 37 m. and a diameter (1.5 m. above the ground) of 46 cm. In the woods of the 5 th quality such trees attain a size of 19 m. and a diameter of 23 cm. About 38 % of the surface in that wood is occupied by trees older than 100 years, the average age of the trees in the whole forest being 93.5 years. The average density of the forest is 0.7.

In the beech wood Rosica, in the Sevlievo district, 42° 46' E. of F., the mean size of 150 years old beech trees of the first quality



Relative dimensions of beech trees at different longitudes, in the Eastern part of the Balcan Peninsula (conf. p. 9).

woods is only 34 m. In the woods of the Kodža Balkan (in the eastern part of the Balkan chain, about 45° 10' E. of F.) the mean size of 90 years old trees (of *Fagus orientalis)* is 20 m. and that of 180 years old trees 23 . 5 m. In the Rila again, according to Müller (28, p. 235), the 120 years old beech trees have a mean size of 35—40 m. and a diameter of 60—100 m. Prof. Chenchine (in a letter) mentions the beech forest of the University Valley at Maidanpek, East Serbia, about 39° 38' E. of F., where in certain places the general age of the wood is more than 200 years, the mean size of the trees more than 40 m. and the mean diameter no less than 100 cm. The general wood reserve on a hectare is there more than 800 m.

Old and primitive beech woods with enormous trees are also mentioned by Beck from Bosnia and by Markgraf from Albania.

The Bulgarian beech woods show generally a considerable power of rejuvenation and usually regenerate after lumbering, if not damaged afterwarts by the pasturing. Turill (42, p. 141), states the same for the Suva Planina, East Serbia. In very dense and uniform woods, and especially in the western part of the Peninsula (but also in several woods in Bulgaria) young beech growth is lacking. In most cases however young beech saplings can be observed, growing together with the ground vegetation. The young growth is especially abundant in the years, following the years of a rich production of beech nuts. Thus in 1929 young beech saplings were extremely abundant in the forests of Western Bulgaria, forming for example on Lulin the largest part of the ground vegetation. The periodicity of the productive years in Bulgaria has not been exactly studied. In every case the period is considerably larger than two years, which period is erroneously given by Müller (l. c., p. 295), and is scarcely shorter than 7 years.

The rejuvenation of primitive Albanian beech woods consists, according to M a r k g r a f (25 a), in a group development of young saplings in chearings producted by the fall of old tree trunks.

Fagus orientalis, growing on the eastern part of the Balkan range, is on the contrary, already known in Bulgarian forestry by its weak power of rejuvenation. It is staded, that young saplings are usually poorly developed in its woods, showing a tendency to be replaced by young oaks, especially by *Quercus cerris.*

Example of an association in a mixed wood with a marked invasion of oaks (Kodža-Balkan; transsection 100 m.; 5 counts; only the trees and shrubs are recorded):

Old trees and shrubs:

	Abund.	Const.		Abund	Const.
Carpinus betulus	4	5	Acer campestre	2	3
Fagus orientalis	8	5	Cornus mas	2	4
Fraxinus ornus	0,5	1	Tilia platyphyllos	2	2
Crataegus monogyna	4	3	Acer platanoides	0,2	1
Quercus cerris	2	4	Fraxinus oxyphylla	0,5	1
Q. conferta	3	5	Hedera helix	0,5	2
Q. sessiliflora	2	3	Ruscus hypoglossum	1	2
Rubus hirtus	9	5	Ulmus campestris	0,2	2
Carpinus duinensis	3	2			
Ruscus aculeatus	2	3			
Sorbus torminalis	1	2			
Crataegus melanocarpa	0,5	3			

Saplings:

Carpinus betulus	5	3	Acer campestre	10	4
Fagus orientalis	6	5	Tilia platyphyllos	0,5	1
Fraxinus ornus	2	1	Ulmus campestris	5	3
Crataegus monogyna	19	4	Sorbus domestica	1	2
Quercus cerris	19	4	Tilia alba	0,5	1
Q. conferta	22	4	Prunus insititia	0,5	1
Q. sessiliflora	56	5	Rosa sp.	4	2
Rubus hirtus	1	5	Fraxinus oxyphylla	17	1
Carpinus duinensis	0,5	1	Hedera helix	0,2	1
Sorbus torminalis	4	3	Euonymus verrucosus	0,5	1
Crataegus melanocarpa	0,5	1			

The advancement of the oaks on the account of the oriental beech is also noticed in the Bulgarian forestry literature (33).

Composition.

Very dense and well developed beech woods may be nearly pure, with only a few other associated trees; but usually a certain number of other woody species occur in beech woods. Some of them are common to the beech woods growing in different parts of the Peninsula.

	Balkan	*Vitoša (with Lulin)*	*Belasica*	*The Illyrian countries.*
Picea excelsa (P. abies)	×	×	—	×
Abies pectinata (A. alba)	×	×	×	×
Pinus silvestris	×	×	—	×
Pinus nigra	×	—	—	×
Populus tremula	×	×	×	×
Salix caprea	×	×	×	×
S. grandifolia	×	×	—	—
Carpinus betulus	×	×	×	×
Betula alba	×	×	×	×
Ostrya carpinifolia	—	—	×	×
Corylus colurna	—	×	×	—
Quercus cerris	×	×	×	×
Q. conferta	×	—	×	—
Q. sessiliflora	×	×	×	×
Castanea vesca	—	—	×	×
Ulmus montana	×	×	×	×
U. campestris	×	—	—	×
Pirus communis	×	×	—	—
P. malus	×	×	×	—
Sorbus torminalis	×	×	×	×
S. domestica	×	—	—	—
S. aucuparia	×	×	×	×
S. mougeotii	—	—	—	×
Prunus avium	×	×	×	×
P. divaricata	×	—	×	—
Tilia parvifolia	×	×	×	—
Tilia grandifolia	×	×	×	×
T. argentea	×	—	×	×
Acer pseudoplatanus	×	×	×	×
A. platanoides	×	×	×	—
A. campestre	×	×	×	×
A. hyrcanum	×	×	×	—
A. visianii	×	×	×	—
A. obtusatum	—	—	—	×
Fraxinus excelsior	×	×	×	—
F. ornus	×	×	×	×
Shrubs:				
Taxus baccata	×	×	×	×
Juniperus communis	×	×	×	×
Ruscus hypoglossum	×	×	—	×
Alnus viridis	×	×	—	—
Corylus avellana	×	×	×	×
Clematis vitalba	×	×	×	×
Ribes grossularia	×	×	×	×
R. petraeum	×	×	×	—

