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SOME RESULTS OF FORESTRY RESEARCH IN CZECHOSLOVAKIA

In implementation of our long-term editorial policy are we presenting to our foreign readers a poly-thematic English issue of our scientific journal „Lesnictví", the objective of which is to publicize this way some major results of forestry research carried out in Czechoslovakia.

We have made it a standard routine to inform this way the world forestry public about our work in the effort to demonstrate our contribution to the progress of forestry science which is of tremendous importance to mankind development.

As it is well known to most readers and friends of our scientific journal, the January-February 1971 double-issue contained a vocabulary of forestry terms in the Czech, Slovak, Russian, English, German, French, and partly in Spanish languages, the aim of which was to improve in an easily understandable manner the understanding of specialized forestry terminology in the languages mentioned above. The vocabulary's reference numbers make it possible to find the respective term equivalents in any of the said languages, and by the end of 1971 an alphabetic English register was published as an Annex to the Vocabulary, enabling quick conversions of forestry terms from the English. Similar German language and other registers are under preparation.

To characterize the subject-matter contents of this English issue of „Lesnictví", we should say that without attempting to submit a fully representative sample we have chosen to release the achievements of some forestry sciences that can well document the trends and findings that had been followed or accumulated in recent years.

First is a mensurational paper dealing with forest stand increment pattern, summarizing and supplementing the research information on the current increment of forest stands, namely on the so called Total Current Increment which is theoretically defined by the first derivative of the total volume production (yield) formula. It has been stressed again that in silviculture and forest management the growing stock and its increment are the very major bases of forest management programming and execution of forest operations. The validity of the formulae expressing the volume-increment relationships has been documented and verified by the author on more than 500 Norway Spruce sample trees by way of stem analyses.

The paper is followed by a study of new trends in the science of silviculture, basing methodically on the principles of retrospection and futurology, as well as on those of logology and logometry. According to its author, the major basic problem and action research projections emphasized are the biological automation, silvicultural rationalization, and silvicultural programming.

The causality governing the growth of forest tree species populations and of the tree-storey biomass should become a real backbone of stand management biotechniques, and in this sense has been very much appreciated the contribution of the International Biological Programme and of the associated UNESCO Project Man and Biosphere to research of the world's forests. A demonstration experimental plot supporting a model Silver Fir (Abies alba Mill.) *stand, belonging to the* Fagetum quercino-abietinum *forest type group, has been described to show Czechoslovakia's participation in the former Programme.*

To facilitate the investigations into the tree growth process and the choice of optimum silvicultur procedures, the UniAgri-1 apparatus (Czechoslovak

Patent) and a tree increment analyzer based on Eklund's year-ring instrument were designed or improved.

In recent years has been growing increasingly the significance of the so called forest influences and, consequently, that of the multiple uses of forest lands. The subject was, inter alia, on the agenda of the Sixth World Forestry Congress 1966, held in Madrid, Spain, as well as of the Fifth Congress convened in 1960 in Seattle, U. S. A. At both Congresses, serious difficulties had been emphasized involved in the economic quantification in terms of value of various forest influences. The paper on valuation of forest recreation is concerned with the utility value of the recreational areas, determining the recreational potential and recreational effect. A relative comparison was made of the the recreation supply cost incurred by forest management, and the price for forest recreation to be paid by the consumer. The recreation valuation method designed by the author is applicable to forest management, particularly to planning and projections of the recreation and production functions of the forest, as well as to decision-making on the optimum forest uses policies.

There is a study on computer applications to model business management systems relating to forestry, the outcome of which is that the proposed general model of business management of forest operations based on the employment of computer techniques is both feasible and economical, one of its merits being its stage-after-stage development and putting in operation. While the full-coverage management model is nearing completion, the major elements of the part-coverage model of short-term planning and logging management had been already tested with success.

The author of the following paper has paid his attention to research projects dealing with forest environments in Czechoslovakia in the years 1965—1970, embracing the subjects of forest bioclimatology, forest geology, and forest soils. The core of the paper lies in forest soils research which had been concerned particularly with the water, air and temperature forest soil regimens, with the problems of humus development and classification, with forest site fertilizing and forest soil forest stand relationships.

Advanced technology, which has been assuming growing importance to forestry, is the topic of a paper on new design electrodes for tree barking by electric current. This is yet another improvement on a Czechoslovak patent, as well as an additional information on the features of the method. It has been found that the performance of the installation depends to a considerable degree on the time required for treatment of the under-bark stem (log) tissues by electric current. The desired changes in them, particularly the temperature ones, must proceed rapidly, and this is why built-up electrodes mounted on an endless electrode band had been designed and found technologically superior, making it possible to utilize in a better and more economical way the patent referred to above.

The last original contribution deals with crooked logs bucking on log depots, and is based on logging records relating to a riverine forest area of 10,900 ha, yielding some 46,320 cu.m. of annual cut. It has been established that one of the controlling factors is the location of the log conversion place, and the best solution proved to be a central log conversion and supply yard, resulting in considerably better marketing and returns from big-diameter tree-length logs.

The poly-thematic issue of Lesnictví contains a review of the forestry college textbook Principles of Forest Growth and Production, and another on the Collection of lectures delivered at the 50th Anniversary of Forestry Research Conference, *It is more than evident from the aforesaid that this issue of the scientific journal Lesnictví has only brought selected examples of solutions to the major research problem areas of forest management and forest research. In no case has its objective been an exhausting problem and solution coverage, this being out of question on the available confined pages. The aim has been to draw the attention of foreign readers to forest research projections and efforts prevailing in Czechoslovakia and aiming at one ultimate goal — the best service to development of her Socialist society.*

Prof. Dr. Ing. Miroslav Vyskot, Dr. Sc., Corresponding Member of the Czechoslovak Academy of Sciences

NĚKTERÉ VÝSLEDKY VĚDECKOVÝZKUMNÉ PRÁCE V ČESKOSLOVENSKÉM LESNICTVÍ

Podle osvědčené praxe předkládáme zahraniční čtenářské obci našeho vědeckého časopisu Lesnictví polytematické číslo v anglickém jazyce, které má touto formou zpřístupnit některé výsledky vědeckovýzkumné práce v československém lesnictví.

Stalo se již dobrým zvykem, že tímto způsobem informujeme širokou lesnickou veřejnost o naší práci ve snaze vyjádřit náš příspěvek k pokroku odvětví tak významného pro vývoj lidstva.

Jak je většině čtenářů a příznivců našeho vědeckého časopisu známo, vydali jsme ve dvojčísle 1—2/1971 Cizojazyčný slovník odborných lesnických pojmů v češtině, slovenštině, ruštině, angličtině, němčině, francouzštině a v řadě pojmů i ve španělštině ve snaze přispět velmi přístupnou formou ke znalosti speciálních výrazů v uvedených jazycích. Slovník je opatřen číselným kódem, který umožňuje převod do všech použitých jazyků. Koncem roku 1971 vyšel jako speciální příloha anglický rejstřík našeho cizojazyčného slovníku, který umožňuje rychlý převod z anglického jazyka. Další klíče pro němčinu, ev. pro ostatní světové řeči se připravují.

K vlastnímu obsahu tohoto čísla vědeckého časopisu Lesnictví v anglickém jazyce uvádíme, že bez nároku na úplnou reprezentaci přinášíme výsledky z některých oborů lesnického odvětví, které mohou dokumentovat tendence a rezultáty, jež byly na tomto úseku koncipovány a získány.

*První práce si všímá přírůstového rozboru lesního porostu a shrnuje dosavadní poznatky o výzkumu běžného přírůstu lesních porostů, zejména o tzv. celkovém běžném přírůstu, který je teoreticky první derivací k celkové hmotové produkci. Pro pěstění lesů a hospodářskou úpravu lesů jsou porostní zásoba a její přírůst vlastně nejdůležitějšími prvky programování a uskutečňování hospodářských opatření. Matematické vyjádření těchto vztahů je dokumentováno a přezkoušeno na více než 500 analyzovaných jedincích smrku (*Picea excelsa *Link).*

Na tuto práci navazuje studie o nových směrech ve vědní disciplíně pěstění lesů. Metodicky vychází z principu retrospekce a futurologie, přičemž exaktní bázi tvoří logologie a logometrie. Jako hlavní základní problémové a realizační soubory jsou akcentovány biologická automatizace, pěstební racionalizace a programování v pěstění lesů.

Kauzalita růstového procesu populací lesních dřevin a biomasy stromového patra slouží jako reálný podklad pro pěstební biotechniku. V tomto směru se velmi oceňuje přínos výzkumu biomu lesa Mezinárodního programu (Interna-

tional Biological Programme) a na něj navazujícího projektu UNESCO Člověk a biosféra (Man and Biosphere). Jako dokladový objekt je prezentována jedlina (Abies alba *Mill.*) *ve skupině lesních typů* Fagetum quercino - abietinum.

Ke zkoumání růstového procesu a k odvozování nejvhodnějších fytotechnických zásahů byly konstruovány, resp. novelizovány aparatury UniAgri 1 (čs. patent) a analyzátor přírůstu na principu Eklundova přístroje.

V poslední době stále více roste význam tzv. užitečných funkcí lesa. Tato problematika byla mimo jiné předmětem V. Světového lesnického kongresu 1960 v Seattle, USA, a VI. Světového lesnického kongresu 1966 v Madridu ve Španělsku. Na těchto kongresech byla konstatována značná obtížnost ekonomického vyjádření užitečných funkcí lesů. Publikovaný příspěvek věnovaný ocenění lesní rekreace si všímá užitkové hodnoty rekreačního území určující rekreační potenciál a rekreační efekt. Jsou zde vyjádřeny náklady rekreace zatěžující lesní hospodářství na straně jedné a konzumenta rekreace na straně druhé. Navrhovaná metoda je použitelná v hospodářské úpravě lesů, zejména v plánování rekreačních a produkčních funkcí lesa a v hospodářském určení lesa.

Další práce si všímá významu samočinného počítače v modelu řídícího systému lesního hospodářství. Konstatuje se, že navržený globální model pro řízení lesního hospodářství s využitím samočinného počítače je reálný a výhodný. Jako přednost se zdůrazňuje možnost etapovité výstavby a realizace. Celkový model se nachází ve stadiu kompletování, přičemž jsou již odzkoušeny hlavní prvky dílčího modelu pro krátkodobé plánování a řízení těžební činnosti.

Rozvoj výzkumu z vědních oborů prostředí lesa v Československu za leta 1965—1970 je obsahem dalšího elaborátu. Zahrnuje obory lesnické bioklimatologie, lesnické geologie a lesnické pedologie. Těžištěm příspěvku je lesnické půdoznalství, kde byly zkoumány zejména vodní, vzdušné a teplotní režimy půd, problematika tvorby a hodnocení humusu, hnojení lesních půd a vztahy mezi půdou a porosty lesních dřevin.

Technické stránky, která má stále stoupající význam v lesním hospodářství, si všímá příspěvek o nových elektrodách pro odkorňování dřeva elektrickým proudem. Vychází se přitom z čs. patentu pro odkorňování dřeva elektrickým proudem a konstatuje se, že výkonnost tohoto zařízení je značně závislá na době potřebné k působení elektrického proudu na podkorní vrstvy kmene. Uvedené změny, zejména tepelné, musí probíhat rychle. Proto byly vyvinuty složené elektrody s nekonečným pásem dílčích elektrod, které se osvědčují, protože umožňují lepší a účinnější využití citovaného patentu.

Poslední původní sdělení je věnováno zpracování křivého dřeva na skladech. Vychází se přitom z faktografie oblasti lužního lesa s roční těžbou 46 320 plm na ploše 10 900 ha. Přitom bylo zjištěno, že jedním z rozhodujících faktorů je místo manipulace. Zde se nejlépe osvědčil centrální manipulační a expediční sklad se značně vyšším zpeněžením tlustých surových kmenů.

Polytematické číslo je doplněno recenzemi celostátní učebnice pro vysoké školy Základy růstu a produkce lesů a sborníku referátů z konference k padesáti letům lesnického výzkumu.

Toto číslo vědeckého časopisu Lesnictví ukazuje pouze na některých příkladech řešení hlavních oborových problémů v lesnickém odvětví a jeho vědecké i výzkumné činnosti. Smyslem je upozornit zájemce na směry a průkopnické snahy v československém lesnictví, adekvátní potřebám rozvoje socialistické společnosti.

Prof. Dr. Ing. Miroslav Vyskot, DrSc., člen korespondent ČSAV

V. Korf

ANALYSIS AND PATTERN OF FOREST STAND INCREMENT

It is very well known in forestry that in a Working Circle (basic unit of cut regulation) the volume of growing stock, its pattern, and its increment are and will remain basic elements of forest management, both for the purpose of yield regulation and for all other management purposes. This is a finding that had been formulated for the first time in 1795 by one of the foremost German foresters, J. Ch. Paulsen, by the words: "Ohne genaue Kenntnis von der Größe des Holzvorrates und dessen Zuwachs ist es unmöglich die Forste aufs Vollkommenste und nachhaltig einzurichten".

This basic finding has been constantly stressed in forest management in various connections, and it is also included in various methods of yield regulation as well as in various conceptions of growing stock and increment control, the latter having gained particular significance namely since World War II. The search for appropriate methods of growing stock and increment control has been motivated by the objective to collect the best possible information on the condition of the forest, and to utilize it in forest management intensification.

The problems of growing stock and increment control had been studied by a number of authors, both abroad and in this country, and theoretically justified and practically being verified methods on the subject were recommended, some of them applying also to the age-class management system, i. e. to the age-class evenaged forest. As for the selection system, the growing stock and increment control has been for long the theoretical backbone of the "méthode du contrôle" and has been also applied practically and perfectioned to real forests. It should be borne in mind, however, that in the future the objective will be not only a quantitative control but also that it will be necessary to examine (measure) the forest growing stocks also from the point of quality. In this country it was A. Priesol (1961) who elaborated after World War II. the methods of forest production control on a comprehensive approach basis.

In forest management, the cut regulation is generally based on the volume of growing stock and on its distribution, as well as on the average increment figures (MRI, TRI), in association with the rotation, and particularly with the area and volume representation of individual age-classes. However, in contrary to the above, the basic production indicator for forest planning should be the Current Stand Increment, which is in fact the very primary factor. It is because only by addition of the current increments will in the course of time — according to the nature of this increment — be created either the growing stock (volume) of the residual stand, or the total volume production. In line with the above definition, of primary importance is the so called Total Current Increment (TCI), this being the actual volume production for a definite period of time (period, or one year). Its part is the residual (main) stand current increment, which is accumulated in the form of the stand volume (residual stand volume). Under normal conditions is the whole forest stand growth process a result of tree growth combined with periodically recurring cutting, the latter affecting — inter alia — also the rate of growth. Thus, the major growth element that must be studied in the first place is the Total Current Increment (TCI), which is, from the point of theory, a differential coefficient of the total volume production.

The Total Current Increment has been assuming greater importance particularly because it is at the same time a yardstick for the evaluation of the silvicultural and other measures aiming at higher production of quality timber. It is obviously hard to judge the effects of certain silvicultural operations on the yield variations without knowing the actual pattern and development of the Total Current Increment. It is also an undisputed fact that Forest Management only can play the major role in the comprehensive evaluation of the impact of specified silvicultural practices on the quantity and quality of wood production. It is Forest Management only supplying all the necessary production process information and planning on the basis of it the development of forestry towards fulfilling in the optimum and maximum degree the national role of forests.

A great number of scientific papers, theoretical studies, and dissertations following the above goal have been written on the utilization of the Current Stand Increment in Forest Management and Silviculture, yet efficient application of this forest production yardstick to forestry pracice has been so far relatively scarce, with the exception of the management and silviculture of the selection forests, where this value has been assigned a concrete contents and role in the conception of the control methods. The possibilities of utilizing the Current Increment in Forest Management and Silviculture with regard to evenaged forest stands have been discussed in my earlier papers (Korf 1960, 1961, 1962), in 1967 G. Hildebrandt published a thorough study on the major methods of Current Increment determination, and also in the recent college textbook by Vyskot et al. (1971) has adequate attention been paid to current increment of individual trees and forest stands in the evaluation of the Czechoslovak and foreign biometrical and mensurational papers.

There is no need for particular stressing that the Total Current Increment of evenaged forest stands operated under the clearcutting management system can be regarded in a Working Circle as a total cut measure only under the assumption (if there is) of a certain normality of the age-class distribution. The proportion of all or some age-classes is also the major element of present cut regulation in this and other countries. As a rule, the distribution of age-classes would be abnormal and this is also why the Total Current Increment — measure of wood production at the moment — would be different. Thus for instance abnormally high Total Current Increment would be recorded generally for Working Circles showing large area surpluses of medium age-classes (second and third) since at this very forest stand age the Current Increment has its culmination. The Total Current Increment of a Working Circle would be calculated in this country on the basis of actual growing stock of individual age-classes, and the growth rate (increment percentage) taken from the yield tables. The theory of this method had been justified already during World War II. when the latter had been used for the purpose of quick forest assessments (Korf 1944).

The importance of the Current Increment has been well known already to earlier foresters' generations, and the necessity has been also stressed again and again to look both for feasible methods of its determination and for its best practical utilization in the regulation of forest production. It is particularly necessary to recall, in this context, the ideas of an outstanding Czechoslovak forester, R. Haša (1925) who, when studying the Swiss check method ("methode du contrôle") pointed out the imperative necessity to take up as soon as possible the problem of Current Increment measurement. To this end, Haša recommended the setting up of experimental forests showing typical tree species and age-class patterns in which systematic increment survey and inventory would be pursued.

The search for suitable methods of Current Increment determination has thus become a major forest mensurational research project not only in this country but also abroad, this being also evident from a considerable number of papers published on the subject. The significance of Current Increment has been emphasized particularly at the International Congress of the Forest Research Institutes in Rome in 1953, and in the papers submitted to the 25th Congress Section had invariably been quoted as a major forest research project the development of a practical, economically feasible, and sufficiently accurate method for the measurement of the Current Increment of forest stands.

Regarding utilization of the Current Increment of forest stands, the opinion has been prevailing for the time being that it is necessary to devise in the first place the methods for the Current Increment measurement to serve as a production yardstick in older stands awaiting regeneration (Hildebrandt 1967). It is namely very important that forest stand reproduction planned in the working plans be fully justified also from the point of economics. In other words, in the chronological and spatial sequence of the planned stand regenerations should inter alia be applied as an important factor the Total Current Increment and its changes (development) throughout the regeneration period. It goes without saying that there are more criteria and factors governing the planning of stand regeneration, and thus the Total Current Increment will have to be assigned a role it deserves among them.

In young forest stands is it possible at the moment to abstain from the Volume Current Increment determination because of the complexity of the problem, and the choice of thinning type and grade aiming at improved production may be objectively based on the quickly-determined basal area; to the same end can as much as possible be utilized the results of research conducted by Assmann (1953, 1954) as recommended by Hildebrandt (1957).

More and more has been also emphasized the utilization of quantitative forest production projections and the resulting cutting possibilities to technological and economic development of forestry, and beyond any doubt also in this field will the knowledge of the Current Increment variation for individual stands and for whole Working Circles be a safe guideline, naturally along with other indicators. The knowledge of the Total Current Increment is also likely to be of future significance in the checking of forest management records, in certain aspects of forest valuation, etc.

The employment of statistical methods and modern computing techniques in this country and abroad has made it possible to resolve certain problems of theoretical and practical importance relating to stand volume determination and to increment measurement. A number of fairly complex questions have remained, however, still unresolved, and presently are they on the program of biometrical research. In Czechoslovakia, forest biometrics research has been concerned with clarification of the laws governing the growth of evenaged and unevenaged forest stands. The primary objective has been the accumulation of theoretical knowledge and their verification on extensive empirical material in the process of construction of Czechoslovak yield tables and elaboration of suitable methods of Current Increment quantification. In this respect I should refer to the papers of our foremost forest biometrics researchers (J. Halaj, A. Priesol, V. Korf, J. Řehák, Š. Šmelko, J. Wolf, etc.).

THE THEORY OF GROWING STOCK SAMPLE TREE AND INCREMENT SAMPLE TREE

In this Chapter certain theoretical results of my biometrical research on forest stand increment will be discussed and their verification by means of concrete stand measurements.

In a fully enumerated forest stand the mean diameters of the individual diameter--classes were designated d_j ($j = 1, 2, 3, \ldots, 1$) and the respective class tree frequencies n_j. The number of diameter-classes is l, and the sum of all diameter-class frequencies is

$$\sum_{j=1}^{l} n_j = N \, . \tag{1}$$

The relative tree frequencies in terms of percentage for individual diameter-classes are

$$\frac{n_j}{N} 100 \text{ and their total is } \frac{100}{N} \sum_{j=1}^{l} n_j = 100\,\% . \tag{1a}$$

Any tree diameter-class d_j is further represented by a mean tree volume v_j, so that the volumes of individual diameter-classes are $n_j \, . \, v_j$, and the volume of the whole stand is

$$\sum_{j=1}^{l} n_j \, . \, v_j = V \, . \tag{2}$$

The relative volume representation by individual diameter-classes in terms of percentage is $\frac{n_j \, . \, v_j}{V} 100$, and the sum of all partial representations is thus

$$\frac{100}{V} \sum_{j=1}^{l} n_j \, . \, v_j = 100\,\% \, . \tag{2a}$$

Finally, in a similar way can be expressed in absolute and relative terms the distribution of the Annual Current Increment over the individual diameter-classes, this increment per one tree characterizing the respective class being denoted as i_j. Thus, the increment of any diameter-class is $n_j \, . \, v_j$, and the stand increment I is then the sum of all the diameter-class increments

$$\sum_{j=1}^{l} n_j \, . \, i_j = I \, . \tag{3}$$

The relative increment (in terms of percentage) of individual diameter-classes is $\frac{n_j \, . \, v_j}{I} 100$, and the sum of such percentages is

$$\frac{100}{I} \sum_{j=1}^{l} n_j \, . \, i_j = 100\,\% \, . \tag{3a}$$

On the basis of the above formulae is the Mean Volume Sample Tree (Growing Stock Sample Tree) an arithmetic average of the diameter-class volumes

$$\bar{v} = \frac{1}{N} \sum_{j=1}^{l} n_j \, . \, v_j \, . \tag{4}$$

The Mean Annual Current Increment per one tree is then

$$\bar{i} = \frac{1}{N} \sum_{j=1}^{l} n_j \, . \, i_j \, . \tag{5}$$

It is now appropriate to represent graphically the relative distribution of tree diameter frequencies and the volume percentages for individual diameter-classes. The two frequency polygons we obtain are in a certain very significant relationship. For small tree breast-high diameters is

$$\frac{n_j}{N} 100 > \frac{n_j \cdot v_j}{V} 100$$

while for larger diameter classes is it, vice versa

$$\frac{n_j}{N} 100 < \frac{n_j \cdot v_j}{V} 100 \ .$$

It should be added, however, that the above relationships could be expressed sufficiently by simple ratios $\left(\frac{n_j}{N}, \frac{n_j \cdot v_j}{V}, \text{etc.}\right)$. Since it is customary to use percentages in forestry, the same method had been used also in this case.

It can be seen from the graphic representation that the two polygons have a point of intersection corresponding to the DBH of the Mean Volume Sample Tree (Growing Stock Sample Tree) d_v. The proof of this is very simple and was submitted by Korf in 1961. The abscissa d_v of the intersection point P_1 of the two polygons in fact determines the position of the Stand Sample Tree.

A similar relationship can be assumed for the DBH distribution percentages and the volume distribution percentages by individual DBH-classes. In the latter case will the respective polygons be having the intersection point P_2 the abscissa d_i of which represents the breast high diameter of the Increment Sample Tree, placing theoretically also its position within the polygons.

In the following we shall be concerned with a theoretical analysis of the relationship between the Mean Sample Tree volume (Stand Sample Tree volume) $\bar{v}$, and the Annual Current Increment per one tree of the stand in question $\bar{i}$.

It may be assumed in principle that there is a certain stochastic correlation between the volumes of individual trees in the stand v_j and their respective increments i_j that can be expressed by the regression equation given below

$$i_j = f(v_j) \ . \tag{6}$$

This assumption is quite realistic since the Annual Current Increment is virtually deposited by the cambium activity on wood layers produced in earlier years, and consequently there must be a close relationship of the two variables — strictly speaking a stochastic one. Let us assume further that the DBH distribution within individual DBH-classes is approximately normal. It is also well known that under certain circumstances can the function $f(x)$ be expanded in a Taylor series of this general form

$$f(x) = f(a) + \frac{f'(a)}{1!}(x-a) + \frac{f''(a)}{2!}(x-a)^2 + \ldots + \frac{f^k(a)}{k!}(x-a)^k + R_{k+1}(x) \tag{7}$$

in which $R_{k+1}(x)$ is a residue. Should the above series be convergent for a given point x and its sum be equal to $f(x)$, the above residue must be

$$\lim_{k \to \infty} R_{k+1}(x) = 0 \ .$$

Our hypothetical equation expressing the increment of any tree of the stand $i_j = f(v_j)$ will be expanded, in line with the above explanations, in a Taylor series for the value $a = \bar{v}$, i. e. around the Mean Sample Tree volume (Stand Sample Tree), so that

$$i_j = f(v_j) = f(\bar{v}) + \frac{f'(\bar{v})}{1!}(v_j - \bar{v}) + \frac{f''(\bar{v})}{2!}(v_j - \bar{v})^2 + \ldots + \frac{f^k(\bar{v})}{k!}(v_j - \bar{v})^k . \quad (7a)$$

The above series expansion will be confined on its right side to $(k + 1)$ members, and under this assumption will for any diameter class with n_j tree frequency the volume increment be

$$n_j i_j = n_j f(v_j) = n_j f(\bar{v}) + n_j \frac{f'(\bar{v})}{1!}(v_j - \bar{v}) + n_j \frac{f''(\bar{v})}{2!}(v_j - \bar{v})^2 + \ldots + n_j \frac{f^k(\bar{v})}{k!}(v_j - \bar{v})^k . \quad (8)$$

The sum of partial increments of all diameter classes is then the total stand increment I

$$I = \sum_{j=1}^{l} n_j i_j = \sum_{j=1}^{l} n_j f(v_j) = \sum_{j=1}^{l} n_j f(\bar{v}) + \frac{f'(\bar{v})}{1!}\sum_{j=1}^{l} n_j(v_j - \bar{v}) + \frac{f''(\bar{v})}{2!}\sum_{j=1}^{l} n_j(v_j - \bar{v})^2 + \ldots \quad (9)$$

and the mean current increment per one tree is

$$\bar{i} = \frac{\sum n_j i_j}{N} = f(\bar{v}) + \frac{f'(\bar{v})}{1!}\,\frac{\sum_{j=1}^{l} n_j(v_j - \bar{v})}{N} + \frac{f''(\bar{v})}{2!}\,\frac{\sum_{j=1} n_j(v_j - \bar{v})^2}{N} + \ldots \quad (10)$$

It is obvious that the second series member is represented by the expression (designated as m_1)

$$\frac{\sum_{j=1}^{l} n_j(v_j - \bar{v})}{N} = m_1$$

which is the first central moment known to be equal to zero ($m_1 = 0$). The third member of the right-hand side of the equation is

$$\frac{\sum_{j=1} n_j(v_j - \bar{v})^2}{N} = m_2$$

which is the second central moment. The same will apply to other central moments $m_3, m_4, \ldots, m_k$, and this way the increment equation (for individual trees) will be much simplified

$$\bar{i} = f(\bar{v}) + \frac{f''(\bar{v})}{2!} m_2 + \frac{f'''(\bar{v})}{3!} m_3 \ldots + \frac{f^k(\bar{v})}{k!} m_k . \quad (10a)$$

The distribution of tree frequencies and volumes governing the above moments is available, consequently it remains to choose properly the function

$$i_j = f(v_j) \ . \tag{6}$$

According to our previous measurements of the Norway Spruce and Scots Pine stands is it possible to express the function (6) by a simple formula

$$i_j = K\, v_j{}^n \tag{6a}$$

in which K and n are the parameters that can be derived from the empirical data by means of the method of least squares. The curve represented by the above equation passes through the zero point of the rectangular coordinates, this being in perfect agreement with the reality since for zero volumes the corresponding increments must be zero too. In the simplest and as it appears in the frequent case will $n = 1$, so that the formula will then represent a straight line passing through the origin and having a K sloping coefficient ($i_j = K\, v_j$).

If however the abovedescribed relationship is analyzed on the basis of empirical data v_j, i_j obtained from sample trees selected at random, it may occur that due to various random factors may the regression line miss the coordinate origin and its analytical expression will then be

$$i_j = a + b\, v_j \tag{6b}$$

as demonstrated by Š. Šmelko (1967) by analyzing mathematico-statistically the empirical data of 12 Norway Spruce stands found in Slovakia. In contrast to the above, for a general tree population the curve represented by the above function will be passing through the coordinate origin irrespective of its linear or non-linear character.

Under the assumption of linearity between the variables v_j and i_j will the average one-tree increment be given by the formula (10a)

$$\bar{i} = f(\bar{v}) = K\, \bar{v} \tag{6c}$$

since the second and higher derivatives are equal to zero. Thus, the Growing Stock Sample Tree is identical with the Increment Sample Tree, this resulting also directly from the $\bar{i}$ formula since this increment figure attributed to the Increment Sample Tree under the validity of linearity $i_j = K\, v_j$ is

$$\bar{i} = \frac{K \sum_{j=1}^{l} n_j v_j}{N} = K\, \bar{v} \ .$$

In a more general case when $n \neq 0$, the Increment Sample Tree is slightly shifted from $\bar{v}$. The displacement depends, as obvious from the equation (10a), on the respective differential coefficients and central moments and can be in either direction from the Growing Stock Sample Tree.

THE EXAMINATION OF THEORETICAL FINDINGS BY APPLICATIONS TO A CONCRETE FOREST STAND

The examination of the abovementioned theoretical relationships was carried out in a number of Norway Spruce and Scots Pine stands, and for the research purposes sample trees were used placed appropriately within the tree population, similarly to the technique employed by Šmelko (1965). Having in mind comprehensive increment research objectives, aimed inter alia also at re-examination of the methods proposed

I. Basic volume and increment characteristics of a 70-year old Norway Spruce stand (School Forest, Kostelec nad Černými lesy). — Základní hmotové a přírůstové údaje smrkového 70letého porostu (Školní lesní podnik v Kostelci nad Černými lesy)

d_j		Tree frequency		Volume			Increment		
j	cm	n_j	$\frac{n_j\ 100}{N}$	v_j	$n_j \cdot v_j$	$\frac{n_j v_j\ 100}{V}$	i_j	$n_j \cdot i_j$	$\frac{n_j i_j\ 100}{J}$
			%	cu. m.	cu. m.	%	cu. m.	cu. m.	%
1	11	1	0.20	0.0834	0.0834	0.04	0.0015	0.0015	0.03
2	12	6	1.19	0.1035	0.6208	0.27	0.0019	0.0118	0.19
3	13	13	2.58	0.1247	1.6211	0.70	0.0019	0.0250	0.40
4	14	16	3.17	0.1522	2.4348	1.06	0.0024	0.0385	0.62
5	15	27	5.35	0.1789	4.8298	2.10	0.0032	0.0869	1.41
6	16	22	4.37	0.2147	4.7239	2.05	0.0042	0.0927	1.50
7	17	29	5.75	0.2478	7.1849	3.12	0.0046	0.1340	2.17
8	18	37	7.34	0.2878	10.6469	4.62	0.0063	0.2319	3.75
9	19	35	6.94	0.3288	11.5071	4.99	0.0081	0.2829	4.57
10	20	45	8.93	0.3708	16.6854	7.24	0.0102	0.4603	7.44
11	21	33	6.55	0.4077	13.4535	5.84	0.0115	0.3786	6.12
12	22	37	7.34	0.4654	17.2189	7.47	0.0129	0.4762	7.70
13	23	44	8.73	0.5255	23.1222	10.04	0.0143	0.6305	10.19
14	24	37	7.34	0.5740	21.2387	9.22	0.0167	0.6197	10.02
15	25	27	5.35	0.6169	16.6558	7.23	0.0174	0.4698	7.59
16	26	25	4.96	0.6922	17.3052	7.51	0.0187	0.4677	7.56
17	27	15	2.97	0.7454	11.1806	4.85	0.0214	0.3207	5.18
18	28	19	3.77	0.8146	15.4780	6.72	0.0239	0.4548	7.35
19	29	13	2.58	0.8478	11.0219	4.78	0.0241	0.3134	5.07
20	30	9	1.79	0.9385	8.4463	3.67	0.0244	0.2194	3.55
21	31	7	1.39	0.9713	6.7993	2.95	0.0284	0.1985	3.21
22	32	4	0.79	1.0280	4.1121	1.79	0.0359	0.1435	2.32
23	34	1	0.20	1.2501	1.2501	0.53	0.0466	0.0466	0.75
24	35	1	0.20	1.4308	1.4308	0.62	0.0433	0.0433	0.70
25	36	1	0.20	1.3601	1.3601	0.59	0.0380	0.0380	0.61
		504	100.00		230.4116	100.00		6.1862	100.00

for Current Increment determination, once again were tested the above described relationships by means of empirical mensurational data on a 70-year old Norway Spruce stand (Schwappach's II Site Class) where some time ago a permanent sample plot had been set up (area 0.50 ha, all trees numbered). The sample plot stand was successively clear-cut in 1965, and stem analyses were made of all its trees, using 2m-long sections. On this basis the Current Volume Increments (stem volume) were calculated for the last five years, i.e. for the period 1961—1965, and the obtained five-year periodical increments were converted to annual ones. There were altogether $N = 504$ trees on the sample plot, and the results of measurements are entered in Table I. All trees of the stand were assigned — in line with statistical rules — to 1-cm DBH-classes, the total number of the latter being $l = 25$, the lower $d_j = 11$ cm, the upper $d_j = 36$ cm, and the tree population $\sum_{j=1}^{l} n_j = N = 504$ trees. The number of trees in individual diameter-classes was given both in absolute and in relative terms (%).

The single tree volumes for individual diameter-classes are in fact arithmetic averages of volumes of all trees belonging to a certain diameter-class. Thus for instance the 17cm diameter-class comprises all trees of the stand under study with diameters ranging from 16.5 to 17.4 cm, the total (aggregate) stem volume of which was 7.1849 cu. m. Since there were 29 trees in this diameter-class, the respective arithmetic average is $v_j = 7.1849 : 29 = 0.2478$ cu. m. The stem volumes of all trees analyzed were rounded off to the fourth decimal, the same applying to increments too. The aggregate stem volume of all tree diameter-classes was

$$V = \sum_{j=1}^{l} n_j \cdot v_j = 230.4116 \text{ cu. m.} ,$$

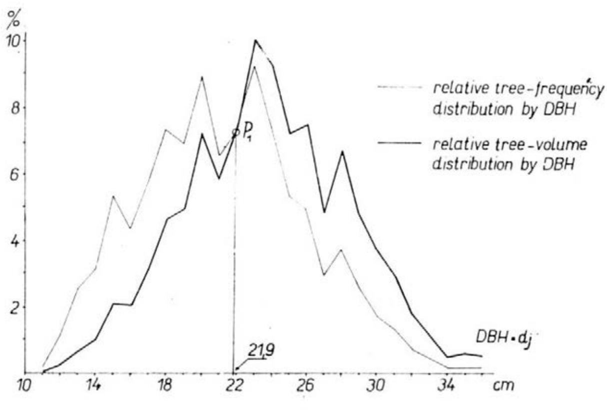
the Mean Tree volume was

$$\bar{v} = \frac{1}{N} \sum_{j=1}^{l} n_j \cdot v_j = 0.4572 \text{ cu. m.}$$

The volume representation of individual DBH-classes was also expressed in terms of percentage of the aggregate stem volume o. b. = 230.4116 cu. m. = 100 %.

The relation of the tree frequency percentages and the volume percentages for individual DBH-classes can be best seen in Fig. 1. The two polygons have a common intersection point P_1 corresponding to the abscissa $d_v = 21.9$ cm, which is the very DBH of the Mean Volume Sample Tree — of the Stand Sample Tree.

A similar technique was employed to determine the Stem Volume Current Annual Increment. Individual annual current increments were computed for all 504 analyzed trees on the basis of their five-year periodical current increment, as indicated above. According to the tree classification, the increment figures (Tab. I) were assigned to individual DBH-classes. In other words, the DBH-class $d_j = 28$ cm comprising all trees with a diameter range $\langle 27.5 - 28.4 \text{ cm} \rangle$ showed a total annual current stem increment of 0.4548 cu. m. Thus, the annual current increment per one tree of this DBH-class amounted to $i_j = 0.0239$ cu. m. The aggregate stem volume increment for all the trees of the stand (for all DBH-classes) was thus



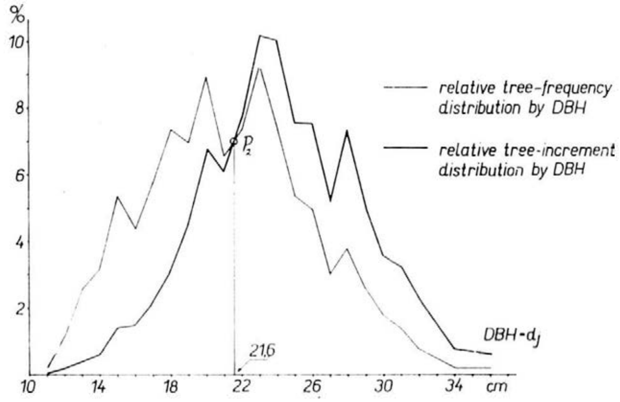
1. Relative tree-frequencies and relative volume-frequencies by DBH-classes. Position of the Mean Volume Sample Tree. — Vztah relativního zastoupení stromových četností a relativního zastoupení hmot podle výčetních tlouštěk. Poloha středního hmotového kmene

$$\sum_{j=1} n_j i_j = 6.1862 \text{ cu. m.}$$

and the average increment per tree

$$\bar{i} = \frac{1}{N} \sum_{j=1}^{l} n_j \,.\, i_j = 6.1862 : 504 = 0.01227 \text{ cu. m.}$$

This is the annual stem volume current increment of the Increment Sample Tree. With regard to the fact that the relative distribution of the above increment over individual DBH-classes also depends on the relative DBH distribution, their interrelationships can be followed easily, e. g. in the polygons of the relative tree frequency and tree volume distributions.



2. Relative tree-frequencies and relative increment-frequencies by DBH-classes. Position of the Mean Increment Sample Tree. — Vztah relativního zastoupení stromových četností a relativního zastoupení přírůstu podle výčetních tlouštěk. Poloha přírůstového vzorníku

And this is also why the increments of individual DBH-classes were also given in terms of percentage (related to the aggregate increment = 6.1862 cu. m. = 100 %). The relationship of the tree frequency percentage and increment percentage polygons can be seen particularly in Fig. 2. This graphic representation shows (together with figures in Tab. I) that for the smallest diameters is

$$\frac{n_j}{N} 100 > \frac{n_j \,.\, i_j}{I} 100 \;.$$

The two polygons intersect each other in point P_2, the abscissa of which ($d_i = 21.6$ cm) represents the DBH of the Increment Sample Tree. This is also how in principle also the Increment Sample Tree position within the population is determined. The respective proof is similar to that applied to location of the position of the Growing Stock Sample Tree. With tree diameters larger than is the DBH of the Increment Sample Tree tend the relative tree frequencies be smaller than the corresponding increment percentages, i. e.

$$\frac{n_j}{N} 100 < \frac{n_j \,.\, i_j}{I} 100 \;.$$

In the graphic representation, the polygon of relative tree frequencies is higher than that of increment percentages up to the Increment Sample Tree position (intersection point P_2 of the two polygons) from then on is it below the increment percentage distribution polygon.

