FERNOW BERNHARD EDUARD

A BRIEF HISTORY OF FORESTRY.

Bernhard Fernow

A Brief History of Forestry.

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Содержание

Bernhard E. Fernow
A Brief History of Forestry. / in Europe, the United States and Other Countries

PREFACE TO SECOND EDITION

It has been a great surprise and also a great gratification to the author to see the first edition of this volume exhausted within less than two years since its appearance in complete form. The gratification has come especially because of the opportunity thus afforded of revision, improvement in style, and correction of the many inaccuracies which the first edition contained, excusable only by the manner in which (as explained in the preface of the first edition) the volume had come into existence.

Only in a few cases has it seemed desirable to expand, since the object of the book is not to be complete, but to give as briefly as possible an oversight over a rather large field. The chapter on France has, however, been entirely re-written and considerably enlarged to meet the just criticisms of reviewers; the excellent work of Huffel, full of historical data, which was not available when the first edition was printed, permitting a clearer and fuller statement to be made.

As long as history is in the making, a book of this kind can hardly be brought up to date. This should especially be kept in mind by the reader in regard to the statistics brought in. Since these are only to serve in general to show the magnitude of the interests involved, they may without damage be only approximately accurate, and even of older date.

Some of the chapters have been submitted for criticism and corrections to correspondents in the various countries to which they refer. For the kindly assistance of these friends thanks is due from the author.

Toronto, October, 1911.B. E. Fernow.

PREFACE TO FIRST EDITION

This publication is the result of a series of 25 lectures which the writer was invited to deliver before the students of forestry in Yale University as a part of their regular course of instruction during the session of 1904.

Circumstances made it desirable, in the absence of any existing textbooks on the subject, to print at once, for the sake of ready reference, the substance of the lectures while they were being delivered.

This statement of the manner in which the book came into existence will explain and, it is hoped, excuse the crudities of style, which has been also hampered by the necessity of condensation.

The main object was to bring together the information, now scattered and mostly inaccessible to English or American readers: the style has been sacrificed to brevity; it is a book of expanded lecture notes.

In the nature of the case the book does not lay claim to any originality except in the manner of presentation, being merely a compilation of facts gathered mostly from other compilations, official documents and journals.

For none of the countries discussed does a complete work on the history of forests and forestry exist, excepting in the case of Germany, which can boast of a number of comprehensive works on the subject. It was, therefore, possible to treat that country more *in extenso*. Moreover, it appeared desirable to enlarge upon the history of that country, since it is pre-eminently in the lead in forestry matters and has passed through all the stages of development of forest policies and forestry practice, which, with more or less variations must be repeated in other countries.

Especially the growth of the technical science and art of forestry, which has been developed in Germany for a longer time and to a more refined degree than in other countries, has been elaborated in the chapter relating to that country.

For some of the other countries available sources of information were quite limited. The writer believes, however, that for the purpose of this brief statement the data collected will be found sufficient.

In order to make conditions existing in the different countries and their causes more readily understood it appeared desirable to give very brief historic references to their political and economic development and also brief statements of their general physical conditions.

Present conditions of forest policy and forest administration have sometimes been enlarged upon beyond the requirements of historical treatment.

Ithaca, N.Y., May, 1907.B. E. Fernow.

INTRODUCTORY

The value of studying the historical development of an economic subject or of a technical art which, like forestry, relies to a large extent upon empiricism, lies in the fact that it brings before us, in proper perspective, accumulated experience, and enables us to analyze cause and effect, whereby we may learn to appreciate the reasons for present conditions and the possibilities for rational advancement.

If there be one philosophy more readily derivable than another from the study of the history of forestry it is that history repeats itself. The same policies and the same methods which we hear propounded to-day have at some other time been propounded and tried elsewhere: we can study the results, broadening our judgment and thereby avoid the mistakes of others.

Nowhere is the record of experience and the historic method of study of more value than in an empiric art like forestry, in which it takes decades, a lifetime, nay a century to see the final effects of operations.

Such study, if properly pursued, tends to free the mind from many foolish prejudices and particularly from an unreasonable partiality for our own country and its customs and methods merely because they are our own, substituting the proper patriotism, which applies the best knowledge, wherever found, to our own necessities.

Forestry is an art born of necessity, as opposed to arts of convenience and of pleasure. Only when a reduction in the natural supplies of forest products under the demands of civilization, necessitates a husbanding of supplies or necessitates the application of art or skill or knowledge in securing a reproduction, or when unfavorable conditions of soil or climate induced by forest destruction make themselves felt does the art of forestry make its appearance. Hence its beginnings occur in different places at different times and its development proceeds at different paces.

In the one country, owing to economic development, the need of an intensive forest management and of strict forest policies may have arrived, while in another, rough exploitation and wasteful practices are still natural and practically unavoidable. And such differences, as we shall see, may even exist in the different parts of the same country.

The origin and growth of the art, then, is dependent on economic and cultural conditions, on various economic development and on elements of environment. The development of the art can only be understood and appreciated through the knowledge of such environment, of such other developments as of agriculture, of industries, of means of transportation, of civilization generally.

Hence we find, for instance, that England, located so as to be accessible by sea from all points of the compass and with oceanic shipping well developed, can apparently dispense with serious consideration of the forest supply question.

Again, we find that more than a century ago fear of a timber famine agitated not only the dense populations of many European countries, but even the scanty population of the United States, in spite of the natural forest wealth which is still supplying us; and not without good reason, for at that time wood was the only fuel and rivers the only means of transportation; hence local scarcity was to be feared and was not unfrequently experienced when accessible forest areas had been exploited. Railroad and canal development and the use of coal for fuel changed this condition on both continents. Now, with improved means of transportation by land and by sea, the questions of wood supply and of forestry development, which at one time were of very local concern, have become world questions, and he who proposes to discuss intelligently forest conditions and forestry movement in one country must understand what is going on in other countries.

As will appear from the study of the following pages, with the exception of some parts of central Europe or of some sporadic attempts elsewhere to regulate forest use, the development of the forestry idea belongs essentially to the 19th century, and more especially to the second half, when the rapid

development of railroads had narrowed the world, and the remarkable development of industries and material civilization called for increased draft on forest resources.

Yet we are still largely ignorant as to the extent of available forest area, not only in this country but elsewhere: we do not know whether it be sufficient in extent and yield to furnish a continuous supply for the needs of our civilization, or, if not, for how long a time it will suffice. We can only make very broad statements as to questions of wood supply, and very broad inferences from them as argument for the need of a closer study of forest conditions and of the practice of forestry:

1. Practically, the northern temperate zone alone produces the kinds of wood which enter most largely into our economy, namely the soft conifers and the medium hard woods; most of the woods of the tropics are very hard, fit primarily for ornamental use and hence less necessary. Possibly a change in the methods of the use of wood may also change the relative economic values, but at present the vast forests of the tropical countries are of relatively little importance in the discussion of wood supply for the world.

2. The productive forest area, of the temperate zone, in which the industrial nations are located, has continuously decreased. We shall not be far from wrong in stating this area liberally, to be at present around 2,500 million acres,[1] namely in Europe, 800 million acres; in Asia, 800 million acres; in North America, 900 million acres. How much of this acreage contains available virgin timber, how much is merely potential forest, how much growing crop, it is impossible to state.

3. The civilized wood consuming population of this territory is about 500 million, hence the per capita acreage is still 5 acres. Taking the European countries which now have to import all or part of their consumption (excess over exports), we find that their population is estimated at 180 million and that they use 30 cubic feet of wood per capita, of which 12 cubic feet is log timber; or altogether they use 2,200 million cubic feet of this latter description, of which they import in round numbers 1,000 million at a cost of about 250 million dollars; their forest acreage of 100 million acres being insufficient to produce, even under careful management as in Germany, more than two-thirds of their needs. And the wood consumption in all these nations is growing at the rate of $1\frac{1}{2}$ to 2 per cent. annually.

4. The deficiency is at present supplied by the export countries, Russia, Sweden, Norway, Austria-Hungary, Canada and United States, and these countries themselves also increasing their consumption, are beginning to feel the drain on their forest resources, which are for the most part merely roughly exploited.

5. If we assume a log timber requirement by the 500 million people of 6000 million cubic feet and could secure what France annually produces, namely a little less than 9 cubic feet of such timber per acre, the area supposed to be under forest would amply suffice. But a large part of it is in fact withdrawn from *useful* production and of the balance not more than 250 million acres at best are as yet under management for continuous production. Hence attention to forestry is an urgent necessity for every industrial nation.

The history of the forest in all forest countries shows the same periods of development.

First hardly recognized as of value or even as personal property, the forest appears an undesirable encumbrance of the soil, and the attitude of the settler is of necessity inimical to the forest: the need for farm and pasture leads to forest destruction.

The next stage is that of restriction in forest use and protection against cattle and fire, the stage of conservative lumbering. Then come positive efforts to secure re-growth by fostering natural regeneration or by artificial planting: the practice of silviculture begins. Finally a management for continuity – organizing existing forest areas for sustained yield – forest economy is introduced.

[1] The total forest area of the world is supposed to be 3,800 million acres.

That the time and progress of these stages of development and the methods of their inauguration vary in different parts of the world is readily understood from the intimate relation which, as has been pointed out, this economic subject bears to all other economic as well as political developments.

At the present time we find all the European nations practicing forestry, although with a very varying degree of intensity. The greatest and most universal development of the art is for good reasons to be found in Germany and its nearest neighbors. Early attention to forest conservancy was here induced by density of population, which enforces intensity in the use of soil, and by the comparative difficulty of securing wood supplies cheaply enough from outside. On the other hand, such countries as the Mediterranean peninsulas by their advantageous situation with reference to importations, with their mild climate and less intensive industrial development, have felt this need less.

Again, the still poorly settled and originally heavily timbered countries of the Scandinavian peninsula and the vast empire of Russia are still heavy exploiters of forest products and are only just beginning to feel the drain on their forest resources; while the United States, with as much forest wealth as Russia, but with a much more intensive industrial development, has managed to reach the stage of need for a conservative forest policy in a shorter time.

From each of the European countries we learn something helpful towards inaugurating such policies, and while, owing to a different historical background and to different political and social conditions, none of their administrative methods and measures may appeal to us, the principles underlying them as well as those underlying their silvicultural methods remain the same; they are applicable everywhere, and can best be recognized and studied in the history of their development.

THE FOREST OF THE ANCIENTS

Waldgeschichte des Alterthums, by August Seidensticker, 1886, 2 vols., pp. 863, is a most painstaking compilation from original sources of notes regarding the forest conditions and the knowledge of trees, forests and forestry among the ancients. Contains also a full bibliography.

Die Waldwirthschaft der Rœmer, by J. Trurig, collects the knowledge, especially of arboriculture and silviculture, possessed by the Romans.

Forstwissenschaftliche Leistungen der Altgriechen, by Dr. Chloros, in Forstwissenschaftliches Centralblatt, 1885, pp. 8.

Archeologia forestale, Dell' antica storia e giurisprudenza forestale in Italia, by A. di Berenger, 1859.

The forest was undoubtedly the earliest home of mankind, its edible products forming its principal value. Its wild animals developed the hunter, the chase first furnishing means of subsistence and then exhilaration and pleasure. Next, it was the mast and, in its openings, the pasture which gave to the forest its value for the herder, and only last, with the development into settled communities and more highly civilized conditions of life, did the wood product become its main contribution toward that civilization. Finally, in the refinement of cultural conditions in densely settled countries is added its influence on soil, climate and water conditions.

Although there is no written history, there is little doubt that these were the phases in the appreciation of woodlands in the earliest development of mankind, for we find the same phases repeated in our own times in all newly settled countries.

As agriculture develops, the need for farming ground overshadows the usefulness of the forest in all these directions, and it is cleared away; moreover, as population remains scanty, a wasteful use of its stores forms the rule, until necessity arises for greater care in the exploitation, for more rational distribution of farm and forest area, and finally for intentional reproduction of wood as a useful crop.

Correspondingly forest conditions change from the densely forested hills and mountain slopes during the age of the nomad and hunter to the "enclaves" or patches of field and pasture enclosed by the forest of the first farmers, then follows the opening up of the valleys and lowlands, while the hill and mountain farms may return to forest, and finally, with the increase of population and civilization in valleys and plains, a reduction of the forest area and a decrease of forest wealth results.

1. *Forest Conditions*

While we have many isolated references to forest conditions and progress of forest exploitation among the ancients in the writings of poets and historians, these are generally too brief to permit us to gain a very clear picture of the progress of forest history; except in isolated cases, they furnish only glimpses, allowing us to fill in the rest to some extent by guess.

That the countries occupied and known to the ancients, even Spain and Palestine, were originally well-wooded there seems little doubt, although in the drier regions and on the drier limestone soils, the forest was perhaps open, as is usual under such conditions, and truly arid, forestless regions were also found where they exist now. Although it has been customary to point out some of the Mediterranean and Eastern countries as having become deserts and depopulated through deforestation, and although this is undoubtedly true for some parts, as Mount Lebanon and Syria, generalization in this respect is dangerous.

We know, however, that by the 11th century before Christ, in Palestine, Asia Minor and Greece, especially in the neighborhood of thriving cities, the forest cover had vanished to a large extent and building timber for the temples at Tyre and Sidon had to be brought long distances from Mount Lebanon, whose wealth of cedar was also freely drawn upon for ship timber and other structures. Although about 465 B.C. Artaxerxes I, having recognized the pending exhaustion of this mountain forest, had attempted to regulate the cutting of timber, the exploitation had by 333 B.C. progressed to such an extent that Alexander the Great found at least the south slope exhausted and almost woodless.

The destruction by axe and fire of the celebrated forests of Sharon, Carmel and Bashan is the theme of the prophet Isaiah writing about 590 B.C.; and the widespread devastation of large forest areas during the Jewish wars is depicted by Josephus. In Greece, the Persian wars are on record as causes of widespread forest destruction. Yet in other parts, as on the island of Cyprus, which, originally densely wooded, had rapidly lost its forest wealth during Cleopatra's time through the development of mining and metallurgical works, ship building and clearing for farms, the kings seemed to have been able to protect the remnants for a long time, so that respectable forest cover exists even to date.

The Romans seem to have had still a surplus of ship timber at their command in the third and second centuries before Christ, when they did not hesitate to burn the warships of the Carthaginians (203 B.C.) and of the Syrians (189 B.C.), although it may be that other considerations forced these actions. Denuded hills and scarcity of building timber in certain parts are mentioned at the end of the third century before Christ, and that the need for conservative use of timber resources had arrived also appears from the fact that when (167 B.C.) the Romans had brought Macedonia under their sway, the cutting of ship timber in the extensive forests of that country was prohibited. Although at that time the Roman State forests were still quite extensive, it is evident that under the system of renting these for the mast and pasture and for the exploitation of their timber to companies of contractors, their devastation must have progressed rapidly. Yet, on the whole, with local exceptions, Italy remained well wooded until the Christian era.

In Spain, according to Diodorus Siculus (about 100 B.C.), the Southern provinces were densely wooded when about 200 B.C. the Romans first took possession; but soon after a great forest fire starting from the Pyrenees ran over the country, exposing deposits of silver ore, which invited a large influx of miners, the cause of reckless deforestation of the country. The interior of this peninsula, however, was probably always forestless or at least scantily wooded.

While through colonization, exploitation, fire and other abuse, the useful forest area was decimated in many parts, the location of the Mediterranean peninsular countries was such that wood supplies could be readily secured by water from distant parts, and the *lignarii* or wood merchants of Italy drew their supplies even from India by way of Alexandria; they went for Ash to Asia Minor; for

Cedar to Cilicia; Paphlagonia, Liguria and Mauritania became the great wood export countries. It is interesting to note that a regular wood market existed in Rome, as in Jerusalem, and at the former place firewood was sold by the pound (75c per 200 lbs., in Cicero's time). At the same time that the causes of devastation were at work the forest area also increased in some parts, recovering ground lost during wars and through the neglect of farms by natural seeding; much less by active effort, although planting of trees in parks, vineyards and groves was early practiced to a limited extent.

2. *Development of Property*

As to development of forest property we have also only fragmentary information. Nomads do not know soil as property. When they become settled farmers the plowland, the vineyard or olive grove and orchard are recognized as private property, but all the rest remains common property or nobody's in particular; and even the private property was not at first entirely exclusive. Hence for a long time (and in some parts even to date) the exclusive property right in forests is not fully established. At least the right to hunt over all territory without restriction was possessed by everybody, although an owner might prevent undesirable hunters from entering his property if it was enclosed. The setting aside of hunting grounds for private use came into existence only in later Roman times. But woodland parks, planted or otherwise, like the "paradises" of the Persian kings and the *nemora* of the Romans and Carthaginians were early a part of the private property of princes and grandees from which others were excluded.

Forests formed a barrier and defense against outsiders, or a hiding place in case of need, hence we find in early times frontier forests, or as the Germans called them "Grenzmarken," set aside or designated for such purposes and withdrawn from use, and sometimes additionally fortified by ditches and other artificial barriers. Even before the "Grenzmarken" of the Germans the forest was used by Greeks, Romans and still earlier among Asiatic tribes to designate the limit of peoples as well as to serve as a bulwark against attacks from invaders.

Again, the pantheistic ideas of the ancients led to consecrating not only trees but groves to certain gods: holy groves were frequent among the Greeks and Romans, and also among other pagans; the Jews, however, were enjoined to eradicate these emblems of paganism in the promised land with axe and fire, and they did so more or less, removal and re-establishment of holy groves varying according to the religious sentiment of their rulers. Altogether, in Palestine the forests were left to the free and unrestricted use of the Israelites.

Out of religious conceptions and priestly shrewdness arose church property in farms and forests among the Indian Brahmans, the Ethiopians and Egyptians, as also among Greeks and Romans.

It appears that the oriental kings were exclusive owners of all unappropriated or public forests. This was certainly the case with the princes of India and of Persia, and such ownership can be proved definitely in many other parts, as in the case of the forests of Lebanon, of Cyprus, and of various forest areas in Asia Minor.

