

## THE INFLUENCE OF THE WIND ON THE UPPER HABITATION LINE OF THE FOREST IN THE WESTERN CARPATHIAN MOUNTAINS

The problem of the influence of wind on the upper habitation line of the forest appears in literature as a partial one, namely, in studies concerning the upper frontier of the forest, or the plant communities in the regions of the upper habitation line of the forest, respectively, this being the case of the regions in the Scandinavia (I. Tollan 1937 and others), in the Alps (P. Michaelis 1932, C. Schroeter 1926, R. A. Jugoviz 1908 and others), or in the Carpathian Mountains (M. Sokolovski 1928, J. Jeník 1956, P. Plesník 1958 and others) and in other regions, too. In the region of the upper habitation line of the forest, where comparatively frequent and physiologically strong and mechanically effective winds occur, such winds here can be regarded as a very important factor influencing the course of the upper habitation line of the forest. In this work we are going to discuss mainly the following problems: 1. The total course of the upper habitation line of the forest in the Western Carpathian Mountains; 2. The influence of the wind on the shape of the top and the trunk of a tree in the region of the upper habitation line of the forest; 3. The influence of the relief and the height of the range of mountains on the effectiveness of winds; 4. The influence of the wind on the spreading of some species of coniferous trees in the region of the upper habitation line of the forest.

### 1. The total course of the upper habitation line of the forest in the Western Carpathian Mountains.

The most important factor which in regions situated high above sea level makes the conditions of the growth of the tree vegetation far more difficult — and thus causing overwhelmingly the appearance of the upper habitation line of the forest as well as of the tree, is the lack of warmth and a short vegetation period. The climate gives a rough framework of the course of the upper habitation line of the forest in the Western Carpathian Mountains. The climatic upper habitation line of the forest lies approximately 1 400 to 1 650 metres above sea level. Slovakia is situated in the transition zone between the regions of the oceanic and the inland climate. Owing to the fact that in the climatic region of the upper habitation line of the forest the most decisive factor is the quantity of warmth during the vegetation period, the continental climate is more favourable for the height of the upper habitation line of the forest than the oceanic one, the latter having rather cold summers. Therefore, the upper habitation line of the forest in the direction towards West i. e. towards the region having oceanic climate is generally falling.

The more detailed course of the upper habitation line of the forest within the rough climatic framework depends on various factors. The most important one of them is the bulkiness and the height of the mountains. The high and bulky range of the mountains represent a piece of dry land lifted high, which by intensive heat during summer favourably influences the temperatures of the vegetation period. For example, in the High Tatra Mountains, which in the Western Carpathian Mountains reach the height of 2654 metres [Stalinův štít (Gerlach) this being the highest peak] the upper habitation line of the forest (climatic)

on the slopes having favourable soil-substrata conditions reaches (and here and there even exceeds) the height of 1.650 metres. On the other hand in the Krivanská Malá Fatra Mountains which being of a narrower and more elongated shape and having a vertical and rather diversified relief (the highest peak is Velký Fatranský Kriváň 1708 metres) the climatic upper habitation line of the forest on the slopes with favourable conditions (for the forest vegetation) reaches the height of 1450 metres above sea level. The difference of 200 metres (or even more) is caused above all by the different bulkiness and the height of the two above mentioned ranges of mountains.

The important factor which influences the detailed course of the upper habitation line of the forest very much, is the relief. In the deep and narrow valleys and in the mountain beds where the temperature inversions and, therefore, the vegetation inversion, too, appear, the upper habitation line of the forest is falling. In the glacier beds of the High Tatra Mountains the upper habitation line of the forest vacillates frequently between 1450 and 1500 metres above sea level and on the adjacent slopes is about 100 metres more.

The peak phenomena generally worsen the conditions of growth of the tree vegetation. On the peaks, crests, etc. where there are loose and easily dried up soils and where the wind has access from several sides, where the tops of the trees are not very near to each other the upper habitation line of the forest is as a rule falling about several tens of metres. In consequence of this even the lower ranges of the mountains (Slovenské rudohorie, Poľana) which do not reach the height of 1500 metres above sea level have their peaks in the region of the upper habitation line of the forest (Stolica 1476 metres, Zadná Poľana 1457 metres above sea level, etc.).