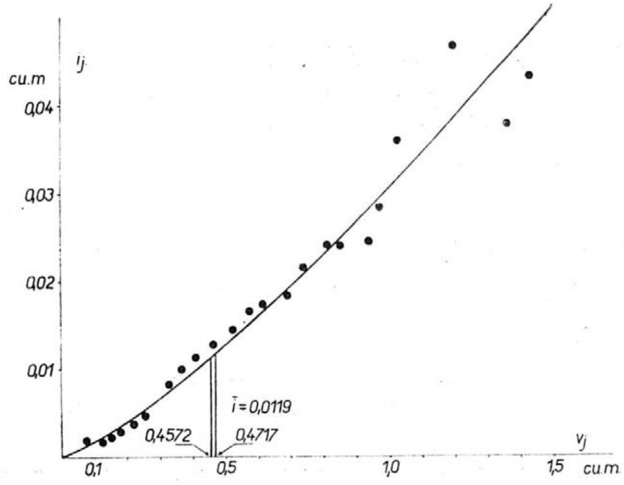
To investigate (find) the relationship of the v_j and i_j variables which is generally expressed by the equation (11), the least squares method was used to calculate the parameters $K = 0.03064$, and $n = 1.258$, so that the actual equation is

$$i_j = 0.03064\, v_j^{1.258} \; .$$

The equation expressing the relation of v_j and i_j does not represent in this case a straight line but a comparatively flat convex curve. The relationship of the two variables expressed this way testifies to the fact that the adjusted increment per one tree $\bar{i}$ is not only a function of the Mean Tree volume $\bar{v}$ but that in general is it given by the series

II. Increment figures adjusted according to equation $i_j = 0.03064\ v_j^{1.258}$ (School Forest, Kostelec nad Černými lesy). — Vyrovnané přírůstové údaje podle závislosti $i_j = 0{,}03064\ v_j^{1.258}$ (Školní lesní podnik v Kostelci nad Černými lesy)

j	d_j	n_j	v_j	$v_j^{1.258}$	i_j	$n_j \, . \, i_j$
1	11	1	0.0834	0.0439	0.0013	0.0013
2	12	6	0.1035	0.0576	0.0018	0.0108
3	13	13	0.1247	0.0729	0.0022	0.0286
4	14	16	0.1522	0.0936	0.0029	0.0464
5	15	27	0.1789	0.1147	0.0035	0.0945
6	16	22	0.2147	0.1444	0.0044	0.0968
7	17	29	0.2478	0.1729	0.0053	0.1537
8	18	37	0.2878	0.2087	0.0064	0.2368
9	19	35	0.3288	0.2468	0.0076	0.2660
10	20	45	0.3708	0.2871	0.0088	0.3960
11	21	33	0.4077	0.3234	0.0099	0.3267
12	22	37	0.4654	0.3820	0.0117	0.4329
13	23	44	0.5255	0.4451	0.0136	0.5984
14	24	37	0.5740	0.4974	0.0152	0.5624
15	25	27	0.6169	0.5446	0.0167	0.4509
16	26	25	0.6922	0.6296	0.0193	0.4825
17	27	15	0.7454	0.6910	0.0211	0.3165
18	28	19	0.8146	0.7727	0.0236	0.4484
19	29	13	0.8478	0.8125	0.0249	0.3237
20	30	9	0.9385	0.9232	0.0283	0.2547
21	31	7	0.9713	0.9641	0.0295	0.2065
22	32	4	1.0280	1.0353	0.0317	0.1268
23	34	1	1.2501	1.3243	0.0405	0.0405
24	35	1	1.4308	1.5694	0.0480	0.0480
25	36	1	1.3601	1.4735	0.0451	0.0451
		504	5.9949 : 504 = 0.0119			5.9949



3. Relation of single tree increment and single tree volume in a Norway Spruce stand. Adjustment curve. Position of the Volume and Increment Sample Trees. — Vztah přírůstů stromů v porostě k jejich hmotám. Vyrovnávající křivka. Poloha hmotového a přírůstového vzorníku

expansion according to equation (10a). In the series representing the right side of the said equation are present in addition to the derivatives also the second and higher central moments.

It goes without saying that when using the adjusted increments resulting from equation (6c), we obtain both for the individual diameter classes and for the whole stand the increment somewhat different from the case when no increment adjustment had been done. This can be best seen from Tab. II, where $\sum_{j=1}^{1} n_j i_j = 5.9949$ cu. m., as compared with the previously given figure 6.1862 cu. m. calculated by addition of the increments assessed by direct measurement. The difference 6.1862—5.9949 cu. m. represents in this case 3 per cent. The arithmetic mean resulting from the adjusted increments 5.9949 : : 504 = 0.0119 cu. m. is a figure we can also obtain from the formula (10a). And really, if we evaluate the right-hand series with four members only, we obtain already exactly the Mean Current Increment (according to equation 10a)

$$\bar{i} = f(\bar{v}) + \frac{f^{\text{II}}(\bar{v})}{2!} m_2 + \frac{f^{\text{III}}(\bar{v})}{3!} m_3 + \frac{f^{\text{IV}}(\bar{v})}{4!} m_4 = 0{,}0119 \text{ cu. m.}$$

It results from the above that:

1) The Increment Sample Tree is in our case not identical — even for non-adjusted increments of individual diameter classes — with the Growing Stock Sample Tree. If we carry out an interpolation on the basis of Tab. I (containing non-adjusted increment figures), then we find that the Growing Stock Sample Tree the volume of which is $\bar{v} =$ $= 0.4272$ cu. m. has a breast high diameter $d_{\bar{v}} = 21.8$ cm. The mean increment computed on the basis of the non-adjusted increment figures is $\bar{i} = 6.1862 : 504 = 0.01227$ cu. m. Again by way of interpolation can we find by means of Tab I. a breast high diameter corresponding to this increment, i. e. $d_{\bar{i}} = 21.6$ cm.

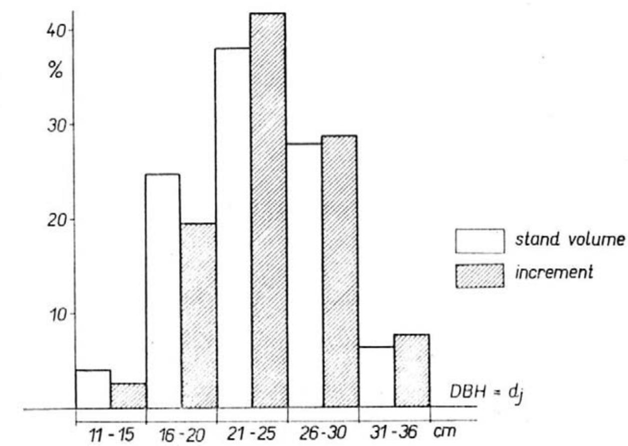
2) If we use, however, the adjusted increments obtained from equation (6c), the respective increment total is 5.9949 cu. m., and the corresponding increment mean $\bar{i} =$ $= 0.0119$ cu. m. According to Tab. II, the above increment figure belongs to a breast high diameter $d_{\bar{i}} = 22.3$ cm.

3) It is obvious from the two increment figures obtained in different ways that it is possible in practice to regard the Mean Volume Tree (Growing Stock Sample Tree) of a $\bar{v}$ volume at the same time as an Increment Sample Tree, since the breast high diameters (DBH) of the two sample trees are very close.

It is undeniably interesting and eventually also important economically to know the relative volume (or basal area) and relative increment proportions by individual tree diameter classes. According to Assmann (1961) this problem had been studied by several researchers like Kraft (1884), Japing (1911), Vanselow (1951), Magin (1952) and others. The available research findings on this subject have clearly shown that in evenaged normally thinned forest stands the dominant and co-dominant trees (1 + 2 Kraft's-classes) produce the bulk of the stand increment, this share being some 85—95 per cent. Other tree categories only account for a comparatively small part of the entire increment. Moreover, it can be stated that the relative increment proportions of the mentioned tree categories are greater than the corresponding volume proportions.

As for the relative distribution of the stand volume and of the increment by tree diameter-classes, the issue has been already clarified. It is thus also obvious that of decisive importance in the increasing relative increment proportions over the relative growing stock (volume) proportions is the diameter-class of the Increment Sample Tree (Growing Stock Sample Tree). For better illustration of the situation were the results of

4. Relative stand volume and increment distribution by DBH-classes. — Relativní zastoupení porostních hmot a přírůstů podle tloušťkových tříd



III. Absolute and relative distribution of a 70-year old Norway Spruce growing stock and increment by DBH-classes. — Absolutní a relativní rozdělení porostní zásoby a přírůstu smrkového 70letého porostu podle DBH

Diameter class DBH o. b. (cm)	Volume		Increment	
	cu. m.	%	cu. m.	%
11—15	9.5899	4.16	0.1637	2.65
16—20	50.7482	22.03	1.2018	19.43
21—25	91.6891	39.79	2.5748	41.62
26—30	63.4320	27.53	1.7760	28.71
31—36	14.9524	6.49	0.4699	7.59
Total	230.4116	100.00	6.1862	100.00

our experimental stand converted from 1-cm diameter-classes to 5-cm ones, and following this, the relative distribution of the stand volume and increment in absolute and relative terms is as follows (Tab. III).

SUMMARY

The paper contains a short review of the available research results on current increment of forest stands, particularly on the so called Total Current Increment, which is theoretically the first derivative of the total volume production. In forest management and silviculture, the growing stock and its increment are virtually the all-important elements of forest planning and implementation of the forest operations. From the above conclusions also results the particular significance of the recently once more emphasized growing stock and increment control, applying in this country namely to management of evenaged forest stands (age-class management system). All forest research institutions of the world have put the problem of current increment determination high on the list of their research priorities, the major objective being particularly the elaboration of a suitable, economical, and sufficiently accurate method of current increment measurement. Also the biometrical research carried out in Czechoslovakia deserves much credit for the contributions to the solution of the above problem by J. Halaj, J. Řehák, V. Korf, Š. Šmelko, J. Wolf, and others.

With regard to the complexity of the increment issues were resolved, apart from the selected methods for current increment determination, also certain particular questions of theoretical nature, e. g. the position of the Growing Stock Sample Tree and of the Increment Sample Tree within the tree stand population. The statistical positions of these two important trees of any forest stand were established by means of the relative tree frequencies, relative volume and increment distribution by tree diameter (DBH) classes.

The frequency polygons based on the above relative figures (percentages), i. e. $\frac{n_j}{N}100$, $\frac{n_j v_j}{V}100$, and $\frac{n_j i_j}{I}100$ are in definite relations enabling general theoretical conclusions on the location of the two sample trees.

A generally valid expression for the average single-tree current increment ($\bar{i}$), i. e. for the increment attributed to the Increment Sample Tree, is represented by the equation (10a) the underlying theory of which and final form had been described too. To quantify the relation of the individual stand tree volumes v_j and their increments on the basis of our considerations and experiments, a simple equation has been suggested

$$i_j = K\, v_j^{\,n} \qquad (6a)$$

in which K and n are the constants that can be easily computed from the empirical mensurational data by the least squares method. Of great importance is the circumstance that for $n = 1$, i. e. in case of a linear correlation between the v_j and i_j variables is the Growing Stock Sample Tree identical with the Increment Sample Tree. In a more general case is the position of the Increment Sample Tree somewhat different from that of the Stand Volume Sample Tree. The above displacement is in fact so small that a Mean Tree having a $\bar{V}$ volume may be regarded at the same time as an Increment Sample Tree.

From the point of forest operations is important the relative stand volume and increment distribution by individual tree-sociological or diameter classes, more specifically the shares of the individual tree categories in the generation of the Current Increment. The problem has been studied from the viewpoint of tree-sociological classes, as reported

by Assmann, by several authors. As for the diameter classes, the findings are similar, and it may be stated that the relative volume shares (percentages) for smaller DBH classes are greater than the corresponding relative increment shares. For bigger tree dimensions (breast high diameters) is it just the reverse since the larger DBH-classes are necessarily associated with greater increment shares.

The abovedescribed relationships and theoretical findings were tested on mensurational data obtained by way of stem analyses of 504 trees on a permanent Norway Spruce sample plot, School Forest, Kostelec n. Č. lesy.

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Přírůstový rozbor lesního porostu

V práci jsou nejprve stručně shrnuty dosavadní poznatky o výzkumu běžného přírůstu lesních porostů, zejména o tzv. celkovém běžném přírůstu, který je teoreticky prvou derivací k celkové hmotové produkci. Pro hospodářskou úpravu a pěstování lesů jsou v podstatě porostní zásoba a její přírůst nejdůležitějšími prvky

plánování a realizace hospodářských opatření. Z toho také vyplývá zvláštní význam v poslední době zvláště zdůrazňované zásobové a přírůstové kontroly, a to v našich podmínkách zejména pro hospodářství se stejnověkými porosty (pro hospodářství s věkovými třídami). Na všech světových výzkumných pracovištích je problematika běžného přírůstu lesních porostů prvořadým biometrickým výzkumným problémem. Jde přitom zejména o nalezení vhodné ekonomicky únosné a dostatečně přesné metody ke stanovení běžného přírůstu lesních porostů. Také náš československý biometrický výzkum vykonal při řešení této otázky mnoho záslužného zejména pracemi J. Halaje, A. Priesola, J. Řeháka, V. Korfa, Š. Šmelky, J. Wolfa aj.

Se zřetelem na tuto složitou přírůstovou problematiku byly kromě návrhů zdůvodněných metod k stanovení běžného přírůstu porostů vyřešeny některé důležité dílčí otázky teoretické povahy. Mezi nimi je to i otázka polohy zásobového a přírůstového vzorníku v porostním souboru. Polohy obou těchto důležitých stromů v porostě jsou názorně řešeny pomocí relativních podílů stromových četností, porostních zásob a přírůstu v tloušťkových stupních.

Polygony těchto relativních hodnot (vyjádřených v %), tj.

$$\frac{n_j}{N}100, \frac{n_j v_j}{V}100, \frac{n_j i_j}{I}100,$$

jsou v konkrétních vzájemných vztazích, z nichž je možno polohu obou vzorníků velmi dobře teoreticky odvodit.

Pro obecné vyjádření přírůstu i, připadajícího průměrně na jeden strom, to znamená příslušejícího přírůstovému vzorníku, platí teoreticky zdůvodněná rovnice v konečné úpravě (10a). Pro vyjádření závislosti mezi hmotami jednotlivých stromů v porostě (v_j) a jejich přírůsty se na základě provedených rozborů doporučuje jednoduchá rovnice

$$i_j = Kv_j^n, \tag{6a}$$

kde K, n jsou parametry, jež se dají určit na základě empirického materiálu metodou nejmenších čtverců. Důležité přitom je, že pro $n = 1$, tedy za předpokladu lineárního vztahu mezi veličinami v_j, i_j je vzorník porostní zásoby současně vzorníkem přírůstovým. V obecnějším případě je poloha přírůstového vzorníku poněkud posunuta od polohy vzorníku porostní zásoby. Tento posun je prakticky tak malý, že je možno střední strom o hmotě $\bar{v}$ považovat současně za přírůstový vzorník.

Pro hospodářská opatření je důležité relativní rozdělení porostní hmoty a přírůstu na jednotlivé sociologické, popř. tloušťkové třídy. Konkrétně jde o to, jak se podílejí jednotlivé stromové kategorie na tvorbě běžného přírůstu. Tato problematika se zřetelem na sociologické třídy byla zkoumána, jak uvádí Assmann, několika autory. Pokud jde o tloušťkové stupně (třídy) jsou poznatky obdobné a je možno konstatovat, že relativní (procentuální) podíly zásoby u tenčích tloušťkových stupňů jsou větší než příslušné relativní přírůstové podíly. U tlustších dimenzí (výčetních tlouštěk) je tomu naopak, neboť na těchto tloušťkových stupních se koncentrují daleko větší přírůstové podíly.

Uvedené vztahy a teoretické poznatky byly přezkoušeny na konkrétních údajích z 504 analyzovaných stromů trvalé výzkumné smrkové plochy na Školním lesním podniku v Kostelci nad Černými lesy.

Анализ прироста лесных насаждений

В работе прежде всего коротко обобщены существующие сведения об исследовании текущего прироста лесных насаждений, главным образом о так называемом общем текущем приросте, который теоретически является первой производной от общей производительности массы. Для хозяйственного лесоустройства и лесоводства запас лесных насаждений и их прирост по существу являются наиболее важными элементами планирования и реализации хозяйственных мероприятий. Отсюда также вытекает особое значение в последнее время особо подчеркиваемого контроля с точки зрения запаса и прироста, а именно в наших

условиях главным образом для лесных хозяйств с одновозрастным насаждением (для лесных хозяйств с классом возраста). Проблематика текущего прироста лесных насаждений на всех исследовательских рабочих объектах в мире является первоочередной биометрической научно-исследовательской проблемой. При этом речь идет, прежде всего, о нахождении пригодного, экономически посильного и достаточного метода определения текущего прироста лесных насаждений. Также наше чехословацкое биометрическое научное исследование при решении этого вопроса сделало многое, в частности работами: Й. Галайе, А. Приесола, Й. Ржегака, В. Корфа, Ш. Шмелки, Й. Волфа и др.

Принимая во внимание эту сложную проблематику прироста, помимо проектов подчеркиваемых методов определения текущего прироста, разрешены некоторые важные частные вопросы теоретического характера. К ним относится также вопрос места среднего ствола по приросту и запасу зеленой массы в лесной совокупности. Места обоих этих важных деревьев в насаждении наглядно решены при помощи относительных долей частоты деревьев, запаса и прироста насаждений в степенях по толщине.

Полигоны этих относительных значений (выраженных в %), т. е.

$$\frac{n_j}{N} 100, \frac{n_j v_j}{V} 100, \frac{n_j i_j}{I} 100,$$

находятся в конкретных взаимосвязях, по которым можно весьма хорошо теоретически вывести место обоих модельных деревьев.

Для общего выражения прироста, приходящегося в среднем на одно дерево и, т. е. относящегося к среднему стволу по приросту, справедливо теоретически обоснованное уравнение в конечном виде (10а). Для выражения зависимости между массами отдельных деревьев в насаждении v_j и их приростами, на основе проведенных анализов, мы рекомендуем простое уравнение

$$i_j = K v_j^n \qquad (6а$$

где: K, n — параметры, которые можно определить на основе эмпирического материала при помощи метода наименьших квадратов. При этом важно то, что для $n = L$, следовательно, при предпосылке линейного отношения между величинами v_j, i_j средний ствол по запасу зеленой массы одновременно является средним стволом по приросту. В общем случае место среднего ствола по приросту несколько смещен от места среднего ствола по зеленой массе. Это смещение практически так мало, что среднее дерево массой в можно считать одновременно средним стволом по приросту.

Для хозяйственных мероприятий важно относительное разделение зеленой массы и прироста на отдельные социологические классы или же классы по толщине. Конкретно речь идет о том, каким образом отдельные категории деревьев участвуют в образовании текущего прироста. Эта проблематика, учитывая социологические классы, как приводит Ассман, изучалась несколькими авторами. Что касается степени толщины (класса), сведения аналогичны, причем можно констатировать, что относительные доли (процентные) зеленого запаса у более слабых классов по толщине больше, чем относительные доли прироста. У более сильных размеров (диаметр на высоте груди), наоборот, так как на этих более сильных по диаметру стволах концентрируется гораздо больше прироста.

Приведенные отношения и теоретические сведения были проверены на конкретных данных 504 анализируемых деревьев с постоянной исследовательской еловой площади в учебном лесном предприятии в Костелцы н/Ч. Л.

Holzzuwachsanalyze eines Forstbestandes

In der Arbeit werden zuerst kurz die bisherigen Erkenntnisse über die Erforschung des laufenden Zuwachses in Forstbeständen und besonders über den laufenden Gesamtzuwachs zusammengefaßt, der theoretisch die erste Derivation zur Gesamtmassenleistung ist. Für die Forsteinrichtung und den Waldbau sind im wesentlichen der Bestandsvorrat und sein Zuwachs die wichtigsten Elemente für die Planung und Realisierung der Wirtschaftsmaßnahmen. Hieraus ergibt sich auch die hohe Bedeutung der in der letzten Zeit besonders betonten Holzvorrats- und

Zuwachskontrolle, und zwar in den Bedingungen der ČSR besonders für die Bewirtschaftung gleichaltriger Bestände (für die Wirtschaft mit Altersklassen). Auf allen Forschungsstellen in der Welt ist die Problematik des laufenden Zuwachses von Forstbeständen ein erstrangiges Forschungsproblem. Es geht hierbei vor allem darum, geeignete, ökonomisch tragbare und ausreichend genaue Methoden zur Bestimmung des laufenden Zuwachses von Waldbeständen zu finden. Auch die tschechoslowakische biometrische Forschung leistete besonders mit den Arbeiten von J. Halaj, A. Priesol, J. Řehák, V. Korf, Š. Šmelko, J. Wolf und anderen vieles für die Lösung dieser Frage.

Mit Rücksicht auf diese komplizierte Zuwachsproblematik wurden außer den Entwürfen der hervorgehobenen Methoden zur Bestimmung des laufenden Zuwachses einige wichtige Teilfragen theoretischen Charakters gelöst. Unter anderem ist es auch die Frage der Lage des Stichprobenbaums für die Vorrats- und Zuwachsbestimmung in der Bestandsgesamtheit. Die Lagen dieser beiden wichtigen Bäume im Bestand wird anschaulich mit Hilfe der relativen Anteile der Baumhäufigkeiten, der Bestandsvorräte und des Zuwachses in den Stärkeklassen gelöst.

Die Polygone dieser relativen Werte, die in Prozenten ausgedrückt werden, d. h. $\frac{n_j}{N} 100, \frac{n_j v_j}{V} 100, \frac{n_j i_j}{I} 100$, sind in konkreten Wechselbeziehungen, aus denen die Lage der beiden Stichprobenbäume sehr gut theoretisch abgeleitet werden kann. Für die allgemeine Erfassung des Zuwachses i der im Mittel auf einen Baum entfällt, das heißt der dem Zuwachsstichprobenbaum zugeordnet ist, gilt die theoretisch begründete Gleichung in ihrer endgültigen Form (10a). Zur Erfassung der Abhängigkeit zwischen den Holzmassen der einzelnen Bäume im Bestand (v_j) und ihrer Zuwachsraten wird aufgrund der durchgeführten Analysen nachstehende einfache Formel empfohlen

$$i_j = K v_j^n \qquad (6a)$$

wo K und n Parameter sind, die aufgrund des empirischen Materials mit der Methode der kleinsten Quadrate bestimmt werden können. Wichtig ist hierbei, daß für $n = L$, also unter Voraussetzung einer linearen Beziehung zwischen den Größen v_j und i_j der Stichprobenbaum für den Bestandsvorrat gleichzeitig auch der Stichprobenbaum für den Zuwachs ist. Im allgemeineren Fall ist die Lage des Zuwachsstichprobenbaums gegenüber der Lage des Holzvorratsstichprobenbaums etwas verschoben. Diese Verschiebung ist praktisch so klein, daß ein mittlerer Baum mit der Holzmasse v gleichzeitig als Stichprobenbaum für den Zuwachs betrachtet werden kann.

Für die Maßnahmen der Forsteinrichtung ist die relative Verteilung der Bestandsmasse und des Zuwachses auf die einzelnen soziologischen oder gegebenenfalls auch die Stärkeklassen wichtig. Konkret handelt es sich darum, wie sich die einzelnen Baumkategorien an der Bildung des laufenden Holzzuwachses beteiligen. Wie Assmann anführt, wurde diese Problematik mit Rücksicht auf die soziologischen Klassen von einigen Autoren untersucht. In bezug auf die Stärkestufen (Stärkeklassen) sind die Erkenntnisse ähnlich, und es ist festzustellen, daß die relativen (prozentuellen) Anteile des Vorrats bei den dünneren Stärkeklassen größer sind als die entsprechenden relativen Zuwachsanteile. Bei den stärkeren Dimensionen (Brusthöhendurchmessern) ist das umgekehrt, denn auf diese höheren Stärkeklassen konzentrieren sich bedeutend größere Zuwachsanteile.

Die angeführten Beziehungen und theoretischen Erkenntnisse wurden an den konkreten Angaben von 504 analysierten Bäumen der dauernden Fichtenbestandsforschungsfläche im Schulforstbetrieb in Kostelec nad Černými lesy überprüft.

Analyse d'accroissement du peuplement forestier

Dans le travail on résume tout d'abord sommairement les acquisitions actulles de la recherche relatives à l'acroissement courant des peuplements forestiers, notamment ledit accroissement courant total qui, au point de vue théorique, est la première dérivation de la production totale en volume. Pour l'aménagement

forestier et la sylviculture ce sont en somme le volume sur pied et son accroissement qui constituent les éléments les plus importants pour la planification et la réalisation des mesures d'aménagement. Il en ressort aussi l'importance particulière, accentuée notamment dans le dernier temps, du contrôle du volume sur pied et des accroissements, et cela dans nos conditions notamment pour l'exploitations des peuplements équiennes (pour le regime comprenant les classes d'âge). Dans toutes les stations mondiales de recherche la problématique de l'accroissement courant des peuplements forestiers constitue le problème de recherche biométrique de premier ordre. Il s'agit notamment de trouver une méthode convenable, économiquement acceptable et suffisamment précise, permettant de déterminer l'accroissement courant des peuplements forestiers. C'est également notre recherche biométrique tchécoslovaque qui a bien mérité de la solution de cette question, notamment grâce aux travaux des auteurs suivants: J. Halaj, A. Priesol, J. Řehák, V. Korf, Š. Šmelko, J. Wolf et autres.

Compte tenu de cette problématique compliquée en matière d'accroissement, on a présenté, outre les projets de méthodes soulignées, destinées à la détermination de l'accroissement courant des peuplement, la solution de certaines questions partielles importantes de caractère théorique. C'est entre autres également la question d'emplacement (de la position) des arbres modèles indiquant d'une part le volume sur pied et d'autre part l'accroissement dans la population du peuplement, dont on a trouvé la solution. Les positions de ces deux arbres importants dans le peuplement sont suggestivement représentées au moyen des quotients relatifs des fréquences des arbres, des volumes sur pied et de l'accroissement en degrés d'épaisseur.

Les polygones de ces valeurs relatives (exprimées en $^0/_0$) soit

$$\frac{n_j}{N}\,100,\ \frac{n_j v_j}{V}\,100,\ \frac{n_j i_j}{I}\,100,$$

se trouvent en rapports réciproques concrets, dont on peut très bien théoriquement déduire la position des deux abres modèles.

Pour exprimer en général l'accroissement revenant en moyenne à l'arbre i, c'est-à-dire appartenant à l'arbre modèle d'accroissement, on applique la forme finale de l'équation théoriquement justifiée (10a). Pour exprimer les corrélations entre les volumes des arbres particuliers dans le peuplement (v_j) et leurs accroissements, on recommande d'appliquer, sur la base des analyses effectuées, l'équation simple suivante:

$$i_j = K v_j^{\,n} \tag{6a}$$

où K, n sont les paramètres qui peuvent être déterminés sur la base du matériel empirique, en appliquant la méthode des moindres carrés. Ce qui est important ici, c'est que $n = L$, et que par conséquent l'arbre modèle du volume sur pied est simultanément, sous conditions du rapport linéaire entre les grandeurs v_j, i_j, l'arbre modèle d'accroissement. Dans le cas plus général la position de l'arbre modèle d'accroissement est quelque peu écartée de la position de l'arbre modèle du volume sur pied. Cet écartement est cependant pratiquement tellement insignifiant qu'on peut considérer l'arbre moyen d'un volume v simultanément comme arbre modèle d'accroissement.

Ce qui est important pour l'application des mesures économiques, c'est la division relative du volume sur pied et de l'accroissement en classes sociologiques particulières, éventuellement en classes d'épaisseur. En réalité, il s'agit de déterminer comment participent les différentes catégories d'arbres à la formation de l'accroissement courant. Par rapport aux classes sociologiques cette problématique a été examinée, comme la mentionne Assmann, par plusieurs auteurs. En ce qui concerne les degrés (classes) d'épaisseur, les acquisitions sont analogues et on peut constater que les quotients relatifs (en pour cent) du volume sur pied sont plus grands chez les degrés d'épaisseur plus faibles que les quotients relatifs d'accroissement correspondants. Quant aux dimensions plus fortes (épaisseur à hauteur de poitrine), c'est le contraire qui a lieu, car sur ces degrés d'épaisseur plus forts se concentrent des quotients d'accroissement beaucoup plus grands.

Les rapports et les acquisitions théoriques mentionnés étaient vérifiés sur les données concrètes, tirées de 504 arbres analysés sur la parcelle expérimentale permanente d'épicéa dans L'entreprise forestière VŠZ à Kostelec n. Č. lesy.

The author's address:

Prof. Dr. Ing. Václav Korf, Dr.Sc., Vědecký lesnický ústav VŠZ,
Kostelec nad Černými lesy

M. Vyskot

NEW TRENDS IN THE SCIENCE OF SILVICULTURE

In forestry sciences as well as in other sciences more and more have been pursued the long-term concepts and approaches basing on the logological principles. However, forestry is handicapped in this case, at least in the field of silviculture, by the unusually long production periods, and a limiting criterion of our investigations from the viewpoint of tangible results is particularly the factor of time. Yet even despite the above comparatively unfavourable circumstance do apply to forestry sciences the same laws and rules governing other science sectors, and if we adopt as a basis of our approach logology or logometry, i.e. the sciences of science, we find that a major problem is the information explosion representing the knowledge so far accumulated, the majority of which has not been applied efficiently to production. The idyll of encyclopaedism as well as the idyll of subsistence farming do belong irreversibly to past times, and the Soviet scientist Prof. G. M. Dobrov has formulated an axiom saying in free interpretation "With increasing man's knowledge, the utilization of this knowledge has decreased". This is but a recent resonance of Socrates' ancient saying "Scio me nihil scire" (I know that I do not know anything). According to international statistical figures solely in the field of nature sciences some three million scientific books and papers are being published annually, and it is well known in the great libraries and documentation centres that the bulk of printed scientific information has been neither demanded nor borrowed — to idle uselessly. Moreover, the degree of efficient knowledge utilization has been declining according to the same international information sources. This is, understandably, a statement based on relative comparisons, as demonstrated again nicely by the Soviet statistical records comprising interesting evidence that one single scientist's contribution to national economy would be some 50,000 roubles a year.

When applying the above general considerations and figures to the particular field of forestry, we learn that also here the general rule of disjunction and caesura of theory and practice, more specificaly of research and production, has retained its validity. To arrive at the root of the problem, it is necessary to recall at least shortly the basic rules of logology. There are, essentially, four of them: 1) the exponential law, 2) the crystallization law, 3) the cumulation law, and 4) the transition law.

The exponential law, constituting the basic law of science, was formulated already in 1844 by Friedrich Engels in the following way: "The science advances proportionally to the amount of knowledge inherited from previous generations. In the terminology of mathematics, the development of science is governed by an exponential law."

The law of crystallization may be characterized by saying that the total number of scientists and researchers increases proportionally to the square (of the number) of outstanding scientists.

The cumulation law is in fact the law of extended knowledge reproduction. John Bernal has commented on this that great scientific theories are, in contrast to great art, in everlasting movement and somewhat "under repair"

The law of transition of an exponential curve into a logistic one characterizes a discrepancy between the absolute growth of scientific information and the possibilities of the society to put it in practice, the uppermost limit of science explotation being essentially the Gross National Income and the number of the country's inhabitants. The available experience has shown that the scientific potential does not embrace, as a rule, more than 6—8 per cent of the population.

With regard to the opportunities of putting the scientific and research achievements in practice is it necessary in a Socialist Society to point out the role of economic planning aiming at a systematic modernization and innovation of the production resources. This must be based, however, on the interest and enthusiasm of researchers and practitioners induced and encouraged by means of the material and psychological incentives. Moreover, of great importance is also the initiative and relation of the two partners.

SILVICULTURAL PROJECTIONS

The perspectives of silviculture and of silvicultural research in terms of futurology for the period until 2000 can be summarized in three principal problem and action areas:

1) biological automation,
2) silvicultural rationalization,
3) silvicultural programming.

Further work in the field of biological automation can very appropriately be based on the progressive traditions of Czechoslovak silviculture, particularly on those of natural regeneration of target tree species, and various forest management systems trying to resolve the difficult tasks of long-term scheduling and location of forest operations (zeitliche und räumliche Ordnung im Walde). The present extent of natural forest regeneration amounts to only 6 — 10 per cent of total forest reproduction, while the actual potential increase is as much as 30 per cent. Similar conclusions apply to problems of the so called primitive selection, i.e. to initial selection of suitable species, ecotypes, and specimens of forest trees. By way of appropriate phytoselection can be increased considerably the stability and production of forest stands both in the quantitative and particularly qualitative terms.

Silvicultural rationalization is likely to apply in the future in the first place to reduction of young stand densities, to efficient mechanization and chemization. Extraordinary attention should be also paid to the question of natural forest regeneration density and to optimum spacing of the new tree plantations. In intermediate-age stands of the II to IV age-classes is an important research and management objective to improve the stand firmness, namely that of Norway Spruce woods, and to stimulate production in general. It is thus a necessity to introduce and/or prescribe more intensive stand treatments embracing on the whole up to 20 per cent of the growing stock by means of mechanization or chemization. We have in mind primarily the logging systems based on mini-

-chain-saws and timber skidding machinery suitable for forest conditions of Czechoslovakia. There is also an open field to make a maximum use of the long-term experience with the Czech 3- mm management method designed by Josef Bohdanecký, which is considered to be very progressive both from the point of its basic idea and system of biotechnology. With coniferous tree species, particularly with Norway Spruce, augmented raw timber resources without major investment expenditure would foster significantly the output of wood for chemical processing.

As for chemistry applications to forestry, the orientation should be towards new chemical preparations based on organic arsenides, which are efficient both with broadleaved and coniferous tree species. The preparations exert, at the same time, neither any toxic effects on man nor on the surrounding stand and, in contrary, they lower the risk of mass outbreaks of the noxious agents, especially of bark-beetles, on the organisms attacked.

Silvicultural programming represents a new subject based on the so called hybrid sciences, dealing with long-term projections of forest management and production and designing them by means of computers. A number of research projects on the subject have been already initiated, and some papers published; the study "The forests of the future and programmed silviculture" by Prof. V. G. Nesterov (1968) serving as an example.

Particular attention should be given in the above connection also to forest classification and to forest management along the lines of new methods of forest phytotechniques. The constantly advancing industrial civilization has been necessarily bringing about an extensive depletion of natural resources and human health, and from this point of view is it imperative in this country to protect particularly the mineral water springs and areas in general. To this should be added the conservation of extensive forest recreation areas in the proximity of big industrial agglomerations and housing projects.

It is for instance desirable that from the above point of view be quantified and incorporated in the economic plans the allocation (setting up) of the special-purpose forests under selective management. On the other hand is it however necessary to pay attention to the establishment and silviculture of the various types of lignicultures which should comprise, apart from the existing poplar plantations the area of which is limited both by climate and site, also commercial growing of introduced forest tree species.

EXAMPLES OF NEW RESEARCH APPROACHES

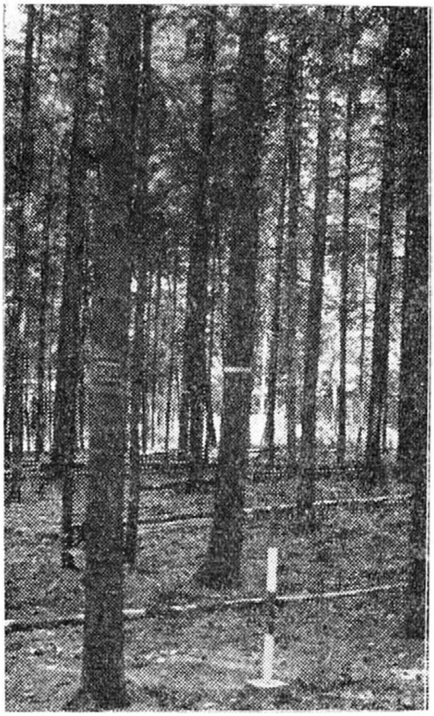
In the field of gnoseology has it become increasingly necessary to study and explain the causality of natural phenomena and to replace the present predominantly empirical methods by exact ones. One of such research projects which had been attacked on a world-wide basis is the study of the tree layer biomass of the tree species associations under the International Biological Programme.

The major objective of the International Biological Programme and of the project Man and Biosphere is research and measurement of the biosphere productivity, this applying particularly to analyses of the productivity of ecosystems. An analytical approach to the study of such complex systems requires investigations to be carried out from the viewpoint of a great number of sciences and various science and research specializations. The International Biological Programme is not only of scientific importance, but also of considerable social and economic significance to all mankind. This is because it is concerned with the key problem of world food supply and future production of organic matter by animals and plants.

The forestry sciences are expected to deal in the first place with International Biological Programme research projects investigating the productivity of terrestrial plant associations, particularly of the forests (PT). The Programme projects are also under way in several places of Czechoslovakia, and our Department is engaged in the study of a riverine forest in Southern Moravia, of a hill forest of the School Forest Farm, Faculty of Forestry, Agricultural University Brno, and of a Norway Spruce stand in the Bohemian-Moravian Hills area. The first report on a research project near Lednice, Southern Moravia, had been submitted earlier (V y s k o t 1970).

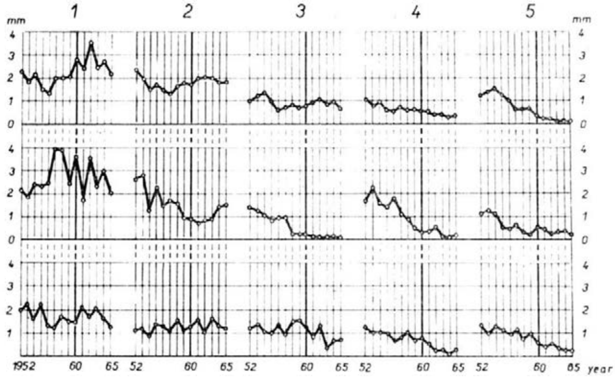
Another research site is located in the *Fagetum quercino-abietinum* forest type group, compartments No. 107 and 108, Forest District Olomučany, near Blansko. The exact geographical location of the site is given by the co-ordinates 49°19′25″ northern latitude, and 16°40′11″ eastern longitude. The altitude is 460 m, and the plateau gently sloping to north-east is underlain by granitite parent rocks. The soil is a brown forest sandy loam, the annual rainfall according to measurements of the Olomučany Meteorological Station averages 628 mm, the mean annual temperature 7.8°C. In 1971, the age of the stand under study was 51 years. The total stand area is 10.84 ha, that of the research plot surveyed in 1959, 1965, and 1970 is 0.84 ha. Silver Fir prevails in the tree species composition by its 90 per cent, other tree species represented being European Larch, Norway Spruce, Scots Pine, European Beech, and some other admixed harwoods.