That in the Greek republics the forests were mainly public property seems to be likely; for Attica, at least, this is true without doubt.

While the first Roman kings seem to have owned royal domains, which were distributed among the people after the expulsion of the kings, the public property which came to the republic as a result of conquest was in most cases at once transferred to private hands, either for homesteads of colonists, or in recognition of services of soldiers and other public officers, or to mollify the conquered, or by sale, or for rent, not to mention the rights acquired by squatters. The rents were usually farmed out to collectors (*publicani*) or to corporations formed of these. Livy, however, mentions also State forests in which the cutting was regulated, probably by merely reserving the ship timber.

That occasionally single cities and other smaller municipal units owned forest properties in common seems also established.

Private forest properties connected with farm estates existed in Ethiopia, in Arabia, among the Greeks and among the Romans at home as well as in their colonies. Especially pasture woods (*saltus*) connected with small and large estates (*latifundia*) into which probably most forest areas near settlements were turned, are frequently mentioned as in private ownership; but also other private forests existed.

The institution of servitudes or rights of user (*usus* and *usus-fructus*) and a considerable amount of law regarding the conditions under which they were exercised and regarding their extinguishment were in existence among the Romans in the first centuries of the Christian era.

3. *Forest Use*

Restrictions in the use of woods were not entirely absent, but with the exception of reserving ship timber in the State forests, they refer only to special classes of forest.

In the frontier forests reserved for defensive purposes, timber cutting was forbidden. And in the holy groves set aside by private or public declaration no wood could be cut thereafter, being in the latter case considered nobody's property but sanctified and dedicated to religious use (*res sacra*), and whoever removed any wood from them was considered a "patricide," except the cutting be done for purposes of improvement (thinnings) and after a prescribed sacrifice.

With the extension of Christendom the holy trees and groves became the property of the emperors, who sometimes substituted Christian holiness for the pagan, and retained the restrictions which had preserved them. Thus the cutting and selling of cypress and other trees in the holy grove near Antioch, and of *Persea* trees in Egypt generally (which had been deemed holy under the Pharaos) was prohibited under penalty of five pounds gold, unless a special permit had been obtained.

In Attica as well as in Rome the theory that the State cannot satisfactorily carry on any business was well established. Hence, the State forests were rented out under a system of time rent or a perpetual license, the renters after exploiting the timber usually subletting the culled woods merely for the pasture, except where coppice could be profitably utilized. The officials, with titles referring to their connection with the woods, as the Roman *saltuarii* or the Greek *hyloroi* (forestguards) and *villici silvarum*, the overseers, both grades taken from the slaves, had hardly even police functions.

Forest management proper, *i. e.*, regulated use for continuity, except in coppice, seems nowhere to have been practiced by the ancients, although *arboriculture* in artificial plantations was well established and occasionally even attempts at replacement in forest fashion seem to have been made deliberately. Not only were many arboricultural practices of to-day well known to them, but also a number of the still unsettled controversies in this field were then already subjects of discussion.

The culling system of taking only the most desirable kinds, trees and cuts, which until recently has characterized our American lumbering methods was naturally the one under which the mixed forest was utilized. Fire used in the pasture woods for the same purposes as with us effectively prevented reproduction in these, and destroyed gradually the remnants of old trees.

Only where for park and hunting purposes some care was bestowed upon the woodland, was reproduction purposely attempted, as, for instance, when in a hunting park an underwood was to be established for game cover.

The treatment of the coppice and methods of sowing and planting were well understood in spite of the lack of natural sciences. Whatever forestry practice existed was based merely on empirical observations and was taught in the books on agriculture as a part of farm practice.

Silviculture was mainly developed in connection with the coppice, which was systematically practiced for the purpose of growing vineyard stakes, especially with chestnut (*castanetum*), oak (*quercetum*), and willow (*salicetum*), while the *arbustum* denoted the plantings of trees for the support of grapes, and incidentally for the foliage used as cattle feed, still in vogue in modern Italy.

This planting of vine supports was done with saplings of elm, poplar and some other species; by pollarding and by a well devised system of pruning, these were gradually prepared and maintained in proper form for their purpose.

The coppice seems to have been systematically managed in Attica as well as in Italy in regular fellings; the mild climate producing sprouts and root suckers readily without requiring much care, even conifers (cypress and fir) reproducing in this manner.

The oak coppice was managed in 7 year rotation, the chestnut in 5 year, and the willow in 3 year rotation.

Yield and profitableness are discussed, and the practice of thinnings is known, but only for the purpose of removing and using the dead material.

Forest protection was poorly developed: of insects little, of fungi no knowledge existed. Hand-picking was applied against caterpillars, also ditches into which the beetles were driven and then covered; the use of hogs in fighting insects was also known. That goats were undesirable in the woods had been observed. Some remarkable precocious physiological knowledge or rather philosophy existed: it was recognized that frost produces drought and that a remedy is to loosen the soil, aerating the roots, to drain or water as the case might require, and to prune; but also sap letting was prescribed. Against hail, dead owls were to be hung up; against ants, which were deemed injurious, ashes with vinegar were to be applied, or else an ass's heart.

Curiosities in wood technology were rife and many contradictions among the wood sharps existed, as in our times. Only four elements, earth, water, fire, air, composed all bodies; the more fire in the composition of a wood, the more readily would it decay. Spruce, being composed of less earth and water but more fire and air, is therefore lighter than oak which, mostly composed of earth, is therefore so durable; but the latter warps and develops season splits because on account of its density it cannot take up readily and resists the penetration of moisture.

Wood impregnation, supposed to be a modern invention, was already practiced; cedrium (cedar oil) being used as well as a tar coating or immersion in seawater for one year, to secure greater durability.

4. *Literature*

As regards literature, we find in Greece, besides what can be learned incidentally from the historians *Herodotus* and *Xenophon* and from the natural history of Aristotle, the first work on plant history and wood technology, if not forestry, in 18 volumes by *Theophrastus* (390-286 B.C.), a pupil of Aristotle and Plato.

Among the Romans, besides a number of historians, at least three writers before Christ discussed in detail agriculture and, in connection with it, tree culture; namely, *Cato* (234-149 B.C.) who wrote an excellent work *De re rustica*, in 162 chapters; *Varro* (116-26 B.C.), also *De re rustica*, in three books; and *Vergilius Maro* (70-19 B.C.), who in his *Georgica* records in six books the state of knowledge at that time. Of the many writers on these subjects who came in the Christian era there are also three to be mentioned, namely, *Cajus Plinius Major* (23-79 A.D.), who in his *Historia naturalis*, in 37 books, discusses also the technique of silviculture; *Lucius Junius Moderatus Columella* (about 50 A.D.), with 12 books, *De re rustica*, and one book *De arboribus*, the former being the best work of the ancients on the subject; and *Palladius*, writing about 350 A.D., 13 books, *De re rustica*, which in the original and in translations was read until past the middle ages.

Only a few references which exhibit the state of knowledge on arboricultural subjects among the Romans as shown in this literature may be cited, some of which knowledge was also developed in Greece and found application, more or less, throughout the Roman empire from India to Spain.

Nursery practice was already well known to Cato, while Varro knew, besides sowing and planting, the art of grafting and layering, and Columella discusses in addition pruning and pollarding (which latter was practiced for securing fuelwood), and the propriety of leaving the pruned trees two years to recuperate before applying the knife again.

The method of wintering acorns and chestnuts in sand, working them over every 30 days and separating the poor seed by floating in water, was known to Columella and, indeed, he discusses nursery management with minute detail, even the advantages of transplants and of doubly transplanted material. The question whether to plant or to sow, the preference of fall or spring planting with distinction for different species and localities are matters under his consideration; and preference of sowing oak and chestnut instead of transplanting is pointed out and supported by good reasons.

Pliny, the Humboldt of the ancients, recognizes tolerance of different species, the need of different treatment for different species, the desirability of transplanting to soil and climatic conditions similar to those to which the tree was accustomed, and of placing the trees as they stood with reference to the sun. But, to be sure, he also has many curious notions, as for instance his counsel to set shallow rooted trees deeper than they stood before, his advice not to plant during rain, or windy weather and his laying much stress on the phases of the moon as influencing results.

While then the ancients were not entirely without silvicultural knowledge, indeed possessed much more than is usually credited to them, the need of a forest policy and of a systematic forest management in the modern sense had not arisen in their time; the mild climate reducing the necessity of fuelwood and the accessibility by water to sources of supply for naval and other construction delaying the need for forest production at home.

There is little doubt, that some of the agricultural and silvicultural knowledge and practice of the Romans found entrance among the German tribes who, especially the Allemanni, came into contact with the Romans in their civilized surroundings during the fourth century.

GERMANY

Besides a dozen or more earlier histories of forestry in Germany, some of which date back to the beginning of the 19th century, there are two excellent modern compilations, namely:

Geschichte des Waldeigenthums, der Waldwirtschaft und Forstwissenschaft in Deutschland, by August Bernhardt, 1872-75, 3 Vols., 1062 pp., a classic, which treats especially extensively of political and economic questions having a bearing on the development of forestry; and

Handbuch der Forst- und Jagdgeschichte Deutschlands, by Adam Schwappach, 1886, 2 Vols., 892 pp., which appeared as a second edition of Bernhardt's history, abridging the political history and expanding the forestry part. This volume has been mainly followed in the following presentation of the subject. In condensed form this history is also to be found in Lorey's *Handbuch der Forstwissenschaft*, 1888, Vol. I, pp. 143-210.

In Schwappach's history a full list of original sources is enumerated. These are, for the oldest period, Roman writings, which are unreliable; the laws of the various German tribes; the laws of kings (*Capitularia*); the laws of villages and other territorial districts; "Weisthümer" (judgments); inventories of properties (especially of churches and cloisters); documents of business transactions and chronicles. For the time after the Middle ages the most important source is found in the Forest Ordinances of princes and other forest owners; forest laws; police orders; business documents, and finally special literature.

It is generally conceded that both the science and art of forestry are most thoroughly developed and most intensively applied throughout Germany. It must, however, not be understood that perfection has been reached anywhere in the practical application of the art, or that the science, which like that of medicine has been largely a growth of empiricism, is in all parts safely based; nor are definitely settled forest policies so entrenched, that they have become immutable. On the contrary, there are still mismanaged and unmanaged woods to be found, mainly those in the hands of farmers and other private owners; there are still even in well managed forests practices pursued which are known not to conform to theoretical ideals, and others which lack a sure scientific foundation; and while the general policy of conservative management and of State interest in the same is thoroughly established, the methods of attaining the result are neither uniform throughout the various States which form the German Federation, nor positively settled anywhere. In other words, the history of forestry is still, even in this most advanced country, in the stage of lively development.

For the student of forestry the history of its development in Germany is of greatest interest not only because his art has reached here the highest and most intensive application, but because all the phases of development through which other countries have passed or else will eventually have to pass are here exemplified, and many if not most of the other countries of the world have more or less followed German example or have been at least influenced by German precedent. There is hardly a policy or practice that has not at some time in some part been employed in the fatherland of forestry.

One reason for this rich historical background is the fact, that Germany has never been a unit, that from its earliest history it was broken up into many independent and, until modern times, only loosely associated units, which developed differently in social, political and economic direction. This accounts also for the great variety of conditions existing even to-day in the 26 principalities which form the German empire.

Politically, it may be mentioned that out of the very many independent principalities into which the German territory had been divided, variable in number from time to time, the 26 which had preserved their autonomy formed in 1871 the federation of States, known as the German Empire. Each of these has its own representative government including the forest administration, very much like the state governments of the United States; only the army and navy, tariff, posts, telegraphs, criminal law and foreign policy, and a few other matters are under the direct jurisdiction of the empire, represented in the Reichstag, the Bundesrath, and the Emperor.

The 208,830 square miles of territory,[2] which supports a population of about 60 million people, still contain a forest area of around 35 million acres (26 % of the land area) or .61 acre per capita, which although largely under conservative management has long ago ceased to supply by its annual increment (somewhat over 50 cubic feet per acre) the needs of the population; the imports during the last 50 years since 1862, when Germany began to show excess of imports over exports, having grown in volume at the average rate of 10 % to now round 380 million cubic feet (45 million dollars) or nearly 15 % of the consumption.

The larger part of Germany, two thirds of the territory and population is controlled by modern Prussia, with a total forest area of 20 million acres; Bavaria comes next with one seventh of the land area and 6 million acres of forest; the five larger states of Wurttemberg, Baden, Saxony, Mecklenburg and Hesse, occupying together another seventh of the territory with 5 million acres of forest. The balance of the area is divided among the other 19 states.

Fifty per cent. of Germany roughly speaking, is plains country, the larger part in the northern and eastern territory of Prussia; 25 % is hill country, mostly in West and Middle Germany; and 25 % is mountain country, the larger portion in the southern states.

There are at best only five species of timber of high economic general importance, the (Scotch) pine which covers large areas in the northern sandy plain and the lighter soils in the south; the (Norway) spruce and (Silver) fir which form forests in the southwestern and other mountain regions and represent, in mixture with broadleaf forest, a goodly proportion in the northeastern lowlands; the (English) oak, of which botanically two species are recognized; and the beech. The last two are the most important hardwoods found throughout the empire, but especially highly developed in the west and southwest. In addition, there are half a dozen species of minor or more local importance, but the five mentioned form the basis of the forestry systems.

The history of the development of forestry in Germany may be divided into periods variously. Bernhardt recognizes six periods; Schwappach makes four divisions, namely, the first, from the earliest times to the end of the Carlovingians (911), which is occupied mainly with the development of forest property conditions; the second, to the end of the Middle Ages (1500), during which the necessity of forest management begins to be sporadically recognized; the third, to the end of the 18th century, during which the foundation for the development of all branches of forestry is laid; the fourth, the modern period, accomplishing the complete establishment of forestry methods in all parts of Germany. For the later historian it would be proper to recognize a fifth period from about 1863, when, by the establishment of experiment stations, a breaking away from the merely empiric basis to a more scientific foundation of forestry practice was begun.

For our purposes we shall be satisfied with a division into three periods, namely: first, to the end of the middle ages, when, with the discoveries of America and other new countries, an enlargement of the world's horizon gave rise to a change of economic conditions; second, to the end of the eighteenth century, when change of political and economic thought altered the relation of peoples and countries; third, the modern period, which exhibits the practical fruition of these changes.

[2] The statistics in this book do not pretend to be more than approximations.

I. From Earliest Times to End of Middle Ages

Many of the present conditions, especially those of ownership, as well as the progress in the development both of forest policy and of forest management, can be understood only with some knowledge of the early history of the settlement of the country.[3]

As is well known, Aryan tribes from central Asia had more than a thousand years before Christ begun to overrun the country. These belonged to the Keltic (Celtic) or Gaelic race which had gradually come to occupy partly or wholly, France, Spain, northern Italy, the western part of Germany and the British Islands. They were followed by the *Germani* (supposedly a Celtic word meaning neighbor or brother), also Aryan tribes, who appeared at the Black Sea about 1000 B.C., in Switzerland and Belgium about 100 B.C. These were followed by the Slovenes, Slovaks, or Wends, crowding on behind, disputing and taking possession of the lands left free by, or conquered from the Germani. Through these migrations, by about 400 A.D., the whole of Western Europe seems to have been fully peopled with these tribes of hunters and herders. The mixture of the different elements of victors and vanquished led to differentiation into three classes of people, economically and politically speaking, namely the free, the unfree (serfs or slaves), and the freedmen – an important distinction in the development of property rights.

1. *Development of Property Conditions*

The German tribes who remained conquerors were composed of the different groups of Franks, Saxons, Thuringians, Bajuvarians, Burgundians, etc., each composed of families aggregated into communal hordes with an elected Duke (*dux*, *Herzog*, *Graf*, *Fürst*), organized for war, each in itself a socialistic and economic organization known as *Mark*, owning a territory in common, the members or *Markgenossen* forming a republic. Outside of house, yard and garden, there was no private property; the land surrounding the settlement, known as *Allmende*, (commons) was owned in common, but assigned in parcels to each family for field use, the assignment first changing from year to year, then becoming fixed. The outlying woods, known as the *Marca* or *Grenzwald*, forming debatable ground with the neighboring tribes, were used in common for hunting, pasturing, fattening of hogs by the oak mast, and for other such purposes, rather than for the wood of which little was needed. In return for the assignment of the fields, the free men, who alone were fully recognized citizens of the community, had to fulfil the duties of citizens and especially of war service.

Only gradually, by partition, immigration and uneven numerical development, was the original Mark or differentiation into family associations destroyed and a more heterogeneous association of neighbors substituted. At the same time, inequality of ownership arose especially from the fact that those who owned a larger number of slaves (the conquered race) had the advantage in being able to clear and cultivate more readily new and rough forest ground. Those without slaves would seek assistance from those more favored, exchanging for rent or service their rights to the use of land; out of this relationship a certain vassalage and inequality of political rights developed.

Under the influence of Roman doctrine, a new aspect regarding newly conquered territory gained recognition, by which the Dukes as representatives of the community laid claim to all unseated or unappropriated land; they then distributed to their followers or donated to the newly established church portions of this land, so that by the year 900 A.D., a complete change in property relations had been effected. By that time the large baronial estates of private owners had come into existence which were of such great significance in the economic history of the Middle Ages, changing considerably

[3] FELIX DAHN, *Urgeschichte der germanischen und romanischen Völker*, 1881.

the status of the free men, and changing the free mark societies into communities under the dominion of the barons.

The first real king, who did not, however, assume the title, was Clovis, a Duke of the Franks, who had occupied the lower Rhine country. About 500 A.D., picking a quarrel with his neighbors, the Allemanni, he subdued them and aggrandized himself by taking their Mark. In this way he laid the foundation for a kingdom which he extended by conquest mainly to the westward, but also by strategy to the eastward, the warlike tribes of Saxons and other Germans conceding in a manner the leadership of the Franks.

