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DENDROCHRONOLOGY IN THE LITHUANIAN SSR

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INTRODUCTION

Radial growth of trees presents a unique possibility of restoring ecological aspects of their growth dynamics, and of evaluating the conditions of their environment in large areas. A study of yearly tree rings can be the basis of reconstructing past climate and of predicting multiannual macroarea conditions, if the dynamic radial growth regularities of trees are known.

Studies of annual and long-term climate and biospheric changes under the effects of natural factors and human activities have recently acquired a first-rate importance. In the Lithuanian SSR studies of tree rings were started in 1953 and initially covered alder (*Alnus glutinosa*), pine (*Pinus sylvestris*), spruce (*Picea abies*) and other dendro-species. This was the beginning of developments in the new branch of dendrochronology as a complex approach to tree ring data. The results were applied in historical studies of past climate reconstruction, in astrophysical and geophysical studies as content variations of radioisotopes in tree rings, and in exact dating of wooden objects.

In the Lithuanian SSR these studies lie in the junction of forestry, dendral taxation, climatology, geliphysics and geophysics, but at the same time they maintain and develop their initial roots of forestry and ecology.

The first tree-ring dynamics study on specimens from local forests was performed by the present author as a worker of the Institute of Forestry of the Lithuanian SSR. In the course of two decades from 1933 to 1952⁸ radial growth of alder plantations

in the habitat of Birzu Giria was studied. The results, together with data on other three species witnessed prospective possibilities of such investigations for spruce, pine, birch and ash (Bitvinskas 1961).

The next important study was carried out at a Forestry Design Establishment (Miskoprojektas) as an evaluation of current growth rates in living forests. Investigation sites were chosen in 105 habitats of pine (*Pinus sylvestris*) and in 30 habitats of spruce (*Picea abies*) and 60 to 260 year long chronologies were built. They showed regularities of forest growth in the Republic and local variations. Experience of processing tree-ring data was accumulated on over 320,000 specimens. The effects of precipitation rates, air temperatures and solar cycles were evaluated for the first time (Bitvinskas 1964, 1965a, 1965b). Applicability fields in different branches of forestry were defined (Bitvinskas 1965c, 1965d, 1968). Several hydrothermal climate factors were found, which closely correlate with tree-ring dynamics in limited areas (Bitvinskas 1984).

A new stage of dendrochronology started, when at the Institute of Botany, Academy of Sciences of the Lithuanian SSR, first a group (1968) and later a Laboratory of Dendrochronology was founded. By supplying exactly dated wood specimens for the vast programme "Astrophysics and Carbon Isothopes" which is performed in a number of Soviet Institutions (for results see the report by prof. G. E. Kolčín), we extended our activities outside the Lithuanian Republic and began active sampling over the whole Soviet Union. A new generation of dendrochronologists appeared: J. Kairaitis, J. Karpavičius, A. Stupneva, V. Brukštus. Programs of dendrochronology were also initiated at the Lithuanian Institute of Forestry (Acad. L. Kairiukštis, V. Stravinskiene) and at the Lithuanian Academy of Agriculture (Prof. V. Antanaitis, I. Čersikiene, V. Bartkevičius). (Bitvinskas & Kairaitis 1975, Bitvinskas et al. 1981, Karpavičius & Ramanauskas 1978, Gikis et al. 1982, Stupneva 1981, Stravinskiene 1981, Pakalnis 1971, Balčiūnas et al. 1983, Zokaitis 1981, Antanaitis & Zagreev 1981, Sitnikaite 1978, Bitvinskas 1981).

SCOPE AND OBJECT

Living forests of our Republic were at the beginning of our work and at present the main object of our studies. Different

habitats of pine and pruce trees, as well as alder and oak have been studied thoroughly. Sampling sites outside Lithuania provide specimens of pine, spruce, larch and cedar.

About 2.5 million annual rings are at present in different stages of processing only at the Institute of Botany. Note, that in the past few decades early- and late-wood tests have been performed separately. This has resulted in an improper mastering of Soviet-produced densitometers owned by our Laboratory (*Bitvinskas* 1983).