For forestry research work within the International Biological Programme, a number of specialized method descriptions were published: D u v i g n e a u d P., A m b r o e s P., T a h o n J. "La productivité primaire des écosystèmes terrestres", G a l o u x A., G r u l o i s J. "Échanges radiatifs et consectifs en phase vernale", M o l č a n o v A. A., S m i r n o v V. V. "Metodika prirosta drevesnych rastenij", N e w b o u l d P. J. "Methods for Estimating the Primary Production of Forests", O v i n g t o n J. D., N e w b o u l d P. J. "General Procedures for Determining the Organic Production of Woodlands". After we had studied all the abovenamed methods, we arrived at the conclusion that the procedure designed by Molčanov-Smirnov (1967) is best suited for our purpose because it integrates forestry, natural science, and

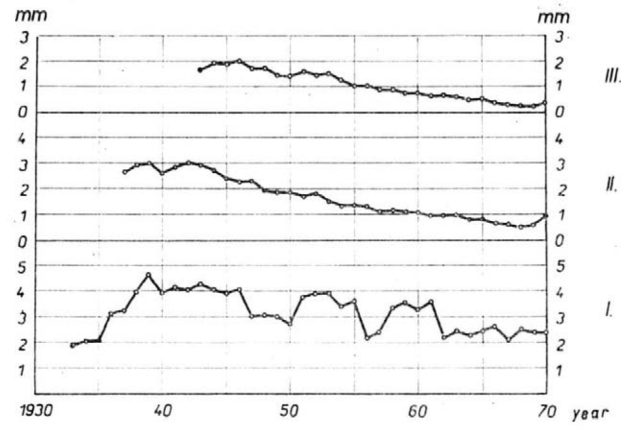


1. Partial view of the Silver Fir experimental plot, Block 108, Forest District Olomučany. — Dílčí pohled na výzkumnou plochu s *Abies alba* Mill. v odd. 108 polesí Olomučany

hydrology findings and is based on long-term research experience in the Tellerman Forest. In the course of our investigations was the M o l č a n o v - S m i r n o v research method further improved, the tree heights were measured with the Blume-Leiss hypsometer, and in the determination of the leaf surface areas was the photographic paper replaced by the photoplanimeter and galvanometer. In order to be able to study the effects of tree crown orientation and exposure, all sample trees were assigned not only to a northern quadrant, but also to the southern, eastern, and western ones. Moreover, since we were interested in the shares of specified tree crown part in total production, the Silver Fir crowns were further sub-divided in the upper, central, and lower parts. The volumes were determined by xylometric methods and not by less suitable mensurational procedures. Besides, certain minor changes and improvements were introduced as required by our research programm.



2. Year-ring width curves indicating DBH increment after logging in 1960. *1* — Dominant trees, *2* — Co-dominant trees, *3* — Intermediate trees, *4* — Shaded trees, *5* — Dying trees. — Letokruhové křivky udávající tloušťkový přírůst po těžbě v roce 1960: *1* — předrůstavé, *2* — úrovňové, *3* — vrůstavé, *4* — zastíněné, *5* — hynoucí stromy



3. Average annual diameter increments for individual tree categories: I — Dominant, II — Co-dominant, III — Overtopped. — Graf znázorňující průměr jednoročních tloušťkových přírůstů v různých kategoriích stromů: I — předrůstavých, II — úrovňových a III — podúrovňových

The sample trees representing the dominant, co-dominant, and lower-storey trees were chosen on the basis of biometrical measurements carried out in 1970, and of social tree classification, so that they are in fact representative samples of the respective tree classes. In September 1970 were taken from the model Silver Fir trees at breast height diameter increment cores (in perpendicular directions) by the Pressler borer, and were examined on a tree-ring analyser of the Department of Silviculture.

The results obtained from the analyses of individual sample trees are very extensive, and this is why with regard to a specific objective of our study we

I. Aerial biomass of Silver Fir model population, fresh and dry weights per ha
a v sušině na 1 ha (váha v kg) — kmen

	Sample tree No.	Cross section	Sawdust	Billets of lm-long section	Dry Branches
Fresh weight	Sa 1– 5	1 073.6	715.5	26 085.1	996.2
	Sa 6–10	503.3	42.1	13 947.9	1 036.8
	Sa 11–15	3 489.3	1 133.7	104 300.8	7 915.1
	Sa 1–15	5 066.2	1 891.3	144 333.8	9 948.1
Dry weight	Sa 1– 5	640.5	426.9	15 562.4	996.2
	Sa 6–10	295.3	24.8	8 180.7	1 036.8
	Sa 11–15	2 191.1	712.6	65 511.0	7 915.1
	Sa 1–15	3 126.9	1 164.3	89 254.1	9 948.1

II. Aerial biomass of the Silver Fir model population, fresh and dry weights per ha
stavu a v sušině na 1 ha (váha v kg) — koruna

	Sample tree. No.	Sample branch			Samples for needle photo- -plani- metry	Section of sample branches
		Sa	Needles	Shoots		
Fresh state	Sa 1– 5	184.0	121.9	62.1	1.7	14.0
	Sa 6–10	104.0	73.7	30.3	14.8	11.8
	Sa 11–15	1 155.5	737.3	418.2	29.7	106.0
	Sa 1–15	1 443.5	932.9	510.6	46.2	131.8
Dry state	Sa 1– 5	90.5	59.2	31.3	0.8	8.8
	Sa 6–10	53.9	37.8	16.1	7.4	6.8
	Sa 11–15	568.9	355.8	213.1	13.9	65.4
	Sa 1–15	713.3	452.8	260.5	22.1	81.0

aimed primarily at the quantification of the biomass (living matter), being of course also interested in the increment pattern and its changes. The year-ring investigations of individual model Silver Firs for the years 1928 — 1970, i.e. for the stand ages of 8 — 50 years have shown that maximum year-ring widths were attained in 1939 on dominant trees, amounting to almost 5 mm per year. However, in 1970 the above figure dropped to a half. The co-dominant Silver Fir trees had widest year-rings (3 mm) in 1939 and 1942, yet their width declined to mere 0.5 mm in 1968. The lower storey Silver Firs showed widest year-rings (2 mm) in 1934 and 1946, but throughout the last 15 years had the year-ring width fallen below 1 mm. The dominant and lower storey Silver Fir sample trees showed slightly increased year-ring widths in 1970. The above-described year-ring growth analyses make it possible to conclude in general on the maximum year-ring width amplitude, ranging from 4.8 mm to 0.2 mm, with absolute maximums in the years 1939 — 1946, and minimums in the period 1967 — 1969. The dry years of 1948 — 1950 have resulted in narrower year- rings.

(kg) — tree stem. — Nadzemní biomasa modelové populace jedle ve svěžím stavu

First green branch	Needles	Total			
		Needles	Branches		Stem
173.8	1.6	29 045.8	1.6	1 170.0	27 824.2
145.5	16.7	15 692.3	16.7	1 182.3	14 493.3
319.1	4.0	117 162.0	4.0	8 234.2	108 923.8
638.4	22.3	161 900.1	22.3	10 586.5	151 241.8
109.0	0.8	17 735.8	0.8	1 105.2	16 629.8
85.4	8.7	9 631.7	8.7	1 122.2	8 500.8
196.2	2.0	76 528.0	2.0	8 111.3	68 414.7
390.6	11.5	103 895.5	11.5	10 338.7	93 545.3

(kg) — tree crown. — Nadzemní biomasa modelové populace jedle ve svěžím

Needles and shoots			Main branches	Total			
Sa	Needles	Shoots		Sa	Needles	Shoots	Branches
7 636.9	5 231.0	2 405.9	1 005.9	8 842.5	5 354.7	2 467.9	1 019.9
1 285.7	914.9	370.8	383.8	1 800.1	1 003.4	401.1	395.6
10 788.0	6 924.1	3 863.9	6 206.7	18 285.9	7 691.1	4 282.1	6 312.7
19 710.6	13 070.0	6 640.6	7 596.4	28 928.5	14 049.2	7 151.1	7 728.2
3 751.6	2 537.6	1 214.0	630.5	4 482.1	2 597.6	1 245.3	639.2
666.6	470.4	196.2	225.3	960.0	515.6	212.3	232.1
5 313.7	3 343.6	1 970.1	3 796.5	9 758.4	3 713.3	2 183.2	3 861.9
9 731.9	6 351.6	3 380.3	4 652.3	15 200.5	6 826.5	3 640.8	4 733.2

The aggregate results of model Silver Fir trees have indicated that the fresh state weight of an average dominant Silver Fir tree was 664.7 kg, and its corresponding dry weight 389.8 kg, the largest shares in the above figures being the stem fresh weight (489 kg) and dry weight (291.8 kg). Of the other tree parts, i.e. needles, shoots, and branches, the needles are heaviest, weighing 94.0 kg in fresh state and 45.6 kg in dry state. A mean lower storey Silver Fir sample tree weighs in fresh state 28.3 kg only, its dry weight being 17.1 kg, the stem representing 23.4 kg of the former figure. The needles weigh only 1.6 kg in green state, and 0.8 kg in dry state. A mean co-dominant sample tree when fresh weighs 136.7 kg, when dry only 87.0 kg, its stem 110 kg in fresh state, and 69.0 kg in dry state. Of the remaining tree parts the branches occupy the first place with their 14.7 kg of fresh weight, and 12.1 kg of dry weight. This signifies that in terms of weight the needles prevail solely in the dominant Silver Fir trees, while in the co-dominant and lower storey ones it is the branches that weigh more.

III. Surface area of Silver Fir needles (sq. m.). — Plocha jehličí jedle v m^2

Tree category	Dominant (1–5)	Shaded (6–10)	Co-dominant (11–15)	Total (1–15)
Sample trees	1 203.805	20.128	107.146	1 331.079
Sample tree average	240.761	4.026	21.429	22.466
Total/ha	13 723.380	2 492.090	21 236.140	37 451.610

Interesting is also the relationship of the weight and surface area of the needles; an average Silver Fir sample tree of the dominant class has a needle surface area of 240.8 sq. m., a low storey tree 4.0 sq. m., and a co-dominant Silver Fir sample tree 22.5 sq. m. When relating the above three figures to one hectare, a remarkable needle surface area of 3.75 ha will be obtained. This quantitative figure will have to be, however, analyzed from the viewpoint of quality, particularly with regard to active participation of individual needle sectors in the photosynthesis. For better illustration and understanding is it necessary to convert the biomass figures to 1 ha. The dominant will then weigh 37.9 m. t./ha in fresh state, 16.0 m. t./ha in dry state, and the needles of this tree class when green will weigh 5.3 m. t./ha, when dry 2.6 m. t./ha. Also the shoots weigh more in green state than the branches (2.5 : 2.2 m.t./ha), yet the ratio is reversed for the dry matter figures (1.2 : 1.7 m.t./ha). Their stems weigh 14.5 m. t./ha in fresh state, and 8.5 m. t./ha in dry state. From among the other parts of trees of this category, biggest weight share is that of fresh branches (1.6 m. t./ha) and that of dry branches (1.4 m. t./ha). Most represented co-dominant Silver Fir trees total 135.4 m. t./ha in fresh state, 119.1 m. t./ha in dry state. Also in this tree category heaviest are the stems (fresh 108.9 m. t./ha, dry 68.4 m. t./ha), of the other parts of co-dominant Silver Fir trees the greatest share goes to branches (weighing 14.5 m. t./ha when fresh, and 11.9 m. t./ha when dry).

For forestry purposes is it important to make a relative comparison of the Silver Fir production expressed in terms of weight (metric tons) with the volume production expressed in terms of cu. m. Thus, the dominant Silver Fir trees represent a volume of 40.1 cu. m./ha, of which the share of derbholz is 33.7 cu. m., and that of small wood 6.7 cu. m./ha. The shaded (lower storey) Silver Fir trees make up a total volume of 21.7 cu. m./ha, of which derbholz is

IV. Summary table of volume (cu. m.) and biomass in fresh and dry state (m. t.), svěžím stavu a sušině (t) 50leté jedle na 1 ha

Tree category	Volume (cu. m./ha)		
	Derbholz	Small wood	Total
I. (1– 5)	33.4	6.7	40.1
III. (6–10)	12.6	9.1	21.7
II. (11–15)	129.8	24.8	154.6
Total	175.8	40.6	216.4

12.6 cu. m., and small wood 9.1 cu.m. The co-dominant Silver Firs represent 154.6 cu. m./ha, their derbholz volume accounting for 129.8 cu. m., that of small wood for 24.8 cu. m. It is important to note that of total of 1,667 trees per ha, in 1970—1971 there were 57 dominant Silver Fir trees, 619 lower storey ones, and 991 co-dominant Firs. An average Silver Fir (Mean Tree) has a breast-height diameter of 11.9 cm, a height of 14.2 m, and a basal area of 111.2 sq. cm. Its stem volume is 0.130 cu. m., of this the derbholz accounts for 0.105 cu. m., the small wood for 0.025 cu. m.

When we add to the above figures on the Mean Tree those in terms of weight, we find that it weighs in green state 114.5 kg, in dry state 71.4 kg. Of this the stem proper accounts for 90.7 kg of fresh weight, and for 56.1 kg of dry weight.

The aggregate results indicate the volume (cu. m.) and the biomass in fresh and dry state (m. t.) of a fifty-year-old Silver Fir population, related to the area of one hectare. The aggregate figures reveal that the Silver Fir volume/ha is 216.4 cu. m., of which the share of derbholz is 175.8 cu. m., that of small wood 40.6 cu. m. The fresh state per hectare weight is 190.8 m. t., the stem weight proportion being 161.9 m. t. The dry matter weight for the whole Silver Fir stand is 119.1 m. t./ha, of which the stems proper weigh 103.8 m. t./ha. The figures show that at the age of 51 years the Silver Fir production under the given environment was 176 cu. m. derbholz/ha, and that the stand biomass weighed 191 m. t./ha in green state, 119 m. t./ha in dry state.

The results obtained do supplement the existing knowledge of the biomass production by the tree layer populations under the International Biological Programme, and represent at the same time a new information on the green matter and dry matter production determination (quantification) in terms of weight, which is of considerable importance both to logging and transport and particularly to chemical wood processing.

NEW EQUIPMENT DESIGN

The choice of appropriate stand silvicultural management methods has made it necessary to determine the stand increment and to decide on this basis on the measures to be adopted. The increment determination has been done so far by way of increment cores taken by a Pressler borer and processed on various apparatuses like e. g. that designed by Eklund of Sweden. In order to make

50-year-old Silver Fir stand (1 ha). — Sumární tabulka hmoty (m^3) a biomasy ve

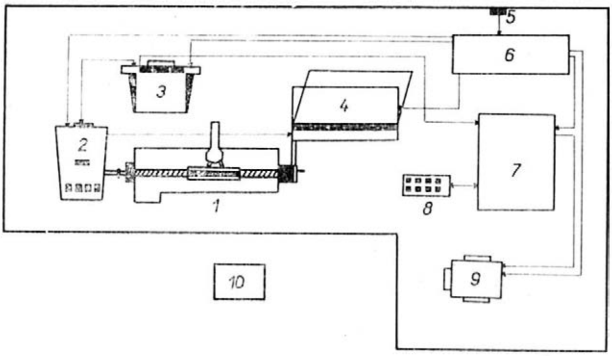
Fresh weight (m. t./ha)			Dry weight (m. t./ha)		
Stem	Crown	Total	Stem	Crown	Total
29.046	8.843	37.889	17.736	4.482	22.218
15.692	1.800	17.492	9.632	0.960	10.592
117.162	18.286	135.448	76.528	9.758	86.286
161.900	28.929	190.829	103.896	15.200	119.096

it possible to do series work and to evaluate the cores by a ZPA 600 computer, Eklund's apparatus and its variant authored by Vinš have been improved and supplemented so that in fact a new installation had been developed which was given the name "Year-ring analyzer of the Department of Silviculture, Faculty of Forestry, Agricultural University Brno".

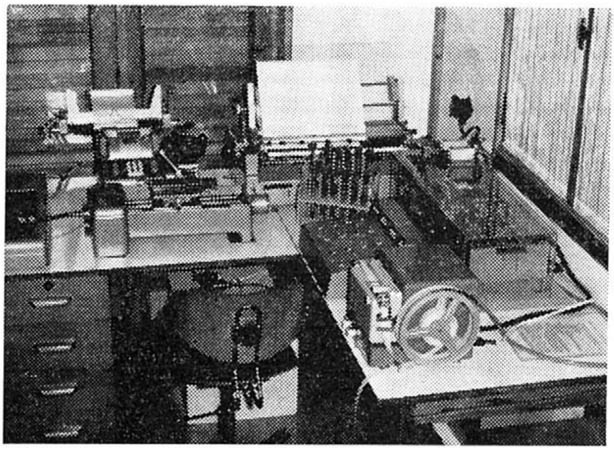
The original Eklund's apparatus for year-ring analyses consisted of three parts: a mesuring device for taking of the measurements proper, an impulse-giving device into which the data are fed and which converts them to electric impulses (Addo), and a calculator receiving impulses, recording the figures, and storing them.

The measuring instrument has a carriage which is moved by turning the measuring screw under a binocular microscope with cross lines. Between the measuring screw and the output shaft there is a gear box which can be set at three gears according to the desired measurement capacity and accuracy. Readings can be taken to the nearest 0.01 mm, yet in our experiments we used a 0.1 mm accuracy as fully satisfactory. The above carriage supports an object stage with a holder and rille for the increment core under study.

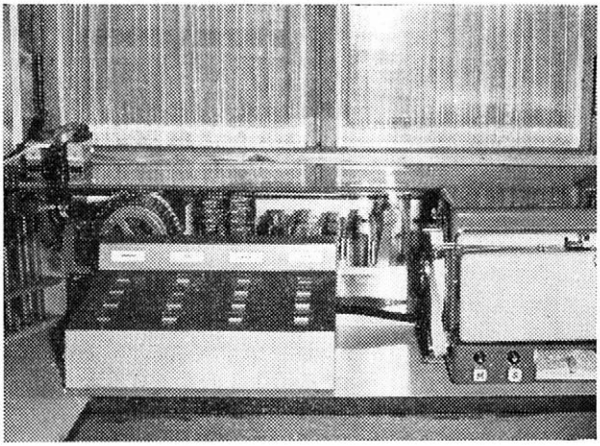
The object stage can be rotated or moved in two perpendicular directions, which is necessary in the cases when distances of year-rings should be measured on the cores the year-rings of which are not perpendicular to the core longitudinal axis.



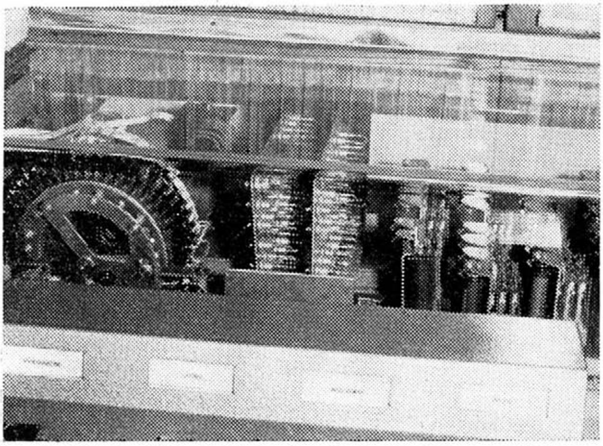
4. Year-ring analyzer based on Eklund's apparatus: *1* — Object measuring stage, *2* — Addo impulse generator, *3* — Addo calculator, *4* — Graphic plotter, *5* — Power mains, *6* — Current regulator, *7* — Synchronizer, *8* — Central panel, *9* — Punching machine, *10* — Operator. — Schéma letokruhového analyzátoru na bázi Eklundova přístroje: *1* — měřicí stůl, *2* — Addo impulsní, *3* — Addo početní, *4* — grafický vynášeč, *5* — síť, *6* — stabilizátor, *7* — synchronizátor, *8* — ovládací panel, *9* — děrovač, *10* — operátor



5. General view of the year-ring analyzer, designed by Department of Silviculture, Faculty of Forestry, Agricultural University Brno. — Celkový pohled na analyzátor vrstveného materiálu vyvinutý na katedře pěstění lesů lesnické fakulty VŠZ Brno



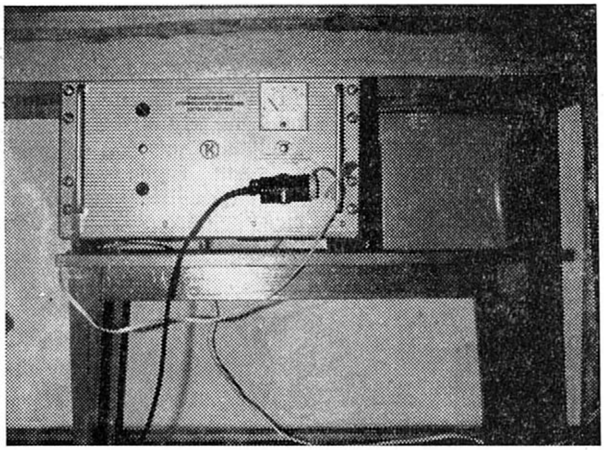
6. Part of the analyzer showing the control panel (left foreground), decoder (background) and electric punching machine (right foreground). — Výsek analyzátoru znázorňující velín (vpředu vlevo), dekodér (podélně vzadu) a elektrický děrovač (vpředu vpravo)



7. Detailed view of the decoder. — Detail dekodéru

The output shaft of the gear box is coupled by a joint coupling with the Addo impulse device (generator) feeding the measurements and transferring them by means of electric impulses to an Addo X calculator incorporating an electromagnetic conversion instrument. Another part of the apparatus is an output device dumping the figures on punched tape or punched cards.

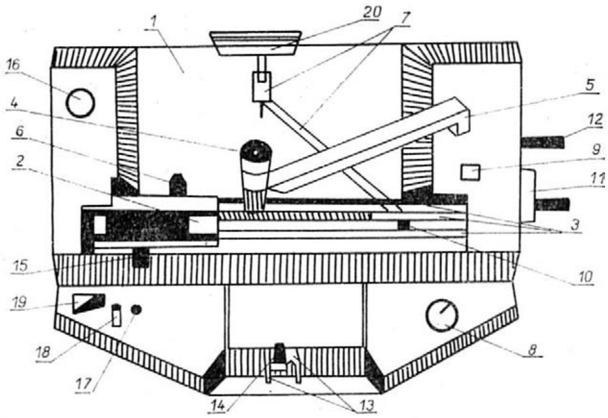
The above apparatus operated by our Department has been improved and extended successively by addition of new apparatuses, and at present the installation is composed — apart from the basic unit described above — of a graphic plotter (adapter) of the figures recorded (design Forestry and Game Management Research Institute, Zbraslav-Strnady — Ing. B. Vinš, C.Sc.), of a decoder (synchronizer) converting by means of a relay system the Addo X figures to code characters, and of a tape punching machine enabling automated processing of the data by a ZPA 600 computer. A plotting machine is another improvement facilitating the plotting of measurements for individual years, this being utilized at the same time as a check on the measurement procedure and exclusion of false measurements. Apart from the above, the graphic plotter draws a cumulative curve indicating the cumulative figures for any reference period within the range under study. The installation is supplemented by a voltage stabilizer which is indispensable for smooth operation.



8. Voltage regulator (Made in Czechoslovakia). — Stabilizátor napětí čs. výroby

It is hoped that during 1972, when the Computing Centre of the Agricultural University Brno is supplied with the digigraph equiment, it will be possible to plot all the recorded data by means of a computer on a pre-selected scale on a graphic paper (form) both for individual trees, whole forest stands, and DBH-grades or classes, either in absolute or relative terms, in accordance with the operating program. The installation is comparatively very sophisticated and will be used for large-scale demanding surveys.

To handle lesser quantities of tree increment cores, we have been using, with reference to a prototype designed by Ing. L. C h r o u s t , a simplier mechanic instrument UniAgri-1 which is easily portable. The year-ring measurement proper is carried out by a special-design device and a Meopta 66201 microscope with 25 X magnification. The recorded widths of individual year-rings



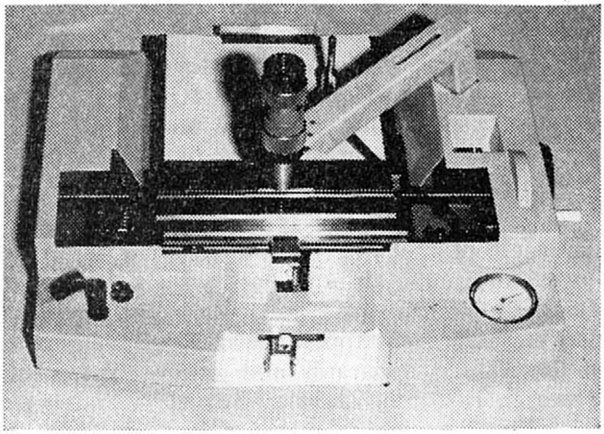
9. Schematic diagram of UniAgri - 1: *1* - Object stage (recorder), *2* - Carriage with sampler, *3* - Bed, guide and guide screw, *4* - Microscope, *5* - Holder of microscope, *6* - Scribe 1 : 1, *7* - Scribe with plotter 5 : 1, *8* - Indicator, *9* - Counter, *10* - Plotter adjusting screw, *11* - Control wheel, *12* - Counter clearance handle, *13* - Safety and reverse tape, *14* - Safety lock of reverse tape, *15* - Nut lead lever, *16* - Suspension control button, *17* - Stage reverse lever button, *18* - Stage feeding lever button, *19* - Stage change-feed lever, *20* - Paper sheet holder. — Schéma UniAgri - 1. *1* - stůl (záznamová část), *2* - vozík se vzorkovačem, *3* - lože, vedení a vodicí šroub, *4* - mikroskop, *5* - držák mikroskopu, *6* - pisátko 1:1, *7* - pisátko s vynášečem 5:1, *8* - indikátor, *9* - počitadlo, *10* - stavěcí šroub vynášeče, *11* - ovládací kolečko, *12* - nulovací klička počitadla, *13* - zajišťovací a vratné pásky, *14* - zajišťovací knoflík pro vratné pásky, *15* - vodicí páka matice, *16* - pérovník, *17* - tlačítko zpětné páky stolu, *18* - tlačítko podávací páky stolu, *19* - měnící páčka podávání stolu, *20* - držák papíru

can be read off a dial measuring gauge with 0.02 mm accuracy. The readings would be added by a counter to one decimal, the grand total being not more than 999.9 mm. The following step is plotting of the recorded data by means of a dual coordinatograph.

The mechanical year-ring analyzer UniAgri-1 was patented on April 13, 1971, under No. 141591.

The two installations described above serve for the determination of the current diameter increment and increment percentage, the procedure being done according to special methods and formulas. The methods used would deserve a separate paper for description, and we shall thus deal with the subject at some later opportunity.

We are strongly convinced that the reported methods of increment and increment rate determination of long-term forest experimental plots and forest tree populations will make it possible to embark in the silvicultural management of intermediate and mature forest stands on exact management methods based on objective and concrete data, and to ensure this way better stability and higher forest outputs.



10. General view of the UniAgri-1 portable analyzer. (Photos by Vyskot). — Celkový pohled na přenosný analyzátor UniAgri-1. Snímky Vyskot)

SUMMARY

The science of silviculture is largely determined by the factor of time, necessitating in the solutions of the theoretical and practical problems the application of both retrospective and futurologic methods. In this direction have many new opportunities been opened by new sciences, in the first place by logology and/or logometry. Also here the four basic laws are applicable, namely the exponential law, the crystallization law, the cumulation law, and the law of transition of the exponential curve into a logistic one.

The perspectives of silviculture and of silvicultural research can be summarized in three basic problem and action groupings: 1. biological automation, 2. silvicultural rationalization, 3. silvicultural programming. The abovementioned groupings should be rightly interlinked and harmonized to exclude the destruction of forest systems. In this connection should we not disregard the

classic triade consisting in a dialectic unity of the natural forest foundations, in the economic objectives of society's needs, and in the adequate technologies.

From the biological point of view is of crucial importance to silviculture the study of the ground and aerial biomasses of the tree-layers of forest tree species populations. This is namely the way towards learning about the causality of the tree growth process and towards utilizing it in applied silviculture. Great opportunities in this research had been opened by the International Biological Programme, and by the associated UNESCO project Man and Biosphere. A unique feature of the two programmes is that for the first time in the history of the science in general and of forestry science in particular co-ordinated research on a world-wide scale has been under way on the basis of internationally standardized working methods that will enable exact relative comparisons of the results and their applications.

In this country, reference can be made to an experimental 51-year old stand of *Abies alba* Mill., located in the Forest District Olomučany near Blansko, Brno Region, School Forest, Faculty of Forestry, Brno, representing the fruits of more than 50-year work of three generations of Professors of Silviculture. The stand is 51 years old, and the respective forest type group is *Fagetum quercino-abietinum*. The Silver Fir stem volume per ha is 216.4 cu. m., of which derbholz accounts for 175.8 cu. m., small wood for 40.6 cu. m. The corresponding fresh state weight is 190.8 m. t./ha, of which that of derbholz is 161.9 m. t./ha. The dry matter weight of the whole Silver Fir stand is 119.1 m. t./ha, the stem dry weight being 103.8 m.t./ha. It appears from the above that at the age of 51 years, the species has produced on the given forest site 176 cu. m. derbholz/ha, its fresh biomass weighing 191 m. t./ha, the respective dry matter weight being 119 m. t./ha.

The investigations of the growth process and choices of optimum stand management methods require adequate equipment enabling large-scale processing of the materials and data with sufficient accuracy. Basing on the already available instruments, particularly on the Swedish Eklund's apparatus, two new or improved apparatuses were designed by us. One installation consists of the Eklund apparatus and graphic plotter (Forestry and Game Management Research Institute, Zbraslav-Strnady), and is supplemented with a special decoder, electric punching machine for a ZPA 600 computer, a control panel and a current regulator. The installation is operated according to a program for the ZPA 600 computer made in Czechoslovakia, and is suitable for large-scale research projects and high requirements.

For small-scale data (year-ring widths) processing the so called UniAgri-1 apparatus based on mechanical principle had been developed by us, and it was patented on April 13, 1971 under No. 141591. It is composed of parts made in this country and is of a portable type. The year-ring widths are recorded on a dial gauge and simultaneously are they being plotted. Because of its comparably simple design, the apparatus can be well used in the forest.

As it is obvious from the preceding considerations, certain aspects of modernization of the silvicultural science had been dealt with, of the science that has been developing most — similarly to other fields of research — on the very borderlines of different subjects, this leading to a truly progressive science hybridization.

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Nové směry ve vědní disciplíně pěstění lesů

Pěstění lesů jako nauka je determinováno faktorem času, což si pro exaktní řešení teoretických i praktických otázek vynucuje pracovat jednak metodou retrospektivní, jednak metodou futurologickou. V tomto směru skýtají mnoho možností nové vědní disciplíny, především logologie, resp. logometrie. I zde platí v podstatě 4 zákony, tj. zákon exponenciální, zákon krystalizace, zákon kumulace a zákon přechodu exponenciální křivky v křivku logistickou.

Perspektivu pěstění lesů a vědeckého výzkumu v této disciplíně lze formulovat do tří základních problémových a realizačních souborů: 1. biologická automatizace, 2. pěstební racionalizace, 3. programování pěstění lesů. Všechny zmíněné soubory by měly správně na sebe navazovat tak, aby nedošlo k destrukci systému lesa. Přitom nesmíme zapomínat na klasickou triádu, která tkví v dialektické jednotě přírodních základů lesa, v ekonomických cílech společenské potřeby a k tomu adekvátních technických nástrojích.

V biologickém smyslu má pro pěstění lesů klíčový význam studium nadzemní i podzemní části biomasy stromového patra populací lesních dřevin. Tak totiž lze poznat kauzalitu růstového procesu a plně jej využívat v pěstební biotechnice. Velké možnosti v uvedeném bádání má Mezinárodní biologický program a na něj navazující projekt UNESCO Člověk a biosféra. Unikátní na těchto programech je skutečnost, že po prvé v historii obecných věd a lesnických zvláště se pracuje ve světovém měřítku sychronizovaně na základě mezinárodně kodifikovaných metodik, jež umožní exaktní komparaci výsledků a jejich aplikace.

Jako náš příklad uvádíme objekt padesátileté jedliny *Abies alba* Mill., která se nalézá na polesí Olomučany u Blanska, kraj Brno, na území Školního závodu lesnické fakulty VŠZ v Brně, který nese pečeť více než padesátileté práce tří generací profesorů. Porost má 51 let a nalézá se ve skupině lesních typů *Fagetum quercino-abietinum*. Stromová hmota jedle na 1 ha činí 216,4 plm, z čehož na hroubí připadá 175,8 plm a na nehroubí 40,6 plm. Váha ve svěžím stavu na 1 ha je 190,8 t, z toho na hroubí připadá 161,9 t. Sušina celého porostu jedle váží 119,1 t/ha. Sušina kmenů z toho činí 103,8 t/ha. Z toho plyne, že v 51 letech věku reprezentuje jedle v daných podmínkách 176 plm hroubí na 1 ha a její čerstvá biomasa váží 191 t/ha, což v sušině činí 119 t/ha.

Ke zkoumání růstového procesu a k odvozování nejvhodnějších fytotechnických zásahů je třeba mít vhodné aparatury, které umožňují sériové vyhodnocování s příslušnou přesností. V návaznosti na známé přístroje, zejména na švédský Eklundův přístroj, jsme vyvinuli 2 nové, resp. novelizované aparatury. První z nich navazuje na původní Eklundův přístroj a grafický vynášeč VÚLHM Zbraslav-Strnady. Je doplněn speciálním dekodérem, elektrickým děrovačem pro samočinný počítač ZPA 600 a vybaven velínem a stabilizátorem. Pro tuto soustavu je vypracován program na samočinný počítač čs. výroby ZPA 600. Uvedená aparatura je vhodná pro velké série a náročná šetření.

Pro zpracování malých sérií jsme vyvinuli přenosný přístroj na mechanickém principu nazvaný UniAgri-1, na který byl udělen patent číslo 141.591 z 13. 4. 1971. Je sestaven z dílců čs. výroby. Tento přístroj zaznamenává letokruhy na číselníku a současně je graficky vynáší. Vzhledem ke své poměrné jednoduchosti se hodí i pro práce v terénu.

Jak patrno, uvedli jsme některé aspekty modernizace disciplíny pěstění lesů, která stejně jako ostatní vědecké obory se nejvíce rozvíjí na styčném území rozdílných oborů, takže vzniká progresívní vědecká hybridizace.

Новые направления в научной дисциплине общего лесоводства

Лесоводство как наука детерминируется фактором времени, что для экзактного решения теоретических и практических вопросов требует применения, с одной стороны, ретроспективного метода, а, с другой, футурологического. В этом направлении много возможностей предоставляют новые научные дисциплины, прежде всего логология или логометрия. И в этом случае действуют, по существу, 4 закона: экспоненциальный, кристаллизации, кумуляции и закон перехода экспоненциальной кривой в логистическую.

Перспективу лесоводства и научного исследования в этой дисциплине можно сформулировать в 3 основных проблемных и реализационных совокупностях: 1. биологическая автоматизация, 2. лесоводческая рационализация, 3. программирование лесоводства. Все эти совокупности должны быть взаимно сопряжены во избежание деструкции лесной системы. При этом, не следует забывать о классической триаде, заключающейся в диалектическом единстве природных оснований леса, в экономических целях общественных запросов и адекватных технических средств.

В биологическом отношении в лесоводстве решающее значение имеет изучение наземной и подземной частей биомассы древесного яруса популяции древесных пород. Таким образом именно можно познать причинность процесса роста и полностью ее использовать в биотехнике лесоводства. Большими возможностями на этом поле действия располагает Международная биологическая программа (International Biological Programme) и связанный с ней проект ЮНЕСКО Человек и биосфера (Man and Biosphere). Уникатен тот факт, что впервые в истории общих наук и в частности лесных работы ведутся в международном масштабе, синхронизованно, на основе международно кодифицированных методик позволяющих точное сопоставление результатов и их применение.

В качестве местного примера приведен объект 50-летней белой пихты *Abies alba* Mill. в лесничестве Оломучаны-у-Бланска, обл. Брно, на территории учхоза лесного факультета в Брно, отражающий более чем 50-летнюю работу 3 поколений профессоров. Возраст насаждения 51 год, он находится в группе лесотипов *Fagetum quercino-abietinum*. Древесная масса пихты на 1 га составляет 216,4 плм^3, в том числе 175,8 плм^3 приходится на крупную древесину, 40,6 плм^3 на мелкую. Вес в свежем состоянии на 1 га = = 190,8 т, в том числе на крупную древесину приходится 161,9 т. Вес сухого вещества всего пихтового насаждения = 119,1 т/га, в том числе вес сухого вещ. стволов = 103,8 т/га. Это показывает, что в возрасте 51 год пихта представляет в данных условиях 176 плм³ крупной древесины/га, а вес ее свежей биомассы = 191 т/га, что равняется 119 т/га сухого вещества.

Для изучения процесса роста и определения оптимальных фитотехнических вмешательств необходима подходящая аппаратура, позволяющая серийно производить оценки соответствующей точности. На базе известных приборов, в частности шведского прибора Эклунда мы построили 2 новых (новелизированных) устройства. Первое связано с первоначальным прибором Эклунда, второе — графический выноситель НИИЛОХ Збраслав-Стрнады. Аппаратура дополнена специальным декодером, электроперфоратором для электронно-вычислительной машины ZPA 600, снабженным щитом и стабилизатором. Для этой системы составлена программа для электронно-вычислительной машины чехосл. производства ZPA 600. Аппаратура годится для крупных серий и сложных исследований.

Для обработки малых серий мы построили прибор на механическом принципе, названный Uni Agri I, на который получен патент № 141.591 от 13. 4. 1971 г. Прибор составлен из деталей чехосл. производства, форма портативная. Прибор отмечает годичные кольца на циферблат и в то же время графически их выносит. Благодаря своей простоте прибор годится для работ на местах.

Итак, мы привели некоторые аспекты модернизации дисциплины лесоводства, развивающейся, как и остальные научные области, на грани различных областей, ввиду чего здесь возникает прогрессивная научная гибридизация.

Neue Richtungen in der Wissensdiszipline des Waldbaus

Der Waldbau als Lehre wird durch den Faktor der Zeit determiniert; für exakte Lösung von theoretischen und praktischen Fragen erzwingt sich dies einerseits mittels der retrospektiven, andererseits mittels der futurologischen Methode zu arbeiten. In dieser Richtung bieten neue Wissensdisziplinen, vor allem die Logologie, bezw. Logometrie zahlreiche Möglichkeiten. Grundsätzlich gelten auch hier vier Gesetze, d. h. das Exponentialgesetz, das Gesetz der Kristallisierung, der Kumulation und das Gesetz des Überganges der Exponentialkurve.

Die Perspektive des Waldbaus und der wissenschaftlichen Forschung im Bereich dieser Disziplin kann in drei grundlegende Problems- und Reasilierungsgesamtheiten formuliert werden: 1. biologische Automatisierung, 2. waldbauliche Rationalisierung, 3. Programmierung des Waldbaus. Diese Gesamtheiten sollten richtig aneinander auf die Weise anknüpfen damit keine Destruktion des Waldsystems eintritt. Dabei sollte die klassische Triade nicht vergessen werden; diese beruht auf dialektischer Einheit der natürlichen Grundlagen des Waldes, auf ökonomischen Zielen des gesellschaftlichen Verbrauches und diesbezüglichen adäquaten technischen Instrumenten.

Im biologischen Sinne ist die Untersuchung des oberirdischen und unterirdischen Teils der Biomasse der Baumschicht von Baumart-Populationen von entscheidender Bedeutung. Auf diese Weise kann man nämlich die Kausalität des Wachstumsprozesses kennen lernen, um diesen in der Waldbau-Biotechnik in vollem Maße auszunutzen. In der angeführten Forschung bestehen für das Internationale biologische Programm (International Biological Programme) und für das anknüpfende Projekt UNESCO Der Mensch und die Biosphäre (Man and Biosphere) große Möglichkeiten. An diesen Programmen ist die Tatsache allein dastehend, daß zum ersten Male in der Geschichte der allgemeinen und insbesondere der Forstwissenschaften synchronisiert im Weltmaßstab aufgrund der international kodifizierten Methodiken gearbeitet wird; diese Methodiken werden einen exakten Vergleich der Ergebnisse und deren Applikation ermöglichen.

Als unser Beispiel führen wir das Objekt eines Weißtannenwaldes (*Abies alba* Mill.) an, der sich im Forstrevier Olomučany bei Blansko, auf dem Gebiet des Schulbetriebes des Lehrstuhls für Forstwirtschaft in Brno befindet; dieser Weißtannenwald repräsentiert eine mehr als fünfzigjährige Arbeit von drei Professoren-Generationen. Der Bestand ist 51 Jahre alt und befindet sich in einer Forsttypengruppe *Fagetum quercino-abietinum*. Die Baummasse der Tanne beträgt je 1 Hektar 216,4 fm; davon entfallen auf das Derbholz 175,8 fm und auf das Nichtderbholz 40,6 fm. Das Gewicht im Frischzustand je 1 ha beträgt 190,8 t, wovon 161,9 t auf das Derbholz entfallen. Die Trockenmasse des gesamten Tannenbestandes wiegt 119,1 t/ha. Davon beträgt die Trockenmasse der Stämme 103,8 t/ha. Daraus geht hervor, daß die Tanne unter den gegebenen Bedingungen im Alter von 51 Jahren 176 fm Derbholz je 1 ha repräsentiert; ihre frische Biomasse wiegt 191 t/ha, was in Trockenmasse 119 t/ha ausmacht.