The edaphic conditions which can substantially influence the height of the upper habitation line of the forest, are usually closely connected with both the relief and the geological basis. On the granite and silica basis, especially in the ranges of mountains having the glacial relief (the High Tatra Mountains and the Ďumbier group of the Lower Tatra Mountains) in the region of the upper habitation line of the forest and above this, there are plenty of rocky seas consisting mostly of blocks of various sizes, stones and gravel. These came into existence by a strong mechanical disintegration mostly in Pleistocene. They worsen the vegetation conditions, because it is rather difficult for the soil cover to remain on them.

In brief it is possible to characterize the course of the upper habitation line of the forest in the Western Carpathian Mountains with the following words; owing to the bulkiness and the height of this range of mountains the upper habitation line of the forest reaches the highest peaks in the High Tatra Mountains and in the Belanské Tatra Mountains where they reach or exceed the height of 1 650 metres respectively. Owing to the influence of the vertically strongly diversified glacial relief as well as to the extensive rocky seas, especially in the High Tatra Mountains, the course of the habitation line of the forest vacillates rather strongly, in the vertical extent of approximately 200 metres (or even more e. g. in the avalanche grooves, under the rocky walls, etc.). Similar in characteristics is the upper habitation line of the forest in some parts of the West and the Lower Tatra Mountains (especially in the Ďumbier group) having the glacial relief. In the Lower Tatra Mountains, Ďumbier 2 043 metres, it reaches approximately 1 550 metres above sea level. In the Malá and Velká Fatra Mountains the natural upper habitation line of the forest (climatic) hardly

reaches 1 450 metres. Besides the above mentioned mountains other ranges of mountains, namely, Velký Choč, Babia hora had quite distinctly developed a (natural) upper habitation line of the forest. The rest of the ranges of the Western Carpathian Mountains did not exceed the original climatic line of the forest on the whole, owing to the influence of the peak conditions of the highest peaks and crests of the ranges of Slovenské rudohorie (Stolica, Fabova hoľa, etc. Poľana mountains) are within the region of the habitation line of the forest.

The upper habitation line of the forest of today is rather lower than the natural (original) line of the forest. This was caused by the man — the herdsman who in his efforts to win the pasture lands removed the dwarf trees as well as other forest growth and thus lowered the habitation line of the forest. A strong devastation of the forest growth by the herdsmen in the region of the upper habitation line of the forest dates from the time of the Walachia colonization (since the 15th, 16th and 17th century). The herdsmen removed the growth mostly in such places where after deforestation there appeared to be good pasture lands, especially on the broad crests and the smooth slopes of a bare relief (Velká and Malá Fatra Mountains), while on the ranges of mountains having strong glacial diversifications and extensive rocky seas they did not carry out the deforestation on such a large scale. On the carboniferous strata (limestones, dolomites and slates) there appear, as a rule, after deforestation, more suitable pasture lands (the plant communities have richer composition as far as the species are concerned) than on other substrata where there are (mainly a short time after deforestation) plenty of broad pasture lands with a less suitable, but prevailing growth of whortleberries (*Vaccinium myrtillus*). Therefore, the herdsmen carried out, as a rule, the deforestation on the above mentioned substrata more intensively than on the granite and the silica strata. In consequence of this the ranges of mountains with the bare relief on the carboniferous strata (the Kriváňska Malá Fatra Mountains, the Velká Fatra Mountains, the Belanské Tatra Mountains) had the upper habitation line of the forest strongly lowered. The Kriváňska Malá Fatra Mountains, for example, having the carboniferous basis, had its upper habitation line of the forest lowered by 250—300 metres on an average and here and there (see Belanské Tatra Mountains and other mountains) even by 400—500 metres.