	Balkan	*Vitoša (with Lulin)*	*Belasica*	*The Illyrian countries.*
R. alpinum	×	×	—	×
Sorbus aria	×	×	×	×
Crataegus monogyna	×	×	×	×
Rubus idaeus	×	×	×	×
R. hirtus	×	×	×	—
Rosa pendulina	×	×	—	×
R. arvensis	—	—	—	×
R. coriifolia	—	—	—	×
Prunus laurocerasus	×	—	—	—
P. spinosa	—	—	—	×
Cytisus hirsutus	×	×	×	×
C. alpinus	—	—	—	×
C. laburnum	—	—	—	×
Coronilla emeroides	—	—	×	×
Ilex aquifolium	—	—	×	×
Euonymus europaeus	×	×	×	—
E. latifolius	×	×	×	—
Staphyllea pinnata	×	—	—	×
Rhamnus fallax	—	—	—	×
Daphne mezereum	×	×	×	×
Cornus mas	×	×	×	×
C. sanguinea	×	×	×	×
Hedera helix	×	×	×	×
Vaccinium myrtillus	×	×	×	×
Erica carnea	—	—	—	×
Syringa vulgaris	×	—	—	—
Sambucus nigra	×	×	×	×
S. racemosa	×	×	—	×
Viburnum lantana	×	×	×	×
V. opulus	×	×	×	—
Lonicera xylosteum	×	×	×	×
L. nigra	×	×	—	—
L. alpigena	—	—	—	×

The woods of *Fagus orientalis* have a composition not entirely dissimilar to that described above. They contain however some specific elements, both in their tree vegetation and among the shrubs.

The following secondary trees occur usually in the woods of *Fagus orientalis:*

	E. Balkan	*N. Strandža*	*Rhodope*
Populus tremula	×	×	×
P. nigra	×	×	×

	E. Balkan	*N. Strandža*	*Rhodope*
Juglans regia			×
Carpinus betulus	×	×	×
C. duinensis	×	×	×
Ostrya carpinifolia			×
Corylus colurna	×		
Alnus glutinosa			×
Quercus conferta	×	×	×
Q. cerris			×
Q. sessiliflora	×	×	×
Q. pubescens	×	×	×
Ulmus campestris	×	×	×
Sorbus torminalis	×	×	×
S. domestica	×	×	×
Mespilus germanica		×	
Prunus avium	×	×	
P. divaricata			×
Tilia argentea	×	×	×
T. parvifolia	×	×	×
T. platyphyllos	×	×	
Acer pseudoplatanus	×	×	
A. platanoides	×		×
A. monspessulanum			×
A. campestre	×	×	×
A. tataricum	×	×	×
Fraxinus ornus	×	×	×
F. oxyphylla	×		

On the southern part of Strandża the oriental beech is to be met with in the Society of the chestnut and the eastern plane tree.

Shrubs:

Taxus baccata		×	
Juniperus communis			×
Ruscus aculeatus	×	×	
R. hypoglossum	×	×	
Smilax excelsa	×	×	
Corylus avellana	×	×	×
Clematis vitalba	×	×	×
Crataegus monogyna	×	×	×
C. melanocarpa	×	×	
Rubus hirtus	×		
Rosa dumalis	×		
Prunus laurocerasus		×	
Colutea arborescens	×		
Ilex aquifolium		×	
Euonymus verrucosus	×	×	×
E. latifolius	×	×	×

	E. Balkan	*N. Strandža*	*Rhodope*
Vitis silvatica	×	×	×
Staphyllea pinnata	×		
Hypericum androsaemum		×	
H. calycinum		×	
Daphne pontica		×	
Cornus sanguinea	×	×	×
C. mas	×	×	×
Hedera helix	×	×	×
Rhododendron ponticum		×	
Vaccinium arctostaphylos		×	
Periploca graeca	×	×	

The oriental beech woods of Strandža are especially rich in elements of the Colchic and South-Euxine Flora.

At the lower limit of the beech belt transitions can be observed into: 1) mixed broad leaved woods, 2) oak woods, 3) woods of *Castanea vesca*, 4) woods of *Pinus nigra*. As an intermediate phase often a zone with predominant *Carpinus betulus* occurs.

At the upper limit transitions into Coniferous woods are especially common; the woods may consist of 1) *Picea excelsa*, 2) *Pinus peuce*, 3) *P. leucodermis*, 4) *P. silvestris*.

In many places a narrow zone of mixed woods with *Betula alba* as a predominant tree can be observed. Such a zone often lies between the beech belt and that of the coniferous woods.

Examples of the transition.

I. Transition from a mixed wood with predominant *Carpinus betulus* into a beech wood. Lulin, about 900—1000 m. alt. Four successive counts were made in the direction towards the trop of the mountain, every belt being approximately 100 m. long and 2 m. broad.

	I	II	III	IV
Fagus silvatica	4	18	27	31
Carpinus betulus	25	24	13	7
Quercus sessiliflora	2	—	4	—
Acer campestre	4	4	1	2
Corylus avellana	6	—	—	—
Crataegus monogyna	19	—	—	—
Clematis vitalba	1	—	—	—
Rosa canina	1	—	—	—
Viburnum lantana	6	—	—	—
Pirus communis	5	—	1	—
Prunus divaricata	3	—	—	—

	I	II	III	IV
Sorbus torminalis	—	—	1	—
Ulmus montana	—	—	1	3
Acer hyrcanum	—	—	2	—
A. pseudoplatanus	—	—	—	6
Tilia platyphyllos	—	—	—	3

II. Transition from a beech wood into a mixed wood, with predominant *Betula alba* and then into a coniferous wood. Vitoša, between 1400 and 1500 m. 7 counts were made in the direction towards the top.