Zur Forschung des Wachstumsprozesses und zur Ableitung der geeignetsten phytotechnischen Maßnahmen sind zweckmäßige Apparaturen, die eine serienmäßige Auswertung mit angemessener Genauigkeit ermöglichen, erforderlich. In Anknüpfung an bekannte Geräte, vor alem an die schwedische Registrierkluppe von Eklund, entwickelten wir zwei neue, bezw. novellisierte Apparaturen. Die erste knüpft an das ursprüngliche Gerät von Eklund und an das graphische Austragungsgerät des Forschungsinstituts für Forstwirtschaft und Jagdwesen in Zbraslav-Strnady an. Sie ist durch eine spezielle Dekodier-Einrichtung, einen elektrischen Locher für die Rechenanlage ZPA 600 ergänzt und mit einer Schaltanlagewarte und mit einem Stabilisator ausgestattet. Für dieses System wurde ein Programm für die Rechenanlage tschechoslowakischer Erzeugung ZPA 600 ausgearbeitet. Die angeführte Apparatur eignet sich für große Sorten und anspruchsvolle Untersuchungen.

Zur Verarbeitung von kleinen Serien entwickelten wir ein Gerät auf mechanischem Prinzip, unter dem Namen UniAgri-1, dem das Patent Nr. 141.491 vom 13. 4. 1971 erteilt wurde. Dieses ist aus Teilen tschechoslowakischer Erzeugung zusammengesetzt und ist übertragbar. Dieses Gerät registriert die Jahresringe auf einem Zifferblatt und trägt sie gleichzeitig graphisch aus. Mit Rücksicht auf die verhältnismäßige Einfachheit ist es auch für Arbeiten im Gelände geeignet.

Aus dem Gesagten sind einige Aspekte der Modernisierung der Fachdisziplin Waldbau ersichtlich; der Waldbau entfaltet sich wie die übrigen wissenschaftlichen Fachgebiete am meisten innerhalb der Kontaktsphäre unterschiedlicher Fachgebiete, so daß eine progressive wissenschaftliche Hybridisierung entsteht.

The author's address:

Člen korespondent ČSAV prof. Dr. Ing. Miroslav Vyskot, Dr. Sc.,
lesnická fakulta VŠZ, Brno

F. Papánek

VALUATION OF FOREST RECREATION

In this paper, the economic approach to the valuation of forest recreation is based on the following assumptions:

1) Forest recreation is a function of the forest, i. e. a service intentionally produced by forest management.

2) The utility of the service rendered to the visitors seeking recreation in the forest is measured in terms of technical units of quantity and quality.

3) The quantity of recreation utility is expressed by the number of visitor-days per annum and hectare of forest.

4) The quality of recreation utility is expressed by the forest's attractiveness comprising the combined effect of natural surroundings and recreational development on the degree of satisfaction derived from forest recreation.

5) The quantity and quality of recreation utility are closely interrelated since the quantity of visitor-days depends to a great deal on the attractiveness of the forest, and the quality of forest recreation is influenced, ceteris paribus, by the number of visitors.

6) Recreation utility as to quantity and quality is the carrier of recreation value; therefore, the greater and better the utility of forest recreation, the higher is its value.

7) The value of forest recreation – like the value of any other service or commodity – is derived from the total amount of socially necessary and socially required labor expended in order to meet the demand.

8) Socially necessary labor – with regard to forest recreation – means the average amount of expenditures made for the recreational use of the forest, adding average losses in timber production and additional operational cost in forestry caused by forest recreation.

9) Socially required labor in connection with forest recreation means the amount of labor which should be spent in order to meet demand – as distinguished from the real amount of labor actually spent on forest recreation.

10) The cost of forest recreation differs from its value in the same way as the total cost of the socially required amount of forest recreation differs from the individual cost of recreational utility produced in specific local conditions.

The valuation of forest recreation refers either to the planning stage or to the control of this service. In recreation planning the potential of the land for forest recreation is assessed and, consequently, valuation of forest recreation reflects, in this case, the importance of a forest for the purpose of recreation and for recreational development. In recreation control the actual performance of a forest for recreational use is estimated and, in this respect, valuation of forest recreation expresses the effect achieved in meeting recreational demand with a view to the degree of satisfaction provided by the recreational environment and facilities.

The value of forest recreation is derived from three different factors:

1) from the number of visitors and the time they spend in the forest,
2) from the recreation utility of the recreation area as expressed by its attractiveness,
3) from the distance of the recreation area from urban centres.

These factors constitute the value of forest recreation in different ways according to two different kinds of recreation.

In long-term recreation during leave all the territory of the country (tourism abroad is not taken into account) may be visited, the travelling distance being of minor importance since the recreationist assumes quasi nomadic habits and his dominant concern is the attractiveness of the recreation area. On the contrary, in short-term recreation during week-ends spent in the surroundings of urban centres the binding on the recreationist's home is of great consequence and prevails over the attractiveness of the recreation area.

LONG-TERM RECREATION

Let us suppose that on the basis of statistical and planning data an annual volume of 50 milion visitor-days is established as the national demand for long-term recreation in Czechoslovakia and that this country's recreational area comprises 6 271 000 ha of forest land, meadows, pastures and water surface. Consequently, the average annual number of visitors would be 7.973 visitor-days per hectare of recreation area.

The actual nation-wide distribution of visitors will depend, of course, on the attractiveness of the recreation area. Since the attractiveness a of the recreation area is defined as the relation between the actual number of visitors on a given recreation site n' and their nation-wide average $\bar{n}$, i. e.

$$a = \frac{n'}{\bar{n}} \tag{1}$$

it is necessary to assess the quality of each recreation site in the same terms as are used for expressing its attractiveness, i. e. in proportion to the number of visitors and the duration of their stay. Consequently, the relation between the degree of recreational quality of a given site q' and the average quality of recreation sites $\bar{q}$ should reflect the proportion in the number of visitor-days, as expressed by the attractiveness of the site, according to the formula

$$\frac{q'}{\bar{q}} = \frac{n'}{\bar{n}} = a\ . \tag{2}$$

The recreational quality of a recreation site depends on a number of factors influencing the recreational potential, or the recreational effect of the site. The recreational potential is determined by such factors as climatic conditions, water resources, topography of the area, forests and flora, game and fauna, national monuments and — in an adverse sense — deficiencies of civilization. The recreational effect of a site is determined, in addition, by the recreational development as to accessibility, facilities, shaping and adjusting of natural environment, availibility of service and comfort, security and sanitation.

In determining the attractiveness of recreational sites two problems are encountered. The first problem is to attribute a specific weight to each factor by which recreation is affected. The second problem is to adopt for each factor a scale of quality degrees corresponding to the attractiveness of the site for visitors. Both problems can be solved only through research; but as long as detailed investigation is missing, more or less accurate suppositions must be made in order to provide necessary data.

A factor influencing outdoor recreation is e. g. the climate. Climatic conditions influence various recreational activities such as skiing and other winter sports, bathing and other water sports, camping, hiking and other summer sports. Therefore, the first problem is to know to what extent are climatic conditions responsible in decision-making for outdoor recreation, as compared with other factors. It may be assumed, for instance, that the specific weight of climatic conditions in this respect amounts to 25 % in this country, and that — with regard to the duration of the various recreational activities — 7.5 % of this weight goes to winter sports. Consequently, climatic conditions suitable for winter sports would account for 7.5 % of the average 7.973 visitor-days in outdoor recreation, or for 0.6 days. In the same way allocations should be made to all other factors, bringing the total to the average 7.973 visitor-days.

Now, the question arises, in what way could be the climatic quality of the recreation site with regard to skiing adequately expressed? What kind of a yardstick should be used for this purpose and what should be its gradation? The most important circumstance in this respect seems to be the duration and the height of the snow cover. In Czechoslovakia, the average duration of the snow cover is 68 days and its average maximum height is 33 cm. In order to establish a scale for measuring the quality of the snow cover with reference to its attractiveness for skiing the assumption is made that the number of visitor-days for a given site is directly proportional to the product of duration and height of the snow cover. The product of 68 and 33 being 2244 (which corresponds to 0.6 visitor-days) it is assumed that a snow cover lasting e. g. 102 days and having a height of 44 cm (which gives a product of 4488) is twice as attractive for skiing as the average snow cover and corresponds, accordingly, to 1.2 visitor-days.

The parameter to be used for expressing the quality of the recreation site as to its utility should be carefully considered and chosen for each factor. A correct expression of the attractiveness of an area for bathing and water sports may be, for instance, the product of the number of summer days (i. e. days with a temperature exceeding 25 °C) and of the length of water courses and beaches in a surface unit (km/km^2). As to camping, hiking and other summer sports the classification of the main climatic factors into climatic regions may prove helpful.

The relief of land surface is related to the attractiveness of a recreation site by its altitude above sea level, by its orographic classification and by geomorphologic features such as formations of rocks, caves, lakes, waterfalls etc. The importance of forests for recreation may be assessed by the density of their occurrence, and also by the different groups of forest types. The parameter for the attractiveness of game and fauna may be constructed as the number of game increased by the annual killing and valued for each kind of game by the value of its observation and shooting which, in turn, is the product of the game's weight, age and rareness. The positive attractiveness of national monuments and the negative attractiveness, or repellence, of deficiencies of civilization (such as man-caused erosion, pollution etc.) can be expressed by the classification of these factors according to their impact on visitors.

In a similar way as shown for the recreational potential, suitable parameters should be established for each factor influencing the recreational effect of a site.

By this procedure, the number of visitor-days for a given recreation site n' can be expressed as the product of its attractiveness a (expressed for each factor as the relation of the actual quality of a site q' to the average quality $\bar{q}$) and the average number of visitor-days per surface unit per annum, according to the formula

$$n' = a \, . \, \bar{n} = \frac{q'}{\bar{q}} \, . \, \bar{n} \, . \tag{3}$$

The value of each visitor-day in outdoor recreation is equal to the cost (including interest on capital outlay) incurred by both the forest owner and the visitor in procuring and acquiring the recreation service. In calculating the expenses incurred by the forest owner the following items are taken into account:

1) Expenses incurred in order to promote forest recreation by improving accessibility, construction of facilities, cleaning and sanitation etc.

2) Losses caused in timber production by adapting forest management to the needs of recreation and by hindrance of forest operations through recreational activities.

3) Damage done to the forest in consequence of forest recreation.

In this calculation not the actual expenses should be considered but attention should be paid to the level of expenses which correspond to the social demand, and reflect the average.

The expenses of the visitor consist of the cost of travelling and accomodation. In this respect, again the socially required average should be considered.

Preliminary calculations show that in Czechoslovakia at present the cost of a one--day-visit to the forest is, on the average, 10 Kčs for the visitor and 3 Kčs for the forest owner, making a total of 13 Kčs per visitor and day.

This sum represents the average value of forest recreation $\bar{v}$, i. e. the value of forest recreation in average conditions providing average recreational satisfaction for the user. Since the quality of recreation sites differs widely, the user's satisfaction in outdoor recreation is also subject to variance. It may be assumed that the satisfaction derived from outdoor recreation is directly proportional to the utility of the site as expressed by its quality. Consequently, the value of the recreation unit (i. e. of the visitor-day) on a given site v' should be differentiated according to the quality of the site, as shown by the formula

$$v' = \frac{q'}{\bar{q}} \,.\, \bar{v} = a \,.\, \bar{v} \,. \tag{4}$$

Thus, the recreation value of 1 ha of forest land v is equal to the product of the number of visitor-days and the recreational value of a visitor-day on the given site:

$$v = n' \,.\, v' = \left(\frac{q'}{\bar{q}}\right)^2 \,.\, \bar{n} \,.\, \bar{v} = a^2 \,.\, \bar{n} \,.\, \bar{v} \,. \tag{5}$$

Since $\bar{n} = 7.973$ and $\bar{v} = 13$ in the above formula, $v = 103.65\ a^2$. This means that the recreation value of a forest in long-term recreation is proportional to the square of its attractiveness.

SHORT-TERM RECREATION

The urban population of Czechoslovakia is for the purpose of short-term recreation defined as the population living in towns and cities with 13 000 and more inhabitants. These urban inhabitants seek short-term recreation in the surroundings of their cities. With respect to outdoor recreation, urban centres may be classified according to their size which is equal to the second root of the number of inhabitants expressed in thousands, the result being rounded off to whole numbers.

The smallest size pertaining to urban centres with 13 000 inhabitants is size 4, the largest size in Czechoslovakia, referring to Prague, is size 33.

Inside the boundaries of cities about 5000 inhabitants live to the square kilometer without difference as to the size of urban centres. Consequently, the populated area, not suitable for outdoor recreation, is represented by a circle with a radius of one fourth of the size of the city.

In order to determine the recreational potential of city surroundings four belts are distinguished around cities, their radiuses being dependent on the size of the city S as follows:

Belt	Specification	Distance from city centre in km minimum	maximum
A	Adjoining area (first ring)	0.25 S	– 0.5 S
B	Near surroundings (second ring)	0.5 S	– 1 S
C	Far surroundings (third ring)	1 S	– 2 S
D	Border area (fourth ring)	2 S	– 4 S

These four belts together form the confines for outdoor recreation of the urban population. In determining the recreational potential of these confines the following suppositions are made:

1) Within the city's confines at least 90 % of short-term recreation takes place. This percentage increases with the size of the city, till for a city of one million inhabitants or more, like Prague, 100 % of the short-term recreation is concentrated in the city's confines.

2) Each inhabitant of an urban centre between the age of 8 and 55 (women) or 60 (men) years performs a number of visits of various durations to the recreation confines of the city totalling on the average ten visitor-days per annum.

3) With increasing size of the city increases also both the share of the urban population seeking short-term recreation and the frequency of visits per visitor. Thus, the average of ten visitor-days for the country falls down to an average of 7 visitor-days in towns of size 4 and attains an average of 13.5 visitor-days in a city of size 33.

4) The total number of visitor-days m (in thousands) computed on this basis is distributed equally into the four recreation belts. The surface of each belt is $\pi r^2_{max} - \pi r^2_{min}$, or $3\pi r^2_{min}$, since $r_{max} = 2r_{min}$. The average distance of frequenting each belt d (in km) being equal to $1.25r_{min}$, the surface of each ring amounts to $6d^2$. Consequently, the number of visitor-days per year and hectare of the city's confines n_o can be computed by the formula

$$n_o = \frac{m}{4} \cdot \frac{1}{6d^2} \cdot 10 = \frac{10m}{24d^2} . \tag{6}$$

The cost in short-term recreation is for the forest owner the same as in long-term recreation, i. e. again 3 Kčs per visitor-day, while the cost for the visitor, at the present rates for bus fare, are travelling expenses of 0.60 Kčs per km bee-line.

Accordingly, the value of the recreational potential of a hectare of the total territory of a city's confines v_0 can be expressed as follows:

$$v_0 = (0.60d + 3)n_o = \frac{m}{4d}\left(1 + \frac{5}{d}\right) \tag{7}$$

For 1 ha of the recreation area the value of the recreational potential v is the greater, the smaller the percentage $0.0p$ representing the recreation area (i. e. forest and grazing land, meadows and water surface) in the whole territory of the city's confines, and the greater the attractiveness of a specific forest a in comparison to the average attractiveness of the recreation area in the city's confines a', as shown by the formula

$$v = \frac{v_o}{0.0p} \cdot \frac{a}{a'} . \tag{8}$$

The attractiveness of the forest a and of the city's confines a' are computed in the same way, as for long-term recreation.

If instead of the recreational potential the recreational effect should be valued the number and distribution of visitor-days should be established by direct observation and multiplied by the value of one visitor-day.

THE ROLE OF RECREATION VALUES

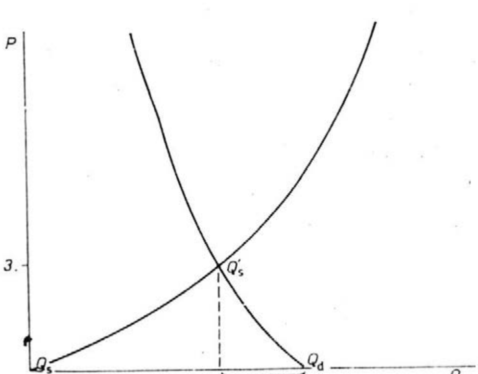
As can be seen, the recreation value of a forest can be obtained in the above way — either with respect to the potential or to the effect of the forest — by adding the value of long-term recreation to the value of short-term recreation, as far as the forest is situated within the confines of one or more cities.

Both the potential and the effect of a forest for outdoor recreation are of importance in the approach to valuation. In planning the development of forest resources and their management the potential for outdoor recreation is important. In controlling and financing forest management the effect of the forest as to outdoor recreation is decisive.

But there is an important limitation in the practical significance of this valuation. The values for forest recreation, as they can be computed according to the above explanation, are only a theoretical calculation and they cannot be transformed into prices. Forest recreation values are of little practical consequence in the market, since forest recreation is a service where both producer and consumer incur some cost, but no price is charged for this service.

As the forest enterprise receives at present no revenue from outdoor recreation, it has no material interest in developing and improving the recreation service, in contrast to timber production. In order to remedy this situation where recreation development is seriously lagging behind social requirements, society could step in and pay for recreation services on the basis of their valuation, thus providing an incentive for forest enterprises to render improved and enlarged recreation service without suffering material impairment.

For such purpose a special feature of the developed method of valuation should be observed. According to the formula of valuation, the cost of the performance of the recreation service is divided between the forest owner and the visitor; consequently, only



1. Equilibrium Market Price Chart: P — Price paid per visitor-day in Kčs, Q — Quantity of recreation service in visitor-days, Q_d — Q according to demand if service is provided free of charge, Q_s — Q according to supply if service is provided free of charge, Q'_s — Q according to supply if 3 Kčs are paid per visitor-day, $\Delta Q = Q_d - Q_s$ — Shortage if service is provided free of charge, $\Delta Q' = Q_d - Q'_s$ — Shortage if 3 Kčs are paid per visitor-day. — Diagram rovnovážnej trhovej ceny: P — poplatok platený za jeden návštevný deň, Q — množstvo rekreačných služieb vyjádrené počtom návštevných dní, Q_d — Q — podľa dopytu, ak sa poskytuje služba zdarma, Q_s — Q podľa ponuky, ak sa poskytuje služba zdarma, Q'_s — Q podľa ponuky ak sa platí 3 Kčs za 1 návštevný deň, $\Delta Q = Q_d - Q_s$ — nedostatok, ak sa služba poskytuje zdarma, $\Delta Q' = Q_d - Q'_s$ — nedostatok, ak sa platí 3 Kčs za 1 návštevný deň

the smaller part of the service is provided free of charge (about one quarter of its value), the remaining part of the service value being paid for directly by the consumer.

In such circumstances, the forest enterprise is entitled only to that portion of the value of the recreation service which corresponds to the expenses incurred by forestry. This amounts to the selling of recreation service loco forest (analogically, timber is sometimes sold on the stock) though, at least theoretically, outdoor recreation service could be sold to the consumer also loco his dwelling in the city, the forest owner providing transportation from the city to the forest, and back.

On the other hand, the forest visitor pays less for recreation than corresponds to its value, because the visit of the forest is free. This amounts to a cheapening of service which leads, in turn, to the expansion of demand. A chronic shortage of recreation service is the inevitable consequence but this shortage could be reduced, if the cost of forest recreation provided by the forest enterprise would be refunded to it, as is shown by the equilibrium market price chart (see Fig. 1).

The valuation of forest recreation proposed in this paper can be used with advantage in forest management, especially in planning the use of forest resources and in allocating recreational functions to a forest. The value of forest recreation as has been discussed in this paper is a true and reliable information regarding the importance of forest recreation in specific conditions and is a suitable instrument for policy-making decisions in the recreational use of the forest. The valuation of forest recreation allows for the comparison of recreation service with timber production as to economic merits and importance of both management objectives. On this basis, working plans can be adjusted according to the priority of social demand and the optimum composition of management objectives can be envisaged.

SUMMARY

The paper submitted is an attempt to value long-term and short-term forest recreation on the basis of amount and quality of forest visitor-days, the total utility value of the recreational service being allocated to social cost of recreation.

Long-term recreation is that taking place during leave or vacation time, embracing the whole of the country. Its value depends on the number of visitor-days per year and hectare of the recreational area, and on its recreational quality expressed in terms of its attractiveness. The utility value of a recreational area is determined by a number of factors controlling its recreational potential (e. g. climatic conditions, water surfaces, topography, forest percentage, game, natural and other monuments, etc.) or its recreational effect (e. g. accessibility, recreation facilities, services, etc.) Each of the above factors will be assigned a corresponding weight, and it will be expressed and measured in suitable terms (units).

Short-term recreation is confined to the town surroundings and would be also valued in terms of visitor-days. In short-term and long-term recreation averaged the cost of recreation incurred by the forest owner 3 Kčs/visitor-day, while the cost of transport paid by a visitor averaged 10 Kčs/visitor-day.

Since forest recreation is provided free-of-charge by forest management, the demand exceeds the level forest recreation would attain if a market price was paid for it corresponding to its value. This demand and supply relationship is represented graphically in Fig. 1.

The proposed method of forest receration valuation can be used to advantage in forest management, particularly in forest recreation and production projections, and in forest use decisions.

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Ocenenie lesnej rekreácie

Predmetná práca predstavuje pokus oceniť dlhodobú a krátkodobú rekreáciu v lese podľa množstva a akosti rekreačných návštev v lese, pri čom sa celková úžitková hodnota rekreačných služieb rozvrhuje na spoločenské náklady rekreácie.

Dlhodobá rekreácia je rekreácia počas dovolenky a vzťahuje sa na celé územie štátu. Jej hodnota závisí od počtu návštevných dní za rok na hektár rekreačnej plochy a od jej rekreačnej hodnoty, vyjadrenej jej atraktívnosťou. Úžitková hodnota rekreačného územia je podmienená radom faktorov, určújúcich rekreačný potenciál (napr. klimatické podmienky, vodné plochy, reliéf terénu, lesnatosť, zver, pamätihodnosti a i.) alebo rekreačný efekt (napr. sprístupnenie, vybavenosť, služby atd.). Každému jednotlivému faktoru se prizná príslušná váha a vyjadruje a meria sa pomocou vhodnej technickej jednotky.

Krátkodobá rekreácia sa obmedzuje na záujmovú oblasť mesta a oceňuje sa taktiež počtom návštevných dní. Pri krátkodobej i dlhodobej rekreácii činia náklady rekreácie zaťažujúce majiteľa lesa v priemere 3 Kčs/návštevný deň, kým dopravné náklady hradené návštevníkom dosahujú v priemere 10 Kčs/návštevný deň.

Keďže rekreácia v lese sa poskytuje zo strany lesného hospodárstva zdarma, stúpa dopyt po nej nad objem, ktorý by mala rekreácia v lese, keby sa za ňu platila trhová hodnota odpovedajúca jej cene. Túto závislosť dopytu a ponuky znázorňuje diagram na obr. 1.

Predkladaná metóda oceňovania rekreácie v lese sa môže s výhodou použiť v hospodárskej úprave lesa, najmä pri plánovaní rekreačných a produkčných funkcií a pri hospodárskom určení lesa.

Оценка лесного отдыха

Настоящая статья является попыткой оценки долговременного и кратковременного отдыха на основе количества и качества рекреационных посещений леса и распределения общественных издержек рекреационных служб пропорционально их полезной стоимости.

Стоимость долговременного отдыха, который проводится во время отпуска и занимает всю территорию страны, создается из количества посетителедней, затраченных в год на гектар рекреационной площади, и из ее полезной стоимости, выраженной ее привлекательностью. Качество рекреационной площади зависит от ряда факторов, влияющих на рекреационный потенциал (вроде климатических условий, водных площадей, рельефа ландшафта, лесистости, наличия дичи, достопримечательностей и др.) или на рекреационный эффект

местности (напр., коммуникации, устройство и другие виды рекреационного освоения). Каждому фактору приписывается соответствующий вес и выбирается пригодный показатель, отвечающий привлекательности фактора для посетителей.

Стоимость кратковременного отдыха в окрестностях городских центров во время воскресного отдыха также основана на числе посетителедней в год на гектар рекреационной площади в окрестностях города. Так же как для долговременного отдыха и для кратковременного отдыха издержки лесной рекреации составляют, для собственника леса, в среднем 3 кроны; издержки перемещения достигают в среднем 10 крон за посетителедень.

Так как посещение леса разрешается бесплатно, спрос на отдых расширяется за границу объема, отвечающего равновесию торговой цены, как объясняет диаграмма 1.

Оценка лесного отдыха, предложенная в этой работе, пригодна для использования в лесоустройстве, особенно в планировании использования лесов для отдыха, в определении рекреационных функций леса и их отношений к продукции древесины.

Die Bewertung der Walderholung

Die vorliegende Arbeit stellt einen Versuch dar die Bewertung von lang- und kurzfristiger Erholung auf die Menge und Qualität der Erholungsbesuche im Wald zu gründen, wobei der gesamte Nutzwert der Erholungsdienste den verursachten gesellschaftlichen Kosten gegenübergestellt wird.

Die langfristige Erholung bezieht sich auf Urlaubsgäste und das gesamte Staatsgebiet. Ihr Wert hängt von der Anzahl der Besuchstage pro Jahr und Hektar Erholungsgebiet und vom Erholungswert des Erholungsgebietes, das durch seine Anziehungskraft ausgedrückt wird, ab. Die Erholungsqualität eines Erholungsgebietes hängt von einer Reihe von Faktoren ab, die das Erholungspotential (z. B. klimatische Bedingungen, Wasserflächen, Bodengestaltung, Bewaldung, Wildvorkommen, Sehenswürdigkeiten usw.) oder den Erholungseffekt (wie Erschließung, Ausstattung, Dienstleistungen usw.) bestimmen. Jeder einzelne Faktor wird gewogen und mit einem entsprechenden Maßstab gemessen.

Die kurzfristige oder stadtnahe Erholung ist auf die Umgebung der Stadtzentren beschränkt und wird gleichfalls mit der Zahl der Besuchstage bewertet. In kurz- wie langfristiger Erholung betragen die Kosten der Walderholung, die den Waldeigentümer belasten, im Durchschnitt 3 Kčs pro Besuchstag, während die vom Waldbesucher bestrittenen Transportkosten im Durchschnitt 10 Kčs betragen.

Da der Besuch des Waldes frei ist, steigt die Nachfrage nach der Walderholung über den Gleichgewichtsmarktpreis, wie Diagramm 1 versinnbildlicht.

Die hier vorgeschlagenen Bewertung der Walderholung kann vorzüglich in der Forsteinrichtung, insbesondere in der Planung der Waldfuktionen und in der Bestimmung der Wirtschaftsziele, ihre Verwendung finden.

The author's address:

Prof. Dr. Ing. František Papánek, Výskumný ústav lesného hospodárstva, Zvolen

M. Novotný
B. Fišer
M. Dejmek

COMPUTER APPLICATIONS TO FORESTRY MANAGEMENT SYSTEMS

General trends of rationalization and perfectioning of business management and administration by means of computers have in recent years fully applied also to forestry, Czechoslovakia being no exception to the rule. The developmental stages of computer exploitation in the solution of forestry problems of the latter country are essentially two.

In the first stage were the computers used for the processing of a number of mathematical models of the research, technological, and economic projects, this stage having started in 1961. As a second stage of computer application expansion can be regarded automated processing of the routine administrative agenda which had been treated earlier by means of conventional office mechanization. This second stage began in 1967.

In spite of the fact that in the course of the two abovementioned stages considerable progress has been made in the methods and practice of computer techniques, it should be stated that by far have the existing possibilities been exploited sufficiently which are being offered by this sophisticated computer technology. There is a number of reasons of which the following two are of major importance in our opinion:

1) It is an obvious fact that nowadays computers process the data relating to individual operations circles predominantly as relatively closed entities. The output data are under the circumstances supplied mainly to management boards, to a lesser degree to medium-level management, and rarely to top management. (A certain exception represent the results of forest inventories.) Having in mind, however, that the medium and higher management levels are responsible for the operation of the organization as a fully integrated unit, not as an arithmetic sum of the individual activities, they are particularly in need of being supplied with the information characterizing the respective organization as an integrated establishment. Yet, so far have the above data not been made available by automated information processing.

2) Apart from this circumstance, adverse are also the effects of the fact that in forestry the scientific methods of decision-making have not become routine practice so far, and that both the existing organization pattern and the present management methods are not favourable to introduction of advanced integrated management systems. It should be borne in mind in this connection that it is only the integrated management systems that make it possible, on the one hand, to utilize all technological developments in the field of management and, on the other hand, to derive from them the intended economic benefits.

The research projects on the subject that have been under way at the respective research and development institutions in Czechoslovakia have followed the objective to remove successively (gradually) the abovementioned retarding factors and to improve the existing situation in computer applications to forestry in this country.

RESEARCH METHOD ADOPTED BY FORESTRY AND GAME MANAGEMENT RESEARCH INSTITUTE, ZBRASLAV-STRNADY

The method of operations on a research project concerned with exploitation of advanced computer techniques in the management of forestry was designed by the above Forest Research Institute with regard to the objective of removing the two retarding factors described in the introduction. One of them is essentially identical with the issues of management information systems, another is related with the decision-making aspects of the management process. Both factors are, however, closely interrelated and interacting.

When approaching the research task ahead of us, we proceeded first towards clarification, on the basis of a general analysis of the management process in forestry, of a model concept of management system utilizing computer techniques, and towards overall requirements to be satisfied by the information system proper. After that we began to work on certain sub-problems of the decision-making nature, this being done already with regard to the projected system of integrated management. Simultaneously, an analysis of the information system was initiated, the latter being the essential prerequisite for the implementation of the automation programs.

With regard to the present organisation and general management of forestry in Czechoslovakia, we have chosen the State Forest Directorate level as a basis for our analyses, to proceed further to the sector and Forest Farm levels. For the projections of the information system a system approach was chosen, and in the solutions to the decision-making problems was the orientation to a maximum degree on the analytical computing procedures (economic mathematical methods). The algorithms resulting from this research stage have been gradually introduced into the management information system.

The outcome of our analyses, studies, and method designs is a prototype of a general model of the overall management information system, a proposal of the logic of information flow and processing technique, and the resulting ways and organization of information collection, further the requirements for the technological configuration of the computer system proper, and eventually a detailed model of short-term (one year or less) planning and management of the logging operations. In the following, a description is given of the major results of our investigations.

PROPOSED MODEL OF AN OVERALL FORESTRY MANAGEMENT SYSTEM

Our proposal for a model of forestry management system on the State Forest Directorate level can be seen in Fig. 1. It appears from this organization chart that this is a system based on a computer which on the one hand is a source of information necessary for the management of forest operations, on the other hand actually prepares certain decision-making stages of the management process.

This is further a system embracing the major management activities, among them belonging particularly

— planning and operations projections,

— execution of the plans of operations,

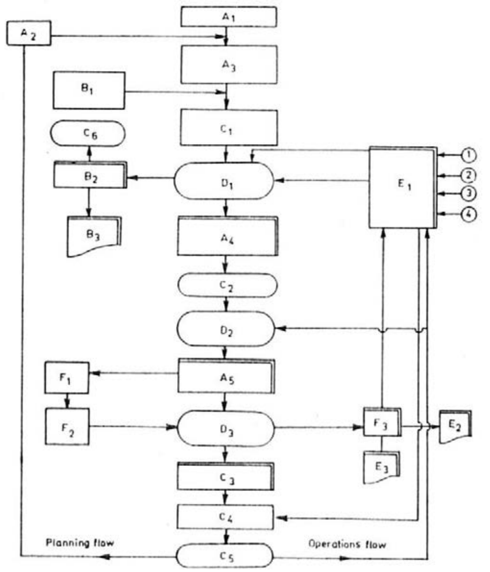
— recording, accounting, and auditing of resources and operations.

This is eventually a system

— keeping and storing the information on the past operations and management, but being at the same time aimed

— at the decision-making aspects of management, not only on the production of records and reports, and

— is concerned with informations necessary for the management control.



1. Proposed model of forestry management system, State Forest Directorate level: A_1 — State plan, A_2 — Other production targets, A_3 — Allocation of production targets in terms of quantity to lower units, A_4 — Computation of alternatives of the financial, material, and labour resources needed for plan execution, A_5 — Technico-economic and financial plan of operations (of the unit in question), B_1 — Balanced production targets projected in a Working Plan for lower units, B_2 — Deviations from Working Plan figures, B_3 — State Forest Supervision, C_1 — Choice of worksites for implementation of the planned targets by the management body, C_2 — Choice of the operational alternative by the management body, C_3 — Comparison of plan figures with actual ones, C_4 — Judgement of deviations by the management body, C_5 — Orders, C_6 — Decisions of the management body, D_1 — Computer, D_2 — Computer, D_3 — Computer, E_1 — Data bank, E_2 — Development of forest resources, E_3 — Statistics, accounting, etc., F_1 — Plan execution, F_2 — Administrative records (production, wages, materials, labour, accounts, sales, forest resources), F_3 — Forest operations records, *1* — Base conditions of forest resources of lower units, *2* — Production resources of lower units, *3* — Technological and economic standards and normatives, *4* — Technological description of forest worksites. — Návrh modelu řídícího systému v lesním hospodářství na úrovni nodniku: A_1 — Státní plán, A_2 — Ostatní úkoly, A_3 — Rozpis výrobních úkolů v kvantitativních jednotkách na podřízené jednotky (řídící subjekt), A_4 — Výpočet variant finančního, hmotového a kádrového zabezpečení plánu, A_5 — Technicko-ekonomický a finanční plán hospodářské činnosti dané jednotky, B_1 — Bilancované úkoly HÚL u podřízených jednotek, B_2 — Odchylky od předpisů HÚL, B_3 — Státní péče o lesy, C_1 — Výběr pracovišť pro realizaci plánovaných úkolů řídícím subjektem, C_2 — Výběr prováděcí varianty řídícím subjektem, C_3 — Porovnání ukazatelů plánu a skutečnosti, C_4 — Posouzení odchylek řídícím subjektem, C_5 — Příkazy, C_6 — Rozhodnutí řídícího subjektu, D_1 — Počítač, D_2 — Počítač, E_1 — Databanka, E_2 — Vývoj lesního fondu, E_3 — Statistika, účetnictví atd., F_1 — Plnění úkolů, F_2 — Záznamy evidenčního charakteru (výroba, mzdy, MTZ, pracovníci, účetnictví, odbyt, lesní fond.), F_3 — Evidence o skutečnosti, *1* — Výchozí stav lesního fondu u podřízených jednotek, *2* — Výrobní zdroje podřízených jednotek, *3* — Technicko-hospodářské normy a normativy, *4* — Technologický popis pracovišť lesního fondu

One of the major technological elements which is projected to constitute the backbone of the proposed management model is a data bank, the establishment and development of which will make it possible to replace the existing traditional forestry information system based on subject-matter responsibilities by a system designed according to subject and functional viewpoints. Such a system is composed of the so called information files which are stored in the computer memory in a way to be at any time and comparatively easily available. If the objective is to process data on a particular subject or to supply a required information, the computer will sort out the information desired from the respective information files with a velocity that could be never attained by man. The extent and coverage of the informations files must be designed to limit the amount of primary input data, which is yet another important advantage both from the viewpoint of economic computer operation and its potential application to actual management action. In the proposed model the following subject-matter information files were considered:

Forest stands	Finished products
Forest stand operations conditions	Forest product customers
Forest nurseries	Basic resources
Working techniques	Forest materials
Forest machinery and equipment	Forest labour

The overall functioning of the management system according to the proposed model can be learned from the graphic representation and therefore no further description will be given. The analyses, projections, and programming of concrete problems would be implemented in stages, separately for the routine and decision-making operations, and for the individual production sectors.

PROBLEMS OF DESIGN OF THE INFORMATION SYSTEM

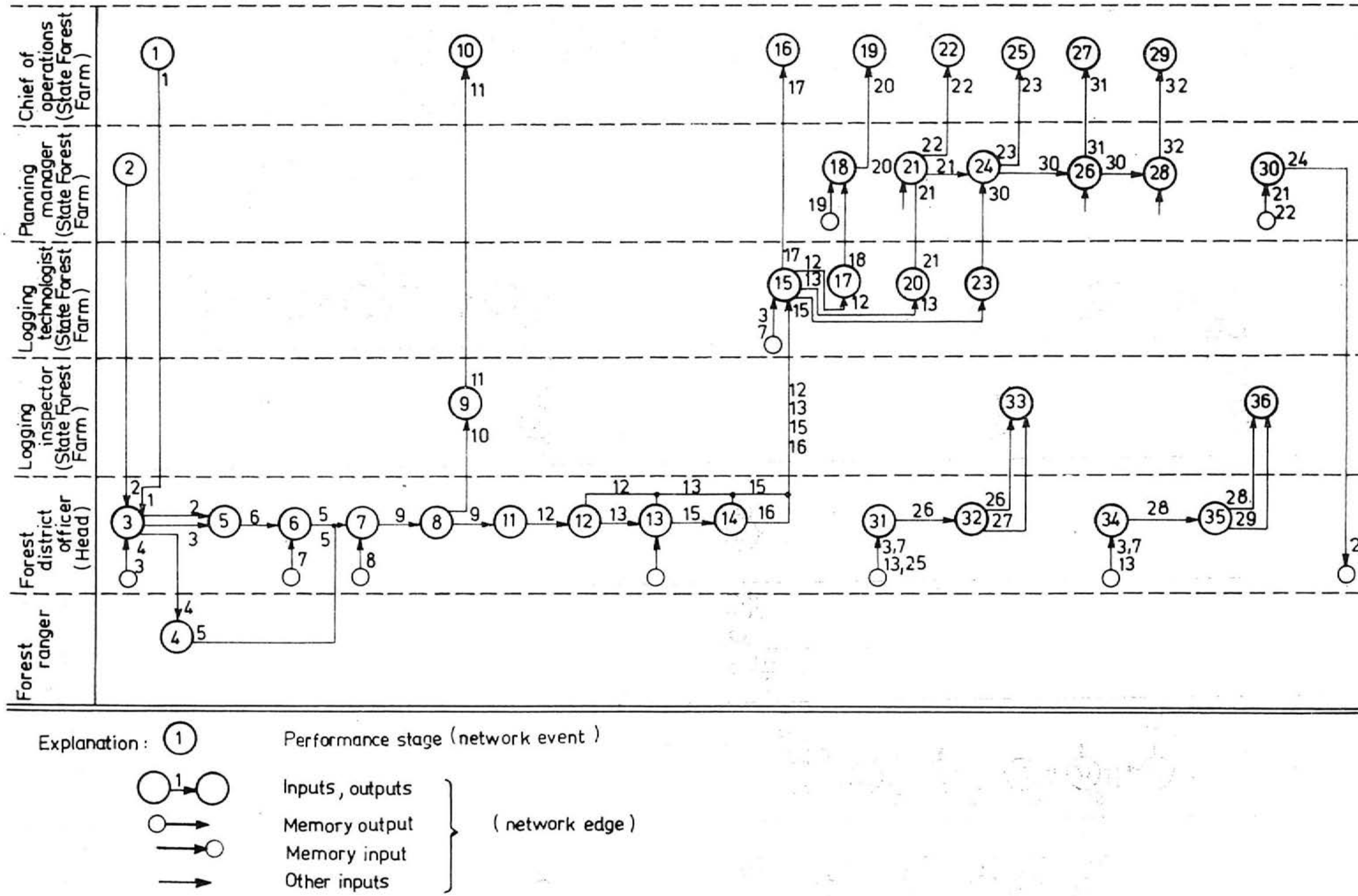
The problem of design of an information system that would exhibit the optimum qualities with regard to management requirements is unusually complex and extensive. The present situation may be characterized roughly by a statement that at present a number of routine computer programs are operational, like wages agenda, accounting, timber sales and marketing, etc., the above problems being resolved as non-integrated separate procedures, featuring however all the resulting shortcomings and adverse effects. The ultimate objective should be essentially a comprehensive system handling the basic primary data, intermediate results, and final tableaux with a maximum degree of integration.

