FOREST RESEARCH WORK IN FINLAND

THE ORIGINS
AND DEVELOPMENT OF FOREST RESEARCH WORK

AND

A REVIEW OF THE INVESTIGATIONS CARRIED OUT
UP TO DATE

BY

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Preface.

The results of the forest research work carried out in Finland have been published for the most part in Finnish (with German summaries) or in German, which has rendered it difficult for the Anglo-Saxon world to take cognizance of them. It has, therefore, appeared necessary to compile a short review, in English, of the origins and development of forestry research in Finland, and of the investigations carried out hitherto. The present publication attempts to serve this purpose.

Of course, in a brief sketch like this it has not been possible to pay attention, to any great degree, to quite small studies, published, for instance, as articles in periodicals. Likewise such earlier investigations, particularly the smaller ones, as at present possess only a historical value, if even that, have mostly been left unmentioned.

In the review itself the titles of the investigations have been given in English translations, but in the catalogue at the end the title of each publication is easily found in its original language, as well as other particulars, such as the series of the transactions (as well as the volume) in which a publication is contained, the year of publication, the number of pages (and tables, plates, maps and other appendices), and when an investigation is furnished with a summary in English, French or German, the number of pages of the summary is also stated.

Helsingfors, May, 1926.

The Author

Contents.

Abbreviations.

A.F.F. = Acta Forestalia Fennica.
A.S.F.F.F. = Acta Societatis pro Fauna et Flora Fennica.
Cs.I.F.F. = Communicationes ex Instituto Quaestionum Forestalium Finlandiae editae (Publications of the State Forest Research Institute of Finland).
Erikoistutk. = Erikoistutkimuksia
Specialund. = Specialundersökningar } »Special Investigations» published by the Finnish Forestry Association.
F.F.M. = Finska Forstföreningens Meddelanden
S.My.J. = Suomen Metsänhoitoyhdistyksen Julkaisuja } (Proceedings of the Finnish Forestry Association.)
Mets. Aik. = Metsätaloudellinen Aikakauskirja—Forstlig Tidskrift (Review of Forestry).

The Origins and Development of Forest Research Work in Finland.

The Early Stages.

Young as *purposeful* forest research work in Finland is, the importance of the scientific interpretation of forest and forestry questions was, nevertheless, recognized very early. The first, although very modest, attempts in the field of forest research work were made during the eighteenth century already, during the so-called economic or utility period, the distinguishing characteristic of which was the raising of the standard of living and the improvement of economic conditions in the country. Especially professors P. KALM (Professor of Economics from 1747) and P. A. GADD (Special Professor of Chemistry and Economics from 1758, later regular Professor of Chemistry and Director of Plantations) of the University of Turku, and their numerous pupils, published several treatises on native and foreign species of trees and on subjects in the domain of silviculture and forest utilization. KALM and GADD also carried out in Turku and its vicinity experiments with the cultivation of foreign tree species especially of American ones, the seeds of which KALM brought with him in great numbers, when he returned home from his research voyage to North America (1747—1751). These investigations and cultivation experiments — measured according to modern standards — did not, however, have any great scientific or practical value worthy of mention, interesting as they are from the historical point of view. The interest that was awakened in economic investigations by KALM and GADD relaxed rapidly during the time of their followers and the experimental plots which they had established, and which the extraordinarily severe winters treated roughly, became dilapidated.

Not until the middle of the last century, in connection with the amendment of the forest laws and the arrangements for establishing a State forest service as well as the planning of a higher forestry education, did interest again become centred in forestry investigations and experiments, too. Thus, in the first regulation of 1859 for the Forest Service the establishment of a »model park» was laid down in each province, wherein was to be effected »concomitantly with management the provision of foreign tree species for naturalization in our country, and the chemical and mechanical treatment and manufacture into tools of the raw materials of the forest». Likewise, in the first regulation of the Evo Forest Institute, ratified in 1860, it was prescribed that this first forestry school of Finland should institute cultivation experiments with native and foreign tree species in the forest assigned to it as an instruction forest.

The establishment of model parks was not realized in practice; but, on the other hand, experiments were started in the Evo instruction forest. During the first years of operation of the Forest Institute comparative experiments were made in forest seeding and planting methods, and a few years later experiments were started for the formation of woods by aid of cultivation by burning. The latter-mentioned method afterwards came into relatively general use at Evo, and became usual elsewhere in Finland as well. The experiments with foreign tree species, implied in the regulations, were also started during the eighteen-sixties. First, for experimental purposes the European and Siberian larches *(Larix europaea, L. sibirica)* were taken with which a certain amount of previous experience existed in Finland *, and insofar as seeds of other species of trees became available from foreign countries the experiments were conducted with more numerous species: during the eighteen-seventies with *Pinus cembra sibirica* and *Abies sibirica;* during the eighties with *Abies balsamea* and *A. pectinata*, *Pinus strobus* and the oak *(Quercus pedunculata)* which was not a native of Evo; during the eighteen-nineties with *Pinus montana* and *Picea alba* and a few other North American species, certain Japanese tree species, etc. Already during the eighteen-sixties and seventies prunings and thinnings, as well as various reproduction cuttings were practised, and during later times the drainage of swamp lands was instituted.

* In 1738—1921 the well-known larch forest of Raivola had been established by order of the Russian Government, and in the eighteen-forties two larch forests had been established by private interests.

It is to be regretted that the results of these experiments were scarcely ever published, unless we take into consideration a few reports of a more or less temporary character that were made public in the publications of the Finnish Forestry Association (Finnish: Suomen Metsänhoitoyhdistys). Only after the closing of the Evo Forest Institute in 1908, in some investigations, descriptions were given of the results of cultivation experiments with foreign tree species and of burn culture.

The Evo Forest Institute was closed from 1866 to 1874 for lack of students, and when the Institute was re-opened after this eight year period of inactivity the instruction was considerably restricted: »the higher scientific subjects of study» were ordered to be excluded and the instruction from henceforth had to be mainly along practical lines. In some measure, this compulsory lowering of the scientific standard of instruction, combined with other factors, primarily the remote location of the Institute, was instrumental in preventing the Evo Forest Institute ever becoming a centre of forest research work. A few meritorious investigations, however, came from the pen of Dr. A. G. BLOMQVIST, the Director of the Institute for many years, of which the most important are: the fairly original yield tables *Yield Tables, Showing the Development of Even-aged, Fully-stocked Pine, Spruce and Birch Stands* [1] (1872, in Swedish *); *A Treatise Describing the Diameter Growth of Pine and Spruce Saw Timber in Different Parts of Finland* [2] (1897, in Swedish); and two valuable monographic studies describing the principal tree species of Finland, *The Tree Species of Finland Described from the Forestry Point*

* Later, T. HEIKKILÄ re-compiled these tables and published them under the title *Yield Tables for our Principal Tree Species: Pine, Spruce and Birch* (Erikoistutk. 2, 1914, 35 pages. In Finnish).

of view: I. The Pine, II. The Spruce[3] (1881 and 1883, in Swedish), as well as a study in forest politics, *Forest Economics and Points in Forest Policy*[4] (1893, in Swedish). All these publications, however, had a more or less temporary character. An even more incidental meaning is attributable to the minor investigations which the instructors of the Institute, Messrs. K. O. ELFVING, K. T. NYHOLM, Y. E. RAINIO and others published. * Mr. J. I. LIRO (LINDROTH) who was the natural science lecturer of the Forest Institute during its last years, published a few important plant-pathological investigations which were directed either altogether or partly to the destructive fungi of forests.

A certain number of forestry experiments and investigations, even though mostly fairly unpretentious, were made at the Mustiala Agricultural Institute, where an agricultural experiment station was operating for two decades from the year 1881. The experiments were made in the forest department of the experimental station by the forestry instructors of the institute, Messrs. A. BORENIUS, TH. CANNELIN and L. STENBÄCK. These experiments, the results of which were partly published in the »Bulletin of the Board of Agriculture» and partly in forestry periodicals, were mainly concerned with the temperature conditions obtaining under different species of trees compared to the temperature of forestless soil, the effects of clearing on the growth of sprouts, the significance of thinnings, burn culture, the cultivation of foreign tree species, the effects of the soil-covering on the germination of the seeds of trees, the detrimental effects of grazing, tar-distilling, the heating efficiency of different species of trees, etc.

Certain experiments belonging to the sphere of silviculture, such as the reafforestation of clearings on burned heaths, cultivation experiments with foreign tree species, swamp drainage, etc., were instituted by the Board of Forestry already during the eighteen-sixties and seventies in the State forests in different parts of the country. The results of the

* The same may be said of the contemporary small articles published by certain forest officers, of which may be mentioned ALBERT SIVÉN'S numerous writings on the cubing and growth of trees.

reafforestation experiments were described by Messrs. T. J. BLOMQVIST and K. O. ELFVING.

We can also not refrain from mentioning that several investigations were made already some decades ago in the field of certain sciences closely allied with forestry, which are of importance to forest sciences as well. Especially worthy of mention are: Professor J. P. NORRLIN's researches in plant geography *, from which developed forest and swamp type investigations carried out later in Finland and which have attained an important scientific and practical significance in forestry; Professor A. O. KAIRAMO's (KIHLMAN) valuable investigation, *Plant Biological Investigations from Russian Lapland*[5] (1890, in German.), in which such fundamental questions in forestry as forest limits against tundras are considered, and Professor THEODOR HOMÉN's night frost investigations **; which apply in the first place to agriculture, but also have ar important silvicultural meaning. Besides these, certain botanical publications of Messrs. HJALMAR HJELT and R. HULT deserve to be mentioned, especially HJELT's *Conspectus Florae Fennicae*[6] (1888—1926) and *The Distribution of the Trees, Shrubs and Dwarf-shrubs in Finland with Special Regard to their Limits*[7] (1897, in Swedish) as well as HULT's *The Distribution of the Ligneous Plants in Finland*[8] (1896, in Swedish) and *Plant Geographical Notices from the Forest Regions of the Finnish Lapland*[9] (1898, in Swedish). The fungus investigations of P. A. KARSTEN ** also have a significance for the knowledge of the destructive fungi of forests.

* The most important of these investigations, which originally appeared in Swedish, were published in German after the death of NORRLIN, by order of the Society of Forestry in Finland in Acta Forestalia Fennica, volume N:o 23. The same volume contains A. K. CAJANDER's review of the life work of NORRLIN in the form of a memorial address, and CAJANDER's paper, *Einige Hauptzüge der pflanzentopographischen Forschungsarbeit in Finnland* (Some Main Features of the Plant Geographical Research Work in Finland). See also CAJANDER's: *Ein pflanzengeographisches Arbeitsprogram in Erinnerung an Johan Petter Norrlin* (A Plant Geographical Working Program in Memory of Johan Petter Norrlin), A. S. F. F. F. 49: 4, 1921.

** Appeared in the publication serial of the Finnish Society of Science.

The Transfer of Higher Forestry Education to the University of Helsinki and the Establishment and Work of the Society of Forestry in Finland.

It has been mentioned in the foregoing that the Evo Forest Institute was closed in 1908. A few years previously, additional instruction staff had been granted to the Institute, so that the instruction could be made more diversified; but these measures were only temporary, as the days of the Institute were already numbered. For it had become apparent that it was extremely difficult to attach a sufficient number of capable instructors permanently to such an out-of-the-way wilderness as Evo, in addition to which the equipping of the Institute with satisfactory instruction and investigation facilities also met with great difficulties. The thought slowly ripened and gained an increasing amount of general support that higher forestry education should be transferred to the University of Helsinki, which, because of its location in the capital city, in this respect had altogether different advantages to Evo. This idea, for which, too, the Director-in-Chief of the State Forestry Department of that time, Mr. P. W. HANNIKAINEN, worked ardently, was eventually realized in 1908.

The transfer of higher forestry education from Evo to Helsinki had an important bearing not only on such education and through it on the forestry of Finland, but also, in some measure directly and in part indirectly, for the forest research work of Finland, to which possibilities of development were thus opened for the first time. Both the teachers and the students were thus removed from the cramped and isolated surroundings of Evo to the comparatively broader scientific environments of the University City, where possibilities of intercourse with students of other sciences existed. In addition to the mainly professional library of the Forestry Institution of the University, the relatively well equipped library of the University, as well as the valuable libraries of several scientific societies and institutions were at their disposal. The interest in the deeper study of forestry, and in connection with it in independent forestry research work, was stimulated by the fact that it was possible, besides completing the forestry course and

examinations for the preparation of forest officers, also to take the examinations for the Master and the Doctor degrees in forestry. The immediate stimulating effects upon forestry research work from the transfer of higher forestry education would, however, not have been felt as soon as they were, if the first incumbent of the professorship in forestry had not been a person who had highly special qualifications for the position, special lecturer Dr. A. K. CAJANDER, who for a short time at Evo already had been engaged as a lecturer and a temporary director of the forest institute. He had received a many-sided and thorough education in natural sciences and forestry, both at home and abroad, and during his extensive research journeys in Europe and Asia he had become acquainted with both cultivated forests and primeval natural forests, in addition to which he possessed a rare ability for inspiring his pupils for scientific research work and for keeping this enthusiasm alive and directed into proper channels.

Indirectly, the transfer of higher forestry education from Evo to Helsinki stimulated forestry research work through the fact that this change also brought about the establishment of a special scientific forestry society in Finland.

Professor CAJANDER, on whose initiative this association, the Society of Forestry in Finland (Finnish: Suomen Metsätieteellinen Seura) was established, states the following reasons for its organization: *

»Those persons, to whom the representation of forestry in the University had been entrusted, felt the obligations of their duties too heavily to venture to carry them alone. There were altogether too many unexplained problems, so that they alone could not find sufficient time for the study and solution of these questions; additional forces were needed. The Geographical Society of Finland as an example seemed to point in which direction it should occur. Scientific work is practised

* A. K. CAJANDER: *A Review of Forestry Research Work in Finland* (Discourse, delivered at the tenth annual meeting of the Society of Forestry in Finland). Contained in the publication: Suomen Metsätieteellisen Seuran toiminta 1917—1920 (The Work of the Society of Forestry in Finland, 1917—1920), A.F.F. 14, 1920, p. 59—68 (in Finnish).

by many others besides those who are professional scientists; for, finally, what else is scientific work but the critical elucidation of problems as they appear. — — — It seemed desirable to marshal together those forces that in different directions, and often without knowledge of each other, were working for the same, common ends.

But there were other reasons as well. Above all, experience had shown that scientific societies have a very important educational meaning. Young novitiate scientists have occasion to hear lectures from the most diversified branches of their science at scientific associations, and thus to obtain numerous new incentives. There they have occasion to present the results of their studies to others as well, to obtain their approval, and when necessary, criticism from other sources than from their own instructors. Such things are conducive to continued and still better investigations. — — —»

After the question of establishing a forestry society had first been discussed in private circles, the constituent meeting was held on April 29th, 1909. According to the statutes adopted, the purpose of the Society of Forestry in Finland is: »to work for promoting the development of forestry in Finland by being the connecting link between those persons who investigate forestry and its principles in the country, and its relation to other branches of economics». This purpose was to be achieved especially by: 1) gathering information pertaining to the field of activity of the Society from the different parts of the country; 2) granting assistance for forestry experiments, excursions, research journeys, and other forestry investigations; 3) issuing publications, and 4) holding meetings.

At the commencement of the activities of the Society of Forestry in Finland its working forces were very few in number; but this deficiency dissappeared in time, especially after the Society commenced to get diligent members from among students in forestry circles, who were inspired in forestry research work. The lack of funds was of a much more serious character, and it embarrassed the activity of the Society to a very great measure during the first years. For the Russian Government of that time refused to recognise the repeated petitions of the Society for State support, such as other scientific societies received for

their work; and since the Society was young and relatively little known, no financial assistance was to be had from private sources either. During the first years in these circumstances no scholarships could be granted to young scientists, for instance; nor could even the manuscripts be published that were submitted to the Society. If Professor CAJANDER — who during these difficult years with unrelaxing energy kept the interest in forestry research work alive in the circles of the Society, looked after the programs for the meetings of the Society, and tirelessly searched for subsidiary resources for it — had not been elected as the first secretary of the Society, its work undoubtedly would have become completely paralyzed. With trust in the dawn of better times, the work of the Society was continued uniterruptedly, even though in a very unpretentious form, mainly by gathering together for meetings several times a year, where lectures were given in forestry and other allied sciences.