A real kingdom, however, did not arise until Charlemagne, in 772, became the ruler, extending his government far to the East.

At times, the kingdom was divided into the western Neustria, and the eastern Austria, and then again united, but it was only when the dynasty of Charlemagne became extinct with the death of Louis the Child (911), that the final separation from France was effected, and Germany became a separate kingdom, the eastern tribes between the Rhine and Elbe choosing their own king, Conrad, Duke of Franconia. There were then five tribes or nations, each under its own Duke and its own laws, comprising this new kingdom, namely the Franks, Suabians, Bavarians, Saxons on the right, and the Lorainers on the left bank of the Rhine, while the country East of the Elbe river was mostly occupied by Slovenians.

With Clovis began the new order of things which was signalized by the aggrandizement of kings, dukes and barons.

In addition to the rule regarding the ownership of unseated lands there developed, also under Roman law doctrine, the conception of seignorial right, *i. e.*, the power of the king to jurisdiction over his property. This right, first claimed by the duke or king for himself, is then transferred with the territory given to his friends and vassals, who thereby secure for themselves his powers and jurisdiction, immunity from taxes and from other duties, as well as the right to exact taxes and services from others, the favored growing into independent knights and barons.

The forest, then, originally was communal property and the feeling of this ownership in common remains even to the present day. Indeed, actually it remained in most cases so until the 13th century, although the changes noted had their origin in the 7th century when the kings began to assert their rights of princely superiority.

In these earlier ages, the main use of the forests was for the hunt, the mast and the pasture, and since wood was relatively plentiful, forest destruction was the rule. Those who became possessed of larger properties through the causes mentioned tried to secure an increased value of their possessions by colonization, in which especially the slaves or serfs were utilized. These often became freedmen, paying rent in product or labor, and acquiring the rights of usufruct in the property, out of which developed the so-called *servitudes* or *rights of user*, the *praedium* of the Romans, a limited right to use the property of another.

With the development of private property there naturally also developed the right of preventing the hunting on such lands, this being then their main use. This exclusive right to the chase or hunt we find recognized as a part of the property of the kings and barons in the 8th century, when the kings forbade trespass under penalty of severe fines; the king's *ban* (interdiction) of 60 shillings being imposed upon the trespassers. Indeed, by the end of the 8th century the word *Forst* (*voorst—foresta*) which until then had been used merely to denote the king's property was exclusively used to designate not necessarily woodland (the latter being referred to as *silva* or *nemus*), but any territory in which the hunt had been reserved.

This right to reserve the chase and the fishing, that is, to establish *banforests* was in the 10th century extended by the kings to territory not belonging to them, the right to the chase being according to the Roman doctrine a regal right over any property. Under this conception fields and pastures, woods and waters, and whole villages with their inhabitants became "inforested" grounds.

The Norman kings, imbued with a passion for the chase, exercised this right widely, especially in England; the forests of Dean, Epping and the New Forest being such inforested territories, the inhabitants of which were placed under special "forest laws," and adjudged by special "forest courts."

Presently the king's right of ban was granted with the land grants to his barons and to the clergy. Banforests also grew up through owners of properties placing themselves and their possessions under the protection of kings or bishops or other powerful barons and giving in exchange this hunting right, and in various other ways. At the same time the headmen of the Mark (*Obermärker*, *Graf*, *Waldgraf*), who from being elected officers of the people had become officials of the king, began to exercise, by virtue of their office, the jurisdiction of the king, and declaring the ban for their own or their friends' benefit, excluded the *Märker* from their ancient right to hunt and fish freely over the territory of the Mark.

While in this way the freedom of the communal owners was undermined, the institution of banforests had nevertheless its value in that it led to forest protection, restriction in forest use and restriction in clearing, all this, to be sure, merely for the benefit of the chase. Special officers to guard the rights of the king, *forestarii*, chosen from the free and freedmen, and also superior officers, *forestmasters*, were instituted, to administer the chase and enforce the restrictions which went with it.

Gradually, with the loss of property rights, there came also a change in the political rights of the märker or commoners, through the large barons interfering with self-government, assuming for themselves the position of Obermärker, appointing the officials, and issuing strict forest ordinances to regulate the cutting of wood; finally, the original right which belonged to every commoner of supplying himself with wood material, became dependent upon permission in each case, and thus his title to ownership became doubtful.

Undoubtedly also through the influence of Roman institutions with which the Franks under their Merovingian kings came into close contact, there arose that social and political institution which became finally known as the *feudal system*. By the grants of lands which the kings made out of their estates to their kinsmen and followers with the understanding that they would be faithful and render service to their masters, a peculiar relationship grew up, based on land tenure, the land so granted being called a *fief* or *feud*, and the relationship being called *vassality* or *vassalage*. This vassalage denoted the personal tie between the grantor and grantee, the lord and the vassal; the lord having the obligation to defend the vassal, and the vassal to be a faithful follower of his lord. Similar relationship arose from the surrender by landowners of their estates to the church or to other powerful barons, to be received back again as fiefs and to be held by them as tenants in exchange for rent or service. In this way a complete organization of society developed in which, from the king down to the lowest landowner, all were bound together by obligation of service and defence, both the defence and service being regulated by the nature and extent of the fief. Finally, all kinds of property of whatever nature, as well as official positions which would give an income, were subject to be treated as fiefs. The obligations of the recipient were of various nature, but finally service in army or court became the main one, giving rise to the class of knights (*Ritter*) or barons, while the fiefs to the small farmer gave rise to the class of peasants (*Bauern*, this name appearing first in 1106 under Conrad II).

The fiefs of the higher class, while at first given only to the individual, became early hereditary, and hereditary succession to estates and offices generally became the rule. Primogeniture in the succession to the estates did then not as in England prevail in Germany; instead, either tenancy in common, or else equal division among the sons was practised. As a result the very many small principalities came into existence in the 14th and 15th centuries, these growing smaller and smaller by subdivision. The first to institute the primogeniture rule by law was the house of Brandenburg (in the 15th century).

In addition to the class of peasants and knights, there came into existence a third class, the burghers, when, by the order of Conrad I in the beginning of the 10th century, towns were built with walls and towers for defence against the encroachments of the Huns, who endangered the eastern

frontier Mark. In order to encourage the settlement of these towns, any slave moving to town was declared a freeman; and the cities became free republics; gifts of land, including forest areas, were made to the cities, and the development of industries was encouraged in every way. These cities, favored by the kings, and, having become rich and powerful, in the later quarrels of the kings with the lawless nobility, gave loyal support with money and arms. In return for their loans, the forest properties of the kings were often mortgaged to the burghers; and, failing of redemption, were often forfeited to them. In this way and through purchases the city forests came into existence.

Still other property conditions arose when, under Otto the Great (960), colonization of the eastern country beyond the Elbe was pushed. In these cases, the Mark institution was absent, although the colonists did often become part owners in the king's forest, or acquired parts of it as common property, or else secured rights of user in the nearest royal forest.

By the end of the period, due to these various developments, a great variety of property conditions in forest areas had developed, most of which continue to the present time, namely royal properties, which by the end of the eighteenth century and the beginning of the nineteenth were in part to become state property; princely and lordly possessions under separate jurisdiction, with or without entail, and mostly encumbered with rights of user; allodial possessions (held independent of rent or service); municipal possessions owned by city corporations; communal properties, the remnants of the Mark; and farmers' woodlots (Bauernwald), resulting from partitions of the Mark.

All these changes from the original communal property conditions did not, of course, take place without friction, the opposition often taking shape in peasants' revolts; hundreds of thousands of these being killed in their attempts to preserve their commons, forests and waters free to all, to re-establish their liberty to hunt, fish and cut wood, and to abolish tithes, serfdom and duties.

2. *Forest Treatment*

As stated, the German tribes which settled the country were herders and hunters, who only gradually developed into farmers while the country was being settled. At first, therefore, as far as the forest did not need to give way to farm lands, its main use was in the exercise of the chase and for pasture, and especially for the raising and fattening of hogs; the number of hogs which could be driven into a forest serving as an expression of the size of such a forest. Oak and beech furnishing the mast were considered the preferable species. It is natural, therefore, that, wood being plentiful and the common property of all, the first regulation of forest use had reference to these, now minor benefits of forest property, as for instance the prohibition of cutting mast trees, which was enforced in early times. The first extensive regulation of forest use came however, from the exercise of the royal right of the ban and merely for the avowed purpose of protecting the chase.

Real forest management, however, did not exist, the *forestarii* mentioned in these early times being nothing but policemen guarding the hunting rights of the kings or other owners. The conception that wood on the stump was of the same nature as other property and its removal theft had not yet become established: "*quia non res possessa sed de ligno agitur*" (wood not being a possessed thing), a conception which still pervades the laws of modern times to some extent.

The necessity of clearing farm lands for the growing population continued, even in the western, more densely populated sections, into the 12th and 13th centuries. The cloisters were especially active in colonizing and making farm land with the use of axe and fire, such cloisters being often founded as mere land speculations. Squatters, as with us, were a frequent class of colonists, and in eastern Prussia continued even into the 17th and 18th centuries to appropriate forest land without regard to property rights.

The disturbed ownership conditions, which we have traced, led also often to wasteful slashing, especially in the western territory, while colonization among the Slavs of the Eastern sections led to similar results. In the 12th century, however, here and there appear the first signs of greater necessity

for regulating and restricting forest use in the Mark forest, and for improvement in forest conditions with the purpose of insuring wood supplies.

In that century, division of the Mark forest begins for the alleged reason that individual ownership would lead to better management and less devastation. In the 12th and 13th centuries also, stricter order in the fellings and in forest use was insisted upon in many places. In the forest ordinances of the princes and barons, which, of course, have always reference to limited localities, we find prescriptions like the following: The amount to be cut is to be limited to the exact needs of each family and the proper use of the wood is to be inspected; the timber is to be marked, must be cut in a given time and be removed at once; only dry wood is to be used for fuel and the place and time for gathering it is specially designated, similar to the present practice. The best oak and beech are to be preserved (this, however, merely with reference to the mast), and in the Alps we find already provisions to reserve larch and pine. The charcoal industry is favored (because of easier transportation of its product), but permitted only under special precautions. Bark peeling and burning for potash is forbidden. The pasture is regulated with regard to the young growth, and sheep and goats are excluded.

Such measures are, to be sure, found only here and there where local conditions gave rise to a fear of a timber famine; such communities may also be found making attempts to protect themselves against reduction of home supplies by forbidding the export of wood from their territory. An amusing restriction of this kind is found at Altenstadt where the bakers were forbidden to bake bread for any but the citizens of the town.

The first ordinance prohibiting for clearings is found at Lorsch in the Rhenish country in 1165, and other ordinances with such prohibition are on record in other parts in the 13th century. In 1237, at Salzburg, clearings were prohibited in the interest of the salt mines, "so that the cut forest may grow up to wood again," and also in other parts where mining interests made a special demand for props or charcoal the regulation of forest use was begun early.

The difficulties of transportation in the absence of roads rendered local supply of more importance than at present, and this accounts for the early measures to secure more economical use while distant woods were still plentiful but unavailable.

While in the 12th and 13th centuries a merely restrictive and regulative, or else a let-alone policy, "allowing the wood to grow up," prevailed, we find in the 14th century the first beginnings of an attempt at forest extension or recuperation.

In 1309, Henry VII ordered the reforestation of a certain stripped area by sowing. Of the execution of this order we have no record, but the first actually executed plantation on record is that by the city of Nuremberg, in 1368, where several hundred acres of burned area were sowed with pine, spruce and fir; and there is also a record that in 1449 this crop was harvested. In 1420, the city of Frankfort on the Main followed this example, relying on the Nuremberg seed dealer, whose correspondence is extant and who was invited to go to Frankfort for advice how to proceed. He sowed densely in order to secure clear boles, but expressed the opinion that the plants could not be transplanted; he also relied on the phases of the moon for his operations.

The planting of hardwoods seems to have been begun much later; the first reference to it coming from the cloister and city of Seligenstadt, which agreed in 1491 to reforest annually 20 to 30 acres with oak.

Natural regeneration by coppice was in quite general practice and proved satisfactory enough for fuelwood production. The system of coppice with standards was also frequently practised, the standards, 20 or 30 to the acre, being "reserved for the lord."

In the timber forest, the unregulated selection system was continued generally through the period, although in 1454 we find in the Harz Mountains a transition to a seed tree management, a few seed trees or groups of seed trees being left on the otherwise cleared area, somewhat in the manner of the French *méthode à tire et-aire*. Toward the end of the 15th century we find here and there a

distinction made between timber forest, where no firewood is to be cut, and “leaf forest” which is to serve the latter purpose, and is to be treated as coppice.

Toward the end of the period we find, however, various provisions which are unquestionably dictated by the fear of a scarcity of timber. The discovery that pasture prevents natural regeneration led to a prohibition of pasturing in the newly cut felling areas. In 1488, we find already a diameter limit of 12 inches – just as is being advocated in the United States now – as a basis for conservative exploitation, the city of Brunswick buying stumpage, and in the contract being limited to this diameter, and in addition obligated to leave 15 oaks or aspen per acre for seed trees.

Attempts at regulating the use of a given forest by division into felling areas are recorded in 1359, when the city forest of Erfurt, 286 acres, was divided into seven felling areas. It is questionable whether this referred to a coppice with short rotation or whether a selection forest with seven periodic areas is meant.

We see, then, that the first sporadic and, to be sure, crude beginnings of a forest management in Germany may be traced back to the 14th and 15th centuries; but it took at least 250 to 350 years before such management became general.

Outside of the information found scattered in forest ordinances, instructions and prescriptions of various kinds there is no forestry literature to be recorded from this period except one single book, published about the year 1300, by an Italian, Petrus de Crescentiis, which was translated into German. It was merely a scholastic compilation on agriculture and allied subjects, mostly cribbed from old Roman writers and without value for German conditions.

II. First Development of Forestry Methods

(Period 1500 to 1800.)

The period following the middle ages marks the gradual changes from the feudal system to the modern State organizations and to considerable change of ownership conditions and forest treatment. Various causes which led to an increased development of industrial life were also instrumental in hastening the progress of forest destruction. At the same time, during this period the germs and embryonic beginnings of every branch of forestry, real forestry policy, forestry practice and forestry science are to be noted. By the end of this period, preparatory to more modern conditions, we find organized technical forest administrations, well developed methods of silviculture and systems of forest management.

1. *Development of Forest Property Conditions*

A number of changes in the conceptions of political relations, in methods of life and of political economy brought further changes in property conditions on the same lines as those prevailing in the 14th and 15th centuries. These changes were especially influenced by the spread of Roman law doctrine regarding the rights of the governing classes; by the growth of the cities, favoring industrial development and changing methods of life; by the change from barter to money management, favored by the discovery of America, by other world movements, and by the resulting changes in economic theory.

Through the discovery of the new world and the influx of gold and silver that came with it gave impetus to industry and commerce of the cities; the rapid increase of money capital increased extravagance and induced a desire for amassing wealth, which changed modes of life, changed policies and systems of political economy.

The fiscal policy of the many little principalities was dominated by a desire to get a good balance of trade by fostering exports of manufactures, but forbidding exports of raw materials like forest products, also by forbidding imports, subsidizing industries, fixing prices by law, and taking in general an inimical attitude towards outsiders except in so far as they sent gold and silver into the country.

This so-called mercantilistic system, which saw wealth not in labor and its products but in horded gold and silver, had also full sway in England under Cromwell, and in France under Colbert's influence. This fiscal policy, which was bent upon bringing cash into the country, led, under the direction of servile officials, to oppressive measures. A reaction naturally followed, when it was pointed out that the real wealth of a nation lies in its natural resources and in its labor. But this so-called physiocratic doctrine had little practical influence except to prepare men's minds for the reception of the teachings of Adam Smith at the end of the period.

The doctrine of the Roman law, deified by the jurists and commentators, undermined the national conceptions and institutions of free citizenship and of existing property relations; courts, legislation and administration were subject to their sway, and this influence lasted, in spite of reactions, until the end of the 18th century. Under it the doctrine of the *imperium*– the seignorage or superior power of the princes (Hoheitsrecht) – was further developed into the *dominium terrae*, i.e., superior ownership of all the land, which gives rise to the title and the exercise of the function of "*Landesherren*," masters of the land, and confers the privilege of curtailing and even discontinuing private property rights. To sustain their position in each of the state units, a restriction of the autonomy of churches and cloisters, of the Mark and of the vassals became needful to the princes. This was secured by taking the first under their protection, by making themselves Obermärkers, and by

changing vassals who held office in fief into employes (Beamte). For a time the three privileged classes of prelates, knights and burghers, combined in the *Landstand* or *Landtag*, participated in some of the functions of government, especially in raising and administering taxes, but by the second half of the 14th century the princes had become absolute, and the doctrine of the *Hoheitsrecht* was firmly established.

Under this doctrine, the historic position of the Mark is perverted and instead of being the common property of the people, it becomes the property of the prince, on which he graciously permits the usufruct; for, forest, pasture and water (Wald, Weide, Wasser) are *res publicae*, hence ownerless and at the disposal of the king. Through this new construction of relationship, as well as through the same machinations and tricks which the princes as *Obermaerker* or headmen of the Mark had employed during the foregoing period in usurping power, and partly through voluntary dissolution was the decadence of the social, economic and political organization of the Mark gradually completed.

The original usufruct of a property held in common is explained in the Roman sense as a *precarium* or servitude, and from being a right of the whole organization becomes a right of the single individual or group of individuals. In this way the socialistic basis of the Mark is destroyed. Through the exercise of the *Forsthoheit*, *i. e.*, the superior right of the prince over all forest property, by the *appointment* of the officials instead of their *election*, by issuance of ordinances, in short, by the usurpation of the legislative and police power, the political power of the Mark is broken and the Thirty Years' War completes the breakdown; the pride of the burgher and the peasant is gone, their autonomy destroyed and their economic and political organizations sink into mere corporations based on land tenure, which, according to Roman doctrine come under the regulation of the State or Prince.

