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THE SUCCESSION PROCESSES AND CLIMAX OF TATRY MTS NATURE FORESTS

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Abstract

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In this paper is presented the study of structure and dynamics of succession processes in nature forest with spruce, ceder pine and larch, situated in spruce vegetation tier (1520–1540 m a.s.l.), in Furkotská dolina valley. The dendrometric measurement was realised in 1992 and 2008. The principal timber species is spruce *Picea abies* with an admixture of ceder-pine *Pinus cembra*, and larch *Larix decidua*. Into experimental plot enters dwarf pine *Pinus mugo* in small islet. The age, height and girth texture is widely differentiated. This fallows from the fact that the stands on the upper forest line are found at different situations in different stages of their development. The forest ecosystems in reserach plot belongs to the spruce vegetation tier and to the optimal developmental stage. The spruce in the experimental plot predominates in height and girth. In the individual layers (especially in the upper and middle ones), however, ceder-pine exhibits relative supremacy and is of greater age. Ceder-pine, like fir, shows great adaptibility of growth to the conditions of the life medium. Besides this, it possesses great vitality which it retains up to considerable age. By single examination on the experimental plot it was possible to judge only the contemporary texture of forest canopy.

Key words: development stage, dendrometric measurement, dynamics of forest ecosystems

Introduction

The Tatry Mountains (Západné Tatry and Východné Tatry Mts) are situated in the northern part of the Slovak Republic. They are the highest mountains in Carpathian range that stretches 1,800 km long from Slovakia into Romania, via Poland, Ukraine and Hungary. They are an outstanding crossroad on the migration routes of Alpine and Arctic biota, an island where rare mountain ecosystems with unique plant and animal species are preserved. A total of 1,300 species of vascular plants occur in the Tatry Mts. These include several species of Nordic origin, most of which are relict species from the last Ice Age at their southern boundary of distribution in the Tatry, and several Tatran and Carpathian endemics. More than 150 species are listed for protection.

In ecological terms, the Tatry Mts are one of the characteristic regions of the Carpathian arc, with wast mountain forests and unique alpine landscape. Their greatest value in Central Europe is that their natural environment is especially well preserved.

Land and natural resources use in Tatry Mts

Mining activities in Tatry Mts started in the 15th century. The longest and most intensive investigation was done on the Kriváň peak. The highest galleries were drilled in the altitude of up to 2,100 m. The gainless operation was closed in 1787. Almost simultaneously with the mining operations, the iron excavations started in some valleys, and the copper, silver and gold exploitation in the main ridge of the Západné Tatry Mts. After 1871, open-pit mines (sand-pits and quarries) appeared in connection with the construction of roads, railroads, hotels and sanatorias in the Tatranské podhorie foothill. The largest impact to natural environment was exerted by the sand-pit near the Tatranská Polianka village, and a quarry near Tatranská Kotlina, which the Tatry National Park Administration forced to abolish in 1958 and 1961 respectively. All historic subsurface mining operations were abandoned before the establishment of the Tatry National Park in 1949.

The first known documents referring to grazing in the sub-Alpine zone in the Belianske Tatry Mts date back to the year 1310 (Somora, 1970). For the time being we lack older documents relative to grazing but it is not necessary to prove that no grazing existed here before. Agriculture is controlled by climatic, terrain and soil conditons, which only allow production of resistant and little demanding cereals. In the past these were mainly hemp and flax. Since the 18th century the principle crop is potatoes. Vegetable and fruit trees are cultivated only in small gardens. Since the beginning of its historical development, farming was connected with cattle and sheep breeding, for which since the Middle Ages alpine pastures were used, mainly in the Belianske and Západné Tatry Mts. Grazing areas extended locally over 2,000 m especially in the height of the shepherding expansion in the 17th and 18th centuries. Grazing had a number of adversary effects and left a considerable damage in the area. The destruction of the environment was mainly caused by shepherds, who in order to obtain more grazing areas intentionally cut dwarf pine stands and the uppermost parts of the forests. It was also caused by animal hoofs, leaving degraded and eroded slopes. In spite of all efforts, the restoration of the original habitat has not yet been completely successful. Cattle and sheep breeding partially decreased in the second half of the 19th century, mainly as a result of industrialization of the region. The grazed area in Alpine pasture was gradually reduced by land reclamation of more accessible and higher quality sub-mountaine pastures and meadows. Sporadic attempts for grazing appeared even after the establishment of the Tatry National Park, but after 1955 they were successfully eliminated for the benefit of nature conservation. Human interference for agricultural production has halted vegetation change or completely destroyed the natural vegetation.