Not until 1913 did the economical position of the Society begin to improve owing to the efforts of the Secretary. During this year the Society was granted Fmks. 3,000 from the LÄNGMAN Endowment Fund which is administered by the Diet. A little while before, the Government had granted the Society permission to print their more important publications free of charge in the Government printing office. It thus became possible for the Society to make public the first two volumes of its publication series, *Acta Forestalia Fennica*. During the same year the Diet petitioned that Fmks. 14,000 ($ 2,617. —) should be annualy appropriated from the State funds for the use of the Society. Although this petition was disregarded in high places, it nevertheless had the encouraging significance that the Diet had acknowledged the importance of the Society's work. The Government also considered it possible to recognize the Society by including a Fmk. 1,000: — appropriation for the Society in its budget. In spite of the repeated petitions of the Society, this small state support was not increased later, as long as the Russian Government forces were in power in Finland. A great help to research work during these difficult times was the fact that the Director-in-Chief of the Board of Forestry, P. W. HANNIKAINEN, at-

tempted to arrange opportunities for research work for young foresters in connection with their regular duties as far as it was possible.

In 1914 the Society received Fmks. 25,000: — from the Endowment Fund of Trade-councillor O. A. MALM for the preparation of growth and yield tables for the main tree species of Finland, and two years later certain companies in the wood-working industry donated Fmks. 10,000: —. Broader fields of operation opened up now to the Society for the first time. In addition to being able to print a few *Acta* volumes again, it also became possible for the Society to commence the printing of the minutes of its meetings including summaries of lectures, and to grant fellowships for forestry research work as stipulated in the statutes. An even happier turn of events was brought about in 1917, when Finland attained freedom from the oppression of czarist power and could decide its own affairs independently. During the same year the Society of Forestry was granted Fmks. 7,000: — in the budget, and commencing with the next year the Society was permitted to enjoy a Fmks. 14,000: — annual subsidy until this support was increased in to 1923 Fmks. 75,000: — upon the depreciation of Finnish currency. In addition to this the Society has continued to receive private donations occasionally, which during the years 1917—1925 amounted to 134,000 Finmarks. These private donations, however, have been restricted to small amounts during the last few years, when the general economic conditions in Finland became strained. As the printing expenses of the Society, as well as the expenses incidental to the exchange of publications, have increased considerably during the same time, the Society has been forced to petition for an increase in the State allowance. And recently it has been increased to Fmks. 100,000: — ($ 2,519. —) a year. The main part of this is to be used for the printing and exchange of publications; only a very small share is left for research fellowships, and they thus are rarely larger than 2,000 or 3,000 Finmarks. Under these conditions there can, of course, be no question of a subsidy for research journeys to foreign countries.

The membership of the Society at present (1926) is 133; in addition, the Society has numerous correspondent members abroad and has bestowed honorary membership on several merited scientists at home and abroad. * The Society is in communication with more than 200 home and foreign scientific institutions, societies, periodicals, etc. The investigations are published in the serial of the Society, *Acta Forestalia Fennica*, either in a well-known language or in Finnish (or Swedish); in the latter case a summary of the investigation in some well-known language is attached to the report.

The following figures may be given as illustrative of the work of the Society of Forestry:

Years of activity	Meetings held	Lectures at meetings	Number of issued volumes of Acta	Investigations in the Acta.
1909—1914	29	58	2	5
1914—1919	24	55	7	16 **
1919—1924	42	69	17	74 ***
1924—1926	13	22	4	14

If the work of the Society of Forestry is compared to the work of other scientific associations in the country during the period after the Great War, there cannot possibly be any difference of opinion on the fact that the activity of the Society, in so far as the productivity of the work is concerned, must be placed among the first Societies. Above everything, it must be placed to the credit of this society that forest research work has developed from almost nothing to a very promising beginning during the short period of about fifteen years. The Society of Forestry has thus occupied a central position in the wide field of forest research work in Finland. The Society, on its own behalf, feels indebted above all for this achievement to its organizer and spiritual leader, Pro-

* The secretaries of the Society have been Prof. A. K. CAJANDER 1909—1917, Forest councillor O. J. LAKARI 1917—1922, and Professor YRJÖ ILVESSALO 1922—. The chairman is changed every year.

** And the minutes of the meetings of the society with added short reviews of the lectures for the years 1909—1917.

*** And the minutes of the meetings of the society with added short reviews of the lectures for the years 1917—1920.

fessor A. K. CAJANDER. »All that has been carried out in the Society grows up of his sowing, gets its nourishment from his sources of knowledge.» *

The Establishment and Activity of the Forest Research Institute.

A long time even before the establishment of the Society of Forestry the idea of founding a forest research institute in Finland had been awakened, although this idea was not realized until several years after the establishment of the Society of Forestry.

The essential need of a forest research institute was, perhaps, first mentioned at a private meeting of Finnish forest officers in 1866. The matter was discussed again at the inaugural meeting of the Finnish Forestry Association held at Hämeenlinna in 1877, and subsequently it was under consideration many times in the meetings of this association, finally culminating in the fact, that the Association proposed the establishment of a forest research institute to the Government in 1900. The committee appointed by the Government in 1896 to study the condition of private forests also proposed the establishment of a forest research institute in 1898. This proposal was further supported in the report issued in 1900 by the committee appointed by the Government in 1896 to consider arrangements for State forest administration. The proposals of the committees differed in that respect, however, that the private forest committee suggested the establishment of a forest research institute in connection with the Evo Forest Institute, whereas the State forest committee that in its report proposed the transfer of higher forestry instruction from Evo to the University of Helsinki, was of the opinion that forestry research work should be installed as a separate department of the agricultural research institute. Mainly for the reason that the re-arrangement of higher forestry education thus became the order of the day the first preliminary steps of the Government to hasten the decision in the question of establishing the institute were not taken

* The words of Dr. A. PALMGREN at the tenth annual meeting of the Society of Forestry.

until 1906, when the Government, at the suggestion of the Board of Forestry *, appointed Dr. A. K. CAJANDER to study the organization of forestry research work in foreign countries and to draw up a proposal for establishing a forest research institute in Finland. The result was an extensive, detailed publication by CAJANDER, *Forest Research Work in Foreign Countries and a Proposal for its Organization in Finland* [10] (in Finnish), which appeared in print in 1909. ** After detailed argumentation it was proposed in this publication to establish in Finland a forest research institute, administratively under the Board of Forestry, but internally independent, which would have its own research workers, free from instruction and administrative duties. The regular officers of the Institute were to comprise three investigators, their fields of research being silviculture, forest production, and forest soil science. It was further conditioned as possible to install special investigators as well as assistants and clerical help in the Institute.

During the same year the Government appointed a committee to draft the requisite, detailed proposals for the establishment of a forest research institute. The report of the committee, which was completed in 1913, was mainly along the same lines as CAJANDER's; but as the committee was cognizant of the fact that on account of lack of competent working forces the work of the forest research institute could not be established without delays on such a broad scale as the proposals of the committee suggested, the committee proposed to establish a temporary forest research institute at first, to which were to be appointed as temporary investigators three capable foresters who were versed in scientific work. The proposal of the committee was supported by the Council of the University, the Board of Forestry, and foresters, and it generally was hoped that the Institute could commence its activities at the beginning of 1915. The exceptional conditions obtaining during the Great War, however, frustrated these hopes, and the establishment of the Institute seemed to be postponed to the indefinite future.

* The initiative in the matter was taken by the then Director-in-Chief of the Board of Forestry, Mr. P. W. HANNIKAINEN.

** The foregoing description of the early phases of forest research work in Finland is founded for the most part on this publication.

But the delay this time was shorter than was anticipated. The Russian Government fell in 1917 and the new native government hastened to realize the establishment of a forest research institute besides other measures of reform. The statutes for the establishment of the Institute were issued on October 24th of the same year, and the Institute commenced its activities on July 1st, 1918.

The Forest Research Institute of Finland is a research academy of forestry that is separated from the forestry education. * Its purpose, according to its regulations, is »by investigations and experiments to elucidate the fundamentals of rational forestry and those facts upon which the forest productivity of Finland depends». For the present there are three departments: Department of Silviculture, Department of Forest Mensuration and Valuation, and Department of Forest Soils, each of which is represented by a professor. ** Their qualification requirements are the same as those for the professors of forestry in the University of Helsinki. They must above all be scientifically versed foresters, but at the same time also acquainted with practical forestry. They must show their scientific competence in their own field of research, in addition to required examinations, also by publications based on independent research; and further, through their publications they must show their ability to apply the results of their investigations to practical forestry. In addition to the professors the Government is authorized to call other persons, too, for a certain time to the institute in order to carry out special investigations. Each professor has an assistant working more or less independently; and there is, of course, a sufficient

* This, of course, does not prevent the investigators of the Institute from acting as docents or special lecturers of the University or the Technical College in connection with their regular duties, as has happened in the past.

** The committee appointed by the Government in 1917 to draft proposals for re-organizing the management of State forests proposed in its report published in 1920 that a fourth professorship should be established in the Institute, the occupant of which would have forest statistical research as his special subject, but this proposal has not yet reached practical action. A forest utilization department, the necessity of which has been recognised in several quarters, is also still unestablished.

number of helpers at the Institute for calculation and other purposes. Administratively the Institute is under the Board of Forestry, but in practice it is fairly independent. Thus it has its own Board of Administration which is composed of its professors and those professors of forestry at the University of Helsinki whom the Government has appointed to this position for a definite period of time. The Board of Administration chooses a Director from among its own members for a term of three years. * Each professor is generally permitted to choose the subjects of his research and they, as well as the assistants, publish the results of their investigations under their own names.

The Forest Research Institute is located in Helsinki, but for its use experimental forests have been set aside, for the present altogether 17, in the State forests in different parts of the country. The purpose is to handle the experimental forest as a model forest **, where various kinds of experiments in forestry are made conjointly with silvicultural measures. Some areas, especially small ones are partly nature protection districts, however. The area of the forests varies considerably: the largest is 40,000 acres (16,500 ha), the smallest only 15 acres (6 ha). The aggregate total of their area is 133,000 acres (53,700 ha). The Director of the Institute has special forest officers as assistants in tending them, and in the larger experimental forests foresters who have passed an elementary forest school. The Research Institute is entitled to make investigations and, if necessary, fell trees for this purpose (with the permission of the Board of Forestry) and carry out experiments, too, on other State owned forest lands than the experiment areas. The estimated expenditure for the Institute for the year 1926 was Fmks. 670,500 ($ 16,890. —);

* The professor of the Department of Silviculture, Dr. OLLI HEIKINHEIMO has acted as director for the whole time. The position of the professor of the Department of Forest Mensuration and Valuation has been filled by Dr. O. J. LAKARI (temporary) 1918—1922 and Dr. YRJÖ ILVESSALO since 1922. The professorship of the Department of Forest Soils has not yet been filled ordinarily; the duties are discharged by Dr. V. T. AALTONEN since 1923. Dr. VÄINÖ AUER acts as a special investigator for swamp problems.

** The idea of »model parks» has thus been realized in this form — seventy years after it was first started.

the expenses arising from the administration and care of the experimental forests are included in the expenditure estimates for the State forests.

During the short time that the Forest Research Institute has been in existence it has succeeded in accomplishing many visible results. A considerable number of investigations have been made, among them a general survey of the forests of the country, which was started in 1922 and is now completed. Recently, cultivation experiments were started in the experimental forests with native and foreign species of trees, as well as reproduction cuttings, swamp drainage and other experiments; numerous permanent thinning and other experimental plots have been established. In some experimental forests these kind of experiments have been in existence for some time past. Ten volumes of the publication series of the Institute, »*Communicationes ex Instituto quaestionum forestalium Finlandiae editae*», containing 33 investigations and a review of the establishment and work of the Institute for the years 1918—1920, have appeared up to the present time. The investigations are published either in Finnish or in some well-known language; in the former instance a summary is appended to each investigation in some well-known language, in the latter instance a synopsis in the Finnish language. The Institute exchanges publications with numerous home and foreign scientific institutions, societies, etc.

The Division of Work between the Society of Forestry and the Forest Research Institute.

In his publication previously mentioned, »Forest Research Work in Foreign Countries and a Proposal for its Organization in Finland» CAJANDER had expressed the opinion that two organs for carrying on forest research work should be established in Finland: a forest research institute and a forestry société, which idea was realized later as we have seen above. A State-maintained forest research institute was indispensable in order to make investigations that comprise large areas or imply experiments of long duration, since experiments of this nature that are beyond the powers of private investigators, are numerous

in forestry because of its special character. On the other hand, the forestry society was necessary to awaken and keep alive the interest in *independent, private* research work, to support this work with endowments, and in some measure to organize it and to publish the results of such investigations. »Going hand in hand, complementing each other, they can advance forest science, and with it also practical forestry, in the best manner in our country.»

In its main features the division of work has developed in practice in this manner between these two organs of forest research work, and experience has shown that CAJANDER's conception of the appropriateness of dividing the work in this way was correctly conceived. Many more investigations have been made and the research work has become more diversified than would have been the case, if research work had been monopolized only as official work of the State Forest Research Institute; and all this has been attained at relatively little extra cost. The friendly spirit which obtains between the Society of Forestry and the Forest Research Institute is reflected in the fact that the officers of the latter have generally given lectures at the Society of Forestry on the results of their investigations and many of them have acted in positions of trust in the Society.

Other Forest Research and Publication Work.

During the first years of this century, or already several years before the establishment of either the Society of Forestry in Finland or the Forest Research Institute, the then Chief Intendant of the Board of Industry, Mr. A. F. TIGERSTEDT, started far-reaching cultivation experiments with foreign species of trees on his Mustila estate at Elimäki (in South Finland). These experiments, which comprise about 200 different species at present, differ from many other corresponding experiments by the fact that they are severely on a scientific basis, even though their purpose is purely practical. Great care has been given to climatic conditions in the choice of the tree species for experiment; and in procuring seed, to their source. In the same manner, in choosing

the sites for the experimental culture and methods of formation and tending, an attempt has been made to satisfy as far as possible the biological characteristics of each species of tree. In order to obtain comparative results, parallel experiments were started with native species of trees. A careful record has been kept of the development of experimental cultures thus established; in this, as in all other experimental work, the Manager of the Mustila estate, Mr. C. G. TIGERSTEDT, has efficiently assisted his father almost from the beginning. With unequalled sacrifices and with interest in the cause an arboretum has thus been created that in its dimensions (about 250 acres or 100 ha) as well as for its scientific and practical value is the only one of its kind in all Northern Europe. The results of the culture experiments up to the present time (with regard to coniferous trees) are recorded in his publication mentioned on page 36.

Besides the culture experiments of Mustila, the culture experiments, although on a much smaller scale, of native and foreign tree species instituted by Forest Master TORSTEN RANCKEN in the forests owned by the Karl Forsström Company at Finby (coast of south-west Finland), also the foreign tree species culture experiments of Professor G. KOMPPA at Tammisto in Karjalohja, and those of Senator A. OSW. KAIRAMO at Pekola in Hattula are worth mentioning. In the Korkeakoski Forest, which has been given to the University as an instruction forest for forestry teaching, both native and foreign species of trees, especially pine, have been sowed and planted on an extensive scale, as well as the carrying out of swamp ditching, various silvicultural reproduction cuttings, etc. These, however, are done in the first place as practical training for the students. In the forests of several industrial companies and large estates also, as well as in the instruction forests of elementary forest schools, experiments are carried out in forest culture and swamp drainage, more rarely, however, on a purely scientific basis.