	I	II	III	IV	V	VI	VII
Fagus silvatica	36	18	10	7	.	11	7
Prunus avium	1	.	.	.	.	.	.
Sorbus aucuparia	1	.	.	.	.	.	.
Populus tremula	5	9	2	.	.	4	.
Betula alba	.	2	16	16	28	10	10
Picea excelsa	.	4	2	.	.	5	23
Pirus communis	.	1	.	.	.	.	.
Pinus silvestris	.	.	2	.	6	.	.
Salix caprea	.	.	.	1	3	.	.
Corylus avellana	6	.	2	7	.	4	8
Lonicera xylosteum	.	1	.	.	1	.	.
Crataegus monogyna	2	2	.	.	.	.	.
Euonymus europaeus	1	.	.	.	.	.	.
Rosa alpina	1	.	.	.	.	.	.
Salix grandifolia	2	.	.	.	.	2	.
Cytisus polytrichus	.	8	2	.	1	1	.
Vaccinium myrtillus	.	19	.	.	.	.	.
Juniperus communis	.	1	2	4	23	6	38
Viburnum lantana	.	1	.	.	.	.	.
Rubus idaeus	.	1	.	.	.	.	.
Vaccinium vitis idaea	.	.	.	34	.	.	.
Alnus viridis	.	.	.	.	.	1	.

Herbaceous ground vegetation.

Corresponding to the wide extent of the beech woods in the Balkan Peninsula, the number of herbaceous species found in these woods is a large one. Long lists of beech woods plants are given by different authors. However it would be scarcely justifiable to take all the species of these lists for typical representatives of the beech wood vegetation. Some of them are probably only an occasional element in the beech forest or occur only under special conditions, for example on shady rocks, on stream shores, and in clearings. The

dense canopy of a typical and well developed beech wood does not allow any development of a diversified ground vegetation. As a result of the adaptation to such conditions the herbaceous vegetation of a beech wood can be divided into two biologic groups: 1) plants which blossom in the spring, before the beech foliage is developed and 2) sciophilous plants which can support the deep shadow of the beech canopy.

As typical and commonest representatives of the herbaceous vegetation, growing in Bulgarian beech woods the following species may be mentioned:

A. *Vascular Plants.*

Cystopteris fragilis
Nephrodium filix mas
N. spinulosum
N. phegopteris
N. dryopteris
Polystichum lonchitis
P. lobatum
P. angulare
Athyrium filix femina
Scolopendium vulgare
Asplenium trichomanes
Polypodium vulgare
Milium effusum
Melica uniflora
M. nutans
Poa nemoralis
Festuca gigantea
F. heterophylla
F. silvatica
Bromus asper
Elymus europaeus
Carex digitata
C. pilosa
Arum maculatum
Luzula maxima
L. albida
Gagea lutea
Allium ursinum
Lilium martagon
Erythronium dens canis
Scilla bifolia
Ruscus hypoglossum (rare)
Polygonatum officinale
P. verticillatum
Streptopus amplexifolius
Paris quadrifolia
Galanthus gracilis
Platanthera montana
Cephalanthera rubra
C. pallens
Neottia nidus avis
Epipactis latifolia
Epipogon gmelini
Asarum europaeum
Moeringia trinervia
Mercurialis perennis
Euphorbia amygdaloides
Impatiens noli tangere
Circaea lutetiana
Epilobium montanum
Viola silvestris
V. riviniana
Monotropa hypopitis
Sanicula europaea
Anthriscus trichospermum
Aegopdium podagraria
Pirola uniflora
P. secunda
P. media
P. rotundifolia
P. minor
Monotropa hypopitis
Gentiana asclepiadea
Primula suaveolens
Pulmonaria officinalis
P. rubra
P. mollis
Symphytum tuberosum

Myosotis silvatica
Lamium maculatum
L. galeobdolon
Galeopsis speciosa
Salvia glutinosa
Glechoma hederacea
Satureja grandiflora (only in south)
Digitalis viridiflora
Scrophularia nodosa
Veronica officinalis
Stellaria holostea
S. nemorum
Helleborus odorus
Isopyrum thalictroides
Actaea spicata
Anemone nemorosa
A. ranunculoides
Ficaria verna
Ranunculus platanifolius
Corydalis solida
C. marschalliana
Dentaria bulbifera
Cardamine flexuosa
C. impatiens
Lunaria rediviva
Saxifraga rotundifolia
Chrysoplenium alternifolium
Potentilla micrantha
Waldsteinia geoides
Geum urbanum
Trifolium pseudomedium
Lathyrus vernus
L. niger
Geranium robertianum
Oxalis acetosella
Veronica montana
V.urticaefolia
Rhynchocoris elephas (rare, only on the Balkan range)
Lathraea squammaria
L. rhodopaea (only in the Rhodope)
Adoxa moschatellina
Asperula odorata
Galium rotundifolium
G. silvaticum
G. vernum
Achillea macrophylla
A. grandifolia
Carduus personata
Prenanthes purpurea
Lactuca muralis
Lampsana communis
Hieracium murorum
H. vulgatum

Vascular plants found in the forests of *Fagus orientalis* in Geniš-Ada (E. part of the Balkan Chain) and in Strandža:

Asplenium trichomanes
A. adianthum nigrum
Scolopendrium vulgare
Polypodium vulgare
Pteris aquilina
Nephrodium filix mas
Dactylis glomerata
Brachypodium silvaticum
Bromus asper
Carex digitata
C. pilosa
Arum maculatum
Luzula pilosa
Lilium martagon
Fritillaria pontica
Allium ursinum
A. siculum var. dioscoridis
Scilla bifolia
C. marschalliana
Cardamine hirsuta
Dentaria bulbifera
Alliara officinalis
Potentilla micrantha
Lathyrus vernus
L. niger
L. inermis
L. variegatus
L. aureus
Geranium asphodeloides
Mercurialis perennis
Euphorbia amygdaloides
E. salicifolia
Hypericum hirsutum
Viola pontica
V. riviniana
V. silvestris
Monotropa hypopitis
Circaea lutetiana