Forests were cut and converted to charcoal which was needed in smelting works and foundries. Krajčovič (1975) reminded, that forest culture in urban and private-owned forests within the area of the Tatry Mts was influenced by pecuniary interests of the owners who claimed possession of the major part of the forests till 1918. Timber production was being effected by total fellings, though small holders practiced random cutting down. Till the Forest Statute was passed, forest owners did not trouble very much about reafforestation. But with the development of timber trade, the need for a speedy reafforestation by plantation or by sowing seeds in the snow became apparent. But reafforestation worth speaking about did not begin till after 1918. Total clearings and areas cleared away after storm devastation were reafforested, by non-repeated planting operations, mainly with spruce, even on limestone. The fir and the beech got into the growing wood only by wind-borne seeds. In the forest economic plans of 1933 and 1952 there are already signs that forest culture will be directed towards making spruce growths more resistant to winds and towards useful changes in the structure of the forest. Unfortunately the steps taken were not correct.

Since the end of the 19th century, the irresponsible forest management provoked considerations about the need for an expropriation act, but such a law never passed. The Hungarian Ministry of Agriculture tried to solve this problem by a systematic acquisition of the most threatened forest lands, which shortly before started to be purchased by rich foreigners, mainly by the Duke of Hohenlohe and by baron Diergardt. After 1918 the new Czechoslovak Republic continued in this effort, which culminated by the complete purchase of the Tatry land from both before-mentioned landlords. At the time when Tatry National Park originated, 29,331 ha of the land out of the total territory of 43,505 ha was in the state ownership, and by 1958 another 18,827 ha became a direct property of the former Tatry National Park Administration. In 1987, the Západné Tatry Mts became a part of the Tatry National Park.

However, traces in the forests and dwarf-pine stands have been left by mining activities, older iron works by charcool burning and in the last century also by lumbering. Therefore the present state of forest and dwarf-pine zones cannot be explained only as a result of abiotic stand factors, since these were primarily influences caused by man, direct and idirect, which by their long, but mainly concious and direct action radically changed the condition of the vegetation cover and in the way surpassed other ecological factors (Somora, 1970).

In 1964 the Tatry National Park Forests (TANAP) are assorted for two groups: the group of natural forests (their area being 19 107 ha) including the upper belt of forest about up to 1250 m a.s.l., and the group of forests in reconstruction (their area being 18 371 ha including the lower belt of forest up to 1250 m a.s.l. The TANAP has its greatest tasks in the group of forests in reconstruction. The forest structure is very changed there owing to pastures, wind and insect calamities. In place of different spruce-trees with fir, larch and maple, there are mostly pure spruce-stands in the granite part. In addition also beech is missing in the calcite part. Owing to those changes stands are weakened, and damages by wind are increased. Spruce stands are also damaged by red deer.

Wind as factor of forest disturbance

Disturbances are a major driver of vegetation change and not necessarily rare events that are „outside" the system. The sudden destruction or death of plants and/or animal can result in a cascade of biotic and physical changes in ecosystems that can play out over centuries and large landscapes (Hunter, 1999). Episodic disturbances appear to control tree regeneration in most forest types. Disturbance is any relatively discrete event in time that disrupts ecosystem, community, or population structure and changes resources, substrate availability, or the physical environment. Disturbances are described in terms of a disturbance regime which is the aggregate behaviour of disturbance over long time frames and large areas. Since forests are highly layed ecosystems, disturbances can affect one layer and leave other layers relatively intact. For example, surface fires may kill only the shrub and herb layer but not the tree layer, whereas crown fires will kill all the trees in a stand but may allow root system of shrubs and herbs to survive, enabling these species to dominate in the early stages of vegetative regrowth. Wind damage that uproots trees and churns the mineral soil has a different effect on ecosystems than wind breakage which only disturb the above-ground portions of ecosystems. In some cases different types of disturbance can have similar effects. Where high winds are frequent, such as at high elevations, wind can kill or damage some species, shifting the competitive balance toward lower-stature, wind-resistant vegetation. The ecological effects of disturbance size are largely a function of biological and physical edge effects between disturbed patches and the surrounding undisturbed forest. In landscape where human activity is a reality and threats to biodiversity are high, using natural disturbance regimes as a model for management may be the best way of maintaining biodiversity while meeting other human needs.