Next to living forests specimens from ancient buildings and archeological excavation sites constitute a very important source of information. By cross-synchronizing with long-living trees, they give long chronologies. In Lithuania we have one more source of samples - logs and stubs from peat excavations (in Lithuania pine wood is well preserved in upper and lower peat layers) (*Bitvinskas* 1978). Similarly to other West European countries, numerous logs of different age are found in rivers, and their ring structure is sometimes relatively well preserved. One of such log "cemeteries" is near Smurgon in the Neris (*Vilija*) river, in Soviet Bielorussia.

METHODS

Widths of tree rings are measured by microscopes MBC-1, MBC-9 and fed to a computerized data-acquisition system mostly on punched cards. Chronologies are processed on computers, which perform indexation, synchronation, and correlation of sequences with climatic, cosmic and other factors (human activities) (*Bitvinskas* 1961).

In the whole Lithuania, which has a rather small territory, practically all forest areas are now covered by our studies. Sampling sites are chosen in areas of different production rates and different moisture contents. For regional studies the samples are taken along profile lines (*Bitvinskas & Kairaitis* 1978). Along such a line, forests of similar habitats and constitutions are chosen. One of such lines extends from Murmansk to the south through Lithuania to the Carpathian Mountains and includes old plantations of pine containing crowberry and bilberry (*Bitvinskas & Kairaitis* 1978).

We have also compiled several methods of evaluating the effects of human activities, such as soil drainage, smog etc.

The ideas were originally suggested by the present author (Bitvinskas 1961, Bitvinskas & Kairaitis 1978).

To build long-term sequences of peat findings, a method of complex studies was compiled. It employs dendrochronological, carbon-isotope, palynological and botanical analyses (Bitvinskas 1978).

We have also found several hydrothermal factors, which are correlative with tree-ring dynamics (Bitvinskas & Kairaitis 1978).

Of cosmic factors affecting tree growth over large areas, we have paid most attention to the solar activity, which has a strong influence on atmospheric circulation, and consequently, on long-term regularities and extreme behaviour of biomass in separate regions of the earth. We have rejected the traditional attempts to correlate tree growth rates and Wolf numbers. Instead we sought, and found, a correlation between long-term variations of solar activity amplitudes and 22-year cycles in the amplitudes of radial growth in the same period. We have also studied radial growth inside separate phases of solar cycles (at the maximum, at the minimum, and in course of reduction and increase) in the same 22-year cycles. In the recent years we have undertaken a more complex programme of evaluating the growth in separate years. We also evaluated radial growth variations for the species, the habitat, and the geographic location in cycles of 44 and 88 years (Bitvinskas & Kairaitis 1978).

RESULTS

Several hundred dendrochronologies of pine, spruce, oak, alder, larch, and other trees have proved the efficiency and the applicability of tree-ring correlation studies for Lithuania and for other regions of the USSR. The revealed regularities are already used in scientific and practical applications.

Our studies cover different ecological levels: relations of radial growth dynamics to the environment studied on separate individuals and tree stands of similar selection (Bitvinskas, Ramanauskas, Karpavičius), on separate habitats (Bitvinskas, Kairaitis, Karpavičius, Kairiukstis, Čerskiene, Brukštus, Balčiūnas), on separate coenoses (Bitvinskas, Kairaitis, Stravinskiene), in separate regions (Lithuania, Mongolia) and o

large areas along profiles (Kola Peninsula-Lithuania-the Carpathian Mountains, Lithuania-Far East along the 50-55 latitudes), as well as the concentration of carbon isotopes in the biosphere (Kocharov, Stupneva, Dergacev, Bitvinskas).

The combined efforts of Lithuanian tree-ring researchers helped in the introduction of a unified approach to the methods of evaluating tree-ring structures, developing long chronologies (Klaipė, Užpelkio Tyrelis), in dating architectural and archeologic objects. Good cooperation with researchers from Leningrad, Yartu, Tbilisi, Uralsk has been established.