Sanicula europaea
Scilla bithynica
Polygonatum multiflorum
Ruscus aculeatus
R. hypoglossum
Asparagus tenuifolius
Tamus communis
Galanthus gracalis
Orchis maculata
Cephalanthera ensifolia
Platanthera montana
Epipactis latifolia
Neottia nidus avis
Epipogon gmelini
Ranunculus ficaria
R. constantinopolitanus
Thalictrum aquilegifolium
Hepatica triloba
Anemone ranunculoides
Epimedium pubigerum
Corydalis solida
Cyclamen coum
Primula acaulis var rosea
Lysimachia nummularia
Calystegia silvatica
Pulmonaria officinalis
Symphytum tuberosum
S. tauricum
Trachystemon orientale
Ajuga genevensis
Glechoma hederacea
Stachys silvatica
Lamium maculatum
L. galeobdolon
Salvia glutinosa
S. forskahlei
Veronica officinalis
Scrophularia nodosa
Lathraea squammaria
Knautia drymeja
Galium silvaticum
Asperula odorata
Lampsana communis
Hieracium brevifolium

Bryophytes, growing in Bulgarian beech woods (communicated by Prof. N. Arnaudoff, Sofia).

Fegatella conica
Blasia pusila
Aneura sinuata
Metzgeria furcata
Plagrochilla asplenioides
Madotheca platyphylla
M. laevigata
Frullania dilatata
F. tamarisci
Radula complanata
Lophusa barbata
L. quinquedentata
Sphenolobus minutus
Calypogeia trichomanes
Wesia viridula
Ulota crispula
Orthotricum speciosum
O. affine
O. leiocarpum
O. pallens
Tortula subulata
Fissidens taxifolius
F. bryoides
Pogonatum aloides
Polytrichum formosum
P. juniperinum
Catarinea undulata
Bartramia halleriana
B. pomiformis
Schistidium apocarpum
Dryptodon hartmani
Eucalypta ciliaris
Eucalypta vulgaris
Mnium undulatum
M. punctatum
M. cuspidatum
Webera nutans
Leucodon sciuroides
Neckera crispa
N. complanata
Anomodon viticulosus
Pylaisia polyantha
Isothecium myurum
Brachythecium velutinum
B. rutabulum
Plagiothecium denticulatum
Homalia trichomanoides
Hypnum cupressiforme

Bryophytes, growing in Illyrian beech woods (according to Beck, 7):

Frullania dilatata
F. tamarisci
Radula complanata
Bazzania tribola
B. tricrenata
Madotheca platyphylla
Dicranum sauteri
Orthotrichum stramineum
O. pallens
Orthotrichum leiocarpum
Neckera crispa
N. complanata
Leskea nervosa
Pterigynandryum filiforme
Amplistegium subtile
Leucodom sciuroides
Antitrichia curtipendula

Bryophytes, growing in Albanian beech woods (according to Markgraf, 25):

Tortella tortuosa
Tortula ruralis
Schizostegium apocarpum
Orthotrichum speciosum
O. leiocarpum
O. stramineum
Leucodon sciuroides
Leucodon sciuroides var. morensis
Leptodon smidtii
Leskea catenulata
Pseudoleskea illyrica
Camptothecium lutescens
Hamalothecium sericeum
Pterigynandrium filiforme

Bryophytes, growing in the beech woods of the Thessalian Olympus (according to Handel-Mazzetti, 18).

a) On the ground:

Tortella tortuosa
Bryum capillare
Polytrichum juniperinum
Plagiocheta asplenioides

b) On the beech bark:

Dicranum strictum
Tortula muralis
Pterigynandrium filiforme
Homalothecium philippeanum
Isopterigium pulchellum
Pseudoleskea filamentosa
P. illyrica
Brachythecium rutabulum
B. sericeum

Lichens, growing in Bulgarian beech woods (according to Kasandjieff, Nikoloff, Szatala and Suza [1]).

a) On the ground:

Endocarpon palldium
Crocinia caesioalba
Nephroma parile
Peltigera pretectata

[1]) S. Kazandžieff in Period. Spis.; LXI; 1901; p. 470—532. Jahrb. d. Unif. Sofia; II; 1906; p. 125—137. A. P. Nikoloff: Jahrb. d. Univ. Sofia, phys.-math. Fak. XXVII/3; 1931. O. Szatala: in Mag. bot. Lap. 1929; p. 82—99. J. Susa: in Acta botan. bohem. VII; 1929; p. 7—25.

b) On the beech bark:

Dimidella punctiformis f. cernua
Metasphaeria rhyponta
Pyrenula nitida
— — var. mayor
Opegrapha diaphora
— — var. violatra
Tomasellia arthonioides
Artonia punctiformis
Collema aggregatum
C. nigrescens
Leptogium saturninum
Lecidea parasema var. rivularis
L. enteroleuca
Lecidea glomerulosa f. euphorea
Nephroma resupinatum
Peltigera scutata
Pannaria coeruleobadia
Lobaria pulmonaria
Pertusaria coccodes
P. leioplaca var. tetraspora
P. globulifera
P. lutescens
P. coronata
P. communis
— — var. leucostroma
Lecanora intumescens
Lecanora allophana var. glabrata
— — — — f. aspicilioides
L. carpinea
L. pallida
L. hageni
L. albida
L. subfusca var. allophana
Ochrolechia parella f. corticola
Aspicilia cinerea f. corticola
Parmelia glabra
P. scortea
P. fuliginosa
P. physodes
P. sulcata
P. revoluta
P. acetabulum
P. tiliacea
P. olivacea
Ramalina fraxinea
— — f. attenuata
— — f. luxurians
Usnea ceratina f. annulata
U. barbata
Evervia prunastri f. sorredifera
Callopisma acerina
Calophaca cerina
— — f. fusca
Physica stellaris
— — var. rosulata
Ph. aipolia var. ambigua
Ph. pulverulenta var, argyphaea
Ph. leucoleiptes
Ph. orbicularis
Ph. ciliaris
Ph. speciosa
Ph. caesia
Ph. obscura
Anaptichia speciosa

Lichens, growing in Illyrian beech woods (according to Beck, 7).