The nobility move into the cities and leave the administration of their estates to officials who are constantly pressed to furnish the means for the extravagant life of their masters. These in turn harass and oppress the peasantry, who finally become bondsmen, *Gutshörige* (bound to the glebe) and lose their independence entirely. These, briefly, are the steps by which the changes, social and economic, progressed.

Reforms in this situation of the peasantry began first in Prussia in 1702, when bondage was abolished for all those who could purchase their houses and farms from the gentry. As few had the means to do so, the result was the creation of a proletariat, hitherto unknown because under the old feudal system the lord had to feed his impoverished bondsmen from which he was now absolved.

Changes in forest property in particular were brought about by the increase of princely property through the various methods of exercising the seignorage. Especially after the Thirty Years' War ownerless tracts falling under this right were plentiful. In addition, wherever waste lands grew up to wood, they were claimed by the princes:

> "Wenn das Holz dem Ritter reicht an den Sporn
> Hat der Bauer sein Recht verlorn."

When wood has grown up to the spur of the knight, the peasant has lost his right.

Some additions came from the secularization of church and cloister property, and others by the slices which the princes as Obermärker secured from the Mark forests by various artifices. It is these properties, which in Prussia were turned over by the King to the State in 1713, and by other princes, not until the 19th century.

The same means which the princes employed were used by the landed gentry to increase their holdings especially at the expense of the Mark from which in their capacity of Obermärker they secured portions by force or intrigue.

The peasants' forest property – the Mark forest – had by the 19th century been almost entirely dismembered, part having come into the hands of the princes and barons, part having been divided among the Märker, and part having become corporation forest in the modern sense.

Partition had become desirable when the restrictions of use which were ordered for the good of the forest became unendurable under the rigid rule of appointed officials, but the expected improvement in management which was looked for from partition and private ownership was never realized.

After the Thirty Years' War the free cities were impoverished and their autonomy undermined by Roman doctrine. From free republics they became mere corporations under the supervision of appointed officials, and experienced decadence in political as well as material directions. Hence, no increase in city forest took place except through division of the Mark forest in which cities had been co-owners, and through secularized properties of cloisters.

The worst feature, from the standpoint of forest treatment, which resulted from these changes in property conditions and relationship, was the growth of the pernicious servitudes or rights of user, which were either conferred to propitiate the powerless but dangerous peasantry, or evolved out of the feudal relations. From the 16th to the 19th centuries these servitudes grew to such an extent that in almost every forest some one outside of the owner had the right to use parts of it, either the pasture, or the litter, or certain classes or sizes of wood.

These rights have proved the greatest impediment to the progress of forestry until most recent times, and only within the last few decades have the majority of them been extinguished by legal process or compromise.

2. *Forest Conditions*

Under the exercise of these various rights and the uncertainty of property conditions, the forest conditions naturally deteriorated continuously until the end of the 18th century; the virgin woods were culled of their wealth and then grew up to brush, as is usual in the United States.

Every forest ordinance began with complaints regarding the increasing forest devastation, and predicted a timber famine in view of the increasing population, increasing industry and commerce, and hence increased wood consumption. Especially along the water routes, which furnished the means of transportation, the available supplies were ruthlessly exploited. More serious enemies than the exploitation of the timber proved the pasturing of cattle, the removal of the litter, and above all, the fires.

Towards the end of the 16th century, ordinances against forest fires began to be enacted; yet, as late as 1778, the necessity of keeping the rides or fire lanes open in the forests of Eastern Prussia is justified by the statement that "otherwise the still constantly recurring fires could not be checked." At another place it is stated that "not a single acre of forest could be found in the province that had not been burnt in former or later times," and that "the people are still too much accustomed to the ruthless use of fires, so that no punishment can stop them."

Other causes of devastation were the Thirty Years' War, the wars of the 18th century, and the loss of interest in the forest by the peasants after the collapse of the Mark. These had often to steal what they needed, and their depredations were increased by the desire to revenge themselves on the landed proprietors for the oppressions to which they were subjected. The increase in game, which was fostered by the landed gentry, did much damage to the young growths, and the increase in the living expenses of the nobility who mostly abandoned country for town had to be met by increased exploitation.

By the end of the middle ages the reduction of forest area had proceeded so far that it was generally believed desirable to restrict the making of clearings to exceptional necessities, except in the northeastern parts and in the distant mountain districts.

Yet a growing population increased the need for farm land, and since intensive use of the existing farm area was not attempted until the end of the 18th century, the forest had to yield still further.

3. *Methods of Restriction in Forest Use*

All ordinances issued by the princes to regulate the management of their properties contain the prescription, that permission of the *Landesherr* is necessary for clearings, and that abandoned fields growing up to wood are to be kept as woodland; this partly for timber needs, partly for considerations of the chase. Still, Frederick the Great in colonizing East Prussia, expressed himself to the effect that he cared more for men than for wood, and enjoined his officials to colonize especially the woods far from water, which entailed even more waste of wood than where means of transportation allowed at least partial marketing.

Improvident clearings proceeded even under his reign on the Frische Nehrung between Danzig and Pillau, and started the shifting sands of that peninsula.

In the absence of all knowledge as regards the extent of existing supplies or of the increment, and with poor means of transportation, at least local distress was imminent.

To stave off a threatening timber scarcity, regulation in the use of wood was attempted by the forest ordinances, even to the extent of forbidding the hanging out of green brush to designate a drinking hall, or the cutting of May trees, – similar to our crusade in the United States against the use of Christmas trees. A diameter limit to which trees might be permitted to be cut, was also frequently urged. Regulation of forest use did not confine itself to the princely properties alone, but, in the interest of the whole, the restrictions were extended to all owners. These restrictions were directed either to the practice in the exploitation of the forest or in the use of the material. In the latter direction the attempts at reducing the consumption of building timber are of special interest. Building inspectors were to approve building plans and inspect buildings to see that they were most economically constructed; that repairs were made promptly, to avoid the necessity of more extensive ones; that new buildings replacing old ones were not built higher than the old ones. In Saxony, as early as 1560, it was ordered that the whole house must be built of stone, while elsewhere, the building of stone base walls and the use of brick roofs instead of shingles was insisted upon.

Even the number of houses in any community was restricted. Fences were to be supplanted by hedges and ditches. Economies in charcoal burning, in potash manufacture for glass works, and in the turpentine industry were prescribed, and about 1600, the burning of potash for fertilizer was forbidden entirely; but these laws proved unavailing. Even in fuel-wood a saving was to be effected by using only the poorer woods and windfalls, by instituting public bake ovens (still in use in Westphalia), by improving stoves, restricting the number of bathing rooms, etc.

The consumption of fuelwood seems to have been enormous, for we find record of 200 cords used by one family in a year and of 1,200 cords or more used by the Court at Weimar during the same time.

The substitution of turf and coal for firewood was ordered in some sections in 1697 and again in 1777, but practically not until 1780 did coal come in as a substitute. Tanbark peeling was also forbidden, or only the use of bark of trees soon to be felled was allowed. For cooperage only the top-dry oak; for coffins only soft-wood, or, according to Joseph II of Austria, no wood, but black cloth was to be used. In some parts of the country the use of oak was restricted, even as early as 1562.

For regulating practices in the forest the restrictions often took only the general form of forbidding devastation, without specifying what that meant.

Then, besides establishing a diameter limit, and regulating pasture in order to protect young growth, excluding sheep and goats entirely, an attempt was made to secure at least orderly procedure in the fellings. Foresters were to designate what was to be cut even for firewood. Marking irons and hammers were employed for this purpose by the middle of the 15th century (usually two markings, by forester and by inspector to check). And this designation by officials extended even into the private forest, where finally no felling was allowed without previous permission and designation by a forester.

The use of the litter by the small farmers had grown to a large extent in these times and it was thought desirable to stop it, but this aid to the poor peasant was so necessary that only regulating the gathering of it could be insisted upon.

It must be understood that all these various attempts at securing a conservative forest use were by no means general but refer to circumscribed territory, and much of it was only paper legislation without securing actual practice.

4. *Development of Forest Policy*

With the beginning of the 18th century we find, besides these prescriptions against wasteful use, and ordinances regulating the management of the properties of the princes, definite forest policies in some sections, having in view forest preservation and improvement of forest conditions, and also means of providing wood at moderate prices.

Between the years 1515 and 1590, most of the German States had already enacted ordinances which had the force of general law exercising police functions over private forest property, although in Prussia this general legislation did not occur until 1720. The objects in view with this legislation were entirely of a material kind: the conservation of resources. Besides securing the rights of the *Landesherr* to the chase, it was to secure a conservative use of the princely as well as private forests, since devastation of the latter would require the former to be drawn on extravagantly; it was to stave off a timber famine, and in certain localities to assure particularly the mining industry of their wood supplies. There were, however, concessions made to the privileged and influential classes of forest owners.

By the end of the 18th century, this forest police, owing to the uncontrolled harshness and the grafting practices of the lower officials had become the most hated and distasteful part of the administration.

The argument of the protective influence of forest cover did not enter into this legislation; this argument belongs to the 19th century.

Yet reboisement of torrents had already in 1788, been recognized as a proper public measure in German Austria, although active work in that direction was not begun until nearly a century later.

The rise of prices during the 17th and 18th centuries had been very considerable, doubling, trebling and even quadrupling in the first half of the 18th century. The mercantilistic doctrines of the time led, therefore, to attempts to keep prices low by prescribing rates for wood and in general by restricting and regulating wood commerce.

This was done especially by interdicting sale to outsiders, forbidding export from the small territory of the particular prince; or, at least, giving preference to the inhabitants of the territory as purchasers and at cheaper rates.

Owing to the small size of the very many principalities, the free development of trade was considerably hampered by these regulations. Sometimes also wood imports were prohibited, as for instance, in Wurttemberg, when, in 1740, widespread windfalls had occurred which had to be worked up and threatened to overstock the market.

Wood depots under government control were established in large cities, and the amount of wood to be used per capita prescribed, as in Koenigsberg (1702).

In Berlin, in 1766, a monopoly of the fuel wood market was rented to a corporation, excluding all others except by permission of the company. This was in 1785 supplanted by government administration of the woodyards.

Another such monopoly was created in the “Nutzholzhandelsgesellschaft” (Workwood sales agency) for the export trade of building materials from Kurmark and Magdeburg, which had prior right of purchase to all timber cut within given territory, the idea being to provide cheap material for the industries. This, too, came into the hands of the State in 1771.

In Prussia, to prevent overcharges, the Jews were excluded from the wood trade in 1761.

The exercise of the Forsthoheit (princely supervision), originating in the ban forests, and favored by the mercantilistic and absolutist ideas of the 17th and 18th centuries, gradually grew until the end of the 18th century to such an extent that the forest owners themselves were not allowed to cut a tree without sanction of some forest official, and could not sell any wood without permission, even down to hop-poles, although the large landed property owners vigorously resisted this assumption of supervisory powers. Much discussion and argument regarding the origin of this right to supervision was carried on by the jurists upon the basis of Roman law doctrine, and it was proved by them to be of ancient date. The degree, however, to which this supervision was developed varied considerably in the different parts of the empire, according to different economic conditions. The interference, and the protection of forests appeared more necessary, where advanced civilization and denser population created greater need for it. We find therefore that the restrictive policy was much more developed in the Southern and Western territories than in the Northern and Eastern ones, where the development begins two centuries later.

The oldest attempts of controlling private forest property are found in Bavaria (1516), Brunswick (1590) and Wurttemberg (1614). Here, forest properties were placed either entirely under the supervision of the princely forest administration, or, at least, permission for intended fellings had to be secured. Later, these restrictions were considerably reduced in rigor (Bavaria, 1789).

In Prussia, private forest property remained free from government interference well into the 18th century. An edict by the Great Elector, in 1670, merely inveighs against the devastation of forests by their owners, but refrains from any interference; and the Forstordnung of 1720 also contains only the general injunction to the owners not to treat their forests uneconomically. But, in 1766, Frederick the Great instituted a rigid supervision providing punishment for fellings beyond a special budget determined by experts. Soon after the French revolution, however, unrestricted private ownership was re-established.

Church and cloister property had always been severely supervised, similar to the Mark and other communal forest property, under the direction either of specially appointed officials or the officials of the princes. Finally, in some sections (Hesse-Kassel, 1711; Baden, 1787), the management of these communal forests was entirely undertaken by the government.

In Prussia, by the Order of 1754, the foresters of the State were charged with the supervision of the communal forests, in which they were to designate the trees to be felled and the cultures to be executed; but as there was no pay connected with this additional duty and the districts were too large, the execution of this supervision was but indifferently performed.

In 1749, a special city forest order placed the city forests in Prussia under the provincial governments, requiring for their management the employment of a forester and the inspection of his work by the provincial forestmaster.

5. *Personnel*

Although all this supervision was probably more or less lax, the possibility of more general and incisive influence was increasing because the personnel to whom such supervision could be intrusted was at last coming into existence.

The men in whose hands at the beginning of the 18th century lay the task of developing and executing forest policies and of developing forestry practice came from two very different classes. The work in the woods fell naturally to the share of the huntsmen and forest guards, who by their practical life in the woods had secured some wood lore and developed some technical detail upon empiric basis. These so-called *holzgerechte Jaeger* (woodcrafty hunters) prepared for their duties by placing themselves under the direction of an established huntsman, who taught them what he knew

about the rules of the chase, while by questioning woodchoppers, colliers, etc., and by their own observation the knowledge of woodcraft was acquired.

At the head of affairs stood the so-called *cameralists* or chamber officials, men who had prepared themselves by the study of philosophy, law, diplomacy and political economy for the positions of directors of finance and State administration. Rather ignorant of natural science, and without practical forestry knowledge, their efforts were not always well directed. They deserve credit, however, for having collected into encyclopædic volumes the empiric knowledge of the practitioners or Holzgerechten, and for having elaborated it more or less successfully. In this work they were joined by some of the professors of cameralia and law at the universities.

By the middle of the 18th century the hunters had so far grown in knowledge and education as to be able to produce their knowledge in books of their own. Quite a literature developed full of acrimonious warfare of opinions, as is the rule where empiricism rules supreme.

Notable progress, however, came only when hunting was placed in the background and more or less divorced from forest work.

6. *Development of Silviculture*

In addition to the restrictive measures and attempts at mere conservative lumbering without much thought of reproduction, there were as early as the 16th century silvicultural methods applied to secure or foster reproduction.

Owing to differences in local conditions and difference in necessities, this development varied greatly in various sections as to the time it took place. The Western and Middle country practiced as early as the 16th century what in the Eastern country did not appear until the 18th century. The forest ordinances, from which we derive our knowledge or inferences of these conditions, prescribed, to be sure, many things that probably were not really put into practice.

a. *Natural regeneration* was at first merely *favored*, without the adoption of any very positive measures to secure it, namely, by removing the cut wood within the year, so as to give young growth a chance of establishing itself, by removing the brush so as not to smother the young growth, by keeping out cattle from the young growth (Schonung).

If the selection method of lumbering, most generally practiced without much plan, did not produce any desirable result in reproduction, the clear cutting which was practiced without system where charcoal manufacturing or river driving invited to it, did even less so. In either case, besides the defective and damaged old stubs which were left in the logging, a poor aftergrowth of undesirable character remained, as is the case in the American woods on so many areas.

As early as 1524 and 1529, we have record of a conscious attempt to secure a reproduction by leaving ten to thirty seed trees per acre; but the result was disappointing, for this practice, being applied to the shallow-rooted spruce, produced the inevitable result, namely, the seed trees were thrown by the winds.

This experience led to the prescription (in 1565) in the Palatinate to leave, besides seed trees, parts of the other stand for protection against wind damage; later, wind protection was sought by leaving parcels standing on all four sides, giving rise to a checkerboard progress of fellings or a *group system* of reproduction, which by the middle of the 18th century had developed into the regular *strip system*, applied in Austria (1766) to fir and spruce, and in Prussia (1764) to pine. And this marginal seeding method remained for a long time the favorite method for the *conifers*.

To avoid long strips and distribute the fellings more conveniently, v. Berlepsch (in Kassel) recommended (in 1760) the cutting in echelons (curtain method, Kulissenhieb), which insured better seeding, but also increased danger from windfalls, and was never much practiced, the disadvantages of the method being shown up especially in the Prussian Forest Order of 1788.

In the first half of the 18th century it was recognized that the wind danger would be considerably reduced by making the fellings progress from East or Northeast to West. The conception of a regular, properly located felling series was first elaborated in the Harz mountains in 1745 by von Langen, who also accentuated the necessity of preserving a wind mantle on exposed situations. Both of these propositions reappear in the Prussian Order of 1780, according to which fellings are to proceed in a breadth of twenty to thirty-five rods from East to West.

The application of a *nursetree method* for conifers was proposed in 1787 by v. Burgsdorf (Prussia), a dark position (Dunkelschlag) and a regeneration period of seven years being advocated.

In broadleaved forest, besides the selection forest, the natural result of the sprouting capacity of the hardwood had led to a coppice method which was extensively relied upon for fuel production. This was rarely, however, a simple *coppice*, for, intentionally or unintentionally, some seedlings or sprouts would be allowed to grow on, leading to a composite forest and finally to a regular *coppice with standards* (1569, etc.), with an intentional holding over of the valuable oak and ash for standards. Probably, however, large areas of unconsciously produced composite forest exhibited sad pictures of branchy overwood with suppressed underwood of poor sprouts, injured by game and cattle – a scrubby growth, into which crept softwoods of birch and aspen. Attempts at *pruning* such scrub growths into shape on quite an extensive scale are on record.

The recognition that more wood per acre could be secured by lengthening the rotation of the coppice, which seems to have been mostly twelve years or less, led to twenty and thirty year turns and finally to fifty, sixty and even eighty year rotations or so-called *polewood management* (Brunswick, 1745), also called *Hochwald* (high forest).