In the Wood Research Department of the Central Laboratory of Industry (in Helsinki) and in the Wood-Chemical Department of the Åbo Academy (in Turku) experiments and investigations are made in wood chemistry. Their results are published in the series *Meddelanden från Industrins Centrallaboratorium — Teollisuuden Keskuslaboratorion Tiedonantoja* (Proceedings of the Central Laboratory of Industry) and *Acta Academiae Aboensis*.

The Finnish Forestry Association has supported investigations in forestry by endowments and published their results in its series, *Erikoistutkimuksia* (Special Investigations) (years 1914—1923, 12 volumes, one investigation in each volume). Many of them are papers written for academic degrees. And further, the Finnish Forestry Association Tapio has also published a few forestry investigations. The Finnish Academy of Science (Suomalainen Tiedeakatemia) has likewise at times assisted forestry investigations and published a few investigations in its *Annales*. Several investigations closely allied to forestry research and a few investigations pertaining altogether to forestry have appeared in the series *Acta Societatis pro Fauna et Flora Fennica* of the Societas pro Fauna et Flora Fennica, and also in the serial *Fennia* of the Geographical Society of Finland (Suomen Maantieteellinen Seura). Many committees appointed by the Government have elucidated important questions in forestry and often published reports on them comparable to forestry investigations.

A Review of the Investigations Carried out up to date.

In the forest research work, so far carried out in Finland, an effort has been made to direct attention mainly to questions, which are of actual practical importance to the forestry of Finland. These researches are mainly of a comparative kind, whilst experimental researches, demanding plenty of funds as well as plenty of time, have so far only been carried out on a small scale. Those already previously described far-reaching experiments of TIGERSTEDT with the cultivation of species of trees deserve, however, to be mentioned, as well as those numerous experiments, commenced during the last few years by the Forest Research Institute.

The forestry researches carried out in Finland may be combined into three groups: 1) biological and silvicultural investigations, 2) those dealing with forest mensuration (and forest valuation) and forest policy, and 3) those concerning forest utilization. The last-mentioned group, however, is so far only scantily represented, mainly for the reason that the comparatively expensive means of investigation (laboratories and apparatus) required by research work of this kind have been wanting.

1. Biological and Silvicultural Investigations.

The guiding idea of the biological and silvicultural research work has been that the silvicultural science — apart from the purely technical tasks of silviculture as, for instance, cutting of trees, ditching, etc. — is principally a plant biological science and that the silvicultural investigations should, consequently, above all develop on plant biological lines and plant geographical lines closely allied to the latter. These investigations have thus, at the same time, essentially also been botanical investigations. However, their final object has been practical silviculture, and to bring the latter on to a firm biological basis.

Forest Types, and Investigations with Regard to Same.

When forest research work during the first decade of the present century was beginning to make a proper start in Finland, the most essential task was to bring about a reliable and, as far as possible, also a natural site (locality) classification that would satisfy the needs of forest research activity as well as those of practical forestry. This task was accomplished by A. K. CAJANDER's research *Forest Types*[11] (1909, in German), describing the classification of sites, based on the so-called forest types. After having studied plant geography under the guidance of Prof. J. P. NORRLIN (see p. 11), CAJANDER had in 1903 turned to forestry. As a plantphytologist he had particularly studied plant communities, and it was only natural that he, after having turned to forestry and becoming acquainted with the old, natural way in Finland of classifying lands (as »dry heath», »fresh heath», etc.) began to ponder, whether it would not be possible to arrive at a more exact classification of these on the basis of the plant topography that had been developed by NORRLIN. The thought came readily that the forest plant communities would afford a method for the classification of forest sites. For solving this question he carried out fundamental investigations, principally in the forests of South and Central Germany in 1906 and 1907, and supplementary ones in his own country in 1907 and 1908, and the positive result of these was his publication mentioned above. This work became the foundation of and impetus to the research work on forest types in Finland, the results of which have been made good use of both by forest science and practical forestry in Finland. Thus in the forest researches in Finland, the classification of sites is exclusively used on the basis of forest types, and since 1914 it is used during the mapping and surveying of the State forests. It has gained a still larger application in the forest statistical elucidation, as is, inter alia, proved by the fact that the forest types served as a basis for the classification of forest lands

during the general forest survey in Finland of 1922 and 1923. The results of several researches suggest that forest types also adapt themselves as a basis to applied silviculture.

The theory of forest types has been further developed by CAJANDER in the publication *Forest Types II* [12] (1921, in German), and particularly in his recently published work *The Theory of Forest Types* [13] (1925, in Finnish; 1926, in English) where the theory of forest types appears in a still wider scope, offering new notable opportunities not only to forestry, but also to the history of settlement and civilization, as well as to the settlement policy and international silviculture. The object of the forest types is shortly explained in CAJANDER's paper *What is the Scope and Aim of the Forest Types?* [14] (1923, in German). *

The forest type researches of CAJANDER supplement in many respects the investigations of some other researchers, among which might be mentioned K. LINKOLA's *Studies of the Influence of Culture on the Flora of the Region North of Lake Ladoga I—II* [15] (1916 and 1921, in German), *Observations Concerning the Forest Types of Eastern Carelia* [16] (1917, in Finnish), and *Notes on Vegetation in the Forests of Pyrola-Type* [17] (1919,

* As the classification of sites, based on forest types, has, indeed, been of a fundamental importance to Finnish forest research work, it might be mentioned that CAJANDER in his work *The Theory of Forest Types* defines the conception of forest type in the following way:

»To the same forest type are referred all those stands of which the vegetation at or near the time of maturity of the stands and provided the stands are normally stocked, is characterised by a more or less identical floristic composition and by an identical ecologico-biological nature, as well as all those stands the vegetation of which differs from that defined above only in those respects which — being expressions of differences due to age, fellings, etc. — have to be regarded as merely accidental and ephemeral or at any rate as only temporary. Permanent differences call forth a new forest type in cases where they are sufficiently well-marked, or a sub-type in cases where they are less essential, but, nevertheless, noticeable. In a forest type, therefore, as a rule, only those primary — climatic and edaphic — factors of the locality are reflected — which may be assumed to remain active, even when the locality is laid bare of all plants.»

in Finnish), and O. J. LAKARI's *Investigations of the Forest Types of North Finland* [18] (1920, in Finnish; German summary), ALVAR PALMGREN's work concerning the Åland Isles *Contributions to the Knowledge of the Characters of the Flora of the Coniferous Forest* [19] (1922, in German), and VILJO KUJALA's *Observations on the Forest and Swamp Types in Kuusamo and in the Region to the South of it* [20] (1921, in Finnish, German summary). PALMGREN also carried out on the Åland Isles several other important plant geographical researches, the results of which have been of importance to forest research, particularly to the elucidation of forest types. Such are his *Studies on the Leaf Meadow Regions of Åland: I. Vegetation, II. Flora, III. Statistical Investigation of the Flora* [21] (1915—1917, in Swedish; Part III also in German), *Distance as a Plant Geographical Factor* [22] (1921, in German), and *The Number of Species as a Plant Geographical Character, and Chance and Secular Rise of the Ground as Plant Geographical Factors* [23] (1925, in German). YRJÖ ILVESSALO's *Vegetation Statistical Investigations of the Forest Types* [24] (1922, in German) is also specially applicable to Finnish forest types, as well as VILJO KUJALA's *Investigations of Forest Vegetation in Southern and Central Finland: I. Contributions to the Knowledge of the Ecologico-Biological Character of Plant Species, with Special Attention to the Formation of Plant communities, A. Vascular Plants, B. Feather Moss, C. Lichen; II. On the Demarcation of Colonies* [25] (1925 and 1926, in German). ILVESSALO explains, on a statistical basis, i.a. the number of species and the abundance of species of various forest types, the structure of the vegetation of the various forest types, and deals on a mathematico-statistical basis with the question, as to how big and numerous the sample plots ought to be for giving a reliable and in the main satisfactorily complete picture of the vegetation of the various forest plant communities. KUJALA principally explains the biology of the main plant species of various forest types, the regularity of their occurrence, and the limitation of forest types (as well as of the plant communities in general).

With regard to research concerning conditions abroad RAF. BJÖRKENHEIM's *Contributions to the Knowledge of Some Forest Types Occurring in the Spruce Forests of the German Central Mountains (Mittelge-*

birge)[26] (1919, in German) and, particularly, K. LINKOLA's many-sided publication *Investigations on the Forest Types Occurring in the Swiss Alps*[27] (1924, in German) should be mentioned.

A different conception of forest types has been put forward by WIDAR BRENNER in his publication *Studies of the Vegetation in Part of Western Uusimaa and on its Relation to the Quality of the Soil*[28] (1921, in Swedish; German summary).

Several of the investigations mentioned later under the headings: »Investigations concerning the forest soil», »Investigations concerning the growth, development and structure of the forest stands» and »Investigations into the distribution of the fertile soil», may be associated with those dealing with the forest types.

Investigations Concerning the Forest Soil.

The forest soil researches have until recently, on account of the lack of necessary laboratories, been comparatively limited. Many of these are very closely attached to the forest type researches, showing the correlation between forest types and the soil. Such are J. VALMARI's *Contributions to the Chemical Analysis of the Soil*[29] (1921, in German), and, based upon these results, YRJÖ ILVESSALO's publication *A Contribution to the Question Concerning the Correlation between the Properties of the Soil and the Growth of Forest Stands*[30] (1923, in German), as well as V. T. AALTONEN's researches *On the Degree of Acidity (p_H) on the Forest Soil*[31] (1925, in German) and *The Decomposition of Nitrogenous Compounds in Woodland Soils*[32] (1926, in German), the aim of which publications is to find out the causes of the yield capacity of various forest soils, and, finally, V. PESOLA's work on *Calcium Carbonate as a Plant Geographical Factor in Finland*[33] (1926, in Finnish; German summary). All these prove the correlation between forest types and soil to be a very strong one, thus, on their part, confirming the suitability of forest types as a basis for site classification.

The maceration phenomena of forest lands are explained in O. J. LUKKALA's publication *A Contribution to the Elucidation of the Bog-ore (Iron pan) Problem*[34] (1920, in Finnish; German summary) and V. T.

AALTONEN's *A Contribution to the Elucidation of Iron Precipitation in the Soil*[35] (1923, in German) and *Experiments for the Elucidation of the Prohibitive Action of Watery Humus Extracts*[36] (1923, in German). All these studies are appended to the researches made by B. FROSTERUS, B. AARNIO, and others, at the agrogeological department of the Geological Commission (the former was detached in 1926 from the Geological Commission, and transformed into an Agrogeological Institute subordinated to the Board of Agriculture).

OLLI HEIKINHEIMO's paper *On the Influence of Forest Devastation and Burning on the Forest Soil*[37] (1917, in Finnish) and V. T. AALTONEN's *Water Consumption of Trees and the Moisture Conditions of the Soil*[38] (1920, in German) also deal with the soil.

P. KOKKONEN has published a preparatory research work *Observations on the Structure of Ground Frost*[39] (1926, in German); some special research works are still unfinished.

Investigations Concerning the Biology of the Native Forest Trees.

An object of much research work has been the biology of the native forest trees, particularly the natural reproduction of the various species of trees, so important from a silvicultural point of view. This research work has above all been concentrated on the two main species of trees in Finland, common or Scots pine *(Pinus silvestris)* and common or Norway spruce *(Picea excelsa)*. The recurrence of the reproduction years of the common pine has been examined by AUGUST RENVALL on the northern forest limit, by O. J. LAKARI in North Finland, and by LAURI ILVESSALO in Central and South Finland. Their researches have resulted in the publications *The Periodic Phenomena Presented by the Reproduction of Pine at the Polar Forest Limit*[40] (1912, in German), *Investigations on the Seed Years and Age-classes of the Heath Pine Forests in North Finland*[41] (1915, in German), and *Investigations on the Reproduction Years of Pine Forests in South and Central Finland*[42] (1917, in Finnish; German summary). From these it appears that common pine has rich reproduction years on the northern forest limit only once in

a hundred years, in North Finland on an average every ten years, and in South and Central Finland on an average every six years (rich, or fairly rich, on an average every three years). I. LASSILA explains in his publication *Investigations of the Natural Reproduction and Development of the Pine Forests north of the Arctic Circle*[43] (1920, in Finnish; German summary) the conditions of the natural reproduction of the northern pine forest as well as the causes of the occurrence of the reproduction years in groups. The northern pine forests are also dealt with by V. T. AALTONEN in his work *On the Natural Reproduction of the Heath Forests in Finnish Lapland*[44] (1919, in Finnish; German summary), in which the birth and development of the pine's second growth are explained. The natural reproduction of spruce forests in North Finland has been examined by OLLI HEIKINHEIMO. The results of his examinations are to be found in the publication *The Silviculture of the Spruce Forests of North Finland* (see p. 37). The reproduction conditions of spruce in South and Central Finland are dealt with by O. J. LAKARI in his publication *Investigations of the Reproduction Years of Spruce Forests in South and Central Finland*[45] (1921, in Finnish; German summary). From this publication it appears that spruce in the southern and central parts of Finland has got rich, or rather rich, reproduction years on an average every 3 to 5 years. Dry and warm summers (or springs) have with regard to pine as well as spruce almost regularly led to an abundant bloom during the following year, followed later on in turn by an abundant seed production and a good reproduction year.

The vegetative reproduction of the native species of trees has been examined particularly by OLLI HEIKINHEIMO. The results of these examinations are included (as subsidiary results) in the publications *The Influence of Cultivation by Burning on the Forests of Finland* (see p. 36) and *The Silviculture of the Spruce Forests in North Finland* (see p. 37).

MARTTI HERTZ has published a research work, *On the natural Reproduction of the Lime Tree in Finland*[46] (1925, in Finnish; German summary), about the sexual and vegetative reproduction of the Lime tree *(Tilia cordata)*, in which he also explains the general biology of the Lime tree, as well as the distribution and occurrence of the Lime tree in Finland.

Phenological observations have already during many decades been made in various parts of Finland. Based upon these observations VILJO KUJALA published his *Calculations of the Length of the Leaf Period of Broadleaved Trees and the Flowering Time of Trees in Finland*[47] (1924, in Finnish; German summary).

A. G. BLOMQVIST's pine and spruce monographies have already been mentioned above (p. 9). In A. K. CAJANDER's big dendrological handbook, *Principles of Silviculture: II. The Main Features of Finnish Dendrology*[48] (1917, in Finnish), there are comprehensive descriptions particularly of the most important native species of trees, but also containing the author's own observations with regard to their biology. VILJO KUJALA has published a comprehensive research work, *The Black Alder (Alnus glutinosa (L.) Gaertn.) in Finland*[49] (1924, in Finnish; German summary), ARTUR THESLEFF has published a research work about oak, *(Quercus pedunculata) The Oak in Eastern Finland*[50] (1895, in Swedish), and SULO LINKO a shorter description about oak, *The Distribution of the Oak in the Parishes of Maaria, Raisio, Kaarina and Parainen*[51] (1914, in Finnish).

HJALMAR HJELT's and R. HULT's publications have already been mentioned above (p. 11).

Several of the investigations mentioned later under the heading »Investigations concerning the growth, development and structure of the forest stands» also elucidate the biology of the native forest trees.

Investigations of the Tree Roots.

Although the root system is of the very greatest importance to the vital functions of the trees, much less attention has been paid in biological-silvicultural researches to the roots than to surface parts, this being evidently in the main due to the fact that an examination of the root systems is generally of a much more troublesome nature. Investigations of the root system were started in Finland only during the last few years. These were partly made as special investigations and partly in connection with other investigations (forest reproduction and swamp investigations). Very little has so far been published about

their results, among other things, some special investigations concerning the root systems of pine and spruce are still incomplete. One part of these investigations deals with the structure and development of the tree roots, whilst another part deals with the root competition between the trees.

