present that the potential climate information would justify the vast amount of work involved. With advances in isotope techniques (Long, this volume), this position might change.

EUROPEAN RUSSIA

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INTRODUCTION

The long-term study of biological processes is a complex and time-consuming problem. In a study of this nature, the short length of existing climate records and the lack of information on climatic variations of low frequency (for example, of periods 100 to 600 years) prevent the determination of the constancy and dynamics of any shorter climatic rhythms (for example, of periods 11 to 22 years). On the basis of research work carried out in the Soviet Union (Bitvinskas, 1974), it is possible to arrive at the following conclusion: dendroclimatological investigations based on natural changes in the annual rings of trees can serve as a valuable basis for forecasting the probable course of future environmental conditions.

At the Institute of Botany of the Lithuanian Academy of Sciences (in the Dendroclimatochronological Laboratory), a research programme on the annual rings of wood has been in progress since 1968 (Bitvinskas, 1968). In the Republic, this research started in 1953, when the author (then a student) carried out the first dendroclimatological investigation of black alder thickets of the Birzai virgin forest (Bitvinskas, 1961). Since then extensive investigations have been carried out in the Republic, of which the following deserve mention: the dynamics of growth of pine stands of the Lithuanian SSR and possibility of its prediction (Bitvinskas, 1964); the dynamics of oak stand increments in the Lithuanian SSR, 1970 to 1975 (Bitvinskas & Kairaitis, 1975); correlation of width of fir annual rings and climatic factors in Lithuania (Cerskiene, 1972).

Since then, dendrochronological methods have been applied when determining fluctuations of water level of lakes in eastern Lithuania (Pakalnis, 1972) and the variability of radial increments of pine and their relationship to environmental conditions (Karpavicius, 1976). During this time, new programs for computer processing of annual ring information were developed, and a start was made on the use of an automated system for the measurement and preparation of annual ring data for the computer (Maleckas, 1972; Maleckas et al., 1975). Radiocarbon measurements obtained in the laboratory are used for the verification (synchronisation) of separate series of annual rings, that is, for the relative dating of samples of unknown age.

Particular attention is being paid to the construction of very long tree-ring chronologies. In the Uzpelkiu Tyrelis peat bog in northwest Lithuania, the first thorough investigation of past environmental conditions was carried out by means of the dendroclimatological method. Stumps and trunks preserved in the surface strata of the peat bog were used for this study (Bitvinskas et al., 1972). It was shown that it is possible to construct millennia-long tree-ring chronologies from continuously overlapped sequences. This has been made possible by a complex method of investigation including dendroclimatological, radiocarbon, pollen, and geobotanical analysis of the investigated samples of wood and peat. The chronology of Uzpelkiu Tyrselis is 2,200 years long extending back from the present and, at present, appears to be the longest in eastern Europe. The construction of chronologies of up to 6,000-7,000 years long using timber from marshes of the northwestern U.S.S.R. should be possible.

LIVING-TREE CHRONOLOGIES

The age structure of the forests of the Soviet Union permits an investigation of the variability of tree rings on a large scale throughout the forest and forest-steppe zones of European U.S.S.R., Siberia, the Caucasus, and other mountainous regions. The Laboratory of the Lithuanian Academy of Sciences does not confine itself to the small territory of Lithuania, but carries out investigations in the territories of other republics of the Soviet Union. The material on a transect through the Murmansk region, Karelia, Leningrad, and Novgorod-Pskov has already been published, as has work on the Latvian SSR, eastern Lithuania, western Byelorussia, and western Ukraine, including the Transcarpathian region (Bitvinskas & Kairaitis, 1978). Another dendrochronological transect under construction at present runs approximately along the 56 to 54 parallels N of the U.S.S.R. and runs from Lithuania to the Far East (Bitvinskas, 1978).

Enormous regions of the Soviet Union have been, and are being, investigated by dendrochronologists. Nevertheless, it is clear from these investigations that in the more inhabited areas and in the zone of intense forest exploitation, few trees exceed 250 to 350 years of age. The species examined were Pinus silvestris L., Picea excelsa L., and Quercus robur L. Longer chronologies are either represented by smaller quantities of samples or have to be constructed by means of cross-dating (that is, they are composite chronologies).