Krajčovič (1975) remarked, that wind in Tatry region is the biggest disturbance factor, especially in terms of frequency, size and severity. In Tatry Mts records of such disturbances are being made only from the year 1915. In that year the storm destroyed 1265 ha of forest with 287 000 m^3 of material in the area between Smokovce and Tatranská Lomnica. In 1919 the disaster overtook Vyšné Hágy on an area of 340 ha and Tatranská Lomnica on an area of 150 ha. In 1925 a storm laid low 150 000 m^3 of wood in Tatry Mts. In the years 1930 to 1940 the destruction were on a smaller scale. The greate calamity that overtook the Tatry region was that of 1941 when the trees felled by the storm in stateowned forests represented material on 270 000 m^3 . In the forest belonging to the town of Kežmarok about 150 000 m^3 of calamity material of 1941 was made into timber. The period from 1941 to 1961 was one of current disasters. In 1961 the storm rooted out some 150 000 m^3 of material, in 1964 about 80 000 m^3 , in 1965 about 48 000 m^3 and in 1966 about 67 000 m^3 . In the region of Podspády and Javorina the uprooted material amounted to about 130 000 m^3 in 1970, and about 94 000 m^3 in the year 1971. Recuring disasters make the cultivation of spruce growths difficult, and sometimes, systematic group-restoration by small lots practically impossible. Disastrous damages in the Tatry region cannot be entirely eliminated in the future, but they can be minimized by correct tending of the trees (Krajčovič, 1975).

The largest blowdown area (12 000 ha, 2,7 million m^3) in Tatry region on November 19, 2004 lies within the forest of the Tatry National Park. It forms a nearly continuous belt just above the lower margin of the forest, 34 km long and 1 to 5 km wide, from Podbanské to Tatranská Kotlina. It is within a narrow altitudinal zone, from 800 to 1250 m, generally with a south aspect. There is a big outlier of blowdown on the steep slopes of Mount Grúnik, at 1400–1500 m. Single trees and small groups were blown down in otherwise intact forests in a wider area. Immediately before the storm the forests were undistinguished and not particularly attractive. They would have been a forbidding monotonous monoculture of millions of young spruce, each exactly like each other to anyone who is not a forester or a botanist. They lacked the flowers, diversity, and old trees that make the beauty of forests. As far as can be ascertained, this landscape was very recent: only just beyond human memory it had been far more diverse and beautiful. Spruce will probably always be dominant, whatever is done; but every effort should be made to promote larch, fir, birch, alder, rowan, and sallow. These will reduce the dangerous dependency on a species that is particularly prone to windblow and bark-beetle. They will add greatly to the beauty of the Tatry and its value as a habitat. An attempt to bring back beech should be considered (Rackham, 2006).

Ecological succession and climax

Ecological succession is the process of temporal change in community composition. Succession is the process of community change throug time. Three mechanisms – facilitation, tolerance, and inhibition – probably describe species-by-species replacement during succession. Succession is the nearly universal phenomenon of temporal change in species composition following natural or anthropogenic disturbance. Although the study of succession was pioneered by plant ecologicts who traditionally focused on vegetation change, succession results in corresponding changes in the community composition of animals, fungi, bacteria, and protists. Some ecologists suggest that the phrase „plant succession“ should be replaced by „vegetation dynamics“ to emphasize that the population dynamics of interacting organisms are ultimately responsible for successional patterns (Morin, 1999).

Succession occurs when the structure and species composition of a community change because of natural causes. Change due to the direct influence of humans is not considered to be succession. Primary succession is vegetation change on bare ground (xeroseres), on rock (lithoseres) or in new lakes (hydroseres). Secondary succession is colonisation and change on areas disturbed by fire, flood or cultivation where some seeds, vegetation, animals or soil structure remain. The grass and herb stage of a xerosere is usually invaded by scrub species and later by trees. Environmental factors, such as fire and heavy grazing pressure, can halt or divert succession (Chapman, Reiss, 1999). Secondary succession occurs after disturbances disrupt established communities without completely eliminating all life. Storms, fires, clear cuts, mining, and agricultural clearing all provide the kinds of disturbances that set the stage for secondary succession. By understanding succesion, it is possible to predict and perhaps accelerate rates of community change after natural disturbances such as fires or storms. Optimal ecological restoration of sites disturbed by human activity clearly depends on knowledge of the factors that promote rapid or othervise desirable successional changes. Succession provides a conceptual framework for integrating the many diverse processess that effect natural community patterns and can also inform the application of sound ecological principles when restoring degraded ecosystems. Seasonal succession refers to a regular annual phenology of abundance or activity that occurs without the permanent loss or addition of species from the community. Example could include the sequence of flowering by woodland plants, seasonal variation in insect reproduction, or seasonal variation in the activity and abundance of aquatic microorganisms. Cyclic succession occurs in special circumstances in which a small number of species tends to replace each other over time. A classic example of cyclic succession involves the heather, *Calluna,* and the bracken fern, *Pteridium. Calluna* can invade stands of *Pteridium* under some situations. However, as the *Calluna* plants age andsenesce, they can in turn be replaced by *Pteridium.* The cycle may take over 25 years to complete (Morin, 1999).