Complex studies of peat and preserved trees buried in peat in Lithuania open the prospect for a chronology of no less than 200 years, which will be published soon.

Floating chronologies on sub-fossil oak are 5700 years long. Solar-activity based regularities of tree growth (Karpavičius, Ramanauskas 1978, Bitvinskas 1978) are linearly related to the amplitudes of solar activity variation in the corresponding periods. The already mentioned reference scale of solar activity periods opens the way towards a prediction of long-term advantageous and adverse environmental situations in the biomass production rates. At present the method is being developed and checked for different species, climatic and edaphic factors and regional conditions.

Tree-ring chronologies on the Murmansk - Carpathians line, on specimens from Bashkiria and West Caucasus revealed optimal and unfavourable situations in large areas, as well as minimum and maximum growth periods over different times. The advantages of the profile-line or regional studies over those including only separate sites were shown. A shortening trend of the growth period was found in the North-South and North-West directions (Stupneva 1981).

We are proud of our contribution to modern studies of astrophysical and geophysical phenomena based on carbon isotope measurements on exactly dated tree rings. Our laboratory has 3000 dated wood specimens from Lithuania, Karelia, the Caucasus and other areas for the program "Astrophysics and Carbon Isotopes". Solar activity based 11-year, 22-year and 100 year cycles of ^{14}C content were observed for the first time in tree rings. The relation of the solar effect to the cosmic radiation rates was shown.

The variation of carbon isotopes in the chronology of exactly dated tree rings from our laboratory indicated an unam-

biguous effect (relative carbon isotope reduction in combustion), and the effect of nuclear explosions. Our physicists derived from this observation several dynamic parameters of the atmosphere, hydrosphere and biosphere (Bitvinskas 1984).

The self developed methods serve as a foundation for the principles of efficiency evaluation for a number of forestry undertakings, including environmental factors and growth indices. The methods are now extensively used in evaluating soil drainage, fertilization (Lithuanian Institute of Forestry) and pollution rates (Lithuanian Academy of Agriculture (Bitvinskas 1965, 1984, Stravinskiene).

Some dendrochronology researchers in Lithuania are involved in the program on hydrothermal factors related to chronology (Bitvinskas, Kairaitis, Karpavičius, Kairiukštis, Stravinskiene, Čerskiene). Their main conclusion is that in our conditions tree growth is under a combined influence of temperature and hydrologic factors, and that their separate contributions are related to the properties of separate species and to their habitat. Reasonable evaluations of the influence are only possible on long samples (Bitvinskas 1965, 1984, Bitvinskas & Kairaitis 1975, Karpavičius & Ramanauskas 1978).

Bank of Dendrochronology Data of the Soviet Union operates in Kaunas under combined sponsoring of the Institute of Botany, Academy of Sciences of the Lithuanian SSR, and Computer Centre of the Lithuanian Institute of Forestry. It employs a number of original computer programmes, and issues a bulletin "Dendrochronologies of the Soviet Union".

CONCLUSIONS

On the basis of experience accumulated in the course of more than 30 years we state that the most promising way is a complex approach to the problems of the human activities and environment relationships, cosmic and solar radiation and the biosphere relationships, climatic changes, prediction of extreme ecological situations; accompanied by constant improvement of methods involved. This implies that a dendrochronologist must not concentrate on local problems, because any interpretation of radial growth dynamics involves both vast and deep insight in all possible fields of natural sciences. Here the only way is a close cooperation with different specialists whoever may be

interested in the success of dendrochronology. The more knowledge of the past history is acquired, the more independent becomes our research as a branch of human knowledge. We must be aware of the fact that atmospheric circulation does not record the state boundaries, and we must apply our results to a common and a synchronic approach.

In this context our results on dendrochronology in the region of the Baltic Sea must be understandable and valuable to all participants of the present Symposium, so that the Baltic Sea and the people of its surroundings countries may live and flourish in peace.

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