HEALTH CONDITION STUDIES OF DOMINANT CONIFEROUS TREES ALONG AN ELEVATION TRANSECT IN THE EASTERN ALPS

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INTRODUCTION

Mountain ecosystems are projected to experience a higher rate of climate warming than most other regions of the world (IPCC 2007). For example, the average warming within the last century was 1.6°C in south-eastern Switzerland, which is two times higher than the average increase for the Northern Hemisphere (Wipf et al. 2013). The growing season has lengthened an average of 2.7 days every decade since 1951 (Defila & Clot 2005; OcCC 2008). Longer growing seasons enable plants to grow at higher elevations. Lenoir et al. (2008) estimated that forest species shifted their optimum distribution by 29.4 m/decade in the 20th century based on the altitudinal optimum of 171 species in France. Elevation shifts of distribution towards mountain summits, spread of thermophilous species, colonisation by new species from warmer areas and phenological shifts are already evidens for all considered taxonomical groups, including higher plants (Vittoz et al. 2013). These changes will likely cause extinctions for alpine species (competition, loss of habitat) and lowland species (temperature or drought stress). On the other hand warmer conditions induce an upward shift of the tree line and in species distribution. In addition important turnovers for the dominant forest trees are to be expected (Vittoz et al. 2013).

The aim of the study was to determine the state of health of two dominant conifers from the montane to the subalpine belt along an elevation transect in the Alps. Another goal was the compare the health status of the selected taxa in the light of the possible elevation shift. We hypothetized that the most severely deteriorated plants occur in their lowest elevation in both taxa.

MATERIALS AND METHODS

The examinations were executed in the Hochkar Mountain, in the Eastern Alps along a vertical transect from 800 m to 1750 m amsl. Among the dominant species of the given vegetation belt 3-3 individuals were measured in 50 meters. In the montane and supermontane belts (800-1500 m) the Norway spruce (*Picea abies*), while in the subalpine belt (1550-1750 m) the dwarf mountain pine (*Pinus mugo*) were investigated with an acoustic tomograph. The measurements were completed in different heights from the soil respecting the various physiognomy of the species (0.4, 0.8, 0.2 m for *P. abies* and 0.2, 0.4 m for *P. mugo* respectively).

Measurements were made using the FAKOPP 3D acoustic tomography, which is able to detect the size and location of decayed or hollow regions in the trunk non-destructively (Trenyik et al. 2017). This mobile instrument is suitable for determining the extent of rotting by using a method not destroying tree tissue. Parallel to the fibers the propagation speed of sound can reach 4000 to 5000 m/s; it is 15 times faster than in the air. FAKOPP has been developed based on this considerable difference as well as on the fact that propagation speed of sound waves is in strong correlation with the mechanical characteristics of wood substance (Divós & Divós 2005). This advanced method of examination measures the propagation speed of sound within the tree. The basic measurement principle is that sound velocity drops if there is a hole between two sensors. The existence of deterioration and cavities are mapped by identifying the change of propagation speed (Divós et al. 2005, 2008). FAKOPP is generally used in case of park trees in order to examine the health status of one specimen (Trenyik et al. 2018). There was no previous example of using it on dominant coniferous trees (Picea abies and Pinus mugo) in systematically selected elevations along a vertical transect, thus our examination can be considered as novum.

RESULTS AND DISCUSSION

The highest rate of deterioration (56%) and the highest average deterioration considering all examined layers were detected in the lowest altitude (800 m) of the *Picea abies*. This could refer to significant stress which indicates the changes' rapidity in the montane and supermontane belt. According to the lower rate of decay and the standard deviation, the altitudinal optimum of the species is presently around 1000 m and above 1400 m. The lowest average deterioration (1.44%) was recorded in the highest stands dominated by *Picea abies* at 1500 m amsl. From 900 to 1200 m, and above 1400 m, the decay of *Picea abies* had similar values than the managed and mixed-age *Quercus petraea* stands in the Carpathian Basin (Trenyik et al. 2017, 2018). The extent of the decay of the species slightly decreases from the ground level.

In the case of *Pinus mugo*, the degree of decay was the lowest (6.67%) in the upper limit of the subalpin belt. The measured decay of *Pinus mugo* was varied in a very tight scale and only in the highest parts, in the upper limit of the species habitat showed changes.

Our measured data correspond with the field observations of Lenoir at al. (2008) and the model of Vittoz et al. (2013) which predicts the future expansion of species and vegetation belts to the higher alpine zone in line with the warming temperature.

CONCLUSIONS

Our results showed that the individuals of *Picea abies* had the worst health status in the lower limits and the best health status in the higher limits of the species habitat, which predicts the spreading of the species and its dominated stands to the higher levels. In the case of the *Pinus mugo*, the frequency of the investigations were not sufficient to express the changes clearly. According to our results, the sensitivity to the global warming of the dominant tree species in the supermontane belt and their altitudinal optimum could be expressed by instrumental examinations.

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