V. T. AALTONEN was the first one in Finland to draw attention to the root competition in his investigation of forest reproduction on the Lapland heaths mentioned above (p. 32). He treats the same subject more exhaustively in his investigation *On the Extension and Abundance of the Tree Roots in the Heath Forests of Lapland*[52] (1920, in German), this work being based upon the material gathered for the former one. He has also in an experimental way tried to throw light on the root competition by making pot and field cultivation experiments with maize. He explains the results of these experiments in his publication *On the Spatial Arrangement of Plants on Field and in Forest*[53] (1923, in German).

OLLI HEIKINHEIMO has published an investigation *On the Determination of the Age of the Spruce and on its Adventitious Roots*[54] (1920, in Finnish; German summary); his publication dealing with storm damage in the Larch Forest of Raivola (see p. 39) contains observations on the root system of larch. P. KOKKONEN and S. E. MULTAMÄKI have in connection with their investigations of the growth of swamp forests made observations about the pine's root system on drained and undrained swamps (see p. 44).

Heredity Investigations.

(The origin of species, source, and so-called small forms.)

In his big work, *Principles of Silviculture: I. The main features of the Plant Biology and Plant Geography*[55] (1916, in Finnish), A. K. CAJANDER, in giving an account of the history of vegetation, has thrown more light on the idea about the origin of species and source, putting forward independent ideas, afterwards published as a special publication, entitled *Some Reflections on the Origin of Species especially within the Group of Ligneous Plants*[56] (1921, in German). — OLLI HEIKINHEIMO has

examined the spruce *(Picea excelsa)* forms, based upon the differences with regard to their cones and branches, as well as their silvicultural value. The results of his investigations are recorded in his publication, *On the Forms of the Spruce and their Silvicultural Value*[57] (1920, in Finnish; German summary). A. OSW. KAIRAMO had already earlier in his plant biological investigation from Kola peninsula (see p. 11) dealt among other things with spruce forms which differ on account of their cones.

At the Forest Research Institute various experimental investigations are just now being carried out with regard to the heredity of the trees' properties.

The Cultivation of Foreign Species of Trees.

The theoretical fundamentals of the cultivation of foreign species of trees are explained by A. K. CAJANDER. In Part II of his previously (p. 34) mentioned work, *Principles of Silviculture*, he puts forward the general lines with regard to the cultivation of foreign species of trees in Finland, showing under what conditions the cultivation of trees outside their natural area of distribution in general is possible, and on which areas of the globe there are to be found climatically corresponding areas to those of Finland from which species of trees can be got for cultivation experiments. According to W. KÖPPEN's division of climates, he has in Part I of his work developed a division of climates which is very suitable as a basis for a comparison of climates. This division of climates has also been published (slightly abridged) as a special publication under the title *A Contribution to the Question of the Mutual Relations between Climate, Soil and Vegetation*[58] (1921, in German). General principles with regard to the cultivation of foreign species of trees are also dealt with in CAJANDER's paper, *The Cultivation of the Foreign Species of Trees as a Silvicultural and Plant Geographical Problem*[59] (1923, in German). By virtue of the experimental culture results obtained in various parts of Europe with regard to foreign species of trees, LAURI ILVESSALO shows in his publication, *On the Possibilities of Cultivation of Foreign Species of Trees, with Special Regard to Finland*[60] (1920,

in Finnish; German summary), how a successful cultivation of foreign species of trees depends closely upon the degree of similarity between the climate of natural distribution and the cultivation region (or, more accurately, cultivation site) of the species of trees, as well as how important the origin (the geographical races of the species of trees) of seeds is to the cultivation of foreign species of trees.

In his publication, *Arboretum Mustila: I. Conifers*[61] (1922, in Finnish; English summary), A. F. TIGERSTEDT reports on the results achieved with regard to conifers during the experiments with cultivation of species of trees, mentioned earlier (p. 23). FREDR. ELFVING's publication, *The Ligneous Plants in the Botanical Garden of the University of Helsinki*[62] (1913, in Swedish) also contain information about the thriving of several foreign forest trees in the Botanical Garden of Helsinki University. Already earlier (in 1897) ELFVING had in one of his publications about Finland's cultivated plants given short notes on the distribution and thriving as park trees in Finland of some foreign species of trees.

LAURI ILVESSALO has also published a monography on *The Cultivation of Larch Species in Finland*[63] (1916, in Finnish; German summary) and a research on *The Larch Forest of Raivola*[64] (1923, in Finnish; German summary), dealing with the oldest and most noteworthy foreign wood in the northern countries.

Investigations Concerning Silvicultural Methods.

No other form of human culture has in such a high degree and in so many ways affected the forests of Finland as cultivation by burning. A century ago it was still very general, but in the latter part of the last century it began to disappear rapidly, owing to the progress of ordinary feald tillage as well as to the increase in the value of timber; nowadays one encounters it only in East Finland, and even there as a rarity. OLLI HEIKINHEIMO has made investigations into the prevalence at various times of cultivation by burning, into the methods and, particularly, into the effect of cultivation by burning on the forests in Finland. He gives an account of the results of his investigations in his extensive publication, *The Influence of Cultivation by Burning on the Forests of Finland*[65] (1915, in Finnish; German summary). Cultivation by burning has in later times been taken into silvicultural service as a means of forest reproduction. The importance of cultivation by burning just in this respect is explained by THOM. CANNELIN in his publication, *The Importance of Cultivation by Burning for our Forests, for the Country and People*[66] (1917, in Swedish). E. WUORI and LAURI ILVESSALO have investigated the forest cultivation experiments with native and foreign species of trees which have been made since 1870 by means of cultivation by burning in the Vesijako State forest. The results of these examinations have been published in *Investigations of Coniferous Forest Stands originated by Cultivation by Burning in the State Forest of Vesijako*[67] (1913, in German) and *Experiments with Foreign Species of Trees in the State Forest of Vesijako*[68] (1913, in German). — The topping of trees, nowadays also disappearing into the past, has been dealt with by O. J. LUKKALA in his paper, *Gathering of Leafy Twigs for Foddering Purposes in South-western Finland and its Silvicultural Importance*[69] (1920, in Finnish; German summary).

In his study, *The Reproduction Cuttings Compared with one another*[70] (1910, in Finnish), A. K. CAJANDER gives a comparative, critical review of various reproduction cuttings, and examines their suitability for the forests of Finland. The results of the compartment shelterwood (seedtree) method, already in use for many decades on the landed estates of the State, are described by G. HJ. ENROTH in his publication, *On the Compartment Method in the Forests of State estates*[71] (1915, in Finnish). V. T. AALTONEN and I. LASSILA have dealt with the silviculture of the pine forests on the dry heaths of Lapland in their previously (p. 32) mentioned publications, whilst the silviculture of the spruce forests in North Finland is described by OLLI HEIKINHEIMO in his publication, *The Silviculture of the Spruce Forests of North Finland*[72] (1922, in Finnish; German summary). O. J. LAKARI has examined the effect of pruning on the growth and technical properties of spruce; the results have been published under the heading of *Investigations of the Pruning of the Spruce*[73] (1920, in Finnish; German summary).

The dependence of silvicultural methods on forest types in Central Europe is described by A. K. CAJANDER in his previously (p. 27) mentioned work *Forest Types* (1909). V. T. AALTONEN has published a critical review, based upon his own observations, *On the newer Silvicultural Systems in Germany*[74] (1924, in German).

Investigations into Forest Injuries.

Along with cultivation by burning, forest fires have also had a very notable influence on the forests of Finland. In earlier times the forest fires were allowed to rage almost at their own free will until they died out by themselves, but even nowadays in dry summers, particularly in the thinly populated North Finland, they sometimes cover a big area, causing considerable economic losses. The effect of forest fires on the proportions of the species of trees in the Finnish forests is described by A. K. CAJANDER in his previously (p. 34) mentioned work, *Principles of Silviculture I.* VILJO KUJALA has recently published a research *Investigations of the Influence of the Forest Fires on the Vegetation in North Finland*[75] (1926, in German). — The causes of outbreak of forest fires, their occurrence (number, extent, and economic damages) in various years, and on different classes of soil and forest and the influence of weather conditions on the occurrence of forest fires is described by EINO SAARI in his statistical investigation, *Forest Fires in Finland, with Special Reference to the State Forests*[76] (1923, in Finnish; English summary). Already earlier ONNI LÖNNROTH had published a smaller investigation on the same subject, *Forest Fires in the State Forests*[77] (1913, in Finnish). The destruction caused by the fires, as well as the practical measures adopted for their prevention, are extensively dealt with by the forest fire committee, appointed by the Government in 1924, in its recently published report. (The chairman of this committee, O. J. LAKARI, will prepare an English summary of the report.)

Damages caused by storms have been investigated particularly by A. J. BONSDORFF. The results of his investigations are the publications *Studies of the Directions of Storms in Finland*[78], and *Contributions to our Knowledge of Storm Damages in Finland*[79] (1917 and 1918, in German).

OLLI HEIKINHEIMO has recently completed a work on *Damage Caused by Storm to the Larch Forest of Raivola on September 23, 1924*[80] (1926, in Finnish; German summary).

After A. K. CAJANDER in one of his lectures at the Society of Forestry in 1916 * had drawn attention to the usual snow injuries to forests in the eastern parts of North Finland, OLLI HEIKINHEIMO made a circumstantial examination of these. In his publication, *The Snow Damage Regions of Finland and their Forests*[81] (1920, in Finnish; German summary), he gives an account of the extent of the area affected by the snow injuries, their causes, and the kind of injuries caused by the snow. V. T. AALTONEN has in his previously (p. 32) mentioned work about reproduction on the heath forests of Lapland also touched upon the damage caused to the seedlings by the crushing of snow and freezing of the soil.

The drift sand danger and the possibilities of preventing it are elucidated by LAURI ILVESSALO in the study: *Coast Dunes of the Outlying Islands of the Finnish Gulf and the Possibilities of Arresting them*[82] (1926, in Finnish; German summary).

Damage caused by insects has been examined particularly by UUNIO SAALAS. His most notable publications are *The Spruce Beetles of Finland: Studies on the Developmental Stages, Habits and Geographical Distribution of the Coleoptera Living in the Picea excelsa Link., together with a Table for Determining the Larvae I & II*[83] (1917 and 1923, in German), and *On Bark-beetles and the Damage caused by them in the Forests in Finland*[84] (1919, in Finnish; German summary). K. O. ELFVING has published a research work, dealing with *Diseases and their Causes in Forest Cultures*[85] (1905, in Swedish), in which he gives an account of damage, caused by insects as well as by fungi.

ARTUR THESLEFF has investigated the occurrence of the noxious forest fungi belonging to the class of *Basidiomycetes.* His most noteworthy publications are: *On Parasitic Basidiomycetes, Occurring on Ligneous Plants*[86] (1892, in Swedish), which contains a catalogue of the Basidio-

* A summary of the lecture is to be found in the publication on the Society of Forestry's activity in 1909—1917 (A.F.F. 7, 1917, p. 214—216, in Finnish).

mycetes of the Finnish forest trees and shrubs, and *Studies on the Basidiomycetes Flora of South-eastern Finland, with Regard to its Composition, Physiognomy, Phenology and Ecology*[87] (1919, in Swedish). The most noteworthy of the publications by J. I. LIRO (LINDROTH), dealing with the noxious fungi of forests, are: *Contributions to our Knowledge of the Decomposition Phenomena of Birch Wood*[88] (1904, in German), and *Culture Experiments with Finnish Rust Fungi I—II*[89] (1907, in German), finally *Uredinae Fennicae, Finnish Rust Fungi*[90] (1908, in Swedish). — As subsidiary results observations on injuries caused by insects and fungi have been published in several studies, especially in the silvicultural ones.

Forest Grazing Investigations.

The use of forests for grazing is still very common in our day in Finland, though in several parts of the country artificial grazing lands are already coming into use. It is thus but natural that efforts have been made to expound the effect of grazing on the forests. The effect on the forests of domestic animals (horses, cows, sheep, and goats) has been investigated by S. E. MULTAMÄKI. He gives an account of the results of his investigations in his publication, *On the Grazing in Forests and Tending of Grazing Lands*[91] (1916, in Finnish). Also A. PALMGREN's previously (p. 20) mentioned publication, *Studies on the Leaf Meadow Regions of Åland: I. Vegetation*, contains observations about the grazing effect on forests, among other things accounting for how the spruce gained predominance in the hardwood forests of the Åland Island.

In North Finland, particularly in Lapland, reindeer breeding is still comparatively general. The effect of reindeer on the forests has been examined principally by AUGUST RENVALL and V. T. AALTONEN. The results of Renvall's investigations are to be found in his publication mentioned below, *On the Question of Protection Forests*, those of Aaltonen in his previously (p. 32) mentioned publication about reproduction of the heath forests in Lapland. Earlier, this question was dealt with also by EINAR REUTER (in several papers in S.My.J.) and in the Report of the Reindeer Commission (1914) appointed by the Government in 1911.

The Problem of Protection Forests.

The problem of protection forests, so important in the northern parts of Finland from the point of view of forestry as well as agriculture and settlement, has been examined by AUGUST RENVALL and OLLI HEIKINHEIMO, earlier also by H. R. SANDBERG and the so-called Protection Forest Commission, appointed by the Government in 1907. SANDBERG has published the results of his investigations in the *Report of a Journey Made by Means of a Public Stipend to Inari, Utsjoki and Enontekiö with a View to Carrying out Forestry Investigations*[92] (1898, in Swedish). The report of the Protection Forest Commission appeared in 1910 (in Finnish). RENVALL has published an extensive research *On the Question of Protection Forests*[93] (1919, in Finnish; German summary), in which lines are suggested for the solving of the problem of protection forests, as well as the main principles for the management of protection forests of farthest Lapland. Part I deals with the vital conditions of the pine forest on its northern limit and the reasons for the descent of this limit, Part II with the objects and conditions of the protection forest system, Part III with protection of forests from fires, Part IV with the arrangement of reindeer-grazing on protection forest regions, Part V with silvicultural principles in the actual forest limit region, and Part VI with the arrangement of settlement conditions in the pine forest limit region. Soon afterwards appeared HEIKINHEIMO's research work, *On the Forests at the Forest Limit in Finland and their Future Treatment*[94] (1921, in Finnish; German summary).

Swamp Investigations.

Swamp investigations have been carried out in Finland on a comparatively large scale. This is, as a matter of course, due to the fact that a huge part of the whole land area of Finland is covered with swamps (34.6 %); they constitute a notable landscape feature, and are at the same time of substantial economic importance. As the swamps of Finland in bygone times had been but very little examined, it proved necessary to carry out very thorough examinations, particularly as

the swamps in the northern countries differ considerably from those of Central Europe.

The foundation for Finnish swamp researches, closely connected with J. P. NORRLIN's investigations (see p. 11), was laid by A. K. CAJANDER with his work, *Studies on the Swamps of Finland*[95] (1913, in German). * This work is of the same importance to swamp researches in Finland as the same author's work *Forest Types* (1909) to actual forest researches. In the general part of the work the author describes the origin and development of swamps, as well as various swamp complexes, whilst in the special part he gives a thorough, systematic description of Finland's swamp types. Those swamp types distinguished by CAJANDER have come into general use during swamp examinations, but they are also of great importance during practical swamp draining.