Usnea barbata
Allectoria sarmentosa
A. implexa
A. prolixa
Evernia prunastri
E. divaricata
Ramalina calcaris var.
R. farinacea
R. pollinaria
Lobaria pulmonaria
L. linita
L. amplissima
Parmelia olivacea
Physcia ciliaris
Ph. pulverulenta
Ph. venusta
Xanthoria concolor
Calphaca cerina
C. pyracea
Lecanora pallescens
L. tartarea
Lecanora subfusca
L. albida
Pertusaria communis
P. amara
P. wulfenii var.
Phlyctis agelaea
Bacidia rubella

B. albenscens
Lecidea rivulosa
Lecidella enteroleuca
Catillaria globulosa
C. laureri
Buellia parasema
Comocybe pallida
Graphis scripta
Gyalecta ulmi
Opegrapha vulgata
O. varia
Artonia radiata
Acrocardia gemmata
Pyrenula nitida
Pyrenula glabrata
Nephromium tomentosum
Pannaria rubiginosa
Collema nigrescens
Leptogium saturninum

Lichens, growing in Albanian beech woods (according to Markgraf, 25).

a) Epiphytes:

Collema rupestre
Pannaria rubiginosa
Lobaria pulmonaria
Peltigera canina
Nephroma resupinatum
Lecidea parasema
Pertusaria communis
Lecanora calcarea
L. subfusca
Phlyctis agealea
Parmelia furfuracea
P. fuliginosa
P. sulcata
Cetraria glauca
Ramalina farinacea
Blastema rupestris
Physcia pulverulenta
Anaptichia ciliaris

b) Growing on the ground:

Lecanora calcarea
Blastenia rupestris
Pseudoleskea illyrica

Lichens, growing in beech woods of the Thessalian Olympus (according to Handel-Mazzetti, 18).

a) On the ground:

Cladonia ochrochlora

b) Epiphytes:

Usnea florida
Evernia prunastri
Parmelia saxatilis
P. sulcata
P. furfuracea
Lobaria pulmonaria
Nephromium tomentosum
Lecanora intumescens
L. glabrata
Buellia disciformis
Pyrenula nitida

Fungi, growing on beech trees in Bulgaria (according to Atanasoff and Petroff *).

*) *D. Atanasoff* and *D. Petroff:* List of plant diseases in Bulgaria. — Sofia 1930.

I. Especially growing on *Fagus silvatica.*

Agaricus melleus
Chlorosplenium eruginosum
Clasterosporium carpophyllum
Clavaria bissiseda
Corticium lacteum
Daudelea unicolor
Gleosporium fagi
Hypoxylon multiforme
Lenzites flaccida
L. variegata
Lepiota personii
Marasmius cauticinalis
Nectria ditissima
Nummularia bulliardii
Peniophora cremea
Phyllactinia coerulea
Phyllosticta fagi
Pleurotus cornucopiodes
P. ostreatus
Polyporus ferruginosus
P. fomentarius
P. fulvus
P. hirsutus
P. versicolor

Growing on beeches generally:

Crepidotus mollis
Hypoxylon fuscum
Mycena denticulata
Panus conchatus
P. pudens
P. stipticus
Peziza aurantiaca
P. coccinea
Physosporus vulgaris
Pleurotus fimbricatus
P. limpidus
P. palatus
P. planus
P. striatulus
Polyporus abietinus
P. arcularius
P. brumalis
P. caesius
P. calceolus
P. connatus
P. igniarius
P. officinalis
P. radiatus
P. squamosus
P. velutinus
P. zonatus
Polystictus hirsutus
Pluteus exignus
Solenia poriaeformis
Stereum hirsutum
S. insigne
S. insignitum
S. purpureum
S. repandum
Tragia faginea
Xylaria hypoxylon

Commonest Fungi, growing on the ground of beech woods (communicated by Mr. B. Barzakoff, Sofia).

Boletus scaber
B. edulis
Peziza aurantiaca
Morchella esculenta
Clavaria coralloides
Cantharellus cibarius
Collybia radicata
Hygrophorus chrysodon
Lactarius piperatus
Lepiota citrophylla
L. procera
Psaliota campestris
Tricholoma album
T. nudum
Schizophyllum commune
Clavaria flava
Hygrophorus eburneus
Hydnum erinaceum
H. coralloides
Hypholoma fasciculata
Lycoperdon coelatum
Bovista gigantea
Geaster vulgatus
Cyathus hirsutus

Coprinus congregatus	Collybia clusillis
Amanita rubescens	Rusula foetens
A. vaginata	

The above named vascular plants, as well as others less typical of the beech forest may form different kinds of communities which are practically indefinitely variable. Even the rarest representatives of this vegetation, like *Rhynchocoris*, different species of *Pirola* etc., can appear under certain circumstances as chief or characteristic elements of communities. A dependence of these communities upon recognizable ecological conditions is not always to be traced. It is probable that many of them simply submit to the laws of chance [1]) and thus have no more individual value (as a plant unity), than the possible combinations, into which for example different kinds of grains may enter if mixed together.

Following examples of associations may be refered, which are especially often to be met with in Bulgaria:

A) In woods of Fagus orientalis:

a) Rubus hirtus type (Kodža-Balkan; transsection 100 m.; 4. measurements):

	Abund.	Const.		Abund.	Const.
Fagus orientalis	14	4	Viola sp.	1	2
Carpinus betulus	1	3	Scilla bifolia	2	3
Quercus cerris	1	2	Hedera helix	2	1
Quercus conferta	1	1	Ajuga genevensis	0,2	1
Rubus hirtus	12	4	Geum urbanum	0,5	1
Primula rosea	2	2	Ruscus hypoglossum	1	2
Fragaria vesca	1	2	Fritillaria pontica	1	1
Carex pilosa	2	2	Pulmonaria officinalis	0,2	1
Euphorbia amygdaloides	2	3	Lathyrus inermis	0,2	1
Potentilla micrantha	2	3	Acer platanoides	0,2	1
Pteris aquilina	1	2	Carex digitata	0,2	1

The type is characterised by a relatively dense tree vegetation. a sparse ground flora and a poor renewement.

b) Scilla bifolia type (Geniš-Ada; transsection 100 m.; 2. measurements):

	Abund.	Const.		Abund.	Const.
Fagus orientalis	12	2	Dentaria bulbifera	2	1
Cornus mas	1	1	Viola pontica	3	2

[1]) Conf. A. Palmgren in Proceed. IV Intern. Congr. Pl. Sc. 1929; I; p. 591—602.