In order to devise such an information system, a survey was made of the organization units and departments of selected State Forest Directorates, resulting in formalized records that have made it possible for us to analyze the existing information system from the viewpoints of ensuring the information provision required by management and administration, and from that of information flow. The major subject of investigation were the various printed records carrying information, the major followed activity was the so called partial performance. (Partial performance is any processing of the information carriers, defined on the basis of the classification, relationship, and causal analysis.)

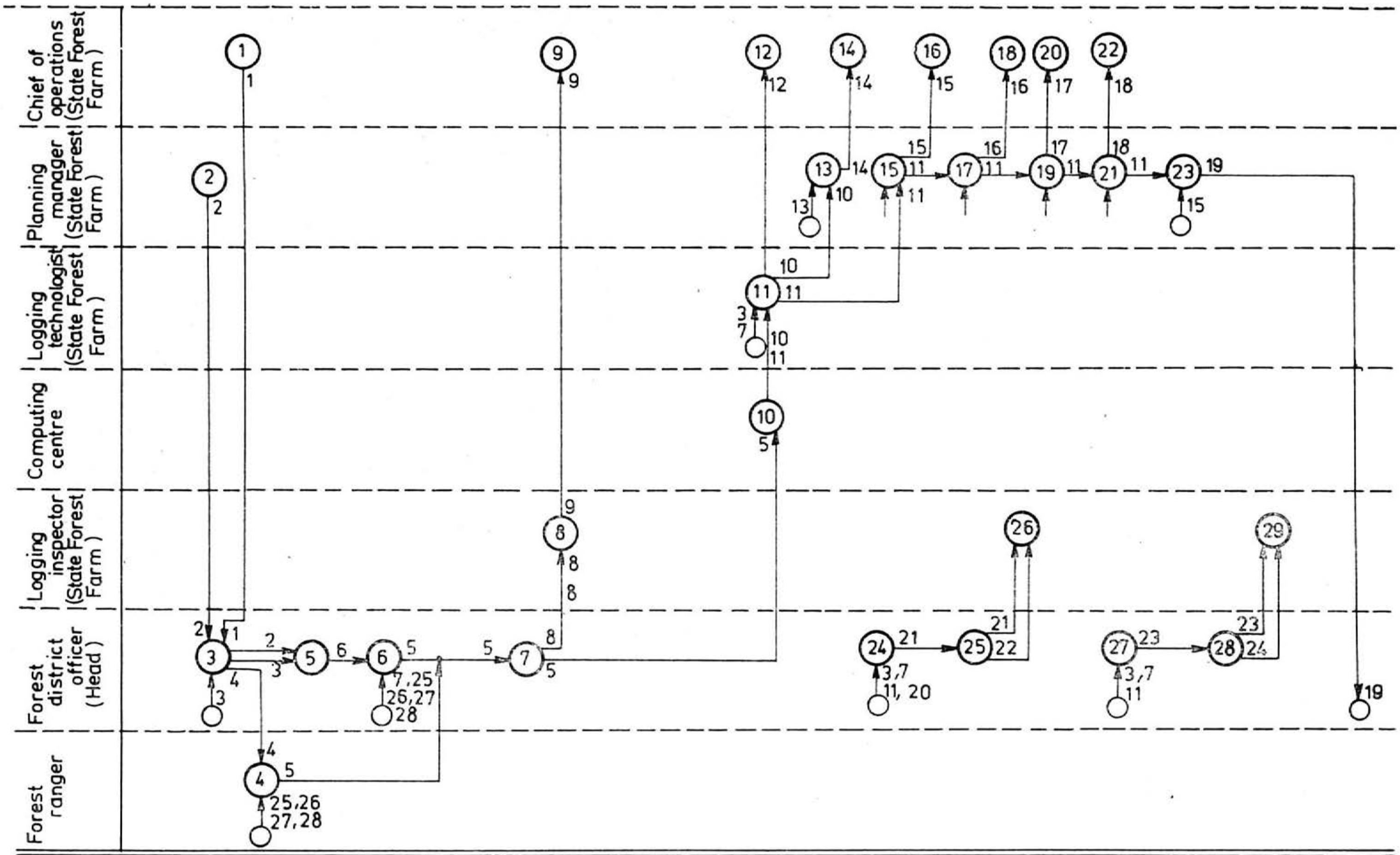
A complete list of the frequency of the partial performances is an important background for the considerations on the exploitation of the computer techniques. Their employment is comparatively simple in the field of routine administrative agenda, yet in the sphere of decision-making the problem will become fairly complicated.

In our survey, a total of 2,478 partial performances was found to be necessary to attain our objective on the level of a State Forest Directorate. However, only some 35 per cent of them related to production management, and the bulk of them, i. e. about 65 per cent of all partial performances were concerned with administration. Of the total number or partial performances in the sphere of management have still a full 56 per cent a routine character, while those of a genuine decision-making nature account for 44 per cent only.

To represent the flow of information graphically, a network diagram was used enabling not only an analysis of the subject-matter order of the information flow but also a depicting of the assignment of individual partial performances to the respective organization levels.



2. Simplified information flow model for production preparation, logging and skidding plan — present position (the symbols are explained in the text). — Zjednodušený model toku informací v oblasti přípravy výroby a plánu těžby a přibližování dřeva — současný stav (symboly jsou vysvětleny v textu)



3. Simplified information flow model for production preparation, logging and skidding plan (position after computer application). — Zjednodušený model toku informací v oblasti přípravy výroby a plánu těžby a přibližování dřeva (stav po zapojení počítače)

To demonstrate our method from the above point of view, a graphic representation of an information flow model relating to production preparation, logging plan, and log skidding was drawn.[1]) Fig. 2 shows the present situation, Fig. 3 the projected solution based on (involving) computer techniques.

The following is a list of items of the information flow model for production preparation and the logging operations — tree cutting and log skidding, belonging to Fig. 2.

Partial performance:

1. Compilation of cut allocation for tree marking
2. Allocation of the general cutting budget
3. Compilation of a preliminary intermediate cutting budget
4. Marking of trees for intermediate cutting
5. Compilation of a preliminary final cutting budget
6. Marking of trees for final cutting
7. Calculation of volumes of marked trees
8. Compilation of a report on marked volume
9. Summarization of reports on marked volume
10. Progress report on tree marking
11. Compilation of logging resource assortment distribution
12. Compilation of assortment and logging method summaries
13. Labour cost budgeting for tree cutting and skidding
14. Compilation of comments on logging projects
15. Checking of logging projects
16. Approval of a protocol on checking of logging projects
17. Summarization of allocation and assortment of logging resource
18. Compilation of assortment production plan — VT1
19. Approval of assortment production plan — VT1
20. Summarization of assortment and logging method schemes
21. Compilation of plan of operations — V 1
22. Approval of plan of operations — V 2
23. Summarization of logging technique forms
24. Compilation of techno-economic plan justification
25. Approval of techno-economic plan justification
26. Compilation of labour plan (man-day requirement)
27. Approval of labour plan
28. Compilation of cost of operations plan
29. Approval of cost of operations plan
30. Allocation of plan of operations (tree cutting, skidding)
31. Compilation of applications for exemption from Forest Act
32. Summarization of applications for exemption from Forest Act
33. Compilation of applications to District National Council for approval of exemptions from Forest Act
34. Compilation of applications for approval of deviations from Forest Working Plan
35. Summarization of applications for approval of deviations
36. Compilation of applications to District National Council for approval of deviations from Forest Working Plan

Information

1. Allocation of annual cutting budget for tree marking
2. Cutting plan guide figures for Forest Districts
3. Forest management register (Working Plan)
4. Preliminary intermediate cutting budget
5. Calipering form L 111
6. Preliminary final cutting budget
7. Logging map (Working Plan)
8. Volume tables
9. Volume calculation form L 112
10. Report on marked volume (growing stock)

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[1]) The model is simplified.

11. Summarization of reports on marked volume (growing stock)
12. Extent and assortment pattern of the logging stock, L 113 and I.
13. Summary of logging stock assortment pattern and of logging techniques, L 113 b
14. Performance standards for logging and skidding
15. Logging technique forms for cutting and skidding
16. Comments on logging projects
17. Protocol on checking of logging projects
18. Summary of logging stock allocation and assortment pattern, L 113 and I.
19. Cutting plan guide figures for State Forest Farm
20. Assortment production plan, VT 1
21. Summary of assortment and logging technique allocations
22. Plan of operations — VI
23. Techno-economic plan justification — Tech 1
24. Allocation of plan of operations (logging, skidding)
25. Forest Act
26. Application for approval of exemptions from Forest Act
27. Summary of applications for approval of exemptions from Forest Act
28. Application for approval of deviations from Forest Working Plan
29. Summary of applications for approval of deviations from Forest Working Plan
30. Summary of logging technique forms
31. Plan of labour
32. Cost of operations plan

List of items of the information flow model for production preparation and logging operations plan — tree cutting and log skidding — belonging to Fig 3.

Partial performance

1. Compilation of cut allocation for tree marking
2. Allocation of the cutting budget guide figures
3. Compilation of preliminary intermediate cutting budget
4. Marking of trees for intermediate cutting
5. Compilation of a preliminary final cutting budget
6. Marking of trees for final cutting
7. Compilation of a report on marked volume
8. Summary of reports on marked volume
9. Progress report on tree marking
10. Compilation of logging stock project and plan
11. Checking of logging projects
12. Approval of protocol on checking of logging projects
13. Compilation of assortment production plan — VT 1
14. Approval of assortment production plan — VT 1
15. Compilation of plan of operations — V1
16. Approval of plan of operations — V1
17. Compilation of techno-economic plan justification — Tech 1
18. Approval of techno-economic plan justification — Tech 1
19. Compilation of labour plan
20. Approval of labour plan
21. Compilation of cost of operations plan
22. Approval of cost of operations plan
23. Allocation of plan of operations (logging, skidding)
24. Compilation of application for exemptions from Forest Act
25. Summary of applications for exemptions from Forest Act
26. Compilation of application to District National Council for approval of exemptions from Forest Act
27. Compilation of application for approval of deviations from Forest Working Plan
28. Summary of applications for approval of deviations from Forest Working Plan
29. Compilation of application to District National Council for approval of deviations from Forest Working Plan

Information

1. Allocation of annual cutting budget for tree marking
2. Cutting plan guide figures for Forest District
3. Forest management register (Working Plan)

4. Preliminary intermediate cutting budget
5. Calipering form, FGMRI Zbraslav
6. Preliminary final cutting budget
7. Logging map (Working Plan)
8. Report on marked volume (logging stock)
9. Summary of reports on marked volume (logging stock)
10. Logging stock assortment distribution
11. Plan of labour, equipment, and cost of operations
12. Protocol on checking of logging projects
13. Cutting plan guide figures for State Forest Farm
14. Assortment production plan
15. Plan of operations — V 1
16. Techno-economic plan justification
17. Labour plan
18. Cost of operations plan
19. Allocation of plan of operations (logging, skidding)
20. Forest Act
21. Application for approval of exemptions from Forest Act
22. Summary of applications for approval of exemptions from Forest Act
23. Application for approval of deviations from Forest Working Plan
24. Summary of applications for approval of deviations from Forest Working Plan
25. Guidelines for filling of FGMRI forms
26. Code numbers
27. Classification table of tree defects
28. List of Forest Farms

It can be seen from a relative comparison of the two patterns that there are certain major changes in the job descriptions of the forest ranger, forest district officer, logging technologist, and State Forest manager of operations.

A design of the information flow model incorporating changes in the information techniques and improvement of the management procedures is not only a necessary prerequisite of a comprehensive project of organized information and data processing, but it also represents the best opportunity of preparing — prior to introduction in practice of the new system — the respective job descriptions and responsibilities for individual management levels.

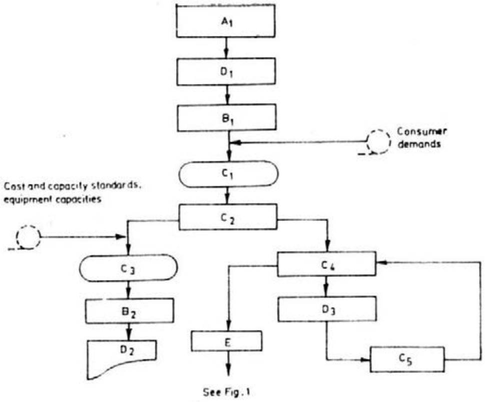
Apart from the abovedescribed general analyses based on available operations records are we also working on information systems intended for individual specialized information, and in the latter case the analysis provides directly a basis for the projections proper.

A MODEL FOR SHORT-TERM PLANNING AND MANAGEMENT OF LOGGING OPERATIONS

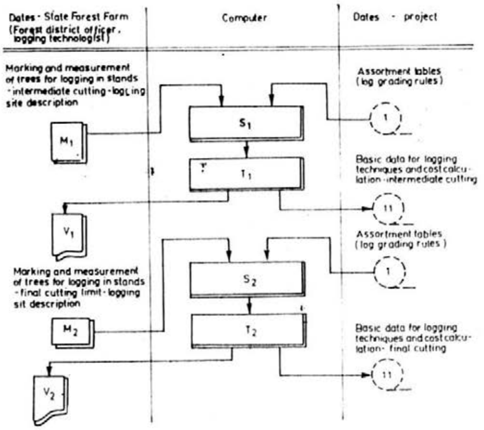
A model for short-term planning and management of logging operations is closely related to the five-year working plan periods, and the annual production targets for the State Forest Directorates and State Forest Farms are in fact derived from the Forest Working Plans to be perfectioned according to the respective base conditions of the year in question. A general block diagram of the model can be seen in Fig. 4.

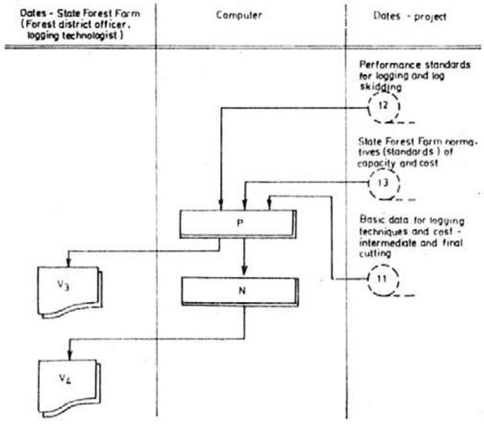
By means of a computer would be processed the volume calculations and the assortment distribution and output, would be determined the optimum transport directions (routes) and the optimum logging technique combinations, as well as the cost calculations and assessments of equipment capacities. For the analyses of operations scheduling and implementation the Gantt-diagrams (cyclograms) would be used.

Once a plan of operations had been drawn and the implementation of the projected activities had started, the role of the computer lies in the ensuring of the control feed--back as it appears from Fig. 1.



4. Generalized block diagram of the model for planning and management of logging operations: A_1 — Planned logging targets, B_1 — Volume and assortment calculations, B_2 — Cost calculation, C_1 — Determination of optimum transport directions (routing), C_2 — Choice of logging technique alternatives for individual stands, C_3 — Determination of optimum logging technique combinations for individual stands, C_4 — Scheduling of forest stands for logging with regard to timber sales plan (targets), C_5 — Operational orders, D_1 — Tree marking for logging, D_2 — Compilation of the cost of operations plan, D_3 — Analysis of plan implementation progress, E — Fullfilment of annual plan targets. — Hrubé blokové schéma modelu pro plánování a řízení těžební činnosti: A_1 — Plánované úkoly v těžbě, B_1 — Výpočty hmot a sortimentace, B_2 — Výpočet nákladů, C_1 — Určení optimálních dopravních směrů, C_2 — Stanovení technologických alternativ v jednotlivých procesech, C_3 — Určení optimální kombinace technologií v porostech, C_4 — Určení časové posloupnosti porostů k těžbě s ohledem na úkoly v dodávkách, C_5 — Operativní příkazy, D_1 — Vyznačení těžby, D_2 — Sestavení plánu nákladů, D_3 — Rozbor plánu časového průběhu, E — Roční plnění





5. Generalized block diagram of the Volume and assortment calculation stage: M_1 — Calipering forms, M_2 — Calipering forms, S_1 — Calculation of volumes of trees marked for logging, assortment distribution of the logging stock for the purpose of sales, intermediate cutting, S_2 — Calculation of volumes of trees marked for logging, assortment ditsribution of the logging stock for the purpose of sales, summary of final and intermediate cutting, T_1, T_2 — Assorment distribution of the logging stock for the purpose of logging techniques, record block construction (technique and cost), V_1 — Forest stands, summaries, Forest District, State Forest Farm, V_2 — Forest stands, summaries, Forest Range, Forest District, State Forest Farm. — Hrubé blokové schéma fáze Výpočty hmot a sortimentace: M_1 — Průměrkovací manuály, M_2 — Průměrkovací manuály, S_1 — Výpočet hmoty vyznačené k těžbě, sortimentace těžebního fondu pro odbyt — předmýtní, S_2 — Výpočet objemu dřeva vyznačeného k těžbě, sortimentace těžebního fondu pro odbyt — sumarizace mýtní a předmýtní, T_1 — Sortimentace těžebního fondu pro technologie — tvorba vět pro technologie a náklady, T_2 — Sortimentace těžebního fondu pro technologie — tvorba vět pro technologie a náklady, V_1 — Porosty, sumáře lesnických úseků, polesí, LZ, V_2 — Porosty, sumáře lesnických úseků, polesí, LZ

6. Generalized block diagram of the Cost calculation stage: P — Calculation of man-hours, wages, needed worker-shifts and auxiliary materials and devices for

logging and skidding, N — Calculation of man-hours, labour input per cu. m., labour requirement, equipment requirement, wage requirement, average wage per cu. m., cost of material, direct cost, average direct cost of logging and skidding per one cu. m., V_3 — Forest stands, V_4 — Forest Ranges, Forest Districts, State Forest Farms. — Hrubé blokové schéma fáze Výpočet nákladů: P — Výpočet normohodin, mezd, potřeby směn dělníků a pomocných prostředků na těžbu a přibližování dřeva, N — Výpočet normohodin, pracnosti na 1 plm, potřeby dělníků, pracovních prostředků, mezd, průměrné mzdy na 1 plm, materiálových nákladů, přímých nákladů, průměrných přímých nákladů na 1 plm těžby a přibližování dřeva, V_3 — Porosty, V_4 — Lesnické úseky, polesí, LZ

With regard to a crucial importance of the stage "volume calculation and assortment distribution" and "cost calculation", in Figs. 5 and 6 the generalized block diagrams of the respective programs can be seen.

The computation results originating from both programs are printed in two types of final lists. In the first list type are the output data arranged by forest stands, in the second list are they summarized by organization levels (units). The lists on the composition of the logging stock contain information on volumes, broken down by tree species, diameter classes, and assortments (poles, roundwood total, roundwood by diameter classes, stacked wood, interchangeable assortments). Separately are given the volumes and areas of intermediate cuttings in the stands below 40 years and over.

The Tab. I and II represent examples of final lists for the logging technique and cost calculations.

The optimum transport routes (directions) are determined with the objective to minimize the transport cost and to distribute in the best way possible the interchangeable assortments. The respective objective function has the following general form:

$$\text{To find } Z = \sum_{i=1}^{m} \sum_{j=1}^{n} c_{ij} \,.\, x_{ij} = \min.$$

For the constraints

$$x_{ij} \geqq 0 \qquad (i = 1, 2, \ldots, m, \quad j = 1, 2, \ldots, n)$$

$$\sum_{i=1}^{m} a_i = \sum_{j=1}^{n} b_j$$

$$\sum_{j=1}^{n} x_{ij} = a_i \qquad (i = 1, 2, \ldots, m)$$

$$\sum_{i=1}^{n} x_{ij} = b_j \qquad (j = 1, 2, \ldots, n)$$

$$a_i = \sum_{i=1}^{n} a_{ij} + \Delta a_i \qquad (i = 1, 2, \ldots, m)$$

where a_i — total capacity of the i-th supplier,
a_{ij} — capacity of the i-th supplier with regard to j-th assortment,
Δa_i — interchangeable assortment capacity of the i-th supplier,
b_j — capacity of the j-th customer,
c_{ij} — transport cost per cu. m. from the i-th supplier to j-th customer.

I. Final List of Logging Technique. — Vzor výsledné sestavy o technologii

Year
State Forest Farm
Forest Dictrict
Forest Range

Logging Operation		Tree logging				
Forest Stand	Tree Species	Poles	Tree-length logs	Round-wood	Stacked wood	Total
Intermediate Cutting						
280407	Norway Spruce-Silver Fir Cu. m. Average tree volume (cu. m.)					
Man-hours						
Wages Kčs						
Number of worker shifts						
Number of equipment shifts						
280503	Norway Spruce-Silver Fir					

II. Final List of Cost Calculation. — Vzor výsledné sestavy o nákladech

Year State Forest Farm Forest District	Total logging	Log skidding		
		Foreign	One horse	Two horses
Cu. m.				
Mean tree volume (cu. m.)				
Man-hours				
Man-hour (cu. m.)				
Workers required				
Equipment required				
Wages (Kčs)				
Wage (Kčs/cu. m.)				
Material cost (Kčs)				
Direct cost (Kčs)				
Direct cost (Kčs/cu. m.)				

Note: c_{ij} is always prohibitive where x_{ij} must be 0.

To find an optimum combination of the logging (operations) techniques for the existing capacities of the available equipment, the objective function (decision-making model) given below will be used

To find $z = \sum_{i=1}^{m} \sum_{j=1}^{n} c_{ij} x_{ij} = \min$.

For the constraints:

$$\sum_{i=1}^{m} x_{ij} \leqq a_i \qquad (i = 1, 2, \ldots, m)$$

	Log skidding						
	Foreign (contract)	One horse	Two horses	Wheel tractor	Tract-layer tractor	Special tractor	Total

	Log skidding			
	Wheel tractor	Track-layer tractor	Special tractor	Total

$$\sum_{j=1}^{m} v_{ij} \, . \, x_{ij} = b_j \qquad (j = 1, 2, \ldots, n)$$

$$x_{ij} \geqq 0 \qquad (i = 1, 2, \ldots, m, \quad j = 1, 2, \ldots, n)$$

where x_{ij} — time worked by the i-th machine in the j-th stand,
a_i — total available worktime capacity of the i-th machine,
b_j — operation objective in the j-th forest stand,
v_{ij} — performance of the i-th machine in the j-th forest stand in terms of output (technical units),
c_{ij} — cost of one-hour operation of the i-th machine in the j-th forest stand

The choice of the stands where the projected cutting budget is to be implemented can theoretically be done also by means of algorithms, yet with regard to a great number, variability and difficult quantification of the limiting factors involved have we so far adhered in our model to empirical procedures.

A description of the graphic simulation of scheduling of the logging process is given in detail in one of the references (Novotný 1971), and this is why it had not been dealt with more thoroughly in this paper.

CONCLUSIONS

In line with the available experience is it safe to say that the proposed model of computerized management of forestry operations is feasible, and that one of its great merits is the possibility of developing and implementing it step by step.

At the moment have already been tested practically the major elements of the partial model of short-term planning and management of the logging operations, and the model itself is now in the stage of completion. There are promising indications that its application to forestry practices will result in considerable economic benefits, particularly in savings in cost of skidding and transport. In a similar stage-by-stage way are we going to proceed also when improving other sub-systems of the management process.

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Místo samočinného počítače v modelu řídícího systému lesního hospodářství

Obecný vývoj racionalizace a prohlubování řídících a administrativních prací pomocí samočinných počítačů zasáhl v plné šíři i československé lesní hospodářství. Postup dosavadních aplikací by bylo možno věcně rozdělit na dvě etapy. V první etapě byly samočinné počítače používány k řešení jednotlivých matematických modelů vědeckých, technických a ekonomických úloh. Za druhou etapu rozvoje využívání samočinných počítačů je možno považovat automatizované zpracování rutinních správních agend před tím řešených mechanizovaně.

Přesto, že v rámci obou těchto etap bylo již vykonáno mnoho metodické i praktické práce, je třeba konstatovat, že zdaleka nebylo dostatečně využito všech možností, které nová technika řízení nabízí. Předpokládáme, že v tomto směru bude dosaženo podstatného zlepšení současné situace, bude-li do praxe zaveden návrh na automatizaci nového modelu řídícího systému v lesním hospodářství na úrovni podniku, který byl vypracován ve VÚLHM Strnady.

Jde o systém opírající se o počítač, který jednak poskytuje informace nutné pro řízení, jednak sám některé rozhodovací fáze řízení přímo připravuje. Jedním z nejdůležitějších technických prvků, s kterým navržený model počítá, je Databanka. Její vybudování umožní změnit dosavadní tradiční informační systém v lesním hospodářství podle zodpovědnostních agend na informační systém, tvořený podle věcných a funkčních hledisek. Tento systém bude složen z tzv. informačních souborů, které umožní jednak rychlejší zpracování příslušných podkladů, jednak omezí i množství vstupních primárních dat, která právě v lesním hospodářství tvoří významný faktor.

Problematika tvorby informačního systému, který by měl optimální vlastnosti z hlediska potřeb řízení, je neobyčejně složitá a rozsáhlá. K jejímu vyřešení jsme uskutečnili v organizačních jednotkách a útvarech podnikového ředitelství Státních lesů průzkum. Hlavní šetřenou veličinou byly doklady jako nositelé informací. Výsledkem průzkumu jsou formalizované záznamy, které umožnily analyzovat stávající informační systém z hlediska toku těchto informací. Vedle těchto celkových logických rozborů na úrovni dokladů byly na řadě úseků zpracovány již informační systémy i na úrovni jednotlivých informací. Taková analýza pak slouží přímo vlastnímu projektování.

Z dílčích modelů pro rozhodovací fáze řízení v rámci celého systému byl v podstatě již dokončen model pro krátkodobé plánování a řízení těžební čnnnosti. Model navazuje na pětiletý cyklus hospodářských plánů. Z nich jsou roční úkoly lesních podniků a jejich základních organizačních jednotek, lesních závodů, odvozeny a zpřesněny podle konkrétních výchozích podmínek daného roku. Pomocí samočinného počítače jsou v tomto modelu zpracovány výpočty hmot a sortimentace, určují se optimální dopravní směry a optimální kombinace technologií a uskutečňuje se výpočet nákladů a odhad kapacity prostředků. K rozboru plánu časového průběhu používá model cyklogramu. Hlavní prvky tohoto dílčího modelu byly již v praxi odzkoušeny.

Место электронно-вычислительной машины в модели системы управления лесным хозяйсвтом

Общее развитие процесса рационализации и углубления управленческих и административных работ с применением ЭВМ в полной мере коснулось и чехословацкого лесного хозяйства. Последовательность применения ЭВМ можно, по существу, разделить на два этапа.

На первом этапе использование ЭВМ ориентировалось на решение отдельных математических моделей научных, технических и экономических задач. Вторым этапом развития применения ЭВМ можно считать автоматизированную обработку рутинных данных административного делопроизводства, прежде обрабатывавшихся механизированным способом.

Несмотря на то, что в рамках обоих этих этапов было проведено уже много методической и практической работы, следует отметить, что еще далеко не полностью использованы все имеющиеся возможности новой техники управления. Мы предполагаем, что в этом направлении будет достигнуто существенное улучшение современного положения на основе внедрения новой автоматизированной системы управления лесным хозяйством на уровне лесного предприятия, разработанной и предложенной Научно-исследовательским институтом лесного и охотничьего хозяйства в Стрнадах.

ЭВМ, служащая основой автоматизированной системы управления, с одной стороны обеспечивает необходимую для управления информацию и, с другой стороны, непосредственно подготовляет некоторые фазы принятия решения. Одним из самых важных технических элементcв, предусматриваемым предложением АСУП, является База данных. Ее построение позволит изменить существующую традиционную информационную систему в лесном хозяйстве по отдельным ответственным делопроизводствам в информационную систему, основанную на деловых и функциональных аспектах. Эта система сложится из так наз. информационных совокупностей, которые позволят не только ускорить процесс получения информации, но ограничат также количество исходных первичных данных, именно в лесном хозяйстве имеющих большое значение.

Проблематика создания информационной системы оптимальных свойств с точки зрения потребностей управления исключительно сложна и обширна. Для ее решения мы осуществили обследование потоков экономической информации в организационных подразделениях предприятия лесного хозяйства. Предметом обследования была экономическая информация на уровне носителя. Результат обследования — формальная запись, позволяющая анализ существующей информационной системы с точки зрения информационного обеспечения системы управления и потоков информации. Кроме этого общего логического анализа системы на уровне носителей информации были уже разработаны частичные информационные модели и на уровне отдельных показателей. Такой анализ служит затем непосредственно проектированию.

Из частичных моделей принятия решения как одной фазы управления общей системой была уже по существу закончена модель краткосрочного планирования и управления лесозаготовительной деятельностью. Эта модель опирается на пятилетний цикл хозяйственных планов. Из них годовые задачи предприятий лесного хозяйства и их основных организационных подразделений — лесхозов — выведены и уточнены на основе конкретных исходных условий данного года. С помощью ЭВМ в этой модели разрабатываются вычисления объема массы и сортиментов древесины, определяются оптимальные направления транспорта и оптимальные комбинации технологий и проводится вычисление расходов и оценка производсвтенной мощности средств. Для анализа временной последовательности модель использует циклограмму. Основные элементы этой частной модели были уже проверены на практике.

Die Stellung der Rechenanlage im Modell des forstwirtschaftlichen Leitungssystems

Allgemeine Entwicklung der Rationalisation und die Vertiefung der Leitungs- und Administrationstätigkeiten durch die EDV betrifft auch die tschechoslowakische Forstwirtschaft. Das Vorgehen der bisherigen Anwendungen können wir auf zwei Etappen sachgemäß teilen.

In der ersten Etappe wurden die EDV zur Lösung der einzelnen mathematischen Modelle, der wissenschaftlichen, technischen und ökonomischen Aufgaben angewendet. Zweite Etappe der Entwicklung und Anwendung der EDV stellt die automatische Verarbeitung der Verwaltungsagenden dar, die vorher durch die Mechanisierung der Bearbeitung gelöst wurden.

Trotzdem, daß im Rahmen beider Etappen schon viel methodischer und praktischer Arbeit getan wurde, muß man feststellen, daß alle Möglichkeiten, welche die neue Leitungstechnik bietet, ungenügend ausgenutzt wurden. Wir nehmen an, daß in diesem Kurs der wesentlichen Verbesserung derzeitigen Situation erreicht werden wird, wenn in die Praxis der Vorschlag der Automatisierung des Leistungssystems in Forstwirtschaft auf dem Betriebsniveau, der in VÚLHM Strnady ausgearbeitet wurde, eingeführt. werden wird.

Es handelt sich um ein System, welches einer EDV ausnützt. Diese EDV bietet nicht nur die notwendigen Leitungsinformationen an, sie bereitet jedoch auch gerade manche Entscheidungsphasen vor. Einer von der wichtigsten technischen Elemente, mit welchen das Modell rechnet, ist die Datenbank. Aufbau dieser Datenbank ermöglicht bisheriges Informationssystem der Forstwirtschaft in ein neues System, welcher nach sachlichen und funktionellen Gesichtspunkte geschaffen wird, zu verwandeln. Dieses System wird aus sogenannten Informationssätzen zusammengefaßt werden. Diese Informationssätze ermöglichen nicht nur schnellere Verarbeitung der zugehörigen Urbelege, sondern auch begrenzen die Menge der Primäreintrittsdaten, welche besonders in der Fortswirtschaft einen bedeutsamen Faktor schafft.

Die Problematik der Informationssystemaufbau ist ungewöhnlich kompliziert und umfangreich, weil das System die optimale Beschaffenheit vom Gesichtspunkt des Leitungsbedarfs haben sollte. Zur Lösung dieser Problematik haben wir in den Staatsforstverwaltungsorganisationen und Einheiten eine Untersuchung durchgeführt. Eine der Hauptgrößen, die untersucht wurden, waren die Belege als Informationsträger. Als Ergebnis dieser Untersuchung sind die formalisierten Aufzeichungen. Diese Aufzeichnungen ermöglichten, daß derzeitiges Informationssystem aus dem Gesichtpunkt der Versicherung der Leitungs- und Verwaltungsfunktionen, ebenso aus dem Gesichtspunkt des Informationsflusses zu analysieren. Neben dieser gesamten logischen Analysen auf dem Belegniveau wurden auf manchen Abschnitten schon die Informationssysteme auch auf dem Niveau der einzelnen Informationen verarbeitet. Solche Analyse dient dann unmittelbar zur Projektierung.

Von den Teilmodellen für die Entscheidungsphasen der Leitung im Rahmen des ganzen Systems wurden schon im Grunde die Modelle für kurzzeitige Planung und für die Leitung der Nutzungstätigkeiten beendet. Das Modell knüpft auf den Zyklus der fünfjährigen Wirtschaftsplane an. Von diesen stammen die einjährigen Aufgaben der Forstbetriebe und deren Grundorganisationseinheiten. Sie werden dann nach den konkreten Ausgangsbedingungen des betreffenden Jahres präzisiert. Durch die Anwendung der EDV werden in diesem Modell die Massen- und Sortimentenausrechnungen verarbeitet. Gleichzeitig werden die optimale Verkehrsrichtungen und Technologieauswahlen festgestellt. Die Aufwandausrechnung und Maschinenkapazitätschätzung wird auch durchgeführt. Zur Analyse des Zeitaufplanes benützt man das Modell eines Zyklogrammes. Die Hauptelemente dieses Teilmodelles wurden schon in Praxis geprüft.

The authors' addresses:

Doc. Ing. Milan Novotný, C.Sc., Ing. Bedřich Fišer, Ing. Miroslav Dejmek, Výzkumný ústav lesního hospodářství a myslivosti, Zbraslav - Strnady

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J. Pelíšek

THE DEVELOPMENT OF RESEARCH IN CZECHOSLOVAKIA OVER 1965–70 IN THE FIELDS OF SCIENCE CONCERNED WITH FOREST ENVIRONMENT

Mainly forest geology, forest bioclimatology and forest pedology have been grouped, as scientific subjects, in the fields concerned with the abiotic environment of the forest. The results of research obtained most recently in these fields of science have meant valuable contributions, both to the respective theories and to practical forestry as well.

Close co-operation between specialists of the above fields of forest science and those specialized in the biological aspects of the forest, together with systemic evaluations of the results obtained via research, always results in new knowledge indicating the trend to improvement, or to degradation, of the forest environment; this in particular applies to regeneration of the forest, to situations during the development and tending of stands, further the relationsship to internal structure of the stands and the systems of management, and finally with reference to the production of timber. Formation of the units of production in forests as a basis for forest distribution and planning is an important outcome of this kind of science-research co-operation.

In the below sections are presented surveys of essential results of the studies on forest environment conducted during recent years. The arrangement is according to individual fields of science.

In the field of forest bioclimatology: — Attention was paid in the studies especially to the dynamics of the temperature and precipitation conditions in forest stands of the lowlands and mountain regions; further, to the microclimate of felling areas with reference to afforestation. Another series of observations in the sector of soil microclimate included extensive measurements of the soil temperature and the soil moisture, detailed investigations being made of the microclimate and water regimes in the group fellings of pine stands on podzol soils underlain by Pleistocene gravel sands (Central Bohemia). The soil temperature regime was studied in group fellings of various sizes, systematic measurements being made at depths ranging from 2 cm up 100 cm over a period of several years. The amounts of the data thus obtained furnished, apart from the current average figures, also frequencies of the soil temperatures highly interesting from the biological point of view; further they allowed to obtain the arithmetic probability of surpassing the biologically important temperature levels, or their differences between the various places in the group fellings; and finally they provided for calculation of the long-term average differences in the soil temperatures.

Using the ambulant method of measuring the soil temperature in a number of places of the group fellings during the seasons of the year, both the daily and the seasonal dynamics of the temperature regime could be investigated in the surface soil layers. Nature of the soil temperature study was that of a basic research. Evaluated results of the studies of this kind together with other microclimatic elements examined in the complex of the soil-atmosphere environment furnished fundamental knowledge directly for the silviculturalist, on the biosphere as formed by the regeneration fellings.

The systematic research of soil moisture in the group fellings was meant to reveal differences, if any, in the soil moisture regimes between two types of group fellings, and to throw light on the influence of an isolation ditch made along the circumference of the felling, in the same way as this is practised when the loss of moisture from the group-felling soil due to suction power of the roots of adjoining trees is to be prevented. Moreover, considerable knowledge on the distribution of soil moisture over areas of the group fellings examined was obtained too.

In examining the microclimate in connection with the forest land improvement and reclamation, attention was paid to effects of certain methods used for the afforestation of weeded areas (afforestation of areas worked preliminarily in full extent; afforestation with the use of cover crops; afforestation by pit planting, by furrow planting). Special observations were made of the microclimatic conditions in the afforestation of sandy soils and waterlogged soils; as a result of the studies, methods were suggested which the investigators considered most convenient for afforestation of such areas from the microclimatic aspect. Further studies were devoted to the effect of windbreaks on the microclimate within the forest stand; to questions associated with effects of various structures of forest stands on the microclimate, in particular those of mixed stands and monocultures.

In the region of the Beskydy Mountain Range (Carpathians) investigations of the relationships between forest and water have been under way; besides, effects of the climatic, microclimatic, and soil conditions on variations in the water courses have been observed; and due attention has also been paid to the surface discharge and to erosion.

In the field of forest geology: — Main emphasis was laid on investigation of the chemism of soil-forming rocks; both macro- and micro-elements were included. Especialy the precesses of weathering in the soil-forming rocks, which cause liberation of nutrients into the soil were studied. A classification was developed for the mineral strength of the soil-forming rocks, and clay minerals were studied with reference to the sorption capacities of forest soils.

In the field of forest pedology: — Studies in this sphere were concerned primarily with the water, air, and temperature regimes important from the ecological point of view; with problems associated with the formation and evaluation of humus; with questions associated with the regimes of nitrogen and available nutrients; with problems connected with the fertilization of forest soils; with estimation of the soil quality; with effects of the forest species on the soil; etc.

From among the physical, ecologically important soil properties a good deal of attention was given to the water regime. Research of the water regime dynamics in forest soils was based on systematic measurement of the soil moisture during the year, the aim being to trace variations in the soil moisture content, especially in the water supplies, for the major types of soils in the course of the growing season. The observations concerned with the course of the instantaneous soil moisture were carried out largely in areas characteristic of low precipitations, where the deficit of water is one of the principal causes for the low increments in forest species. The permanent test plots established in such situations (the measurements are continued) were selected under stands with various structures of species and with various forms of the forest, to serve the purpose of establishing the most favourable conditions for the maintenance and improvement of the water regime in forest soils of these areas; conceivably, important conclusions are expected to be drawn from the results also for forest practice.

In addition to the above studies, research was also directed to the establishment of two forms of water, those termed as available or unavailable to forest stands. These studies resulted in new, important data throwing light on the content of the water unavailable to plants, especialy in the mountain forest soils of which but little had been known before. Mehodically, a new and very rapid procedure — the electrometric resistance method — was adopted for the measurement of soil moisture.