RESEARCH RESULTS

About 250 chronologies of Pinus silvestris L., Quercus robur L., Picea abies L., Larix sibirica Lebed., and other forest stands have been constructed. Detailed information on climate changes in the Lithuanian SSR and other regions of the Soviet Union was collected. The interdependence between the amplitudes of 22-year cycles of solar activity and the stand increments were examined. Climate factors which have an influence on the stand

increment were determined as well. A series of complex hydrothermic indices reflecting the variability of the dynamics of annual rings was also drawn up. Regularities in the dispersion of trees in stands of which changes in the width of annual layers and the sensitivity of trees to environmental conditions were examined.

The possibility of constructing extremely long chronologies from timber taken from peat bogs and sand and gravel pits was proved (Bitvinskas et al., 1976), as well as the effectiveness of investigations into the yearly information on radiocarbon content in annual rings of trees. Convincing correlation between radiocarbon and solar activity was obtained on the basis of tree-ring data accumulated by the laboratory. Regularities of the distribution of climate trends in different stages of solar activity were examined statistically (Bitvinskas, 1974). The profile method was applied to the examination of the variability of radial increments and of their relationship with solar-physical components. The opposition of prevailing trends in five stages of solar activity from 22-year cycles was found in northern latitudes and southern regions of the Murmansk-Carpathians transect.

Investigation of the occurrence of stumps in peat deposits in Lithuania showed that the complex examination of such deposits by radiocarbon, pollen, and dendrochronological methods yields excellent information on past environmental conditions. Information on climatic cycles of average duration (11 and 22 years) and on secular environmental changes are reflected in the width of pine annual rings, in changes in pollen and botanical composition, and in the extent of decomposition of the peat (Bitvinskas et al., 1976). The results obtained in several of our laboratories showed that radiocarbon analysis of annual rings of the recent century helps to trace the extent of anthropogenic effects on the biosphere (Dergachev & Sanadze, 1974).

CONCLUSIONS

Dendroclimatological investigations have been carried out in the Lithuanian SSR as well as in areas to the north and south of the Republic and in other areas of the Soviet Union. This research demonstrates the success of the methods employed and also shows the large unexplored resources of dendroclimatic information available in the Soviet Union. The obvious value of cooperation between scientists of different disciplines both in the Soviet Union and throughout the world is clearly demonstrated.

THE MEDITERRANEAN AREA

A.V.Munaut

INTRODUCTION

From a dendrochronological point of view, the common climate characteristic of the regions comprising this area is the simultaneity of the warmest and the dryest season. Such a climate strongly affects tree growth since evapotranspiration reaches its maximum when the water supply is lowest. Water stress is the major limiting factor although in the mountainous regions, low temperatures play an important role. Roughly, the Mediterranean area extends from the Atlantic Ocean to the Himalaya, between the high pressure subtropical belt and the temperate regions. To the east, it is in contact with countries influenced by the monsoon. The sunny, hot and dry summers are dependent on the seasonal shift of the desert regime, while winter rains fall by displacement of northerly cyclonal activity. The Mediterranean area is thus a very sensitive area, favourable to the detection of annual or long-term variations of climate affecting large parts of Europe, North Africa, and Asia.

VEGETATION

Although adapted to summer dryness, the Mediterranean flora is not uniform. Indeed, two climate gradients affect the vegetation: increased warmth to the south, and continentality to the east. Other phenomena can modify these general trends. Location, orientation, and the altitude of mountain masses are important factors of differentiation. Also the migration of floras during the climate vicissitudes of the Quaternary must be taken into consideration. Finally, topographic and edaphic peculiarities contribute to the diversification of the local composition of the vegetation. Nevertheless, in most conditions, the forest is the climax. This is a favourable feature for the dendrochronologist who can choose trees growing in various environments. The diversity of suitable species giving various response functions also extends the possibilities for climate reconstructions.

THE INVESTIGATED SPECIES

According to literature and information given by several dendrochronologists, many species have been sampled and the analyses are still in progress. The species sampled are summarised under each laboratory.

Laboratoire de Botanique Historique et Palynologie de Marseille-St-Jerome (F.Serre-Bachet, M.L.Tessier and A.Pons):

France: Abies alba, 5 sites; Larix decidua, 3 sites; Picea excelsa, 1 site; Pinus halepensis, 3 sites; Pinus laricio, 2 sites; Pinus sylvestris, 5 sites; Fagus sylvatica, 3 sites; Quercus pubescens, 3 sites.

Italy: Pinus leucodermis, 1 site.