	Abund.	Const.		Abund.	Const.
Scilla bifolia	16	2	Ruscus hypoglossum	3	2
Hedera helix	6	2	Fritillaria pontica	3	2
Rubus hirtus	6	2	Carex digitata	3	1
Geum urbanum	2	2	Sorbus tormnalis	0,5	1
Luzula silvatica	1	1	Lathraea squammaria	0,5	1
Mercurialis perennis	6	1	Corylus avellana	0,5	1
Glechoma hederacea	0,5	1	Arum maculatum	0,5	1
Salvia glutinosa	0,5	1	Lamium maculatum	0,5	1
Veronica officinalis	1	1	Potentilla micrantha	2	1
Lathyrus niger	0,5	1	Ajuga genevensis	1	1
Carex pilosa	2	1	Carpinus betulus	2	1
Pulmonaria officinalis	0,5	1	Acer platanoides	0,5	1
Lathyrus inermis	0,5	1			

(A relatively light canopy and abundant grass vegetation. A poor renewement).

c) Primula acaulis var. rosea type (Genish-Ada; transsection 100 m.; 2 measurements).

	Abund.	Const.		Abund.	Const.
Fagus orientalis	14	2	Primula acaulis var. rosea	10	2
Carpinus betulus	1	2	Carex digitata	0,5	1
Ruscus hypoglossum	0,5	1	Fraxinus ornus	0,5	1
Scilla bifolia	3	2	Potentilla micrantha	2	2
Hedera helix	2	1	Quercus cerris	0,5	1
Geum urbanum	0,5	1	Fragaria vesca	0,5	1
Ulmus campestris	0,5	1	Carex pilosa	2	1
Dactylis glomerata	0,5	1	Pteris aquilina	2	1
Quercus conferta	3	2	Viola pontica	0,5	1
Rubus hirtus	8	2			

B) In woods of Fagus silvatica:

a) Asperula odorata — Poa nemoralis type (Belasica; transsection 100 m.; 4 measurements).

	Abund.	Const.		Abund.	Const.
Fagus silvatica	9	4	Lathyrus vernus	1	3
Carpinus betulus	0,7	2	Potentilla micrantha	0,5	1
Galium silvaticum	5	3	Euphorbia amygdaloides	0,2	1
Fraxinus ornus	0,2	1	Viola silvatica	0,2	1
Saxifraga rotundifilia	0,2	1	Corylus avellana	0,5	1
Mercurialis perennis	0,2	1	Rubus hirtus	2	2
Carex digitata	0,7	1	Dentaria bulbifera	1	2
Lamium galeobdolon	2	4	Acer platanoides	0,2	1
Fagus-saplings	18	4	Primula suaveolens	2	2
Aremonia agrimonioides	0,2	1	Ostrya carpinifolia	1	2
Poa nemoralis	6	3			

	Abund.	Const.		Abund.	Const.
Veronica chamaedrys	0,5	1	Lathyrus niger	0,2	1
Fraxinus-saplings	0,2	1	Asplenium trichomanes	0,2	1
Trifolium medium,			Ilex aquifolium	0,2	1
v. balcanicum	2	2	Luzula forsteri	0,2	1
Hieracium murorum	0,7	1	Betula alba	0,2	1
Prenanthes purpurea	0,7	2	Pulmonaria rubra	0,2	1
Luzula silvatica	0,7	1	Asperula odorata	8	3

(A 100—120 years old wood. The middle size of trees 30—35 m.; the midle diametre 40 cm. N. and W. exposure. Steepness 50—60°. Stony soil. Water capacity 116, 3. Lime content 0.15 %. Humus 21 %. Actual acidity 6; general acidity 5. Subsoil: Water capacity 56,5 %. Lime content 0,28 %. Humus 12 %. Actual acidity 5,5; general acidity 4. A rich renewement of beech).

b) Ficaria verna type (Vitoša; transsection 75 m.; 4 measurements).

	Abund.	Const.		Abund.	Const.
Fagus silvatica	10	4	Corydalis solida	1	1
Poa nemoralis	3	4	Carex digitata	0,2	1
Ficaria verna	10	4	Mercurialis perennis	0,2	1
Carpinus betulus	1	3	Helleborus odorus	1	1
Galeobdolon luteum	1	3	Potentilla micrantha	0,5	1
Lathraea squammaria	0,2	1	Polypodium vulgare	0,5	1
Arum maculatum	0,5	1	Viola riviniana	0,2	1
Isopyrum thalictroides	0,2	1	Anemone ranuncu-		
Dentaria bulbifera	0,2	1	loides	0,2	1
			Hieracium murorum	0,2	1

(About 1000 m. above the sea; N. and N-O. exposure. 20—40%; stony soil; mosses and lichens lakes on the ground and grow only on the basal part of the steems and on stones. A poor renewement).

c) Dentaria-Erythronium type (Lulin; transsection 60 m.; 6 measurements).

	Abund.	Const.		Abund.	Const.
Fagus silvatica	7	6	Poa nemoralis	1	2
Dentaria bulbifera	32	6	Pulmonaria officinalis	0,3	2
Isopyrum thalictroides	1	4	Doronicum cordifolium	0,2	1
Helleborus odorus	3	4	Lamium maculatum	3	3
Erythronium dens canis	21	6	Lathyrus vernus	0,5	2
Scilla bifolia	6	6	Veronica hederaefolia	1	2
Arum maculatum	3	4	Potentilla micrantha	0,3	2
Galeobdolon luteum	3	5	Paris quadrifolia	0,2	1
Corydalis marschalliana	2	3	Galium silvaticum	0,2	1

	Abund.	Const.		Abund.	Const.
Anemone ranunculoides	3	4	Carpinus betulus	2	4
Lilium martagon	0,3	1	Luzula silvatica	1	2
Quercus sessiliflora	0,6	3	Acer pseudoplatanus	0,5	1
Ficaria verna	0,2	1	Aremonia agrimoni-		
Mercurialis perennis	1	4	oides	0,2	1
Fagus-saplings	2	4	Acer platanoides	0,3	1

(About 1000 m. above the sea. W. exposure. Steepness 15—20°. Diametre of trees 15—35 cm. Moderate renewement. Stony soil with humus. Mosses and lichens lake on the ground and are developped only on the basal part of the stems).