A full description and working plan for such a forest to be managed in eighty year rotation, the city forest of Mainz in the Odenwald and Spessart mountains, dates from 1773, and this polewood forest management became quite general after the middle of the 18th century, but in the last half of the 19th century it was generally replaced by the true high forest management under nursetrees, the experiences with the natural reproduction of conifer forest having proved the advantages of this method.

The primitive beginnings of this so-called *Femelschlag* method (Compartment selection or shelterwood method) are found, in 1720, in Hesse Darmstadt, where Oberforstmeister von Minnigerode prescribed regular fellings progressing from north to south, in which all material down to polewood size (in selection or virgin forest) was to be removed, excepting only a number of clean boles, one every ten to twelve paces being left for seed and nursetrees. The good results in reproduction stimulated owners of adjoining estates to imitate the method (1737).

The observation that in beech forest the young crop needed protection and succeeded better when gradually freed from the shade of the seed trees, especially on south and west aspects where drought, frost and weeds are apt to injure it on sudden exposure, led to the elaboration of the principle of *successive fellings*.

In the ordinance of Hanau, as early as 1736, three grades of fellings were developed, the cutting for seed, the cutting for light, which was to begin when the young crop was knee-high, and the removal cutting when the crop was high.

This method spread rapidly and was further developed by the addition (in 1767) of a preparatory cutting, to secure a desirable seedbed, and by lengthening the period of regeneration and elaborating other detail, so that, by 1790, the principles of natural regeneration under nursetrees for beech forest were fully developed in Western Germany.

In other parts, hardwood forest management was but little developed. The Prussian Forest Ordinance of 1786 contented itself with forbidding the selection method, by declaring natural regeneration, as practiced in the pineries, not applicable; while the Austrian Ordinance of 1786 recognizes only clearing followed by planting as the general rule.

b. *Artificial Reforestation.* Although sporadic attempts at sowing and planting are on record as early as the beginning of the 14th century, extensive artificial reforestation did not begin until the middle of the 18th century, by which time planting methods were quite fully developed.

Among the hardwoods, the *oak* was the first to receive special attention. By the middle of the 16th century the forest ordinances gave quite explicit instructions for planting oak in the so-called *Hutewald*, a combination of pasture and tree growth such as is found to-day in the bluegrass region of Kentucky; the remnants of these poor pasture woods with their gnarly oaks have lasted into modern times.

In the forest ordinance of Brunswick (1598) orders are given to plant on felling areas: "every full farmer shall every year at the proper time set out ten young oaks, every half farmer five, every farm laborer three, well taken up with roots (wildlings), and plant them in the commons or openings at Martini (November) or Mitfasten (Easter) and cover them with thorn brush" (to protect them against cattle).

About that time it was, indeed, incumbent on every marker to sow annually five oaks, or plant several young seedlings for every tree cut and to tend them a few years; and the custom existed in the low country, – afterwards (1700) introduced by law in Saxony – to plant in celebration of certain occurrences – a kind of *arborday*– especially to celebrate the marriage day; in order to be married the bridegroom had to prove that he had planted a certain number of oaks, which in Prussia (1719) had to be six, besides six fruit trees. The existence of this custom, now long forgotten, has given rise in the United States to the story that this is the method by which the German forest is maintained.

The method of collecting and keeping acorns over winter was well known in 1579, as is evidenced by the Hohenlohe Forest Ordinance, which advised fall sowing, but, if that did not prove successful, to prepare the ground in summer, leave it through the winter and sow in the spring.

While, in earlier times, *sowing* seems to have had the preference, at a later period planting was practiced, at first with wildlings, but as early as 1603 we find mention of oak nurseries.

The Prussian Order of 1720 ordered the foresters to plant oaks in the openings before Christmas, for which they were to be paid, if the trees were found alive after three years. The growing and culture of oak also interested Frederick the Great, who ordered its extension everywhere. Very explicit and correct rules for growing and transplanting them, and some to which we would not subscribe, were given in the books of the 18th century. Among the planting methods we find, in 1719 and again in 1776, one similar to the Manteuffel method of planting in mounds.

While oak culture was especially fostered in Northwestern Germany, the cultivation of *conifers* first received attention in the southwest, and in the same manner which was inaugurated by the Nuremberg seed dealer in 1368. A new idea, introduced in the Palatine Forest Ordinance (1565) and in the Bavarian Forest Ordinance (1568), was the prescription, to soak the seed before use and sow mixed with sawdust or sand, bringing the seed under with brush or iron rakes.

Carlowitz (1713) taught well the methods of collecting, extracting and keeping the seed, and even proposed seed tests. The seedbeds were to be made as for carrots, dense sowings to be thinned, and the thinnings transplanted into nursery rows, the seedbeds to be covered with moss and litter to protect them against heaving; he also discusses the question of cost. The adaptation of plant material to different sites – conifers where oaks are not suitable – was also understood (Bavarian Forest Ordinance, 1683).

As long as the old method of extracting the seed in hot stoves or ovens prevailed, conifer sowings gave but indifferent results.

In the pine forests of Prussia, during the second half of the 18th century, the method of sowing the cones on large waste and sand barrens, where the sun would make them release the seed, was practised, and before Brémontier had written his celebrated *mémoire sur les dunes*, sanddunes had been recovered with pine plantations in Germany in the manner which is still in vogue.

The *planting* of conifers came into practice much later, and then it was mostly done with wildlings. Opinions differing as to the value of sowing or planting, it was erroneously held until the 19th century that planting was less successful and too costly in comparison with the small harvest yield, which necessitated cheapness of operations. It was only towards the end of the 18th century that planting of pine was resorted to, but merely for repairing fail places in sowings and natural regeneration, and then with a ball of earth (1779), using a hollow spade, – a costly method. The cost of a certain plantation made in 1751 is, however, reported as less than $3.00 per M., in 1770 as low as 70 cents per M. To cheapen the operations the labor was exchanged for wood, pasture or other materials or advantages.

In Prussia, in 1773, all recipients of free wood had to do service in the cultures; in 1785, every farmer had to furnish a certain amount of cones or acorns. The method, lately adopted in Russia, came into vogue in Prussia in 1719, namely, of charging, besides the value of the wood, a toll to be paid into the planting fund (about 7 % of the value). This method was also imitated elsewhere.

The use of the *Waldfeldbau* (combined farm and forest culture) was also inaugurated for the purpose of cheapening the cost of plantations (by v. Langen in 1744) when the great movement for reforesting wastes and openings began, the tree seed being sown with the grain either at once or after farm use for some years.

Regular annual planting budgets (of $50 – $100 – $200) were inaugurated in Brunswick by v. Langen in 1745; and in 1781, the Prussian forest administration had attained to entirely modern planting plans and annual planting budgets.

It was no wonder that the fear of a timber famine and the apparent hopelessness of bringing improvement into the existing forest conditions created anxiety and a desire to plant *rapid growers*, such as birch, willow, aspen, alder; the planting of the White Birch became so general in the beginning of the 18th century that a regular betulomania is recorded corresponding to the incipient catalpomania in the United States.

At that time, to be sure, firewood was still the main concern, and the use of these rapid growing species had some justification. But where birch was mixed in spruce plantations its baneful effects consisting in whipping off the spruce tips and injuring its neighbors were soon recognized, and much trouble was experienced in getting rid of the unwelcome addition.

The *Robinia*, which had been brought from America in 1638, was also one of the trees recommended in the middle of the 18th century and was much planted until Hartig pointed out that the expectations from it were entirely misplaced.

Of course no building material could be expected from these species, hence the larch, also a rapid grower, was transplanted from the Alps (1730 in Harz mountains), and its use was extended, as with us, to conditions for which it was not adapted.

It was principally a desire for novelty and perhaps for better, especially foreign things, that led to the planting of North American species in parks during the first half of the 18th century. But, although F. A. J. von Wangenheim's very competent writings on the American forest-flora and on the laws of naturalization (1787) stimulated interest in that direction, the use of American species for forest planting was not inaugurated till nearly 100 years later, with the single exception of the White Pine (*P. strobus*), of which large numbers were planted.

7. *Improvement of the Crop*

Thinning of stands had been practiced early in the 16th century, not for improvement of the remaining stand so much as to secure fence material, although in 1531 the observation was already recorded that thinning improved and stimulated the remaining growth.

In the 17th century, opposite views, or, at least doubts as to its usefulness were expressed in the forest orders, and sometimes thinning was even forbidden. Even in the 18th century some of

the prominent foresters, Doebel and Beckman, were opposed to it, and although others favored the operation, the practice of it remained limited.

In 1761, we find the first good statement of the theory of thinnings by Berlepsch, who advised taking out the suppressed trees when the sound poles were clear of lower and middle branches; he also accentuated the financial argument of earlier returns and increased value of the remainder.

About the same time, Zanthier recommended two thinnings, namely, for conifers first in the thirtieth to fortieth year and again in the fiftieth year, for broadleaf forest first in the forty-fifth and again in the eightieth to ninetieth year.

In 1765, the financial gain from thinnings is figured by Oettelt, and the possible reduction of the rotation due to thinnings is recognized by Leubert in 1774.

Just as the thinning in polewoods arose from the need of earlier utilization, so the weeding of young growths was done for the purpose of getting material for withes to bind the grain, etc.

The removal of coppice shoots in oak plantings was practiced in Prussia in 1719, and the thinning of too dense sowings was advised by Carlowitz in 1713. Yet much later, even such an intelligent man as Oettelt inveighed against the weeding out of the birch in spruce sowings because "nature prefers variety, with which preference it is not good to interfere."

This was in opposition to v. Langen (1745), who prescribed for the first time regular cleaning or weeding, especially the removal of the softwoods, aspen and birch, and of coppice shoots from seedling forest. It was also known that this weeding is best done "in the full sap," in order to kill the stocks.

8. *Methods of Regulating Forest Management*

Organized forest management was slower to develop than silvicultural methods. The first attempts to bring order into the progress of fellings took the form of dividing the whole area into a certain number of felling areas (12, 16, 20, 30, etc.), several ordinances dating from the middle of the 15th and 17th centuries containing prescriptions to that effect.

It is doubtful whether the numbers of these areas indicate years of rotation, in which case they could only have applied to coppice, or whether they indicate periods of return in selection forest, although the historians seem to jump to the former conclusion. The area division practiced by v. Langen in the Harz mountains (1745), who prescribed the division of larger districts into fifty to sixty, of smaller districts into twenty to thirty felling areas, also leaves it doubtful, whether the areas corresponded to an assumed rotation or to a period of return.

At first, the division was not into equal areas, for no survey existed, and its object was simply to localize the cutting and provide orderly progress. The subdivision was made in the mountain country by following the topography, valleys and ridges, while in the plain the lines opened up for purposes of the chase (to set up nets), called *Schneisen* or *Gestelle* (rides), bounding square areas called *Jagen*, *Quadrat*, *Stallung*, were used for the limitation of the felling areas. Most commonly, however, largely due to absence of surveys, the ordered division did not materialize, but existed only on paper.

With more exact measuring of areas, and with the conception of a rotation or longer periods of return, it was recognized that the inequality of the sites or soil qualities, especially in mountain districts, produced very unequal felling budgets. To overcome this inequality, Jacobi, in Goettingen (1741) introduced *proportional* felling areas, making the felling areas on poor sites permanently larger.

Similarly, v. Langen and Zanthier attempt to secure equal annual returns without slavishly holding to the geometric division, merely making sure that the total area be cut over in the predetermined rotation.

The first attempts to introduce a regulated management by making a *volume* division the basis is recorded from the Harz mountains in 1547. This method, based on very crude estimates although upon very fair forest description, was continued into the 18th century.

In the last half of the 18th century all these crude methods were improved, and applied on extensive areas.

In 1785, Zanthier combined area and volume division, determining the felling budget on each felling area by counting and estimating the trees and calculating how many trees could be used annually under a sustained yield management; the area division being used only as a check or means of control.

A very considerable advance was made by Oettelt, (who surveyed and regulated the Weimar forests in 1760) in the elaboration of details and establishment of proper principles for regulating the felling budget.

In his forest description he introduces for the first time periodic age classes, usually six, but of uneven length: Young growth, below twelve years; thicket, twelve to twenty-four years; polewood, twenty-four to forty years; clear timber, forty to fifty; medium timber, fifty to seventy-five; mature timber, seventy-five years and over.

He divides the forest into proportional areas (which were marked by stones in the woods), equalizing them according to age, quality, increment, soil, exposure, so as to secure equal annual budgets; the stands were ranged into seven or eight unequal age classes and each into as many annual felling areas as there are years in the age class; if some of the age classes were absent, he extended the time for cutting in the older class until the younger had grown to the proper age and by varying the cut from good to poor sites for stands he tried to even out the budgets. The volume budget he determined by average increment measurements. This method was, however, much too far advanced and required too much mathematics to find imitators at that time.

Another method which proved also too complex for the foresters of the time was that of v. Wedell; nevertheless, by 1790, he had by it put into working order 800,000 acres in Silesia. He divided this area into districts, the districts into blocks or management classes, and used an elaborated proportional area division for determining the felling budget. He distinguished quality of stand and quality of site, and made four site classes. The volume of stock, he found by means of sample areas, to which he added the increment in order to find the total volume for harvest, when it could be determined how long with a given budget the stands would last, or what average annual felling budget could be taken before the next age-class would be mature.

In the North German plain, with very uniform conditions of soil and timber, the method of equal felling areas was the most natural and most easily applied.

Frederick the Great, who took a considerable interest in forestry matters, ordered such an area division for the State pineries in 1740, fixing upon different numbers of felling areas, but finally, in 1770, deciding on a rotation of seventy years. Lack of personnel retarded progress in this forest survey and regulation until in 1778 v. Kropff undertook the direction. Not agreeing with his master regarding the short rotation of seventy years, he arranged to have each district divided into two working blocks, and by cutting alternately in these, managed to double that rotation. His successor, Hennert, in 1788, devised a new method by introducing allotment of a number of annual felling areas to a period of the rotation when at least the periodic budget could be equalized. A value or money yield equalization of the felling budgets was also attempted.

For easier handling, the forest was divided into small compartments or Jagen and a classification of four, still uneven, periodic age classes (of different length for conifers and broadleaved forest), and three site qualities were employed. The merchantable stock was ascertained by a sample area method and the felling budget by dividing the oldest age class by the number of years it must last until the next was ready. Since no attempt was made to secure a proper age class gradation, the method failed to improve conditions for the next rotation.

Some 500,000 acres were regulated according to this plan in Prussia, probably very superficially.

In 1789, Bavaria also ordered a division into annual felling areas.

In all these methods of regulating the yield or budget, the area played the main role, the volume being only a secondary consideration.

The first elaboration of a pure volume division was made by Beckman in 1759. He estimated stock on hand by trees and guessed more or less at the increment, allowing 2.5, 2, and 1 % for the different sites, and then made a year to year calculation of stock for 125 years. How the felling budget was finally determined is not known.

Two methods were simultaneously devised in Württemberg in 1783, which form the transition to the so-called *allotment* methods, making periodic age classes of an equal number of years and allotting either felling areas or volumes to each period of the rotation. Incapacity of the officials prevented the application of the one method, while the other, devised by Maurer, remained also only a proposition.

But, in 1788, Kregting in his Mathematical Contributions to Forestry Science teaches a pure volume allotment method with ten year age classes and nearly all the apparatus which was afterward developed by Hartig, who in the next period dominated to such a large extent the development of forestry in all its branches.

9. *Improvements in Methods of Mensuration*

In scientific direction, the mathematical disciplines were the first to be developed; the natural sciences received attention much later.

A considerable amount of mathematical knowledge was required for this work of forest organization. The mathematical apparatus of the foresters even at the end of this period was rather slender, but its development went hand in hand with the development of these methods of regulation; and even elaborate mathematical formulæ for determining felling budgets were not absent.

Until nearly the middle of the 18th century, surveys of exact nature were almost unknown; only when the division into equal or proportionate felling areas became the basis for determining the felling budgets, did the necessity for such surveys present itself.

Plane table and compass were the instruments which came into use in the beginning of the 18th century. But not until the latter half of that century were extensive forest surveys and maps of various character made, especially in Prussia under Wedell, Kropff and Hennert.

The methods of measurement of wood developed still later. Until Oettelt's time no method of precise determination of volumes was known, everything being estimated by cords or by diameter breast-high and height, or by the number of boards which a tree would make (board feet?).

The diameter was sometimes used as a price maker, the price increasing in direct proportion to the diameter increase. Oettelt calculated the volume of coniferous trees as cones, and *Vierenklee*, who wrote a book on mathematics for the use of foresters, calculated timbers with the top removed by using the average diameter, to which Hennert added the volume of a cone with the difference of the two diameters as a base, to make the total tree volume.

Most measurements of standing trees were, of course, made on the circumference, for, in the absence of calipers, the diameter could be directly measured only on the felled tree. Doebel had already measured the height by means of a rectangular triangle, and the first real hypsometer with movable sights was described by Jung in 1781; and a complete instrument, which could be used for measuring both height and diameter at any height, similar to some more modern ones, was constructed by Reinhold.

Determination of the real wood contents in a cord of wood and of the volume of bark by measurement was taught by Oettelt, and the method of immersion in water and measuring the displaced volume, by Hennert (1782).

In 1785, Krohne first called attention to the variation of the increment in different age classes and the need of determining the accretion for each separately.

In 1789, Trunk taught how to determine average felling age increment, and also the method of determining the change of diameter classes, which is now used by the United States Forest Service: "On good soil a tree grows one inch in three years, on medium soil in four years, on poor soil in five years." With this knowledge, the attainment of a given diameter, or the change from one diameter or age class to the next could be calculated.