## **2. The influence of the wind on the shape of the top and the trunk of the tree in the region of the upper habitation line of the forest.**

In the region of the upper habitation line of the forest and tree there are two shapes to be found, namely, the tablelike shape and the flaglike shape. The tablelike shape is characterized by the fact that the live (usually thick and long) branches are in the lower part of the trunk at a certain distance above the ground and end abruptly so that the trunk is bare or has only thin, dried-up or drying-up branches, respectively. At the top of the tree there is usually a cluster of live branches. The tablelike shapes are to be found both on the windward and on the leeward side (with respect to the prevailing winds). They come into existence when the wind dragging the snow crystals along the surface of the snow cover damages the branches as well as the needles which afterwards dry up and fall to the ground. The branches under the snow cover are protected and remain alive. The tablelike shapes can be found from time to time even under the upper habitation line of the forest on old large trees having intertwined tops. (Plesník 1959.) They explain the fact that these individuals grew during

their younger days on a free surface, where there was free access of wind and snow. The flaglike shapes have the top elongated in the direction of the physiologically and mechanically effective winds, which in the Western Carpathian Mountains are usually identical with the direction of the prevailing winds. While the origin and the development of the tablelike shapes is influenced by the course of weather in winter, the winds coming during the whole year are very important for both the origin and the development of the flaglike shapes.

As to the origin of the flaglike shapes the proper moment of the prevailing is not so important. More important is, in my opinion, the occurrence and the



A tablelike spruce-tree. The southern slope of Úplaz (Kriváňská Malá Fatra-mountains).

Stolová forma smreka. Južný svah Úplazu (Kriváňská Malá Fatra). *Foto P. Plesník*

Столообразная ель (Южный склон Уплаза, Криваньская Малая Фатра).



frequency of strong winds which are physiologically and mechanically especially effective. Besides other things this is confirmed by the fact that very striking flaglike shapes are to be found in places which are within the reach of the falling winds. On the windward slopes where the wind is forced to go upwards, the flaglike shapes are less striking in comparison with some places on the leeward side of the range of mountains, i. e. where the falling winds penetrated through the main crest.

The wind influences both the shape and the structure of the trunk. On the leeward side the tree is stowing away the wooden substance more intensively ('pressure wood'). In consequence of this the trunk is elongated in the direction of the wind and it has more or less a tearlike shape in the cross section. And the annual rings, too, are excentrically situated; on the leeward side of the trunk they are narrower and on the windward side they are wider. Together with the flaglike shape the excentricity of the annual rings and the elongation of the trunk increases in the direction of the wind, too. For example, in the case of striking flaglike shapes in the region of the upper habitation line of the forest near the Kriváňská Malá Fatra Mountains, the excentricity of the annual rings in the direction of the flaglike shape had the value of about  $(1/1,5 - 1/2,5)$  in which case the figure in the numerator is the distance of the centre of the annual rings — from the pith to the bark on the windward side of the tree, and the figure in the denominator is the distance of the pith from the bark on the leeward side of the trunk. There appeared, sporadically, of course, even individual trees having the excentricity of  $1/3$  (which means that the width of the annual rings on the leeward side of the trunk was three times as large as that of the windward side). The elongation of the trunk in the direction of the wind, measured at the height of 130 cm above the ground, was most frequently 1/1,02 rarely 1/1,1 in which case the figure in the denominator is the width of the trunk in the direction of the flaglike shape and the figure in the numerator is the width of the trunk in the direction which is vertical to the direction of the flaglike shape.

The wind aided by snow and ice brakes the branches and the tops and thus deforms the trunk of the trees. In the region of the upper habitation line of the forest this is quite a common phenomenon. After breaking away the top branch, some of the side branches crooks in the direction upward and thus takes over the function of the top branch. And so there appear in the region of the upper habitation line of the forest quite common bayonetlike shapes, this being the case of the spruce-tree (*Picea excelsa*/LINK). At the same time more branches can get crooked upwards. In the case of low and wide-branched trees growing above the habitation line of the forest, there very frequently appear various and almost bizarre shapes, in spite of the fact that after the destruction of the part of the trunk reaching above the dwarf trees (either by breaking or by grinding of the wind) and by means of snow (the rough and long branches, as a rule, bend upwards and are on the same level as the dwarf trees. They are more or less distant so that we have the impression as if there were a group of spruce trees among the dwarf trees, in spite of the fact that it is one tree) up to the level of the dwarf trees the trunk is usually rough and not at all branched with several tops. The tops are often lined up in the direction of the flaglike shapes. Sometimes there can even appear shapes of spruce-tree reminding us of a chandelier.

