

Ecological and hydrological field studies in southern Karelia within the easternmost part of the Baltic Sea Basin in Onego/Ladoga Lakes system

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During more than 40 years ecophysiological investigations of woody plants (*Pinus sylvestris* L., *Picea abies* L., *Betula pendula* Roth.) responses to different natural and anthropogenic factors in conditions of the north-western Russia (Eastern European taiga forest) have been conducted (Fig. 1-2).



Fig. 1: Geographical location of the research areas.

Stationary research ("Gabozero" Research Station) :

Long-term investigations in the northern taiga of Karelia were organized by Dr. L. Kaipainen, who was an initiator of studies of biophysics of woody plants in the Karelian Research Center in Petrozavodsk. Major studies are conducted at the "Gabozero" Research Station located 50 km north of Petrozavodsk in bilberry pine forest (Fig. 3). The environmental factors and main physiological processes in woody plants, namely photosynthesis, transpiration, water flux, water potentials, and growth rate have been monitored using an automatic system for continuous monitoring and discrete methods. Variability range of water potential quantities and grad. Ψ , a speed of water fluxes, water storage and resistances were obtained in different links of soil-plant-atmosphere system.

Dynamics of daily and seasonal CO_2 exchange in the woody plant shoots was defined and quantified and developed a model of the potential CO_2 exchange as function of environmental factors. Thereafter, we investigated effects of the main regulatory environmental factors on water regime and photosynthesis. We found that the high rate of these processes was observed within a large range of the hydro-meteorological factors, suggesting that the species under study have adapted to the wide range of growth conditions.



Fig. 3: "Gabozero" research station



Fig. 2: Karelian pine forests.

Field studies across the north taiga of Karelia:

In addition to stationary system of measurements, portable equipment was used to perform ecological measurements in different forest types (Fig. 4). We found that needle transpiration capacity ($41.7 \text{ mm ha}^{-1}\text{yr}^{-1}$) and xylem water conductivity ($101 \text{ ton m}^{-2} \text{ yr}^{-1}$) were constant in the forest types of different productivity. On the base of analysis of our own data and data available in literature, it have been found that annual photosynthetic productivity averaged over crown in the middle-aged pine trees ($1.52 \pm 0.13 \text{ g g}^{-1}\text{year}^{-1}$) is constant in the similar climatic conditions (Karelia, Finland, Sweden). Using portable system of measurement of gas exchange (Li-Cor), photosynthesis and respiration of coniferous trees exposed to toxic pollutants were conducted in the north of Karelia, (Kostomuksha Mining Plant ("Костомукшский ГОК") and on Kola Peninsula. Monchegorsk and North Nickel Mining Plants ("Мончегорский комбинат", "Североникель"). Among the results of this research, we estimated photosynthetic sink of CO_2 into pine forests in normal (background) conditions and near large sources of industrial pollution.



Fig. 4: Field studies

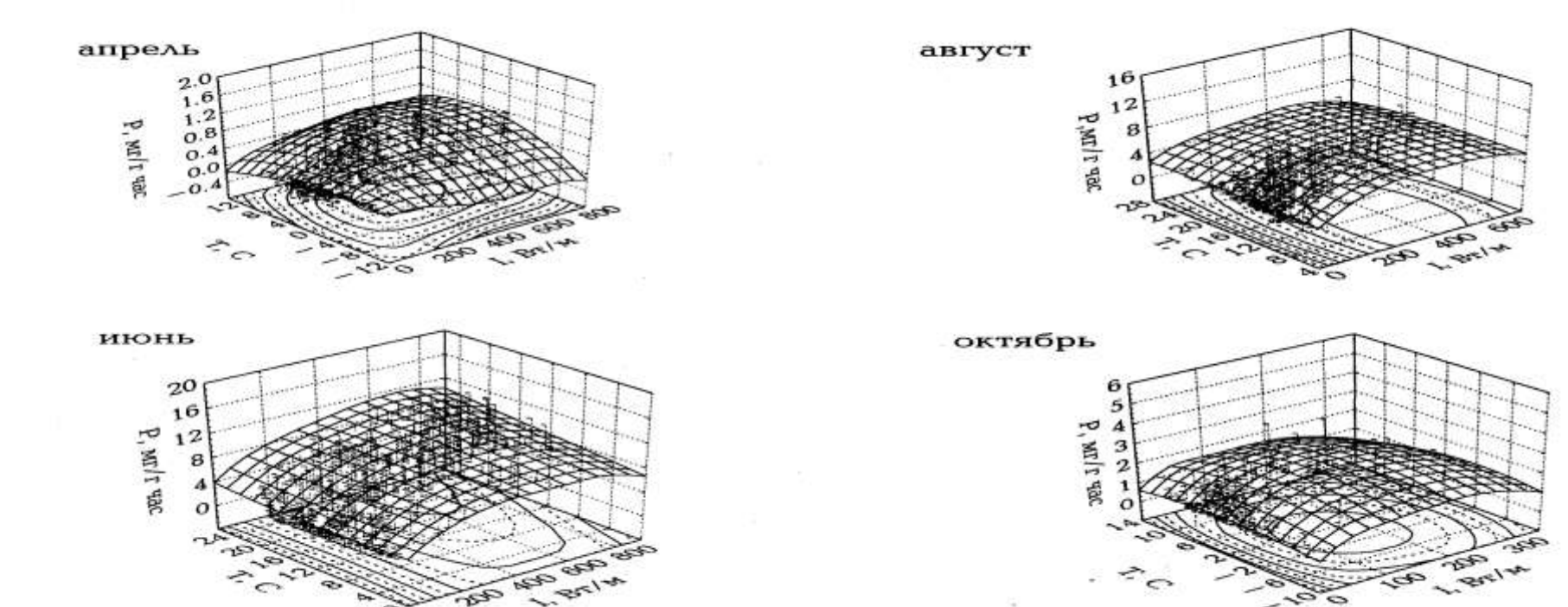
Laboratory studies:

We assessed the acquisition of efficient and biological (internal) ratio optima N:P:K for *Pinus sylvestris* L., in the vegetative tests (53:28:19 and 55:8:37 respectively) (Fig. 5). Comparison of these values with those obtained for *Pinus sylvestris* L. under natural growth conditions showed their affinity with an internal optimum. Our finding indicates that the optimization of mineral nutrition in nature follows the path of stabilization of the internal (biological) optimum. These results are perhaps the experimental confirmation of the idea of a plant organism development strategy, which is not aimed to achieve maximum economic efficiency but to maintain some steady state, favorable to life of the species.



Fig. 5: In the laboratory

On the base of field researches conducted during many years, the scopes of natural variability of main physiological characteristics of woody plants were revealed in wide range of environmental conditions of large region of the north-western taiga zone.



1. Experimental values of photosynthesis (P) approximated with spline-function of temperature (T) and illumination (I) and contours of transections of these functions for four months during the warm season.

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