Volume tables were at Trunk's command, and Paulsen in 1787, Kregting in 1788, mention periodic yield tables; but generally speaking "ocular taxation" or estimating was the rule, checked by experience in actual fellings, the method of the American timber looker. Generally, of course, only the log timber was estimated as with us, and only the very roughest estimating or rather guessing was in vogue until near the end of the period.

The first attempt at closer measurement was made by Beckman (1756), who surrounded the area to be measured with twine, drove a colored wooden peg into each tree, one color for each diameter class, when, knowing the original number of pegs that had been taken out, the difference gave the number of trees in each diameter class, and by multiplying the average cubic contents of a measured sample tree in each class by the number in the class its volume was found.

The method, often employed at present, of ascertaining by tally the diameter classes on strips forty to fifty paces wide, the so-called strip survey, was described by Zanthier in 1763.

These measurements were usually confined to sample areas, the use of such being already known in 1739. The contents of the sample area, if a special degree of accuracy was desired, were ascertained by felling the whole and measuring.

Oettelt, of mathematical fame, was the first to publish something about the determination of the age of trees by counting rings, although the practice probably antedates this account. He knew of the dependence of the ring width on the site and on the density of the stand.

It seems that long before this time the French had made the determination of yield in a more scientific manner, Réaumur reporting in 1721 to the French Academy comparative studies of the yield of coppice and of volumes of wood.

Oettelt, too, laid the foundation of forest financial calculations when he ascertained the value of a forest by determining the value of an acre of mature wood – the oldest age class – and multiplying it by half the acreage of the whole forest, suggesting the well known expression for the normal stock soon after to be developed by an obscure Austrian tax collector.

Even the first forest finance calculations with the use of compound interest, and a comparison of the profitableness of the different methods of management, are to be recorded as made by Zanthier in 1764, bringing the beginning of forestal statics into this period.

10. *Methods of Lumbering and Utilization*

At the beginning of this period, rough exploitation was still mainly in vogue, only parts of trees being used, just as in the United States now. Here and there, attempts were made toward more conservative use; for instance, at Brunswick in 1547, the use of log timber for fuel was discouraged; in Saxony, as early as 1560, the brushwood was utilized for fuel. High stumps were a usual feature in spite of the threats of punishment of the forest ordinances, as in Bavaria (1531). The axe was the only instrument used until the end of the 18th century for felling as well as cutting into lengths; not until 1775, do we find an allusion to the use of the saw, when the forest ordinance of Weimar ordered that the saw-cut should be made for three-fourths of the tree's diameter and the axe be used

to finish (!) the last quarter. Not until the 18th century was the fuel-wood split in the woods, and it was near the end of the period before it was set up in mixed cords (round and split) after the splitting had been introduced. The measurement was, until about that time, made merely in loads, the cord being of later introduction.

The value of low stumps and of the use of the saw was recognized in Austria in 1786. To show how variously and locally the need of conservative use of wood developed, we may cite the fact that in the Harz, about 1750, trees were dug with their roots as now in some of the pineries of the Mark Brandenburg, in order to utilize more of the body-wood and the root-wood. In 1757 we find stump-pulling machines described.

In measurement of standing trees the circumference at breast-height was measured with a chain, and for the body-wood when felled the mean diameter was employed.

As regards the felling time, specific advice is found in many forest ordinances which recommend mostly winter felling, stating the proper beginning and end of the season by the phases of the moon, the rule being that all white wood, for example conifers, beech and aspen should be felled on the increase or waxing of the moon; oak, at the waning; but coppice, because it is desired to secure a new growth, at the waxing moon. Prescription was also made sometimes regarding the time by which the removal of the wood from the felling area was to be finished (May to June).

Means of transportation were poor up to the end of the period; snow, as in the United States, was in the Northern country the main reliance for moving the wood. River driving, both with, and without rafts was well organized; various systems of log-slides were developed to a considerable extent; in one place even an iron pipe, 900 feet in length, is reported to have been used in such capacity.

Originally, the consumer cut his own wood, but in the middle of the 17th century special wood-choppers appear to have been employed, for, in 1650, mention is made in Saxony of men, who, under oath to secure honest service, were organized for the exploitation of the different classes of wood. A system of jobbers came into existence about this time, something like the logging bosses in the United States (Holzmeister) who were responsible for the execution of the logging job. The organization of wood-choppers went so far that, in 1718, we find in the Harz mountains mention of an Accident Insurance and Mutual Charity Association among them.

The sale of wood was at first carried on in the house; later it became customary to indicate in the forest the trees to be cut or the area from which they should be cut by the purchaser, and finally they were felled by the employes of the owner. For a long time, persisting into the 18th century, the sale was by area, and this method developed the necessity of surveying; at the same time, however, sales by the tree and by wood measure occurred, but only in the 18th century did the present method of selling wood by measure after felling come into existence. In Prussia, the buyer had to take the risk of felling, and pay, even if the tree proved to be rotten, or broke in the felling. The forest owner seems to have had the whip hand in determining the price one-sidedly, revising, i.e., increasing the toll in longer or shorter intervals. But, in 1713, we find mention of wood-auctions, or at least similar methods of getting the best prices. Finally, special market days for making sales and for designating of wood were instituted; on these days also, all offences against the forest laws were adjudged.

11. *Forest Administration*

The administration of the different forest properties which the princes had aggregated in the course of time was at first a part of the general administration of the princely property. The requirements in the woods being merely to look after utilization and protection, illiterate underlings (*Forstknechte*) were sufficient to carry out the police functions, generally under a *Forstmeister*, or *Oberforstmeister*, who from time to time would make an inspection tour. Later on, when a more intensive forest management had come into existence, it became customary to call in experienced foresters from outside to make inspections and give advice.

A much more elaborate organization of service is, however, reported in the mining districts of the Harz mountains, in 1547, with the Director of Mines (*Berghauptman*) at the head, and different grades of officials under him, who were called together periodically for reports and discussions.

Until the middle of the 18th century all those employed in the forest service, at least those in the superior positions, had also duties in connection with the chase, the head official of the hunt being also the head of the forest service; and hunting had usually superior claims to forestry. The men were supposed to be masters of the two branches, i.e., to be familiar with the technique of the hunt and of forestry (*Hirschgerecht* and *Holzgerecht*). The higher positions were usually reserved to the nobility until (during the 18th century) the Cameralists came into control of the administration; and with them, under the mercantilistic teachings, the apparatus of officials also increased.

These men usually possessed wide, but not deep knowledge of matters bearing upon their charges. In Prussia, in 1740, the forest service was at least in part combined with the military service, Frederick the Great instituting the corps of riding couriers for the carrying of dispatches who were selected from the forest service, an institution which persists up to date in the corps of *Feldjaeger*, while the sons of foresters were enlisted in a troop known as *Fussjaeger* (*chasseurs*). A new era dates from the middle of the 18th century when the connection with the hunt, the military organization, and the preferred position of the nobility, were at least in part abrogated, and a more technical organization was attempted. The cause for this change was the increase of wood prices, which made a more technical management desirable, and also a decrease in the passion for the hunt. Still, although the forests in Bavaria were declared, in 1780 to 1790, to be of more importance than the hunt, and the two services were distinctly separated, the head of the hunt still ranked above the head of the forest service.

In Prussia, the professional men became early independent and influential, and by 1770, an organization had been perfected which excelled in thoroughness and simplicity. The salaries of the foresters consisted originally mainly in a free house, use of land and pasture rights, their uniform, and incidental emoluments, such as a toll for the designation of timber etc. Later, when everywhere else a regular money management had been introduced, the absence of a cash income and general poverty forced the foresters to steal and extort; and the bad reputation established in the last part of the 18th century, as well as the bad practice, persisted until the 19th century. The lower grades in the service were exceedingly ignorant, and their social position, consequently, very low. Their main business was, indeed, simple, and consisted in the booking of the cut, issuing permits for the removal and the sale of wood, and looking after police functions in the woods. Yet, by 1781, we find regular planting plans submitted in the Prussian administration, and, in 1787, felling plans are on record.

The administration of justice against offenders in the forests was until the end of the 18th century in charge of the head foresters, and only then was transferred to law officers. Theft of wood, as in olden days, was considered as a smaller offense than other thefts, except if it was cut wood. In the beginning of the period, the judge had wide latitude as to amount of the fine to be imposed, but in the 17th century more precise fines were fixed, and in the 18th century, a revision of the fines brought them into proportion with the value of the stolen wood; a choice of punishments by fines, imprisonment or labor in the woods was then also instituted.

12. *Forestry Education*

The course of education for the foresters until the middle of the 18th century was a simple one and mainly directed to learning the manipulations of the chase, training of dogs, tending of horses, setting of nets, shooting, etc. Two or three years' life with a practical hunter were followed by journeying and working for different employers, woodlore being picked up by the way from those that knew.

When in the 18th century the need for better woods knowledge became pressing, the few really good forest managers were sought out by the young men who wished to secure this knowledge. In this way, a number of so-called "master-schools" came into existence, each depending on one man. Such a school was that of v. Zanthier in Wernigerode, later transferred to Ilsenburg, started in 1763 and ending with his death in 1778. Theoretical teaching and opportunity for practical demonstration here was such that even students from the Berlin school and men in actual employment attended the courses.

The two great masters and fathers of modern forestry, Hartig and Cotta, each instituted such master-schools, the former in 1789, and the latter in 1785. Cotta's school was afterwards transferred to Tharandt and became a State institution.

The interest of the State in forestry education found first expression in Prussia in a course of lectures in botany, later also in forest economy, given to the forest officials by *Gleditsch*, professor of botany at the University of Berlin (1770), to which was added a practicum at Tegel under Burgsdorf, who finally became the head of this mixed State school, and continued in this position until at his death, in 1802, the school was discontinued.

In imitation of this move by Prussia, a military planting school was instituted by Württemberg at Solitude in 1770. The most noteworthy feature of this school, which under various changes lasted less than 25 years, was the course of lectures by Stahl, mentioned before.

Besides this higher school, a lower grade school was started in 1783, but its career was even briefer, not more than ten years.

Bavaria organized a forest school at Munich in 1790 with a four years' course, and at least three years' study at this school was required of those seeking employment in the State service; but without having ever flourished, this school, too, collapsed by 1803.

13. *Forestry Literature*

The oldest forestry literature of this period is contained in the many forest ordinances, which allow us to judge from their prescriptions as to the conditions of the practice in the woods and as to the gradual accumulation of empiric knowledge. Of a forestry science one could hardly speak until an attempt had been made to organize the knowledge thus empirically acquired into a systematic presentation, and this was not done until the middle or last half of the 18th century.

The first attempts at a literary presentation of the empiric knowledge are found in the encyclopædic volumes of the so-called "Hausväter" (household fathers – domestic economists), who treated in a most diffuse manner of agriculture in all its aspects, including silviculture.

A number of these tomes appeared during the 17th century; the best and most influential being published at the very beginning of that century (1595-1609), written by a preacher from Silesia, *Johann Colerus*, and entitled *Oeconomia ruralis et domestica, worin das ampt aller braven Hausväter und Hausmütter begriffen*.

Colerus relied upon home experience and not, as Petrus de Crescentiis in his earlier work, *Praedium rusticum* (translated from the French, in 1592), had done, upon the scholastic expositions of the Italians. He was rewarded by the popularity of his work which went through thirteen editions and became very widely known.

Somewhat earlier, a jurist, *Noë Meurer*, wrote a book on forest law and hunting (second edition, 1576), which on this field remained long an authority, and gives insight into the condition of forest use at the time.

But the first independent work on forestry, divorced from the hunt and farming, did not appear until 1713, *Sylvicultura œconomica*, written by the Saxon director of mines, *Hans Carl v. Carlowitz*.

This book, while containing quaint and amusing ideas, gives many correct rules for silvicultural methods, especially as regards planting and sowing, but the subject of forest management or organization is entirely neglected.

At about the same time (1710) a forest official, *v. Göchhausen*, published *Notabilia venatoris*, which, however, contained little more than a description of the species of trees and methods of their utilization.

About the middle of the 18th century great activity began in the literary field. This was carried on by two distinct classes of writers, namely, the empiricists and the cameralists. The former – the *holzgerechte Jäger*– were the "practical" men of the woods who proved in many directions most unpractical, and exhibited in their writings, outside of the record of their limited experience, the crassest ignorance. The cameralists were educated in law and political economy and, while lacking practical contact with the woodswork, tried to sift and systematize the knowledge of the empiricists, and to secure for it a tangible basis.

Some five or six of the empiricists deserve notice as writers; the first and most noted of them was *Doebel* (*Heinrich Wilhelm*) whose book, *Jägerpraktica* (hunters' practice), published in 1746, remained an authority until modern times for the part referring to the chase. The author was pre-eminently a hunter, who worked in various capacities in Saxony, a self-taught man with very little knowledge of natural history. Being familiar mainly with broadleaf forest he condemned planting and thinning, but described quite well for his time the methods of survey, subdivision, estimating and measuring, and the methods of selection forest and coppice with standards. His ignorance is characterized by his reference to the "sulphurous and nitric elements of the soil" as cause of spontaneous forest fires.

Opinionated and one-sided, like many so-called practical men, he came into polemic controversies with other practitioners, not less opinionated, among them *J. G. Beckmann*, who worked in another part of Saxony, where, having to deal with coniferous woods, he had gathered different experiences from those of Doebel. Although he was himself poorly educated, especially in natural sciences, he complained of the ignorance of the foresters, and in his book (*Anweisung zu einer pfleglichen Forstwirthschaft*, 1759), used for the first time the word *Forstwissenschaft* (forest science), and insisted upon the necessity of studying nature.

He may be credited with having really advanced forest organization by devising the first good volume division method, and silviculture by advocating the method of clearing followed by sowing.

The first practical forester with a university education was *J. J. Büchting*, who worked in the Harz mountains. His main interest lay in the direction of survey, division and orderly utilization. He did not, however, make any striking advance, except that he gave equal standing to both planting and sowing.

The two most eminent practitioners of the period, however, active during the middle of the century, were *Johann Georg von Langen* and his pupil, *Hans Dietrich von Zanthier*, both of noble family, and better educated than most of their contemporaries, and both engaged in the organization and management of Harz mountain forests, namely, those of the Duke of Brunswick and of the Count of Stolberg-Wernigerode.

The former, without occupying himself directly with literary work, laid down in his expert reports and in his working plans many instructions which form the basis for orderly management and silviculture far ahead of the times. Zanthier, writing considerably (especially *Kurzer systematischer Grundriss der praktischen Forstwissenschaft*, 1764), is also notable as the founder of the first forestry school (at Wernigerode), 1763.

Another of this class of better educated practitioners, and co-worker with the former two, was *von Lassberg*, who in 1764-1777 organized the Saxon forests.

An interesting incident in the life of the last three men is their journey to Denmark and Norway, whither they were called to organize the management of the forests connected with the mines.

Another prominent forest manager of the last half of the century, whose literary work is to be found only in various excellent official instructions, among which is one for the teaching of foresters, was the head of the Hessian forest service, a nobleman, *v. Berlepsch*.

Of the cameralists who helped to make forestry literature, six or seven deserve mention. These, men of education and polyhistors, were either at the head of affairs, or else professors at universities, where they included forestry as one of the branches of political economy.

The credit of the first really systematic presentation of forestry principles and rules, as developed at the time, belongs to *Wilhelm Gottfried von Moser*, a pupil of von Langen, who served in various principalities, and finally with the Prince of Taxis. In his *Principles of Forest Economy*, published in 1757, which for the first time brought out the economic importance of the subject, he discusses in two volumes divided into nine chapters the different branches of forestry.

A mining engineer, *J. A. Cramer*, came next with a very notable book, "*Anleitung zum Forstwesen*" (1766), which, although not as comprehensive as Moser's, treats the subject of silviculture very well.

Equal in arrogance and opinionated self-satisfaction to any of the empiricists with whom he frequently crossed swords, was the Brunswick councillor, *von Brocke*, who, as an amateur, practising forestry on his own estate, developed the characteristic trait of the empiricists, namely, a profound belief in his own infallibility. He produced, besides many polemic writings, in which he charged the whole class of foresters with ignorance, laziness and dishonesty, a magnum opus in four volumes, entitled "*True bases of the physical and experimental general science of forestry*," which is an olla podrida of small value.

Less original, but more fair and well informed, a typical representative of the cameralists, was *J. F. Stahl*, finally head of the forest administration of Württemberg, and at the same time lecturer on mathematics, natural history and forestry at the forest school of Solitude (Stuttgart). Although an amateur in the field of forestry, he was a good teacher and left many valuable and wise prescriptions evolved during his administration.

He compiled in four volumes a dictionary of forest, fish and game practice (*Onomatologia forestalis-piscatoria-venatoria*, 1772-1781) and founded the first forestry journal.

Since 1770, forestry courses had been given for the cameralists at most of the German universities, and many of the professors prepared textbooks for the purpose. At least three of these professors deserve mention, Beckman, Jung and Trunk.

The first, *J. Beckman*, professor of political economy at Göttingen, one of the most noted cameralists, was author of a work in forty-five volumes on the *Principles of German Agriculture* (1769), in which he devotes sixty-one pages to forestry, giving a complete system of forestry, with extracts from all known forestry writings.

J. H. Jung, who gave a special course on forestry at the Kameralschule of Lautern, published a textbook in 1781 in which forest botany was well treated.

J. J. Trunk, who was Oberforstmeister in Austria, as well as professor at Freiburg, was the most prominent of the three, and wrote a comprehensive work full of practical sense (*Neues vollständiges Forstlehrbuch oder systematische Grundsätze des Forstrechtes, der Forstpolizei und Forstökonomie, nebst Anhang von ausländischen Holzarten, von Torf und Steinkohlen*, 1789).

While at first the ephemeral writings, especially the polemic ones of the empiricists, found room in literary and cameralistic magazines, the need of a professional journal first found expression in 1763, in Stahl's *Allgemeines ökonomisches Forstmagazin*, which ran into twelve volumes, and contains many articles important to the history of forestry, and is especially rich in its references to foreign literature.