Communities, in which the southern element is well represented, are especielly characteristic for the lower part of the beech belt. There occur:

Ostrya carpinifolia
Corylus colurna
Quercus cerris
Q. conferta
Castanea vesca
Sorbus domestica
Ruscus hypoglossum
Clematis vitalba
Crataegus monogyna
Coronilla emeroides
Ilex aquifolum
Staphyllea pinnata
Cornus mas
Hedera helix
Syringa vulgaris
Viburnum lantana
Lonicera xylosteum
Glechoma hederacea
Satureja grandiflora
Lathraea squammaria
Digitalis viridflora
Arum maculatum
Erythromium dens canis
Scilla bifolia
Polygonatum officinale
Galanthus gracilis
Cephalanthera pallens
Asarum europaeum
Helleborus odorus
Isopyrum thalictroides
Ficaria verna
Dentaria bulbifera
Lunaria rediviva
Aremonia agrimonioides
Potentilla micrantha
Waldsteinia geoides
Lathyrus vernus
Geranium robertianum
Impatiens noli tangere
Symphytum tuberosum
Lamium maculatum
L. garganicum
a. o.

In the upper part of the beech belt communities appear, which recall the vegetation of the northern beech woods, their caracteristic elements being:

Picea excelsa
Abies pectinata
Pinus silvestris
Betula alba
Sorbus aucuparia
Alnus viridis
Ribes petraeum
R. alpinum
Anemone nemorosa
Pirola uniflora
Pirola secunda
P. media

Rubus idaeus
Rosa pendulina
Daphne mezereum
Vaccinium myrtillus
Lonicera nigra
Polygonatum verticillatum
Cephalanthera rubra
Actaea spicata
a. o.

A large number of species are however common to both parts of the belt.

Extreme sciophilous plants, such as *Monotropa*, *Neottia*, *Sanicula*, etc. are especially characteristic of the very thick and shady forests. In thin beech woods, in which the sun penetrates as much as in woods with a very stony or humid ground, specific communities occur, which scarcely belong to the real beech vegetation. Thus in sunny woods are found *Brachypodium silvaticum*, *Orchis fusca*, *Veratrum album*, *Fragaria vesca*, *Genista sagittalis*, *Viola dacica*, *Chaerophyllum hirsutum*, *Ch. aureum*, *Verbascum pannosum*, *Digitalis ambigua*, *Senecio nemorensis*, *Cirsium candelabrum*, etc. On rocky ground: *Geranium macrorhizum*, *G. lucidum*, *Saxifraga rotundifolia*, *Umbilicus erectus*, *Linaria dalmatica*, *Lamium bithynicum*, etc. On humid ground and especially on the shores of the mountain streams: *Lysimachia nummularia*, *Valeriana officinalis*, *Petasites albus*, *Ranunculus serbicus*, *Geum rivale*, etc.

Several species have a definite horizontal distribution.

According to the geographic distribution of characteristic species, 4 chief types of beech woods may be distinguished on the Balcan peninsula and many intermediate between them.

I. The Adriatic (Illyrian and Albanian) type, which is characterised by a marked presence of the alpine and western element. The Mediterranean is also well represented. As specific elements of these woods on the Balcan peninsula following species may be refered:

Acer obtusatum
Aria mougheotii
Cytisus alpinus
C. laburnum
Erica carnea
Lonicera alpigena
Majanthemum bifolium
Aconitum lycoctonum
Helleborus multifidus
Dentharia enneaphyllos
Cardamine trifolia
Peltaria alliacea
Euphorbia angulata
Myrriis odorata
Genista germanica
Calluna vulgaris
Cyclamen europaeum
Phyteuma spicatum
Buphtalmum salicifolium
Mulgedium pančičii

Here belong also following species refered for the Albanian beech woods (25):

Scilla bifolia var. nivalis
Lonicera periclymenum
Circaea alpina
Nephrodium villarsi
Quercus macedonica

II. The Hellenic type. The Mediterranean elements are especially well represented some specific representents of the Hellenic flora occur:

Arabis crepidifolia
Dianthus indodorus
Campanula oxya
Lonicera formaneckiana
Euphorbia heldreichii
Knautia nympharum a. o.

As elements of these woods occur also:

Acer monspessulanum
Pirus amygdaliformis
Pinus pallasiana
P. heldreichii
Abies regis borisii
a. o.

III. The Central type, intermediate between the precedent two and the following one. A mixture of western and eastern forms is characteristic for this type, the same as the occurence of some secondary species of beech woods. The predominant characteristic species of the beech woods, belonging here, have mostly a wide distribution on the peninsula. Characteristic are:

Secondary elements:

Heracleum verticillatum
Digitalis viridiflora
Pulmonaria rubra
Angelica pančiči
Trifolium balcanicum
Achillea grandifolia (common with II)
a. o.

Rare species:

Rynchocorys elephas
Prunus laurocerasus
Waldsteinia ternata
Lathraea rhodopaea
a. o.

IV. The Pontic type. The woods are composed by the oriental beech (Fagus orientalis). Many Colchic and South-Euxinian plant elements occur especially in the underground. Such are:

Juglans regia (wild in the Rhodope)
Mespilus germanica
Fraxinus oxyphylla
Smilax excelsa
Crataegus melanocarpa
Prunus laurocerasus (common with III)
Hypericum calycinum
Daphne pontica
Rhododendron ponticum
Vaccinium arctostaphylos
Periploca graeca (common with II)
Fritillaria pontica
Allium siculum var. dioscoridis

Scilla bithynica
Ranunculus constantinopolitanus
Epimedium pubigerum
Primula acaulis var. rosea
Symphytum tauricum
Trachystemon orientale
Salvia forskahlei

All possible intermediate forms between the 4 types named may practically be met with.

A detailed description of the numerous communities occurring in different parts of the Peninsula is not yet possible, but even that which is known concerning them in Bulgaria alone exceeds the limit of a lecture.