The origin and development of swamps were also examined by CAJANDER's pupils, A. L. BACKMAN, VÄINÖ AUER, and VILJO KUJALA. The examinations were carried out in North Finland where, particularly in Ostrobothnia, swamp invasion is very common and extensive. In his publication, *Investigations of Swamps in Mid Ostrobothnia*[96] (1920, in Swedish; German summary), BACKMAN shows that at least 95 % of the swamp area in Ostrobothnia is the outcome of forest area having been invaded by swamp. AUER published: *On the Modes of Invasion of Land by Swamp in Mid Ostrobothnia*[97] (1921, in Finnish; German summary), *Contributions to the Stratigraphy of the Swamps of Mid Ostrobothnia*[98] (1921, in German), *Investigations on the Flooded lands in Lapland*[99] (1921, in Finnish; German summary), and *Investigations of Swamps in the Hill Regions of Kuusamo and Kuolajärvi*[100] (1922, in Finnish; German summary), the last one being a very extensive and manysided research work. KUJALA published a smaller investigation *On the Genesis of Swamps in Mid Ostrobothnia*[101] (1924, in Finnish; German summary).

* Already earlier CAJANDER had published some research works on swamps, but in this work all his extensive swamp examinations have been collected into one integral whole.

Some of AUER's investigations mentioned above also deal with the surface morphology of the swamps. He treats this subject separately in his publication, *On the Origin of Cords on Swamps*[102] (1920, in German). Already earlier ANTTI TANTTU had published a smaller research work, *On the Origin of Hummocks and Cords of Swamps*[103] (1915, in German). — O. J. LUKKALA describes the relation between swamp types and the surface peat of the swamps in his paper *Studies of the Relations between the Swamp Type and the Surface Peat of Swamps*[104] (1920, in German). In his publication, *Investigations of the Botanical Development of Swamps with Reference to the Chemical Composition of Peat*[105] (1924, in German), H. WARÉN describes the relation between the botanical and chemical composition of swamp peat.

The tree-stump strata found in swamps are described by O. J. LUKKALA in his publication, *Investigations of the Stump Strata of Swamps*[106] (1920, in Finnish, German summary), as well as by AUER in some of his previously mentioned publications.

In the service of post-glacial chronology the swamps have gained a very great importance. The research work on this subject was started in Finland by RAFAEL HERLIN in the nineties, when he published his work *Studies in Paleontological Plant Geography of North Satakunta*[107] (1896, in Swedish); later on investigations were carried out by the Swede G. ANDERSSON, H. LINDBERG, and VÄINÖ AUER. The most noteworthy research work is that of AUER, explaining the development of the lake Vanajavesi and its surroundings, the results of which have been published in two publications: *Post-glacial History of Lake Vanajavesi*[108] (1924, in German), and *Investigations of the Ancient Flora of Häme (Tavastland)*[109] (1925, in English). A. L. BACKMAN and ASTRID CLEVE-EULER describe in their publication, *The Fossil Diatomeae Flora of Ostrobothnia*[110] (1922, in German), the fossil *Diatomeae* discoveries in Ostrobothnia and, on the strength of these, the limits of the Litorina Sea in Ostrobothnia.

The draining and afforestation of the swamps is a very important research subject from the point of view of practical forestry. This subject has principally been examined by ANTTI TANTTU and S. E. MULTAMÄKI.

After describing what swamp type each drained swamp represented in its natural state, TANTTU shows in his publication, *Investigation of the Afforestation of Drained Swamps*[111] (1915, in Finnish; German summary), that each swamp type changes as a result of draining — if only the draining has been thoroughly carried out — into a certain forest type. By means of the swamp type one is thus able to determine, how much productive forest land the swamp will yield after draining. In his publication, *On the Swamps of Finland and their Afforestation*[112] (1920, in Finnish; German summary), S. E. MULTAMÄKI deals especially with the draining qualifications of various swamps for forest growing, and the importance of draining and afforestation of swamps from the point of view of economics. From his publication, *Investigations of the Growth of Forest on Drained Swamps*[113] (1923, in Finnish; German summary), it is obvious that as far as swamp types in respect of their surface vegetation can be compared with actual forest types, they will also correspond to the latter with regard to their forest growth. The same publication also contains numerous observations about the root forms of the pine on swamps and the drainage influence upon them. P. KOKKONEN also deals with this subject in his paper, *Observations on the Root System of the Pine in Swampy Grounds*[114] (1923, in German). An important technical question concerning draining is treated by KOKKONEN in his publication, *Studies of the Circumstances Affecting the Condition of Drainage Canals*[115] (1923, in Finnish; English summary).

THEODOR HOMEN's research work, *Our Forests and our Water Conditions*[116] (1917, in Swedish), dealing with the water circulation in nature, tells us also about the part played by swamps in this circulation, and particularly about the influence of swamp draining upon it.

Among the publications belonging to the domain of swamp research a paper by VÄINÖ AUER has finally to be mentioned: *Some Future Tasks in the Domain of Swamp Research in Finland*[117] (1924, in Finnish; German summary).

2. *Investigations Concerning Forest Mensuration (with Forest Valuation) and Forest Policy,*

The investigations concerning forest mensuration (with forest valuation) and forest policy carried out in Finland have dealt with the following subjects: the form of tree stem, growth, development, and structure of the stand, forest resources and general conditions of forestry, consumption of forests, the relation between the growth and consumption of forests, forestry among the various owner groups, wood working industry and wood working companies, export of forest products and export duties of forest products, evolution of timber prices, forest legislation, distribution of the fertile soil in Finland and in its various parts, settlement conditions and settlement policy, and the land granting policy of the State.

The Application of Mathematico-Statistical Methods to Forest Research Work.

The investigations concerning forest mensuration (with forest valuation) and forest policy are essentially based upon statistical work, principally upon so-called representative statistics. For the purpose of getting reliable results it is, therefore, often necessary to employ so-called mathematico-statistical methods which have been vastly developed of late. A very essential feature of the investigations concerning forest mensuration (with forest valuation) and forest policy carried out in Finland is the mathematico-statistical treatment of the material under investigation.

In Finland WERNER CAJANUS was the first to prove the utility of applying mathematico-statistical methods to investigations concerning forest mensuration. In his paper on the methods of preparing yield tables, read in 1912 before the Society of Forestry *, he drew attention to the great significance of stem distribution series in the preparation of yield tables. By classifying the trees of stands in diameter-classes ac-

* A summary of the paper is to be found in the publication on the Society of Forestry's activity in 1909—1917 (A.F.F. 7, 1917, p. 75—77, in Finnish).

cording to breast-height diameter, one arrives at the stem distribution (frequency) series of the stands, which one is able to characterize accurately enough by means of some easily determined parameters (mean diameter, number of trees, dispersion, asymmetry, and excess). As distribution series of this kind further determine the total volume of the stand as well as many other data recorded in the yield tables (whilst the converse is not true), they are better than the total volume to serve as a basis for the preparation of yield tables. The effect of various silvicultural methods on the development of stands shows itself more clearly in the distribution series than in the total volume, because stands that have been tended according to various methods may be of the same volume, but one and the same stem distribution series applies only to stands (of the same age and grown on sites of the same biological value) that have been tended according to the same method. Thus the stem distribution series offer excellent guidance, when it has to be determined which of the younger and older stands belong to one and the same developmental series. By examinations of stem distribution series one also gets the chance to elucidate the development of mixed forests and uneven-aged stands, which would not be possible by a mere examination of the volume. — These facts, the main features of which CAJANUS had only touched upon in his paper, he treated more circumstantially in his work, published two years afterwards based upon Swiss material of observations, *On the Development of the Even-aged Forest Stands. A Statistical Study I*[118] (1914, in German). This work is of fundamental significance in Finland, when applying mathematico-statistical methods to investigations concerning forest mensuration and valuation and to forest researches in general.

Some years after CAJANUS's work had been published, the Society of Forestry entrusted YRJÖ ILVESSALO with the preparation of growth and yield tables for the main species of trees in Finland. After the research material had been collected, the method of stem distribution series, recommended by CAJANUS, and mathematico-statistical methods in general, were used in working it up and thus one got the growth and yield tables on a safe basis. During the handling of the material

for his investigation into the structure and development of pine stands, ERIK LÖNNROTH also resorted to mathematico-statistical methods.

Besides the investigations concerning development, structure, and growth conditions of the stands, mathematico-statistical methods have also gained an important place in the testing of the results of the so-called *line-survey method*. The line-survey method has been used in Finland already for many decades. However, it was taken into extensive use only after its capability for forest surveying had been scientifically proved to be reliable, and after mathematico-statistical methods had been applied to testing its results. On the initiative of the Finnish Forestry Association Tapio, a general survey of the forests of Sahalahti and Kuhmalahti parishes was carried out in 1912, one of the aims of this survey being to establish the exactness and suitability of line-survey to the inventory of forest resources of larger areas. The survey was carried out under the direction of CAJANUS, but after his death in 1919 the preparation of the material was entrusted to YRJÖ ILVESSALO in 1920. In the meantime ILVESSALO had in 1919 prepared a small investigation *On the Accuracy of Line-Survey*[119] (1920, in Finnish). This publication also contains a short mention of those mathematico-statistical methods by which the results of line-surveys may be tested. They are more extensively explained in ILVESSALO's publication, *Investigations of the Condition of the Private Forests in the Central Parts of the Province of Häme* (see below p. 52). Basing himself upon one experiment, M. LAPPI-SEPPÄLÄ gives an account of the accuracy of line-survey in his publication, *On the Line-Survey and its Accuracy*[120] (1924, in Finnish, German summary).

In his investigations, *On the Calculation of the Mean Error in the Results of a Line-Survey*[121] (1924, in German), J. W. LINDEBERG has critically examined the mathematico-statistical testing methods of line-survey as they are employed both at home and abroad, and submits new formulas for testing the results of line-survey. These newest testing methods were afterwards used in the general survey of the forests of Finland (see p. 50) which is the most extensive survey work in which line-method has been put to practical use in Finland.

In forest political investigations, too, the mathematico-statistical methods have come into use in Finland. EINO SAARI, in particular, adapted them for investigations into this subject in his publications mentioned further on.

Investigations Concerning the Form of Trees.

In his paper submitted to the Society of Forestry in 1911, published the same year under the heading of *Methods for Investigating the Form of Trees*[122] (1911, in Finnish; German summary), WERNER CAJANUS explained the defects in the investigation methods of the form of trees, and proposed a new method for the mathematical description of the tree form. This method was afterwards employed by O. J. LAKARI during his examination of the form of pine trees. The results of his examination are published under the name of *Investigations of the Form of the Pine*[123] (1920, in Finnish; German summary).

Investigations Concerning the Growth, Development, and Structure of the Forest Stands.

WERNER CAJANUS's research work has already been mentioned above (p. 46), in which he gives an account of the prevailing regularities in the development of even-aged stands.

Closely connected with A. K. CAJANDER's fundamental work, *Forest Types* (1909), is YRJÖ ILVESSALO's publication, *Investigations of the Importance of the Forest Types with Regard to Forest Mensuration*[124] (1920, in Finnish; German summary), basing itself upon investigations carried out on sample plots in 467 stands, and definitely proving that forest types can be used successfully as a basis for the classification of forest soils according to quality, for all kinds of investigation into forest mensuration, and particularly for the preparation of growth and yield tables. Already earlier ILVESSALO had made a preliminary comparison in his concise investigation, *On the Growth of the Dominating Trees in the Pine Forests of Myrtillus and Calluna Types in the State Forest of Salmi*[125] (1916, in Finnish; German summary) between the growth of two forest types. After it had become definitely clear that forest types are a suitable

basis for the classification of forest soils according to quality *, ILVESSALO published *Growth and Yield Tables for the Pine, Spruce and Birch Forests of the Southern Half of Finland*[126] (1920, in Finnish; German summary), constructed on the basis of the material collected from the above mentioned 467 stands. These growth tables differ from corresponding foreign ones in principle in two respects: firstly, all their species of trees have got common site classes, forest types being used for this purpose, and, secondly, as already stated above, mathematico-statistical methods were employed during the treatment of the material. On the strength of the material offered by ILVESSALO's Growth and yield tables, V. T. AALTONEN in his paper, *On the Self-Thinning of Forest Stands and on the Space Condition of Trees in Virgin Forests*[127] (1925, in Finnish; German summary), describes the self-thinning of the stands and the growth space of the trees in virgin pine, spruce, and birch stands, on the most common forest types in the southern half of Finland. AALTONEN also published a study, *On the Influence of Trees on One Another in General*[128] (1925, in German).

For the preparation of growth tables for forests in the northern half of Finland, O. J. LAKARI elaborated a scheme, published under the title *A Proposal for the Preparation of Yield Tables for the Forests of North Finland*[129] (1919, in Finnish). As orientating investigations may be mentioned LAKARI's *Investigations into the Forest Types of North Finland* (see above p. 29) and *Investigations of the Growth of the Spruce and Pine in Forests of the Hylocomium-Myrtillus Type in North Finland*[130] (1920, in Finnish; German summary). T. HEIKKILÄ examined the value increment percentage of the stands on some forest types in North Finland; the results were published under the title *Investigations of Growth in the Far of North Finland*[131] (1925, in Finnish; German summary).

In his publication, *Investigations of the Internal Structure and Development of Even-aged Nature-Normal Pine Stands, Based on Materials*

* See also YRJÖ ILVESSALO: *The Forest Types as Foundations for New Yield Tables for Finland.* Included in the above mentioned publication *Forest Types II* (p. 42—63, in German).

from the Southern Half of Finland[132] (1925, in German), which on corresponding points fully confirms YRJÖ ILVESSALO's investigations into the importance of forest types in forest mensuration and valuation, ERIK LÖNNROTH describes the structure and development of virgin pine stands on the most common forest types in the southern half of Finland. Dealing with this subject the author especially examines the share of biological tree classes in the structure and development of the stands subjected to investigation, his tree classes being independently formulated by him on the basis of GUNNAR SCHOTTE's tree-classification. In his study *The Stereometrical Mean Stem of the Stand*[133] (1926, in German), LÖNNROTH critically examines the calculation methods of the stand's average stem, and developes the formula for calculating the average stem of the stand. *

Investigations into the growth of swamp forests have already been mentioned above, in connection with the swamp investigations.

In his publication, *Investigations of the Influence of the Meteorological Factors on the Height and Diameter Growth of the Pine*[134] (1920, in Finnish; German summary), ERKKI LAITAKARI explains how the growth of the trees is dependent upon weather conditions.

Forest Resources and General Conditions of Forestry.

The knowledge of Finland's forest resources was very defective until the main results of the general line-survey of the forests of the whole country carried out in 1922 and 1923 were published. This research work, so very important to Finnish forestry, started in 1921, when O. J. LAKARI on the initiative of the Assessment Committee, appointed by the Government, carried out the preliminary investigations. The actual survey was carried out in the summer of 1922 and 1923, in the

* LÖNNROTH also constructed a dendrometer which is adapted to the measurement of the height as well as the diameter. (See ERIK LÖNNROTH: *Ein Dendrometer.* A.F.F. 30, 1926. 14 p. and 3 pl. and 3 tables.) Dendrometers of various types had already before been invented by FABIAN LANGENSKJÖLD, J. H. A. AF FORSELLES, N. C. NORDENSKIÖLD, ROBERT MONTELL, H. H. HACKSTEDT, WERNER CAJANUS and T. HEIKKILÄ. Several types of callipers for measuring stems have also been devised.

State forests by the Board of Forestry, and in other forests by the Forest Research Institute. The work was put under the direction of YRJÖ ILVESSALO, Professor of the Department for forest mensuration and valuation of the Forest Research Institute. Already in 1924 it was possible to publish two concise reports on the main results of the work done: YRJÖ ILVESSALO's *The Forests of Finland: the Forest Resources and the Condition of the Forests*[135] (1924, published in Finnish, Swedish, English, and French), and OLLI HEIKINHEIMO's *The Silvicultural Condition of the Forests of Finland*[136] (1924, in Finnish). A comprehensive main publication, containing an account of the results in detail, is now being prepared.