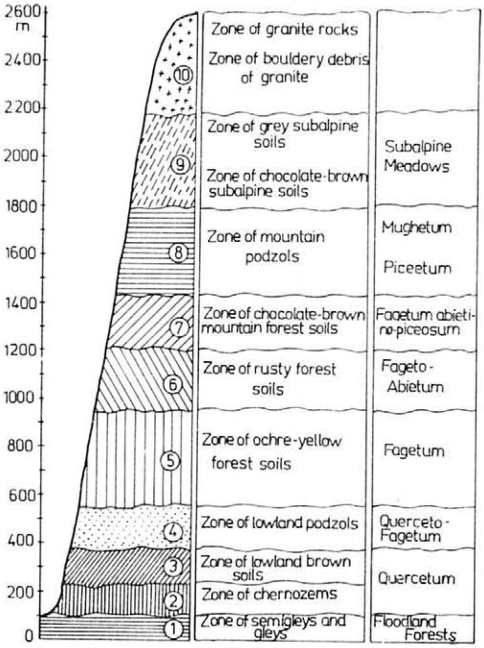
Apart from the investigations as outlined above, the water regime was studied during the development of selected forest stands and under the influence of different silvicultural treatments, according to the vertical soil and vegetation zonalities and in association with forest grouping. The relationships between the soil water regime and the internal stand structure were examined, particularly with reference to the arrangement of individual tree storeys. The studies conducted to serve the purpose of orientation and concerned with the interrelationships between the water regime and available nutrients in the soil as based on the vertical soil and vegetation zonalities showed significant results in correlations to the production of timber. Moreover, further research was made for the water regime in felling areas, again according to the vertical soil and vegetation zonalities, and the results appear to be of appeciable importance to forestry.

From among the chemical and ecologically significant properties primary attention was given to soil acidity, again according to the vertical zonality. Extensive studies were devoted to problems associated with forest humus, specifically to its composition and classification as established by the techniques of extraction. Observed were the interrelationships between the surface humus accumulations under a variety of forest stands (slightly altered and artificial) and the biological cycle of nutrients in the forest, for they are of considerable practical importance from the aspect of the replenishment of nutrients in forest soils.

Much attention was paid to the regime of nitrogen, especially to the available forms of N, and experiments were established where N fertilizing was applied with the aim to increase the production of timber. As a whole, the studies revealed appreciable deficiencies of available N forms in Czechoslovak forest soils, which accounted for the failures experienced in places with both natural and artificial regeneration of the forest.

Most recently, extensive investigations have been under way to defect the present state of available nutrients in the forest soils of Czechoslovakia, the aim being their replenishing and thus improving production capacities of the soils. In doing so, data are gathered on the basis of which to make surveys of nutrients utilizable for the fertilizing of forest soils in the years ahead. Results of the laboratory research hitherto made have revealed an interesting pattern of the supplies of available nutrients according to the climate-soil and vegetation zonalities.

Some of the studies were concerned with relationships between the soil properties of ecological importance and the site qualities of stands, especially in the region of the Bohemian Massif.



1. Showing relationships between zones of the soil zonality and those of the forest vegetation on the territory of Czechoslovakia. — Vzájemné vztahy mezi výškovými pásmy půd a výškovými vegetačními lesními pásmy

As a part of the project covering the effects of forest species on soils, research was made as to the effect of artificial Spruce monocultures on forest soils. The influence of Spruce monocultures as exercised on soils, maintenance of the soil production capacities, and quality of artificial Spruce monocultures all are of great importance from the viewpoint of national economy, for the Spruce species represents nowadays not only an important resource of raw material for the manufacture of cellulose, it is also a highly valuable raw material utilizable by other industries.

The studies made on the sites utilizable for comparison were based on the climato-soil and vegetation zonalities, over a range from the river plains up to the mountain regions and in a number of situations of Czechoslovak territory, including both the Bohemian Massif (western parts of Czechoslovakia) and the Carpathians (eastern parts of the country). The territory of Czechoslovakia, because of its distinct climato-soil zonality, offers ideal conditions for comparative studies of this kind, both from the aspect of scientific research and its practical applications as well.

The research works were made on comparative parallel areas, in situations the altitudes of which ranged from 200 m to 1500 m. Alterations were examined in the soils under pure Spruce crops and under more natural stands.

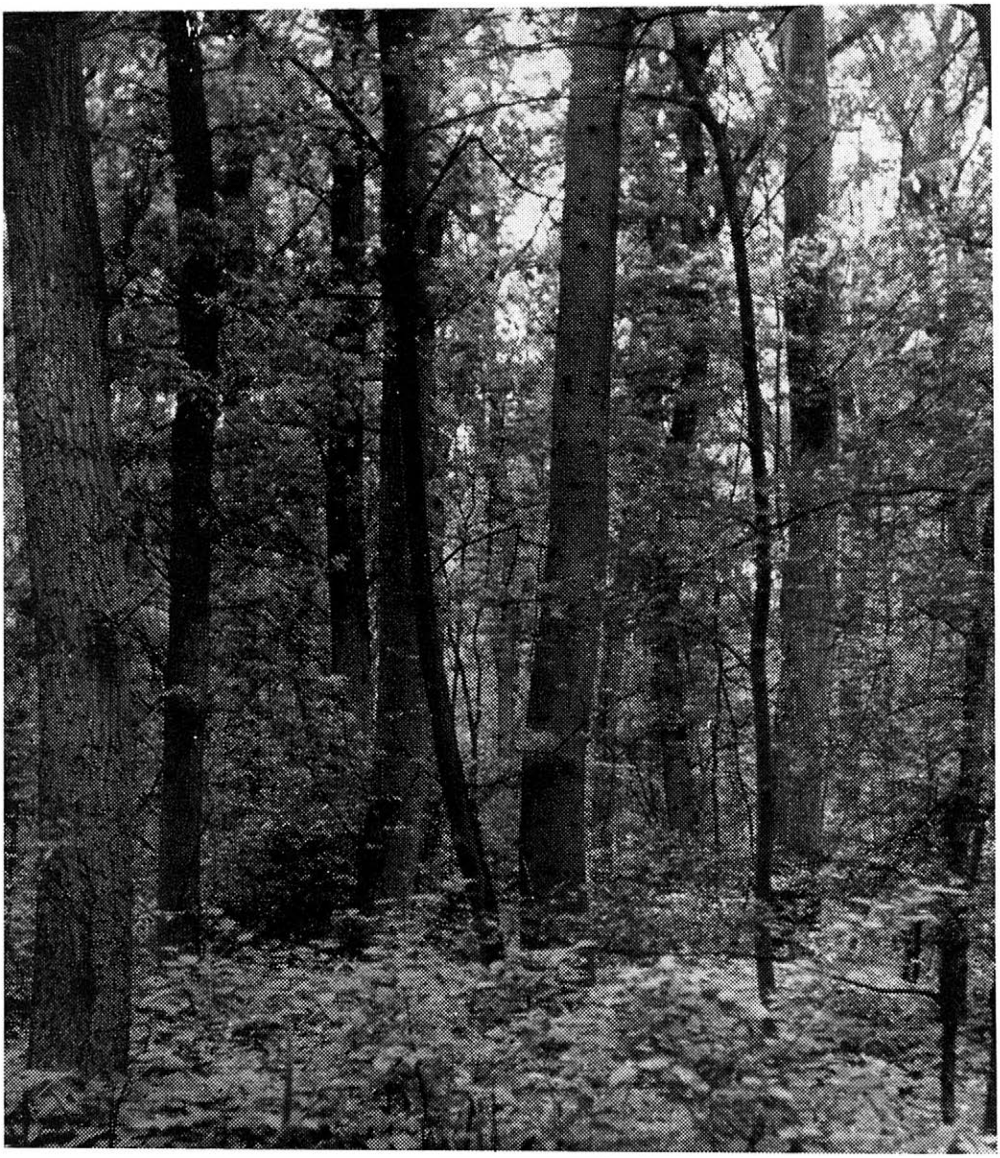
The results of our comparative studies have revealed:

1. The soils under Spruce monocultures feature but shallow superficial humic horizons and, conversely, rather thick layers of superficial raw humus.

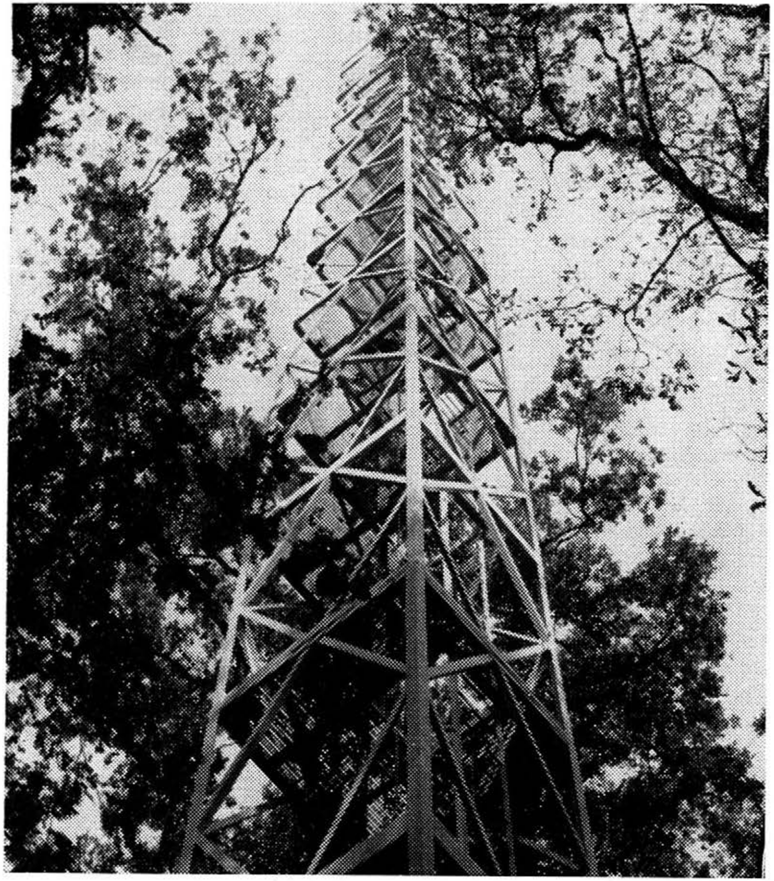
2. The soils under Spruce stands in the low-lying and rolling areas show accumulations of raw humus (aggravated humification) and their contents of true mull humus are lower. With the altitude increasing, the differences in the contents of true humus tend to become relatively smaller and the total contents of humus indicate the upward trend.

3. The podzol soils under Spruce stands in the low-lying and rolling situations show relatively higher accumulations of physical clay in their enriched horizons; increased compactness can be observed in the humic podzols of mountains, compared to the B-horizons.

4. The soils of lowlands under Spruce stands show aggravated water regimes during the year; their surface layers tend to dry up, while the subsoils feature excessive moisture contents in places.



2. The flood-plain forest in southern Moravia where the detail studies of forest environment and biomass production are under way. — Lužní les v oblasti jižní Moravy, kde jsou konány podrobné výzkumy lesního prostředí a produkce biomasy



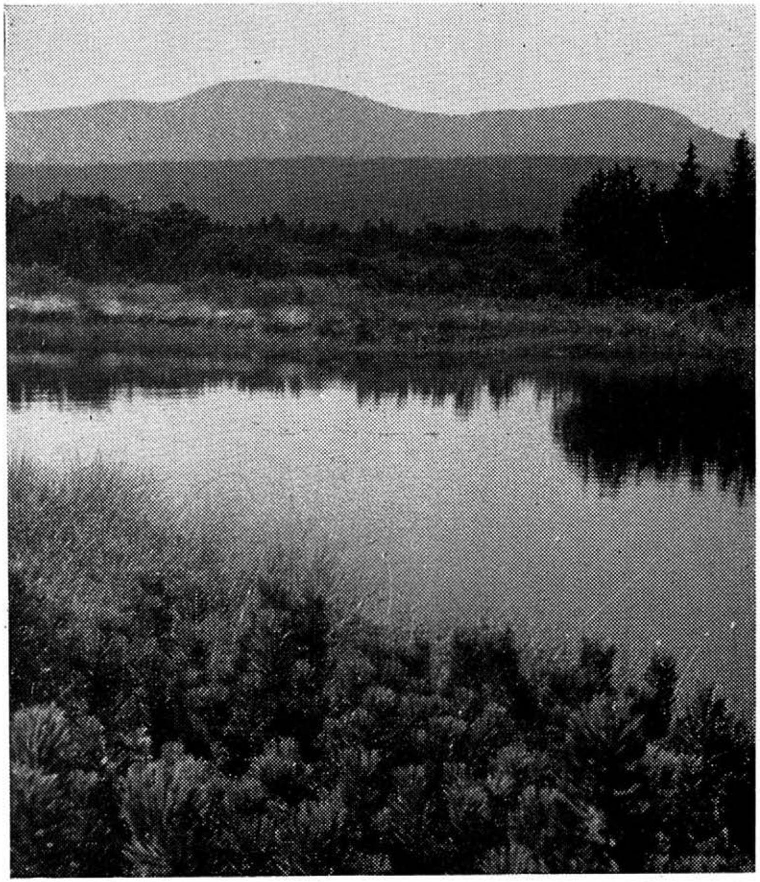
3. The tower (20 m high) provided with a number of apparatuses with which to measure bioclimatic values in the flood-plain forest environment of southern Moravia. — Věž (výška 20 m) s četnými přístroji na měření bioklimatických hodnot prostředí lužního lesa na jižní Moravě

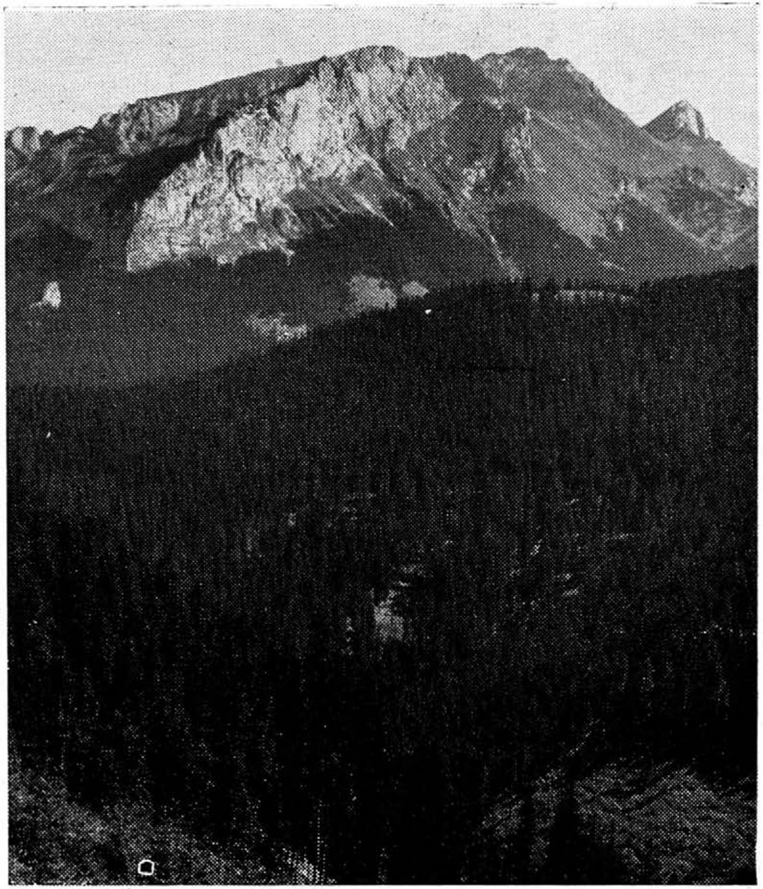
4. Special vessels catching the leaf fall for the study of humification and the cycle of nutrients in the food-plain forest of southern Moravia. — Speciální nádoby na zachycování listového opadu pro studium humifikace a koloběhu živin v lužním lese jižní Moravy

5. A poor Pine stand growing on heavily degraded soils (podzols with ortstein on sands) where the detail studies are under way of alterations in the forest environment in association with the soil-improvement trials. — Špatný borový porost na silně degradovaných půdách (podzoly s ortštejnem na pískách), kde se konají podrobné výzkumy změn lesního prostředí v souvislosti s melioračními pokusy

6. An extreme podzol soil with ortstein on sands as a heavily degraded soil; it was used as a basis upon which to develop and test the method applicable to improving soils of this kind. — Extrémní podzol s ortštejnem na pískách jako silně degradovaná půda, kde byla vypracována a ověřena metodika na melioraci těchto půd

7. A Beech stand in the Carpathians, growing on brown forest soils underlain by flysh rocks. — Bukový porost v oblasti Karpat na hnědých lesních půdách na flyšových horninách s pokusnými plochami





8. A top mountain area in the Bohemian Massif (western part of Czechoslovakia), with stands of Spruce and dwarf Pine on mountain podzols and peat soils. — Vrcholová horská oblast s porosty smrku a kleče na horských podzolech a rašeliništních půdách v oblasti Českého masívu (západní část ČSSR) s pokusnými plochami

9. Spruce stands in the region of Carpathians (eastern part of Czechoslovakia), growing on brown forest soils underlain by flysh rocks and on brown rendzina soils underlain by limestones. — Smrkové porosty v oblasti Karpat (východní část ČSSR) na hnědých lesních půdách na flyšových horninách a hnědých rendzinách na vápencích s pokusnými plochami

5. The soils under Sprucs monocultures in the low-lying and rolling situations are much more acid (by as much as 2.5 pH) than those under stands with more natural composition of speciés. As the elevation increases, the differences in pH values tend to diminish although the total acidity rises. Accordingly, Spruce monocultures appear to be relatively the heaviest acidifiers of the soils of lowlands and rolling grounds and thus of areas that are climatically dirier and warmer.

The soils of lowlands under Spruce stands show aggravated regimes of nitrogen (especially diminished levels of its readily available forms) and distincly reduced supplies of readily available nutrients (CaO, K_2O, P_2O_5). This is accounted for by diminished humification, accunulations of superficial and raw humus, and reduced biological cycle of nutrients.

The results hitherto obtained have pointed to aggravated conditions in some of the soil properties in the lowlands and rolling grounds under Spruce cultures. While the results of those studies concerned with the possibilities of including Spruce in the stands with no danger of causing aggravation of soil properties have indicated the whole-year water regime and the supplies of nutrients in the soil to be highly important factors. An elevated content of soil moisture in the lowlands and rolling ground during the summer season allows a higher admixture of Spruce in forest stands with no aggravation of ecologically important soil properties as a result. With the elevation increasing, from lowlands up to mountain situations, the degrading effect of Spruce on the soil tends to diminish; accordingly, the admixture of Spruce in the forest stands can be increased. In the mountain situations Spruce presumably does not exercise the 'degrading' effect on the soil.

On the basis of extensive comparative studies using parallel pairs of experimental plots the problem of unequal representations of Spruce in afforested areas of Czechoslovakia with no soil-degrading consequences has roughly been solved. Results of these comparative investigations have suggested that in Czechoslovakia Spruce can be grown over a range from the mountain down to the low--lying situations, but only on definite sites and at definite percentages in the forest stands.

Judging from the results mentioned above, we can reckon with increased representations of Spruce in our forest stands according to the vertical climato-soil zonality, with no danger of causing degradation in properties of the soils. The results obtained are therefore well utilizable for suggestions on the representation of Spruce in areas under forest on definite sites and thus also in definite types of production. The same results also reveal that much higher representations of Spruce in our stands can be considered than are those given in some of the previous suggestions conceived as part of the typological survey of forest with predominance of phytocenological observations.

Increased percentages of Spruce in afforested areas (stands) are highly important from the viewpoint of national economy, for they provide for an increased production of timber without inducing any degrading effect upon the soil and thus without any reduction in the production capacities of Czechoslovak soils.

Significant achievements were made in the reclamation of degraded forest soils; these were classified and characterized, certain methods applicable to the improvement and reclamation of degraded forest soils, in particular those of sandy nature, were developed and tested on the pilot-plant level. It is hardly exaggerated to claim that for some types of degraded forest soils the method of their recultivation, and thus afforestation as well, has practically been solved already, which is highly important to the national economy as it provides for higher increments of timber.

Moreover, the full-size cultivation of weeded clearings on light soils was successfully solved. In this connection, special attention was given to the working of soil in its full extent. The research resulted in a draft of particular working instructions. A method was also developed for the cultivation of sandy soils, the aim being regeneration of the stand. The method is based on ameliorative measures applied on full area; deep ploughing is made use of, to improve thereby the physical and other conditions of the soil. Contribution of the measures is seen again in accelerated regeneration, improved site quality, and primarily in increased increments.

The method by which to improve degraded light soils has been developed, applied in practice, and due instructions have been worked out. It is based on a complex of mechanical, chemical and biological measures applied to the soil, the aim being improvement of the site production capacity, acceleration of the regeneration, increased increments and improved quality of the stand.

At present the cultivation of degraded light soils may be considered as largely solved. On the other hand, the improvement and reclamation of heavy degraded soils present still a serious problem, both in this country and on an international scale as well.

Various modes of cultivation were tested in the study sites selected for the improvement of degraded heavy soils, particular attention being paid to devastated clearings. The full-area mechanical soil working did not prove well; the method based on the chemical control of weeds proved a failure too. Of the other measures tested the one consisting of the small-area soil working combined with the biological treatment was found most effective. The application of ameliorative measures to waterlogged forest soils did not start until most recently. The reason was that, in draining waterlogged soils — peat soils in the first place, certain doubts arose pointing to potential adverse effects of such ameliorative measures on the water regime of the streams. This explains why the microclimatic and hydropedologic significance of peat moors has been studied for a longer period of time.

The soil research and survey programme is an important part of the typological research and survey of Czechoslovak forests, for soil properties and phytocoenoses form the basic indicators on the ground of which to delimit areas charasteristic of a definite production capacity in view of expedient mixtures of stands. In such areas under forest where the structure of species has undergone heavy alterations and thus also the entire phytocoenosis has appreciably changed, the soil remains the only reliable indicator on the basis of which to delimit areas of equal productivities in respect of forest production.

On the basis of the results obtained from the research of soils (when necessary, from that of climate or microclimate) with reference to the maintenance, improvement or aggravation of the soil environment due to application of various system of management, the instructions were compiled so as to cover the principles of due land use on areas of the production units; instructions of this kind forming an important part of the economic plan.

Forest pedology furnished valuable data to silviculture. This sector, using the stands and due silvicultural techniques, utilizes forest land to the maximum and simultaneously optimum level of its production capacity, together with its climate or microclimate. The different soil properties and their annual dynamics are co-agents, not infrequently even the only agents which are directly decisive in the seletion of the modes of soil preparation to be applied for the natural and even artifical regeneration of a forest; for selection of the modes of treatment, improvement and conservation of soils during the development of farest stands (such as loosening, regulation of the water, air, and temperature regimes in the surface soil layers); and for due applications of various partial silvicultural treatments or systems of management on areas of the forest production units.

The main role of silvicultural techniques is seen in the tending of forest stands; besides, they simultaneously exercise strong effects on production capacity of the forest site, i. e. its soil and climate, or microclimate.

Forest pedology also furnished important fundamental data to the sector of forest management. Thus, for instance the dynamics and the amounts of moisture in forest soils during the year significantly affect the spatial arrangement of forest in the number of its storeys and thus in the entire economic use of forest land together with its climate. Especially some extreme properties of soils and climate markedly affect forest management and thus its plan as well. This applies primarily to the forest management on swampy soils with low stability for stands; further to that practised in regions where the soils have degraded and their production capacities are reduced; on moving detrital soils; in areas with sloping grounds; in areas of sandy soils; etc.

Detailed research of forest soils is now used as a basis for the hydro-ameliorative measures, for the fertilization of forest soils in stands or nurseries.

Much important work has been done to date also in the sector of forest soil microbiology, with reference to the precesses of humification and to the liberation of nitrogen into forms available to forest stands as nutrients.

SUMMARY

In this paper are summarized essential results of the research projects concerned with problems related to the abiotic environment (bioclimatology and pedology). The items referred to are the development and tending of the forest, its internal spatial arrangement, the management systems and forms, the natural and artificial regenerations of stands, the problems of nutrition and fertilization in forest soils, the hydro-ameliorative measures, the modes of recultivating forest soils, etc., all aiming at an increased production of Czechoslovak forest stands. The studies furnished a number of highly valuable results, both theoretical and practical. It is now highly desirable that they are utilized by forestry as much as possible.

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Rozvoj výzkumu z vědních oborů prostředí lesa v Československu v letech 1965—1970

K vědním oborům abiotického prostředí lesa jsou dnes hlavně čítány jako vědecké disciplíny lesnická bioklimatologie, lesnická geologie a lesnické půdoznalství, které v posledních letech přinesly cenné výsledky pro stránce teoretické i z hlediska lesního hospodářství. Úzká spolupráce specialistů těchto lesnických vědních oborů s lesnickými specialisty biologického zaměření a syntetické vyhodnocování získaných vědeckých výsledků je důležité zejména pro vytvoření produkčních jednotek lesů jako základu lesní rajonizace a plánování.

Z oboru lesnické bioklimatologie byla studována zejména dynamika teplotních a srážkových poměrů v lesních porostech nížin a horských oblastí a dále pak mikroklima pasek se zřetelem na zalesňování. Další výzkumné práce se týkaly zejména měření půdních teplot a vlhkosti půdy při mikroklimatickém výzkumu kotlíků v borových porostech na podzolových půdách v oblasti středních Čech. Byl též konán výzkum mikroklimatu při některých melioračních způsobech, při zalesňování zabuřenělých ploch, studovány otázky vlivu různé skladby lesních porostů na mikroklima, a to zejména ve smíšených a nesmíšených porostech.

Z oboru lesnické geologie byl kladen hlavní důraz na výzkum chemismu půdotvorných hornin (makroelementů i mikroelementů), studovány zvětrávací procesy půdotvorných hornin a jílové minerály.

Lesnické půdoznalství se zabývalo zejména ekologicky významným režimem vodním, vzdušným a teplotním, problematikou tvorby a hodnocení humusu, režimem dusíku a přístupných živin, problematikou hnojení lesních půd, vztahy mezi půdou a porosty, vlivem dřevin na půdu aj. Z ekologicky důležitých fyzikálních půdních vlastností byla studována dynamika hydrotermálního režimu a provzdušení lesních půd.

Z chemických a ekologicky důležitých vlastností byla studována problematika kyselosti půd podle výškové pásmitosti, biologický koloběh živin v lese, zejména podle lyzimetrických studií, režim dusíku a stav přístupných živin v lesnich půdách ČSSR se zřetelem na jejich doplnění a zvýšení produkční schopnosti půdy. Pokračoval též výzkum vlivu smrkových monokultur na půdy podle výškové půdní pásmitosti. Výsledky studií o zastoupení smrku v porostech bez zhoršování půdních vlastností ukazují, že velmi důležitým faktorem je tu celoroční vodní režim v půdě a zásoby živin. Byla vypracována klasifikace degradovaných lesních půd a poloprovozně prověřeny určité způsoby meliorace degradovaných lesních půd, zejména půd písčitého charakteru. Důležitou součástí typologického výzkumu a průzkumu lesů ČSSR byl rovněž výzkum a průzkum půd, neboť ekologické vlastnosti půdy a fytocenózy jsou základními indikátory pro vymezení ploch s určitou produkční schopností pro vhodné porostní směsi. Byly též konány studie hydropedologické jako základ pro meliorační opatření, studie o stavu přístupných živin pro hnojení lesních půd v porostech a lesních školkách. Významné práce byly vykonány z oboru mikrobiologie lesních půd ve vztahu k humifikačním procesům a uvolňování dusíku do forem přístupných pro výživu lesních porostů.

Развитие исследования научных отраслей лесной среды в Чехословакии в 1965—1970 годах

К научным отраслям абиотической лесной среды в настоящее время в качестве научных дисциплин принадлежат, главным образом, лесная биоклиматология, лесная геология и лесное почвоведение, которые за последние годы дали ценные результаты не только в теоретическом отношении, но и с точки зрения лесного хозяйства. Тесное сотрудничество специалистов этих лесных научных отраслей с лесными специалистами биологического направления и синтетическая оценка достигнутых научных результатов важно как в интересах углубления научных отраслей, так и в практическом отношении, прежде всего путем создания производственных единиц леса как основы лесного районирования и планирования.

В области лесной биоклиматологии изучалась, прежде всего, динамика условий температуры и атмосферных осадков в лесных насаждениях низменных и горных областей, а затем и микроклимат лесосек с учетом их облесения. Наряду с этим научные работы были направлены преимущественно на измерение температур и влажности почвы при микроклиматическом обследовании просветов в сосновых насаждениях на подзолистых почвах в области Средней Чехии. Кроме того производились исследования микроклимата при некоторых мелиоративных способах облесения засоренных площадей, изучались вопросы влияния разного состава лесных насаждений на микроклимат, а именно прежде всего в смешанных и в несмешанных насаждениях.

В области лесной геологии основное значение придавалось научному исследованию химизма почвообразовательных горных пород (макро- и микроэлементов), изучались процессы выветривания почвообразовательных пород и илистые минералы.

Лесное почвоведение было направлено на изучение прежде всего экологически важного водного, воздушного и температурного режима, проблематики образования и оценки гумуса, режима азота и доступных питательных веществ, проблематики удобрения лесных

почв, зависимости между почвой и насаждениями, влияния древесных пород на почву и др. Из важных в экологическом отношении физических свойств почвы изучалась динамика гидротермического режима и аэрации лесных почв.

Из важных с химической и экологической точек зрения свойств изучались, прежде всего, проблематика кислотности почв по вертикальной зональности, биологический круговорот питательных веществ в лесу, главным образом на основании лизиметрических обследований, затем изучался также режим азота. Кроме того были произведены обследования содержания доступных питательных веществ в лесных почвах ЧССР с учетом их дополнения и повышения продуктивности почвы. Продолжались исследования влияния еловых монокультур на почвы по вертикальной почвенной зональности. Результаты исследований процента ели в насаждениях без ухудшения почвенных свойств свидетельствуют о том, что весьма важный фактор здесь представляют круглогодичный водный режим в почве и запасы питательных веществ. Разработана классификация деградированных лесных почв, главным образом почв песчаного характера. Важной частью типологического исследования и обследования лесов ЧССР было также научное исследование и обследование почв, так как экологические свойства почвы и фитоценозы являются основными индикаторами при определении площадей с известной продуктивной способностью для соответствующих смешанных лесонасаждений. Кроме того производились гидропочвоведческие исследования в качестве основы для мелиорационных мероприятий, затем исследования содержания доступных питательных веществ для удобрения лесных почв в насаждениях и лесных питомниках. Важные работы были произведены в области микробиологии лесных почв в отношении к процессам гумификации и освобождения азота в доступные формы для питания лесных насаждений.

Die Entwicklung der Forschungen auf dem Wissensgebiet Waldumwelt in der Tschechoslowakei in den Jahren 1965—1970

Zu den Wissensgebieten der abiotischen Waldumwelt zählt man als wissenschaftliche Disziplinen heutzutage hauptsächlich die forstliche Bioklimatologie, die forstliche Geologie und Bodenkunde, die in den letzten Jahren wertvolle Ergebnisse seitens der Theorie sowie vom Gesichtspunkt der Forstwirtschaft brachten. Eine enge Zusammenarbeit der Spezialisten dieser forstlichen Wissensgebiete mit den forstlichen Spezialisten der biologischen Richtung und eine synthetische Auswertung der gewonnenen wissenschaftlichen Ergebnisse ist von Wichtigkeit vom Gesichtspunkt der Vertiefung von Wissensgebieten und von der praktischen Seite vor allem durch die Schaffung von Produktionseinheiten der Wälder als eine Grundlage der forstlichen Rayonierung und Planung.

Auf dem Fachgebiet der forstlichen Bioklimatologie untersuchte man vor allem die Dynamik der Temperatur- und Niederschlagsverhältnisse in den Waldbeständen der Niederungen und Gebirgsgebiete und ferner das Mikroklima der Schlagflächen mit Rücksicht auf die Aufforstung. Weitere Forschungsarbeiten betrafen vor allem die Messung der Bodentemperaturen und Bodenfeuchtigkeit bei mikroklimatischer Forschung der Kessel in Kieferbeständen auf Podsolböden auf dem Gebiet von Mittelböhmen. Ferner wurden Mikroklimaforschungen bei einigen Meliorationsarten der Aufforstung von verunkrauteten Flächen vorgenommen, Fragen der Einflüsse von verschiedener Waldbestadeszusammensetzung auf das Mikroklima behandelt, und zwar besonders in Mischbeständen und Reinbeständen.

Vom Fachbereich der forstlichen Geologie widmete man höchste Aufmerksamkeit der Forschung des Chemismus bodenbildender Gesteine (der Makro- und Mikroelemente), man untersuchte die Verwitterungsprozesse bodenbildender Gesteine und die Tonmineralien.

Die forstliche Bodenkunde befaßte sich in erster Reihe mit dem ökologisch bedeutenden Wasser-, Luft- und Wärmehaushalt, mit der Problematik der Bildung und Bewertung von Humus, mit dem Haushalt von Stickstoff und aufnehmbaren Nährstoffen, Problematik der Düngung der Waldböden, Beziehungen zwischen dem Boden und den Beständen, mit dem Einfluß von Holzarten auf den Boden u. ä. m. Von den ökologisch wichtigsten physikalischen Bodeneigenschaften studierte man die Dynamik des hydrothermalen Haushaltes und die Durchlüftung der Waldböden.

Von den chemichen und ökologisch wichtigen Eigenschaften befaßte man sich vor allem mit der Problematik der Bodenazidität nach der vertikalen Zonalität, mit biologischem Nährstoffkreislauf im Walde vor allem nach lysimetrischen Studien; weiter untersuchte man den Stickstoffhaushalt, den Stand aufnehmbarer Nährstoffe in den Waldböden der ČSSR mit Rücksicht auf ihre Ergänzung und Erhöhung der Produktionsfähigkeit des Bodens. Die Forschungen des Einflusses von Fichten-Monokulturen auf Böden nach der vertikalen Bodenzonalität wurden fortgesetzt. Die Ergebnisse der Untersuchungen der Vertretung der Fichte in den Beständen ohne Verschlechterung von Bodeneigenschaften zeigen, daß der ganzjährige Wasserhaushalt des Bodens und die Nährstoffvorräte einen äußerst wichtigen Faktor bilden. Eine Klassifikation von derartigen Waldböden wurde ausgearbeitet und bestimmte Arten der Melioration von degradierten Waldböden, vor allem von Böden eines bestimmten sandigen Charakters wurden im Versuchsbetrieb überprüft. Ein wichtiger Bestandteil der typologischen Forschung und Durchforschung von Wäldern der ČSSR war auch die Untersuchung und Durchforschung der Böden, denn die ökologischen Eigenschaften des Bodens und die Phytozönosen bilden grundlegende Indikatoren für die Spezifikation von Flächen mit einer bestimmten Produktionsfähigkeit für geeignete Bestandsgemische. Ferner wurden hydropedologische Studien als Grundlage für Meliorationsmaßnahmen, Studien über den Stand der aufnehmbaren Nährstoffe für die Düngung der Waldböden in Beständen und Baumschulen vorgenommen. Bedeutende Arbeiten auf dem Gebiet der Mikrobiologie der Waldböden in Beziehung zu den Humifizierungsprozessen und zur Freimachung von Stickstoff zu aufnehmbarer Formen für die Ernährung der Waldbestände wurden durchgeführt.

Développement des recherches dans les disciplines scientifiques relatives au milieu de la forêt en Tchécoslovaquie, au cours des années 1965—1970

Parmi les branches scientifiques du milieu abiotique de la forêt on compte aujourd'hui surtout comme disciplines scientifiques la bioclimatologie forestière, la géologie forestière et la pédologie forestière qui ont apporté dans les dernières années de précieux résultats aussi bien à la théorie qu'à la sylviculture. La coopération étroite des spécialistes de ces branches scientifiques forestières avec les spécialistes d'orientation biologique et l'évaluation synthétique des résultats scientifiques obtenus sont importantes d'une part pour l'approfondissement des disciplines scientifiques et d'autre part pour la pratique, en créant notamment les unités forestières de production en tant que base pour la rayonisation et la planification forestières.

Dans la branche de bioclimatologie forestière on étudiait surtout la dynamique des facteurs de température et de précipitations dans les peuplements forestiers de plaines et de régions montagneuses et puis le microclima des clairières en vue de leur boisement. Les travaux de recherche ultérieurs concernaient notamment la mesure des températures et de l'humidité du sol faite au cours de la recherche microclimatique des trouées dans les peuplements de pins sur les sols podzoliques dans la région de la Bohême centrale. On effectuait également les recherches du microclimat que l'on rencontre lorsqu'on applique certains modes d'amélioration lors du boisement des surfaces recouvertes de mauvaises herbes et enfin on étudiait les influences de la structure variée des peuplements forestiers sur le microclimat et cela en premier lieu dans les peuplements purs et les peuplements mélangés.

Dans le domaine de géologie forestière on attachait la plus grande attention à la recherche du chimisme des roches importantes pour la genèse des sols (macroéléments et microéléments), tout en étudiant les processus de désagrégation des roches importantes pour la genèse des sols et les minéraux argileux.

La pédologie forestière s'occupait surtout du régime hydrique, atmosphérique et thermique, écologiquement important, du problème de formation et d'estimation de l'humus, du régime d'azote et de matières nutritives assimilables, du problème de fumure des sols forestiers, des rapports entre le sol et les peuplements, de l'influence des essences sur le sol et ainsi de suite. Quant aux propriétés physiques de sol importantes au point de vue écologique on étudiait la dynamique du régime hydrothermique et l'aération des sols forestiers.

Quant aux propriétés chimiques écologiquement importantes, on étudiait notamment la problématique de l'acidité des sols selon la zonalité altitudinale, la circulation biologique des matières nutritives dans la forêt, surtout d'après les études lysimétriques et puis on étudiait le régime de l'azote. On a fait également les explorations sur l'état des matières nutritives assimilables dans les sols forestiers de Tchécoslovaquie, en regard de leur apport éventuel et de l'augmentation de l'aptitude du sol à la production. On continuait les recherches relatives à l'influence des monocultures d'épicéa sur les sols, selon les zonalités altitudinales des sols. Les résultats des études relatives à la participation de l'épicéa aux peuplements sans détérioration des propriétés des sols montrent que c'est le régime hydrique le long de l'année entière dans le sol et les réserves en matières nutritives qui constituent ici le facteur important. On a élaboré la classification des sols forestiers dégradés et on a vérifié certains modes d'amélioration des sols forestiers dégradés, notamment des sols accusant un caractère sablonneux déterminé. La partie composante importante de la recherche et de l'exploration typologiques des forêts en Tchécoslovaquie consistait également dans la recherche et l'exploration des sols, car les propriétés écologiques du sol et de la phytocénose constituent les indicateurs principaux pour la délimitation des surfaces qui accusent une certaine aptitude à la production pour les peuplements mélangés convenables. On procédait également aux études hydropédologiques en tant que base pour les mesures d'amélioration, aux études relatives à l'état des matières nutritives assimilables nécessaires à la fumure des sols forestiers dans les peuplements et les pépinières forestières. On a réalisé des travaux importants dans la sphère de microbiologie des sols forestiers par rapport aux processus d'humification et de dégagement de l'azote en formes assimilables pour la nutrition des peuplements forestiers.

The author's address:

Prof. Dr. Ing. Josef Pelíšek, Dr. Sc., lesnická fakulta VŠZ, Brno

M. Bumerl

NEW ELECTRODES FOR ELECTRIC LOG BARKING

The results of theoretical research have shown that the effects of the electric current can be utilized, under certain circumstances, to tree and log barking and that they can bring about a lessening or even complete breaking of the wood-bark cohesion bonds. Thus, the employment of the electric current to timber barking appears to be both technologically and economically feasible.

The removal of free bark is a very labour-intensive, tiresome, and difficult and costly operation, and the amount of logs and short wood to be peeled annually is considerable. For the reasons given above an incessant search has been under way for better, cheaper, easier, and faster methods of tree barking, involving a minimum labour input. In most cases, tree barking machines of various designs have been used, basing largely on the mechanical principles. and differing widely in their performance and output.