The concept of climax as a stable end point is misleading. It is uncommon for vegetation or ecosystems to reach an equilibrum point or condition of no net change, which requires a perfect balance between opposing forces of disturbance and biotic development. Some ecologists still find to use „climax“ or the potential natural vegetations in a less formal way. Most applied ecologists who deal with real pieces of ground still need to use some way of classifying and mapping the potential vegetation assemblages that could occur over time on a site (Hunter, 1999).

Most classification of forest successional stages recognise four to six major types and potentially many more of these are stratified by different environments, or potential natural vegetation types. The Slovak forest ecologists use mostly the classification by professor Korpeľ (1989). In forest management is frequently discussed the late successional stage with old growth forests. Old growth is frequently associated with absence of evidence of human activity. This meaning is more accurately described by the term „virgin“ or „primary“ forest which is commonly used term in Europe. Ecological definitions of old growth or virgin forest have typically been based on age, live and dead stand structure, or population processess. A common denominator is the presence of a population of old trees and their associated structures (dead trees, tree canopy gaps). Virgin forests in which the canopy trees can regenerate in small canopy gap disturbances will frequently develop a fine-grained patch structure and will theoretically develop a „reverse-J“ age class disturbation or become multi-cohort over long time periods (Hunter, 1999).

Material and methods

Changes in the growth structure, production ability and regeneration processes are evaluated on the basis of dendrometric measurements on the Furkotska Valley experimental plot on the upper forest line in a forest group *Piceeta cembrosa* (Zlatník, 1970). The research experimental plot was established in 1992 for the purpose of obseving stand structure dynamics in the spruce vegetation tier. Evaluation varies from 1520 to 1540 m a.s.l., its inclination is 20 degrees and exposure is south-west. Soil type is Podzol. The obtained results from observing in 1992 were published (Vološčuk, Míchal, 1995).

Detailed biometric and taxa-dendrometric measurement was repeated in 2008. Despite a signed tourist trail with relatively high use pass through Furkotská dolina valley, the forest in experimental plot has retained the character of a natural forest. There are visible tracks on the stands around the plot as a result of former long-term sheep grazing on the neighbouring alpine meadows. The windstorm in november 2004 was not intervened this experimental plot. The natural forest of the group of forest type *Piceeta cembrosa* in experimental plot is very good pattern for study of natural succession processes in spruce vegetation tier of Tatry Mts forest with spruce, larch and ceder pine.

Results

Characteristic of the forest vegetation tiers in Tatry Mts

Zlatník (1975) reminded, that by the time when people commenced felling and burning the Tatry Mts forests of fir-beech, spruce-beech-fir and spruce tiers and the dwarf-pine *(Pinus mugo)* stands of subalpine tier, the leader woody plant biocoenoses, whose species composition had already been the one characteristic of the present time and developing under the type of climate nearly identical to the present late Subatlantic, had occupied a continuous area reaching as high as the mountain ridges and right below the rocky shields. In the present woody species tiers, these are relict dealpine and prealpine species, primarily the rocky and detritat chasmophytes, which belong to the *Carex-Elyna* belt composing the arctic and alpine vegetation (the alpine tier in Tatry Mts). The *Larix-Pinus cembra* belt, to which belong, from among the species of the present subalpine tier, *Pinus mugo, Ribes petraeum* and *Betula pubescens* subsp. c*arpatica*, has also survived the last Glacial in the Tatry Mts *Pinus cembra* and *Larix decidua* are found at significantly lower position of the subalpine tier, mainly in the valleys. The spruce species now dominanting the natural and even the present altered Tatry Mts. Forests of all tiers did not „move into" the Tatry Mts as the *Picea* belt, together with its accompanying species, until during the postglacial period. The last belt of the series to appear on the Tatry Mts scene, mainly as late as during the Subatlantic period, was that of *Fagus-Abies.* Fir is now capable of forming stands in the fir-beech tier of the northern and eastern Carpathian bordelines, particularly on limestones and calcareous dolomites. In the Západné Tatry Mts this species reaches, from the south, as high as the bordeline between the spruce-beech-fir and spruce tiers, where it grows together with *Pinus cembra*. Beech, either as the dominant or subdominant species, occurs now solely in the flysch and limestone northern margins of the Tatry Mts (Zlatník, 1975).

