# Declining and injured needles in young spruce outplantings and their causes

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## *Introduction*

Unfavourable conditions of large-area clearings in the localities of the Orlicke hory Mts, which are heavy laden by imissions, mark also the number of the contemporary problems with a forest reproduction. Large amount of the stand, mostly spruce, established here in the 1980s now runs to (or approaches) Age Class II. Nonetheless, the forest economy is still confronted with their unsatisfactory growth, development and health condition. The aim of my contribution is to describe briefly some of the general ecophysiological presumptions of prosperity, preservation and dispersion of the
botanical types.

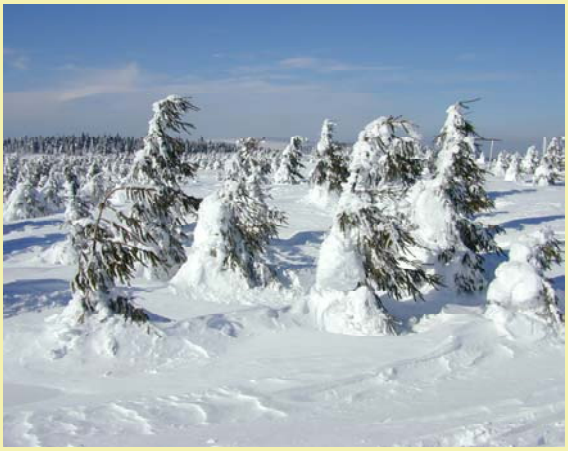

Fig 1: The influence of abiotic factors (frost, high insolation, wind and heavy snow) on spruce needles and shoots in course of winter time at high mountains.

Fig 2: In early spring the anaerobic stress is comming through the creation of the frost incrustation, which prevents the access of the oxygen (air) to young spruce shoots.

## *About dormancy*

In our geographical location the active and passive vegetation periods of some wood species are regulated by the environmental factors, in particular by the day photoperiodism and thermoperiodism. The process of the plant hardening against the frost effects proceeds in gradual mutually connected phases. The autumn cool weather activates the process of hardening and any following exposition to the cold and frost deepens it. When the tissue is exposed to early cold, it underlies to this stressor. In particular, young needles and sprouts can lost this resistence to frost also in the middle of the winter after several days with temperatures above 8 C. The temperatures above zero at the end of winter cause the renewal of the meristematic activity of the cells and the possibility of the late frost stress appears; budding sprouts get frozen, the cambial zone and the condactive function of the trunk are disturbed.

## *Damages of the tissues caused by frost*

Direct damage of vegetative tissues by frost is connected with the creation of the ice crystals in tissues which destruct them mechanically by their enlargement. The destruction concerns both needles and trunks in the areas with higher concentration of parenchym where the frost cracks happen, later to be cured by the frost ruptures. The extracellular ice-cover formation in apoplast happens more often. The ice acts as the dry air. Since the steam pressure over the ice is lower than the steam pressure over a supercooled liquid, the ice drains the water from protoplasts and they contract up to 2/3 of their original size. Redistribution of the free or fixed water and the ice phase continues until there is a balance of water potential between the ice and the water in the protoplast. Survival in such situations helps those tissues get over the water stress during dry and hot summer days. The older age-groups of needles and generally grown, mature trees, often displayed to the necessity to face such conditions, react quickly and adequatly, and the damage by the frost or heat or dryness happens less often (the so-called frost paradoxon).

The examples of the frost damage of needles and sprouts are shown in the pictures. The 2002 examinations pointed out the combined frost effects with high illumination during sunny bright winter days and the further aspects of the spruce damage in the Orlické hory Mts. One of these aspects is also the anaerobic stress (hypoxy) in the tissues under the snow cover. The compaction of the snow layers (the extrusion of air from the snow) and the creation of the frost incrusation, which prevents the access of the oxygen (air) under the packed layers of the snow, are caused during the winter by a drop in temparuteres during the day, by the shorter or longer periods of warming or cooling, by the new snowfall or mixed rain-and-snowfall. The solid snow cover lasts mostly in the highest locations from November to April. In early spring the anaerobic stress, the shortage of the oxygen in the constant cold and other stressors (Fig. 2), of the spruce under the packed snow culminates. Pathological frost desiccation continues until the spring during higher air temperures. At that time thes pruce finishes the winter passive period (kviescency).

Trees cannot refill the waterlost from the soil reserves if the soil is frost or just cold - the roots do not breathe and the water has higher viscisity. The water balance of the trees is negative, the content of the water in the tissues drops below the life threshold. The water lost, contraction and mortification of the cells, untightness of the tissues, drawing in the air, oxidation of the phenolitic substances, including the lignin (See Fig. 3) is the result. Reddening and browning of the needles and their mortification is the visual manifestation. The crucial role plays the condition of energetic balance, respectivly the malnutrition of the individual trees and their youngest parts in particular. The young growth with a generally low reserve of energeticly rich substances cannot successfully face many stress factors. This is not a physiological state, but a pathological state. It concerns a life phase when a phenotypical plasticidy and the modification adaptation of the wood species to the environment only gradually implement. The processes of adjusting the growth and architecture of the trees to the environment would probably proceed more successfully (i.e. physiologically) under the screen of the parent stand..

## *Acknowledgement*

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Fig 3: Direct damage of current spruce shoots by late comming frost is connected with the creation of the ice crystals in tissues which destruct them mechanically by their enlargement. Young, nonlignified shoots are deformated


Fig. 4: Frost dessication and break down of needle mesophyll cells (Norway spruce). 4. 6. 2002, top of hill “Anenský vrch”, Orlicke hory Mts.