THEORY OF ELECTRIC LOG BARKING

A new method of log barking utilizing the effects of the electric current on the underlying bark tissues, by letting the current flow through the subcortical tissues which (the cambium and other tissue layers adjacent to it), as a rule, are moister than the other tissues inside-out or outside-in (in fresh-felled timber, in partly dried timber some weeks or months after felling, or in timber treated in a special way) and show thus a better electric conductivity than the other tissue strata. The finest wood cells with delicate, thin walls, rich in plant saps, are in the cambial zones, and this is also why the cambium tissues are best current-conductive of all the under-bark tissues. In addition, also the moist tissues adjacent to the cambium are comparatively good conductors of the electric currents.

The subcortical tissues offer a resistance to the flow of the electric current, and the factors involved simultaneously are the Ohm's resistance capacitive resistance, electrolysis, and polarisation of the electrodes. The resistors are set into circuit in various ways and act simultaneously according to the type of electric current used. Hence, the measurements result in the apparent resistance figures, composed of the Ohm's, capacitives and other resistance types.

The passage of the electric current through the subcortical tissues brings about changes in them, changes mainly in temperature and chemical composition. Having in mind the objective of utilizing the effects of electricity on the lowering and disruption of the wood-bark cohesion (regarding as tree bark all tissues outside the cambium), we are interested particularly in the temperature changes electric induced by the electric current since it is they which result in a considerable drop and break of the wood-bark cohesiveness. We should also add that it is principally Ohm's resistance that makes the subcortical tissues warm on electric current passage, and it is also only natural that the best conductive tissue layers are heated most.

Increasing temperature of the above-mentioned tissues leads to softening of the cell walls in the warmed-up zone, and this only reduces the wood-bark cohesion forces. However, with temperature increasing, the volume of the present liquids grows too, and as soon as the cell water (sap) begins to evaporate, the vapor pressure destroys the thinnest, finest and softest wood cells and when the pressure of the vapor generated has exceeded the strength limits of the thinnest and weakest cell walls, the latter would be torn and fissured and the wood-bark bonds would be broken. The tree bark gets then loose, and the vapors escape; at the same time is broken the plant tissue zone of highest electrical conductivity, the escaping vapors result in lesser humidity of the tissues and consequently the resistance of them rises comparatively sharply.

The effects of the electric current on the under-bark tissues and on the wood-bark cohesion drop are almost the same in all Central-European forest tree species, and the abovedescribed method of bark removal can be thus applied to all forest tree species the logs of which are to be peeled, both to big or small diameter wood, to logs or log sections with thick and thin bark, or with Pine-type bark. The effects of the electric current on the wood-bark cohesion disruption can be utilized all-year-round, in the growing season or out of it, as well as during the frost period. The wood-bark bond would always be broken in the cambial zone, hence there would be no residual bark or phloem on the log surface, the bark removal would be complete, and the wood matter losses would be nil. The surfaces of the bark-free logs would be smooth, similar to those after spring peeling during the sap flow period. It should be however taken into account that the electric energy (power) input would be depending on the initial temperature of the under-bark tissues, and that the cooler the tissues will be the higher will be the amount of electricity required to heat them.

Most economical and feasible in electric log barking appears to be the alternating, line current, of the mains or higher voltages (600, 800 — 1,000 V), and of a 50 Hz frequency Better results can be obtained, however, with higher than 50 Hz frequencies.

The resistance of the subcortical tree tissues along the fibres is lesser than that offered to electric current flowing perpendicularly to them, and it would be thus advantageous to make the electric current flowing in the under-bark tissues parallel to their fibres. Unfortunately, from the point of operation and with regard to the simplicity of design and required performance of the installation is it fairly difficult, and it is much simpler and economical to design the eletric barking device into which the logs to be barked will be fed continuously, their flow being in the log longitudinal axis direction, and the electric current entering the subcortical tissues perpendicularly to their fibres.

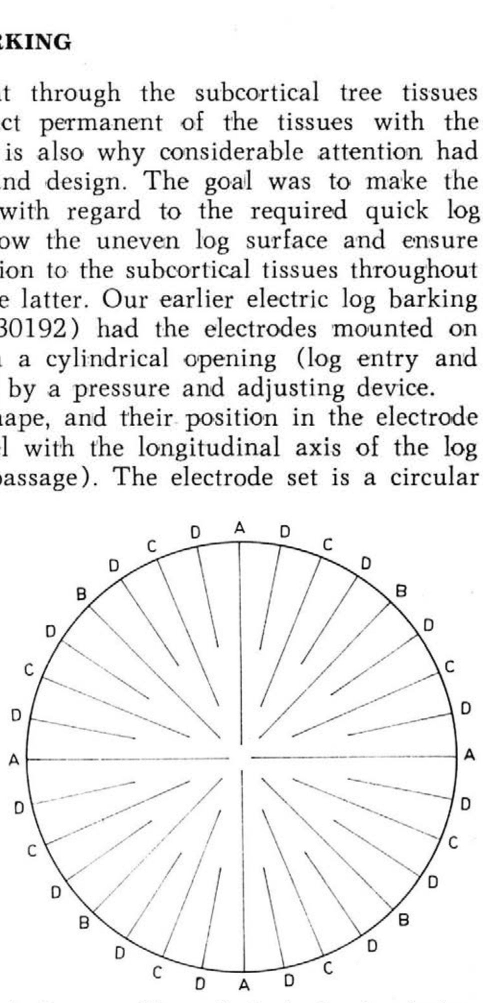
Should the effect of the electric current on the disruption of the wood-bark cohesion bonds be satisfactory, the warming-up of the subcortical tissues must be rapid, and this can be attained within several seconds if the type and voltage of the electric current and the electrode clearance were chosen properly. If however the temperature of the subcortical tissues rises slowly, then the disruption of the wood-bark linkage by the electric current will not be sufficient enough, and the slowly developing vapors will be escaping through the bark fissures, along the electrodes, etc., and their pressure will not suffice to blast the cell walls. Yet even in cases like that will the wood-bark cohesion be greatly lowered.

The tree bark that had been loosened by electric current must be removed from the log surface until hot; in the hot state is it plastic and soft and its complete taking-away presents no difficulties. Throughout the process of electric barking will the bark be partly separated from the wood, and the rest will be sticking to wood very feebly, more or less because of adhesiveness. If we let, on the other hand, the bark treated with electric current cool down in situ, or even dry out, it will become more fragile, drier, and its removing from the log surface will be more difficult.

ELECTRODES FOR ELECTRIC LOG BARKING

The passage of the electric current through the subcortical tree tissues depends very much on a perfect contact permanent of the tissues with the electrodes delivering electricity, and this is also why considerable attention had been paid to optimum electrode shape and design. The goal was to make the electrodes sufficiently strong and long with regard to the required quick log (longitudinal) feeding, so that they follow the uneven log surface and ensure at the same time a perfect electric connection to the subcortical tissues throughout the period necessary for the heating of the latter. Our earlier electric log barking installation (Czechoslovak Patent No. 130192) had the electrodes mounted on a head consisting of a metal frame with a cylindrical opening (log entry and passage); the electrodes can be controlled by a pressure and adjusting device.

The electrodes are longitudinal in shape, and their position in the electrode head is such that their edges are parallel with the longitudinal axis of the log passing through the head opening (log passage). The electrode set is a circular one, and by operation of the adjusting device can they be fixed at any distance from the log passage centre. The gaps between the two neighbouring electrodes are the same for any pair in operation. To facilitate the barking of logs of different diameters, particularly long logs of considerable taper, the lay-out of electrodes in the head is such that in their base positions (maximum extension towards log passage centre) do they protrude differently far from the head. The electrode blades with parallel edges are placed evenly in the head hollow, lying — in their base position — on concentric circles of different diameters, and being adjustable to fit the diameters of larger logs. So for instance are on the smallest concentric circle also 4 electrodes, 16, 32 etc. The number of concentric circles carrying electrodes depends on the log diameter range for which the instal-



1. Base position of electrodes in electrode head (number of electrodes; A — 4, B — 4, C — 8, D — 16) — diagram. — Příklad základního postavení elektrod v hlavici s elektrodami (počet elektrod: A — 4, B — 4, C — 8, D — 16) — schéma

lation had been designed. With increasing diameters of logs undergoing barking will in succession be put in action the bigger- circle electrodes as required. The number of electrodes operating simultaneously is governed by the respective log diameter, and the current flow is controlled systematically so that always the two neighbouring electrodes represent a working unit and so·that the current could pass from one to another through the subcortical tissues lying between them. The electrode clearance will necessarily be extended with bigger log diameters up to a point when the next concentric electrode circle had entered into operation. The concentric circle diametres were designed with the aim to minimize the differences in the electrode clearance.

The electrode blades will be inserted in the bark of logs passing through the installation by the action of the feeding and pressure device (until reaching the wood tissues) and will be cutting the bark into narrow stripes parallel to the log axis, and the electrode blades will be connected to the electricity sources (mains). Through the contact of the electrodes with the moist subcortical tissues will an electric connection be established, and it is necessary that this connection be perfect and lasting throughout the period required for intensive heating of the under-bark zone.

Since a perfect electric connection of the electrodes with the subcortical tissues is of primary importance in the process of electric log barking, electrodes of various shapes and designs had been tested. One important consideration is that with regard to the projected capacity of the installation the log feeding speed must be some 15—30 m or more per minute, and if at this speed also the duration of the intensive heating of the subcortical tissues (1 or several seconds) should be enough, the electrodes must be of adequate length (0.5 to 1.0 m or more). The heating time depends necesarily on a number of factors, e.g. on the moisture of the under-bark tissue, on their thickness, clearance of electrodes (width of cut- out bark stripes), type and voltage of the electric current used, temperature of the subcortical zone, etc. Some of the above variables can to some extent can be cut or extended the time of intensive tissue heating. In any case is it however necessary to take into contideration that intensive heating-up of the subcortical zone, even when very fast, may last one or more seconds, and this is why the electrodes must be long enough.

Apart from the above must they satisfy yet another requirement, namely to follow at least the small and medium-size uneveness of the log along their full length and, if this is not the case, the electrode blades inserted in the bark may be easily removed from the cut when negotiating the bulges and knots of the log surface, this resulting inevitably in a complete or at least partial electrical disconnection of the electrodes and the subcortical tissues. Consequently, the barking efficiency will be reduced considerably, and certain electrodes can be on some exceedingly bumpy log surfaces be entirely put out of action.

In our investigations into the feasibility and efficiency of log barking electrodes use was made of the blade electrodes that proved to be satisfactory in general, and no colouring or staining resulting e.g. from the contact with tannins and other substances contained in the subcortical tissues has been encountered.

Put to testing were the electrodes of various designs and with differently arranged parts; those having blades of long knife-shape were found suitable only with logs of perfectly smooth surfaces (without bumps, badly removed knots, and other protrudings) and only when the log undergoing barking was not on the move, the effected heating of the subcortical zone and broken wood-bark cohesion having taken place but in the spot of electrode insertion in the bark over a distance equivalent to electrode length. The pushing forward of logs embraced by electrodes cutting the bark in narrow longitudinal strips was fairly difficult and a perfect electric connection of the electrodes to the subcortical tissue was ensured but at the electrode faces where the bark was being cut freshly (as deep as to the wood surface). Along the electrode edge, particularly towards its bottom, the electrical connection between it and the under-bark tissue was far from being perfect and reliable, and this handicap could neither be overcome by special conical sharpening of the electrode edges, consisting in making the front edge thinner (smaller wedge angle) and in widening it continuously up to the electrode bottom (wider wedge angle). Difficult was also the necessarily accurate and continuous thickening of the edge in the process of sharpening. Imperfect connection of the electrode edges and the subcortical tissues has necessitated an extension of the heating-up time, and consequently the feeding velocity had to be reduced to break sufficiently the wood-bark cohesion bonds. From the point of efficient operation are these undersirable phenomena slowing down the warming-up of the subcortical zone, and resulting both in imperfect bark loosening from the underlying wood, and in reduced performance of the installation. Of no use at all are the above-described knife-shaped electrodes in the barking of logs of uneven surface when the bumps and knots may very often result in an electrode or at least in its greater part being kicked out of the bark kerf, and the following electrical disconnection. If this happens, the wood-bark cohesion in places of electrical disconnection is not cancelled enough, and when at the same time several neighbouring electrodes are put out of action, the subcortical tissues will not be heated in the respective place, and the bark and wood will hold tightly together.

Also the blade electrodes composed of sprung parts to overcome the uneven log surfaces, have not proved too successful. The sprung electrode segments had short blades and were arranged within the composite electrode in a way to form a straight blade line; in other words, the cutting blade of this composite electrode consisted of the segment blades, as though a long electrode blade was cut to pieces. There were naturally narrow gaps among the segment electrode edges, and each segment was provided with a spring device adjusting the edge position to the uneven surface of the logs fed through the electrode head passage. The design and manufacturing of the above electrodes were comparatively complicated, difficult, and expensive, yet the adverse effects of the surface unevenness on continuous electrical connection between the composite electrode edges and subcortical tissues have been removed, the effects which were caused — in the earlier described full-blade electrodes — by „derailing“ of the electrode edges from the cut made in log bark. However, despite of this advantage, perfect permanent contacts of all segment electrode edges with the subcortical tissues could not have been established, particularly in long composite electrodes. Satisfactory electrical connection of the segment edges and the under-bark tissue zone was attained for the front segments cutting the log bark deep as to the wood surface, and for some following segments that were moved in the bark cut freshly made in the first segment edge. On the other hand, other segment edges were entering a comparatively wide bark cut, and consequently a perfect electrical connection of their edges and log tissues could not have been fully secured.

Similar adverse phenomena (imperfect electrical connection of the electrode edges and under-bark tissue) could have been observed also in composite electrodes having — instead of short segment edges — fixed or sprung cutting wheels.

The efficiency of electrode types which, in the course of log feeding through the barking installation, have their blades fixed and the making of the bark cut is done by the electrode edge faces (while other edge parts only move forward in the finished cut), is invariably lower — as assessed by measurements — than that of the electrodes inserted only without being moved in the log bark throughout the heating-up time of the subcortical tissue. The respective efficiency drop in such electrodes is considerable, averaging some 30 to 50 per cent. This efficiency decline is marked particularly in longer electrodes which are necessary with regard to the required high capacity of the electrical log barking installation. For this reason are such electrodes unsuitable in practical operation, and if used, the installation performance would be low. Otherwise, the forwarding speed of the log passing through the machine should be increased greatly.

A perfect lasting contact of the electrodes with the subcortical tissues can be established if the electrode edges inserted in log bark (down to wood surface) remain immobile in the bark on continuous proceeding of the log being barked through the installation all over the period neccessary for treatment of the under--bark tissue by the electric current.

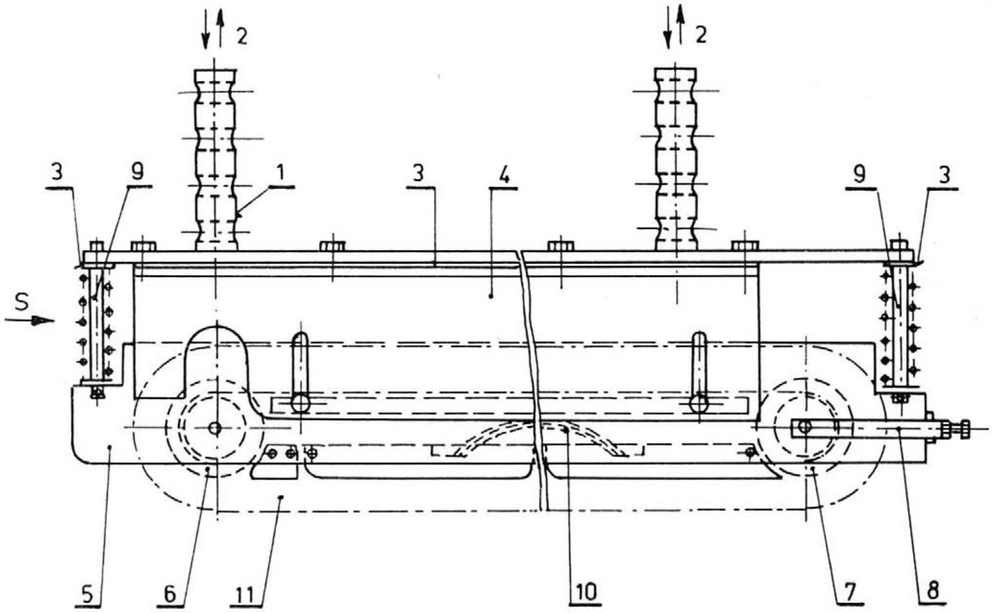
For the above reasons special electrodes were designed and tested the edges of which move forward, after they had been inserted in the log bark, continously together with the logs fed through the machine. Throughout the whole passage of a log through the installation do they remain immobile-inserted in its bark, hence a perfect electrical cennection of the electrodes and the subcortical tissues is secured all along the electrode length. It is only neccessary design the electrode length and the feeding velocity in a way ensuring that any place of the log surface should be treated electrically for a period required for the current to affect the subcortical tissues sufficiently. The above period depends primarily on the wood moisture contents, on the thickness of the subcortical tissues, type and voltage of the electric current, initial temperature of the subcortical zone, clearance of the electrodes, etc.

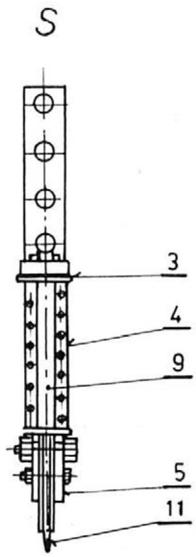
The major parts of successful electrodes for electric log barking are endless bands of segment electrodes moving in the grooves of the guide bars and over the guide and tension rollers. Endless bands of segment electrodes will be moved, after their first segments been sunk in the bark, together with the log being barked and pushed forward by the feeding device of the installation. On moving forward, other segment electrode edges will be inserted in bark, and the endless band of the segment electrodes will be rolling over the guide and tension rollers, sliding in the grooves of the electrode guide bars. The edges of the segment electrodes remain inserted in the bark throughout the whole passage of the log along the working parts of the electrode guide bars.

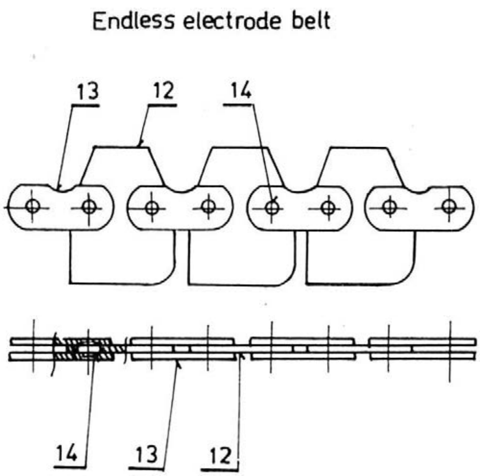
Individual segment electrodes are held (throughout the whole passage time of the log between the bark-inserted electrodes) motionless in the bark by a sprung pressure device placed in the working part of the guide bar, and by another sprung pressure device serving the composite electrodes. The sprung pressure device of the guide bar working part makes it possible to cope with the surface bumps, and the composite electrode sprung pressure device makes allowance for irregular log cross sections and different log diameters.

When the endless bands of the segment electrodes proceed towards the end of the composite electrode (over the tension rollers) the segment cutting edges will be lifted successively from the cut.

A composite electrode for electric log barking (Fig. 2) consists of holders (*1*), pressure and forwarding devices (*2*), insulation inserts (*3*), a pocket (*4*), a guide bar (*5*), a guide roller (*6*), a tension roller (*7*), a tensioning device (*8*), and sprung pressure springs (*9, 10*), and an endless band of segment







2. A composite electrode with endless band of segment electrodes — design alternative. — Složená elektroda s nekonečným pásem dílčích elektrod — příklad provedení

electrodes (*11*). An endless band of segment electrodes (*11*) is composed of a number of segment electrodes with cutting edges (*12*), chain links (*13*), and rivet links (*14*). Fig. 2 is a generalized graphic representation of the design, not depicting however other alternatives.

The length of the composite electrodes may be chosen as required, depending on the log forwarding speed, on the type and voltage of the electric current, etc.

The segment electrodes can be short blades with edge, needles, cutting wheels, etc., also can they be joined in the endless band in various ways, e.g. by chain links, rivets, V-belt, etc., as indicated above. The composite electrode parts may be made of metal, plastics, etc.

The experiments with various types of composite electrodes have shown that most suitable and efficient are those involving an endless band of segment electrodes. Of the latter designs most economical were the segment electrodes the edge face of which was rounded. Their efficiency was equal or about equal to that exhibited by simple blade electrodes of the same length used for comparison, that were inserted in the log bark immobile throughout the whole heating of the subcortical tissues, the log under barking being also motionless. Composite electrodes having endless belts of needles (representing the electrode segments) were not succesful, and their efficiency was 30—50 per cent lower. The composite electrodes with endless band were submitted for patent awarding.

SUMMARY

Composite electrodes with endless band of segment electrodes described in this paper make it possible to utilize better and more efficiently the log barking equipment using the effects of electricity (see Patent No. 130 192). They do ensure perfect electric connection of the segment electrode edges with the subcortical tree tissues even on continuous forwarding of the logs through the installation. This way is the time required for a thorough heating of the subcortical zone shorter than in cases when a similar electrode-tissue connection had not been secured. The composite electrodes featuring endless bands of segment blade electrodes bring about faster warming-up of the under-bark tissue layers, this permitting — under the assumption of other factors remaining the same (subcortical tissue moisture, electrode length, temperature, electrode clearance) — a faster forwarding of the logs being barked and consequently an attaining of better installation productivity.

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Nové elektrody pro odkorňování dřeva elektrickým proudem

Výkonnost zařízení pro odkorňování dřeva elektrickým proudem podle čs. patentu číslo 130 192 je velmi závislá na době potřebné k působení elektrického proudu na podkorní vrstvy. Změny, ke kterým dochází v podkorních vrstvách dřeva působením elektrického proudu (zejména změny tepelné), musí probíhat rychle. Není-li zajištěno dobré elektrické spojení mezi břity elektrod a vlhkými podkorními vrstvami, pak je prodlužována doba potřebná k porušení soudržnosti mezi kůrou a dřevem.

Při plynulém podélném pohybu odkorňovaného krátkého i dlouhého dříví ve směru délky výřezů zařízením, který je z provozního hlediska nejvýhodnější, lze dosáhnout stálého dokonalého styku břitů elektrod s podkorními vrstvami tím, že dílčí části elektrod zapuštěné do kůry zůstanou nehybně pevně zaříznuty do kůry (až k povrchovým vrstvám dřeva) i během podélného pohybu odkorňovaného dřeva zařízením po celou dobu potřebnou k působení elektrického proudu na podkorní vrstvy. Rychlost posunu dřeva zařízením musí být taková, aby se postupně a plynule každá část odkorňovaného dřeva nacházela mezi elektrodami po dobu nutnou pro ošetření dřeva elektrickým proudem a aby po celou tuto dobu mohl podkorními vrstvami procházet elektrický proud.

Proto byly vyvinuty složené elektrody s nekonečným pásem dílčích elektrod, které se osvědčily. Hlavní částí takové složené elektrody je nekonečný pás dílčích elektrod vedený v drážce vodicí lišty a přes vodicí kladku a napínací kladku. Nekonečný pás dílčích elektrod je po zapuštění první dílčí elektrody do kůry uváděn do pohybu spolu s odkorňovaným dřevem pohybujícím se zařízením silou, kterou působí podávací ústrojí zařízení na odkorňované dřevo a uvádí ho do podélného plynulého pohybu. Přitom se postupně zařezávají do kůry břity dalších dílčích elektrod. Nekonečný pás dílčích elektrod se při pohybu odvaluje přes vodicí i napínací kladku a klouže v drážce vodicí lišty. Na konci složené elektrody se při přechodu nekonečného pásu dílčích elektrod přes napínací kladku opět z kůry postupně za sebou uvolňují břity jednotlivých dílčích elektrod ze spáry proříznuté v kůře.

Jednotlivé dílčí části elektrody jsou po celou dobu průchodu dřeva mezi elektrodami po zaříznutí do kůry udržovány bez změny polohy v kůře pomocí přítlačného a pružicího zařízení umístěného v pracovní části vodicí lišty a pomocí přítlačného pružicího zařízení působícího na složené elektrody. Přítlačné pružicí zařízení umístěné v pracovní části vodicí lišty umožňuje i kopírování nerovností povrchu odkorňovaného dřeva a přítlačné zařízení působící na složené elektrody umožňuje kopírování nepravidelností kruhového průřezu a změn průměru odkorňovaného dřeva pohybujícího se zařízením mezi elektrodami.

Uvedené elektrody s nekonečným pásem dílčích nožových elektrod umožňují lepší a účinnější využití zařízení pro odkorňování dřeva elektrickým proudem podle patentu číslo 130 192.

Новые электроды для окорки древесины электрическим током

Производительность устройства для окорки древесины электрическим током, согласно чехословацкому патенту № 130 192, очень зависит от срока, необходимого для действия электрического тока на снятие коры. Изменения, которые происходят в слоях под корой под действием электрического тока (в частности, изменения тепловые), должны протекать быстро. Если же не обеспечено хорошее соединение между лезвием электрода и мокрыми слоями под корой, то продляется срок, необходимый для нарушения связности между корой и древесиной.

При бесперебойном продольном передвижении древесины (короткой и длинной) при скорке, по направлению длины кряжа, который является с производственной точки зрения наиболее выгодным, можно достигнуть постоянного совершенного контакта лезвий электродов со слоями под корой тем, что отдельные части электродов, запущенные в кору остаются неподвижно прочно углубленными в коре (вплоть до поверхностных слоев древесины), а также при продольном передвижении древесины при окорке устройством в течение всего времени, необходимого для действия электрического тока на слои под корой. Скорость передвижения древесины устройством должна быть такой, чтобы постепенно и непрерывно каждая часть древесины при окорке находилась между электродами в течение необходимого времени для обработки древесины электрическим током и чтобы в течение этого времени под корой мог проходить электрический ток.

Поэтому были разработаны составные электроды с бесконечной лентой частных электродов, которые оправдали себя. Главная часть такого составного электрода представляет собой бесконечную ленту частных электродов, проложенную в пазу направляющей планки и через направляющий и натяжной ролики. Бесконечная лента частных электродов после углубления первого частного электрода в кору приводится в движение вместе с деревом, передвигающимся при помощи устройства, с силой, действующей подающим устройством на дерево при окорке, и приводит его в продольное непрерывное движение. При этом постепенно углубляются в кору лезвия других частных электродов. Бесконечная лента частных электродов при передвижении откатывается через направляющий и натяжной ролики и скользит по пазу направляющей планки. На конце составного электрода при переходе бесконечной ленты частных электродов через натяжной ролик опять из коры постепенно друг за другом освобождаются лезвия отдельных частных электродов из пропилов в коре.

Отдельные частные электроды в течение всего времени прохода древесины между электродами после углубления в кору остаются без изменения положения в коре при помощи прижимающего и пружинящего устройства, расположенного в рабочей части направляющей планки, и при помощи прижимающего и пружинящего устройства, действующего на составные электроды. Прижимающее и пружинящее устройство, расположенное в рабочей части направляющей планки, позволяет также копирование неравномерной поверхности древесины. Прижимающее устройство, действующее на составные электроды, позволяет копировку неравномерности круглого сечения и изменений диаметра ствола, передвигающегося при помощи устройства между электродами.

Приведенные электроды с бесконечной лентой частных режущих электродов позволят лучше и эффективнее использовать устройства для окорки древесины при помощи электрического тока согласно патенту № 130 192.

Neue Elektroden für das Entrinden von Holz mit elektrischen Strom

Die Leistung der Anlage für das Entrinden des Holzes mit elektrischem Strom laut tschechoslowakischem Patent Nr. 130 192 ist sehr stark von der zur Einwirkung des elektrischen Stroms nötigen Zeit auf die unter der Rinde liegenden Schichten abhängig. Die Veränderungen, zu denen es in den Holzschichten unter der Rinde durch die Wirkung des elektrischen Stroms kommt (besonders Temperaturveränderungen), müssen schnell verlaufen. Wenn keine gut leitende elektrische Verbindung zwischen den Schneiden der Elektroden und den feuchten Schichten unter der Rinde gesichert ist, wird die zur Störung des Zusammenhalts zwischen Rinde und Holz notwendige Zeit verlängert.

Bei der kontinuierlichen Bewegung des geschälten Holzes (Langholz und Schichtholz) in Längsrichtung der Zuschnitte durch die Anlage, was aus betrieblichen Gesichtspunkten am vorteilhaftesten ist, kann dadurch eine ständige, einwandfreie Berührung der Elektrodenschneiden mit den Schichten unter der Rinde erzielt werden, daß ein Teil der in die Rinde eingesenkten Elektroden unbeweglich fest in die Rinde eingeschnitten bleibt (bis zu den Oberschichten des Holzes), und zwar auch während der Längsbewegung des geschälten Holzes durch die Einrichtung und während der ganzen Zeit, die für die Einwirkung des elektrischen Stroms auf die Rindenunterschichten notwendig ist. Die Vorschubgeschwindigkeit des Holzes durch die Einrichtung muß so sein, daß jeder Teil des geschälten Holzes kontinuierlich sich so lange zwischen den Elektroden befindet, als für die Behandlung des Holzes mit dem elektrischen Strom notwendig ist, und daß der Strom während dieser ganzen Zeit durch die Schichten unter der Rinde fließen kann.

Daher wurden zusammengesetzte Elektroden mit einem endlosen Band von Teilelektroden entwickelt, die sich gut bewährten. Der Hauptteil einer derartigen zusammengesetzten Elektrode ist das endlose Band der Teilelektroden, die in der Nut der Führungsleiste über die Führungsrolle und die Spannrolle geführt werden. Das endlose Band der Teilelektroden wird nach dem Einsenken der ersten Teilelektrode in die Rinde gemeinsam mit dem geschälten Holz in Bewegung gesetzt. Die Bewegung des Holzes erfolgt kontinuierlich durch die Kraft, mit der die Vorschubeinrichtung auf das Holz einwirkt. Hierbei schneiden sich nach und nach die Schneiden der weiteren Teilelektroden in die Rinde ein. Das endlose Band der Teilelektroden rollt sich bei dieser Bewegung über die Leitrolle und die Spannrolle ab und gleitet in der Nut der Leitschiene. Am Ende, wo das endlose Band der Teilelektroden über die Spannrolle läuft, werden die einzelnen Teilelektroden aus dem in die Rinde geschnittenen Schlitz ausgehoben.

Die einzelnen Teilelektroden sind während der ganzen Durchlaufszeit des Holzes zwischen den Elektroden mit Hilfe einer elastischen Anpreßvorrichtung ohne Veränderung der Lage in der Rinde fixiert. Die elastische Anpreßvorrichtung ist im Arbeitsteil der Leitschiene angebracht. Eine zweite elastische Anpreßvorrichtung wirkt auf die kombinierten Elektroden. Die erste Anpreßvorrichtung in der Führungsschiene ermöglicht, die Unebenheiten der Oberfläche des geschälten Holzes zu kopieren. Die zweite Anpreßvorrichtung kopiert die Unregelmäßigkeiten des Querschnittes und die Durchmesserveränderungen des entrindeten Holzes, das sich zwischen den Elektroden durch die Einrichtung bewegt.

Die angeführten Elektroden mit dem endlosen Band von messerförmigen Teilelektroden ermöglichen, die Anlage zur Holzentrindung mit elektrischem Strom laut Patent Nr. 130 192 besser und wirksamer auszunutzen.

Electrodes nouvelles pour l'écorçage du bois par le courant électrique

Le rendement du dispositif destiné à l'écorçage du bois par le courant électrique d'après le brevet tchécoslovaque numéro 130 192 dépend très fortement du temps nécessaire à l'action du courant électrique sur les couches sous-corticales. Les changements qui ont lieu dans les couches sous-corticales du bois par suite de l'action du courant électrique (notamment les changements thermiques) doivent se dérouler rapidement. Du moment que l'on n'assure pas un bon raccordement électrique entre les tranchants des électrodes et les couches sous-corticales humides, on prolonge le temps nécessaire à la rupture de la cohésion entre l'écorce et le bois.

Pendant le mouvement longitudinal continu du bois (court ou long) que le dipositif écorce dans le sens de la longueur des billons et qui apparaît comme le plus avantageux du point de vue d'exploitation, on peut obtenir le contact permanent parfait des tranchants des électrodes avec les couches sous-corticales du fait que les éléments partiels des électrodes plongés dans l'écorce restent immobiles et solidement enfoncées dans l'écorce (jusqu'aux couches superficielles du bois) même au cours du mouvement longitudinal du bois à écorcer par le dispositif, et cela pendant tout le temps nécessaire à l'action du courant électrique sur les couches sous-corticales. La vitesse du déplacement du bois au moyen du dispositif doit être telle à permettre que chaque partie du bois en train d'écorçage se trouve successivement et en continu entre les électrodes pendant un temps nécessaire au traitement du bois par le courant électrique et que le courant électrique puisse passer pendant le temps mentionné par les couches sous-corticales.

C'est pour cela que l'on a développé les électrodes composées à bande sans fin comprenant les électrodes partielles qui ont fait leurs preuves. La partie principale d'une telle électrode composée consiste dans une bande sans fin, comprenant les électrodes partielles, conduite dans la rainure de la glissière et sur le galet-guide et galet-tendeur. Une fois la première électrode partielle enfoncée dans l'écorce, la bande sans fin des électrodes partielles est mise en mouvement simultanément avec le bois à écorcer, au moyen du dispositif en mouvement et grâce à la force qu'exerce le mécanisme d'avance du dispositif sur le bois à écorcer, mettant ce dernier en mouvement longitudinal et continu. Pendant cette opération s'enlisent successivement dans l'écorce les tranchants des électrodes partielles ultérieures. Pendant le mouvement la bande sans fin des électrodes partielles passe sur le galet-guide et le galet- tendeur, glissant dans la rainure de la glissière. Au bout de l'électrode composée, au moment du passage de la bande sans fin des électrodes partielles sur le galet-tendeur, les tranchants des électrodes partielles individuelles se dégagent successivement, un à un de l'écorce, c'est-à-dire de la fente percée dans l'écorce.

Pendant tout le passage du bois entre les électrodes, les parties partielles particulières de l'électrode, après leur enfoncement dans l'écorce, sont maintenues, sans changement de position dans l'écorce, au moyen d'un dispositif presseur et élastique, situé dans l'organe opérateur de la glissière et à l'aide d'un dispositif presseur et élastique agissant sur les électrodes composées. Le dispositif presseur élastique, situé dans l'organe opérateur de la glissière, permet également d'épouser les aspérités de la surface du bois à écorcer et le dispositif presseur agissant sur les électrodes composées permet d'épouser les irrégularités de la section circulaire et des changements du diamètre du bois à écorcer qui se déplace dans le dispositif entre les électrodes.

Les électrodes mentionnées à bande sans fin des électrodes à lame permettent l'utilisation meilleure et plus efficace du dispositif destiné à l'écorçage du bois au moyen du courrant électrique d'après le brevet tchécoslovaque numéro 130 192.

The author's address:

Doc. Ing. Milan B u m e r l, C. Sc., Vědecký lesnický ústav VŠZ, Kostelec nad Černými lesy

F. Piškula

THE HANDLING AND PROCESSING YARD WITHIN THE HARVESTING PROCESS OF BROADLEAVED TREES

The rapid technical advance in the field of timber harvesting has made it possible to choose a lot of combinations of technological systems. In fact all of them could be set into the framework of the following basic methods: 1. full tree method, 2. long length method, 3. short wood method, 4. method of chips.

Each of these four methods has its advantages and disadvantages which manifest themselves markedly according to the given conditions and the employed machines. None of them can be classified as optimum.

From the viewpoint of labour consumption and labour hygiene the short wood method realized with a combined felling – branching – bucking – skidding machine serviced only by one operator could be regarded as the best one. But this method is typical of the forests of the North with their small coniferous trees covering a big area of flat land and harvested on gigantic clearcuttings. Its application to Central European conditions would be minimal.

If another machine combination is used (e. g. a chain-saw for felling, limbing and topping, an articulated skidder for skidding, and a lorry for hauling), the shortening of bole into several pieces in the stand is followed by a lower efficiency of machines and workers. The law of big numbers and low mass becomes thus evident.

When a forwarder for skidding is used, then bunching of short assortments along the skidding track must be applied. In case the pieces are not heavy it is performed manually, if they are heavier a horse or winch must be used. It is always time-consuming and needs greater expenditure.

Even though the short wood method, using a modern forwarder, can be of good service in our forests. Till now we have still very little experience with it. The method of long length stems (sometimes shortened according to the skidding and hauling conditions) seems to be the most suitable for the Central European forests, where much bigger trees, a higher density of stands growing on slopes can be found and, moreover, the shelterwood silvicultural system predominates. And that is why prominent experts (Hafner, Pestal, Steinlin, Turk and others) recommend this long length method as the most suitable one for Central European conditions (Giordano 61. et al. 1970).

In Czechoslovakia there are about 26 % of broadleaved timber trees scattered irregularly throughout the country. There are some areas where conifers are absolutely predominant but there exist also places with hardwoods only. Czechoslovakia, however, as a wood exporting country, imports also some exotic foreign timbers for furniture manufacture, but among them the hardwoods which can be found in our forests if the assortment of our broadleaved trees was better.

Which type of technology has to be chosen for the harvesting of hardwood timbers?

The number of factories specialized in the processing of hardwood is rather small and, therefore, they are scattered all over the country; moreover a good deal of stacked hardwood is exported. That is why the greater part of broadleaved timbers is transported by rail (in South Moravia 79 %).

In spite of this reality only a fraction of broadleaved timbers is rough processed in the central timber processing and shipping yards and this refers mostly only to the shortening of roundwood, because of loading on vans and bucking-off a bad piece of the log.

The following reasons speak in favour of bucking hardwoods right in the stand:

1) Lingering of the old method of complete assortment in the stand.

2) No suitable implements available for extraction and skidding of heavy long stems.

3) That was another reason why heavy boles were difficult to handle during loading, transport, unloading, and their relocation in the yard.

4) The big crookedness of boles does not allow the use of the same machines and facilities that are employed for processing straight boles of conifers. New ones for processing broadleaved long boles do not exist as yet.

5) The reward paid to a lumberman for veneer logs made in the stand may be regarded as a handicap in transferring processing to the yard as well.

If we want to determine the type and place of bucking and assorting of hardwoods — in the stand, near the haul road (forest bucking yard), or central processing timber yard — we have to consider the aspects of silviculture, forest and soil protection, technology, physiology of work, and economics of the whole harvesting process.

When extracting whole long boles sometimes with thick branches, damage to standing trees can be wrought. In this case the boles must be shortened into transport lengths, so called shortened rough stems or multiple — length logs. Extremely short pieces cause a lot of troubles during skidding and hauling and reduce the output even if the most modern machines are used and sometimes may result in greater damage to young trees than long length transport. Other means for limiting the damage to trees and the soil are: suitable preparation of the working site — skidding tracks, guard stems and stumps, guiding logs — the observance of technological rules and working morale during felling and skidding.

From the viewpoint of a lumberman — it is absolutely impossible to use human force for extraction of heavy hardwood logs and billets to the skidding track.

Taking into consideration the preceding analysis we can say that the harvesting method of long length rough stems is well suited for broadleaved timbers even if there is a lack of more experience and economic data. Many foresters, however, are preferrving the complete processing of hardwood at the stump, the economic calculations can show us the right way. The main determinant factors are the costs and productivity of labour. When expensive machines and investments are used, the productivity rises rapidly, but the costs may increase as well.

In the economic calculations all the technologies thrown into competition must be put on the same comparable level.

The calculations can be realized separately for thin timbers from thinnings and for thick timbers or for the whole allowable cut of the area.