The shapes of the trunks and the tops of the trees are rather various, especially in such places of the habitation line of the forest trees, where there are

quite intensive wind activities. The wind here can be regarded as one of the fundamental factors which prevent its growing upwards. In this way the growth upwards lags behind the growth into the width, the trees become low, wide-branched and consequently receive the appearance of bushes. The wind, in collaboration with snow, speeds up the transition of trees into the bushlike vegetation in the region of the upper habitation line of the forest.

The wind, making the growth conditions of the tree vegetation worse, lowers the upper habitation line of the forest. The more the trees receive the expressiveness of the flaglike shapes, when the sea level is increasing, the quicker the height of the trees falls with the sea level increasing and, in consequence of this, the upper vegetation line of the forest decreases through the influence of the wind. Taking measurements in the area of the Kriváňska Malá Fatra Mountains, the author has found out that while the sea level is increasing the height of the tree is decreasing three times as quickly in such places where the trees have flaglike shapes, in comparison with those places where the influence of the winds is favourable.

### 3. The influence of the relief and the height of the range of mountains on the effectiveness of winds.

With the increasing height of sea level the general power of the wind and the number of strong winds is increasing, too, and these winds especially have strong influence on the tree vegetation. Therefore, the influence of the wind, within the area of the Western Carpathian Mountains, on the upper habitation line of the forest is the more striking, the higher the figure of the orographic unit. As far as the morphological factors are concerned, the degree of the diversification of the relief and the height of the main crest is especially to be felt in the above mentioned case. In the ranges of the mountains where the habitation line of the forest almost reaches the crest or lies only a few metres from the crest itself (e. g. Slovenské rudohorie, partially the Velká and Malá Fatra Mountains, etc.) the influence of the winds is less noticeable than in the higher ranges of the mountains (the High and partially the Lower Tatra Mountains). In the first case where the falling winds skip over the upper habitation line of the forest on the leeward side of the slopes and touch even the undergrowth below the habitation line of the forest, the uprootings in the region of the upper habitation line of the forest are on the whole rather less important. On the other hand in the high ranges of the mountains e. g. in the High Tatra Mountains where the crests reach 1 000 metres (or even more) above the habitation line of the forest, the falling winds are attacking the slopes situated still in the zone of the dwarf trees, so that they touch the zone of the habitation line of the forest. They are the cause of the appearance of very striking flaglike shapes. Above the habitation line of the tree on the southern side of the High Tatra Mountains, we meet rather frequently with cases (Predné Medodoly, southern slopes of Gerlach, Slavkovský štít [Peak], etc.), where the top of the trees is formed almost by one line of tree branches lying one above the other on the leeward side of the trunk. Further it points out that a very important factor for the development of the flaglike shapes are the strong and especially the falling winds.

The undergrowth in the region of the upper habitation line of the forest is rather resisting to the respective uprootings: they have their centre of gravity

rather lowered (owing to the fact that the trunks have branches reaching almost to the ground), their growth is low and their tops intertwine somewhat less, etc. In spite of this, on the southern side of the High Tatra Mountains, on the southern slopes of Lomnický štít (Peak) and Slavkovský štít (Peak) and elsewhere, the uprootings of the spruce-trees in the region of the upper habitation line of the forest are quite a common sight (in this case, however, rather unfavourable edaphic conditions have their co-effects, too, e. g. stones and block of stones with soft layers of soil).

The total orientation of the range of mountains and the prevailing winds there have their influence on the effects of the winds in the region of the upper habitation line of the forest. Central Europe has overwhelmingly in its free atmosphere air-currents coming from the North-West. Even the western winds have their share here, too. The figures concerning the directions of the winds in % on the Lomnický štít (Peak) (2 632 m) during the years 1941—1944 and 1947—1957 were such as follows (I.—XII. month): \*)

Period	N	NE	E	SE	S	SW	W	NW	C
I.—XII. month	16	3	3	4	8	13	21	25	7

In consequence of this, the most frequent direction of the growth of the trees in our mountains is from North-West to South-East and from West to East, or directions similar to those mentioned above. The directions of the flaglike shapes from West-North-West, North-West and North-North-West appear usually in the top parts of the crests as well as on the cliffs and slopes of the leeward side of the range of mountains where the falling winds are effective. In the north range of mountains, where the main crest is situated more or less vertically to the prevailing winds, the air-currents have to go upwards the windward slope, however, they try to go round the range of mountains which thus form an obstacle for them, and, therefore, they follow the direction of general orientation of the range of mountains. This is well to be seen, for example, in the Kriváňska Malá Fatra Mountains, the general direction of which is from West-South-West to East-North-East. On the windward slope of the main crest the growth of the trees is mostly to be seen in the direction from West-South-West to South-West and on the cliffs on the leeward side of the range of mountains the growths appear in the direction from North-West and West-North-West. These are, however, only rough directions of the growth of trees, in details the influence of the relief is to be seen, which in fact is veering the air-currents.