Forests in the spruce vegetation tier (1250–1550 m a.s.l.) in granite mainly belong to the group of forest types *Lariceto-Piccetum* superior grade and *Cembreto-Piceetum,* and in limestone and dolomite to the group of forest types *Fageto-Piceetum* superior grade. This forests have been greately influenced by human activities, mainly from grazing un the past. The wind disturbance on wide areas was very rar. Remnants of the natural forests have a very high ecological functions which are very closely connected with the specific forest structure. This structure is also stable in the smaller areas and the major characteristics are unchanged. In this tier occur climax forets in some small areas with *Picea abies, Pinus cembra, Larix* *decidua* and *Sorbus aucuparia.* In this forests the vegetation change can be caused by effects of the plants themselves (autogenetic succession), or from external environmental influences (allogenetic succession). A large number of factors can influence vegetation change. Some of these are due to human interference (pasture, shepards), wind storm events or the effects of seasonality and are not part of succession, although they may have considerable effects on the communities.

The potential climatic forest timberline in the Vysoké Tatry Mts is 1685 m a.s.l. and in the Belianske Tatry Mts 1625 m a.s.l. The forest timberline in Tatry Mts is unnaturally decreased by a minimum of 10–40 m and a maximum of 200–250 m. To reconstruct of forest timberline has been used ceder pine (75%), larch (10%), spruce (10%) and mountain ash (5%). Dwarf pine has been used as a supporting preparatory species. It has been also assumed that a long-term natural seeding of spruce, larch, dwarf pine, mountain ash and subalpine wilow species (mainly *Salix silesiaca)* are occuring (Somora, 1970).

Forests in the spruce-beech-fir tier (650–1250 m a.s.l.), in central Vysoké Tatry Mts in continental variant spruce-fir tier, belong predominantly to the group of forest types *Pineto-Piceetum* and *Lariceto-Piceetum* low grade. The wind permanently disturbed the forests in this tier. Due to the long time human influence (grazing) and wind disturbance the succession processess in forests of this tier were permanetly disrupted on the development phase befor the optimum phase (age 80–120 year). For this reason in this tier are not possibilities for vegetation to come to an end (climax or final vegetation type), and the vegetation type is not able to regenerate on the site. Certainly trees are very long lived, and therefore, within our time-scale, seem to form a highly stable vegetation type. But they do not regenerate. Many trees seem unable to establish directly underneath adults of the same species. This create a shifting patchwork of regeneration. Often major phases of regeneration only occur after some catastrophically destroyed part of the forest. In such cases, which species regenerate may depend on the type of catastrophe. So regeneration of damaged communities may not always end in the same species structure (Chapman, Reiss, 1999).

Discussion

According to height, age and spatial differentiation, with such signs as layering and vertical structure, the stands in the Furkotská dolina valley research plot belong to the advanced phase of the immature stage, with a stagnation of regeneration. There is big stem size and height differentiation, volume is 345 $m^3.ha^{-1}$ and natural density, represented by basal area is 44.31 $m^2.\ ha^{-1}$. According to tree volume, spruce represents 56%, ceder pine 38%, and larch 6%. According to tree numbers, spruce represents 75%, ceder pine 19%, and larch 6% (Vološčuk, Míchal, 1995). The dominant species in herb synuzial complexes are *Calamagrostis arundinacea* and *Vaccinium myrtillus*.

The lower boundary of the ceder pine area is connected to the upper boundary of the spruce forests. The upper boundary of the ceder pine area is approximately 100 m above the spruce and larch areas. Today´s area of occurrence for the ceder pine is only a remnant of its natural area which has mainly been reduced by shepherds.

For ceder pine the optimal environment for regeneration is light accumulation of raw humus with berries and mosses. Shade and an environment of moss carpets 5–15 cm thick are also suitable for ceder pine seedlings, but not for larch regeneration. Ceder pine not only requires this environment, but also creates it.

The well-being of ceder pine and larch seed germination depend not only on the availability of a favourable environment, but at the some time also on sites exposed to continuous succession.

Larch is equipped with all the qualities of „R-strategies" species (except a nominal short age), with wide ecological valence, they are selected for the quick occupation of open niches, and they are equipped with a high reproductive ability, but in the face of strong interspecific competition they are not able to use it. For this reason they dominate during the initial stages of succession.