Some of the more important figures concerning the results may be mentioned below:

Finland's forest area comprises 62.43 million acres (25.26 million hectares) or 73.5 % of the total land area. Forest land per head of the population averages 18.3 acres (7.4 hect.). The State owns 39.8 %, parishes 1.0 %, rural and municipal communities 0.7 %, Joint Stock companies 7.5 %, and private individuals 51.0 % of the total area of forest lands.

With regard to various species of trees, the forest area is divided in such a way that common pine dominates 55.2 % of the forests, spruce 24.8 %, birch 16.9 %, alder 1.5 %, and aspen 0.2 % of the forests, whilst 1.4 % is clear.

The total growing stock of forests amounts to 57,213 million cubic feet (1,620 million m^3). The growing stock per each acre of forest land averages 919 cubic feet (per hect. 64.3 m^3), and per head of population 16,810 cubic feet (476 m^3).

The total annual growth of forest is at present 1,568 million cubic feet (44.4 million m^3). The growth per each acre of forest land averages 25.3 cubic feet (per hect. 1.77 m^3), and per head of population 459 cubic feet (13.0 m^3).

The forest percentage differs for various parts of the country, likewise also the quality of forest lands, and the growing stock and the growth of forests, as well per acre as per head of population, the difference being particularly big between the northern and southern parts of Finland.

Earlier investigations into the forest resources of Finland deal primarily with the condition of the forests. The oldest description of the forests and forestry in Finland is EDMUND VON BERG's publication, *The Forests of Finland*[137] (1859, in German). * Many Government Committees afterwards issued accounts of the condition of the forests. Among these accounts may be mentioned particularly the reports of the so-called State Forest Committee and of the so-called Private Forest Committee, each of the reports being issued in 1900. On the strength of the statistical material collected on the initiative of the Finnish Forestry Association Tapio, A. BENJ. HELANDER published in 1910 a study, dealing with the condition of the private forests in Finland, *The Private Forests of the Country*[138] (1910, published in Finnish, Swedish and French). The line-survey of the forests in Sahalahti and Kuhmalahti parishes, carried out in 1912, has already been mentioned above (p. 47), the results of which are described by YRJÖ ILVESSALO in his publication, *Investigations of the Condition of the Private Forests in the Central Parts of the Province Häme*[139] (1923, in Finnish; German summary). In 1917 O. J. LUKKALA and S. E. MULTAMÄKI carried out an investigation into the condition of the forests in East Finland (in the Savo and Karjala provinces). MULTAMÄKI published the results of these investigations under the title *Investigations of the Condition of the Forests in Savo and Karjala*[140] (1919, in Finnish; German summary). Smaller studies about the condition of private forests were published by WERNER CAJANUS and RAGNAR SAXÉN, but since the main results of the general line-survey of the forests of the whole country were published, the former are no longer of any practical importance.

OLLI HEIKINHEIMO published a research work, *The Occurrence, Area and the Growing Stock of the Spruce Forests in North Finland*[141]

* At the invitation of the Finnish Government Baron V. BERG made a journey to Finland for the purpose of reporting on the organization of forest administration. In Finland he undertook an extensive tour, acquainting himself with the condition of the forests in various parts of the country. As a result of his journey he handed to the Government in 1858 an exhaustive report, »An account of Finland's forests», published in 1859 in Finnish, Swedish, and German.

(1920, in Finnish; German summary), based principally upon information gathered from working plan documents, but partly also on his own observations.

In the report of 1920 of the State Forest Committee, appointed in 1917, A. K. CAJANDER gives an account, primarily from a geographical point of view, of the natural prospects of forestry in Finland, afterwards published in a condensed form under the title of *Forestry-Geographical Review of Finland*[142] (1923, in German).

Forest Consumption, and the Relation between Growth and Consumption.

With regard to the amount of forest consumption in Finland, and the relation between growth and consumption, private individuals as well as committees have made calculations. Many of these, particularly the older ones, are, however, very approximate ones and based upon uncertain sources of information. The oldest calculation is as early as the fifth decade of the 19th century. Some of the calculations comprise the whole country, others only a part of it.

Among the calculations comprising the whole country, one of the most notable is the estimate, dealing with the relation between the growth and consumption of forests, which was prepared by the committee, appointed in 1916 by the Finnish Forestry Association[143] (1916, in Swedish). This committee estimated the annual growth of the forests in 1913 at 1,243 million cubic feet (35.19 million m³), and the consumption at 1,317 million cubic feet (37.30 million m³), the consumption thus exceeding the growth by 74 million cubic feet (2.11 million m³). In their essay, *Statistical Exposition of Fuel Consumption and the Need of Wood in Finland*[144] (1922, in Finnish and Swedish), KARL STRÖMBERG and LEO KROHN estimated the annual consumption during peace time at 1,377 million cubic feet (39 million m³). In his paper, *On the Relation between Forest Growth and Wood Consumption in Finland*[145] (1923, in German), A. K. CAJANDER estimates that the consumption scarcely exceeds 1,400 million cubic feet (40 million m³). As the annual forest growth, according to the results of the line-survey of the forests of

the whole country, is 1,568 million cubic feet (44.4 million m³), it seems as if the annual growth would exceed the consumption by 140—180 million cubic feet (4—5 million m³). However, the consumption estimates are in many respects (especially with regard to the home consumption of the rural population) moving on an uncertain basis. The Board of Forestry has also quite recently suggested to the Government that the Forest Research Institute should be charged with an exhaustive and in all respects reliable investigation into the forest consumption. It is also probable that an investigation of this kind will be started in the near future.

YRJÖ ILVESSALO, EINO SAARI, and M. LAPPI-SEPPÄLÄ have elaborated calculations, covering a part of the country. In his paper, *On the Relations between the Yield Capacity, the Present Yield of Forests and the Wood Consumption*[146] (1920, in Finnish; German summary), ILVESSALO presents an estimate, dealing with Savo and Karjala. Principally based upon the material collected by himself, SAARI published a research work, *The Domestic Consumption of Wood in the Country in the Province Turku-Pori*[147] (1922, in Finnish; German summary). This research differs from earlier native and foreign investigations into the consumption of wood in that the material used is much more plentiful and the treatment more versatile, besides which mathematico-statistical methods have been resorted to during the work. LAPPI-SEPPÄLÄ's publication, *On the Balance of Forest Growth and Felling as well as on the Wood Consumption and the Yield Capacity of Forest Lands in the Province of Turku-Pori*[148] (1925, in Finnish; English summary), is based partly on SAARI's investigation, supplemented in a few points by his own research material, and partly on the survey investigation into the country's forests.

Investigations Concerning the Forestry of Various Owners' Groups.

Under the management of P. W. HANNIKAINEN and afterwards A. K. CAJANDER, the forestry of the Finnish State has during this century developed into a notable source of income to the State, and thereby attained an important place in the economy of the State. The forest management principles of the State have been expounded by numerous

Government committees, especially the committees appointed by the Government in 1896 and 1917. A. K. CAJANDER has published a study, *State Forestry as a Business Enterprise*[149] (1921, in Finnish; German summary), describing the general business prospects of State forest management, the development and results so far, and the prospects for the future. The sawmill activity of the State has been dealt with by A. OSW. KAIRAMO and ADOLF BURGMAN, the former in his paper, *The State as a Wood Working Concern*[150] (1925, in Finnish) and the latter in his paper, *The State Sawmill Industry*[151] (1925, in Finnish). The significance of the State's forestry as a source of employment is described by A. BENJ. HELANDER in his publication, *On Employment Afforded by Forestry: I. The State Forests in 1911—1913*[152] (1923, in Finnish; German summary). — In his statistical investigation, *The Extra-Ordinary Forest Officers*[153] (1919, in Finnish), AARNE BOMAN gives an account of the position and activity of the State's extraordinary forest officers.

The Board of Forestry issues annually an official statistical review of the forestry of the State, and of the activity of the forest administration, these reviews being supplied with summaries in French.

YRJÖ HARVIA has published a research work, *The Municipal Forests of Finland*[154] (1916, in Finnish and Swedish), giving an account of the forest resources and forestry of the towns as well as of the importance of town forests to municipal economy, suggesting lines for future forest policy to the towns.

The forest ownership and forestry of rural communities is elucidated by the statistical exposition by MAUNO PEKKALA: *The Forest Acquisition Movement in Rural Communities in the Light of Statistics*[155] (1920, in Finnish).

In his publication, *The Commonly Owned Forests of Finland*[156] (1926, in Finnish; English summary), MAUNO PEKKALA gives an account of the origin, administration, and management of the commonly owned forests, also supplying statistical information about these forests.

Many Government Committees have published reports, too, on the management principles of the private forests, these reports being accom-

panied by circumstantial suggestions with a view to furthering private forestry. Among the oldest of such reports mention should particularly be made of the reports issued in 1898 and 1900 by the so-called Private Forest Committee appointed by Government in 1896. Only quite recently a report was published by the committee which the Government appointed in 1922 for planning measures with a view to improving private forestry. (The chairman of this committee, MAUNO PEKKALA, will prepare an English summary of the report.)

As a historical publication may be mentioned A. BENJ. HELANDER'S *Origins of the Finnish Forestry Association Tapio: a Review of the Movement for the Promotion of Private Forestry in 1897—1907*[157] (1914, published in Finnish and Swedish).

Investigations into the Wood Working Industry and Wood Working Companies.

The wood working industry in Finland is so closely connected with forestry that, with regard to the forest investigation activity described, it is worth mentioning these investigations, too provided, they do not deal with purely technical questions.

In Finland's wood working industry the sawmill industry holds the first place. The history of this branch of industry has been examined by E. G. PALMÉN and J. T. HANHO. PALMÉN'S paper, *On the Development of the Sawmill Industry in Finland*[158] (1911, in Finnish), gives an account of the origin and earlier conditions. In his publication, *Investigations into the History of Finnish Foresty during the XIX Century: I. Sawmill Industry and the Export of Sawmill Products during the 4th and 5th Decades of the XIX Century*[159] (1915, in Finnish), HANHO deals with an important phase in the history of forestry and the sawmill industry in Finland.

The period of the big rise and development of Finland's wood working industry in the latter half of last century as well as in this century, is pictured in those historical chronicles that have been published about the origin, development, and activity of the old, big wood working companies or industrial establishments. Among those that most deserve to

be mentioned are: LENNART GRIPENBERG'S *Aktiebolaget W. Gutzeit & C:o 1872—1922*[160] (1924, published in Finnish and Swedish), GUSTAF LANGENSKIÖLD'S *Kymmene Aktiebolag 1872—1922*[161] (1922, in Swedish), *Reposaaren Höyrysaha O/Y 1872—1922: To Celebrate the Fiftieth Anniversary of the Firm's Existence*[162] (1922, in Finnish and English), W. PARVIAINEN'S *Säynätsalo, a Fragment of the Development of the Industry of Central Finland*[163] (1922, in Finnish; English summary), the publication of A. Ahlström Osakeyhtiö: *The Varkaus Mill, a Historical Sketch*[164] (1925, published in Finnish and Swedish), and KARL EKMAN'S *Aug. Eklöf, Aktiebolag 1864—1924*[165] (1926, in Swedish). I. K. T. LASSILA and JOHN FLOMAN published a large volume, *The Industry and Trade of Finland I—II*[166] (1922 and 1924, in Finnish and Swedish).

The labour conditions in the wood working industry shortly before the great war are described by G. R. SNELLMAN in two official statistical research works, *An Investigation of the Finnish Paper Industry*[167] (1912, in Finnish and Swedish; French summary), and *An Investigation of the Finnish Sawmill Industry, Forest Cutting, Timber Floating and Loading Connected with It*[168] (1914, in Finnish and Swedish; French summary). More recently the Social Statistics Department of the Central Bureau of Statistics published an exposition: *Wages in the Sawmill Industry in 1913—1924*[169] (1924, in Finnish and Swedish). In order to collect information about the working, wages, housing, family and other conditions among the labourers employed in forest and floating work of the wood conversion industry, the Social Statistics Department of the Central Bureau of Statistics arranged in 1921 an inquiry, the results of which were afterwards published under the title: *An Inquiry into the Conditions of Forest and Floating Labour in the Spring of 1921*[170] (1923, in Finnish and Swedish; French summary).

With a view to safeguarding their supply of raw material, the industrial companies in the wood conversion trade acquired extensive forest territories. Primarily for social political reasons public opinion has taken up an antagonistic attitude towards the companies' acquisition of land, and this has also been considerably limited by legislative measures on the part of the State. Some ten years ago this was one of

the most prominent questions of the day, and many efforts were made to throw light upon this question by means of various investigations. The most far-reaching one of these has not been completed, but the following works have been published: AUGUST RENVALL's *A Plan for the Investigation of Acquisitions of Land by the Joint Stock Companies*[171] (1919, in Swedish), AARNE BOMAN's *Private and Joint Stock Company Ownership of Land*[172] (1920, in Finnish and Swedish; German summary), and RENVALL's and BOMAN's joint publication *Investigations of the Land Ownership of the Joint Stock Companies in the Parishes of Multia, Heinävesi, Sulkava, Ruokolahti and Luumäki: I. Introductory Part*[173] (1921, in Finnish; German summary). The same question is also elucidated in HEIKKI RENVALL's study, *The Struggle between Industry and Agriculture for the Forests of Finland*[174] (1914, published in Finnish and Swedish) and in the reports of the committees appointed by the Government (1906 and 1920).

Investigations into the Export of Forest Products and Export Duties of Forest Products.

The export of Finland's forest products has grown in a few decades to a degree previously inconceivable. It occupies such a dominant place in the country's exports that the value of all the other goods put together only amounts to 10—20 % of the whole exports. The development of the export of the forest products and their distribution among various kinds of goods and various countries has thus offered material for investigation, as interesting as it is important from a practical point of view. HEIKKI RENVALL has treated this subject in his comprehensive research work, *The Export of Finnish Forest Products Considered from the Point of View of Economics*[175] (1910, in Finnish). Shortly afterwards T. W. PAAVONEN published a statistical study, *The Export of Finnish Forest Products During the 25 Years' Period of 1886—1910*[176] (1911, in Finnish). The great importance of the export of forest products for Finnish railway traffic appears clearly from the study by TOPI KALLIO: *The Directions of the Railways from the Point of View of Export and the Public Revenue in Finland*[177] (1925, in Finnish).

Already during a score of years paper manufacturers have demanded measures for limiting the export of raw materials for paper making from the country. The projected limitation of the exports of small timber by means of export prohibition or duties has, however, been met with fierce resistance among the forest owners. A. BENJ. HELANDER has dealt with this dispute in two of his studies: *On the Export Duties on Small Timber*[178] (1909, in Finnish and Swedish), and *Export Duties on Timber: How to Plan Our Future Policy Concerning Duties with Due Regard to Economics*[179] (1918, in Finnish). The Government has recently appointed a committee for the examination of this question.

Investigations into the Development of Timber Prices.

Since Finland began in the latter half of last century to take part in an ever increasing degree in supplying the world's markets with forest products, timber prices in Finland have considerably increased. The great war with its complex consequences later on also influenced the prices.

T. W. PAAVONEN, T. HEIKKILÄ, and EINO SAARI investigated the development of timber prices in Finland. On the strength of the f.o.b. values of sawmill products, published in the official export statistics, PAAVONEN examined the price movement of the most important sawmill products, i. e., that of planks, battens, and boards, during the period of 25 years 1886—1910. The results of his investigations were published under the title, *Has the Rise in the Prices of Sawmill Products to be Taken into Account When Timber Sales are Made?*[180] (1916, in Finnish). In his study, *The Rise in the Prices of Saw Timber*[181] (1917, in Finnish), HEIKKILÄ examines the movement of sawlog prices in the Finnish State forests in 1871—1913. SAARI published a study, *The Stumpage Price and the Sale of Saw Timber in the Finnish State Forests in 1913—1922*[182] (1924, in Finnish; German summary). In a way, this work constitutes a continuation of HEIKKILÄ's study, but the subject is treated more extensively and more minutely, and a different investigation method was employed.

Investigations Concerning Forest Legislation.