#### 4. The influence of the wind on the spreading of some species of the coniferous trees in the region of the upper habitation line of the forest.

With the exception of the High and Belanské Tatra Mountains the climatic line of the forest in the Western Carpathian Mountains was originally formed by the spruce-tree (*Picea excelsa* LINK). The herdsman in his effort to get vast areas for grazing purposes, removed not only dwarf trees, but also the forest overgrowth. He intensively removed (most frequently by fire) the overgrowth of spruce-trees in the highest forest zone. On many places he moved the upper habitation line of the forest to the beech zone which is situated below

\*) According to the data given by Dr J. Otruba (a publication on the wind conditions in Slovakia is being prepared at present).

the spruce-tree zone. Therefore, in the zones of a strongly lowered habitation line of the forest, we find the beech-tree forest. The beech-tree (*Fagus sylvatica* L.) strongly prevails on the upper habitation line of the forest in the Kriváňská Malá Fatra Mountains, Velká Fatra Mountains (and elsewhere, too, where there were extensive pasture lands to be found), but in all cases its presence is of secondary importance only.

In the zone of the natural upper habitation line of the forest there appears, if we mention the deciduous trees, the rowan-tree (*Sorbus aucuparia* L.) which especially in the High Tatra Mountains appears on some places rather frequently, this being the case where the rocky seas are situated rather low, the birch-tree (*Betula pubescens* EHRH.), both trees, however, seldom grow as high trees for they have mostly the shape of low, wide-branched trees or bushes. Quite a different character has the upper habitation line of the forest in the High Tatra Mountains and partially in the Belanské Tatra Mountains, too. In the High Tatra Mountains the beech-tree does not practically appear at all. The fundamental trees which form the upper habitation line of the forest are the spruce-trees. In the region of the upper habitation line of the forest there appears rather frequently the pine-tree (*Pinus cembra* L.). It usually grows in groups or individually, too, and is to be seen above the habitation line of the forest. In the region of the habitation line of the forest, there, on some places, mixes with spruce-trees and forms light spots of spruce-pine overgrowths e. g. in the region of Zelený potok, Bielovodská dolina and elsewhere. Here and there we can find it growing in groups or individually, too, even in light spruce-tree overgrowths under the habitation line of the forest.

In the southern parts of the High Tatra Mountains, in the region of the upper habitation line of the forest, we can rather frequently see the the larch-tree (*Larix decidua* Mill.). On some places it reaches even the southern slopes of the Tatra Mountains, and mixes especially with spruce-trees. On the other hand, in the northern part of the Tatra Mountains its occurrence is very rare. In the region of the upper habitation line of the forest on the southern slopes of the High Tatra Mountains it forms, in some places, together with spruce-trees rather light overgrowths where there frequently appears as a member of trees belonging to the lower habitation line of the forest where the larch-tree does not appear at all, or sporadically only.

In sections, where on the southern slopes the larch-tree mixes frequently with the spruce-tree, the upper habitation line of the forest runs rather low (usually about 1 490—1 540 metres above sea level). Apart from this there are many uprootings of the spruce-trees to be seen. In the overgrowth there is usually a lack of superannuated spruce-trees. Uprootings occur either in the case of individual spruce-trees or groups, but those occurring on the continuous surfaces are rather rare. The uprooted spruce-trees are usually in various degree of decay, some of them are covered with a layer of humus and are overgrown with whortleberries, others again are beginning to decay or their uprootings occurred not long ago. The uprootings being of various age show that this process is quite a normal one and that it steadily repeats itself. The spruce-trees reach large dimensions and are less resisting to uprootings and are uprooted finally by the gust of strong winds, especially by the so-called falling winds which frequently occur in this region.