I do not know in Bulgaria any species, which can be regarded as exclusive elements of beech forests. Even such extreme sciophilous species as *Paris quadrifolia*, *Sanicula europaea*, *Circaea lutetiana*, *Asperula odorata*, *Neottia*, etc. which are chiefly to be met with in beech woods, occur also in shady coniferous forests etc.

The great resemblance, which exists between beech woods, growing in distant countries can scarcely be denied. Thus among 293 species, which Beck (7) records as elements of the Illyrian beech woods, 239 grow in Bulgarian beech woods too (although not all of them are typical beech wood elements in Bulgaria). Still more noteworthy is the resemblance between the beech woods of the North Carpathians and these of Bulgaria. Of 112 species, which Pawlowski [1]) records for the beech woods of Zadeczyzna 93 grow in Bulgarian beech woods also.

Of 23 vascular plants, recorded by Markgraf for the Aira Type of community in Swedish and German beech woods, 19 grow in Bulgarian beech woods too (not all are typical); of his 20 species in the *Oxalis acetosella* Type, 17 are common in Bulgaria, and of 41 species of the *Melica uniflora* Type — 39.

Of 25 trees and shrubs, growing in a beech wood near Box Hill, S. England (communicated by Dr. W. B. Turrill in a letter), 18 grow in Bulgarian beech woods too. Of 64 vascular plants, growing at Symonds Yat [2]), in the valley of Wye, 56 occur in Bulgarian beech woods.

These facts can scarcely be explained as a result of similar ecological conditions, the true explanation lying probably in the past his-

[1]) B. Pawlowski: Geobotaniczne stosunki Sadeczyzny. Krakow 1925.

[2]) According to E. Armitage in Journ. of Ecology. XII.—XIV. 1926; p. 98—109. Conf. N. Stojanoff in Bullet. Soc. bot. bulg. IV. 1931; p. 57-66.

tory of the beech association. The conservative character, which is proper to a large number of species, occurring in beech woods [3]), gives reason to suppose that they are of ancient origin, probably as old as the beech itself. It is possible, that they were spread through Europe at the same time and in the same way, as the ancestor of the beech, *Fagus pliocenica* a fossil species scarcely different from the existing *Fagus orientalis*. The Diluvial refuges of the beech, traced by Lämmermayr [1]), were probably also refuges of its companions. The post diluvial spreading of the beech was followed by their spreading, as is proved by their existing distribution. The differences in the composition of the beech woods in different parts of Europe can be understood as a result of the migrations; besides this, the woods in different parts of Erope had probably not quite the same composition even in Tertiary time.

It seems thus to be probable, that the elements of the beech communities have had a common origin and a common distributional history. Therefore, I take it to be reasonable to accept, that, if an assemblage of plant individuals belonging to different species can be regarded as a biological unity, the unity of the beech woods is one of the most typical.

There is evidence from different parts of Bulgaria, that in localities, where to day beech woods are spread, in historic times coniferous forests existed. A slow superseding of coniferous woods by beech is observed in the Balkan range and in the Rhodope. In several places in the Rila and Rhodope after the lumbering of coniferous woods beech communities take their place. The beech belt in the mountains of Bulgaria and probably also in those of Macedonia seems thus to move gradually upwards and to replace the coniferous zone. According to Turrill it is also true for Eastern Serbia. It is possible, that its postglacial movement is yet not finished, as has also been observed in North Europe (conf. Lämmermayr, l. c.). Same relations are recorded from the South Carpathians (Enculescu) and from Crimea (Wulff).

Less clear are the relations which exist on the lower part of the beech belt, because of the large destruction of the oak woods, which

[3]) Conf. also L. Diels in Berichten d. Deutsch. bot. Ges. XXXVI, 1918, p. 337.

[1]) In Beih. zu Fedde Repert. Bd. XXIV. 1920, p. 1—100.

form a natural belt beneath that of the beech. On the eastern part of the Balkan range, where large oak forests are preserved, a spreading of the oak at the expense of the oriental beech *(Fagus orientalis)* is recorded. It is yet not possible to say if it is a local phenomenon or if all altitudinal zones of the vegetation in the eastern part of the Peninsula are still moving. A retreat of the eastern beech boundary is stated also in Poland (Szafer). This movement on the eastern end of the beech area corresponds to the observations of Braun-Blanquet in Switzerland, which stated, that the eastern frontiere of the area of several Atlantic species retreated there in historic time [1]). These facts are especially interesting, if compared with the conditions in West Europe, where the beech area shows rather a tendency for an advancement. Thus, according to Lämmermayr, the beech has still not reached its natural distributional boundary in Scandinavia. Also in England the beech seems to have spread since the Roman time its spreading being stopped only by the activity of man (Tansley). The whole impression is, as if the whole beech area in Europe has a tendency for a slowly movement. If we remember on the other hand, that in the Russian scientific literature the oppinion has been several times uttered, that the climate of East Europe underlies to a slow change, growing gradually more continental, there is here a complex of questions, which deserve a nearer investigation.

The forest vegetation of the Balkan Peninsula has been in general strongly destroyed by the activity of man. A detailed account of that phenomenon is given by Adamovič (5) and more lately by Turrill (42). The beech woods remain however comparatively less damoged, than the oak forests, which grow nearest to the dwellings of men and than the coniferous, which are preferred from the technical point of view. Grazing is everywhere in the Peninsula one of the most important factors which prevents the lumbered forests regenerating. In the Strandža district fires are sometimes intentionally caused by villagers, who light the dry leaves of the previous year to destroy the abundant ticks. The fire does not do much damage to the big and sappy trees but the underwood ist severaly burnt. The chief natural factors damaging the beech woods, are

[1]) J. Braun-Blanquet: Ueber die Genesis der Alpenflora. — Verh. Naturforsch. Ges. Basel. XXXV, 1923, p. 243—261.

winds and snow avalanches in winter. Parasites cause only relatively insignificant damages.

Both beech species, occuring in the eastern part of the Balkan Peninsula, are connected together by intermediate forms. Such forms occur in all localities, where both species meet together, as in the eastern part of the Balkan range and in the Rhodope. They have an intermediate shape of the leaves and of the cupula. They form whole forests on the eastern part of the Balkan chain as above Aitos. It is there not always easy to decide to which of the two species the wood belongs.

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