An account of the earlier phases of the development of Finland's forest legislation is given by E. G. PALMÉN in his study, *Forest Legislation in Finland up to 1861*[183] (1914, in Finnish). ERKKI LAITAKARI has published a study, *A Survey of Forest Legislation in Different Countries*[184] (1923, in Finnish), describing the various kinds of forest laws and their application in various countries, and containing as well a condensed review of the development of forest legislation in the most prominent forest countries.

Investigations into the Distribution of the Fertile Soil.

The distribution of the fertile soil in Finland is an important question, particularly for the history of settlement, but also for agriculture and forestry, as well as for plant and zoogeography. In forest research circles, where attention was originally drawn to this question, it has been examined principally with the aid of botanical methods. The first impulse towards an elucidation of the question was given by A. K. CAJANDER who already during his researches of forest types (see p. 27) had noted the close correlation that exists between vegetation and the fertility of the soil. CAJANDER proves in his work, mentioned above (p. 34) *Principles of Silviculture I* and at the same time in Metsätaloudellinen Aikakauskirja (Review of Forestry) (1916, in Finnish) that by examining the distribution and occurrence of the more pretentious species of plants and plant communities in Finland, the distribution of the fertile soil is ascertained. Where there are plenty of pretentious species of plants or plant communities, there are also to be found considerable quantities of fertile soil. By marking on the map the places, where the more pretentious plants or plant communities occur, it is thus possible to get a general view as to the distribution of fertile soil. CAJANDER dealt rather more circumstantially with this question in his papers, *On the Distribution of Fertile Soil in Finland and on the Influence of this Distribution on the Economical Conditions of the Country*[185] (1923, in German), and *The Distribution of the Fertile Soil in Finland*[186] (1925, in Swedish; English summary), and in his previously (p. 28) mentioned

work *The Theory of Forest Types*, in which he also shows how closely the settlement of Finland has depended upon the distribution of the fertile soil.

O. J. LUKKALA, in the main resorting to CAJANDER's research methods, has examined the distribution of the fertile soil in Finland, particularly in East-Finland, where he was in a position to make circumstantial examinations. The results of the investigations have been published under the title of *Investigations of the Distribution of the Fertile Soil Area especially in Savo and Karjala (Carelia)*[187] (1919, in Finnish; German summary). In his publication, *On the Distribution of Agricultural Settlements among the Soils of the Different Forest Types in Finland*[188] (1922, in German), K. LINKOLA divides Finland into 13 agricultural and plant geographical districts, differing from one another with regard to the relative abundance of fertile soils and relative richness, hereby primarily basing himself on floral observation material. Each of these districts is further divided into smaller districts. On the basis of this classification the author then points out the lines of the future agricultural development, as well as that of settlement activity.

The influence of the distribution of the fertile soil upon the fauna has been examined by O. J. LUKKALA (the results are to be found in his publication mentioned above), by ILMARI HILDÉN: *On the Bird Fauna of the Different Forest Types*[189] (1920, in Finnish; German summary 1921), and by K. J. VALLE: *Investigations of Fishing Waters in the State Forest Evo*[190] (1923, in German).

Investigations into Settlement Conditions and the Settlement Policy.

The settlement of Finland took place, and in a large degree does so still, in the shelter of the forests. Settlement needs forests, but, on the other hand, forestry also requires settlers. This close dependency of theirs on each other, has had as a result that investigations into the settlement policy very often also become forest political investigations, at any rate they approach one another very closely. In the following some of the more important of such investigations will be mentioned.

The settlement history of the State lands and the results to date are circumstantially described in report No. 1 of the State Forest Committee appointed by the Government in 1917, the report having been published in 1920. In this report a policy will be found suggested for the future organization of settlement on the State lands. The report of the Settlement Committee, appointed by the Government in 1917, was also got ready in 1920, the report dealing with the settlement question in regard to the State lands. Already earlier the sub-committee of the Landless Population had dealt in its report published in 1904 with settling prospects and settling methods with regard to the State lands. — E. CAJANDER has published a review, *The Colonization Activity of the State and the Legislation Concerning It in Finland in the Beginning of the XX Century*[191] (1925, in Finnish and Swedish).

The settlement conditions of the northern parts of Finland have been examined specially by K. T. JUTILA and E. CAJANDER. JUTILA has published a research series, comprising 4 parts, *Researches into the Economic and Colonization Conditions of the Far North and Lapland*[192] (1920, and 1923, in Finnish; English and German summary). CAJANDER has published: *Agricultural and Colonization Conditions of Tenant Farms in State Forests in the Parish of Rovaniemi*[193] (1918, in Finnish), and *Agricultural and Colonization Conditions of Tenant Farms in State Forests in the Parish of Suomussalmi*[194] (1919, in Finnish). About the same time MAUNO PEKKALA carried out a similar investigation in some West-Finnish parishes. He gives an account of these investigations in his publication, *Investigations into the Management of Tenant Farms in the State Forests in the Parishes of Kuru, Parkano and Ikaalinen*[195] (1920, in Finnish; German summary).

Investigations into the Land Granting Policy of the State.

Besides what is needed for settlements, State forest land has in Finland also been granted to private persons for forestry purposes. These land grants are from a general point of view dealt with in the above mentioned report of the State Forest Committee. MAUNO PEKKALA has published a comprehensive research work, *On the Taxation and Partition of Land in the Parishes of Kuusamo, Kemijärvi and Kuolajärvi*[196] (1921, in Finnish; German summary). In his research work, *On the Forest Policy Applied to the Estates in Fee in East Finland*[197] (1919, in Finnish), EINO SAARI deals with the question of grants to private persons of State forests situated on the former Estates in Fee. In 1923 the Government appointed a committee for dealing with the same question. After the committee had finished its work, a comprehensive report was published in 1924. E. J. CASTRÉN has published a study: *The Recognition Forests and Factory Estates*[198] (1924, in Finnish).

3. Investigations Concerning Forest Utilization.

As has already been pointed out, investigations concerning forest utilization have so far been made on a very small scale in Finland. A. BENJ. HELANDER's *Forest Utilization*[199] (1918, second edition in 1922, in Finnish), contains several results of the author's own investigations, likewise Y. TALVITIE's handbook *Wood Distillation and Resin Making*[200] (1924, in Finnish). HELANDER has also published *Resin Tapping According to Observations Made in Lithuania, Poland and Germany*[201] (1919, in Finnish).

T. J. HINTIKKA has investigated the »curled wood» (in Finnish *visa*) of the white and the pubescent birch *(Betula verrucosa* and *B. odorata)*, which is much in demand by joiners, for which reason its price is high. Of the results of the investigation HINTIKKA has published a preliminary communication: *The »Visa» Disease of the Birches in Finland*[202] (1922, in German); according to this investigation the »Visa» formation in birch arises from the asymmetrical expansion of the pith rays. What are the causes of this pathological phenomenon, is so far unsettled.

Only the following three investigations on forest technological subjects have been published in the Acta Forestalia Fennica Series: OLLI HEIKINHEIMO's *Some Observations on the Cutting and Conservation of Fuel Wood*[203] (1919, in German), AUGUST RENVALL's *The Radial Shrinkage of Laplandish Pine Wood*[204] (1923, in German), and the same author's *Observations on the Eccentricity of Laplandish Pine Stem*[205] (1923, in German). I. LASSILA has only lately delivered to the press a critical review:

The Research of the Technical Properties of Trees Up to Now, Judged by Its Results and Systems [206] (in Finnish; English summary) and a historical study: *Sketches of the Earlier History of the Saw and Saw Frame* [207] (in Finnish; English summary).

As an historical publication may also be mentioned LENNART GRIPENBERG's work, *The Kymi Floating Association: A Memorial Publication Celebrating the 50 Years' Common Floating in the Basin of Päijänne 1873—1922* [208] (1924, published in Finnish and Swedish), giving a clear picture of the powerful development during last century and this of the floating conditions on the extensive Päijänne water-system. K. E. LINDBERG has prepared a study, *Legislation Concerning Floating and the Floating Conditions in Sweden and Norway* [209] (1917, in Swedish).

As the significance of chemical wood conversion has in recent years been greatly on the increase in Finland as in other countries, special attention has been paid to the chemical research of wood and particularly to the questions connected with the production of cellulose. This branch of research, however, does not belong to the domain of forestry research proper, for which reason the investigations dealing with it are here passed over. Chemical investigations of cellulose have been carried out especially by A. O. ASCHAN, G. K. BERGMAN, JARL ENCKELL, ALFONS HELSTRÖM, S. V. HINTIKKA, ERIK HÄGGLUND, F. W. KLINGSTEDT, H. ROSCHIER and O. ROUTALA and investigations concerned with dry distillation by A. O. ASCHAN and G. KOMPPA. The results of these investigations are to be found in the proceedings of the Finnish Academy of Science and the Finnish Society of Science, further in the »Meddelanden från Industriens Centrallaboratorium — Teollisuuden Keskuslaboratorion Tiedonantoja» (Proceedings of the Central Laboratory of Industries), »Acta Academiae Aboensis», »Finska Kemistsamfundets Meddelanden» (Proceedings of the Finnish Chemical Association), finally in the »Teknillinen Aikakauslehti» (Technical Periodical) and the »Teknikern» (Technician). Several investigations have simultaneously been published abroad, too, for instance in the periodicals »Der Papierfabrikant», Svensk Papperstidning» and »Kemisk Tidskrift».

Catalogue of Investigations Referred to in the Text.

(Abbreviations, see p. 6.)

[1] A. G. BLOMQVIST: *Tabeller framställande utvecklingen af jemnåriga och slutna skogsbestånd af tall, gran och björk.* Helsingfors 1872. 22 p. + 7 tables and 2 diagr.

[2] A. G. BLOMQVIST: *Undersökningar af tjocklekstillväxten hos timmerträd af tall och gran i olika delar af Finland.* Helsingfors 1897. VIII + 170 p. + 5 p. diagr.

[3] A. G. BLOMQVIST: *Finlands trädslag i forstligt hänseende beskrifna: I. Tallen, II. Granen.* F.F.M. 3, 1881 and 1883. 196 and 182 p. + 2 pl.

[4] A. G. BLOMQVIST: *Skogshushållningens nationalekonomi och synpunkter i forstpoliti.* Helsingfors 1893. 230 p.

[5] A. OSW. KIHLMAN: *Pflanzenbiologische Studien aus Russisch Lappland.* A.S. F.F.F. 6: 3, 1890. 264 + XXIV p. + 14 pl. and map.

[6] HJALMAR HJELT: *Conspectus Florae Fennicae.* A.S.F.F.F. 5, 21, 30, 35, 41, 51 and 54, 1888—1926.

[7] HJALMAR HJELT: *Utbredning af Finlands träd, buskar och ris med särskildt afseende å deras gränser.* F.F.M. 14, 1897. 43 p. + 2 maps.

[8] R. HULT: *Vedväxternas utbredning i Finland.* Vetenskapliga Meddelanden af Geografiska Föreningen i Finland 3, 1896, p. 1—61 with pl. and map.

[9] R. HULT: *Växtgeografiska anteckningar från den Finska Lappmarkens skogsregioner.* A.S.F.F.F. 16: 2, 1898. 200 p.

[10] A. K. CAJANDER: *Metsätieteellinen tutkimustoiminta ulkomailla ja ehdotus sen järjestämiseksi Suomessa.* Helsinki 1909. Liite Metsähallituksen vuosikertomukseen v. 1907. 138 p.

[11] A. K. CAJANDER: *Ueber Waldtypen.* Fennia 28 and A.F.F. 1, 1909. 175 p.

[12] A. K. CAJANDER und YRJÖ ILVESSALO: *Ueber Waldtypen II.* Drei Vorträge. Fennia 43: 3 and A.F.F. 20, 1921. 77 p.

[13] A. K. CAJANDER: *The Theory of Forest Types.* A.F.F. 29, 1926. 108 p.
A. K. CAJANDER: *Metsätyyppiteoria.* A.F.F. 29, 1925. 84 p.

[14] A. K. CAJANDER: *Was wird mit den Waldtypen bezweckt?* A.F.F. 25, 1923. 16 p.

[15] K. LINKOLA: *Studien über den Einfluss der Kultur auf die Flora in den Gegenden nördlich vom Ladogasee I—II.* A.S.F.F.F. 45: 1, 1916 and 45: 2, 1921. Part I 429 p. + 6 tables and 20 maps, Part II 490 p.

[16] K. LINKOLA: *Itä-Karjalan metsätyyppejä koskevia havaintoja.* Suomen Metsätieteellisen Seuran toiminta v. 1909—1917, A.F.F. 7, 1917, p. 224—245.

[17] K. LINKOLA: *Muistiinpanoja kasvillisuudesta talvikkityypin (Pyrola-tyypin) metsiköissä.* Mets. Aik. 1919, p. 174—182.

[18] O. J. LAKARI: *Tutkimuksia Pohjois-Suomen metsätyypeistä.* A.F.F. 14, 1920. 85 p. + 10 tables and map. Summary: Untersuchungen über die Waldtypen in Nordfinnland. 8 p.

[19] ALVAR PALMGREN: *Zur Kenntnis des Florencharakters des Nadelwaldes.* A.F.F. 22, 1922. 115 p. + map.

[20] VILJO KUJALA: *Havaintoja Kuusamon ja sen eteläpuolisten kuusimetsäalueiden metsä- ja suotyypeistä.* Cs. I.F.F. 4, 1921. 23 p. + 42 p. tables. Summary: Beobachtungen über die Wald- und Moortypen von Kuusamo und der südlich von dort gelegenen Fichtenwaldgebieten. 3 p.

[21] ALVAR PALMGREN: *Studier öfver löfängsområdena på Åland: I. Vegetationen, II. Floran, III. Statistisk undersökning af floran.* A.S.F.F.F. 42, 1915—1917. 634 p. + 16 tables and 2 maps. Part III has also been published in German: A.F.F. 22, 1922.

[22] ALVAR PALMGREN: *Die Entfernung als pflanzengeographischer Faktor.* A.S. F.F.F. 49: 1, 1921. 103 p. + 10 tables and map.

[23] ALVAR PALMGREN: *Die Artenzahl als pflanzengeographischer Charakter sowie der Zufall und die säkulare Landhebung als pflanzengeographische Faktoren.* Acta Botanica Fennica 1: 1, 1925 and Fennia 46: 2, 1925. 142 p. + 2 maps.

[24] YRJÖ ILVESSALO: *Vegetationsstatistische Untersuchungen über die Waldtypen.* A.F.F. 20, 1922. 73 p.

[25] VILJO KUJALA: *Untersuchungen über die Waldvegetation in Süd- und Mittelfinnland: I. Zur Kenntnis des ökologisch-biologischen Charakters der Pflanzenarten unter spezieller Berücksichtigung der Bildung von Pflanzenvereinen. A. Gefässpflanzen. B. Laubmoose. C. Flechten. II. Über die Begrenzung der Siedlungen.* Cs. I.F.F. 10, 1926 and 1925. Part I, A. 146 p., B. 47 p. + 2 pl., C. Ready for printing. Part II, 26 p. and appendix.

[26] RAF. BJÖRKENHEIM: *Beiträge zur Kenntnis einiger Waldtypen in den Fichtenwaldungen des deutschen Mittelgebirges.* A.F.F. 6, 1919. 65 p. + 5 tables.

[27] K. LINKOLA: *Waldtypenstudien in den Schweizer Alpen.* Veröffentlichungen des Geobotanischen Institutes Rübel in Zürich 1, 1924. 86 p.

[28] WIDAR BRENNER: *Studier över vegetationen i en del av västra Nyland och dess förhållande till markbeskaffenheten.* Fennia 43: 2, 1921 and Geologiska Kommissionens geotekniska meddelanden 32, 1921. 97 p. Summary: Studien über die Vegetation im westlichen Nyland (Süd-Finnland) und ihr Verhältnis zu den Eigenschaften des Bodens. 8 p.