Specification of thin rough boles: maximum thickness at the butt end 30 cm, sweep allowance 70 cm for 10 m log, length from 3 m.

Thick rough boles: diameter at the butt end in bark over 30 cm, maximum sweep allowance 1 m for 10 m log, length more than 5 m.

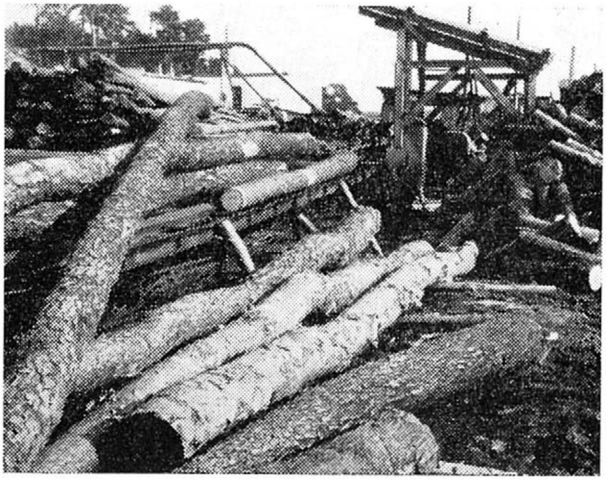
The following calculations were made for an area of a broadleaved forest of 10 900 hectares with annual cut:

in thinnings:	pine	1 191 cu. m.	2.57 %
	hardwoods (oak, ash, elm, poplar, and others)	11 682 cu. m.	22.52 %
	thin wood	12 873 cu. m.	27.74 %
in harvest cutting:	pine	2 796 cu. m.	6.04 %
	hardwoods	30 651 cu. m.	66.17 %
	thick wood	33 447 cu. m.	72.21 %
together:	pine	3 987 cu. m.	8.61 %
	hardwoods	42 333 cu. m.	91.39 %
	totalling	46 320 cu. m.	100.00 %

The pine — sweep and crooked — may be considered to belong from the viewpoint of processing — to broadleaved timbers.

The present technology of harvesting is the production of assortments in the stand, skidding of logs in thinnings and unsorted cordwood mostly by horses and skidding of round wood by agricultural tractors equipped with a winch, chokers and a spray blade. The stacked wood is sorted at the road or in the yard. A small part of the rough stems from thinnings is bucked in the yard, too (1,600 cu. m.).

As the result of our attempts and calculations we have found the possibility of raising the productivity and lowering the costs if the agricultural tractors used in the final harvesting are replaced by special articulated skidders and half the lorries have a hydraulic crane. We would get 3.57 Kčs/cu. m. and 0.45 working hour/cu. m. in skidding and 0.61 Kčs/cu. m. and 0.04 work hour/cu. m. in hauling, although the old harvesting method would continue to be employed.



1. The pine can be ranked to the broadleaved trees according to its crookedness (pine and alder). — Borovici můžeme řadit s ohledem na její křivost k listnáčům

In the following calculations we proceeded from the level of this better technique.

The basic idea is to find optimum of different possibilities and places for stem bucking, where total production costs and working time are minimum

$$C_t = C_f + C_s + C_b + C_h + C_e = \text{min.} \;,$$
$$T_t = T_f + T_s + T_b + T_h + T_e = \text{min.} \;,$$

where C_t – total costs (Kčs/cu. m.),
C_f – costs of felling, limbing, and bucking in the stand (Kčs/cu. m.),
C_s – costs of skidding (Kčs/cu. m.),
C_b – costs of bucking and landing at the road (Kčs/cu. m.),
C_h – costs of hauling (Kčs/cu. m.),
C_c – costs of processing in the yard (Kčs/cu. m.),
T_t – total working time (hours/cu. m.),
T_f – time of felling, limbing and bucking in the stand (h/cu. m.),
T_s – time of skidding (h/cu. m.),
T_b – time of bucking and landing at the road (h/cu. m.),
T_h – time of hauling (lorry transport) (h/cu. m.),
T_c – time of processing in the yard (h/cu. m.).

THE COSTS OF FELLING, LIMBING AND BUCKING IN THE STAND IN THE AREA UNDER EXAMINATION

Thinnings – 26 % of round wood, 74 % of stacked wood.

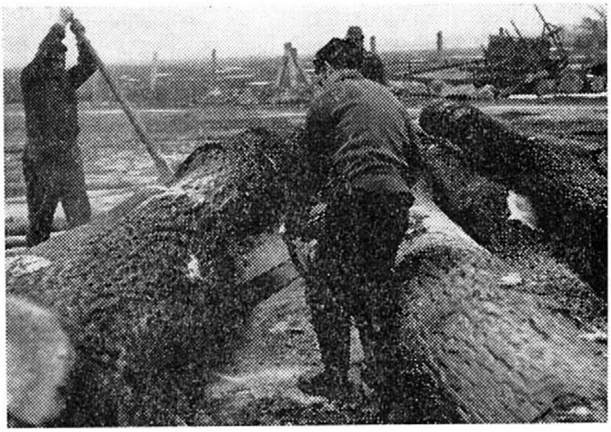
Assortment in the stand:	C_{f1n} = 61.63 Kčs/cu. m.;	T_{f1n} = 4.06 h/cu. m.
Rough stems partially shortened:	C_{f2n} = 44.04 Kčs/cu. m.;	T_{f2n} = 2.90 h/cu. m.
	$f1n - f2n$ = 17.59 Kčs/cu. m.;	1.16 h/cu. m.

Final cut – 82 % of round wood, 18 % of stacked wood.

Assortment in the stand:	C_{f1k} = 29.60 Kčs/cu. m.;	T_{f1k} = 1.95 h/cu. m.
Rough stems:	C_{f2k} = 19.73 Kčs/cu. m.;	T_{f2k} = 1.30 h/cu. m.
	$f1k - f2k$ = 9.87 Kčs/cu. m.;	0.65 h/cu. m.

Average – 28 % of thinnings, 72 % of final cut.

Assortment in the stand:	C_{f1a} = 38.57 Kčs/cu. m.;	T_{f1a} = 2.54 h/cu. m.
Rough stems:	C_{f2a} = 26.54 Kčs/cu. m.;	T_{f2a} = 1.75 h/cu. m.
	$f1a - f2a$ = 12.03 Kčs/cu. m.;	0.79 h/cu. m.



2. When hauling thick stems in the long lengths, a lot of valuable wood can be gained. — Vyváží-li se tlusté listnaté kmeny v celých délkách, může být při manipulaci získáno množství cenného dřeva

THE COSTS OF SKIDDING

The average distance of skidding being 600—700 m.

Thin wood:		
Short assortments:	$C_{s1n} =$ 30.97 Kčs/cu. m.;	$T_{s1n} =$ 1.56 h/cu. m.
Long stems:	$C_{s2n} =$ 26.58 Kčs/cu. m.;	$T_{s2n} =$ 1.34 h/cu. m.
	$s1n - s2n =$ 4.39 Kčs/cu. m.;	0.22 h/cu. m.
Thick wood:		
Short assortments:	$C_{s1k} =$ 20.36 Kčs/cu. m.;	$T_{s1k} =$ 1.02 h/cu. m.
Long stems:	$C_{s2k} =$ 15.83 Kčs/cu. m.;	$T_{s2k} =$ 0.81 h/cu. m.
	$s1k - s2k =$ 4.53 Kčs/cu. m.;	0.21 h/cu. m.
Average:		
Short assortments:	$C_{s1a} =$ 23.33 Kčs/cu. m.;	$T_{s1a} =$ 1.17 h/cu. m.
Long stems:	$C_{s2a} =$ 18.84 Kčs/cu. m.;	$T_{s2a} =$ 0.96 h/cu. m.
	$s1a - s2a =$ 4.49 Kčs/cu. m.;	0.21 h/cu. m.

THE COSTS OF BUCKING AND SORTING AT THE ROAD

Thin wood:		
Assortments:	$C_{b1n} =$ 4.53 Kčs/cu. m.;	$T_{b1n} =$ 0.36 h/cu. m.
Long stems:	$C_{b2n} =$ 13.70 Kčs/cu. m.;	$T_{b2n} =$ 0.64 h/cu. m.
	$b1n - b2n =$ —0.17 Kčs/cu. m.;	—0.28 h/cu. m.
Thick wood:		
Assortments:	$C_{b1k} =$ 1.10 Kčs/cu. m.;	$T_{b1k} =$ 0.08 h/cu. m.
	$C_{b2k} =$ 9.03 Kčs/cu. m.;	$T_{b2k} =$ 0.42 h/cu. m.
	$b1k - b2k =$ —7.93 Kčs/cu. m.;	—0.34 h/cu. m.
Average:		
Assortments:	$C_{b1a} =$ 2.06 Kčs/cu. m.;	$T_{b1a} =$ 0.16 h/cu. m.
	$C_{b2a} =$ 10.33 Kčs/cu. m.;	$T_{b2a} =$ 0.48 h/cu. m.
	$b1a - b2a =$ —8.27 Kčs/cu. m.;	—0.32 h/cu. m.

THE COSTS OF HAULING

The calculation is more complicated. It is necessary to count:

$C_{h1} = C_{h2} =$ the average costs — $T_{h1} = T_{h2} =$ the average time — of transport when the assortments are delivered directly from the forest to the factory or railways (Kčs/cu. m. or h/cu. m.);

$C_{h3} =$ the average costs — $T_{h3} =$ the average time — of transport of long rough stems from the forest to the central processing yard (Kčs/cu. m. — h/cu. m.);

$C_{h1} =$ the average costs — $T_{h1} =$ the average time — of secondary lorry transport from the yard to the factory (Kčs/cu. m. — h/cu. m.).

$$C_h = Cl + C_u + 2LC_g \ ,$$

where Cl — costs of loading in the forest (Kčs/cu. m.),
C_w — costs of unloading (Kčs/cu. m.),
C_g — costs of 1 km drive of the lorry (Kčs/cu. m.),
L — average transport distance (km).

$$C_g = \frac{C_{km}}{M},$$

where C_{km} – cost of 1 km of the trip (Kčs/km),
M – amount of cu. m. in one load.

$$L = \frac{L_1E_1 + L_2E_2 + \ldots + L_nE_n}{E_1{}^n},$$

where E_1, E_2, E_n – annual cut in the hauling area 1, 2, ..., n (cu. m.)
$\varDelta_1, L_2, L_n$ – actual transport distance from area 1, 2, ..., n (km).

For our area:

Thin wood:	$C_{h1n} = C_{h2n} = 30.35$ Kčs/cu. m.;	$T_{h1n} = T_{h2n} = 1.37$ h/cu. m.
Thick wood:	$C_{h1k} = C_{h2k} = 21.17$ Kčs/cu. m.;	$T_{h1k} = T_{h2k} = 0.97$ h/cu. m.
Average:	$C_{h1a} = C_{h2a} = 23.74$ Kčs/cu. m.;	$T_{h1a} = T_{h2a} = 1.08$ h/cu. m.
Thin wood:	$C_{h3n} = 14.93$ Kčs/cu. m.;	$T_{h3n} = 0.61$ h/cu. m.
Thick wood:	$C_{h3k} = 13.03$ Kčs/cu. m.;	$T_{h3k} = 0.49$ h/cu. m.
Average:	$C_{h3a} = 13.56$ Kčs/cu. m.;	$T_{h3a} = 0.52$ h/cu. m.

$$C_{h4} = (Cl_4 + C_{u4} + 2L_{h4}C_{b4})\frac{p}{100},$$

where Cl_4 – costs of loading on lorries in the yard (Kčs/cu. m.),
C_{n4} – costs of unloading in the factory (Kčs/cu. m.),
L_{h4} – average transport distance from the yard to the factory (km),
p – percentage of wood transported from the yard to the factory by lorry (secondary transport).

Thin wood:	$C_{h4n} = 7.94$ Kčs/cu. m.;	$T_{h4n} = 0.14$ h/cu. m.
Thick wood:	$C_{h4k} = 3.38$ Kčs/cu. m.;	$T_{h4k} = 0.06$ h/cu. m.
Average:	$C_{h4a} = 4.66$ Kčs/cu. m.;	$T_{h4a} = 0.08$ h/cu. m.

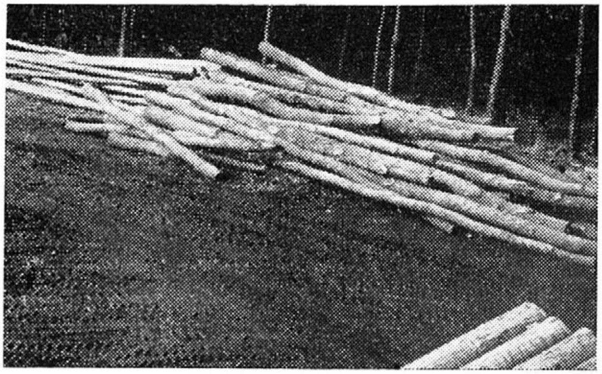
THE PROCESSING COSTS IN THE TIMBER YARD

The total costs of the timber yard should be divided into the costs for bucking and sorting and those for shipping.

The costs are determined from the basic project of the yard, which must be elaborated before the calculations start. The investment and operational costs are very high and the study must be done very carefully and in more variations.

The total costs for one year's operation consist of:

O_1 – depreciation costs and interest from technological investments,
O_2 – depreciation and interest from buildings and engineering constructions,



3. Thin broadleaved trees do not give a high quality yield, but require a lot of troublesome work which can be lowered when working with long lengths. — Zpracování tenkých listnáčů je velmi pracné při malé kvalitní výtěži. Výrobou surových kmenů je možno dosáhnout úspory práce

O_3 – maintenance costs of machines,
O_4 – maintenance costs of buildings,
O_5 – costs of the private siding (rail),
O_6 – price of fuels, lubricants, electricity, etc.,
O_7 – costs of waste disposal,
O_8 – salaries and wages.

$$C_y = O_1 + O_2 + \ldots + O_8$$

where C_y – total costs of the yard (Kčs).

In our area:

$$C_y = 411\,590 + 686\,822 + 60\,510 + 45\,120 + 114\,420 + 141\,000 + 7\,000 + 534\,100 = 2\,000\,562.00 \text{ Kčs/yearly}$$

$$\frac{2\,000\,562 \text{ Kčs}}{46\,320 \text{ cu. m.}} = 43.19 \text{ Kčs/cu. m.}$$

This sum divides into

C_e – expedition by rail = 28.33 Kčs/cu. m.
C_m – processing and grading = 14.86 Kčs/cu. m.

The working time, 9 workers in the bucking and grading process, makes 19 800 working hours: 46 320 cu. m. gives 0.43 working hours/cu. m.

CONCLUSION

Summing up the production costs and time consumption of different methods of harvesting, we are able to compare the economic aspects and estimate what place for bucking and grading of hardwood is optimum.

1. Bucking and grading in the stand:

Production costs:

thin wood: $C_{t1n} = 61.63 + 30.97 + 4.53 + 30.35 = 127.48$ Kčs/cu. m.
thick wood: $C_{t1k} = 29\ 60 + 20\ 36 + 1.10 + 21.17 = 72.23$ Kčs/cu. m.
average: $C_{t1a} = 38.57 + 23.33 + 2.06 + 23.74 = 87.70$ Kčs/cu. m.

Time consumption:

thin wood: $T_{t1n} = 4.06 + 1.56 + 0.36 + 1.37 = 7.35$ h/cu. m.
thick wood: $T_{t1k} = 1.95 + 1.02 + 0.08 + 0.97 = 4.02$ h/cu. m.
average: $T_{t1a} = 2.54 + 1.17 + 0.16 + 1.08 = 4.95$ h/cu. m.

2. Bucking and grading at the roadside

Production costs:

thin wood: $C_{t2n} = 44.04 + 26.58 + 13.70 + 30.35 = 114.67$ Kčs/cu. m.
thick wood: $C_{t2k} = 19.73 + 15.83 + 9.03 + 21.17 = 65.76$ Kčs/cu. m.
average: $C_{t2a} = 26.54 + 18.84 + 10.33 + 23.74 = 79.45$ Kčs/cu. m.

Time consumption:

thin wood: $T_{t2n} = 2.90 + 1.34 + 0.64 + 1.37 = 6.25$ h/cu. m.
thick wood: $T_{t2k} = 1.30 + 0.81 + 0.42 + 0.97 = 3.50$ h/cu. m.
average: $T_{t2a} = 1.75 + 0.96 + 0.48 + 1.08 = 4.27$ h/cu. m.

3. Bucking and grading in the central processing and shipping yard: because of the high investments, the calculation is made for the whole cut — both thinnings and final cut — as an average sum.

Production costs:

average: $C_{t3a} = 26.54 + 18.84 + 0.00 + 13.56 + 14.86 + 4.66 = 78.46$ Kčs/cu. m.

Time consumption:

average: $T_{t3a} = 1.75 + 0.96 + 0.00 + 0.52 + 0.43 + 0.08 = 3.74$ h/cu. m.

Looking at the Table I above we can see that the method of rough stems (long lengths) is more suitable in the area for which the calculation was made than that of assortments produced in the stand. If there is enough money for investments, a central processing and shipping yard should be included into the timber harvesting process.

A remark should be made at the end: the timber yard for processing of rough long stems offers, in addition to the direct savings of money and time, a better working site, possibilities of ready sale and delivery, as well as better prices of roundwood. This makes in our area 30.00 to 35.00 Kčs/cu. m. on the average.

I. Comparison of total costs C_t Kčs/cu. m. — Porovnání celkových výrobních nákladů C_t Kčs/plm

Material processed	Place of bucking			Note
	in the stand	at the road	yard	
1. Thin broadl. timber C_{tn}	127.48	114.67 (+12.81)		*) Better prices for thick wood 30.00 Kčs/cu. m. are not included
2. Thick broadl. timber C_{tk}	72.23	65.76 (+6.47)*)		
3. Average C_{ta}	87.70	79.45 (%8.25)*)	78.46 (+0.99)*)	
Comparison of total time consumption T_{tn} h/cu. m.				
1. Thin wood T_{tn}	7.35	6.25 (+1.10)		
2. Thick wood T_{ta}	4.02	3.50 (+0.52)		
3. Average T_{ta}	4.95	4.27 (+0.68)	3.74 (+0.53)	

SUMMARY

With advancing forest mechanization, a number of new working techniques have been introduced in the logging operations. The objective of the paper was to determine the optimum place of log conversion in a riverine forest area of 10 900 ha, with an annual cutting budget of 46 320 cu. m. It has been found that apart from the time and cost savings that can be obtained by the employment of more productive skidding and hauling equipment (4.18 Kčs and 0.49 hr per cu. m.), the place of log conversion is a controlling factor.

The cost-calculations contained in the summary table of this paper have clearly shown that the optimum place for logbucking and conversion is a central conversion and supply yard which, in addition to other well-known advantages, enables better marketing of roundwood (30 to 35 Kčs/cu. m. more) as a result of improved conversion of big-diameter tree-length logs. Worst is the economy of hardwood bucking and conversion on the felling site.

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Zpracování křivého dřeva na skladech

S rozvojem mechanizace se objevuje řada nových technologických postupů v procesu těžby dřeva. Vypracoval jsem studii, která měla určit nejvhodnější místo manipulace v oblasti lužního lesa s roční těžbou 46 320 plm na ploše 10 900 ha. Bylo zjištěno, že kromě časových a finančních úspor, které je možno získat nasazením výkonnějších přibližovacích a odvozních prostředků (4,18 Kčs a 0,49 h na plm) je rozhodujícím faktorem místo manipulace.

Ekonomické propočty shrnuté v závěrečné tabulce jasně ukazují, že nejvhodnějším místem manipulace je centrální manipulační a expediční sklad, který kromě jiných známých výhod zajistí přesnější manipulací tlustých surových kmenů lepší zpeněžení kulatiny o 30 až 35 Kčs/plm. Nejméně vhodná je detailní manipulace listnatého dřeva v porostu.

Обработка кривой древесины в складах

С развитием механизации появляется целый ряд новых технологических приемов в процессе лесозаготовки. Поэтому я разработал метод, который позволяет определить наиболее подходящее место для раскряжевки в области поименного леса с годовой заготовкой 46 320 $м^3$ на площади 10 900 га. Было установлено, что помимо экономии времени и денег, которую можно достигнуть путем внедрения более мощных трелевочных и транспортных средств (4,18 кроны и 0,49 часа на 1 $м^3$), решающим фактором является место раскряжевки.

В заключительной таблице данной статьи обобщенные экономические расчеты явно свидетельствуют о том, что наиболее подходящим местом для раскряжевки является нижний промежуточный и экспедиционный склад, который кроме других известных преимуществ, обеспечит более точной манипуляцией толстых хлыстов стволов лучшую реализацию кругляка на 30—35,— крон/$м^3$. Меньше всего пригодна детальная раскряжевка лиственной древесины в насаждении.

Verarbeitung von Krummholz auf Ausformungsplätzen

Mit der Entwicklung der Mechanisierungsmittel erscheint im Prozeß der Holznutzung eine Reihe neuer technologischer Verfahren. Es wurde eine Studie ausgearbeitet, die den vorteilhaftesten Ort für die Ausformung im Bereich eines Auenwaldes mit einem jährlichen Holzeinschlag von 46 320 fm auf einer Fläche von 10 900 bestimmen sollte. Hierbei wurde festgestellt, daß außer den finanziellen und Zeiteinsparungen, die durch den Einsatz leistungsfähigerer Mittel für das

Rücken und Bringen des Holzes gewonnen werden können (4,18 Kčs und 0,49 h je 1 fm), der Ausformungsort der entscheidende Faktor ist.

Die in der Abschlußtafel dieser Abhandlung zusammengefaßten ökonomischen Berechnungen zeigen deutlich, daß der vorteilhafteste Ort für die Ausformung des zentralen Ausformungsplatzes in Kombination mit dem Expeditionslager ist, wo außer anderen bekannten Vorteilen durch genauere Ausformung der starken Rohholzstämme ein um 30,00 bis 35,40 Kčs/fm besserer Verkaufswert des Rundholzes erzielt wird. Am ungünstigsten ist die Einzelausformung von Laubholz direkt im Bestand.

Traitement du bois courbé dans les dépôts

A mesure que la mécanisation se développe on aperçoit au cours du processus d'exploitation du bois toute une série de procédés technologiques nouveaux. J'ai élaboré une étude, dont l'objectif consistait à déterminer la place la plus convenable à la manipulation dans la zone de forêt fluviale, dont l'exploitation annuelle se chiffre à 46 320 mètres cubes sur une surface de 10 900 hectares. Il a été identifié qu'outre l'économie de temps et d'argent qu'on peut obtenir en employant les moyens de débardage et de transport plus puissants (4,18 Kčs et 0,49 heure par 1 mètre cube), c'est l'endroit de la manipulation qui constitue le facteur décisif.

Dans le tableau final du présent traité les calculs économiques résumés montrent clairement que c'est le dépôt central de manipulation et d'expédition qui est le lieu le plus convenable pour la manipulation, pouvant en effet assurer, entre autres avantages déjà connus, une manipulation plus précise des tiges brutes épaisses et une meilleure réalisation du bois rond, et cela de 30 à 35 Kčs par 1 mètre cube. C'est la manipulation détaillée du bois des essences feillues dans le peuplement qui est la moins convenable.

The author's address:

Prof. Ing. František Piškula, C. Sc., lesnická fakulta VŠZ, Brno

TOPICAL NEWS

VYSKOT M. ET AL.: PRINCIPLES OF FOREST GROWTH AND PRODUCTION (ZÁKLADY RŮSTU A PRODUKCE LESŮ). 1971, PRAGUE

This is a college textbook covering the subject matter in line with the curriculum approved by the Ministry of Education on "analytical silviculture" and "forest yield science". This is also the first comprehensive publication on forest tree growth and production in Czechoslovak forestry literature. It is a collective work by our foremost college professors, basing largely also on latest European publications on the subject, yet to a considerable extent have the authors approached the problem with full regard to Czechoslovak research and scientific achievements in the field in question, particularly to their own publications on the subject.

The textbook is divided in six major parts:

The first chapter Biology of forest tree growth and production was authored by Asst. Professor J u r č a. It contains description of the tree anatomy, nutrition, and growth, as well as detailed information on stand structure and growth. The chapter deals also with forest stand ecology from the viewpoint of light, temperature, water, air, and soil requirements.

The second chapter Primary productivity, biomass production, and silviculture was compiled by Professor V y s k o t. It is concerned both with investigations into primary productivity of forest ecosystems, representing nowadays a newly developing forest science branch promoted mainly within the research projects under the International Biological Programme carried out also in Czechoslovakia. Described are here the problems of biomass production and the methods of its measurement and analysis; also certain results on the on-going International Biological Program research are reported. More attention has been paid to long-term or permanent experimental plots, especially to the operation of the thinning trial plots. In great detail have been dealt with the Czechoslovak and foreign thinning experiment procedures, including the IUFRO one. Analyzed have been also the problems of stand tending effects on forest stand production and forest environments.

The third chapter Growth, Increment, and Shape of Forest Trees was elaborated by Asst. Professor K o r p e ľ. It contains information on height, diameter, and volume increment of individual forest trees, as well as on their shape. A separate section is devoted to position of individual trees within forest tree associations and to formation of tree-classes. Various systems of tree classification are described.

The fourth chapter Forest stand development — growth changes in time was written by Professor P r i e s o l. It contains findings on changes of basic stand characteristics (number of trees, diameter, height, basal area, volume) for evenaged pure stands, for evenaged mixed stands, and for unevenaged mixed ones (the shelterwood and selection forests). There is a special study on forest stand productivity in relation to site, namely the mensurational yardsticks of stand site-class and the types of site-class grading. The chapter comprises also a section dealing with the development of virgin and natural forests.

Professor K o r f authored the sixth chapter on the Laws governing the growth of forest stands, dealing thoroughly with the theory of growth functions and with their mathematical formulation, mentioning specifically the growth formulas designed by Czechoslovak (van der Vliet, Korsuň, Korf) and foreign (Backman) researchers. There is a mathematical analysis and justification of forest growth functions and a treatment on their practical utilization. A study of yield tables compilation methods was written by Dr. Řehák.

The last chapter Application of forest tree and forest stand growth functions to forest management and silviculture was written by Professor Doležal and his collaborators. This is a summary of knowledge on the effects of silvicultural form, silvicultural system, and stand tending on the formation of pure and mixed forest stands of various tree species. A special part is devoted to year-ring analysis and dendrochronology.

Despite of the great advantages of the collective preparation of this textbook, this is also the very reason for certain shortcomings of it. In the first place, the authors have not specified clearly in advance the contents and extent of individual chapters, this being obvious namely from the easily recognizable over-lappings of the subject matter, i. e. treatment of the same problems in several chapters.

It is however necessary, irrespective of the above objections, to stress rightly that the textbook is the first comprehensive publication on forest yield and productivity in Czechoslovakia (440 pp., 172 Fig., 109 Tab.). It is suitable not only as college textbook but also as a major reference source for forestry scientists and researchers who will find in it a full information on the present knowledge in the field.

Prof. Dr. Ing. Ján Halaj, Dr. Sc., Výskumný ústav lesného hospodárstva, Zvolen

FIFTY YEARS OF FORESTRY RESEARCH IN CZECHOSLOVAKIA

FORESTS AND FORESTRY IN THE DEVELOPMENT OF OUR SOCIETY[1])

The development of human society at the very beginning of the scientific and technological revolution has posed also entirely new problems to forestry. Higher productivity efforts induced by shortage of forest labour, projections of increasing timber demand, rapidly rising needs of the nations for water, recreation and protection against the adverse civilization effects have introduced in forest management approaches many new, sometimes contradictory elements and have created a number of problems that cannot be resolved in isolation.

Conservative features of forestry, determined primarily by exceedingly long production cycle, make it imperative to consider carefully and with full responsibility all the relevant factors and to analyze objectively the entire problem coverage from a long-term point of view.

The collection of lectures delivered at the Conference of Forestry and Game Management Research Institute, Zbraslav-Strnady, on the 50th anniversary of forestry research origins in Czechoslovakia, represent the contribution by the country's Forest Research Institutes to this most timely priority of forest management.

After the opening speech by Ing. L. Hruzík, Czech Minister of Forests and Waters, two lectures were delivered dealing with problems of present forest management from the viewpoint of historical development and future needs of the nation:

Samek V.: Changing ideas about the role of forests and forestry

Papánek F.*: New approach to forest management objectives — multi-purpose forestry

The following series of lectures deal

[1])Collection of lectures delivered at the Conference of Forestry and Game Management Research Institute, Prague, held on September 28-29, 1971 (Forestry and Game Management Research Institute, Zbraslav-Strnady, Czechoslovakia, 412 pp.)

with changes in forest management objectives due to social development, with the natural resource forest function in the environment, and with the role of forestry in the formation and conservation of human habitats:

Materna J.: Development of production resources and forestry

Krečmer V.: Hydrological role of forests

Mráček Z.: Forest recreational value assessment

Samek V.: Forest and countryside

Zachar D.*: Forest influences

The third group of subject matter lectures is devoted to wood consumption trends, potential forest productivity and ways to higher production of timber, to reduction of production losses, as well as to certain new social factors discussed in the second lecture section.

Bluďovský Z.: Wood consumption trends

Řehák J.: Analysis of Czechoslovak forest resources

Vinš B.: Biological foundations of wood production

Peřina V. et al.: Some aspects of silvicultural research in Czechoslovakia

Šindelář J.: Potential raising of forest production by tree species choice and improvement

Holubčík M.* et al.: Possibilities of wood production increase in Slovakia

Novák V.: Modern tools of forest protection for control of harmful biotic agents

Bozděch J.: How to minimize the logging and wood processing losses

Other lectures were concerned with the possibilities of practical application of the principles of multi-purpose forest management in the near future and in long-term conceptions of forestry development, particularly with the choice of silvicultural systems embracing a full range of the silvicultural and forest management procedures ensuring in differentiated ways the multi-purpose objectives of forestry, and with the impact of the above changes on forest economics and forest administration:

Nymburský B.: The concept of multi-purpose forest management

Greguš C.*: New trends in forest management

Peřina V.: Problems of choice and application of silvicultural systems

Štaud V.: Choice of silvicultural systems for multi-purpose forestry and new technology

Novotný M.: Economic aspects of new social needs and their satisfaction by forestry, forest administration and policies under new conditions

In a concluding lecture, the Director of the Forestry and Game Management Institute, Zbraslav - Strnady, Ing J. Jindra, C. Sc., summarized the major priorities of forestry research to be observed towards achievement of the planned development objectives.

With regard to the fact that the syllabi of the lectures had been discussed and improved by the Editorial Board, they do represent in fact the opinion of the Institute on the subjects dealt with. Since also the research officers of the Forest Research Institute Zvolen (marked *) were invited to deliver lectures aimed specifically at forestry conditions in Slovakia, the Conference covered virtually forestry problems of the whole country. The lectures were then supplemented by discussions and comments, icluded too in the Conference Report.

The lectures delivered at the Conference have provided a review of the basic factors that are likely to play a major role in the development of forestry in Czechoslovakia, and that may thus also influence long-term planning. In contrast to previous, mostly general considerations, the first estimate has been obtained of the extent of forest areas where other forest functions will be more prominent than wood production. From this figure can be derived the potential scope for the application of new silvicultural and logging techniques complying with the imperative forest labour saving requirement, and with maintenance or raising of wood production. The lectures have shown that even full sactisfaction of wider and much more varied needs of the present and future national community will leave in general a very big room for the employment of advanced technology in Czechoslovakia's forestry. The above conclusions result, however, from an extrapolation of the present wood consumption trends, and it is only natural that detailed long-term planning will necessitate mutual balancing of all the basic factors in various alternatives corresponding to their limit or mean values.

The lectures have also shown that even in the future there will be certain reserves enabling both to increase wood production and to manage our forests in a way resulting in certain water management benefits and in better utilization of the forest recreational potential, this requiring however certain technical, organization, and economic measures. An analysis of the country's forest resources has revealed that in the coming decades the actual timber removals will be growing, this circumstance being of greater significance to this country because the cut increase culmination will roughly occur in the period (end of the millenium) when according to the latest FAO estimates a considerable shortage of wood is likely to be expected on world-wide scale. The latter forecast should be also confronted in detail both with the opening possibilities of higher wood production by choice of optimum species composition, by utilization of tree breeding and improvement, by forest soil amelioration and fertilizing, and with the factors that may lead to production declines, i. e. occupation of forest land by housing projects, and in the first place with increasing air pollution that obviously will affect extensive forest areas. For a similar confrontation, the Conference's lectures have provided at least the necessary background facilitating long-term forestry projections.

On the whole, the lectures and discussion submitted at the Conference represent a major contribution to the very timely problem of forestry objectives and trends in the period of stormy development of science and technology, as well as of all mankind. Because of the time limitations was it impossible to investigate deeper a number of industrial relations, and equally impossible was it to deal thoroughly with all aspects of forestry. In spite of the wide approach, necessary for such a synthetic evaluation, or because of it, a number of questions and issues have been only raised but left unresolved. Nevertheless, even this inventory of the factors govering forestry development and their likely future trends do constitute a good basis for long-term forestry planning. It goes without saying that the discussion on the subject has not ended by the publication of this Collection.

The participants in the Conference have approved a final resolution the text of which is given below in full:

Resolution

On September 28—29, 1971 a Scientific Conference was held in Prague to celebrate the 50th Anniversary of Forestry Research in Czechoslovakia, on the subject Forests and Forestry in the Development of Our Society, organized by the Forestry and Game Management Research Institute, Zbraslav-Strnady.

Forestry of this country stands presently at the very beginning of a new, qualitatively different developmental stage, which is characterized by the increasing demand of the nation for higher wood production and by additional demands for other benefits and influences the forests can offer. In contrary, further developments of industries and human civilization in general put to some extent in jeopardy the very existence of our forests and limit the freedom of foresters in the choice of optimum solutions. At the same time, new scientific findings accumulated in the course of the technological revolution do open new significant possibilities for application to forest management.

From the above developments conclusions must be drawn which, in line with the resolutions of the XIV. Congress of the Czechoslovak Communist Party, will play a major role in further management of the country's forest resources, and simultaneously in their utilization towards creation and conservation of our living environmets. To orientate Czechoslovak forest management quickly to this development is the decisive task of the nearest future. A necessary prerequisite is, however, a clarification of the relationships of forestry with other sectors of the national economy, and a thorough analysis of all consequences that will result from their further expansion.

The lectures delivered and the comments have resulted in the following:

1) With regard to the growing demands of the nation for forest benefits must increasing production of high-quality timber and a simultaneous improvement of other services to man be considered the foremost priority of forest management.

2) In the environmental and economic conditions of this country, of the protective influences of the forests their hydrological role must be regarded all-important, of the social influences their health and recreation functions.

3) In the above connection is it necessary to re-examine the existing forest classification from the viewpoint of the prevailling management objective, i. e. with regard to the environmental conditions, technological and economic factors, and the projected development of the nation's demands.

4) In line with the abovenamed conclusions has already been formulated the State Plan of Scientific and Technological Research 1971—1975, and a com-

parison of the State Plan with the Resolution of the XIV. Party Congress has resulted in the necessity to direct forestry research towards providing quickly the background information, though incomplete, required for accelerated classification of forest areas by management objectives, for differentiation of the silvicultural systems, for conservation and improvement of man's living environments.

5) To this end it is necessary to co-ordinate better the work on all forest research projects, including international co-operation, particularly with the COMECON countries. In co-operation with the basic research establishments is it necessary to promote early application of new basic findings, especially in the biological sciences.

6) A necessary prerequisite of practical utilization of forest research results is closest co-operation of forest research with forest management, namely in the field of forest classification, and differentiated management with regard to the multi-purpose management objectives.

In addition is it necessary to secure the participation of other bodies and organizations concerned with nature and living environment conservation and improvement.

It is desirable that in line with the new findings on special-purpose forest management the abovenamed problems be given corresponding attention in the curricula of all Czechoslovak forestry schools.

Ing. Bohuslav Vinš, C. Sc. et al., Výzkumný ústav lesního hospodářství a myslivosti, Zbraslav - Strnady

SEVENTH WORLD FORESTRY CONGRESS OCTOBER 4—18, 1972. BUENOS AIRES, ARGENTINA

Foresters from all corners of the world will be meeting this fall in Buenos Aires, to discuss the achievements and shortcomings of the past, and to work out projections and decide on sound future policies in the field of world forestry.

Typically, the general theme of the Seventh World Forestry Congress is "Forests and Social Economic Development", which has been a major concern of both dedicated and far-looking foresters and all nature conservationists and economists concerned with mankind's future and living environments in this age of technological revolution.

According to the Congress organizers, four general objectives will be governing its programme and sessions: sound world forestry projections must be based on a thorough knowledge of the present trends and of the society's basic needs; exchange of ideas and experience is essential towards achieving of the above goal; foresters from abroad will, be having a chance of becoming acquainted in detail with the tremendous forest potential of Latin America and with the relevant problems; this will be an excellent opportunity to meet personally and to strenghten the human contacts which are of vital importance.

The Programme of the Congress will consist of several phases, Plenary Sessions, and sessions of the seven Technical Commissions, of an Open Forum, and a number of Tours and Excursions, apart from informal and other meetings. Without going into details, the first Congress phase entitled "The Global Assessment" will be devoted to the evaluation of the last six years in world forestry, and the other phase called "The Political Synthesis" will be concerned with discussions and considerations of the action priorities during the next six-year inter-Congress period. Apart from the above two topics, the endless range of specialized subjects and problems will be taken up by the seven Technical Committees (Silviculture, Forestry Education, Forest Conservation and Recreation, Forest Logging, Forestry Research, Forest Economics, Administration, and Planning, Forest Industries) and the Open Forum Commission. On the agenda of them will be all the well-known priorities and burning problems of forestry in the developed and developing countries — the order of which is impossible to define.

A very important event will be the Plenary Session held on October 11, 13, and 14, on the "Contribution of the Region to the Congress", providing a rare opportunity to the world forestry public of becoming informed about the vast forest resources of Latin America, and about the formidable problems of their sound management.

A coronation of the Congress activities will be its final Plenary Session dealing with "A Plan of Action for the Next Six Years", and approving "The World Forestry Congress Declaration of 1972". No doubt the two headings represent a tremendous coverage of forestry problems, providing however also a convincing evidence that the problems of world forestry development and mankind development in general have become a major concern of all countries of the world and can be resolved only by way of co-operation on an international basis.

We only wish that the Seventh World Forestry Congress be another step forward towards the implementation of its ultimate goal — conservation and utilization of the world's forest resources and their influences to an eternal benefit of all mankind.

Ing. Miroslav M a r t i n ů, Institut tropického a subtropického zemědělství VŠZ Praha-Suchdol

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LESNICTVÍ No. 1—2/1971

THE FOREIGN LANGUAGE VOCABULARY OF SPECIAL FORESTRY TERMS

Years ago the scientific magazine Lesnictví (Forestry) started the difficult but meritorius work in compiling partial terminological foreign language vocabularies according to the various departments of forestry. This often very difficult task in its partial form has been virtually finished in 1970. In this way a quantitative base of a summary vocabulary of forestry has been gathered to be subjected to expert lectoring and arranged into a summary vocabulary of cca 3500 basic terms of the main forestry departments in the Czech, Slovak, Russian, English, German, French and, where possible, Spanish languages.

36 expert and linguistic specialists with assistants participated in the elaboration of the foreign language vocabulary of special forestry terms for the scientific magazine Lesnictví.

We are therefore offering a foreign language vocabulary to the expert forestry public with the wish that it may be a useful aid for its work and contact with scientific workers on the international scale.

We wish to point out to interested parties abroad that the terms have serial numbers and there has been published the English index. By the end of this year will appear also the German index.

Price of the dictionary is 24,— Kčs, price of the English index is 8,— Kčs.

Orders should be sent to the following address:

Institute of Scientific and Technical Information, Slezská 7, Praha 2

LESNICTVÍ Č. 1—2/1971

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