On the mentioned sections of the upper habitation line of the forest with its steadily occurring process of uprootings (sometimes more and sometimes less)



we find on the forest overgrowths nearing the habitation line of the forest or even below this line (up to 100 metres or even more under the habitation line of the forest) isolated bushes of dwarf-trees (*Pinus mugo* TURRA) which in some places are dying out or have just died out and are decaying under the tops of the spruce-trees. It is quite clear that the dwarf-tree, as an outstanding heliophyte, could take roots in the middle of the forest overgrowth on free areas only, where the wind had uprooted the whole groups of trees, or on the continuous areas of forest respectively. The spruce-tree appears after some time among the dwarf-trees. It grows and overshadows the dwarf-trees under it, which, when the tops of the trees become intertwined, have to die out for want of light.

When we compare the individual larch-trees with the spruce-trees growing on the habitation line of the forest or above it, we see that the habitus of the larch-tree is, as a rule, worse than that of the spruce-tree individuals. Both the top and the trunk of the larch-tree is more deformed in comparison with the spruce-tree. The larch-tree, too, does not reach over the spruce-tree both on the habitation line of the forest and above it. It is not to be seen that the larch-tree is a tree overcoming the spruce-tree, as far as the upper habitation line of the forest is concerned, and that it appears both on the habitation line of the forest and above it. The author has never seen the appearance of larch-trees in such places where the upper habitation line of the forest is high and where the spruce-tree reaches its climatic line.

It is obvious that the spruce-tree as a heliophyte likes above all the sunny sides of the southern slopes. As it is to be seen from the analysis of the above mentioned phenomena, one of the main reasons of the growth of the larch-tree in the upper habitation line of the forest is the loosened intertwining of the spruce-tree overgrowth. The loosening of the intertwining occurs on the one hand from edaphic reasons, because on the rocky seas there hardly appears a thicker and continuous soil cover, and on the other hand in consequence of the wind conditions. On the southern slopes of the High Tatra Mountains strong and especially falling winds destroy the continuance of the spruce-tree overgrowth by causing frequent uprootings, whereas the larch-tree is resisting both to the uprootings and breakings. In this way the wind enables the weaker and heliophyte larch-trees to grow on free areas of the spruce-tree overgrowths. Rather a frequent occurrence of the larch-tree on the southern side of the High Tatra Mountains is the consequence of the co-ordination of two factors, namely: the favourable southern position advantageous for the larch-tree and the effects of strong winds removing the spruce-tree, which can be regarded as a strong rival of the larch-tree in the struggle for survival.

At the end of this work the author wishes to stress the fact that the wind plays an important part as an ecological factor in the upper habitation line of the forest. It makes the growing conditions of the tree vegetation worse. It has a strong influence on the habitus of the top and the trunk of the tree and forms a whole series of various shapes. It quickens the transition of the tree vegetation into the bush vegetation and lowers the upper vegetation line of the forest. An especially unfavourable influence have the winds which are of a falling character. In the High Tatra Mountains (especially on the southern slopes where the occurrence of the falling winds is rather frequent and reaches even the upper vegetation line of the forest, the wind becomes a factor which has a definite influence on the habitation line of the forest: it not only lowers the same, but

also influences by its intervention in the struggle for the survival of the trees the composition of the species of the growth on the vegetation line of the forest, by which fact it impresses on the habitation line of the forest, which is on the southern slopes of the High Tatra Mountains, a special character which differs in principle from the habitation line of the forest in the rest of the Western Carpathian Mountains.

The analysis of the phenomena enables us to learn the processes which take place on the upper habitation line of the forest. The knowledge of the above mentioned processes has practical significance. In Slovakia in the region of the upper habitation line of the forest and above this line, too, where there are pasture lands in existence for several hundreds of years, the vast bare areas above the habitation line of the forest cause a whole series of undesirable phenomena (avalanches, speedy erosion, floods, etc.). At present, at the time of stormy development of the national economy and industrialization of Slovakia, where many hydro-electric power stations are being erected, we have to take care of the water resources. It is one of the reasons why we have started the reconstruction of the upper habitation line of the forest and why we try our best to move it upwards.