Two continuations of the magazine under different editorships were of less value. But von Moser's *Forstarchiv*, running from 1788 to 1807 with its thirty volumes, is an authority and a historical source of the first rank.

A very characteristic literature of the last half of the 18th century consisted in *forest calendars* in which advice as to monthly and seasonal procedures in the forest were given, Beckman and Zanthier being among the authors.

III. Development in the Nineteenth Century

The last hundred years or so has seen in Germany the development of fully established forest policies and the complete organization of stable forest administrations, based upon thorough and careful recognition of the principles of forest management and intensive application of silvicultural methods.

1. *Changes in Property Conditions*

The change in forest treatment from that prevailing during the previous period was mainly due to the change in property conditions, and especially to the establishment of *state forests*. This change was largely the result of the revolutionary movements at the beginning of the new century which brought about changes in state organizations. In Prussia, the princely forest property had been declared state domain in 1713, but elsewhere, the public domain had been considered the property of the princes in their capacity as head of the country, as *domanium*, outside of their personal private property (Chatullgüter). The income from this *domanium* was in part liable to be applied to the expenses of the court and of the administration of the realm, to some extent alleviating the burdens of taxation. This property arose from a variety of relations which have been discussed at length in the foregoing chapters. It was derived mainly from feudal properties, fiefs of vassalage and fiefs of official position, secularized church property and other forfeited property, division of mark forests, and from allodial possessions of the family. Gradually, by agreement with the landed estates, it was understood that this property could not be disposed of or dissipated by the prince, and was inherited by the eldest son together with the princely dignity, being an attribute of his position in the state. In the reconstruction period of 1806 to 1815, during and after the Napoleonic wars, many of the small princes lost their seigniorage (Landeshoheit *ipso jure*), and with the loss of the princely dignity, the obligation of carrying the expense of court and administration naturally falling away, these properties became in most cases purely individual property of the former princes.

Not, however, until the revolutionary movements of 1848 and even later, was this divorce of the state idea from that of the person of the prince everywhere accomplished, nor was it carried through without many bickerings and quarrels between the princes and the representatives of the people, who claimed this *domanium* for the state. In the larger states, all this domanial property was finally declared state lands, while in the smaller principalities a partition of the land between the princes and the state took place, or else a relation was established by which a part of the revenue resulting from the state lands was secured to the princes.

An increase of the State's property came also during the first decade of the century through the abolishment of cloisters and secularization of church property generally, the lands of both Protestant and Catholic church institutions being taken by the State.

Curiously enough, at the same time that the idea of state forest was being realized, the changes in economic thought which brought the principle of individualism to the fore gave rise to a movement to sell the state properties. This movement was inspired by French doctrines, whose influence was at the time very strong, by the teachings of Adam Smith who held that the state is not fit to conduct business, and by the hope that in private ownership an improvement in forest conditions would be more readily realized. These ideas by themselves would, probably, not have led to the adoption of a policy of sale if it had not been for the need for cash which, as a result of the French wars, was felt everywhere during the first years of the decade. The sale of this property seemed to provide a ready means for States to secure funds.

In Prussia, after the collapse of 1806, this measure was widely discussed, and eventually, in 1810 to 1813, repeatedly instructions for the sale of state forest property were issued. There were to

be excluded from such sales only large complexes of forest, those on the sea coast, sand dunes and river fronts, where the protection of the forest cover was needed, and those which it was desirable to maintain for the use of important industrial establishments. Only the accession of Hartig (1811), as chief of the forest administration which was a branch of the Treasury department, prevented the execution of this dismemberment. It was due to him that the difference in character between farm and forest property began to be recognized. Although, after 1820, sales of forest property took place, they were never a fiscal measure, but were made either for the purpose of rounding off existing state forest property or paying off servitudes, or else in order to turn over agricultural soil to farm use. At present everywhere in Germany state properties are on the increase.

The property conditions of the *communal forests* naturally changed also with the political changes of the 19th century, when existing communities were made part of the large political machine and changed from economic and social to modern political municipalities. The ownership conditions, however, were not simplified, but as before, remained extremely varied.

Of the Mark forest but a very small portion remains to-day. The majority of it had been finally divided among the Märker in the first decade of the century, and the few remaining parts became independent of the political organization and now exist merely in the form of appurtenances to certain farm property known as *Genossenwald* (association forests). In addition to the variety of communal ownerships existing in the preceding period, some new communal properties originated from the granting of land in the settlement and dissolution of servitudes, whereby an undivided property (*Interessentenwald*) in which sometimes even the state retains an interest, came into existence.

The municipal property of the cities had become either the property of the entire community or of that part which constituted the real citizenship, or at least of a certain class of citizens of the municipality.

The incumbrances which had grown up with regard to forest property under the name of *servitudes* and which so much retarded the development of better forest management continued into this period, and although through the influences of the French revolution a desire had been stimulated to get rid of all curtailments of property, some have persisted to this day. Indeed, for a time an increase of these servitudes took place, due to the carelessness of forest officials in keeping unjustified use of the forest in check, when ancient usage of these rights of user was claimed and new servitudes were established.

In Bavaria, it became at last necessary (1852) to positively forbid the further establishment of new servitudes or rights of user. Laws having in view the dissolution or buying out of these rights were issued in Bavaria in 1805, and in Prussia in 1821, giving the right to forest owners whose properties were so encumbered, to call for a division of interests; but as at first the only way to settlement was by exchange for definite parcels of forest property, the progress in the abolishment of these rights was slow, until money exchange was permitted (as in Saxony, 1832). At the present time, the state forest administrations have mostly got rid of these servitudes, or at least have progressed so far in their regulation that they are now rarely impediments to forest management. These peaceable adjustments of the rights of user constitute the last act of freeing property socially and economically.

2. *Forest Conditions*

In spite of the sporadic efforts which had been made to bring about the recuperation of forest areas during the 18th century, the conditions of the forest at the beginning of the new century were most pitiable; the division of the Mark, by which the peasants became individual owners, profited little, and led to devastation rather than to improving the condition of the property. In addition, export trade in wood had become brisk, and the financial depression, a result of the French wars, led to increased exploitations, which, with the improvement in means of transportation, progressed to the more distant forest areas, and enlarged the waste area. Especially in the more densely populated parts

of the country, the deforested area widened, and large wastes with poor young growth increased in all directions, in the same manner as now in the United States. The alarmists had good cause for renewing their cries, and, around the year 1800, a considerable literature sprung up on the subject of the threatened timber famine.

It is interesting to note that at that time the Catalpa played a role, at least on paper, as it does in our own day, being recommended as the only means of staving off the timber famine. A renewed *betulomania* spread widely over the country. In North Germany especially, great efforts were made to replant the denuded areas and to change the coppice areas, fit only for firewood, to coniferous species, pine, etc., by which eventually a great change in the forest type from the original mixed forest to the pure forest was effected.

3. *Personnel*

The great change which led to improved conditions, during the first half of the century, was pre-eminently due to the knowledge and intelligence of a group of men, six in number, competent foresters, who combined the high grade education of the Cameralists with the practitioners' knowledge: Hartig, Cotta, Hundeshagen, Koenig, Pfeil and Heyer. These men built, to be sure, on the shoulders of their precursors of the century in which they were born, but, being placed in authoritative positions, found better opportunities for putting their teachings into practice.

The first two mentioned were older than the rest, and are usually described as the "fathers of modern forestry." Born about a year apart, both educated at universities, they excelled in both scientific and practical directions.

Georg Ludwig Hartig (1764-1837), studied at the University of Giessen and, after having served in various functions in various parts of Southern Germany, became, in 1811, head of the Prussian forest administration. He was equally eminent as a practical man and organizer, as a writer, and as a teacher. In literary direction his work lay not so much in developing new ideas as in formulating clearly the known ones, as evidenced in his celebrated "General Rules" in silviculture.

Not less than thirty separate publications attest his assiduity. Among them stands pre-eminent "*Anweisung zur Holzzucht für Foerster*" (1791; 8th edition, 1818). As a teacher he began his work by establishing a masterschool (1789-1791) at Hungen, transferred to Stuttgart in 1807; and afterwards, as head of the Prussian forest administration, he lectured at the University of Berlin, continuing his lectures there, even after the forestry school at Eberswalde had been established, until his death.

He may be considered as having established on a firm basis the forest administration of Prussia; and many of the things he instituted still prevail. In organizing the service, he introduced fixed salaries, he relieved the foresters from financial responsibilities, transferring all handling of money to a separate set of officials, whereby the temptation to fraudulent practice of graft was removed, and he issued instructions for the different grades of foresters; and every part of this work was all his own. In regulating the forest area of the state he developed the volume allotment method, which, however, proved too cumbersome to be readily applied to large areas. Toward the end of his life, his work was not entirely successful, and he lost prestige in his later years.

Heinrich von Cotta (1763-1844) studied at the University of Jena, and afterwards practiced in Thuringia, where he established a master school at Zillbach (1795). In 1811, he was called to Saxony, as director of forest surveys, whither he also transferred his school, at Tharandt, which in 1816 was made a state institution and is still flourishing. In that year he was made the director of the Bureau of Forest Management. Like Hartig, he was eminent in the three directions of practical, literary, and educational work, but he excelled Hartig in originality, developing new principles and thought. Being a good plant-physiologist and observer of nature, he developed new ideas in silviculture, especially with reference to methods of thinning, and his "*Anweisung zum Waldbau*," written in the simplest, clearest and most forceful manner, forms a classic worthy of study to this day. In the field of forest

management he became the inventor of the area allotment method and the originator of the highly developed Saxon forest management. As a teacher he excelled in clearness, exposition, wealth of ideas and geniality.

Of an entirely different stamp was the third of the great masters, *Johann Christian Hundeshagen* (1783-1834), who having studied in Heidelberg, became after some years of practice, professor of forestry at Tuebingen, in 1817, and at Giessen, 1825. He was a representative of the theoretical or philosophical side of forestry, being highly cultivated and imbued with the spirit of science. His bent was to systematize the knowledge in existence and extend it by means of exact experiments. In forest organization, he invented the well known formula method or "rational method" of regulating felling budgets and became also one of the founders of Forest Statics (1826) which he called "the doctrine of measuring forestal forces," being thus the forerunner of modern scientific forestry.

The fourth of the group, *Gottlob König* (1776-1849), was a practitioner without a university education, who had enjoyed the teaching and influence of Cotta whom he succeeded in Eisenach as the head of the ducal forest administration. He also founded here a private forest school, which, in 1830, became a state institution, and is still in existence. König became noted by his contributions to the scientific, especially the mathematical side of forestry, developing forest mensuration and statics. In this latter branch he was the forerunner of Pressler and of the modern school of finance. In his "*Anleitung zur Holztaxation*" (1813) he gives a complete account of forest mensuration and in the part devoted to forest valuation he develops the first soil rent formula and the methods of determining the cost value of stands. His "Forest Mathematics" (1835) in which he introduces factors of form and many other new ideas was an original contribution to science.

Very different in character from these four leaders was the aggressive, sharp-witted *Friedrich Wilhelm Leopold Pfeil* (1783-1859), who, without a university education, and in spite of his poor knowledge of mathematics and natural history, advanced himself by native wit and genius. After a brief period of employment in private service, in the province of Silesia, he accepted the position of professor of forestry at the Berlin University, in 1821, in connection with Hartig, with whom, however, he was at sword's point. It was at his instigation, with the assistance of von Humboldt, that the school was transferred, in 1830, to Eberswalde, Pfeil becoming its director.

While Hartig was a generalizer, Pfeil was an individualizer, free from dogma, and most suggestive; a free lance and a fighter. Critical in the extreme and prolific in his literary work, he domineered the forestry literature of the day by means of his *Kritische Blaetter*, a journal of much import and merit.

The youngest of the group, *Karl Heyer* (1797-1856), a thoroughly educated man, combined the professorial position in the University of Giessen (1835) with practical management of a forest district, but in 1834 abandoned the latter in order to devote himself entirely to literary work. He was one of the clearest and most systematic expounders, and both his *Waldbau* (silviculture, 1854) and his *Waldertragsregelung* (forest organization, 1841) are classics. The last, fifth edition of the Waldbau, appearing in 1906 in two volumes, has been brought up to date by Professor Hess. He devised one of the most rational methods of forest organization, and, imbued with the necessity of basing forest management on exact scientific inquiry, instead of on empiricism alone, he formulated instructions for forest static investigations, a subject which his son, Gustav Heyer, elaborated into a science.

4. *Progress in Silviculture*

Natural regeneration continued to be the favorite method well into this period, and, for a long time, selection forest and coppice were all that was known in practice until Hartig and Cotta forced recognition of the shelterwood system.

The only way in which a transition from the generally practiced, unregulated selection forest to an intensive management was possible, with the ignorant personnel of underforesters, was to

formulate into an easily intelligible prescription the necessary rules, allowing the least play to individual judgment. This was done by Hartig when he formulated his eight "General Rules" (1808) which coincided also closely with the teachings of Cotta. Since these rules represent in brief and most definitely the status of silvicultural knowledge on natural regeneration at the time, it may be desirable to translate them *verbatim*.

(1) "Every forest tree which is expected to propagate itself by natural regeneration must be old enough to bear good seed.

(2) "Every district or stand which is to be replaced by a thoroughly perfect stand by means of natural regeneration, must be brought into such position (density) that the soil may everywhere receive sufficient seeding.

(3) "Each compartment must be kept in such condition (density) that it cannot, before the seeding takes place, grow up to grass and weeds.

(4) "With species whose seed loses its power of germination through frost, as is the case with the oak and beech, the compartments must be given such a position (density) that the foliage which after the fall of seed covers and protects the same cannot be carried away by wind.

(5) "All stands must be given such density that the germinating plants in the same, as long as they are still tender, find sufficient protection from their mother trees against heat of the sun and against cold.

(6) "So soon as the young stand resulting from natural regeneration does not any longer require this motherly protection, it must gradually, through the careful removal of the mother trees, be accustomed to the weather, and finally must be entirely brought into the open position.

(7) "All the young growths, whether secured by natural or artificial seeding, must be freed from the accompanying less useful species and from weeds, if these in spite of all precaution threaten the better kinds.

(8) "From every young forest until it is full grown, the suppressed wood must be removed from time to time, so that the trees which are ahead or dominate may grow the better; the upper perfect crown cover, however, must not be interrupted until it is the intention to grow a new forest again in the place of the old one."

Since these rules are applicable only in beech forests, much mischief and misconception resulted from their generalization; pure, even-aged high forests became the ideal, and the mixed forest, which was originally the most widespread condition, vanished to a large extent. This was especially unfortunate in Northern and Northeastern pine forests.

A reaction against Hartig's generalization began about 1830, under the lead of Pfeil. He had at first agreed with Hartig, and then with equal narrowness advocated for many years a clear cutting system with artificial reforestation. Finally, however, he was not afraid to acknowledge that his early generalizations in this respect were a mistake, and that different conditions required different treatment.

In the development of the shelterwood system there was at first, under the lead of Hartig, a tendency to open up rather sharply, taking out about three-fourths of the existing stand, but gradually he became convinced that this was too much, and finally reduced the first removal to only about one-third of the stand. This was the origin of his nickname of *Dunkelman*. In spite of the fact that it was claimed that Cotta took the opposite view (for which he was called *Lichtman*), he, too, grew to favor a dark position, and, as he progressed, leaned more and more towards more careful opening up. Hartig originally recognized only three different fellings: the cutting for seed; the cutting for light; and the removal cutting. By and by, a second cut was made during the seed year, and the number of fellings to secure gradual removal were increased, so that, by 1801, this system seems to have been pretty nearly perfected to its modern conditions. The best exposition of this *Femelschlagbetrieb* (shelterwood system), as then developed, is to be found in Karl Heyer's Handbook, 1854.

The method was unfortunately extended by Burgsdorf (1787) to the Northern pineries with a seventy year period of rotation. Within ten years, however, he recognized its inappropriateness, and modified it by instructions to leave only six to twelve seed trees per acre. His successor, Kropff, reduced the number of seed trees to four or five, which were to be removed within two or three years. In spite of the development of this more rational method, the practitioners under Hartig's approval, held mainly to a dark position even for pine, much in the manner of a selection forest, which produced a poor growth of oppressed seedlings, retarding for a long time the development of the pineries.

In spruce or fir, either a pure selection forest or a strip system was employed. Attempts at a shelterwood system were made, but experience with the wind danger soon taught the lesson that this was not a proper method with shallow-rooted species. Even Hartig preferred for spruce clearing and planting, and this is still the most favored method with that species. For the deep-rooted and shade-enduring fir the shelterwood method with a long regeneration period was thoroughly established in the Black Forest, and in Württemberg by 1818.

Natural regeneration being the main method of reproduction until the beginning of the 19th century, *artificial* means, as is evident from the forest ordinances of Prussia and Bavaria (1812 and 1814), were usually applied only to repair fail-places, or to plant up wastes. In this artificial reforestation, with the exception of the planting of oak in pastures, sowing was almost entirely resorted to because it could be done cheaper and easier, but as the sowings were mostly made on unprepared soil and with very large amounts of seed (30 to 60 pounds per acre, now only 7 to 10 pounds), the results were not satisfactory, either because the seed did not find favorable conditions for germinating, or when germinated the stand was too dense.

Planting, if done at all, was done only with wildlings dug from the woods, and usually, following the practice of the planting of oak in pastures, with saplings: the plant material was too large for success. Nurseries, except for oak, were not known, even to Cotta in 1817; and Heyer, having to plant up several thousand acres, still relied on wildlings, two to three years old, which he took up with a ball of earth by means of his "hole spade," a circular spade re-invented by him and much praised by others. Hartig, in 1833, still advised the use of four to five year old pine wildlings, root-pruned, but, eventually, having met with poor success, for which he was much discredited, came to the conclusion that un-pruned two-year-old plants were preferable.