[29] J. VALMARI: *Beiträge zur chemischen Bodenanalyse.* A.F.F. 20, 1921. 31 p. + 36 p. tables.

[30] YRJÖ ILVESSALO: *Ein Beitrag zur Frage der Korrelation zwischen den Eigenschaften des Bodens und dem Zuwachs des Waldbestandes.* A.F.F. 25, 1921. 31 p.

[31] V. T. AALTONEN: *Über den Aziditätsgrad (p_H) des Waldbodens.* Cs. I.F.F. 9, 1925. 33 p. + 16 p. tables.

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19.

OLLI HEIKINHEIMO and EINO SAARI (1922): Forestry in Finland. (In Finnish and English.)

AUGUST RENVALL ja AARNE BOMAN: Tutkimuksia yhtiöiden maanomistuksesta Multian, Heinäveden, Sulkavan, Ruokolahden ja Luumäen kunnissa: I. Johdannollinen osa. *Summary:* Untersuchungen über den Grundbesitz der Aktiengesellschaften in den Kommunen Multia, Heinävesi, Sulkava, Ruokolahti und Luumäki: I. Einleitender Teil.

20.

A. K. CAJANDER und YRJÖ ILVESSALO (1921): Ueber Waldtypen II.

A. K. CAJANDER (1922): Zur Begriffsbestimmung im Gebiet der Pflanzentopographie.

YRJÖ ILVESSALO (1922): Vegetationsstatistische Untersuchungen über die Waldtypen.

J. VALMARI (1921): Beiträge zur chemischen Bodenanalyse.

21.

A. K. CAJANDER (1921): Zur Frage der gegenseitigen Beziehungen zwischen Klima, Boden und Vegetation.

—»— (—»—): Zur Kenntnis der Einwanderungswege der Pflanzenarten nach Finnland.

—»— (—»—): Einige Reflexionen über die Entstehung der Arten.

S. E. MULTAMÄKI (1921): Tilastoa Pohjois-Suomen metsä- ja suotyypeistä. *Summary:* Beiträge zur Statistik der Wald- und Moortypen Nordfinnlands.

MAUNO PEKKALA (1921): Verollepano- ja jakotoimituksista Kuusamon, Kemijärven ja Kuolajärven knihtikontrahtipitäjissä. *Summary:* Über die Besteuerungs- und Landeinteilungsmassnahmen in den Kirchspielen Kuusamo, Kemijärvi und Kuolajärvi.

22.

ALVAR PALMGREN (1922): Über Artenzahl und Areal sowie über die Konstitution der Vegetation.

—»— (—»—): Zur Kenntnis des Florencharakters des Nadelwaldes.

K. LINKOLA (1922): Zur Kenntnis der Verteilung der landwirtschaftlichen Siedlungen auf die Böden verschiedener Waldtypen in Finnland.

A. L. BACKMAN und ASTRID CLEVE-EULER (1922): Die fossile Diatomeenflora in Österbotten.

23.

(A memorial publication dedicated to late professor J. P. NORRLIN. Edited 1923 by A. K. CAJANDER.)

A. K. CAJANDER: Gedächtnisrede für Johan Petter Norrlin, gehalten in der Versammlung der Finnischen Wissenschaftssozietät am 10. Mai 1918.

Verzeichnis der Schriften Norrlins.

Lectio praecursoria, gehalten von J. P. Norrlin bei seiner Disputation am 13. Mai 1871.

J. P. NORRLIN (1870): Beiträge zur Flora des südöstlichen Tavastlands.

—»— (1871): Flora Kareliae onegensis: I. Über die Vegetation von Onega-Karelien und die naturgeschichtliche Grenze Finnlands sowie Skandinaviens im Osten.

—»— (1873): Bericht über eine naturgeschichtliche Reise in Torneå-Lappmark.

—»— (—»—): Übersicht der Moose und Flechten von Torneå-(Muonio-) und den angrenzenden Teilen von Kemi-Lappmark.

—»— (—»—): Über die Prinzipien bei der Anordnung botanischer Exkursionen in Finnland.

—»— (1884): Adnotationes de Pilosellis Fennicis I.

—»— (1906): Die Habichtskräuter Finnlands.

A. K. CAJANDER (1923): Einige Hauptzüge der pflanzentopographischen Forschungsarbeit in Finnland. Vortrag gehalten in der Jahresversammlung der Finnischen Akademie der Wissenschaften am 10. April 1922.

24,

A. K. CAJANDER (1923): Der Anbau ausländischer Holzarten als forstliches und pflanzengeographisches Problem.

A. F. TIGERSTEDT (1922): Arboretum Mustila: I. Havupuut. *Summary:* Arboretum Mustila: I. Conifers.

25.

A. K. CAJANDER (1923): Forstlich-geographische Übersicht Finnlands.

—»— (—»—): Über das Verhältnis zwischen Waldzuwachs und Holzverbrauch in Finnland.

—»— (—»—): Über die Verteilung des fruchtbaren Bodens in Finnland und über den Einfluss dieser Verteilung auf die wirtschaftlichen Verhältnisse im Lande.

—»— (—»—): Was wird mit den Waldtypen bezweckt?

J. W. LINDEBERG (1924): Über die Berechnung des Mittelfehlers des Resultates einer Linientaxierung.
V. T. AALTONEN (1923): Über die räumliche Ordnung der Pflanzen auf dem Felde und im Walde.
—»— (—»—): Zur Kenntnis der Ausfällung des Eisens im Boden.
—»— (—»—): Versuche zur Klärung der Schutzwirkungen von wässerigen Humusauszügen.
—»— (1924): Über neuere forstliche Betriebsarten in Deutschland.
YRJÖ ILVESSALO (1923): Ein Beitrag zur Frage der Korrelation zwischen den Eigenschaften des Bodens und dem Zuwachs des Waldbestandes.
P. KOKKONEN (1923): Beobachtungen über das Wurzelsystem der Kiefer in Moorböden.
K. J. VALLE (1923): Fischwasseruntersuchungen im Staatsrevier Evo.

26.

A. BENJ. HELANDER (1923): Metsätalouden tarjoamasta ansiotyöstä: I. Kruununmetsät vv. 1911—1913. *Summary:* Der Arbeitsbedarf in der Forstwirtschaft.
WERNER CAJANUS—YRJÖ ILVESSALO (1923): Tutkimuksia yksityismetsien tilasta Hämeen läänin keskiosissa: Sahalahden ja Kuhmalahden pitäjien metsät. *Summary:* Untersuchungen über den Zustand der Privatwälder in den mittleren Teilen des Regierungsbezirkes Häme (Tavastland): Die Wälder der Kirchspiele Sahalahti und Kuhmalahti.
AUGUST RENVALL (1923): Das radiale Schwindmass des lappländischen Kiefernstammholzes.
—»— (—»—): Beobachtungen über die Exzentrizität des lappländischen Kiefernstammes.
EINO SAARI (1923): Kuloista, etupäässä Suomen valtionmetsiä silmällä pitäen. *Summary:* Forest Fires in Finland, with Special Reference to State Forests.

27.

S. E. MULTAMÄKI (1923): Tutkimuksia ojitettujen turvemaiden metsänkasvusta. *Summary:* Untersuchungen über das Waldwachstum entwässerter Torfböden.
EINO SAARI (1923): Sahapuun kantohinta ja menekki Suomen valtionmetsissä vv. 1913—1922. *Summary:* Preis und Absatz des Sägeholzes in den Staatswäldern Finnlands in den Jahren 1913—1922.
P. KOKKONEN (1923): Tutkimuksia viemärien kuntoon vaikuttavista seikoista. *Summary:* Studies on the Circumstances Affecting the Condition of Drainage Canals.

28.

K. T. JUTILA (1923): Tutkimuksia Perä-Pohjolan ja Lapin talous- ja asutusoloista: I. Luonnontieteellis-taloudellinen yleiskatsaus. III. Maanviljelyksestä. IV. Karjanhoidosta. *Summary:* Researches into the Economic and Colonization Conditions of Perä-Pohjola and Lappi (Lapland): I. Natural Scientific and Economic Survey. (II. See A.F.F. 18.). III. Re Plant Culture. VI. Re Animal Culture.

29.

V. T. AALTONEN (1925): Allgemeines über die Einwirkung der Bäume auf einander.
A. K. CAJANDER (1925): Metsätyyppiteoria.
A. K. CAJANDER (1926): The Theory of Forest Types.
T. HEIKKILÄ (1925): Kasvututkimuksia Perä-Pohjolasta. *Summary:* Zuwachsuntersuchungen aus Nordnord-Finnland.
MARTTI HERTZ (1925): Niinipuun uudistumisesta Suomessa. *Summary:* Uber die Verjüngung der Linde in Finnland.

30.

ERIK LÖNNROTH (1925): Untersuchungen über die innere Struktur und Entwicklung gleichaltriger Kiefernbestände basiert auf Material aus der Südhälfte Finnlands.
—»— (1926): Der stereometrische Bestandsmittelstamm.
P. KOKKONEN (1926): Beobachtungen über die Struktur des Bodenfrostes.
ERIK LÖNNROTH (1926): Ein Dendrometer.

Appendix 2

Communicationes ex Instituto Quaestionum Forestalium Finlandiae Editae

(Publications of the Forest Research Institute of Finland)

1–10 (1919–1926)

1.

V. T. AALTONEN (1919): Kangasmetsien luonnollisesta uudistumisesta Suomen Lapissa. *Summary:* Über die natürliche Verjüngung der Heidewälder im Finnischen Lappland.

2.

O. J. LAKARI (1920): Tutkimuksia kuusen ja männyn kasvusuhteista Pohjois-Suomen paksusammaltyypillä. *Summary:* Untersuchungen über die Zuwachsverhältnisse der Fichte und Kiefer auf dem Dickmoostypus in Nordfinnland.

OLLI HEIKINHEIMO (1920): Kuusimuodoista ja niiden metsätaloudellisesta arvosta. *Summary:* Über die Fichtenformen und ihren forstwirtschaftlichen Wert.

—»— (—»—): Kuusen iän määräämisestä ja kuusen myöhäisjuuristä. *Summary:* Über die Bestimmung des Alters der Fichte und ihre Adventivwurzeln.

O. J. LAKARI (1920): Tutkimuksia kuusen karsimisesta. *Summary:* Untersuchungen über die Astung der Fichte.

3.

O. J. LAKARI (1920): Tutkimuksia männyn muodosta. *Summary:* Untersuchungen über die Form der Kiefer.

OLLI HEIKINHEIMO (1920): Pohjois-Suomen kuusimetsien esiintyminen, laajuus ja puuvarastot. *Summary:* Vorkommen, Umfang und Holzvorräte der Fichtenwälder in Nordfinnland.

—»— (—»—): Suomen lumituhoalueet ja niiden metsät. *Summary:* Die Schneeschadengebiete in Finnland und ihre Wälder.

VÄINÖ AUER (1921) Piirteitä Keski-Pohjanmaan soistumistavoista. *Summary:* Über Versumpfungsprozesse in Mittel-Österbotten.

4.

Metsätieteellisen Koelaitoksen perustaminen ja sen toiminta vuosina 1918—1920. *Summary:* Die Gründung der Forstwissenschaftlichen Versuchsanstalt Finnlands und ihre Wirksamkeit in den Jahren 1918—1920.

O. J. LAKARI (1921): Tutkimuksia kuusimetsien uudistumisvuosista Etelä- ja Keski-Suomessa. *Summary:* Untersuchungen über die Verjüngungsjahre der Fichtenwälder in Süd- und Mittelfinnland.

OLLI HEIKINHEIMO (1921): Suomen metsärajametsät ja niiden vastainen käyttö. *Summary:* Die Waldgrenzwälder und ihre künftige Nutzung.

VÄINÖ AUER (1921): Tutkimuksia Lapin tulvamailta. *Summary:* Untersuchungen in den Überschwemmungsgebieten Lapplands.

VILJO KUJALA (1921): Havaintoja Kuusamon ja sen eteläpuolisten kuusimetsäalueiden metsä- ja suotyypeistä. *Summary:* Beobachtungen über die Wald- und Moortypen von Kuusamo und der südlich von dort gelegenen Fichtenwaldgebiete.

5.

EINO SAARI (1922): Kotitarvepuun kulutus maaseudulla Turun ja Porin läänissä. *Summary:* Über den Verbrauch des Holzes im Hausbedarf auf dem Lande in dem Län Turku-Pori (Abo-Björneborg).

OLLI HEIKINHEIMO (1922): Pohjois-Suomen kuusimetsien hoito. *Summary:* Über die Bewirtschaftung der Fichtenwälder Nordfinnlands.

LAURI ILVESSALO (1923): Raivolan lehtikuusimetsä. *Summary:* Der Lärchenwald bei Raivola.

6.

VÄINÖ AUER (1922): Suotutkimuksia Kuusamon ja Kuolajärven vaara-alueilta. *Summary:* Moorforschungen in den Vaaragebieten von Kuusamo und Kuolajärvi.

7.

VILJO KUJALA (1924): Tervaleppä (Alnus glutinosa (L.) Gaertn.) Suomessa. Kasvimaantieteellinen tutkimus. *Summary:* Die Schwarzerle (Alnus glutinosa (L.) Gaertn.) in Finnland. Pflanzengeographische Untersuchung.

—»— (—»—): Laskelmia lehtipuiden lehtikauden pituudesta ja puiden kukkimisajoista Suomessa. *Summary:* Berechnungen über die Länge der Laubperiode der Laubbäume und Blühzeiten der Bäume in Finnland.

M. LAPPI-SEPPÄLÄ (1924): Linja-arvioimisesta ja sen tarkkuudesta. *Summary:* Über die Linientaxierung und deren Genauigkeit.

8.

VILJO KUJALA (1924): Keski-Pohjanmaan soiden synnystä. *Summary:* Ein Beitrag zur Kenntnis der Entstehung der Moore in Mittelösterbotten.

VÄINÖ AUER (1924): Eräitä vastaisia tehtäviä suotutkimuksen alalla Suomessa. *Summary:* Über einige künftige Aufgaben der Moorforschung in Finnland.

—»— (—»—): Die postglaziale Geschichte des Vanajavesisees.

9.

YRJÖ ILVESSALO (1924): The Forests of Finland: the Forest Resources and the Conditions of the Forests. (In Finnish, Swedish and English.)

OLLI HEIKINHEIMO (1924): Suomen metsien metsänhoidollinen tila.

V. T. AALTONEN (1925): Metsikön itseharventumisesta ja puiden kasvutilasta luonnonmetsissä. *Summary:* Über die Selbstabscheidung und den Wuchsraum der Bäume in Naturbeständen.

—»— (—»—): Über den Aziditätsgrad (p_H) des Waldbodens.

M. LAPPI-SEPPÄLÄ (1925): Metsänkasvun ja hakkuun välisestä suhteesta sekä puunkulutuksesta ja metsämaitten tuottokyvystä Turun-Porin läänissä. *Summary:* On the Balance of Forest Growth and Felling as well as on the Wood Consumption and the Yield Capacity of Forest Lands in the Province of Turku-Pori.
VÄINÖ AUER (1925): Investigations of the Ancient Flora of Häme (Tavastland).

10.

VILJO KUJALA: Untersuchungen über die Waldvegetation in Süd- und Mittelfinnland: I (1926). Zur Kenntnis des ökologisch-biologischen Charakters der Pflanzenarten unter spezieller Berücksichtigung der Bildung von Pflanzenvereinen. A. Gefässpflanzen. B. Laubmoose. C. Flechten. II (1925). Über die Begrenzung der Siedlungen.
—»— (1926): Untersuchungen über den Einfluss von Waldbränden auf die Waldvegetation in Nord-Finnland.
V. T. AALTONEN (1926): Über die Umsetzungen der Stickstoffverbindungen im Waldboden.