The afforestation in the region of the upper habitation line of the forest or on the line of the bare existence of the forest vegetation is unusually difficult. An especially unfavourable influence has the wind mixed with snow, because it grinds off the top branches of the trees when these penetrate through the snow cover. It is necessary to give protection to young trees against the wind (by erecting obstacles to the wind — planting out dwarf trees, erecting artificial obstacles from the cut-off branches, stones, etc.). Only the analysis of the conditions in the upper habitation line of the forest and the knowledge of the processes taking part there will help in practice to find the suitable way of tackling such a difficult problem, namely, how to carry out the afforestation in the upper habitation line of the forest.

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## VPLYV VETRA NA HORNÚ HRANICU LESA V ZÁPADNÝCH KARPATOCH

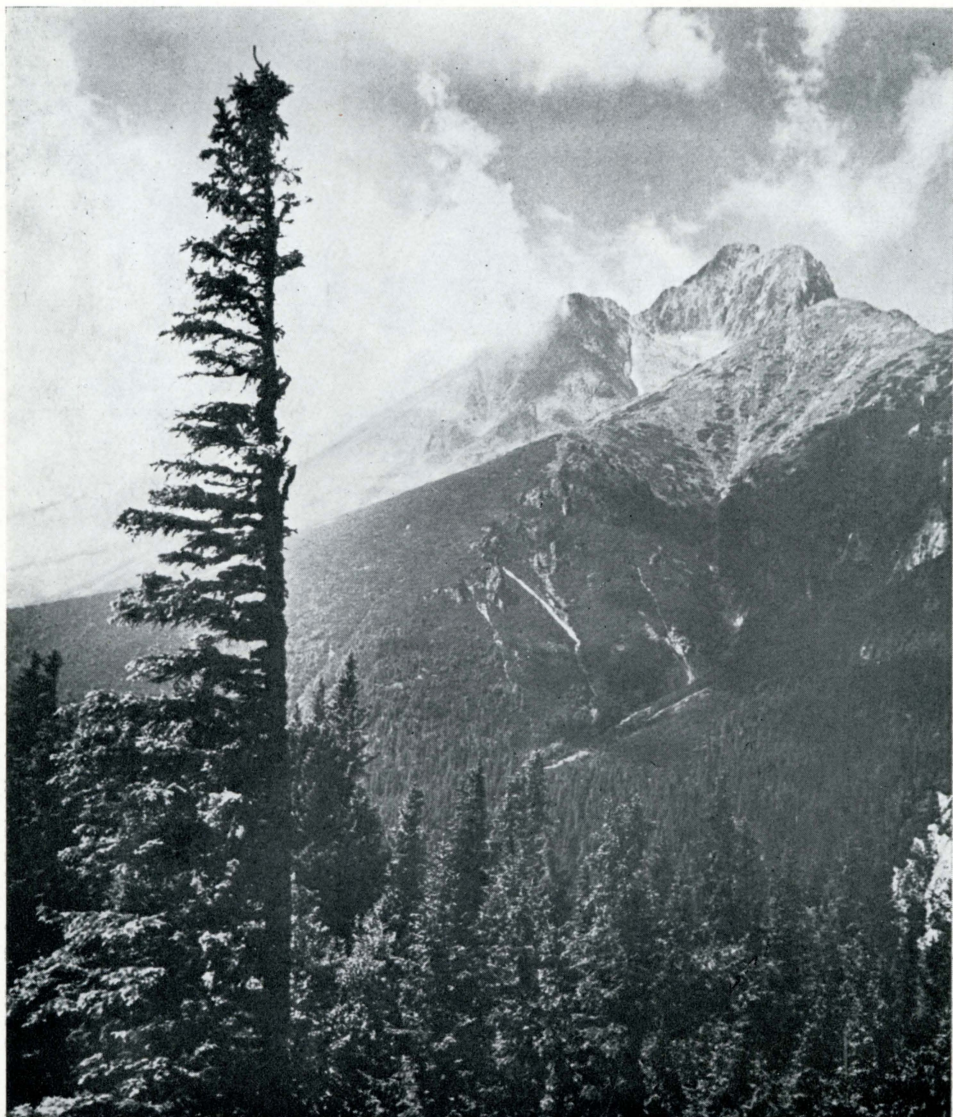
Vietor je v oblasti hornej hranice lesa mechanicky a fyziologicky silno pôsobiacim činiteľom. Vplýva (najmä za spoluúčinkovania snehu, snehového a ľadového závesu) na tvar koruny a kmeňa stromov, čím vznikajú zástavové, stolové a iné formy. Vietor brzdí predovšetkým vzrast do výšky, v dôsledku čoho stromy rýchlejšie nadobúdajú krovitý vzhľad. Celkove zhoršuje vzrastové podmienky stromovej vegetácie, čím znižuje hornú hranicu lesa.