The ceder pine is typical „K-strategies" species and therefore is a tree of the advanced stages of succession. In contrast to larch and spruce ceder pine is a tree of only medium growth. Its height seldom exceeds 20 m. Ceder pine is similar to the larch in that it is a long-lived tree. It reaches 500–600 years in stand and more that 1000 years as solitary trees. The permanent participation of ceder pine in a stand requires, that in the following generations, it will not be endangered by close horizontal density, so typical of the optimal phase in a virgin spruce forest.

Ceder pine succession is most well-developed in zones in the Tatry Mts ecosystems where local climates allow maximum ceder pine occurence, areas absent of larch. Larch in the Tatry Mts with typical narrow crown and wind resistanc in climax stands has all the sign of a pioneer tree with clear connections to the damage of progressive succession, above all, windfall. Long-term larch participation on areas without forest calamities can ensure only a mosaic of average climax and extreme azonal stands.

Analysis of the forest structure of research plot in Furkotská dolina valley with spruce, ceder pine and larch shows, that natural forests of the spruce forest vegetation tier are mostly in the immature stage today, or at the beginning phase of the optimum stage. Only a few stands are in the advanced phase on the immature stage.

It can be stated generally that in introduced developmen stages, natural regeneration stagnates, or has yet to begin. It could be expected that the long-term synergic effect of anthropogenic factors, mainly air pollution, speeds up development phases towards forest breakdown. It could then, in turn, result in the creation of better conditions for the regeneration of light loving trees – ceder pine and larch. In natural forests of the spruce vegetation tier, stand development is governed by the autoregulation ability of the typical progress through the stages of development cycle.

Situation in structure of Lariceto-Piceetum nature forests

Korpeľ (1990, 1992) mentioned that forest of the spruce and spruce-beech-fir tiers are made heavy functional and integrated demands on by society, that requires their longevity and functionally suitable structure. Despite of their species simplicity they are relatively sensible to biotic, but especially abiotic injurious agents. Kubíček et al. (1992) noted, that forests of spruce vegetation tier have not yet been adversely affected by emission. However, due to the permanent and long-time wind disturbances of this forest ecosystems, the succession is unable to came of climax stadium. There are in Tatry Mts only a few areas with old *Lariceto-Piceetum* climax forests.

By Holubčík (1970) due to the protection against man´s interference the structure of the stands points out the conditions of an evenaged, horizontally and vertically little articulated stand. In the majority of cases then predominate trees in layer 2 and 1. Layer 3 (the low one) attains the highest representation only in stands on very unfavourable sites on which the trees are very low owing to soil shallowness. These were the consequences of the natural development of the stand eliminated and in the majority of cases, cropped. Natural mortality and elimination of the trees due to destructive effect of snow and wind is highest in spruce stands in which annually attains 1.1% to 2.6% of the stock.

In stands affected by windstorm in November 2004 one must reckon also with artificial planting in order to secure regeneration and multifunctionality of forest ecosystems in Tatry National Park. In that case the planting material must be obtained from resistant trees.

Conclusion

Structure of natural forest with spruce, ceder pine and larch in Furkotská dolina valley given by the origin of the stand and its components, by stand admixture, girth and height articulation, by crown closure and internal construction of the stand. On the basis of dendrometric taxation measurements and valuation of each individual it is possible to come to the following conclusions:

- The experimental plot in Furkotská dolina valley has been established in 1992 in natural forests in which the principal timber species is spruce *Picea abies* with an admixture of ceder-pine *Pinus cembra*, rowan tree *Sorbus aucuparia* and larch *Larix decidua*. Into experimental plot enters dwarf pine *Pinus mugo* in small islet.
- The age, height and girth texture is widely differentiated. This fallows from the fact that the stands on the upper forest line are found at different situations in different stages of their development.
- On the experimental plot there is relatively a great number of trees – 528 per ha, non-uniform density and in some places interrupted crown canopy.
- The spruce in the experimental plot predominates in height and girth. In the individual layers (especially in the upper and middle ones), however, ceder-pine exhibits relative supremacy and is of greater age.
- Ceder-pine, like fir, shows great adaptibility of growth to the conditions of the life medium. Besides this, it possesses great vitality which it retains up to considerable age.

– By single examination on the experimental plot it was possible to judge only the contemporary texture of forest canopy. In the future, on periodically repeated measurements, it will be possible to valuate also the development of the stands.

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