The credit of having radically changed these practices belongs to Pfeil, who, entirely reversing his position, advocated for pine forest a system of clearing followed by sowing, or by planting of wildlings with a ball of earth. Then, suggesting that possibly planting without this precaution could be attempted, and pointing out the necessity of securing a satisfactory root system, he recommended, about 1830, the use of one-year-old seedlings grown in carefully prepared seed beds. While for securing these, he relied upon the simple preparation of the soil by spading, *Biermans* added the use of a fertilizer in the shape of the ashes of burned sod. The method of growing pine seedlings and planting them when one to three years old was further developed by *Butlar* (1845), who introduced the practice of dense sowing in the seed beds. He also invented an ingenious planting iron or dibble, a half cone of iron, which was thrown by the planter with great precision, first to make a hole and then to close it. This was improved by the addition of a long handle into the superior, well-known and much used *Wartenberg* planting dibble. At the same time (1840), *Manteuffel* devised the method known by his name of planting in mounds, which is especially applicable on wet soils.

It was not until 1840 that transplanting of yearling pines with naked roots became general. The widespread application of this latter system resulted in abandoning to a large extent mixed growth, and led to the establishment of pure pine forests, introducing thereby most intensively all the dangers incident to a clearing system and pure forest which are avoided by the mixed forest, namely, insects, frost and drought.

A practice of planting spruce in bunches, originally twelve to twenty plants in a bunch, had been in existence since 1780. This practice increased until 1850, and is still in use in the Harz mountains

and in eastern Prussia, although the bunches have been reduced so as to contain only from three to five plants, the object of the bunching being to make sure that one or the other of the plants should live. Much discussion as to the merits of this method took place between the old masters, Cotta favoring the small bunches upon the basis of a successful plantation of his own, Hartig and Pfeil opposing it, but finally weakening. Since 1850, however, the practice of setting out single plants has become more general.

A reaction from the indiscriminate application of the shelterwood method to the hardwoods and of the clearing method to the pine set in during the last quarter of the 19th century under the lead of Burkhardt and Gayer. These advocated return to mixed forest and to natural regeneration with long periods, approaching a selection forest. Gayer especially, professor of silviculture at Munich, became the foremost apostle of this school. Yet even to this day, the principles of silvicultural treatment under the many different conditions remain unsettled. On the whole however, with the financial question assiduously brought forward, the clearing system has made most progress, and the selection system has nearly vanished, being replaced by the group method and the shelterwood system.

A number of special forms of silvicultural management applicable under special conditions have been locally developed, without, however, gaining much ground and being mainly of historical value. Among these may be mentioned *Seebach's Modified Beech Forest*, which consists in opening up a beech stand so as to secure regeneration, merely to form a soil cover, leaving enough of the old stand on the ground to close up in thirty or forty years. By this treatment the large increment due to open position is secured without endangering the soil. Similarly the *Storied* or *Two-aged High forest*, was applied to the management of oak forest in mixture with beech. In a few localities also, on limited areas, a combination of forest and farming (*Waldfeldbau*) has been continued and elaborated, besides the more general use of coppice and coppice with standards.

According to the statistics for 1900 the following distribution of the acreage under different silvicultural methods prevailed throughout the empire:

	Deciduous Per cent.	Coniferous Per cent.
Total Forest	32.5	67.5
High Forest	18.4	60.1
Selection Forest	2.3	7.4
Coppice	6.8	—
Coppice with standards	5.	—

Coniferous forest, of which 68 % is pine and 30 % spruce, prevails in Eastern and Middle Germany, deciduous forest, of which 20 % is oak, the balance principally beech, in the West and South.

Coppice and coppice with standards are mostly in private hands as well as the coniferous selection forest, the State forests being almost entirely high forest, i.e., seed forest, other than under selection method.

Methods of Improving the Crop. The credit of having first systematically formulated the practice of thinnings under the name of *Durchforstung* (for the first thinning), *Durchplenterung* (for the later thinnings), belongs to Hartig, although the practice of such thinnings had been known and applied here and there before his time. He confined himself mainly to the removal of the undesirable species, dead and dying, suppressed and damaged trees, being especially emphatic in his advice not to interrupt the crown cover. Excepting the early weeding or improvement cuttings, these thinnings were not to begin until the fiftieth to seventieth year in the broadleaved forest, but in conifers in the twentieth to thirtieth year.

The first attempt to explain on a biological basis the process and effect of thinning was made by Späth in a special contribution (1802). Cotta, in his Silviculture, although at first agreeing with Hartig, later in his third edition (1821) changes his mind, and improves both upon the biological explanation

of Späth and the practice of Hartig, pointing out that the latter came too late with his assistance, that the struggle between the individuals should be anticipated, and the thinning repeated as soon as the branches begin to die; but he also recognizes the practical difficulty of the application of this cultural measure on account of the expense. Curiously enough, he recommends severer thinnings for fuel-wood production than for timber forests.

Pfeil accentuates the necessity of treating different sites and species differently in the practice of thinnings. Hundeshagen accentuates the financial result and the fact that the culmination of the average yield is secured earlier by frequent thinnings. Heyer formulates the "golden rule:" "Early, often, moderate," but insists that first thinning should not be made until the cost of the operation can be covered by the sale of the material. Propositions to base the philosophy and the results of thinning on experimental grounds rather than on mere opinion were made as early as 1825 to 1828, and again from 1839 to 1846, at various meetings of forestry associations, until, in 1860, Brunswick and Saxony inaugurated the first more extensive experiments in thinnings. The two representatives of forest finance, Koenig and Pressler, pointed out, in 1842 to 1859, the great significance of thinnings in a finance management as one of the most important silvicultural operations for securing the highest yield.

In spite of the advanced development of the theory of thinning, the practice has largely lagged behind, because of the impracticability of introducing intensive management. Only lately, owing to improvement in prices and the possibility of marketing the inferior material profitably enough to justify the expenditure, has it become possible to secure more generally the advantages of the cultural effect. Within the last thirty or forty years, great activity has been developed among the experiment stations in securing a true basis for the practice of thinning.

New ideas were introduced through French influence and by others independently in the latter part of the eighties, when the distinction between the final harvest crop (Fr. élite, le haut) and the nurse crop (le bas) was introduced.[4]

The physiological reasons for the practice of thinning upon experimental basis, were advanced by the botanists Goeppert and R. Hartig, and among foresters, the names of Kraft, Lorey, Haug, Borggreve, Wagener, and others are intimately connected with the very active discussion of the subject lately going on in the magazines. Thinnings have become such an important part of the income of forest administrations (25 to 40 % of the total yield) that the prominence given to the subject is well justified, and a more modern conception of the advantages of thinnings and especially of severer thinnings is gaining ground.

The proposition, now much ventilated, of severe opening up near the end of the rotation, in order to secure an accelerated increment (*Lichtungshiebe*) is, however, much older; Hossfeld, in 1824, and Jäger in 1850, advocated this measure for financial reasons, while Koenig and Pressler anticipated the development of an individual tree management by pruning, and differentiation of final harvest and nurse crop, a method which is working itself out at the present time.

5. *Methods of Forest Organization*

As stated before, to Hartig and Cotta belongs the credit of having applied systematically on a large scale methods of forest organization for sustained yield; Hartig having been active in Prussia since 1811, and Cotta beginning to organize the Saxon forests in the same year. The method employed by Hartig, the so-called volume allotment, had been already formulated and its foundation laid by Kregting and others (although Hartig seems to have claimed the invention). But it was reserved to Hartig to build up this method in its detail, and to formulate clearly and precisely its application, as

[4] The conception of such subdivision and the English nomenclature was independently first employed by the writer in his Report for 1887, as Chief of Forestry Division, when discussing planting plans for the prairies.

well as to improve the practice of forest survey, calculation of increment, and the making of yield tables. His method involved a survey, a subdivision, a construction of yield tables and the formulation of working plans, in which the principle according to which the forest was to be managed during the whole rotation was laid down for each district. The rotation was determined, divided into periods, finally of twenty years, and the periodic volume yield represented by all stands was distributed through all the periods of the rotation in such a manner as to make the periodic felling budgets approximately equal; or, since the tendency to increased wood consumption was recognized, an increase of the felling budget toward the end of the rotation was considered desirable.

Cotta based his system of forest organization upon a method described by a Bavarian, Schilcher (1796); it relied primarily upon area rather than volume division. This method was later on (1817), called by him *Flaechenfachwerk* (area allotment). It divides the rotation into periods and allots areas for each periodic felling budget. But before this time, in 1804, Cotta had himself formulated a method of his own, which combined the area and volume method, the volume being the main basis and the area being merely used as a check. While Hartig dogmatically and persistently carried out his difficult scheme, Cotta was open-minded enough to improve his method of regulation, and by 1820, in his *Anweisung zur Forst-Einrichtung und – Abschaetzung*, he comes to his final position of basing the sustained yield entirely on the area allotment, using the estimate of volume simply to secure an approximately uniform felling budget. He laid particular stress on orderly procedure in the subdivision and progress of the fellings. He did not prepare an elaborate working plan binding for the entire rotation, but merely prescribed the principles of the general management, and, after 1816, he confined the formulating of felling and planting plans only to the next decade.

A similar method, making a closer combination of volume and area allotment, now known as the combined allotment, in which the area forms the main basis for distributing the felling budgets, was prescribed by Klipstein in 1833. This, also, confines the working plan to the first period of the rotation and for this period alone makes a rather careful statement of the expected volume budget; a new budget is then to be determined at the beginning of the next period. This idea of confining the budget determination to a comparatively short period is now generally accepted, the future receiving only summary consideration.

These methods of organization were the ones generally applied in practice, and are still with some modifications in practical use. About 1820, however, new theories were advanced which led to the formulation of methods based upon the idea of the *normal forest*. The conception of a normal forest, with a normal stock, distributed in normal age classes, so as to insure a sustained yield management, was evolved, in 1788, by an obscure anonymous official in the Tax-collector's office of Austria, designed for assessing woods managed for sustained yield. This fertile idea, which is still the basis of forest organization in Austria, and explains better than any other method the principles involved in forest organization, did not find entrance into forestry literature in all its detail until 1811 when André compared this so-called *Cameraltaxe* with Hartig's method of regulation. We find, however, that, simultaneously with the Austrian invention of this method, Paulsen (1787) proposed to determine the felling budget as a relation between normal stock and normal yield, and in his yield tables (the first of the kind, 1795), he gives the proportion of increment to normal stock in percentic relation, so that the felling budget may be either expressed as a fraction of the stock or as a per cent.; in beech forests, for instance, he determines the felling budget as 3.3 % on best sites, 2.5 % on medium, and 1.8 % on poor sites.

Probably stimulated by André's description, *Huber* (1812) developed a method and formula which may be considered the foundation of the later development by Carl Heyer

$$\left(\text{Felling budget} = I + \frac{Sa - Sn}{e}\right).$$

Based upon the normal forest idea, a number of methods were elaborated which, because of their employing a mathematical formula for the determination of the felling budget, are known as *formula methods*; they are, indeed modified rational volume divisions.

Hundeshagen has the merit of having first clearly explained the basis of these methods, and himself developed a formula, of the correctness of which he was so convinced as to designate his method as "the rational" one. Two other formulæ were brought into the world by Koenig (1838-1851), but the credit of the most complete elaboration both of the principles of the normal forest idea and of its practical application belongs to Carl Heyer. The principles of his method are briefly: First determine upon the period of regulation during which the abnormal forest is to be brought nearer to normal conditions; the length of this period to be determined with due regard to the financial requirements or ability of the owner and to the conditions of the forest. The actual stock on hand is then determined and the total increment, based on the average increment at felling age of each stand, which will take place during this period, is added. Deducting from this total what has been calculated as the proper normal stock requisite for a sustained yield management, the balance is available for felling budgets which may be utilized in annual or periodic instalments during the period of regulation. A working plan is provided which takes care of securing an orderly progress of fellings and proper location of age classes, to be revised every ten years.

Although this is undoubtedly the most rational method yet devised, it has remained largely unused, and is found in somewhat modified application only in Austria and Baden.

An entirely new principle in the theory of forest organization was introduced, when the aim of forest management was formulated to be the highest soil rent. According to this requirement the proper harvest time of any stand, or even of any tree, was to be determined by the so-called index per cent., that is, a calculation which determines whether a stand or a tree is still producing at a proper predetermined rate, or is declining. The advocates of this principle were especially *Pressler* (professor of mathematics at Tharandt, 1840 to 1843) and *G. Heyer*, son of Carl Heyer, who based his method on his father's formula, merely introducing values for volumes. *Judeich*, director of the Tharandt school, also developed in the sixties a method, based upon financial theory, which is to attain the highest rate per cent. on the capital invested in forest production. On the basis of survey and subdivision of working blocks composing a felling series, and with a rotation determined by financial calculations with interest accounts, he makes a periodic area division for determining the felling budget in general, and in addition employs the index per cent., as explained, for determining in each allotted stand the more exact time for its harvest.

While these men pleaded for a strict finance calculation, such as is properly applied to any business making financial results the main issue, the defenders of the old regime, which sought the object of forest management mainly in highest material or value production, advanced as their financial program the attainment of the highest forest rent as opposed to the highest soil rent. They neglected and derided the complicated interest calculations which have to take into consideration uncertain future developments, and were satisfied with producing a satisfactory balance, a surplus of income over expenses, no matter what interest rate on the capital involved in soil and forest growth that might represent.

At the present time these financial propositions are still mainly under heated discussion.

In actual practice, the various state forest administrations, with the exception of the Saxon one, continue to rely upon the older methods in regulating the management of their forest properties without reference to financial theories. This is largely due to momentum of the practical existence and application of these methods in earlier times and the difficulty and impracticability of a change. Just now, however, several of the State administrations are preparing to radically revise their working plans.

In Prussia, the instructions for working plans of 1819 formulated by Hartig were improved upon by his successor, Oberlandforstmeister *von Reuss* (1836), and these instructions formed the basis of

the work of forest regulation until the end of the 19th century. It is a periodic area allotment with only a summary check by volume. The working plan is only to secure a rational location and gradation of age classes; the calculations of yields and specific rules of management are lately confined to the first period and are revised every six years.

In Saxony, Cotta's area method was systematically developed, and, as the larger part of Saxon forests is coniferous, mainly spruce, the proper location of age classes forms a special consideration for the progress of fellings. The determination of volume and increment was left to summary estimates, and the area division became entirely superior. The original idea of Cotta that orderly procedure in the management is of more importance than the actual determination and equalization of yield still pervades the Saxon practice. Since 1860, an attempt has been made to calculate the rotation and determine the felling budget on the principle of the soil rent, at least as a corrective of the annual budget, and in general to lean towards Judeich's stand management.

In Bavaria, after various changes, a complete allotment method of area and volume had come into vogue, in 1819; but, at the present writing (1911) an entirely new and modern re-organization has been begun, in which most modern ideas and especially much freedom of movement, even to deviation from the principle of sustained yield, is allowed.

In Württemberg, where, in 1818 to 1822, a pure volume allotment had been introduced, in 1862 to 1863 the combined allotment method was begun, the felling budget being determined in a general way for the next two or three periods, and more precisely for the first decade, without attempting more than approximate equality.

In 1898, new instructions were issued, which abandon the allotment method and restrict the yield regulation to designating felling areas for the first period.

In Baden, where the forest organization began in 1836 upon the basis of volume allotment, a change was made in 1849 to an area allotment, simplifying to a greater extent than anywhere else the calculation of the yield; finally, Heyer's method was adopted entirely in 1869.

It appears then that the schematic allotment methods found the most general application in the earlier time of the period, being favored probably on account of their simplicity in application. The improvement in their present application over the original methods as designed by Hartig and Cotta, is that now they require no volume calculation for any long future, but are satisfied with making a sufficiently accurate calculation and provision for the proper felling budget for the present.

6. *Forest Administration*

About the middle of the 18th century the recognition of the importance of forestry led to a severance of the forest and hunting interests, and it became the practice to place the direction of the former into the hands of some more or less competent man – a state forester – usually under the fiscal branch or treasury department of the general administration. Fully organized forest administrations, in the modern sense, however, could hardly be said to have existed before the end of the Napoleonic wars (1815) which had undoubtedly retarded the peaceful development of this as well as of other reforms.

The present organization of the large Prussian forest department in its present form dates from 1820, when Hartig instituted the division into provincial administrations, and differentiated them into directive, inspection and executive services. The direction of the provincial management was placed in the hands of an Oberforstmeister, with the assistance of a number of Forstmeister, who acted mainly as inspectors, each having his inspection district consisting of a number of ranges. The ranges (100,000 to 125,000 acres) were placed in charge of Oberförster or Revierförster, who with the assistance of several underforesters (Förster) conducted the practical work. At first only indifferently educated, these latter were allowed little latitude, but with improvement in their education they became by degrees more and more independent agents.

This tri-partite system of directing, inspecting and executive officers, after various changes in titles and functions, finally became practically established in all the larger German states; in some rather lately, as for instance, in Bavaria, not until 1885, and in Württemberg in 1887.

With this more stable organization, the character and the status of the personnel changed greatly: the prior right of the nobility to the higher positions, which had lasted in some States until 1848, and the practice of making connection with military service a basis for appointment were abolished, and, instead of Cameralists, educated foresters came everywhere to the head of affairs. The lower service, which had been recruited from hunters and lackeys, and which was noted for its low social, moral and pecuniary status, was improved in all directions. The change from incidentals in the way of fees, and natural instead of money emolument for the lower grade foresters, (which had been the rule, and still play a role even to date), to definite salaries, and the salutary change of methods in transacting business, which Hartig introduced, became general. With the development and improvement of forestry schools, the requirement of a higher technical education for positions in State service could be enforced. Yet only within the last twenty-five or thirty years, has the ranking position of forest officers been made adequate and equalized with that of other public officials of equal responsibility, and still later have their salaries been made adequate to modern requirement.

The central administration now lies in the hands of technical men (*Oberlandforstmeister*

Конец ознакомительного фрагмента.