V nižších pohoriach, kde klimatická hranica lesa siahla do vrcholových častí hlavného hrebeňa alebo len o niečo nižšie, účinky vetrov sú oveľa menšie než vo vysokých pohoriach. Vo Vysokých Tatrách s vertikálne silno členeným glaciálnym reliéfom, kde najvyššie hrebene vyčnievajú až 1000 m nad hornú hranicu lesa, je vplyv vetra z celých Západných Karpát najmarkantnejší. Vetry, ktoré sa prevalili cez hrebene, dopadajú spravidla na svah ešte nad hranicu lesa a ako padavé vetry veľmi účinne pôsobia na najvyššie ležiace stromové porasty. Vo voľnom ovzduší prevládajú u nás SZ vetry. Preto účinky vetrov sú veľmi badateľné najmä na južnej strane Vysokých Tatier. Nachádzame tu veľmi výrazné stromové zástavy, vietor tu celkove silno znižuje hranicu lesa. Je tu veľmi veľa vývrátov, ktoré v nižších pohoriach v oblasti hranice lesa sú dosť zriedkavé. Tým, že silné, najmä padavé vetry odstraňujú väčšiu časť vývrátov málo vzdorný smrek, vytvárajú vhodné podmienky pre rozšírenie konkurenčne slabšieho svetlomilného smrekovca a ovplyvňujú jeho zastúpenie v porastoch na hornej hranici lesa.

## ВЛИЯНИЕ ВЕТРА НА ВЕРХНЮЮ ГРАНИЦУ ЛЕСА В ЗАПАДНЫХ КАРПАТАХ

В области верхней границы леса ветер является сильно действующим механическим и физиологическим фактором. Вместе со снегом, снежным и ледяным покровом он оказывает влияние на форму кроны и ствола деревьев так, что возникают барьерные, столовые и др. формы. Ветер замедляет, прежде всего, рост в высоту, в следствие чего деревья быстрее принимают кустообразную форму. В целом он ухудшает условия роста древесной растительности и тем самым снижает верхнюю границу леса.

В невысоких горах, где климатическая граница леса поднимается почти до вершины главного хребта, влияние ветра значительно меньше, чем в высоких горах. Влияние ветра в Западных Карпатах лучше всего можно проследить в Высоких Татрах, где преобладают сильно расчлененные ледниковые формы рельефа, и самые высокие хребты поднимаются на 1000 м и выше верхней границы леса. Ветры, которые переваливают через хребты, опускаются, как правило, на горный склон еще выше границы леса и сказываясь вниз, сильно влияют на древесную растительность, находящуюся в самых высоких местах. На территории ЧСР преобладают ветры северозападного направления. Их воздействие, поэтому, больше всего заметно на южной стороне Высоких Татр. Здесь можно встретить хорошо выраженные древесные барьеры, и ветер здесь заметно снижает границу леса. Имеется здесь много вывороченных деревьев, которые редко можно встретить в области границы леса в более низких горах. Тем, что сильные опускающиеся ветры выворачивают не очень устойчивую ель, создают условия для распространения еще менее устойчивой лиственницы и для ее появления в растительности около верхней границы леса.



A flaglike spruce-tree, Stezky, High Tatra Mountains.

Zástavová forma smreka, Stežky ve Vysokých Tatrách.

Флагообразная ель (Стежки, Высокие Татры).

(Příloha k článku: P. Plesník: The influence of the wind...)

*Foto P. Plesník*





The pine-tree in Bišlovodská Valley, High Tatra Mountains.  
Limba v Bišlovodskej doline, Vysoké Tatry.  
Кедр в Беловодской долине (Высокие Татры).

*Foto P. Plesník*